Shimelis Gebriye Setegn
Maria Concepcion Donoso *Editors*

Sustainability of Integrated Water Resources Management

Water Governance, Climate and Ecohydrology

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Foreword

All around the world, people are feeling enormous pressures from the challenges of managing water resources. Climate change is affecting the global water cycle, leading to irregular rainfall, more floods and more droughts. Water availability has been reduced due to mining of groundwater, pollution and abstraction from upstream water sources. Expanding cities and accelerating economic activity are increasing the demand for energy and food and creating further unsustainable pressures on water resources. Competition for land, water and food is threatening to exacerbate poverty, hunger and environmental deterioration.

Addressing the complex inter-linkages effectively requires an integrated framework that leverages the synergies among access to water and sanitation, education and health, equality and women's empowerment, energy security, food and nutrition, climate, biodiversity and ecosystems, governance and the rule of law. The Millennium Development Goals included the target of halving, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation. Member States of the United Nations in 2010 explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of all human rights. Building on the achievements and the lessons learned thus far, the new sustainable development agenda will be adopted in September 2015 to set the world on a path to sustainable development.

The new sustainable development agenda will build on the work of the Open Working Group established after the Rio+20 Conference in 2012. It conducted an unprecedented transparent and inclusive process, open to the participation of all stakeholders, including civil society, businesses, academia, local authorities, parliamentarians and citizens. The outcome of the Open Working Group contains a proposal for the Sustainable Development Goals (SDG), which will be the main basis for the final set of negotiations leading to the world leaders' Summit in September 2015.

The new agenda will be strongly human-development focused while addressing the planetary boundaries, economic growth and social inclusion in an integrated

manner. It will reflect universality, integration and transformative change, backed by accountability supporting the data revolution.

During the deliberations of the Open Working Group, member states acknowledged that water is at the core of sustainable development, as water and sanitation are central to the achievement of many other development goals and play a vital role in economic growth and poverty eradication. The relevance of sustainable management of watersheds and other water-related ecosystems has also been acknowledged. The Integrated Water Resources Management (IWRM) perspective is reflected in the proposal for an SDG on "Ensuring Availability and sustainable management of water and sanitation for all", with a target to implement IWRM at all levels by 2030.

This book will contribute to providing science-based evidence on the ways of better implementing its goals and targets, monitoring progress through appropriate indicators and data, and the means for implementation. The text addresses some of the theoretical, practical and political issues encompassed by IWRM in a comprehensive and multifaceted way. It includes the households, local, country and regional perspectives on IWRM, linking experiences and evidence with the major global challenges. The book covers a wide range of factors that ultimately influence the effective exercise of the human rights to water and sanitation in a sustainable way, including the links with governance and conflicts.

I believe this publication will help better inform the post-2015 development agenda by bridging the gap between evidence and policy making, between science and programs, between academics, policy makers, civil society, businesses and communities.

Special Advisor of the UN Secretary-General on Post-2015 Development Planning, United Nations

Amina J. Mohammed

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Chapter 1
Introduction: Sustainability of Integrated Water Resources Management (IWRM)

Shimelis Gebriye Setegn

1.1 Overview

Water is essential for life, ecosystems, and social and economic development. We depend on a reliable, clean supply of drinking water to sustain our health. Water is also needed for agriculture, energy production, navigation, recreation, and manufacturing. Its exploitation and use must be well planned and managed in a sustainable manner. Water availability has been reduced due to periodic droughts, overconsumption of surface and groundwater resources, and pollution and climate change. Population increase, fast growth of cities, and accelerating economic activity are increasing the demand for water, energy, and food and creating further pressures on water resources. In many developing countries, the lack of adequate, clean, and safe water, pollution of aquatic environments, and the mismanagement of natural resources are still major causes of environmental health problem and mortality. Irregular rainfall, more floods, and droughts are becoming more frequent events in different parts of the world.

