

## **Water Management through Its Models with an Administrative Approach**

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### **Abstract**

*Water management is a topic written in a lot of books and papers, due to the growing world concern for the shortage of the resource; however, few studies have scientific rigor. The purpose of this paper is to integrate a water management model with an administrative approach. From documentary research, concepts and models are established on this topic. The results show that the integration of the proposed model is feasible, and it is suggested further scientific research in this kind of models because they are scarce in the literature.*

**Key words:** water management, models of water management.

### **1. Introduction**

The term "management" was conceived in the nineteenth century, in the studies of Bonnin (1812) and it was defined in terms of actions, processes, tasks and public activities. Over the years, this definition has not changed substantially, it only has been adapted to different contexts as a result of the growth and development of society. It is worth to mention that management has been considered as a factor of the administration (Calderón & Castaño, 2005).

Water management, as a human resource, has been considered in most countries of the world as a responsibility of the Public Administration and therefore of their respective States (World Water Assessment Programme, 2009), creating from this, public-private associations in different countries for water management with both positive and negative results (Elnaboulsi, 2001; Organisation for Economic Co-operation and Development, 2009; World Water Assessment Programme, 2009).

Concern over water is a global problem, being of special restlessness the problems that arise to achieve a regular distribution and supply with the necessary quality in many cities, towns and rural areas (Comisión Nacional del Agua, 2011; World Health Organization & UNICEF, 2010). Experts say that the most developed countries are the ones with more coverage of potable water and also the ones that use the most water for their daily activities (UNICEF, 2012), which are very different (World Water Assessment Programme, 2009) in contrast to countries with highest amounts of water per capita but that fail to achieve a high fluid supply (Food and Agriculture Organization of The United Nations, 2013).

The increase in population has resulted in an increased demand for water (Anisfeld, 2010) and especially the problematic is latent in the mega cities (Tortajada, 2008), not to mention the effects of climate change (Bates, Kundzewicz, Wu, & Palutikof, 2008) and the limitations that may exist naturally for obtaining water (Miller & Spoolman, 2011; UNESCO, 2011; Domènech & Peral, 2006; Woodhouse, Howlett, & Rigby, 2000). It is necessary to explain that the problem is the management of water resources and it is one of the main factors restricting the sustainable development of countries over the coming decades (Programa de las Naciones Unidas para el Desarrollo, 2006; Naciones Unidas, 2011). In the literature, there are few models of water management with an administrative approach, in contrast are more abundant the models of water management with operational factors. It stands out the Hooper model (2006), for the integral of its administrative elements.

This paper discusses water management, as a human resource, through different approaches with special emphasis on models with administrative elements in order to build a model of this nature. To achieve this objective, a number of certain points are covered. First, to establish the reference framework, a review of these issues is done, to clarify how it is that the authorities conduct the management of this resource. Second, water management is defined by the main authors who have conceptualized this phenomenon. Third, the most important models for the management of water resources that contribute to management science are analyzed, indicating their advantages and disadvantages and emphasizing the administrative models.

## ***2. Conceptualization of water management***

The first time the term was used was in the early nineteenth century in the work of Bonnin (1812). This author equates the management and administration with actions, processes, tasks and activities to dealing with public issues. Fremont and Rosenzweig (1979) conceptualized the term "management" as the optimization of an organization through technological direction, the organization of people and its relationship with its environment. De Bruyne (1983) focuses on pragmatism, because it indicates that management includes knowledge and a practice that requires science and art. Complementary to this definition is the one of Aubert and Gaulejac (1987) who assert that the fundamental function of management is to generate organization, referring to the establishment of mechanisms that allow solve problems that arise daily in an organization and achieve continuous tension in a coexistence of partially ordered elements. Following the approach in the private sector, Martínez and Camargo (1995) define management as a set of social development objectives and the administration of organizations in interaction with the social rationality their environment. Moreover, Brugué and Subirats (1996) suggest that management consist in using knowledge as a tool to facilitate continuous improvement and assumption of responsibility over the action of a system.

