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Synthetic analysis of the debate on the integrated management of water resources in Peru

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Abstract.- Water management has always been at the center of human development attention. All civilizations of the world have had their establishment, growth, peak moments and many times its decline, related to water resources and their management. In Peru, the actual management of water resources confronts different realities in its three main geographical zones: the coast, the highlands and the Amazon. In the present work, the concepts, the series of legal devices that deal with the use and management of water resources, the institutionalization in relation to water and its evolution in Peru, are described in a succinct and concrete way, in the framework of Integrated Water Resources Management (IWRM).

Keywords: water management; integrated management of water resources; water management in Peru; water management tools

Análisis resumido del debate sobre la gestión integral de los recursos hídricos en el Perú

Resumen.- La gestión del agua siempre ha estado en el centro de la atención del desarrollo humano. Todas las civilizaciones del mundo han tenido su establecimiento, crecimiento, florecimiento y muchas veces su declive, relacionado con los recursos hídricos y su gestión. En Perú, la gestión actual de los recursos hídricos enfrenta diferentes realidades en sus tres principales zonas geográficas: la costa, el altiplano y el Amazonas. En el presente trabajo se analizan en forma suscinta, los conceptos, la serie de dispositivos legales que se ocupan del uso y manejo de los recursos hídricos, la institucionalización en relación con el agua y su evolución en el Perú en el marco de la Gestión Integrada del Agua (GIRH).

Palabras claves: gestión del agua; manejo integrado de recursos hídricos; gestión del agua en Perú; herramientas de gestión del agua.

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1. Problem statement

Water management has always been at the center of human development attention. All civilizations of the world, fortunately diverse and complex, have had their establishment, growth, peak moments and many times its decline, related to water resources and their management in relation to climate, watersheds and human needs [1].

Over time, intervention modalities in river basins have been different for the treatment of water resources. The oldest ones have referred to the management of water resources, from navigation and water supply, to flood protection, water quality control, the fight against erosion and the production of energy. This was followed by the interventions that led environmental management, a recent approach that emphasizes environmental conservation and resources. However, the lack of an integrating and interdisciplinary conceptual framework that guides the management of water is deepening inter and intergenerational rivalries, affecting the sustainability of the resource, even in surplus areas in terms of water. Sectoral approaches used as a conceptual framework for the management and administration of water resources have dominated and continue to prevail. This leads

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to an uncoordinated and fragmented management and development where the use of the resource is inefficient. The institutions in charge of the management of the resource have acted in general isolated from the users, without connection with the different intervening parties and in competition for this finite resource [2].

Water is a fundamental resource for sustainable development, but in many cases it is not taken into account when it is desired to find effective and lasting solutions to problems related to water resources. In this context, a new form of governance and management paradigm emerges, which is within the concept of Integrated Water Resources Management (IWRM), which has been defined by the Global Water Partnership (GWP) as "a process that promotes the coordinated management and development of water, land and related resources, in order to maximize the resulting social and economic well-being in an equitable manner, without compromising the sustainability of ecosystems" [3, 4, 5, 6, 7, 8, 9].

IWRM challenges conventional and sectoral management systems, with an emphasis on holistic approaches, which promote decision making between different sectors and levels. It also recognizes that "top–down management" focused on supply with little interest in the demand of beneficiaries, as well as the emphasis on technical aspects and conventional sectoral approaches have imposed and impose high economic, social and ecological costs on the society and the environment. It is generally known that the way in which water is managed today is not sustainable from the environmental point of view, nor is it financially and socially.

IWRM is defined as a process of change which aims to transform existing water management, which is why it does not have a starting point as well as one of completion. The global economy and society are dynamic as well as the environment, which is why the different systems that are based on IWRM must be able to respond to changes and be able to adapt to new conditions and/or economic, social, environmental and of human values.

The IWRM is not an end in itself, but a means to achieve 3 strategic objectives

1. Efficiency to achieve greater coverage of the demand for water resources.
2. Equity in the water resource disposition among the different socioeconomic groups.
3. Environmental sustainability, to protect water resources and related ecosystems.

The Dublin principles as a guide: the general principles, approaches and relevant guidelines of the IWRM are numerous and each of them has its appropriate area of application. Of these principles, those of Dublin are particularly useful. They have been carefully formulated through a consultation process of the GWP.

The Dublin principles contributed significantly to the recommendations of Agenda 21, Chapter 18, on freshwater resources, adopted in 1992 at the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil. Since then, these principles, referred to as the Dublin-Rio principles, have found universal support through the international community as the guiding principles of IWRM. More recently they have been re-declared and developed in 1998 at the major international water conferences in Harare and Paris and by the Commission for Sustainable Development (SDC) at the "Rio + 5" meeting in 1998. The four principles of Dublin are [2, 7, 9, 10, 11]

1. Fresh water is a vulnerable and finite resource, essential to sustain life, development and the environment.
2. The development and management of water should be based on a participatory approach, involving users, planners and policy makers at all levels.
3. Women play a central role in the provision, management and protection of water.
4. Water has an economic value in all its competitive uses and should be recognized as an economic good.

In Peru, the management of water resources confronts different realities in its three main geographical zones: the coast, the highlands and the Amazon. The coast more developed and densely populated but dry, has large hydraulic

infrastructures and a viable institutional framework for IWRM. The mountain range, with abundant water resources, has little infrastructure, a large part of its population is poor, and its institutions for water management are generally traditional in nature. The Peruvian Amazon, with the lowest density of population and infrastructure in the country, covers half of the Peruvian territory and gives birth to the Amazon River.