The crucial importance of water to the various aspects of human health, development, and well-being has led to specific objectives concerning water and the support to each of the eight millennium development goals (MDGs), established by the UN in the year 2000. With a human population and water demand that are continuing to grow, the management of water resources will become of vital importance. Moreover, sustainable freshwater resource management will need to be included in future development plans and implementations. The sustainability of integrated water resources management (IWRM) in the face of climate variability and change is an important issue when planning and/or developing policies that

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consider the impact of climate change, ecohydrology, and water governance in the context of a more holistic approach to ensure sustainable management of water resources. Sustainable IWRM is more about processes, and more should be done to articulate the most essential IWRM components that ensure the ongoing IWRM sustainability efforts. Hence this book addresses the importance of integrated water resources management toward achieving water, energy, and food security. It addresses appropriate means of managing the scarce surface and water resources in the face of climate change and increased population pressure and high water demand. The book also addresses the question of how to define and measure the sustainability of IWRM. Main topics covered in this book include global prospective of IWRM; allocation of environmental flows in IWRM; ecohydrology, water resources, and environmental sustainability; climate change and IWRM; IWRM and water governance including social, economic, public health, and cultural aspects; climate change resiliency actions related to water resource management sustainability; and tools in support of sustainability for IWRM.

This book will be of interest to researchers, practitioners, water resource managers, policy- and decision-makers, donors, international institutions, governmental and nongovernmental organizations, educators, as well as graduate and undergraduate students. It is a useful reference for integrated water resources management (IWRM), ecohydrology, climate change impact and adaptations, water governance, environmental flows, geographic information system and modeling tools, water and energy nexus, and related topics.

1.2 Integrated Water Resources Management: Global Perspective

IWRM, as the Global Water Partnership defined, is the process of promoting the coordinated development and management of water, land, and related resources, to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM aims to support countries in their efforts to tackle specific water challenges, e.g., water scarcity, waterborne diseases, floods, droughts, and access to water and sanitation, and thus sustain their development to achieve the goals such as poverty alleviation, food security, economic growth, and ecological conservation. IWRM is a comprehensive, participatory planning and implementation tool for managing and developing water resources, ensuring the protection of ecosystems for future generations.

Efforts to achieve the millennium development goals involve planning and action in water resource development, management, and use. Better management and development of water resources through IWRM approach has been recognized in 2002 during the Johannesburg World Summit on Sustainable Development with the Summit urging all countries “to develop IWRM and water efficiency plans by 2005.” IWRM is a constantly evolving subject, and its development and application

have received intense attention and contributions from many parties, including national authorities, international and intergovernmental bodies, and academic and nongovernmental organizations.

In this book we have addressed several issues of IWRM with special emphasis to African, Latin American, and global perspective of IWRM.

1.3 Ecohydrology, Water Resources, and Environmental Sustainability

A defining characteristic of integrated water resources management (IWRM) is its commitment to balance socioeconomic development of water resources with environmental sustainability. This is articulated in the definition of IWRM by the Global Water Partnership (GWP 2000) and is being adopted in new water policies and legislation worldwide (UNEP 2012). A major component of environmental sustainability in water resource development is the explicit allocation of water to meet ecosystem needs. This environmental water allocation is commonly referred to as an environmental flow. The most widely accepted definition of environmental flows is "the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems" (Brisbane Declaration 2007). Ecosystem services, or the beneficial roles that forests and wetlands have on water availability and quality, are being increasingly recognized worldwide. Forests and wetlands store water during the rains, promote groundwater recharge, and feed streams and springs in the dry season. Harnessing this inherent capacity of ecosystems to maintain water quality and to regulate hydrology is then the logical way to manage water resources sustainably and affordably. Understanding the links between different ecosystems in a catchment and local/regional hydrology enables restoration and maintenance of the ecosystems along with the services they provide.

This book consists of different issues on how environmental flow and ecohydrology play significant roles for sustainable management of water resources. The main topics addressed in this issue include allocation of environmental flows in IWRM, understanding and maintaining ecosystem services for IWRM, and application of ecohydrology in IWRM.

1.4 Climate Change and Integrated Water Resources Management (IWRM)

A reliable and clean supply of drinking water is necessary to sustain human health. Water is also needed for agriculture, energy production, navigation, recreation, and manufacturing. These demands place pressures on water resources that are likely to

be exacerbated by climate change. In many areas, climate change is likely to reduce surface and groundwater resources, accompanied by increasing water demand. A major effect of climate change is likely to be alterations in hydrologic cycles and changes in water availability. Increased evaporation, combined with changes in precipitation, has the potential to affect runoff, the frequency and intensity of floods and droughts, soil moisture, and available water for irrigation and hydroelectric generation.

