Base document.

Transverse Perspective D.

Science, Technology and Knowledge Application

This document was prepared by the Mexican Water Technology Institute with the contribution of the Internacional Water Association

1 The role and importance of science, technology and knowledge

There is nothing more fundamental for life than water. Through time the use of water has evolved with society in the framework of different conceptions about the purpose and progress models. Current development problems are linked simultaneously to environmental objectives and the aspiration of eradicating poverty situations which are present in many countries. This is how the concept of sustainable development is presented, which is associated to the management of national resources and the orientation of technological and institutional change, including the adaptation of law frameworks, in such a way that it ensures the on-going satisfaction of human needs with due environment care.

To move forward to a sustainable development, decision makers at any government level will need to make informed selections among options which are frequently in conflict and uncertain. These decisions can be made in the best way possible if science, technology and knowledge benefits are profited from.

BOX 1. PEDAL PUMPS IN ASIA.

Pedal pumps, simple technology enabled by human beings, are an example of a nation technology that has made irrigation available for millions of small and marginal farmers. They have been successful particularly in Bangladesh, but they are also used in India, Vietnam and Cambodia. In 1991, half a million of pedal pumps were used in Bangladesh. With an annual benefit per user estimated around USD 100, the 500 thousand pedal pumps represented one third of the total contribution of the agricultural sector to the country's gross domestic product (GDP).

Science, technology and knowledge fill almost every aspect of life. Recalling Alfred Marshall, a distinguished British economist of the 19th century, knowledge is our most powerful engine for production. This statement endures and currently we acknowledge that the long-term triggering force of modern economic growth has been the science-based technological advance[1]. Science, technology and knowledge contribute significantly to raise productivity and competition in the countries, but its contribution to development is much wider, it contributes to raise life quality, solve environmental problems and increase the efficiency of the State's administration. Talent and human knowledge are, of course, essential for the advance of science and innovation, as well as for generating productivity knowledge.

Development is a learning process which implies considerable experimentation. There are examples of developing countries which alleviated their poverty and grew their economies in recent decades, specially in the Asian-Pacific Region.

In each case, science, technology and knowledge were crucial factors in their success[2]. But, science, technology and knowledge have a cost. It is the product of important

[1] United Nations Millennium Project, Investing in Development, a Practical Plan to Attain the Millennium Development Goals, New York. 2005.

[2] UN Millennium Project, Innovation: Applying Knowledge in Development. Task Force on Science, Technology, and Innovation. 2005.

social investments in education, scientific research and technological progress focused specifically on strengthening innovation national systems[3]

The global panorama of science, technology and knowledge presents clear contrasts.

While high income countries make special public investments in higher education and scientific and technological capacity, most of poor countries have been spectators or users, at best, of technological advance produced in high income countries.

RECUADRO 2. BUG WATER IN ÁFRICA.

Imititating bug's hydraulic tricks, a group of British scientists has developed unique materials to collect water. A plastic laminate, inspired in the bug's back, provides an alternative for water collection for agriculture and consumption in arid regions. This alternative may also serve to improve destilation processes and dehumidification in devices such as air conditioners or others.

Poor countries do not have large scientific communities and their scientists suffer from a chronic lack of funding, therefore, most of the highly qualified ones go abroad searching for colleagues and support for their scientific research.

Another big difference is that while in developing countries science and technology are highly dependant from the State, which contributes with more than 60% of financing, in developed countries, the origin of the funds and more than two thirds of the execution of technological and scientific activities are in the hands of private companies.[4]

Patents are the best available indicators of innovation production. In this sense, there is significant correlation between the number of patents and the expense financed by the industry for research and development. Therefore, countries with a high industrial financing level for research and development are also those which have the largest amount of patents.[5]

Companies transform scientific and technological knowledge into goods and services, but the State plays an essential role in promoting science and technology application. In fact, it is the State which assumes an active role to: set major objectives and priorities; allocate public resources in science and technology; implement technological and scientific policy instruments and mechanisms; encourage regulations and profit from bidding processes to foster corporate innovation, invest in infrastructure that supports small and medium companies, offer fiscal incentives to private investment in science and technology; widen and establish research centers focused on specific needs that are top priority in the long term, such as water, agriculture or public health, among others, as well as to improve access to credit and other forms of capital.

At the same time, the State shall consider the effects which its decisions in other government activities may have related to scientific and technological development.

The presence of the State is also necessary to encourage creativity and innovation, broaden the source of scientific knowledge for the benefit of society, and support

[3] Ministry of Education, Culture, Sports, Science and Technology, White Paper on Science and Technology, Japanese Government. 2004.

[4] Organization for Economic Co-Operation and Development, STI, R&D financing and performance. Scoreboard, 2003.

[5] Organization for Economic Co-Operation and Development, Compendium of patent statistics. 2004.

research and development activities in areas where market mechanisms are not adequate or scarce to respond to social demands or to meet government specific objectives. Likewise, the incorporation of highly qualified personnel favors the creation of a critical mass, indispensable for an intelligent decision making.

To create capacity in science, technology and knowledge, it is necessary to broaden the access to higher education. Unfortunately, in several countries there is clear evidence of a decreasing interest of young people in math and natural sciences, as well as a decrease in the number of graduates in science and engineering. This has led to worries of an imminent or future lack of scientists and engineers.

BOX 3. AQUATIC PLANTS MAY ELIMINATE ARSENIC FROM WATER.

Aquatic lirium (*Eichhornia crassipes*) dry roots dust may remove high concentrations of toxic arsenic in contaminated water. After an hour of adding plant roots to the water, the arsenic level drop from 200 micrograms per liter to 10 micrograms per liter (limit accepted as safe). The research was performed in the United Kingdom and the technology is used in Bangladesh.

In countries where companies' investment is weak in science, technology and knowledge, the demand for scientific talent is restricted and limits the nation's capacity to profit from their investments in human capital, and it may even cause the migration of young researchers that are looking for an opportunity. Addressing this problem should be of paramount importance for governments.

Universities, on the other hand, should have a more entrepreneurial character and focused at solving the key development challenges. Universities may participate in technological parks and company formation services. They may introduce training and corporate trainee programs in their curricula; encourage students to bring the university research to companies. One of the most prestigious universities of the world, the MIT, has a long and successful tradition of encouraging the establishment of technology-based companies.

Universities should address the solution of science and technology issues in a more interdisciplinary way to have a wider perspective and be able to face the challenges presented by the immediate future. This statement is particularly pertinent regarding water. But, most of the universities should change in order to deal with these new functions.

Changes in development models, State presence, more regulating than producing, the importance of the private sector as an engine to innovation and society's relevant role, make mandatory the participation of all social stakeholders in CTC.

Since its adoption in the United Nation's Millennium Summit, in 2000. the Millennium Development Goals have become the international benchmark to measure and follow-up improvements in human conditions in developing countries. Attaining these goals demands a special global effort to create science, technology and knowledge capacity in the poorest countries, as well as to direct research and development towards specific challenges which the poor face.

