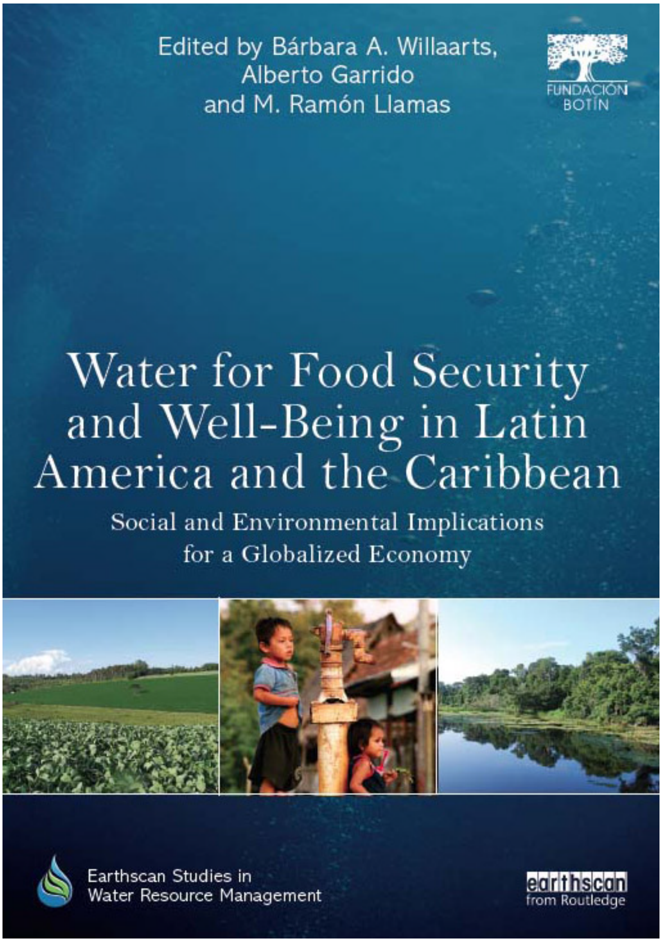

Chapter 15

Rethinking integrated water resources management: towards water and food security through adaptive management

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15

RETHINKING INTEGRATED WATER RESOURCES MANAGEMENT: TOWARDS WATER AND FOOD SECURITY THROUGH ADAPTIVE MANAGEMENT

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Highlights

- Integrated Water Resources Management increasingly means looking at the anthropo-hydrogeological cycle, thus considering a range of conventional and non-conventional resources which are part of water resources management, such as conjunctive use, the potential of rainwater harvesting, water reuse and virtual water trade.
- Virtual water is an important component of integrated strategies in redistributing water resources. On the whole, in terms of agricultural products, the Latin America and Caribbean (LAC) region was a net exporter of green virtual water (141.5km^3/yr) especially from Argentina and Brazil, and a net importer of blue virtual water (16.1km^3/yr) especially Mexico, during the period 1996–2005.
- There are many opportunities for LAC to achieve more sustainable, equitable, and efficient use of their resources thus facilitating a transition towards a green economy, already present in numerous successful cases. Although many challenges still need to be faced; in many cases economic growth in LAC has been achieved through intensive use of natural resources like land and water – coupled with an increase in the levels of pollution and the loss of ecosystems and biodiversity. Collectively, these represent a serious challenge to water-security.
- In the LAC countries water governance occurs at very different levels – from the international political sphere down to the irrigation district level. Despite the progress made during the past decade, coordination of all these levels, i.e. achieving integrated water resources management, and strengthening stakeholders' involvement are fundamental to ensuring the legitimacy of the process and thus achieving clearly stated policy goals.
- The LAC region is in active pursuit of water security through IWRM with a clear focus on social equity and environmental quality and the way forward is clear, with a well-defined pathway. However, it will require institutional communication, political will and a strong dose of civil-society engagement in the planning process; the building blocks required for a resilient, robust future.

15.1 Introduction

IWRM is coordination (process), water security is the goal (result, status). IWRM is a process of change, which takes place continuously and dynamically. Water Security is a development objective. (Christopher Scott)

The Integrated Water Resources Management (IWRM) paradigm has just celebrated its twenty-first birthday in 2013, a period over which it has become dominant in both the water sector and sustainable development circles. It was born in 1992 as a result of the International Conference on Water and the Environment in Dublin and at Rio de Janeiro with Agenda 21 (Ait-Kadi, 2013). Its conceptual and implementation framework was developed by the Global Water Partnership, under the auspices of the World Water Council (GWP/TAC, 2000; GWP, 2004). IWRM is defined as '*a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems and the environment*' (GWP/TAC, 2000).