The Intergovernmental Panel on Climate Change (IPCC 2007) findings suggest that developing countries will be more vulnerable to climate change due to their economic, climatic, and geographic settings. According to IPCC (2007) report, the population at risk of increased water stress in Africa is projected to be between 75 and 250 and 350 and 600 million people by the 2020s and 2050s, respectively. Moreover, yields from rain-fed agriculture could be reduced by up to 50 %, in countries which depend mainly on rain-fed agriculture.

In some areas, climate change increases runoff, flooding, or sea level rise. Changes in the amount of rainfall during storms provide evidence that the water cycle is already changing. Setegn et al. (2011) investigated how changes in temperature and precipitation might translate into changes in stream flows and other hydrological components using downscaled outputs from four climate models.

This book consists of topics on sustainability of water resources in tropical regions in the face of climate change, sustainable development and integrated water resources management, water resources variability due to climate change in Mexico, and sustainable management of floods and extreme events.

1.5 IWRM and Water Governance

Meeting the millennium development goals for water and sanitation in the next decade will require substantial economic resources, sustainable technological solutions, and courageous political will. The challenge is to mobilize the political will to implement water resource development programs which cater in an equitable manner for the various demands on water. A great number of governments and international organizations have launched water-related programs and interventions all over the world as an effective way to improve people's health and welfare. But the challenges to overcome the impacts will be very high. An integrated approach should be designed to decrease the alarming impact of water quality, chemical impurities, and other water pollutions.

IWRM is not just about managing physical resources; it also requires and promotes the positive changes in water governance regarding the enabling environment, institutional roles, and management instruments. IWRM systems should, therefore, not only be responsive to changes among its development process, for example, between projected goals and decision-makers' willingness, but also be capable of adapting to new economic, social, and environmental conditions and to changing human values over a long-term implementation.

The major environmental issues of concern to policy-makers are the increased vulnerability of groundwater quality and the sustainability of natural resources for future generations. To understand the sustainability of the natural resources such as water in general, one needs to understand the impact of future land use changes on the natural resources. Climate change is predicted to negatively alter global and basin hydrologic cycles, stream flows, and water availability (IPCC 2007; Setegn et al. 2011). IWRM is viewed as the water management and governance paradigm best suited for "securing water for people" while reconciling economic efficiency, social equity, and environmental sustainability (Global Water Partnership 2000). Without proper water governance, there is likely to be increased competition for water between sectors and an escalation of water crises of various kinds, triggering emergencies in a range of water-dependent sectors.

In this book we have addressed several water governance issues in the area of water resource management for sustainable environmental public health, climate change and sustainable water access, lessons for treaty formation and development, and basin comanagement plans: a Participative Approach to Water Governance; IWRM and vertical integration across local-, meso-, and macroscale institutions; and the environmental regulatory shift and its impact on water resources management in Latin America.

1.6 Climate Change Resiliency Actions Related to Water Resources Management Sustainability

The most important impacts of climate change will be exerted on water resources and water management systems, reflecting the importance of water resources to social development. Extreme events, linked to climate change, might affect the quantity and quality of water available in rivers, lakes, and underground reservoirs which, in turn, might generate water scarcity at the household level, affecting people's well-being (Bates et al. 2008). These impacts will affect strongly populations with lack of financial resources to implement adaptation plans. Water is also at the heart of adaptation to climate change, serving as the crucial link between the climate system, human society, and the environment.

Adaptation to the global climate change and variability is considered a cornerstone for the application of IWRM for it to be truly effective and sustainable. The adaptive nature of IWRM is considered a good platform to incorporate climate change adaptation. The major driving instrument for international efforts in climate change adaptation is the United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty negotiated at the Rio 1992 UN Conference on Environment and Development that entered into force in 1994.

According to EPA, managing water resources will likely become more challenging with projected climate changes and anticipated population and economic

growth. In many areas, climate change is likely to increase water demand while shrinking water supplies. This shifting balance would challenge water managers to simultaneously meet the needs of growing communities, sensitive ecosystems, farmers, ranchers, energy producers, and manufacturers. Freshwater resources along the coasts face risks from sea level rise. As the sea rises, saltwater moves into freshwater areas. The impacts of climate change on water availability and water quality will affect many sectors, including energy production, infrastructure, human health, agriculture, and ecosystems. Adaptation to climate change is closely linked to water and its role in sustainable development. Various necessary adaptation measures that deal with climate variability and build upon existing land and water management practices have the potential to create resilience to climate change and to enhance water security and thus directly contribute to development. Adaptation to climate change is urgent. Water plays a pivotal role in it, but the political world has yet to recognize this notion (UN 2010).