Goal 8 of Millennium Goals refers to *Encouraging a global association for development,* and it covers Goals 12 to 18.[6] Particularly, regarding science,

[6] UN Millennium Project, Op. Cit.

technology and knowledge, Goal 18 entrusts the international community, along with the private sector, making the advantages of new technologies, specially information and communication available.

The major role of science, technology and knowledge in attaining these goals is acknowledged, but it is necessary that decision makers know the lessons learned locally in a global framework and participate in a continuous learning process. In this regard, the need of creating international associations which will enable shared training has been emphasized.

The reduction in the science, technology and knowledge gap will require deliberate measures to build scientific and technological capacities of poorer countries.

But, besides the orienting statements which have been expressed in different international fora, it is time to move from speech to action.

2 Change options

If science, technology and knowledge can effectively mark a significant change in a country's development, then, the current trend may not continue, where the only certainty is that differences among countries will broaden. This would damage, in general, development possibilities, and, particularly, it would hinder viability of a sustainable development of water resources in less developed countries.

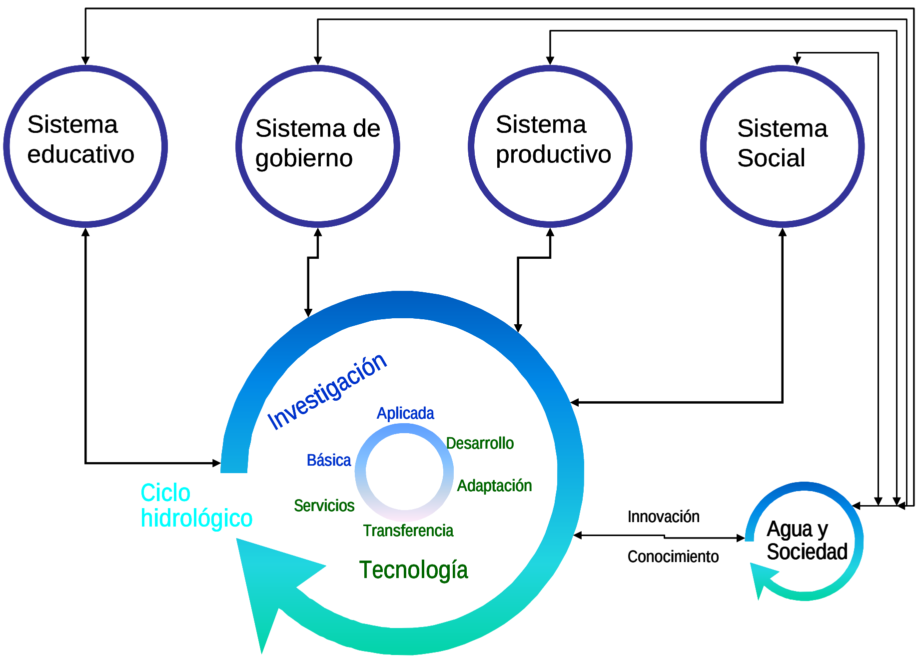
Regarding science, technology and knowledge and water, Illustration 1 presents a scheme in which main systems are presented -educational, government, productive and social- scientific and technology process stages, as well as the interaction of science, technology and knowledge, and water and society, where the links are innovation and knowledge.

If the options to strengthen science, technology and knowledge that have been used recently for promoting the desired change are analyzed, we can find the following four lines of action:

- Regional or inter-regional programs in science, technology and knowledge.
- National reforms in science, technology and knowledge
- International cooperation networks based on water.
- Creation of Excellence Water Research Centers.

The first two are of general character in science, technology and knowledge and the other two specifically refer to water. Additionally some examples are included, although there is no Global Directory which facilitates its location, at least, regarding water.

FIGURE 1. RELATION BETWEEN SCIENCE, TECHNOLOGY AND KNOWLEDGE, AND WATER AND SOCIETY



Sistema educativo	Educational system
Sistema de gobierno	Government system
Sistema productivo	Productive system
Sistema social	Social system
Ciclo hidrologico	Hydrological system
Investigación	Research
Aplicada	Applied
Desarrollo	Development
Adaptación	Adaptation
Transferencia	Transference
Tecnología	Technology
Servicios	Services
Básica	Basic
Innovacion	Innovation
Conocimiento	Knowledge
Agua y sociedad	Water and society

- Regional or inter.regional programs in CTC, examples of these programs are shown below

TABLE 1. EXAMPLES OF REGIONAL OR INTERREGIONAL PROGRAMS IN CTC.

Program	**Reference**
European Union	**European Union, Sixth EU Framework Programme for Research and Technological Development (FP6). En Internet: http://fp6.cordis.lu/index.cfm?fuseaction=UserSite.FP6HomeP**

	age
The Americas	**Organization of American States, First Ministerial and Top authorities Meeting in Science and Technology, Lima, Peru, November 11-12, 2004**
Africa	**NEPAD. The new partnership for Africa's development. October 2001.**
European Union and USA	**European Communities, An impact assessment of the science and technology agreement concluded between the European Community and the United States of America. 2003.**

- National reforms in CTC. Examples of these reforms are shown in the following table:

TABLE 2. EXAMPLES OF COUNTRIES IN WHICH NATIONAL REFORMS IN CTC ARE IMPLEMENTED

Country	**Reference**
People's Republic of China	**International Development Research Centre (Canada) and the State Science and Technology Commission (People's Republic of China), A decade of reform, Science and Technology Policy in China. IDRC 1997.**
Japan	**Ministry of Education, Culture, Sports, Science and Technology, White Paper on Science and Technology. Japanese Government. 2004.**
Brazil	**The World Bank, Brazil, Science and Technology Reform Support Project - PADCT III. Report No: 31601.**
Nigeria	**United Nations Education, Science and Cultural Organization, NIGERIA – UNESCO Collaboration on the Reform of Nigeria's science, technology and innovation system.**

- International cooperation networks based on water. Examples of these networks are included in the following table

TABLE 3. EXAMPLES OF INTERNATIONAL COOPERATION NETWORKS

International Cooperation Network	**Reference**
Global Coalition of Water and Sanitary Resources Centers (STREAMS)	**IRC International Water and Sanitation Centre, Work in progress Streams of Knowledge Coalition. October 2001.**
Inter-American Water Resources Network	**http://www.iwrn.net/index.php**
Réseau International des Organismes de Bassin	**http://www.riob.org/riobesp.htm**
The Global Water System Project-Asia	**http://www.chikyu.ac.jp/USE/GWSP/GWSPasia.htm**
International Water Management Institute-Africa and Asia	**http://www.iwmi.cgiar.org/**

- Creation of Excellence Water Research Centers. Examples of Excellence Centers are included in the following table:

TABLE 4. EXAMPLES OF EXCELLENCE CENTERS.