At present, the Government of Peru is carrying out an important transformation in the management of its water resources, previously focused on the development of irrigation in the coastal zone. The objective is an integrated management of water resources at the basin level that includes the entire country, not just the coast. Despite important advances, such as the creation of a National Water Authority (ANA), several challenges remain, such as

1. Increased water stress in the coastal region
2. Lack of institutional capacity
3. Deterioration of water quality
4. Poor efficiency, especially in the irrigation sector
5. Inadequate supply of drinking water and sanitation

2. Objective

The objective of the work is to carry out a summary analysis and present in a succinct and concrete way the concepts, the series of legal devices that deal with the use and management of water resources, the institutionalization in relation to water and its evolution in Peru in the framework of the Integrated Water Resources Management (IWRM), what has included, procedures, coordination mechanisms and the role they play in the use, exploitation and conservation of natural resources and protection of the environment.

3. Methodology

For the development of the work, a general referential research has been carried out on the background and theoretical framework of main criteria that comprise the integrated management of water resources and more specifically on existing management tools and to be developed in the country.

4. Results

4.1. Background

Water is vital for survival, health and human dignity and is a fundamental resource for development. The world's freshwater resources are under increasing pressure and many people still lack an adequate water supply to meet their basic needs. Population growth, increased economic activity and living standards have led to an increase in competition and conflicts related to limited freshwater resources. Below are some reasons why many people argue that the world faces an imminent water crisis

1. The water resource is under increasing pressure due to population increase, economic activity and increased competition among users;
2. Water intakes have increased twice as fast as population growth and currently one third of the world's population lives in countries experiencing medium to high water stress;
3. Pollution is further increasing water scarcity, by reducing the utility of water in “downstream” places,
4. Limitations in water management, a focus on the development of new sources instead of promoting better management of existing ones and sectorial proposals of a hierarchical nature for the administration of the resource, have resulted in the development and management of water resources, lacking coordination.
5. Greater development means a greater impact on the environment.
6. Current concerns regarding climate variability and change require optimized water resource management to cope with more intense floods and droughts.

During the twentieth century, the Peruvian government has been the highest authority in the management of water resources and the main

investor in hydraulic infrastructure. Hydraulic development has traditionally focused on the construction of infrastructure such as dams and irrigation canals to cope with the growing water demand of a population and an expanding agricultural sector, especially on the coast. For example, in the 1950s and 1960s, the San Lorenzo and Tinajones dams, the largest in Peru, were built in the northern region. In the 1970s, the development of hydraulic infrastructure on the coast continued. In the zones of the highlands and the Amazon, water resources have traditionally been managed through informal associations of users, the irrigation committees, which control the rudimentary hydraulic infrastructures. The Peruvian government has had little presence in the area, as well as state or international investments.

Thus, at the beginning of the 21st century, Peru has a coastal zone with numerous hydraulic infrastructure controlled by structured and developed User Boards. In the highlands and the Amazon, with lands of scattered crops and less than one hectare, the Users' Meetings are still a process in the process of being implemented. Irrigation committees continue to be an important actor in the management of water resources [12, 13].

This way of managing has resulted in the region at the foot of the mountains and the Peruvian coast being prone to flooding and devastating mudslides, mainly due to heavy rainfall in the degraded high basins; while the south of the country is prone to drought. In addition to natural causes such as ENSO (El Niño–South Oscilation), the effects of droughts and floods have been aggravated by human intervention, including soil erosion caused by inefficient practices of cultivation and grazing, deforestation and land use practices.

El Niño hits Peru in cadences of about three to eight years and consists of strong winds and rains that cause floods and devastating mud avalanches. In 1997–1998, the costs for damages reached US$ 2 billion. Droughts seriously affect the south coast, generating losses in agriculture as limitations in drinking water consumption.

Laws and preventive measures (related to zoning, deforestation, etc.) do not apply and there is no reliable early warning system network. As a consequence, the negative impacts due to droughts and floods in the different regions increase, with an increasing impact on the Peruvian economy.

The impacts related to climate change in Peru include the deterioration of watersheds and the depletion of water recharge capacity, the greater probability of sudden fires and biotic changes in the levels and composition of ecosystems, which affect their water storage capacity. The effects and consequences may be different in the initial and final stages of the retreat of the glaciers and may differ depending on the location.

High mountain ecosystems, including páramos (unique wetlands in the northern Andes) and snowy terrain, are among the environments most sensitive to climate change. These ecosystems have a unique endemic flora and provide numerous goods and services of great value to the environment. Although considerable progress has been made in understanding the retreat of glaciers and its consequences, the effects of climate change can have a negative impact on the functioning of the páramos. Between 1970 and 2006, Peru and Bolivia have lost a third of their glaciers.

Data collected recently suggest that climate impacts have already altered the circulation patterns responsible for the production and movement of water vapor in the region. These shocking changes have probably contributed to the disappearance of bodies of water at high altitude

4.2. Legal framework

The legislation provides the basis for government intervention and action and establishes the context and framework for the action of nongovernmental entities; therefore, it is an important element for an appropriate socio-economic and social environment. Specific water laws have been stipulated in a considerable number of countries, but some still lack a water resources law.

Peru has gone through five major stages in the water legislation [2, 11, 14, 15]

1. Spanish Law since 1786
2. Water Code since 1902
3. General Water Law of the year 1968
4. Legislative Decree 653 of the year 1990

5. Water Resources Law of 2009

The Peruvian law No. 29338 (Water Resources Law) is the one that has the approach of the IWRM (Integrated Water Resources Managemnet), the framework that regulates water resources in accordance with the following principles [16, 17]

1. Water assessment and integrated management
2. Priority of access to water
3. Participation of the population and culture
4. Legal security respect for the water of the communities
5. Principle of sustainability
6. Decentralization of public water management
7. Precautionary nature
8. Efficiency
9. Management by watersheds, and
10. Legal protection.

The law creates the National Water Resources Management System (NWRMS), whose governing body is the National Water Authority (Autoridad Nacional del Agua, ANA). It establishes the uses that can be given to water resources, rights and licenses for use, water protection, economic regimes, use planning, hydraulic infrastructure, regulations on groundwater, Amazonian waters, natural phenomena, and finally, infractions and penalties. The regulations of the law specify the Environmental Quality Standards for Water.