As the time limit for the millennium development goals (MDGs) draws to a close in 2015, the global community is taking stock of how it can move toward a sustainable future. A global goal for water and associated targets would build on the MDGs and redouble efforts to develop water supplies and sanitation services for human needs.

In this book several issues were covered in the area of climate change mitigation and adaptation and the role of international ocean and freshwater agreements, sustainable development and the importance of water resources, efficient use of water resources for sustainability and land use, and climate change impact on the coastal zones.

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Part I
Integrated Water Resources Management (IWRM): Global Perspectives

Chapter 2
Integrated Water Resources Management in Latin America and the Caribbean

Maria Concepcion Donoso and Maria Catalina Bosch

Abstract In this chapter, we present an overview of selected Integrated Water Resources Management (IWRM) schemes, legislation, policies, plans, and governance structures designed and implemented by the countries of the region of Latin America and the Caribbean (LAC). Conceptual reasons required a brief introduction on the inspiring ideas of IWRM, stress having been made on the justification of the concept as reflected in its "integrated" note. Such preamble should enable the reader to assess the orthodoxy of the IWRM schemes predominant in the Region as well as the national enabling instruments, measures, and policies enumerated in the second part of the paper, as compared with the IWRM theoretical tenets. Also mentioned is the coordinating, financial, and advisory role of international organizations in response to the limitations of countries to resolve transboundary water issues and in some cases challenges created in federal states by multiple (national, state/provincial, municipal) jurisdictions. Reference is additionally made to the endemic LAC issue of mismatch between abstract legal instruments and actual implementation, as an additional criterion for the reader to judge the value of the actions pursued in this area by the individual nations. The main part of this chapter includes country-by-country available information on the schemes and instruments in force in the Region. The final section of the chapter concludes with findings and an overall assessment of the Region's achievements and margins for improvement going forward.

Keywords IWRM • Sustainability • Water management • Latin America • The Caribbean

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2.1 IWRM Drivers, Definition, and Justification

2.1.1 Drivers

The adoption of an Integrated Water Resources Management (IWRM) approach is today recommended as a response to crucial national development—or, more dramatically, survival—requirements, including mitigation of climate variations, such as extreme meteorological phenomena and environmental risks, particularly as it relates to freshwater and coastal areas and in realms such as those of sustainable development; conflicts around water use and ownership (with their potential for in-country, regional, and international commotions); achievement of a range of United Nations (UN) Millennium Development Goals -MDGs-, including those on water and energy, fight against hunger, rural women empowerment; as well as transgenerational responsibilities and coordination needs (UN Millennium Project 2005). As the global community is undertaking the challenge to define the SDGs (Sustainable Development Goals), the need for a holistic integrated approach to water management is becoming ever more evident. In this context, it is no surprise that following the 2012 UN Conference on Sustainable Development (Rio+20),[1] a set of SDGs were proposed by an Open Working Group established by the UN, among which Goal 6 specifies "ensure availability and sustainable management of water and sanitation for all"(UN 2014).

2.1.2 Definition

Among the several definitions related to IWRM, two of them are mostly accepted in the LAC region. The first one was put forward by the Global Water Partnership (GWP) which states that IWRM consists of "a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems"(Agarwal et al. 1999). Similarly accepted is the definition of Integrated River Basin Management (IRBM) presented more recently by the United Nations Educational, Scientific and Cultural Organization (UNESCO) International Hydrological Programme (IHP) which refers to IRBM as "a holistic approach that seeks to integrate the management of the physical environment within that of the broader socio-economic and political framework. The river basin approach seeks to focus on implementing IWRM principles on the basis of better coordination amongst operating and water management entities within a river basin, with a focus on allocating and delivering reliable water-dependent services in an equitable manner" (UNESCO 2009).

[1] The UN Conference on Sustainable Development (Rio+20) was held in Rio de Janeiro, Brazil, on June 20–22, 2012.