Excellence Centers	**Reference**
Bulgaria	**Gesture and sustainable development of Mar Negro Region Center (CESUM-BS) http://www.io-bas.bg/cesum-bs/**
Bolivia	**Andean Center for gesture and water use. http://www.centroagua.org/**
Chile	**Water Center for Arid and Semi-arid Zones of Latin America and the Caribbean http://www.cazalac.org/mision.html**
India	**The National Institute of Hydrology http://www.angelfire.com/bc/nihhrrc/Roorkee/**
Kenya	**African Centre for Technology Studies**

Excellence Centers	**Reference**
	http://www.acts.or.ke/index.html
Mexico	**Mexican National Autonomous University Engineering Institute http://www.iingen.unam.mx/default.aspx, Mexican Water Technology Institute http://www.imta.mx/ , Interamerican Center of Water Resources http://cira.uaemex.mx/presentacion/descripcion.html**
South Africa	**Water Research Commission http://www.wrc.org.za/index.htm**

Of the four options analyzed, national reforms in science, technology and knowledge seem the more advisable, and the creation or consolidation of excellence centers may substantially contribute to seed awareness of the great need of a change to place scientific and technological innovation in the core of the sustainable water development process.

RECUADRO 4. WATER DESALTING PLANTS IN EUROPE

The great leap from the expensive desalting plants in the seventies up to achieving an accesible price for a high added value agriculture, has been possible due to the drastic cost reduction of inverse osmosis. What had a cost of two and even 3 euros per cubic meter, has been reduced to 0.70 and 0.45 euros on plant site. At present and with more than 900 plants in exploitation, Spain is ranked four worlwide in desalting capacity just behind Saudi Arabia, United Arab Emirates and the USA, Spain is assembling in London the biggest desalting plant in Europe, for 150,000 cubic meters per day.

Regional or inter-regional programs in science, technology and knowledge and international cooperation networks also contribute to scientific and technological innovation and, in some cases, it is convenient to reinforce their diffusion channels in order to achieve a larger number of stakeholders in different subjects.

It is critical to understand that even though governments are the ones to promote change in science, technology and knowledge, the productive sector must assume the role of innovation engine.

Below is a summary of the role that may and must have science, technology and knowledge, in addressing water issues associated with each one of the themes of the IV World Water Forum. Likewise, some examples of successful local actions are included, around the world.

3 Theme 1: Water for growth and development

A constant priority for human beings throughout history has been profiting from all its potential by means of an adequate supply and reduction of its destructive effects, in such a way that it can trigger, rather than hinder, economic growth. The key to achieve this is to establish a minimum platform which allows creating a safe water infrastructure, as well as institutions and the capacity to operate and maintain it.[7]

BOX 5. NEW TECHNOLOGIES FOR WATER MANAGEMENT THE IRRIGATION ZONE OF ARAGON AND CATALUÑA CHANNEL

From the approximately 3,700,000 has os Spanish irrigation channels, 29% of them are are traditional and historical irrigation lands where the incorporation of new technology for water management is considered a necessary action for their sustainability. The CEDEX Hidrographic Studies Center has performed a pilot to incorporate new technologies for water management in the Aragon and Cataluña channel irrigation zone, which is 100 years old and has a surface of more than 98,000 hectares.

[7] Base document for the IV worls Water Forum Theme 1: Water for growth and development.

The zone's original hydraulic design was aimed mainly to winter cereal irrigation, with the objective of releaving the existent hunger of La Litera shire. Throughout its history, the initial statements have changed and the productive dedication has varied to growing alfalfa, corn, fruits and grapes, that have a higher commercial value but with a different water demands regarding its amount and distribution than those initially presented. This has caused water management in the region to have a great importance, since, even having the resources, it is difficult to meet the irrigation demand due to multiple reasons, such as the infrastructure capacity, its status and the irrigation methods used.

The Hydrographic Studies Center, as a support decision-making tool to water managers in the area has created a geographical information system where the irrigation zone is characterized. This is fed with satellite images to follow up the irrigated area and the productive dedication. With this information, a model has been created to leverage the available water resources distribution, in order to address the irrigation demands and a series of recommendations have been formulated, directed, mostly to improve demand management.

Below this *minimum platform*, society and economy are affected *unacceptably* by natural phenomena – by a combination of disasters and lack of trust in water supply for production of goods, services and survival means. Below this level, water hinders economic growth; above this level, water fosters growth in general.

The consequences of this statement have multiple implications. Below are some related to science, technology and knowledge.

The return of investment in water resources, particularly in countries with high water variability can be very low and standard tools for project economic analysis, such as margin rates of performance and payment capacity that governments and donors commonly apply, can be inappropriate to evaluate the initial critical investments, as well as their application may in fact hinder growth. This subject needs research.

Over the years, investment has been jointly made in institutions and infrastructure, but when the hydraulic infrastructure capacity is low; investment in this sector becomes a priority. On the other hand, investment in institutional development and strengthening of capacities becomes more important as a larger and more complex infrastructure is built. This suggests that, while developed countries are focused in the implementation of a comprehensive water resources management, developing countries should adopt a pragmatic administrative approach - based on principles while applying greater emphasis to concurrent investments in infrastructure. Administration and development should go hand in hand, but with a larger infrastructure to manage water, the establishing of solid institutions and better administrative practices becomes possible, necessary and cost-effective.

BOX 6. NATURAL UNDERGROUND WATER POLLUTION TREATMENT

Very often, pumped water of deep aquifers has minerals and metals. Such is the case of Mexico, where natural contamination of underground water has been observed, with iron, manganese and in some cases, arsenic. During the past years, the Mexican Water Technology Institute (IMTA) has been performing a research and development program to solve this issue.

Efforts have been directed to developing a low cost technology, easy to operate and efficient, which fulfills standards for drinking water as well as other uses. The IMTA patented a treatment process by slow filtering and it has been employed in the construction of several water treatment plants, among them, two with large design water-flows: Ramal Peñón Texcoco in the State of Mexico (630 L/s) and Mazatlán in the State of Sinaloa (1,500 L/s).

Recently, the IMTA designed a plant for mango plantation, which extracts underground water contaminated with iron and manganese in Mazatán, Chiapas. The plantation has a production capacity of one million boxes for export in each agricultural station. Untreated water used to wash mangoes caused stains on their skin. This situation caused the rejection of the product in the USA market, which is the most important place for the farm's exports, where 300 persons work. Because Mazatán is a small community, the welfare of the plantation and its employees is critical for the local economy's development. Each worker receives 150 dollars per week, which is a very attractive wage for the region. The plantation also considers to extend its operation, all these economic advantages were compromised by the effect that iron and manganese had on the fruit skin. The plant designed by IMTA has solved the problem at low cost and the owners of plantations are very satisfied with the results.

In an ever more global world, there are pressures on the institutions of developing countries to adopt developed countries' values. Notwithstanding, the latter do not appreciate the urgent and often colossal challenges that developing countries face.

On the other hand, developing countries do not appreciate how much will their values change with growth and therefore, do not include these considerations in their development plans.