From 1993 to 2003, the Peruvian government approved a series of sectoral laws to regulate the use of water through different actions, such as the Law for the Promotion of Investments in the Agrarian Sector (Legislative Decree 653), Law for the Promotion of Investments in the Fishing Sector (DL 750), General Hydrocarbons Law (DL 26221), General Mining Law (DS 014-92-EM), Electricity Concessions Law (DL 25844) and General Tourism Law (Law No. 24027). In the last decade, there has been a profound change in the Peruvian institutional framework with the approval of the Decentralization Law, the Organic Law of Regional Governments and the Organic Law of Municipalities. In 2003, with the official creation of regional governments, the national government began to transfer power to the departments, which does not include competencies in water management, only participation.

The National Strategy for the Integrated Management of Water Resources recognizes the multisectoral nature of water and implements the appropriate institutional and legal framework for integrated management of water resources.

4.3. Institutional Organization

Til 2008 the institutional framework for the management of water resources at the national level is fragmented. The Ministry of Agriculture (MINAGRI) was the main body responsible for managing water resources at the national level. Other ministries had sectoral interferences on the management of water resources: Agriculture for irrigation, Housing, Construction and Sanitation for the use of water for domestic consumption, Health for water quality, Trade and Tourism for thermal and mineral waters, Energy and Mines for hydroelectric power and the operation of mines, the Ministry of the Environment for policies on the environment, energy and water tariffs and regulation of services, and Defense for hydroclimatic information. In 2008, the Peruvian government created the National Water Authority (ANA), a body attached to MINAGRI, absorbing the Water Resources Intendancy, which was previously under the control of INRENA (National Institute of Natural Resources). The ANA is responsible for the design and implementation at national level of policies on sustainable water resources and irrigation.

Regional governments are not responsible for water management. This represents a challenge for the Integrated Management of Water Resources (IWRM) at the basin level, since the administrative limits of the regions do not necessarily coincide with those of the river basins. An additional obstacle is that regional governments are young – created in 2003– and lack the technical capacity and human resources necessary to carry out integrated water resources management.

The Technical Administration of the Irrigation District (ATDR) became the Local Water Authority (ALA); the latter is now the authority in charge of

managing water, guaranteeing rights over water and distributing water among different users.

Finally, other stakeholders that were involved in the management of water resources at the local level were: (i) four Autonomous Hydrographic Basin Authorities (Chira-Piura-Chancay-Lambayeque, Jequetepeque, Santa and Chillón-Rimac-Lurín); (ii)) eight local offices of the General Directorate of Environmental Health (DIGESA) in charge of water quality; and (iii) the Water Users' Boards, were private associations, with public financing, responsible for the operation and maintenance of minor irrigation infrastructures [12].

4.4. Government Strategy

In 2004, the Peruvian government proposed a National Strategy for the Management of Water Resources, with the main objectives of

1. Institutional renovation and a defined legal framework to include: (i) a resolution of the disparities between the General Water Law and the Law of Natural Resources and transfer the operation of the irrigation systems to the Water Basin Authorities, promote participation in the decision-making processes; and (ii) institutional development strategies that formalize water and pollution rights and establish a comprehensive rate system to cover the operation and maintenance activities.
2. Integrated management of water resources, focusing both on water supply and demand, considering environmental, social and economic factors. It includes a plan to modernize Peru's existing irrigation infrastructure with the aim of raising the overall efficiency of irrigation systems from 35 % to 45 or 50 %.
3. Higher quality of water resources with an initiative to conserve water resources upstream to reduce sedimentation; creates a pollution control authority to monitor agricultural and industrial discharges, promotes water recycling and improves coastal drainage and salinity problems.
4. Disaster management and mitigation that includes consistent monitoring of the climate, reforestation in strategic upstream areas, channeling of water and improvement of urban planning to avoid settlements in high-risk areas.
5. Water education and culture and educational programs for students from pre-school to university level on the economic, social and environmental value of water resources.
6. Information system on water resources that strengthen the networks that control the quality and quantity of water, making accurate information available to the public.

4.5. Theoretical framework

Principles of Bublin. The Integrated Management of Water Resources is a process that promotes the coordinated management and development of water, land and related resources, in order to maximize the resulting social and economic well-being in an equitable manner without compromising the sustainability of vital ecosystems. The IWRM uses the Principles adopted as guiding principles in the Conference on Water and the Environment, held in Dublin, in 1992. Those Principles are as followes [2, 10, 12]

Principle No. 1: Water is a finite and vulnerable resource, essential for the support of life, development and the environment. Given that, water is fundamental for sustaining life, its management demands a holistic approach, with an adequate balance between social and economic development and the protection of ecosystems. Effective management of water resources requires the articulation of the different uses of land and water through large catchments and / or aquifers.

Principle No. 2: The development of water resources and their management should be based on a participatory approach, involving all users, planners and policymakers at all levels. A participatory approach involves raising awareness about the importance of water among policymakers and the general public. This means that decisions must be made at the lowest appropriate level, involving extensive consultation with all users in the planning and implementation of water-related projects.

Principle No. 3: Women play a central role

in the provision, management and protection of water. The fundamental role of women as users of water and custodians of the environment has rarely been taken into account in the institutional arrangements for the development and management of water resources. Accepting and implementing this principle implies policies. Water management in global environmental policy 19 addressed to gender needs in relation to their participation at all levels in water-related programs, including decision-making.

Principle No. 4: Water has an economic value in all its uses and must be recognized as an economic good. Within this principle, it is vital to recognize in the first instance the basic right of all human beings to have access to clean and healthy waters at an accessible price. The mistakes of the past in failing to recognize the economic value of the water led to the waste and environmentally unsustainable uses of the resource. Managing water as an economic good is an important way to achieve its efficient and equitable use and to promote its protection and conservation.