2.1.3 Justification

Attune with the definitions accepted, this essay contends that:

- *The integral nature of the challenges faced by water resources management requires a response that also needs to be holistic in nature,*
  and
- *Such response should consist of sound management—a term which clearly denotes the fact that vital goods like water resources, rather than being rightfully 'owned' by a given generation—in the classic legal meaning of discretional use -, enjoyment and arbitrary disposition powers on one's property—should be sustainably administered, and "legated" unimpaired and, if possible, enhanced, to future generations.*

Such opinion is tacitly recognized in and supported by the IWRM Dublin Principle N° 1, in that it proclaims: "Freshwater is a finite and vulnerable resource essential to sustain life, development, and the environment"; one that requires a minimum level of institutional capacity for carrying out "IWRM-inspired principles" (GWP 2012).

Important to note is the fact that IWRM "is not a scientific theory that needs to be proved or disproved by scholars. Rather, it is a set of common sense suggestions as to what makes up important management aspects" (Hassing et al. 2009). Stemming from this caveat is also the fact that the above IWRM definition is an "open-end" statement—one which can be indefinitely enriched by further common sense contributions like those we suggest in the next section of this paper. One should therefore agree with the contention that IWRM "is not just another Water Plan" (Lenton 2005a, b).

2.1.4 IWRM in Latin America and the Caribbean

This section introduces the main IWRM-inspired or IWRM-consistent enabling instruments as enshrined or ratified by the LAC region's States. Different criteria have been proposed in the literature to facilitate useful comparisons and assessments of the effective implementation of IWRM (UNEP 2002, 2010). In making such comparisons among countries, it is important to define the national level of capacity to adopt the IWRM concept, among other criteria. Some methodologies being applied (e.g., Hassing et al 2009) relate to a developed numerical scale for the weight of the IWRM principles at national levels. The following criteria have been used for this type of approach as comparative indicators of IWRM success:

- Participation of stakeholders in water management
- River basin management approach/plan implementation
- Existence of a water law
- Finance contribution by users to water management

- Polluter pays principle enacted
- User pays principle enacted
- Role of women in water management
- Separation of water management and service provision
- Water-use efficiency
- Private sector involvement

Other valuation criteria that could be complementary to those cited above, as based on the "common sense" standard mentioned in the previous section, are, namely:

- Contribution to economic growth implicit in the IWRM scheme
- Ease to obtain water resources
- Ease to reduce the pressure for water resources (as caused, for example, by consumption of commodities with larger water footprints)
- Socioeconomic equity, including recognition of indigenous peoples' ancestral water rights and customary water laws, and conflict mediation venues and procedures
- Facilitation of international cooperation
- Opening of information channels among stakeholders
- Availability of IWRM monitoring tools
- Sensible and fair tradeoffs among various objectives
- Country "ownership" of the IWRM action sets

Among the most recent efforts aimed to define the success or sustainability of water resources management schemes and processes, it is worth mentioning the work being implemented by the Florida International University (FIU) Global Water for Sustainability (GLOWS) program. As part of the execution of the agreement between FIU and the US Agency for International Development (USAID) E3 Water Office, since early 2012, the GLOWS program is engaged in an initiative to develop and apply measurement frameworks to gauge the sustainability of both water-related services and water resources management programs in the context of its own and other's efforts. As part of this initiative, GLOWS is working to create and test a measurement system to track core elements contributing to "sustainability" of water resources and their management. In this context, the objective of the new Water Resources Management Sustainability Index Tool (WRM SIT) being developed is to monitor core elements contributing to sustainable management of water resources in support of USAID's own sector programming as well as that of the development community at large. The WRM SIT is based on a "pillar" conceptual model, where indicators are organized under general factor categories of sustainability. The categories and indicators together reflect a systemic understanding and Theory of Change around what drives Water Resources Management sustainability. Five categories of sustainability have been identified that cover the spectrum of factors shown by evidence and experience to be most critical for ensuring sustainable water resources management over time. These categories are referenced to governance, financial, technical, environmental, and

socioeconomic factors. The measurement of sustainability is defined through the application of a rigorous methodology and data collection procedure followed by a process of validation with the participation of stakeholders at various levels (GLOWS-FIU 2014).

2.1.5 Adoption of IWRM Processes and Roadmaps

Most Latin America and the Caribbean nations have taken steps towards IWRM process implementation. However, the rate of progress in actual IWRM implementation varies among the Region's countries. Similarly, the IWRM criteria that are considered most relevant to particular countries for attaining successful IWRM vary depending mostly on sociocultural factors, level of economic growth, and the overall enabling environment. The following examples illustrate the above statement and in some cases highlight innovative approaches being proposed or implemented by countries of the Region.