The essential point is that water infrastructure is characterized by its longevity and its high impact on environments and societies where it is built. Virtually in all developing countries water, food and energy demand is still growing and there is no doubt regarding the need of a water infrastructure.

The following questions where science, technology and knowledge must help in finding the answers are stated, among others:

May options be selected and designed to adapt to changes in values and priorities?

May ideas be taken from lessons learned by developed countries that may help to design and operate a different infrastructure or alternatives for an infrastructure as a whole that enables achieving water security but that are less damaging for society and the environment?

How important is the role of water in growth – positive and negative – and which are the key water features (lack, excess, seasonality, variability)?

Is the water infrastructure of a country *safe or unsafe?*

What is the investment scale in water infrastructure?

Which is the social and political investment in institutions for water management?

Which is the appropriate balance between institution and infrastructure development?

Which would be the current and future key issues for the use of water resources and growth?

Regarding the last question, some answers are also required connected to adaptation methods required by societies facing the threat of climatic change.

4 Theme 2: Implementation of a Comprehensive Water Resources Management

In examining the current approach to water, many countries have found:

- That they have not been considering a sufficient allocation from a strategic point of view, in the light of national goals.
- That water allocation, although left at the lowest appropriate level, requires to be guided by a system that has been devised at fluvial or national basin level, and
- That links between allocation decisions and national development and the economic planning process are weak or non-existent.

Ann approach of the Comprehensive Water Resources Management (CWRM) gives countries the freedom to consider the allocation in a context of a *more complete* *environment* of sustainable development goals. Rarely is strategic allocation achieved through an administrative order[8]

BOX 7. OPTIMAL ASSIGNMENT OF WATER IN THE LERMA-CHAPALA RIVER BASIN.

The Lerma-Chapala basin is one of the most important in Mexico. The main current is the Lerma river which discharges into Chapala lake - the biggest surface water body in the country. The basin has experienced a large number of issues related to water, for example: i) excessive superficial water extractions for agriculture, which has produced an alarming decrease in water levels in the lake during dry periods; ii) over-exploiting of the aquiferous which has produced a significant decrease in aquiferous level; agricultural practice and tree cutting, which has eroded earth and non-specific water contamination, as well as municipal and industrial waste waters which do not fulfill environmental standards, that have contributed to the increase of river and lake pollution. The basin includes territories of five states in the country: State of Mexico, Querétaro, Guanajuato, Michoacán and Jalisco.

Most of irrigated agricultural areas are located in Guanajuato, where farmers have opposed to any attempt to diminish water allocation which the National Water Commission (CNA) granted them. On the other hand, in Jalisco, located in the basin's lower part, there is some concern for the lake's preservation, both due to environmental reasons, and because it represents the main water source for its capital, the city of Guadalajara, which is the second largest in Mexico. Opposite positions have caused an intense conflict between Guanajuato and Jalisco, the water allocation scheme which prevailed did not work adequately, particularly in low rain years. Negotiations to modify such scheme were stopped due to the existing conflict. The Mexican Water Technology Institute developed the detailed water simulation of the basin and optimization models for allocation, which allows CNA and those interested in the basin to build an awarness once several weather, water use and socio- economic scenarios were studied with the scientific and technological tools developed by IMTA.

As a result, a new agreement for the allocation of sustainable use of water was signed by the governors of five states in the basin, water users and the President of Mexico, as a witness of honor. The agreement is operational now and includes an explicit reference to simulation models and optimization as tools to support decisions. Science and technology proved to be important to achieve a trust environment among stakeholders in the basin, as well as to include the principles of the comprehensive water resources management in the basin.

Usually, this is achieved indirectly—often by means of the results in water optimization– by using tools as water price and tariffs, by introducing adequate incentives and subsidies and eliminating those which are considered as damaging, both in and out of water sector.

To achieve an effective use of the wide range of *indirect* reallocation tools, analysis systems are required that science, technology and knowledge may provide. Another form of leveraging the economic and social welfare which is derived from these resources is an improvement in water use optimization and related resources, including financial resources – an integral part of the CWRM approach.

Before simply providing more water- which often implies the construction of new and expensive infrastructure – the first step should be to search opportunities to improve its exploitation.

It is important to acknowledge that science, technology and knowledge provide a solid support with the use of models and systems which analyze the scenarios of different structural and non-structural actions – as well as measures which help to predict the impact resulting from decisions or variations which may occur in time and space, regarding the amount and quality of available water resources.

In time, science, technology and knowledge with an interdisciplinary focus shall direct the development of local capacities, considering its idiosyncrasy.

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[8] Base document for the IV World Water Forum Theme 2: Implementing a Comprehensive Water Resources Mangement (CWRM).

The reliable measure – at reasonable cost - both of water inventories and uses or exploitations and its quality is a field in which science, technology and knowledge may also provide significant contributions.

Also, it has been observed that due to the lack of information, knowledge and financial resources, technologies are applied in physical, social and economical environments which are different to those to which they were originally designed, a situation which leads to subsequent negative impacts on its operation and maintenance.

BOX 8. METHODOLOGY AND TECHNICAL GUIDES FOR WATER FRAMEWARK DIRECTIVE

The approval of the Water Framework Directive in December 2000 presented a series of technical challenges, obliging to develop new methodologies which allow its implementation. The CEDEX Hydrographic Studies Center, through a collaboration agreement with the Environmental Ministry has participated in the development of these works, among which the most important are:◘ Development of a drainage model in SIG for Spain with a cell size of 100 m. This model served as a basis for many of the required works ◘ Problem analysis in establishing the limits of the hydrographic regions; ◘ Identifying and delimiting both natural and modified water masses ◘ Environmental and water mass characterization.Extense characterization of water masses with variables, both local (mainly climate-realted) as variables that responds to the basin's characteristics (hydrological and physico-chemical), in order to locate main geographical groups, which may conform typologies.; ◘ Studies on pressures. Organization in databases and SIG coverages, as well as pressure indicators process and acumulation on the drainage network. ◘ Selection of possible reference zones derived from the analysis of pressure indicators.

Currently, the works continue in the Framework Directive, developing methodology and technical guides which allow its implementation in an homogeneous form, as well as performing a general study, as it may be the valuation in resources in quality and amount, and the development of a measure catalog and models which allow to optimize measure programs

5 Theme 3: Water and sanitation for everyone

The IV World Water Forum includes a specific subject associated with the fulfillment of the Millennium Development Goals for water supply and sanitation.

Regarding this goal, governments, civil society and private sector partners shall provide support to a wide range of water and sanitation technologies and appropriate service levels from a technical, social, environmental and financial point of view.

In the following tables a summary of technologies for water supply and sustainable sanitation is provided.[9]

TABLE 5. SUMMARY FOR THE TECHNOLOGIES FOR WATER SUPPLY.