Other authors such as Pacheco, Castañeda and Caicedo (2002) integrate the definition of management, discussed above, because they consider it as a system that includes objectives, strategy, technology, structure, organizational processes, corporate culture and personality of the members of an organization. Calderón and Castaño (2005) point out that the object of study of the administration is the management and governance of the people in an organization, which recurs in the public sector, as the focus given by Sánchez (2003) that indicates that management refers to the operational dynamics of institutions that guides the work of its officials towards achieving results. This author points out that the Executive Power of a country has as rationale the management because in this way, matters of public interest of the citizens of an entity are routed. Moreover, Drucker (2007) explains that the management should be understood through what he calls the "theory of the business", which are the assumptions that dictate decisions and define what an organization considers as meaningful results. It aims to empower an organization in an unpredictable mean to achieve its results.

Management concepts have been explained by several authors, highlighting the approaches of the public and the private sector. The definition oriented to the public sector is the largest, taking into account a country's government in its intervention (Sánchez, 2003), emerging as a complement to the study of the public policy of the State (Bozeman, 1993). However, the following definitions considered in this paper focus on water management, without losing of sight that they relate to the management concepts that have been detailed before, as they integrate various entities involved and stand out the practical part of the management. It is necessary to emphasize that there are even different perspectives to define water management, from approaches designed for rural water supply, others grounded in the basin unit, to urban approaches. The difference between them lies in the participation of a greater number of separate organizations in rural areas and greater centralization of these in urban areas (Santos, Cordery, & Lacovides, 2009).

Mollinga (1998) defines water management as a form of social interaction between various entities in which various methods, resources and strategies for usage activities and distribution of water resources are used. Martínez, Graf, Santana, and García (2005, cited in Martínez, Graf, Santana, & Garcia, 2005) describe water management as a series of actions undertaken integrally by entities of a basin for the conservation, management, supply and disposition of water in it, to ensure the quality and quantity for the sustainable development of society. In the Ley de Aguas Nacionales (2012) of Mexico, it is explained that water management belongs entirely to the Government's administration of the water resources and it is defined as a continuous process from a series of principles, policies, events, resources, tools, formal and informal rules, assets, rights, attributions and responsibilities that; in conjunction with the State of a country, water users and civil society organizations, promote and orchestrate, to achieve sustainable development for the benefit of humans and their social, economic and environmental.

The definition of the Ley de Aguas Nacionales (2012) of Mexico is very comprehensive because it considers various involved entities which perform several activities in water management through an approach of the public sector. In this way, it is observed that definition of the term "management" is different according to the contexts and periods when it was conceptualized. Activities immersed in the definitions are relevant as they have been achieved water resource management to propose solutions from different points of view on the existing problems of water management internationally.

### **3. Research method**

The research took as its starting point a bibliographical review through books, master's and doctoral thesis, technical papers, websites and scientific papers in different databases like JSTOR, EBSCO, Springer, Elsevier, among others. Administrative management models of water were analyzed or those who had affinity for Administrative Sciences, they were selected under the criteria of the degree of scientific rigor and citation index.

#### **3.1 Research analysis of water management models**

A significant finding was to observe the lack of management models in the public administration. It is noteworthy that in most of the research on this topic no measuring instruments are made for water management, although a set of variables and dimensions for its analysis are proposed. In addition, most models focus exclusively operational on the aspect of water management.

It should be noted that within the search for models were found some relevant but limited, such as water management policy networks (Rhodes, 2000), integrated water management (Carabias & Landa, 2005; Guhl, 2008), management of intermunicipal water (Ventura, 2010) and the model of environmental management LART (Rivas, 2009). In general, these models attempt to decentralize functions, to promote that various systems of government between regions interact with each other to assist with water management or pose an overview of the elements that must have a model of environmental management, but more research is needed in this class of models to focus them on water management with an administrative perspective.

The models that are explained in this paper are 9 since, they are considered relevant to carry out water management in a given entity. They are very general models, which will give guidelines to be deepened and adapting its elements to be used for a certain context.