Defining the Watersheds. The hydrographic basin is defined as a territorial unit in which the water that precipitates from the atmosphere is gathered and drained by a common hydrographic system that flows all the same river, lake, or sea. In this area live human beings, animals and plants, all of them related to each other. It is also defined as a physiographic unit conformed by the meeting of a system of courses of rivers of water defined by relief [18]. Peru has a territory that covers only 0.87 % of the continental surface of the planet but which accounts for almost 5 % of its freshwater. This undoubtedly constitutes an advantage in terms of the resource, but it is not when it is analyzed in terms of its spatial and temporal distribution. Indeed, the reality shows that the surface waters of Peru are distributed unevenly throughout the year and across the national geography. The relief of Peru is like a large bowl that allows any drop of water that drains its territory to do so only in three possible directions: towards the Pacific Ocean, towards the Atlantic Ocean or toward Lake Titicaca. This characteristic is the reason for dividing the country into three large hydrographic groups or watersheds: The Pacific, the Amazon and the Titicaca; each of them with different characteristics. The summits of the western chain of the Andes are those that determine if the discharges of the waters of the rivers are made either to the Pacific Ocean or to the Atlantic Ocean. The line of summits that separates the flow direction of the waters is called the continental divide. In the south of the country, the Andes open up in the manner of two large arms that force courses to deliver their waters in the lake of Titicaca, this is called a closed basin or endorheic basin, hence the name of the basin of Titicaca [1, 10]

Surface and underground water resources. Peru has a large amount of water resources, with 106 basins and a per capita availability of 68,321 cubic meters (m^3) in 2006, well above the average for South America, 45,399 m^3. According to FAO estimates, the long-term annual rainfall average is 1,738 (m^3). There is considerable seasonal variability in river runoff, with two thirds occurring between January and April. In addition, Peru concentrates 71 % of the tropical glaciers of the Central Andes. As allready mentioned, the Andes divide Peru into three natural drainage basins: the Pacific basin whit 279,689 km^2, the Atlantic basin with 956,751 km^2, and the Lake Titicaca basin with 48,775 km^2). Within the framework of hydrological diversity, one of the principles of the Law of Water Resources considers water management by Watersheds [12].

Storage capacity and infrastructure. In 1980, INRENA established an inventory of Peru's water storage capacity, including lakes and dams. Peru has 12,201 lakes, of which 3,896 are in the Pacific basin, 7,441 in the Atlantic basin, and 841 in the Titicaca basin and 23 in the closed Huarmicocha basin. Of the inventoried values, the INRENA established that 186 lakes are used with a total capacity of 3 km^3 and 342 lakes with a total capacity of 3.9 km^3 are without any intervention. Currently, the largest number of lakes used are in the Pacific basin, with 105 lakes and a total capacity of 1.3 km^3, followed by the Atlantic basin with 76 lakes and a capacity of 1.6 km^3.

Peru has 23 reservoirs with a total capacity of 1.9 km^3 and has sufficient geographic conditions to build some 238 reservoirs with a total capacity of 44 km^3. The Pacific basin has 21 reservoirs with a total capacity of 1.8 km^3; the Atlantic basin has 2 reservoirs with a capacity of 0.06 km^3. The largest reservoirs are Poechos with a capacity of 1 km^3 Tinajones with 0.32 km^3, San Lorenzo with 0.25 km^3 and El Fraile with 0.20 km^3; all in the coastal region.

4.6. Management of water resources by sector

Drinking water and sanitation. Domestic consumption in Peru represents 7 % of water extraction. The water and sanitation sector in Peru has made considerable progress over the past two decades, including increasing access to water from 30 % to 62 % between 1980 and 2004. Access to sanitation also increased from 9 % to 30 %. % from 1985 to 2004. Progress has also been made in the disinfection of drinking water and wastewater treatment. Despite these advances, water and sanitation services in Peru are characterized by low coverage and quality of service, as well as by the precarious financial situation of their suppliers. This, together with the lack of incentives to improve the management of the sector, has reduced investments to a minimum level, which is affecting the sustainability of the sector (see Drinking water and sanitation).

Irrigation and drainage. Approximately 80 % of the water extraction in Peru is used for irrigation; however, most of the water (65 %) is lost due to the dependence on inefficient irrigation systems.

Water quality. The gradual decrease in water quality in Peru is due to untreated discharges, especially from the illegal mining industry (small-scale mining) and environmental liabilities, but also from municipalities and agriculture. Of the 53 rivers in the coastal zone, 16 are partially contaminated with lead, manganese and iron (mainly by illegal mining) and threaten irrigation and increase the cost of drinking water supply to coastal cities. Specifically, MINAGRI considers the quality of the Moche, Santa, Mantaro, Chillón, Rimac, Tambo and Chili rivers to be alarming. In addition, the 18 mining facilities located along the Mantaro River discharge untreated water into the main stream, threatening the water supply of the country's largest hydroelectric plant. Inefficient irrigation systems have generated problems of salinization and drainage in 300 thousand hectares of coastal valleys (with a total irrigated area of 736,000 hectares), endangering the productivity of these lands. Drainage problems also affect 150,000 ha of the Amazon region. In the altiplano and Amazon zones, excessive deforestation caused by nomadic agricultural practices is causing erosion and soil degradation. In the mountains, between 55 and 60 % of the area is affected by this problem which increases the transport of substances downstream [12].

4.7. How to implement iwrm – experiences

The proper legal and social environment. It is essential to guarantee the rights and assets of all stakeholders (individuals, organizations and companies in the public and private sector). Local or provincial policies and legislation constitute the "rules of the game" [19].