Water source	Infrastructure	Equipment	Treatment Required	Applicable Situations
Surface water (rivers, flows, lakes)	Dams Direct pumping (lakes, perennial rivers, pumps) for storing at adjacent surface vessels	Electric pumps	Clarification includes withdrawing solids and turbidity, disinfection, preventive treatment against prevention (water conditioning)	Large scale, for large cities or several cities and communities
Underground water	Small diameter wells	Electric and manual pumps	Partial disinfection in order to fight	Large scale systems

[9] UN Millennium Project 2005. Health, Dignity, and Development: What will it take? Task Force on Water and Sanitation.

Water source	Infrastructure	Equipment	Treatment Required	Applicable Situations
	-Drills		contamination in the distribution system	Institutions
	-Tubed wells			Domestic and small irrigation uses
Wells	Large parameter wells	Mainly manual pumps, in some cases electric	General disinfection is enough	Community use
	Excavated wells			
	Mechanically excavated wells			Domestic use
Underground water	Spring protective case	Open-bottom protective case spring and drilling pipes continuously flowing directly into distribution pipes or storage tanks	Usually without treatment because it is normally portable water	Rural sites
Spring water				
Rain water	Collection at roofs towards domestic tanks	None	None or simple disinfection	Islands without surface or underground waters
		Simple mechanic pumps		
	Vessels collection towards storage tanks			Small rural communities
				Houses
Saline water	Underground or maritime pumping	Electric pumps	Desalination, including inverse osmosis	Areas with scale water with access to saline or sea water

TABLE 6. SOUND TECHNOLOGIES FOR SUSTAINABLE SANITIZATION.

System type	Purpose	Technological options	**Conditions**
Sanitation on site	Excreta disposal	Simple non-vented, double-pit lavatories. One pit is used while the other rests until its contents decompose and it is safe to use it in the land	**Low water use; low soil permeability; low aquifer level; low-to-medium housing density**
		Water flow for cleaning blind twin pits quick alternatively goes from use to stand-by, in order to drain	**Medium water use, water flush; good for permeability; low aquifer level; low to medium housing density**
		Water flows for cleaning of septic pit with blind twin pits but alternatively are used or in stand-by	**High water use; low for the permeability; high aquifer level; high housing density**
		Ecosan latrine	**Low water use**
	Waste water disposal	Blind clean pit system separated for not disposal	**Medium – high level use; on site sanitation for disposing of excreta**
Off-site sanitation	Waste water conduction	WC?? with low water volume lavatory for cleaning with simplified or small diameter thick, shallow and horizontal gradient culverts	**High water use; low soil permeability; high housing density; high aquifer level; on-site sanitation for excreta disposal**
	Primary treatment	Water flush lavatory for cleaning or law water volume with Imhoff tank and mud drying beds	**Small communities or counts with high water use**
		Low volume flush lavatory for cleaning with conventional primary treatment, cleaning, solid and sediment removal	**Small to medium towns and mega cities**

System type	Purpose	Technological options	Conditions
	Secondary treatment	Drop filters with mud digesters of mud echo sands	**Long term solution for disposing of waste waters in medium to large cities**
	Treatment options	Dams construction	**Areas where bad smell risk is low**
		Dams and tanks for waste stabilization	

BOX 9. SANITATION OF THE PÁZTCUARO LAKE BASIN

The basin of Páztcuaro lake, located at Michoacán, Mexico, is one of the most emblematic places in the country due to its natural beauty. Unfortunately, inadequate practices in the exploitation of natural resources has caused degradation. An environmental program for the recovery of the basin has been established with the participation of the state of Michoacán Government, for municipal government and private foundation, as well as the Mexican Institute for Water Technology (IMTA) which provide all the scientific and technological coordination for the program. A critical aspect in the program has been the development, adaptation and transfer of a technology system that is adequate for the stakeholders in the basin, particularly the poor and indigenes population. Main emphasis of this technological effort has been supplying water and sanitation by collecting and storing drain water, pumping, sewage water with bicycle, treating waste water is at house scale and water disinfestations is through solar energy. Besides, there is a soil conservation program and other relevant schemes regarding for reforestation for restoring the basin. Finally, an automatic, high-efficiency, hydraulic device for low water volumes and intermittent irrigation to serve small lots of land has been transferred to the basin inhabitants in order to have a reliable source of food. In total, 1,250 technology transfer actions have been performed today. As a result of these and other efforts included in the program, environmental health of the basin has significantly improved.

Provide the support of a wide range of technical alternatives and promote innovations enable communities to install water and sanitation infrastructure that they desire, deem willing to pay for it and keep it in the long term, which may also reduce the per capita cost, while providing these limited resources to more houses.

Manual pumps, improved wells, rain water storage, locally designed latrines, facilities using voluntary labor, as well as maintenance by the community are some of the examples of the *low technology* approaches that may be particularly relevant and economic for many suburban and rural areas.[10]

The technologies linked to the efficient use of water in urban areas has not had the impact foreseen and it is necessary to complete the full range of technologies, as well as the communication and technology adoption programs that are geared at reduced water demand.

Even though in developing countries it is still necessary to solve those problems related to gastro-intestinal illnesses, there is growing demand to remove specific contaminating agents, such as arsenic and fluorine, as well as to advance in the design of alternate waste water treatment processes in order to increase efficiency, reduce cost and environmental liabilities. In the mean time, it is necessary to assess the impact of water contamination over scarcity.

Stand alone small-scale service providers frequently have an advantage in servicing poor populations and standards and regulations should be revised in order which may hinder alternate suppliers form operating efficiently. In some urban settlements, water supply and sanitation systems that are small and locally operated may be less expensive to build and maintain that the large centralized systems.

[10] Base document for the IV World Water Forum , Topic 3. Water and sanitation for all.

BOX 10. TECHNICAL STANDARD ON CONDUCTION

The Hydrographic Study Center from CEDEX, has been actively working during the last ten years in the area of the technical standard with regard to conduction in such away that during this time several standard documents on the subject matter has been developed while having offers being developed at present, such as the Technical Guide on pipes for water transport and R13 pressure (2003) or the Recommendations on reinforced concrete tubes for sanitation and drainage networks R16 (2005).

Currently work is being done on a Technical Guide on sanitation and drainage networks. In the last two years (2004 and 2005), fruitful collaboration with Canal de Isabel II (the operator of the supply and sanitation service of the Community of Madrid) has been kept through which technical assistance has been provided to this institution in the writing of Sanitation Networks Standards for internal use.

As far as reuse is concerned, as a valid and efficient instrument for achieving the renew management of water resources, a similar collaboration to write some of the water Reuse Standards has been started for the internal use of Canal de Isabel II.

Likewise, work has been done in collaborating the Draft of the Royal Decree to which the Basic Conditions for Direct Pure Water Reuse are set in creating a nation wide database on reuse, the performance of Study about parasite helmintos eggs in waste water and the writing of a good practice manual on the reuse related to the Study about Advanced Technologies for Regenerating Pure Effluence, based basically on several undertaken that exist in Spain.