### **4. Water Management Models**

#### **4.1 Description of nine water management models**

Once done the corresponding analysis, immediately delves into the fundamental localized models to be considered in water management:

- 1. Management model of formal institutions (2006).** In this model, are explained certain dimensions to be used for the management of formal institutions. The elements of the formal institutions have applicable a comprehensive approach to the analysis of institutional performance. These authors quantify through the effectiveness of the size of the institutions, the interrelationships between these elements and the performance of the water sector. The dimensions presented by these authors are: a) the effectiveness of water law; b) effectiveness of water policy; c) overall performance of the water sector, and d) effectiveness in water administration (Saleth & Dinar, 1999). It is a model oriented to effectiveness and it is limited to political factors.

2. **Water governability model (2006).** This model focuses on governance issues, therefore more dimensions for structuring an integral management are not considered. Dimensions of different sectors are used to enrich the management and it focuses more on the political aspect of the resource. It is noteworthy that one of the purposes of governability is policy formulation and its implementation by the State (UNESCO, 2006). The dimensions used in this model according to UNESCO (2006) are: a) social; b) economic; c) political training, and d) environmental sustainability.
3. **Model of integral management of water resources in the hydrographical basins (2006).** In this model, dimensions and general performance indicators for the water sector were formulated; the model development was carried out in several stages, in which participated professional experts, consultants, basin managers and managers of water resources at the international level. The result of this investigation of Hooper (2006) was the formulation of 115 indicators for the river basin management and the following 10 dimensions: 1) coordinated decision making; 2) response in decision making; 3) objectives, change of objectives and finalization of the objective; 4) financial sustainability; 5) organizational design; 6) role of the law; 7) training and development; 8) information and research; 9) responsibility and tracking, and 10) functions of the public sector and private.

Hooper (2006) also developed an instrument for measuring water management taking into account the elements of his model, to achieve this a Likert scale was used. His instrument has been applied in the United States with favorable results. This model needs to be applied in different contexts, to analyze the results that could be obtained.

4. **Model of integral management of water resources at hydrographic river basin level (2008).** Cap-Net (2008a) is a project of international network for capacity building in sustainable water management of the United Nations for the Development, has worked with river basin organizations at national and state level to help them in their development and to be effective in the managing of their water resources. Based on a program for capacity building, it has been developed certain dimensions for a model that is based on the implementation of an integrated approach for sustainable water management: a) allocation of water resources; b) control of the pollution; c) control of the permissions for water allocation; d) watershed planning; e) economic and financial management, and f) information management and participation of interest groups (Cap-Net, 2008b). The dimensions and indicators are presented as the minimum, which do not allow to have an integral view of water management.
5. **Model of management efficiency in the service provision of potable water and sewerage (2009).** A research in Chile was done, where factors affecting the efficiency with the provision of potable water and sewerage services in the eighties and nineties were identified, in a period in which there was an efficient performance and the country was positioned within the first places in Latin America and the Caribbean in coverage with continuous access to health services in excellent conditions of quality and security and with prices set by technical parameters, which the urban population was willing to pay (Alfaro, 2009). The Metropolitan Sanitary Works Company explained certain "underlying guiding principles" to be followed to ensure the efficient and sustainable provision (Alfaro, 2009): a) self-financing rates to cover the actual costs of the provision of services; b) provision of services by an expert judgment emphasizing in the economic and financial evaluation of decisions and avoiding political interference; c) the need to ensure a good level of autonomy of the sector, in particular, internal management on the enterprises, and d) the convenience of structuring the provision units in order to provide maximum utilization of the economies of scale. In addition, according to the author, four dimensions are of special interest: a) Rates for financial self-sufficiency; b) quality of service; c) operation at minimum cost, and d) maximum coverage. It is an integral model for water management organisms, but it was developed for a specific context: Chile.
6. **Model of management in water operating organisms, sewerage and sanitation (2009).** The Consejo de Cuenca Lerma-Chapala (2009) developed a manual that is aimed at operating organisms in Mexico. The model is applicable to any location that provides potable water, but was created in order to help increase the overall efficiency in the localities of the Lerma-Chapala Basin (Consejo de Cuenca Lerma-Chapala, 2009).