Within *Grenada*, broad stakeholder involvement is recognized as crucial and critical for successful IWRM. The importance of participatory processes as it relates to the implementation of specific actions requiring an integral approach to water resources management is captured in the statement: "achieving the MDGs in the water sector is a shared responsibility involving multiple and mutually dependent stakeholders from various sectoral and institutional backgrounds, such as ministries, public agencies, sub-national authorities and private actors including citizens and not-for-profit organizations. But such actors sometimes have conflicting priorities and interests, which may create obstacles for adopting convergent targets" (Akhmouch 2012).

For *Argentina*, securing Federal Government concurrence is fundamental, given the shared nature of the country's Provincial and Federal authorities management and financial responsibilities for a range of public services, including provision of water and sanitation facilities and infrastructure development. Another interesting aspect related to water management in this country refers to the provision in the Constitution (Constitución de la Nación Argentina 1994) in terms of transboundary waters treaties or agreements. The Federal Government is vested the authority to enter into treaties related to transboundary waters with neighboring countries, but it is for the provinces to define the mechanisms to implement these.

In *Colombia*, fostering water resources sustainable management is highlighted by the country's National Development Plans (NDPs) since its 2006–2010 version. A relevant virtue of this country's model is its emphasis in transparency. Water allocation experience in the San Felipe catchment area is a case in point: As stated by Quiroga (1997), "although all stakeholders are not involved in the allocations [in such project], the transparency of the process allows users to challenge others' claims to abstraction and the allocations before they are finalized. . .." This example also underlines implicitly the importance of having reliable data on which to make informed decisions.

Another interesting case study refers to the small Central American country of *Nicaragua*. This nation took a fundamental step in IWRM by developing an Environmental Action Plan under the General Law on National Waters (2007). The actual progress ratio is, nonetheless, questionable, as contended by the International Food Policy Research Institute, which claims the legal provisions enacted remain *dead letter* (Novo and Garrido 2010). These authors substantiate such contention in the following terms: "The water law and sector regulations have not been harmonized and local environmental plans have not been updated based on the law."

As for *Uruguay*, the advance of IWRM has been supported by the Inter-American Development Bank (IDB) through Loan UR-1076 considered to be an IWRM-contributing operation as it entails: 1. "mainstreaming of climate change adaptation to the IWRM process in Uruguay, through including its principles into the National Plan of IWRM, which is currently being developed"; 2. "reducing vulnerability to drought and flood events and prevention of health problems derived from hydrological conditions by defining climate change impacts affecting the water resources along the country as well as identifying adaptation measures for such impacts"; and 3. "coordinating the policies definition and the water resources management with the rest of sector policies" (Inter-American Development Bank 1998).

In *Bolivia*, an innovative *multi-criteria decision analysis* (MCDA) began to be explored in 2010, as a step towards IWRM, in the Lake Poopo area, one of the country's most underdeveloped regions (Calizaya et al. 2010). This approach involves the use of an Integrated Water Sustainability Index (IWSI) and considers stakeholder participation as well as an institutional arrangement structure (Lund University 2009).

Chile, however, provides an example of progress towards the three "E"s of integrated water resources management (IWRM) referenced by the Global Water Partnership (1999), namely, "economic efficiency," "social equity," and "environmental sustainability." As referred by Williams and Carriger (2006), the country has attempted to create a modus vivendi—and, arguably, a synergy—between economic growth and water sustainability. These scholars contend that "in Chile, development has placed additional pressure on the environment in general, and on water resources in particular. Over the two decades studied by a recent review, the use of wells in agriculture has increased sixfold, the use of wells for drinking water fourfold, and, during the last decade, 40 aquifers have been closed to new concessions. This said, environmental sustainability in Chile has actually improved in recent years. This was largely the result of factors outside the water sector, including economic growth, which has provided the financial and technological resources needed to bring about environmental improvements, and an ideological shift, which resulted in greater attention to social and environmental issues on the part of the Government and Chile's citizens. *Improvements in water-use efficiency* have been considerable, especially in those areas linked to exports. In some cases, these were a side effect of the drive to produce higher-quality products for the international market" (Williams and Carriger 2006). It is important to note that the

enabling environment is unique in Chile in comparison to the rest of LAC. Water use in this country is granted by the Direccion General de Aguas (DGA) based on availability of water resources. Productive use is a priority and to an extent mandatory. Water concession recipients who fail to use the allocated volume of water may lose their privilege over the use of water. Exclusions apply when water is used for environmental conservation.