The support of the development and use of several technologies and levels of service, help solving the tension between the need of a quick extension of the services in order to comply the 2015 objective and the purpose of keeping the benefits obtained in the long term. The *one size is appropriately* approach necessarily means that some houses and community end of getting the wrong services. A failure in responding to the circumstances and preferences of the users shall eventually be resolved in favor of such services.

Innovation is particularly necessary in the financial, political and institutional areas, as well as systems that are good for a more productive use of water and sanitation.

With regard the operators of portable water and sewage systems, it is necessary to promote that they have technically certified personnel, as well as comparison base management which is the systematic practice of comparing management indicators of an organization with those of other institution that handle best practices in this area, facilitating the establishment of quantitative clear goals that will allow the agency to come closer to the best practice worldwide and comply more efficiently with its function.

Water supply and sanitation may sometimes be linked to hygiene and become a trio that is the corner stone of public health, as well as economic and social well being.

Sanitation and hygiene disappear during the planning, policy making, budgeting and the implementation phases, while most of the effort and resources are allocated to water supply. This need to be changed: hygiene and sanitation promotion needs to be moved up front instead of being just and adapt to water supply. They are the elements for development with dignity. In this regard, the innovation in local sanitation projects is evident in the Sulabh,[11] and Ecosan,[12] models, which have contributed to remedy the sanitation problem in low income area and to restate the sanitation issue.

[11] In the Internet: http://www.sulabhinternational.org/

[12] In the Internet: http://myweb.absa.co.za/ernstt/index.html

6 Theme 4. Water for food and the environment

Water, food and the environment, all of them together make of a node, an unbreakable network. We require actions geared at local level and a wide range of different scales to be able to reconcile the compensations related with the imperative of increasing food production and the growing acknowledgment of the intrinsic value of the environment and biodiversity, as well as the attractive elements offered by the ecosystems that work in a robust manner.[13]

BOX 11. SIMULATION MODEL FOR THE SYSTEMIC ANALYSIS OF WATER USE IN THE RÍO BRAVO INTERNATIONAL BASIN

Mexico shares the Grand River and Colorado River basins with the United States of America. The cross border water allocation is regulated and International Agreement entered into in 1944 between both countries. The Agreement require the US to allocate 1,800 million cubic meters of water to Mexico every year, and Mexico allocates 432 million cubic meters of water to the US every year. The accounting plan of the cross border allocated volume is implemented for every five-year period. Due to the one-decade drought, the inadequate operation of the dam system and the low efficiency of irrigation on the Mexican side of the Grand River basin, for the first time sends the Agreement was signed, Mexico was not able to comply with the allocation required to the US in the 2000-2004 period. Even though the Agreement allow each country to comply with the deficit of allocated volumes in the five year period following, the situation described created a strong reaction from the Agricultural Community in Texas, which asked the federal government and the state government to exercise pressure over Mexico in order to be able to update the assignation of volumes creating a relationship between the two countries. The Mexican Water Technology Institute developed a simulation model to make a systemic analysis of the use of water in the basin, and it also developed and a scheme for the agricultural which main components are real time system of irrigation for cast and a probability system design for the irrigation system which has allowed implementing operating schemes based on the basic demand. These tools has allowed the National Water Commission to build consensus among the agricultural community on the Mexican side of the basin for increasing the agricultural efficiency in water use and contributing in updating the volume assigned in the terms of the Agreement. Next steps incurred the development and practice of the simulation model, as well as the optimization of the two-way basins, which would imply that the academia and research organization among sides of the border, performed a similar effort for the Colorado river in order to guarantee environmental flow for the sustainability of the sea of Cortés ecosystem.

A critical question in putting these innovations into practice is if the scientific-technological-knowledge sector institutions may successfully respond to the farmers and the needs of the public and how suitable or well adapted are the results of the investigations.

Picture 2 below shows an innovation scheme with scientific basis and technology delivery.[14]

Every time more, high level researchers consider the need of the end user, and, this is also being requested to them.

The technologies that have been developed by high level researchers are incorporated and used, by farmers, once of field tests are performed in order to establish which are the techniques that were the best way possible under its circumstance.

Some of these technologies may be marketed in the private sector, while many others may be spread efficiently by the public sector institutions. In any case, when the socio-economical value of innovations translate into public funding for research, the innovation and technological change cycle may continue. Without a sustained flow of a research, experimentation and the delivery of innovation to public institutions, productivity of the private sector may not grow.

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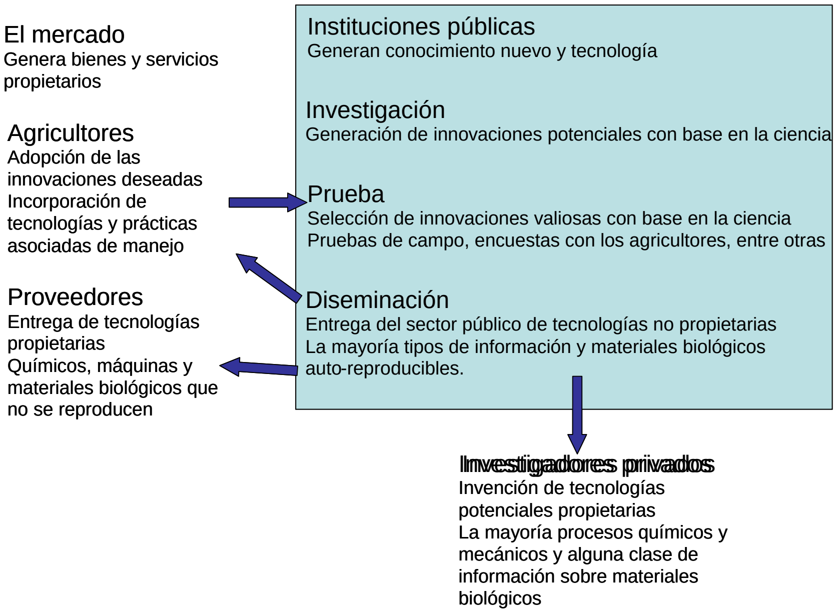
[13] Base document for the IV Water Worldwide Forum, Topic 4. Water, Food and Environment.

[14] USAID AFR/SD, Overview and Priorities for Science and Technology in West Africa: A contribution to USAID West Africa Regional Program. Initiative to End Hunger in Africa (IEHA) Action Plan. Agricultural Policy Development Program PCE-I-00-99-00033-00 (Order No. 5). December 2002.

Both seasonal and irrigation food production systems have great potential for improving water productivity, meaning that it is possible to produce more food for the same amount of water. For example, while 50 liters of water per day per person are the minimum amount recommended for domestic use, it is necessary to have a volume 70 times greater to meet the water consumption for producing the diet of a person based on a 3,000 kcal/day consumption.