Yet, due to the rapidly changing times we are currently immersed in, the lifespan of concepts and paradigms is also put to the test more quickly. According to Kuhn (1962), scientific progress is the result of 'development by accumulation', i.e. when normal science is interrupted by periods of revolutionary science. The IWRM paradigm is therefore in a state of flux (GWP, 2012; López-Gunn et al., 2013). This chapter aims to identify new trends and directions, as well as potential changes in its conceptual basis, particularly from fast-emerging complementary concepts such as water security (GWP/TAC, 2000; Grey and Sadoff, 2007; Pochat, 2008; GWP, 2010; Cook and Bakker, 2012; UN Water, 2013) analysed in Chapter 6. Along these lines, are there enough anomalies in the IWRM paradigm to warrant major changes? This chapter will argue that in order to 'speed up' the implementation of IWRM it is fundamental to ask new questions about its main tenets. The chapter analyses and evaluates the main ingredients of the IWRM paradigm, looking at a) the integration of resources, b) of sectors and c) across organizations. IWRM acquires real added value once a series of clear and specific policy goals are set, e.g. those provided by water security or the upcoming Sustainable Development Goals (SDGs) on water (Sachs, 2012) that in 2015 will effectively replace the merely target-oriented Millennium Development Goals (MDGs).

15.2 'W and R' in IWRM

This chapter will first revisit the resource base and consider how to re-think the hydrological cycle by adopting an 'anthropo-hydrogeological' cycle, i.e. a cycle in the context of the new era of the Anthropocene (Steffen et al., 2011). Building on Chapter 2, it also considers interactions within the unitary water cycle affected and modified by human use, and also innovative ways of thinking about water such as the concept of virtual water.

15.2.1 Water resources: the 'anthropo-hygeodrological cycle'

As highlighted in Chapter 2, the Latin America and Caribbean (LAC) region has great wealth in terms of water resources and presents a resource intensive development pattern, where much of the population lives in cities and human activities deeply and radically alter the water cycle in terms of its quantity and quality in time and space (Figure 15.1). The increasing demand for water on the one hand, and supply constraints on the other, implies a need to rethink the hydrological cycle in order to increase water security for both urban and rural areas, but also from a sectorial point of view (agriculture, mining or energy). The understanding and correct quantification of water in its different forms (atmosphere, surface and underground) are fundamental for the proper management of water resources and this also includes the need of breaking down any false paradigms about sustainability. Thus a first step for IWRM is proper water accounting, where the concept of 'water savings' does not necessarily detract from other uses (see Chapter 10 on water efficiency).

From an IWRM perspective, it is therefore necessary to characterize each source of water available in the water-cycle and their interdependencies. The opportunities offered by both conventional and non-conventional resources add increasing complexity to water management, which will require a new matrix-based approach considering an anthropo-hygeodrological cycle (Galbraith, 1971; Barlett and Goshal, 1990). In modern societies, there are six main sources of water: surface water (lakes, rivers and reservoirs), groundwater (aquifers), soil water (edaphic), precipitation water (rain harvesting), water reuse (treated or untreated), and desalinated water, to which a seventh – 'virtual water' – should be added (as will be discussed below). The first two are the most commonly used for the large water supply systems of cities and agricultural areas. In LAC this represents more than 90% for the cities water supply. The fourth (rain harvesting) has been used for a long time by families in poor regions (in semi-arid zones of Brazil, for example) as an adaptation mechanism and it is starting to be used more widely as an additional source of water in some cities. Desalination and water reclamation are also being implemented in LAC countries due to the increasing costs of obtaining water from conventional sources. In specific locations these new resources can represent a key strategic option for addressing local problems. For example, desalination for mining or for public water supply in Chile and northeastern Brazil respectively is an emergent trend.