The dimensions of the model are: 1) coverage of potable water; 2) sewerage coverage; 3) sanitation coverage, 4) continuity of service; 5) provision per inhabitant; 6) impact on electric energy; 7) coverage in macrometering; 8) coverage in micrometering; 9) physical efficiency; 10) commercial efficiency; 11) global efficiency; 12) superficial offer; 13) underground offer; 14) agricultural reuse before treatment; 15) agricultural reuse after treatment; 16) global agricultural reuse; 17) discharge to receptor's body; 18) network losses, and 19) index of economic sufficiency.

The main dimensions required are presented for an operational management of the resource. The model is more focused on the operational aspect of water management.

7. **Model of integral water resources management in hydrographic basins (2010).** In this model, proposed by Hooper (2010) it is explained that much was learned from the experience in the U.S. basin, and that the procedures to enhance the participation of organizations in the basin have been well articulated in the past and are now receiving renewed attention (Priscoli, 1976; American Water Resources Association, 2005). The concern is that other demands are exerting pressure on land and water resources and that are increasing the callings for basin management (American Water Resources Association, 2007). That is why in this model the following dimensions (Hooper, 2010) are considered: 1) international reciprocity and goodwill; 2) stable democratic conventions; 3) functional specificity; 4) clear management functions and jurisdiction, 5) specificity in the reach of the problem; 6) availability of financial and human resources; 7) participation of the private sector; 8) change of objectives, 9) responsibility; 10) legal and judicial environment; 11) legislative backing; 12) formulation of realistic objectives; 13) failure to establish the need, reach and context; 14) sectoral integration; 15) coordination; 16) organizational style; 17) management of balanced agreements; 18) capacity for local and regional planning; 19) regulations governing the structure; 20) clear coordination process; 21) rules that regulate the process: decision rules for regional leadership of business operations; 22) realistic management; 23) public sector leadership; 24) knowledge system; 25) competition in the informal water sector; 26) improves on the productivity of "green water"; 27) water scarcity through an intersectoral approach; 28) access to information and integration; 29) water pricing and management of the demand; 30) rules on information; 31) research system (data and control); 32) effective participation of the community, and 33) flexible and adaptive management. The posed dimensions focus more on the administrative side of the management, which is very rich, but it needs to be applied to different contexts to analyze how they operate.
8. **Model of Water Management (2011).** This model, designed for the context of Mexico in 2010 by the Consejo Consultivo del Agua (2011), was something new, since there were not many investigations that allowed to assess and compare the performance of water management in the cities of Mexico. Through experts in water issues, five essential dimensions were defined for the management of potable water systems and sanitation: 1) efficiency; 2) public finances; 3) quality of service; 4) environment, and 5) institutionalization (Consejo Consultivo del Agua, 2011). The model needs to be expanded to have an integral water management.
9. **Model of efficient management in the potable water operating organisms and sanitation (2012).** In this model, leaders in water management and operating organisms of sanitation in Mexico, conducted an exercise to help administrators identify and deal with the most urgent needs, 10 important dimensions were identified to have a good management of water resources: 1) product quality; 2) staff development and leadership; 3) operational optimization; 4) customer satisfaction; 5) financial viability; 6) adequate water resources; 7) stability of infrastructure; 8) community sustainability; 9) understanding and support of the actors, and 10) operational resilience (Asociación Americana de Obras Públicas, *et al.*, 2012). The most important dimensions are presented for an efficient management in the management organisms of water under an administrative approach, although it is necessary that the model is extended to have a broader view of the management.

#### 4.2 Elements of water management models

The main feature of water management models discussed in this paper is that they were made with a focus towards the public sector.

In Table 1, the elements that are there in each model were labeled in order to analyze the common elements of these, according to the classification of its dimensions type: economic (E), political (P), administrative (A), social (S), technological (T) and legal (L).

The analyzed models are mixed and seven of them use administrative factors. Of special importance are the models of integral management of water resources in hydrographic basins of Hooper (2006, 2010), since for its elaboration were involved a large number of experts, also, they are models that have more elements, according to the classification that was made in table 1.