The Role of the Government. The government as a facilitator needs to create the conditions under which all the actors that have interests on particular issues can get involved and negotiate between them to reach acceptable solutions to water problems. The government as regulator and controller should play a more limited role as a service provider and concentrate more on the regulation and control of the provision of specific services Governments and water markets. All markets require the support of governments in the provision of an economic, social and legal environment, where they can carry out transactions.

Water Legislation. The legislation provides the basis for government intervention and action and establishes the context and framework for the action of nongovernmental entities; therefore, it is an important element for an appropriate socio-economic and social environment. The idea is to incorporate consultation and seek consensus with all the relevant ministerial lines and in all the ranks of the government, as well as with other

interested parties located in different places of a basin [20, 21].

Financing Structures and Allocating Funds for Investment for Water Resources Infrastructure [22, 23, 24].

- Private financing assumes the security of the investment: It is the government's responsibility to procure and facilitate the global investments necessary to develop and maintain an adequate water infrastructure.
- Growing competition for scarce resources for development assistance: The achievement of these challenges presents increasing difficulties for governments of developing countries. These problems favor the growing development of private sector financing, but this financing can only be carried out if the legislation provides security for the investment. Conditions for the performance of the private sector: While private sector companies may be more sensitive to productivity gains and consumer satisfaction, since their profits and survival in the business depend essentially on these factors, there is no guarantee that the Privatization will currently produce improvements in the desired performance. Simply converting a monopoly of the public sector into a private one does not provide any incentive for the company to operate efficiently, make the appropriate investments or respond to the demands of consumers. Thus, privatization itself can do little to improve the performance of the sector if governments are unwilling or unable to address such fundamental problems as the provision of public and meritorious goods, reduction of over-employment, restriction of inadequate political interventions and adequacy in water prices. The conditions under which the private sector will operate must be clearly explained in bids, contracts and regulatory procedures. Among these there is a clear agreement on the importance of conditions such as: the quality of the services provided, the price policy, especially the subsidies or cross subsidies for the poor, and the varied range of decisions that must be made at the level of the public authority and those that rest only in the private company.
- Charging the total cost of water: In principle, charging for the total cost of water ensures the long-term viability of the water supply service and effectively restricts the demand for water, thereby ensuring the sustainability of the resource. These sustainability considerations require that over time, the direct and indirect beneficiaries of water use should, as far as possible, face prices that reflect the total cost of water.
- Sources of public investment: There are important water characteristics that justify the role for public investment in water-related infrastructure. For example, the control of floods and diseases that come from water are public goods, which can not be easily collected on the basis of benefit and individual use. Additionally, the large size and extremely long time horizons of some investments, combined with the risk inherent in political interference, can reduce incentives for private investment. To ensure adequate financing of the water sector, actions are needed to improve the donor-recipient dialogue on the mobilization of financial resources and their allocation to the development of water resources. The international community and governments (as well as donors and recipients) should be encouraged to maintain and increase assistance to the water resource sector, with the objective of solving specific problems. There is an added value in improving communication and cooperation between different financial groups (public, private, national, bilateral and international), introducing measures to mobilize the enormous untapped financial resources of the community and the provision of credit mechanisms that accelerate the independent efforts of individuals.

Cooperation in the International River Basins.

- Vulnerability of downstream riparian: Nearly half of the total world land rests between river basins covering parts of territories between two or more countries. Riparian downstream users are especially vulnerable since the source of the water they depend on is not in their national territory. This issue has created and still creates substantial political tensions and conflicts, throughout the world, at the regional level.

- Although there are substantive principles in international water law, such as equitable utilization and the prohibition of significant harm, there are procedural restrictions for its application on application because of the non–obligation for countries to resort to a third party to resolve the conflict, unless an agreement is reached on a solution procedure to a specific problem. The Helsinski rules, the International Law Commission and the UN Convention on the Use and Protection of Non–Navigational Waters are international instruments designed to facilitate collaboration. There are protocols developed at regional levels, such as the Protocol on Shared Water Courses Systems in the South African Development Community Region (CDSA). At the river basin level, (including shared lakes and groundwater aquifers) a large number of commissions and agreements have been established. Common to these agreements is the wide gap between rhetoric and action, not only at the political level in terms of the willingness to cooperate, but also at the practical level of establishing the appropriate data, information bases and analytical tools necessary for meaningful collaboration [19]. The Coastal States should cooperate on transboundary water resources, seeking negotiated agreements with respect to all the interests of the coastal countries, based on equitable and reasonable water uses. The international community and water–related organizations could act as catalysts and mediators to reach such negotiated agreements.

Institutional roles. Institutional development is critical for the formulation and implementation of IWRM policies and programs. Demarcations of faulty institutional responsibility among actors, inadequate coordination mechanisms, gaps or jurisdictional overlaps and failures to coordinate responsibilities, authorities and capacities for action are all major sources of difficulties in implementing IWRM. The agencies involved in the management of water resources must be considered in their varied geographical scenarios, including the political structure of the country, the unity of the resource in a basin or aquifer and the existence and capacities of community organizations [22].

Roles and Functions of Organizations at different levels.

1. Organizations at the national level: the establishment of a principal organ at the national level may be desirable for the realization of IWRM. It should at least be responsible for development and coordination policies and strategies and national planning regarding water resources. Preferably, it should be independent of the main water users and should report to a higher level government agency. National organizations can also have a role of accumulation and dissemination of information and in some conditions they can act to regulate and monitor the performance of lower level organizations [24].
2. State/provincial/regional management level: in many countries water is managed at the State/provincial/regional/level and not at the national level. Closer to the resource and service users, this level of government should consider issues such as water allocation and waste discharge permits, water collection, application of conditions and standards and permits, monitoring and evaluation of water resources, conflict resolution and general questions about land use planning. Some countries have grouped municipalities, industries and other water users into organizations with a special purpose to implement adequate measures for water management. These types of organizations may have regulatory

functions to ensure that local service providers are effectively fulfilling their tasks.