FIGURE 2. SCIENTIFIC BASED INNOVATION SCHEME AND TECHNOLOGY DELIVERY



El Mercado. Genera bienes y servicios propietarios	The market. Generates proprietary goods and services.
Agricultores Adopción de las innovaciones deseadas Incorporación de tecnologías y prácticas asociadas de manejo	Farmers Adoption of desired innovation Incorporation of technologies and practice related to a management
Proveedores Entrega de tecnologías propietarias Químicos, máquinas y materiales biológicos que no se reproducen	Suppliers Delivery of proprietary technology Chemical, machines and biologic materials that are not reproduced
Instituciones públicas Generan conocimiento nuevo y tecnología	Public institutions They generate new knowledge and technology
Investigación Generación de innovaciones potenciales con base en la ciencia	Research Generation of potential innovation based on science
Prueba Selección de innovaciones valiosas con base en la ciencia Pruebas de campo, encuestas con los agricultores, entre otras	Testing Selection of valuable innovations based on science Field tests, surveys to farmers, among others
Diseminación Entrega del sector público de tecnologías no propietarias La mayoría tipos de información y materiales biológicos auto reproducibles.	Dissemination Delivery of non proprietary technologies to the public sector Most of the information and biological materials are self-reproducible

Investigadores privados
Invención de tecnologías potenciales propietarias
La mayoría procesos químicos y mecánicos y alguna clase de información sobre materiales biológicos

Private researchers
Invention of proprietary potential technologies
Most of the chemicals and mechanics and some type of information about biological materials

Box 12. Technology transfer for the efficient use and management of water in agriculture

Technology transfer is one of the basic and educational activities of the Public Work Study and Experimentation Center (CEDEX), since its creation in 1957. The agency is especially interested in the permanent updating of methodologies and the scientific disclosure systems in the areas of civil engineering and environment with regard those professional interested in improving their knowledge.

One of the main elements used for the education, diffusion, and technology transfer activities in the topics related with the use and the efficient management of water in agriculture is the Irrigation Engineering Master of CEDEX, for postgraduate students which is now in its twelve consecutive year in 2005. It has collected all the experience accrued along twenty three previous additions of the International Irrigation Engineering Course. This experience has incorporated in recent years environmental and social sensitivity currently required in dealing with this subject matter, its technological advances and recent innovations in the teaching procedures.

With regard the later issue, CEDEX, considering the recent deployment of its Virtual Academic Center, allows those technicians interested base on the professional responsibilities, or its personal situation, may not move from their site for a long period to participate in the Master, and has considered quite interesting to incur an issue activity of the Center in the on-line course on irrigation modernization. Main content of the Irrigation Engineering Masters are geared at the design and efficient management of irrigation from water collection to the application in the plot of land, their implication national and regional planning, their interaction with the environment and irrigation modernization best practices, as well as past and recent experiences on the subject and latest technological innovation, owed in the framework of environmental and social sensitivity that are currently so important.

Among the measures required in which science, technology and knowledge play an important role, the following are included: [15]

- Improved water management in irrigation and seasonal areas, based on the secure water use and land ownership rights
- Improvement of physical, biological, chemical properties of the soil, for example: appropriate farming practices
- Mitigation of long drought seasons by collecting rain water and supplementary irrigation
- Effective support and agreement and services for commercialization, accessible credit, technological improvements and extension services, and specific emphasis in seasonal agriculture.
- Investment in no irrigation infrastructure, as well as improve management of the existing irrigation
- Special attention to water contamination due to irrigation, cattle, as well as food processing and industrial cultures
- The supply of drainage in irrigation schemes that is not usually performed where there is a great delay in investment and maintenance.

7 Theme 5. Irrigation management

In recent years, ninety percent of natural resources are related to climate. Between 1985 and 1999, the less developed countries (LDC) lost 13.4% of their GDP due to disasters, while the developed countries only lost four percent. Water-related risk management has an important impact on the capacity of the countries to attain the Millennium Goals.

[15] SIWI, IFPRI, IUCN, IWMI. 2005. Let it Reign: The New Water Paradigm for Global Food Security. Final Report to CSD-13. Stockholm International Water Institute, Stockholm.

BOX 13. NUMERIC MODELS FOR WHETHER FORECASTING IN THE ATMOSPHERE

Every year, Mexico suffered for almost six hurricanes that has caused a significant material damage. Some years ago there were no modern tools available for whether forecasting, in order to dismiss, the Mexican Water Technology Institute (IMTA) started a strong research and development program in the numeric time forecasting technology. The meso-scale model was adapted to the meteorological region where Mexico is located, using the border conditions generated by a global circulation mode. In 1999, the model was operated for 12, 24, 36 and 48 hours forecast in 1999 and now is operated by the National Meteorological Service. The model has been improving with the years and the resulting technology has contributed to set a prevention culture among the population living in high-risk meteorological areas. Recently, the Institute developed an automatic version of the Tropical Hurricane Early Alert System, which generates alert maps virtually in real time based on the official information from the National Hurricane Center in the US, located in Miami. The maps include the intensity and forecasted path of the hurricanes. The model and the system have enabled civil protection units at federal, state and local levels to publish timely warning messages, as well as alarms or evacuation messages that have saved an undetermined, but significant number of lives.

The risk is inherent to a human being life. Fighting against extreme events, such as flooding, and droughts is as old as man kind itself. Currently, there are new challenges such as:[16]

- Weather change. Greater variability will be accompanied with a high decree of uncertainty in the decisions made with regard to planning and the economic development.
- Intensified use of hydraulic resource will result in an every increasing deficit. At the same time, the societies are less willing to accept the risk. This may lead to social or even armed conflicts.
- Citizen participation is more ethics with regard to interaction with water, specifically during crisis.
- Most of the mega metropolises are located flows to the coast or in low lands, representing a great potential for damage in case of extraordinary events. In these sites, risks are becoming disasters more frequently, the advertising the development and poverty reduction, while putting these citizens faraway from attaining the Millennium Goals.
- A growing concerned all around the world when seemed damages caused by this water-related disasters is growing in a proportionately. There is a widely spread hope that technological and scientific advances will ensure a greater protection against the impact of these natural disasters in the past.

Notwithstanding that these are world trends, the actions to address all these challenges must be started at local level.

The comprehensive risk management approached provides a set of measures for preventing a danger to become a natural disaster and in all of them, science, technology and knowledge have an important participation. The strategies to minimize risk will vary considerably, depending on the type of danger and the site. Among the issues related this risk that need to be addressed to scientific research and technological development are whether changes, droughts, floods and other water

[16] Base document for the IV World Water Forum, Topic 5. Risk management.

excesses, caused by man -intentionally or accidentally- such as contamination and technical failures.

In general terms, two groups of measures may be distinguished: Structural and non-structural.

Among the structural measures, hydraulic infrastructure construction required the evaluation of current hydrologic variability and a reliable forecasting. Multiple types of structural protection may not be adapted to the type of danger. Given that a full protection is not possible, any prevention measure is geared at a given protection objective or a predefined design standard. Knowledge about the danger is a prerequisite for a successful mitigation. Development infrastructure, such as communication ways, hospitals, among others, must be designed in order to support the most dangerous natural dangers and must be functional, even in disaster kinds. Also, such infrastructure should not increase the magnitude of the danger.