The coordination and integration of both conventional and non-conventional sources is likely to be fundamental for specific locations in order to reduce water risks and pressures. Groundwater and surface water feature a clear complementarity in many aspects, which is crucial in order to increase water security for societal needs, e.g. public water supply and economic activities. In many cases, the problem of water supply in cities or for crops production is related to seasonal rain variation (periods of drought) and also to a lack of water infrastructure. Aquifers can store large amounts of water, as available 'natural (green) infrastructure', though there are few cases of planned joint management of surface and groundwater in LAC countries. Some positive examples are in Lima (Peru) and some

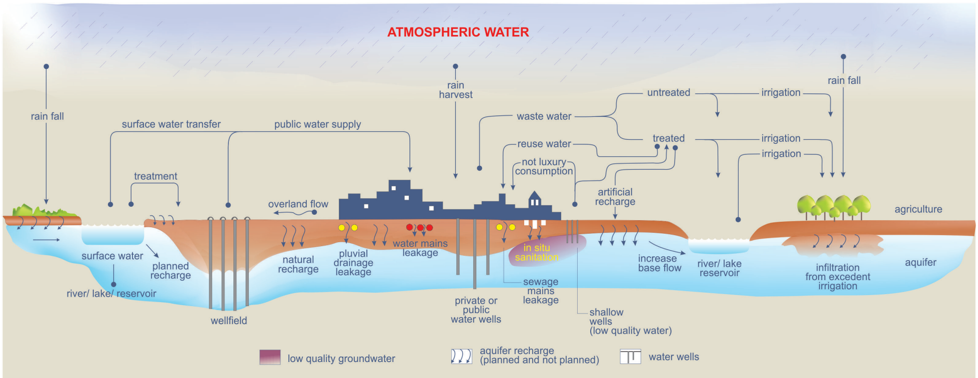


Figure 15.1 The 'anthropo-hygeodrogeological' cycle. *Source: expanded from Foster et al. (2011)*

cities in Mexico, but these are the exception rather than the rule due to the high level of technical knowledge and institutional coordination required. As a consequence, the high-quality, drought-resilient capacity of groundwater resources tends to be underestimated (Garduño et al., 2006). It is also necessary to recognize that there are more cases of spontaneous (or unplanned) conjunctive use than a planned conjunctive management of groundwater and surface water (López-Gunn et al., 2011). This is the case in the State of São Paulo, Brazil, where 15% of cities are supplied by both surface (main source) and groundwater resources (complementary source, i.e. 12,000 wells in the metropolitan area of São Paulo) (Hirata et al., 2006). Although surface and groundwater represent the 'bulk' of apparent resources, a wider perspective should also consider the opportunities of non-conventional resources and the largely unseen or 'forgotten' water resources of virtual water flows and green water. Thus for IWRM, particular attention should be paid to the range of resources and the advantages and disadvantages of each.

From the perspective of IWRM, it is also important to go beyond the evaluation of supply and demand interventions to a more systemic perspective. In this sense, the diversification of resources means a probable reduction of risk (Table 15.1), which allows for the re-visiting of supply side engineering measures, in order to consider alternatives such as rainwater harvesting, aquifer recharge enhancement (with an excess of surface runoff or reclaimed wastewater), desalination, and urban wastewater reuse. Likewise, examples of demand side measures are water conservation, promoting crop changes, improving irrigation efficiency (e.g. irrigation water use quotas, covering open canals, economic incentives to use high-pressure systems or the use of low-pressure water distribution pipes in agricultural areas) or measures that incorporate seasonal and spatial aspects.

One important issue for the integrated management of this resource portfolio refers to the allocation of responsibilities and information. With regard to this, sound information on resource use, accurate water accounting and extended participation would make integrated water resources management more likely (see section 15.4.2). For example,

Table 15.1 Comparative features of different components of water resource portfolios