3. Elements for the success of a basin organization: depending on current conditions and priorities, basin organizations (or lakes or aquifers basin) can vary between being executive bodies with mandates for the allocation of water rights and revenue collection, to be purely advisory and advisory bodies for the current executive and administrative bodies.
4. The participation of civil society and the community: these groups should be encouraged to participate in the operational management of water resources. For example, irrigation schemes can be transferred with appropriate regulations from governments to farmers' associations, and community-based organizations can take responsibility for the operation and maintenance of local water systems. In this way, there is a greater possibility of establishing a sense of ownership, which is often a precondition for improvements and a more sustainable management of assets and resources. As previously mentioned, there is a possibility for public and private associations and private operators, including communities and NGOs, to play a role in the management of water resources. The exact role of participation of each of these actors needs to be evaluated in light of local economic, social and political circumstances.

Developing institutional capacity. Developing an institutional capacity is a means to improve performance. In the context of IWRM, capacity development is the sum of efforts to nurture, increase and utilize the capacities of people and institutions at all levels, local, national, regional and international, so that they can progress in compliance with the objective At the basic conceptual level, developing capacity involves empowering and equipping people and organizations with the appropriate tools and sustainable resources to solve their problems, as opposed to attempts to solve problems directly from a higher level of government.

Instruments for Integrated Water Resources Management. The management tools for the IWRM are the tools and methods that allow and help decision makers to carry out rational and informed choices between alternative actions. These elections should be based on agreed policies, available resources, environmental impacts and precision of economic and social consequences. A wide range of quantitative and qualitative methods are being offered by systems analysis, operational research and modern management theories.

Evaluation of water resources: availability and demand.

1. The management of water resources requires an understanding of the nature and extent of the problem in question: How can all the relevant problems of water resources be identified? how can we ensure that we can acquire useful information that allows us to identify and address current and future problems and solutions about water resources? As a basis for water management, it is useful to carry out an assessment of water resources to acquire such information.
2. The need for a knowledge base of water resources: in many countries the available information on water resources is scarce, fragmented, outdated or otherwise inadequate for management purposes. It is not possible to evaluate the resource or elaborate a quality-quantity balance demand, without adequate access to scientific information regarding the hydrological cycle and the associated ecosystems. Thus, the development of a knowledge base of water resources is a precondition for effective water management. Take the stock of the resource and establish the natural limits of management.
3. Objective of the evaluation of water resources: the concept of evaluating water resources is interpreted to imply a holistic view of the situation of water resources and their interaction with the use of society in a country or region. The evaluation should include the availability of water in time and space, both in quality and quantity,

superficial and underground, and contrast this availability with the demands regarding the resource. In this regard, there is a clear need for measures that compare the efficiency and intensity of different uses (eg product per drop). In the initial stage, the evaluation should preferably be based, as far as possible, on existing knowledge and information to avoid any unnecessary delay in the process of implementing improvements in administration.

4. Environmental Impact Assessment (EIA): the EIA plays a central role in acquiring information on the social and environmental implications of development programs and projects including the implications for water resources, identifying the necessary measures to protect the resource and related ecosystems and then ensuring that these measures are implemented. The IWRM approach involves an assessment of the impact of sectoral development on water resources and that such assessments are also considered in the designs, and priorities of development projects. The EIA is concerned not only about the impacts on the natural environment, but also about the effects on the social environment. Therefore, the EIA touches the center of the need for a cross-sectoral integration involving project managers, water managers, decision makers and the public and provides a mechanism or tool to achieve it.

Information and communication systems.

1. The principle of the participation of stakeholders in the management of water resources requires a serious effort to raise awareness among politicians, decision makers in the water sector, professionals, interest groups and the general public. In any attempt to attract the attention and support of water management of these groups, success will depend on communication mechanisms and the quality and relevance of the information available. Communication and information systems should consider the question of opportunity costs and transactions between alternative water uses and projects, on the one hand, and other social investments on the other.
2. The information needs for the involvement of the interested parties in order to stimulate the participation of stakeholders in the management of water resources and for the participation process to be effective, the availability of timely and relevant information for all interested parties is an essential precondition. Therefore, official reports and inventories of water sources and supplies, records and up-to-date records of water and sewage uses, water rights and their beneficiaries, with their respective water allocations, should be available to the public. In addition, the results of the standards and performance evaluations of service providers should be publicly available, as this contributes to having transparent and competitive water services.

Water allocation and conflict resolution. To efficiently and effectively allocate water among competing users, the following issues should be considered

1. When markets do not fully incorporate the value of water, other mechanisms must be used to allocate water to higher value uses and users;
2. Market mechanisms (transaction systems and / or prices over total costs through valuation) can be improved in conjunction with appropriate regulatory systems; y
3. Conflict resolution mechanisms can be used to facilitate the shared use of water among competing users, such as stakeholders upstream, downstream, in the same course.
4. Assignment by market-based instruments: normal goods and services that are traded in perfectly functioning markets are assigned to their highest use value. In the case of water, due to the intrinsic attributes of the resource and the way in which it has been historically managed, not all water values (including social and environmental values) are or can be reflected in market prices. Thus,

to complement and correct the failures in the market valuation process, measures based on total costs are needed to improve valuation processes and the corresponding markets.

5. Conflict management techniques: a wide range of conflict management techniques, which involve building consensus or preventing and resolving the conflict, are available to assist those interested in their negotiations.

4.8. Regulatory instruments

Three groups of regulatory instruments: to establish appropriate management procedures and structures, water authorities have a multitude of regulatory instruments. These fall into three large groups: direct controls, economic instruments and stimulated self regulation.