BOX 14. FLOODING RISK ZONING

In Spain, floods cause a lot of problems, both material and human. In recent years, economic losses associated with floods have exponentially grown, both due to the increase in number of this type of hydro meteorological phenomena, and by greater exposure of goods and population. Likewise in Spain there are a lot of dams that would be enough laminate entire roads, but they themselves present a risk for the population, in so far any structural failure could increase consequences of the flood. For all these reasons, the Spanish Law (related to water, land and civil protection) has tried to establish land occupation criteria in those areas that suffer from flood and risk prevention standards in large dams in order to minimize risks faced by the population.

An important challenge of protection due to floods is integrating structural measures with the non structural, i.e., by land zoning with real kind alert system and civil protection plan. the Hydrographic Studies Center of CEDEX (a politic agency for water resource research) has participated as the reference center in risk zoning. This lead to the development of criteria for defining the hydrologic public domain, the implementation of a mathematical model for studying the avenues of the lots flooding planes, as well as the SIG methodologies to assess the risk. Likewise a physical model of the flooding plane of the Júcar river has been created in opportune proof the knowledge of river hydraulic and the consequences of the different infrastructural actions.

In case of an emergency, vital facilities, equipment and communications may to be repaired as soon as possible. In the first case, this includes vital infrastructure. Naturally, this means only provisional repairs.

Frequently, reconstruction exceeds local capacity, because time is an important factor and external support need.

During the recovery process, provisional solutions become long lasting and final solutions. This is why final construction permits should also be granted after a risk and damage analysis. Reconstruction is the great opportunity to reduce vulnerability at a very low cost or without any cost. In this phase, there is the need for more research and technological input. There is also an international coordinated effort.

Among the non-structural measures, there is the establishment of danger and risk maps, even if there is only residual risk. Strategic action plans, must include land use plans and allowed the assessment of risk conditions. But, land use plans should be transformed into the evaluation that support the flooding plane zoning, avoid settlement on mountain sides and implement hydro-meteorological disaster insurances.

There may not be any awareness preparation on existing danger. Awareness may only be provided through education and training provided with regularity and especially in those areas exposed to less frequent dangers or in new settlements. Specifically, special attention should be given to informing women, young and children.

Monitoring, forecasting and early warning play the role in the risk management cycle. Paradoxically, while hydro-meteorological disasters are growing in magnitude and frequency, hydro meteorological monitoring is being reduced due to the current trend a government to use fewer funds in extending, operating and maintaining them. Joint effort between governments is required to increase and maintain the networks and the manufacturer in order to improve the autonomy of the instruments and reduce costs. Data is the row material of studies, investigations and technological improvement.

The development in remote sensors, satellite communication and information technology must be used to improve monitoring and developed computer-based models for forecasting and early warning of imminent dangers. Forecasting weather extreme –and their extension– in specific regions required increasing the efforts in the knowledge of the weather and its hydrologic consequences, there is a need for a more investigation in the understanding the nature of regional weathers and hydrologic regimes, including variability and change potential.

This knowledge is basic in order to calculate potential frequency of natural dangers, as well as the available adaptation options. International technical cooperation has proven efficient to prevent extreme hydro meteorological phenomena at regional level.

An early warning safe lives. Reliability of the warning and the trust of that respond to it is an important aspect that determines its efficiency. Warnings should be understandable and the persons involved should not how to react. Early warnings are efficient only if they get to the persons affected who have to respond to such situation. Science and technology try to break the barrier of financial resources in order to enable warnings to get even to the most remote corners of the affected areas. In order to improve cooperation and avoid conflicts, an open and transparent communication mechanisms. Important data and information need to be available for all stakeholders in order to place them at the same awareness level.

The use of traditional and native knowledge is critical to reduce the impact of the disaster, as well as the communicated disaster management by means of mitigation programs, sends community organizations are the first to respond to such dangers. Emergency operations required regular training for different scenarios.

In case of natural disaster, it is important to minimize the extension of the damage and, specifically, the loss of lives, as soon as possible, by means of a fast alert and a rescue mechanism that respond in a fast and professional way.

In order to prevent and prepare, it is critical to analyze previous disasters. This is why is convenient to assess and document the disasters of the support of external specialists to the affected zone. In knowing about the cause, it is important to know the different factors of the impact, for example, the speed, the wind, the height of the flood and the force of the dynamic impact.

In managing those risks related with water, almost all measures has to be locally implemented with local decision making, local knowledge and considering local situations. However, in this *ideal* action level, it is quite common not to have the sufficient scientific and technological knowledge for managing water-related risk. Sometimes, the lack of this knowledge is so clear at local level that they don't even have risk awareness implicit in the local decision making. Nation wide, knowledge and scientific and technical experience availability that the problems in the area are deemed reasonably resolved or even considered at country's level.

8 Ideas for the debate

The role of knowledge –expressed in a technological change with scientific basis and institutional innovation – is in the center of the development process. However, with regard to science, technology and knowledge, there is wider and growing gap between the countries that are already developed and those that are in that way. Also, some developing countries observe constant regional development.

In order to face the backwardness the international community suggest, among other thins, the following actions:

- Adequate infrastructure. Developing countries required an infrastructure to profit from science, technology and innovation. This infrastructure uses a wide range of technologies and complex institutional arrangements; development provides a founding for technological knowledge. Infrastructure is also critical in attracting foreign direct investment. Developing countries need to consolidate their infrastructure and strengthen their capacity to develop, operate and maintain infrastructure services.
- Competitive governments. If the developing country is its potential towards science, technology and innovation, it needs to start a few of basic activities, among which are the creation of an institutional environment that fosters productivity, providing incentives for flourishing and consolidates business capacity, as well as becoming innovation promoter.
- Competitive universities. Universities are critical in the advance of science, technology and knowledge, but the competition principal needs to be introduced into the academic activities. Likewise, universities must be linked to the productive and social sector and provide an environment where younger researchers may attain their creative potential.
- Competitive companies. The creation of links between of knowledge generation and company development is one of the most important challenges of developing countries. The range of tools that may be used to create and xxx these companies. Consequently, companies must convert the society's needs in opportunities to achieve profitable business which is away of innovating.
- Likewise, in order to foster innovative change, it is important to highlight importance of cooperation and international dialog.

Without any doubt, science and technology, as well as knowledge, are critical elements for small towns, countries, regions and the world as a whole to seek for a sustainable water management. Decisions and actions implemented in water issued must be based on the best science and the best technology available, considering local factor that frequently require a applying the appropriate technological packages or innovated adaptations. The only mean to change the paradigms in the world of water is knowledge. The scientific-technological-knowledge community is responsible of responding with pertinent innovations. Government, companies and societies must be aware that is only through innovation that we will be able to break the vicious circles and change them into virtue circles. The work is all ours, since sustaining life in this small blue planet depends on water and each drop count.