We cannot thus see any two countries where IWRM has been adopted in order to attain the very same objectives. Such feature confirms the assertion quoted in the first section of this chapter that IWRM is ultimately an expression of *common sense*, rather than a dogmatic formula to be rigidly enforced throughout the Region ignoring the unique characteristics and needs of each country. Such ductility adds to the worth of the IWRM concept by encouraging the development of novel legal and enabling formulae in response to supervening local circumstances.

2.2 IWRM Contributions to the MDGs' Process

Poverty-, Hunger-, Primary Education-, Women's *Social Capital*-, Child Mortality-, Diseases-, and Environmental Quality MDGs are patently associated with better IWRM. Such reality was recognized already in April 2005 at the Annual Meeting of the Inter-American Development Bank (IDB) Assembly of Governors and the Inter-American Investment Corporation (ICC, an arm of the IDB Group). The participants of the referred venue arrived to the "global consensus that IWRM is crucial in the quest to achieve the MDGs, not only in water and sanitation but in other areas, which include eradicating extreme poverty and hunger; reducing child mortality; improving maternal health combating major diseases; and improving environmental sustainability" (Inter-American Development Bank 2005).

Although several LAC countries have specifically recognized in their Constitutions and/or regulatory codes their inhabitants' right to a healthy and ecologically sound and sustainable environment, *Costa Rica* is one of the Region's nations where such outcome has been most thoroughly considered and decisively furthered through concrete actions, in particular through the development and implementation of the 2002 Integrated Water Resources Management Strategy (IWRMS). This strategy, for which the Costa Rican Ministry of Environment and Energy, with the technical cooperation of the IDB, holds responsibility, attempts to respond to the following questions:

- What are the critical problems?
- What is the vision of the society and of the Government and how to address these?
- What is the strategy required for the water resources to become the driver of the country's sustainable development?

The Costa Rica IWRM strategy intends "to develop a proper Country Concept and find the way to reach the rationality and sustainable water management, to

contribute to achieve the Country development goals and the international commitments" (Villalta Fernández 2005) and is explicitly linked with the country's water policy, its current development plan, and a future version thereof. In turn, the strategy addresses a number of issues critical for the successful implementation of IWRM, including data availability, coordination, decentralization, IWRM legal, financial and institutional structures, and a whole range of water quality issues. This universe of interconnected elements, and its explicit quest for modernization, makes the Costa Rican case an—so far unique—interesting paradigm of the application of IWRM in the Region.

2.3 In-Country Enabling Environment for Centralization or Decentralization of WRM

This specific area of analysis responds to the need to avoid contradictory water resources management policies at national/state/municipal levels in different countries with particular government systems. We will be presenting a sample of country cases where the dialectics and concurring jurisdictions among such management levels are apparent.

Argentina chose to address the issue of conservation and management of natural resources and thus of water resources management in particular, at a constitutional level. In its 1994 Constitution (Section 41), Argentina adopted two convergent mechanisms, mandating that "The Nation shall regulate the minimum protection standards, and the provinces those necessary to reinforce them, without altering their local jurisdictions," that is, assigning the Federal Government the main coordinating responsibilities and counterbalancing such authority by prohibiting the central authorities to impair the provinces' jurisdictions over the resources in their respective geographical boundaries.

Mexico created the Water National Commission (Comision Nacional de Aguas) CONAGUA, an autonomous branch of the Secretary of Environment and Natural Resources (SEMARNAT, for its Spanish acronym). In spite of its affiliation to such particular entity, SEMARNAT, CONAGUA has global coordination and managerial powers for all of the public agencies in the country (those having national, state, or municipal jurisdictions), and its technical council includes representatives of a range of top governmental bodies.

Brazil, a country where water resources responsibilities are particularly fragmented, created an entity—the National Water Agency (ANA, for its Portuguese acronym)—technically ascribed to the Ministry of the Environment. This institution "plays a number of management and co-ordination roles, and consists of ten functional superintendences with implementing and administrative functions. Providing a managerial structure, an authority and the means to implement and co-ordinate the National Water Law, ANA has brought a general improvement of water resources in Brazil" (Akhmouch 2012).