Direct control executive regulations. There is a need for handling instructions and regulations that interpret and detail water legislation. If one is dependent on appropriate laws, which contain the basic substantive principles and the authorization for the delegation of authority and the disclosure of regulations, the usefulness of the executive regulations lies in the fact that they, contrary to the laws, can be amended with notifications quickly disclosed, responding to changes in environmental, economic and social circumstances:
Standards and guidelines: these instruments have been widely applied to:

1. Control the amount of water withdrawn from natural water systems by users in defined periods of time;
2. Control the discharge of waste products in the water courses (controls can be placed on the quantity, quality, time and location of the discharges);
3. Require the contracting of specific technologies (technology standards) to both reduce water use and waste loads; and
4. Specify product standards, water supply for specific users and for goods that are potential contaminants (water efficiency standards)

Economic instruments. The use of economic instruments is increasing, but it is far from reaching its potential. Until now, most governments have mainly had direct regulation in the management of water resources. However, economic tools can offer several advantages, such as providing incentives to change behavior, increasing income to help finance the necessary investments, establishing user priorities and achieving management objectives at the lowest possible global cost for the society. The prerequisites for a successful application of most economic tools are appropriate standards, effective administrations, monitoring, application and control and compliance capabilities, institutional coordination and economic stability.

After designing the appropriate economic instruments, it is required simultaneous considerations of efficiency, environmental sustainability, equity and other social concerns, as well as a complementary regulatory and institutional framework. Some notable examples of economic instruments include water prices, tariffs and subsidies, concessions and concession structure, water markets and taxes. There is fragmented, but suggestive evidence that breeding policies can have large impacts and at least 20-30 % of the water used for domestic use and industries can be saved by applying appropriate policy instruments. Experience shows that higher water prices and pollution charges result in a "win-win" situation of water conservation and reduction of its use.

Charge for waste discharges into the water: According to the "polluter pays" principle, effluent rates may be required for discharges of waste into the water bodies; these should be established to reflect both the cost of environmental externalities and those associated with the treatment of contaminated wastewater or receiving water.

Water markets as an economic regulation are widely used in the American West area. The availability of water supply and water rights are quantified and recorded. Water rights are granted under conditions of cash and beneficial use. The transfers are supervised and monitored by regulatory institutions. These markets have been active. Other countries have implemented water markets without the requirements of beneficial and

effective use. The supervision of governments is minimal. These markets have not been active. The lesson learned is that markets that operate under adequate government regulation, under principles of beneficial and effective use, and prevention of harm to third parties and the environment, have promoted efficient and equitable water reassignment [21, 25].

Taxes: The collection of taxes on products or taxes that harm the environment can be a powerful tool to affect behavior and are especially apt where users have an alternative production or alternatives to waste disposal that are less harmful to the environment. This tool can be applied to products that involve a high consumption of water and products that contribute to water contamination. For non-point pollution problems, especially those related to the use of agrochemicals, this option has turned out to be the most useful tool, since in this case, direct control of the discharge or treatment options is not feasible. Therefore, the reduction of pollution is achieved through the lower use of agrochemicals resulting from the higher prices of products. However, any adverse effect on food production resulting from the higher prices of fertilizers and pesticides should be considered.

Encouraging self–regulation. Transparency of information not only imposes incentives on water service providers to improve their performance (tables of main standards), but also allows civil society and government agencies to judge and press for performance improvements. In recent years, the high costs of controlling and controlling regulation have stimulated the development of "self–regulatory" mechanisms, supported by appropriate performance monitoring procedures. For example, professional organizations can produce better practical guides or governments can introduce "quality" comparison schemes; such schemes are now quite common in areas of product safety and the environment and can also be useful for water sector instruments.

Technology.

1. Technological advances towards sustainability: When evaluating the range of available management tools, the role and field of technological advances should be carefully considered as a factor that can help achieve the sustainable management of water resources. There is a field of technological progress both in the refinement of technology, through the water sector itself, and in those other productive sectors that critically affect the supply and demand of water services. Traditional technologies such as harvesting with rainwater can also play a key role.
2. Research and development in technology: Technological innovation and adaptation are key components of many efforts in the water sector. At the conceptual level, forecast models and systems are being improved, particularly as a result of advances in computer technology, which allows better predictions about temporal and spatial variations in the quantity and quality of available water resources. This can help reduce uncertainty and risk in the use and management of resources. Water-saving technologies in irrigation (drip irrigation), improved and cost-effective methods for the treatment and reuse of wastewater in industries and household systems, water recharge technologies, human waste disposal systems require no or extremely small amounts of water and economic, but effective water purification systems for villages, are other examples of promising innovations which can promote the future sustainability of water resources. However, achieving such technological advances requires appropriate incentives and the willingness of the richer countries, particularly the industrialized nations, to invest in research on a long-term return.
3. Choice of technology: In addition to the promising prospects mentioned above, a warning word on the technological issue is justified. Many projects in the water sector have failed in developing countries due to discretion in the application of technologies that have served in industrialized countries but in different physical, social and economic

environments. It must be taken into account that technological choices must consider the specific conditions prevailing at the place of use. This means that the most advanced and modern technology is not necessarily the optimal decision in all cases. If the system can not be sustained due to lack of answers, lack of skilled labor or economic resources for the operation, this is not the most appropriate solution. Moreover, high-cost technologies can prevent the involvement of the community and families in water management.

4.9. Some experiences cases [5, 6]

In Bogor, Indonesia, as a result of a tariff increase of 200–300 % for different groups of consumers in 1990, a family with a monthly consumption of 30 m3 had to pay $ 0.42 for one cubic meter of water (exceeding the consumption of 20 m^3) instead of $ 0.15. This produced significant reductions, such as 30 %, in the use of water for the affected groups.

In Sao Paulo, Brazil, in 1980, three industrial plants were required to pay effluent charges to the effluent treatment plant. The companies decided to economize through changes in production processes, substitution of supplies, use of more efficient equipment and the use of a mechanical washing machine instead of a washing machine by hand. In the pharmaceutical industry, the volume of effluents (and water consumption) per unit of product in 1982 was 49 % less than in 1980. In the food processing industry, water consumption and effluents decreased by 42 % per unit of product compared to 1980. The steps taken to achieve these reductions were changes in the processes of washing and recycling of effluents and modifications in the cleaning processes. In the dairy industry, the tributaries and the use of water were reduced by 62 % through improvements in the washing process and the expansion of the installation of a treatment plant.