#### 4.3 Discussion and proposal of a model of integral water management

An integral administrative model for water management organisms is proposed, in which various features of the models discussed above are retaken (Hooper, 2006; Cap-Net, 2008b; Consejo de Cuenca Lerma-Chapala, 2009; Asociación Americana de Obras Públicas *et al.*, 2012). The proposal is shown in Figure 1.

It is important to retake the dimensions that are considered pertinent of Figure 1 in a water management organization, as well as deepen or adapt them to a particular context, as they are general models that have a rigorous theoretical basis. Then, in a general way, the dimensions of the model of Figure 1 are explained:

1. Planning of the basin: management activities of the water resources formulated in a basin plan (Cap-Net, 2008b).
  - 1.1. Adequate water resources: ensuring availability of water, management of the operations to provide sustainability and replenishing of surface waters and aquifers (Asociación Americana de Obras Públicas *et al.*, 2012).
  - 1.2. Community sustainability: impacts on community and health, efficient water and energy resource use, economic vitality, ecological and community sustainability (Asociación Americana de Obras Públicas *et al.*, 2012).
  - 1.3. Product quality: compliance with standards and the requirements of reliability and consistency with customer requirements (Asociación Americana de Obras Públicas *et al.*, 2012).
2. Coordinated decision making: coordination mechanisms between organisms of water management and a consensus based on decision making. (Hooper, 2006).
3. Response in decision making: efficiency in decision-making processes that will articulate in new knowledge and new conditions (Hooper, 2006).
  - 3.1. Global efficiency: manage water resources at a given time considering the resources used (Consejo de Cuenca Lerma-Chapala, 2009).
  - 3.2. Stability of the infrastructure: maintenance and improvement of the assets at long term and at the lowest possible cost and coordination for repair of the infrastructure reducing the interruptions (Asociación Americana de Obras Públicas *et al.*, 2012).
  - 3.3. Customer Satisfaction: reliable service, responsible and at affordable prices (Asociación Americana de Obras Públicas *et al.*, 2012).
4. Quality of service: continuity and extent of service, percentage coverage of potable water and sewerage in the population (Consejo Consultivo del Agua, 2011). Objectives, change of objectives and completion of objectives: achievement of water objectives in an integral way (Hooper, 2006).
5. Financial sustainability: active financial support, the costs and transparency in the application of financial resources. (Hooper, 2006).
6. Organizational design: use of organizational structures that adapt to the needs of the managing organisms of water (Hooper, 2006).
7. Role of the law: existence of strong and flexible laws that will support the management of water within river basins (Hooper, 2006).
8. Training and development: ongoing training for appropriate personnel, for the needs of the basin (Hooper, 2006).
9. Research and information: existence of a system that facilitates the decision making process, protocols for information sharing and the establishment of a culture of links between research and knowledge (Hooper, 2006).
10. Responsibility and tracking: responsibility of the basin organizations with governments and citizens, as well as the utilization of transparent mechanisms of information (Hooper, 2006).

**11.** Roles of public and private sector: clear specification the functions of the public and private sector (Hooper, 2006).

**5. Conclusions**

The Conceptualization of the term "management" and "water management" has not changed transcendently over the years, only has been adapted to different contexts as a result of the growth and development of society. In the nineteenth century, in the work of Bonnin (1812) management and administration in terms of actions, processes, tasks and public activities were defined. The concept of water management of the National Water Law (2012) of Mexico is very comprehensive as it consists entirely to the government’s administration of water resources, where many entities are involved.

Concern for water is a worldwide problem (National Water Commission, 2011, World Health Organization & UNICEF, 2010) where the management of this resource is one of the main limiting factors for sustainable development in the world over the coming decades (United Nations program for Development, 2006, Naciones Unidas, 2012).