FEATURE	GROUND-WATER	SURFACE WATER	DESALINATED WATER	RAIN HARVEST WATER	RECLAIMED WASTE WATER
HYDROLOGICAL CHARACTERISTICS					
STORAGE VOLUMES	Very large	Small to moderate			
RESOURCE AREAS	Relatively available	Restricted to water bodies	Restricted to saline water location	Relatively unrestricted	Restricted to water availability
FLOW RATES	Very low	Moderate to high	Depends on the infrastructure	Depends on the infrastructure	Depends on the infrastructure
RESIDENCE TIMES	Generally decades/centuries	Mainly weeks/months	Centuries	Hours/days	Months/years
DROUGHT PROPENSITY	Generally low	Generally high	Low	High	Low
EVAPORATION LOSSES	Low and localized	High for reservoirs	Low	High	Low
RESOURCE EVALUATION	High cost and significant uncertainty	Low cost and often less uncertainty	High and often less uncertainty	Low and often less uncertainty	High and often less uncertainty
ABSTRACTION IMPACTS	Delayed and dispersed	Immediate	Low to moderate	Low	Low to moderate
NATURAL QUALITY	Generally (but not always) high	Variable (but generally needs treatment)	(-)	Generally high to moderate	(-)
POLLUTION VULNERABILITY	Variable natural protection	Largely unprotected	(-)	Associated to atmospheric contamination	(-)
POLLUTION PERSISTENCE	Often persistent in the short to medium term	Mainly transitory	(-)	(-)	(-)
SOCIO-ECONOMIC FACTORS					
PUBLIC PERCEPTION	Not well known by the public	Aesthetic, predictable	Moderate	Moderate	Low
DEVELOPMENT COST	Generally modest	Often high	High	High or modest (depending on technology used)	Low
DEVELOPMENT RISK	Less than often perceived	More than often assumed	Less than often perceived	Less than often perceived	Less than often perceived
STYLE OF DEVELOPMENT	Mixed public and private	Largely public	Mixed public and private	Mixed public and private	Largely public

Source: expanded from Tuinhof et al. (2006)

in Costa Rica the regulatory framework does not allow for the use of groundwater, which makes joint management almost impossible. This links up with transparency on resource use (see Chapter 12), adequate data gathering and the availability of good water registers. For example, in the case of Mexico the Registro Público de Derechos de Agua (REPDA), the main approximation tool for federal water use is incomplete and its validity rather poor. In the case of Costa Rica the water information system (SINIGIRH) compiles information on river basins from different data sources (universities, AyA, ICE, IMN, SENARA, MINAE) into a single database and aspires to improve the hydrologic and hydrogeological information by strengthening the network of metering stations in order to support decision making.

Box 15.1 Extreme water security? Floods, droughts, population growth and migration in the Andes

One of the main functions of water management is dealing with water availability and in particular with climate variability which includes extreme events such as floods, droughts and general climatic changes. Water management when there is too much or too little water, and under a new scenario where underlying baseline resource conditions are subject to change due to climate change, are real stress tests for IWRM. Focusing on the Andean region, composed of Colombia, Ecuador, Peru and Bolivia, we briefly discuss issues related to extreme events, IWRM and water security. In the case of floods, there is a large portion of the population exposed to floods (approximately 15% of the population; see Table 15.2) (General Secretariat of the Andean Community, 2009). As can be seen in Figure 15.2 and Table 15.2 the areas most affected by droughts are in southeastern Peru and southwestern Bolivia. The population that has the potential for being affected by droughts reaches 19% of the total. An extreme drought can cause the total loss of work and capital for a small community. In addition and less well known, the absence of humidity can cause the presence of pests. The areas more prone to droughts have the lowest population growth rates (see Figure 15.2). This indicates that climate variability affects people significantly, forcing them to move to areas in which jobs may be more secure (Figures 15.3). Knowledge and data on climate variability and change can facilitate improved water resource management to reduce the vulnerability of people and areas most exposed, thus increasing system resilience. This is especially if information is produced on how this variability and change affects other systems e.g. economic system (losses), and impact on social system (e.g. migration).

Table 15.2 Population prone to suffering droughts and floods in the Andean Community countries

		UNITS	BOLIVIA	COLOMBIA	ECUADOR	PERU	ANDEAN COMMUNITY
POPULATION	TOTAL	Million	9,427	48,889	13,215	27,254	92,785
	EXPOSURE TO FLOODS	Million	600	5,232	2,428	8,459	13,710
		%	6%	12%	18%	20%	15%
	EXPOSURE TO DROUGHTS	Million	1,819	8,235	4,547	2,616	17,217
		%	19%	19%	34%	10%	19%
AGRICULTURAL AREA	TOTAL	Km²	268,954	533,431	115,342	256,118	1,173,845
	EXPOSURE TO FLOODS	Km²	57,000	120,000	14,000	34,000	225,000
		%	21%	22%	12%	13%	19%
	EXPOSURE TO DROUGHTS	Km²	88,000	59,000	24,000	120,000	291,000
		%	33%	11%	21%	47%	25%

Source: own elaboration based on data from the General Secretariat of the Andean Community (2009).