A case of IWRM from Tamil Nadu, India: Several components of IWRM are being used in the Vaigai basin of Tamil Nadu in South India, including

- The participation of stakeholders ranging from government agencies to washerwomen.
- A decision support system that quantifies implications and transactions of alternative water allocations and policy decisions; and political and administrative support from the government and other agencies.

The problems in the Vaigai river basin, a fairly short water basin, include

- Conflicts among stakeholders due to the multiple uses of water.
- The involvement of multiple institutions in various aspects of planning (often overlapping) and watershed management.
- Conflicts upstream, downstream; and transsectoral conflicts that result from rapid urbanization, while the demand for traditional water remains.

International cooperation: Ten countries share the Nile basin. Nine of these ten countries have agreed to form a regional association known as the Nile Basin Initiative (NBI), built on previous cooperation efforts. Launched in February 1999, the NBI seeks to take advantage of the great potential of the Nile through the management and sustainable development of its waters for mutual benefit. The shared vision of the NBI is "to achieve sustainable socioeconomic development through equitable utilization and to benefit from the common water resources of the Nile Basin". The NBI is governed by a council of ministers responsible for water affairs in the countries of the Nile Basin. The council is supported by the TAC (technical advice council) of the Nile and maintains its secretariat in Entebbe, Uganda.

Management of a river basin in France: In December 1964 a law divided the entire territory of France into six Water Agencies, its spatial boundaries follow hydrological divisions. Each Agency is organized as follows

- The staff prepares the program and implements it after its approval (conscience);
- A committee of about sixty representatives of all interested parties approves the program, fees, concessions and loans (the forum).

Each Agency has the following obligations

- Establish water management investment programs for five years.
- Collect payments for each m3 of water extracted from the natural water resource and for each ton of waste discharged into the natural water resource;
- Grant low-interest loans to all actors (cities, industries, etc.) who contribute to the implementation of the five-year program. Expenses and income must be in balance with the five-year program (the budget).

Localized subsidies- The Chilean experience [26]: Chile has been able to implement a well-functioning system of local subsidies on drinking water and sanitation. The success of the system depends on the joint efforts and institutional capacities of the national government, municipalities and water companies. Other countries in Latin America have tried to replicate Chile's very successful experience. However, the available funds did not match the needs of the users, nor did the institutional capacities of the government equalize the monitoring requirements for the implementation and execution of the system. For this reason, some countries such as Argentina have resorted to traditional cross–subsidies, despite the obvious disadvantages of the system. The lesson is that before suggesting so many localized or crossed subsidies, countries and financial institutions should guarantee, not only the economic and financial viability, but also that the institutional structure allows an effective implementation.

In the case of Peru, the Project "modernization of the integrated management of water resources" in selected basins -(PMGRH) was implemented. This project started in 2010 and culminated in 2015, in which the sustainability of the Watershed Councils was evaluated. Currently, the second stage of the PMGRH is on the run. In the years 1998 to 2006, the National Program for the Management of Hydrographic Basins and Soil Conservation, had a Sub-Directorate for Watershed Management, in which the formation of the Micro-Basin Management Committees was promoted, most of them were not sustainable over time.

5. Conclusions

The Integrated Management of Water Resources is carried out at the basin level. In addition to the government, private companies and community-based organizations should be involved, facilitating the participation of women and economically disadvantaged groups, all stakeholders in the basin should be involved. The Government fulfills a role of facilitator, as regulator and controller. Legislation provides the basis for government intervention and action and establishes the context and framework for action. Downstream populations are especially vulnerable since the source of the water they depend on are not in their territory. In principle, the available water resources can be traded in a market so that the water is assigned to its highest values of use. Although theoretically more efficient, water markets can only work with appropriate institutional arrangements. Specific water laws have been stipulated in a considerable number of countries, but some still lack a water resources law. The private sector has a role to play in many countries to improve the technical and administrative capacities of public service companies and provide the necessary capital investment; however, the investment of private companies will only be carried out if the rates of return on capital are reasonable considering the perceived risk involved. In cases in which greater social concerns restrict the application of total cost in prices, in the short term it may be appropriate to base prices on the total cost of economic recovery or at the minimum on total supply costs. Implicit or explicit subsidies should be identified, with their objectives, and implemented in a transparent manner.

Restrictions and potential for sharing transboundary waters: The enabling environment equivalent to national or local legislation is the international agreement on the principles for managing and sharing transboundary waters; when capacity development is successful, the result is more

effective in individuals and institutions that are better prepared to provide products and services on a sustainable basis; the information available on water resources is scarce, fragmented, outdated or inadequate for management purposes; a key problem is how to include the value of the environment in the provision of water services, including the sustainable provision of the water resource itself. The value of the protection of the catchment area for downstream water users and the value of groundwater recharge areas has not been adequately incorporated by the planning methodologies.

Recommendations

It is necessary to involve the participation of women and economically disadvantaged groups, as well as the participation of private companies.

Integrated Management should be carried out by basin, involving all the stakeholders. The IWRM should consider the implementation of actions to protect the water resources in the upper parts of the watersheds. The IWRM should consider the implementation of actions to plant water in the upper parts of the basins. Incorporate traditional technologies for planting and harvesting water, as well as the recognition of non–traditional organizations for water management.

There is a special need to develop methodologies to assess the benefits of ecological services provided by nature; expand the scope of environmental assessment, relating the experience of economists with the analysis of hydrologists and ecologists; the valuation of the costs and benefits of the ecosystem have not been on the practical water management agenda so far; for this a multidisciplinary research is required.

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