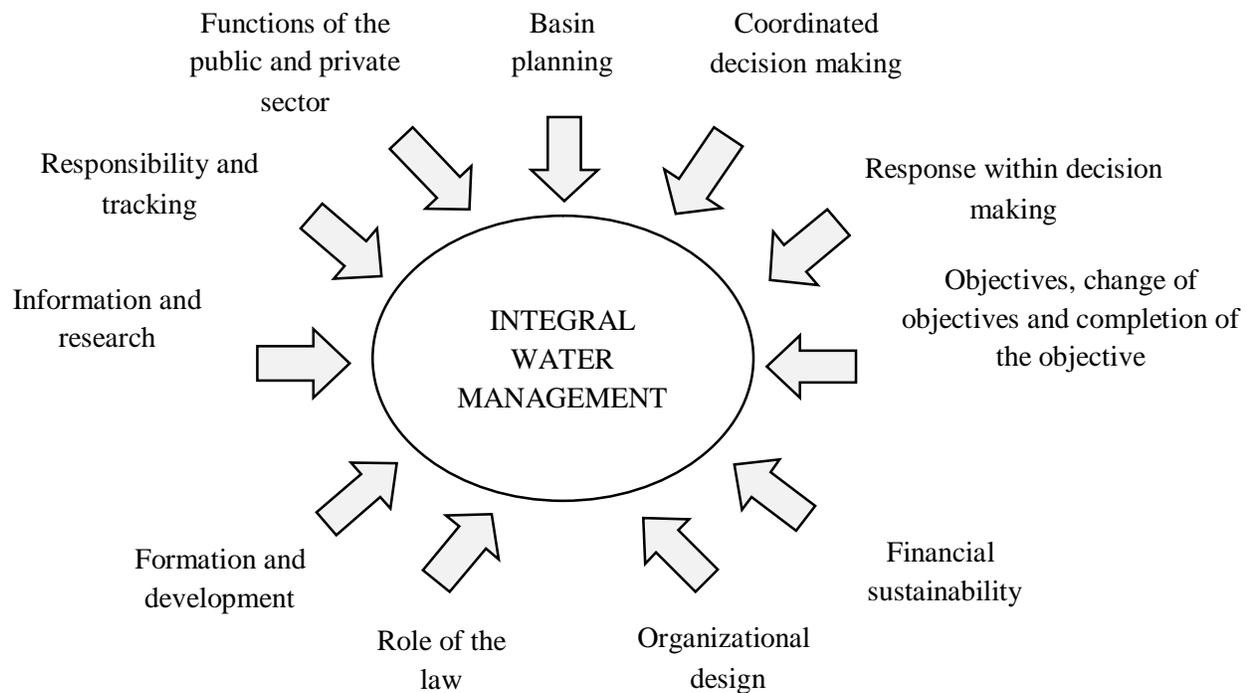
Taking into account the existing water problems is necessary to formulate and establish in the world, new models of water management to solve existing water conflicts. An important finding was that in the literature there are few models of water management with an administrative approach, however, 9 models of this nature, among which stands out the model of Hooper (2006) for the integral manner of its elements, were analyzed.

With these findings and voids, and to fulfill the objective of this paper, a proposal to build a model of water management with an administrative approach through the dimensions used of 7 of the 9 models analyzed here, was formulated. It is recommended to delve into the model proposed in this research to have greater content validity or statistical validity.

Finally, it is necessary to increase research on water management in the administrative science, since scientific researchers are not abundant and the problems derived from water management in the world have been increasing.

**Table 1. Common elements in the models of water management**

Models / dimension type	E	P	A	S	T	L
1. Management of formal institutions (Saleth & Dinar (1999)		X	X			X
2. Water governability (UNESCO, 2006)						
3. Integral management of water resources in the hydrographical river basins (Hooper, 2006)	X	X		X		
4. Integral management of water resources at hydrographic river basin level (Cap-Net, 2008)	X	X	X	X	X	X
5. Management in water operating organisms, sewerage and sanitation (Consejo de Cuenca Lerma-Chapala, 2009)	X		X			
6. Management efficiency in the service provision of potable water and sewerage (Alfaro, 2009)	X					X
7. Integral water resources management in hydrographic basins (Hooper, 2010)	X	X	X	X	X	X
8. Water Management (Consejo Consultivo del Agua, 2011).						
9. Efficient management in the potable water operating organisms and sanitation (Asociación Americana de Obras Públicas <i>et al.</i> , 2012)	X		X	X		X

**Figure 1: Structure of the proposed model of integral water management**

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