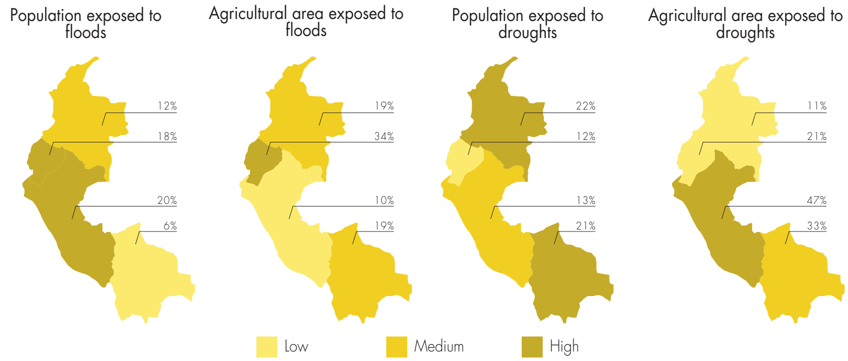


Figure 15.2 Population and areas most affected by droughts and floods in the Andean Community. *Source: own elaboration based on data from the General Secretariat of the Andean Community (2009).*

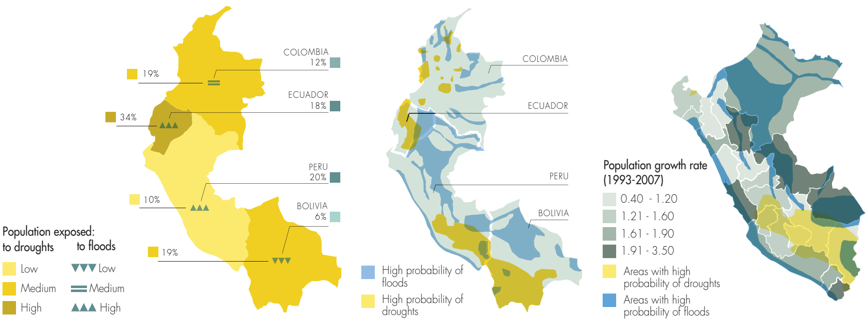


Figure 15.3 Population and areas most affected by droughts and floods in the Andean Community and Peru. *Source: own elaboration based on data from the General Secretariat of the Andean Community (2009).*

15.2.2 Innovations in resource 'thinking': virtual water in IWRM

The virtual water concept represents an important dimension of IWRM, particularly because it links water to use. However, it alone cannot determine optimal water resource allocation in importing and exporting to and from LAC countries and regions since water resources management requires consideration of multiple objectives and trade-offs from different options (Allan, 2011; Yang et al., 2013). The problem of water scarcity can be addressed by different means, i.e., improving water use efficiency locally, transferring water from outside, and transferring virtual water into the region in order to reduce local water demand. These measures are not mutually exclusive and can be combined to form an integrated approach in addressing water security problems. Thus, the trade of virtual water is one important component of integrated strategies in tackling water security (Guodong, 2003). The essence is that countries/regions can undertake economic activities (including agriculture) in which they have a comparative advantage. Virtual water strategies could potentially improve overall water use efficiencies in agriculture by adjusting crop structure and importing most water-intensive crops, thereby easing the level of water stress in specific regions, particularly in arid areas or areas with high population growth (Yang et al., 2013). However, it is fundamental to take the local context into account and to consider whether the local economy can import virtual water in exchange for other value added exports. With regard to agricultural products, during the period 1996–2005 the LAC region was a net exporter of green virtual water (141.5km^3/yr) and a net importer of blue virtual water (16.1km^3/yr), as concluded by Mekonnen and Hoekstra (2011), exporting through agricultural products three times more virtual water than it consumed. Thus when considering water security for countries with lower water availability, virtual water is a key element.

The water footprint indicator provides additional information for policy makers that can complement the classical measure of water withdrawals. Traditional national water use accounts only refer to the direct blue water withdrawal within a country. Beyond this, the water footprint assessment provides additional information on green and blue water consumption and pollution (grey water) including data on direct and indirect water use (virtual water flows), which makes the water footprint very different from other IWRM indicators (Table 15.3). By just looking at water use within its own country, most governments have a partial view of the sustainability of national consumption. In order to support a broader analysis and better informed decision making, national water use accounts could be extended to national water accounting on the basis of the water footprint methodology or other similar water accounting methods (Molden, 1997; Molden and Shakzivadivel, 1999; Molden et al., 2007; Perry, 2012). The specification on whether water resources are being used or consumed, and also whether they refer to blue (surface or groundwater) or green water (soil water) would provide a stronger information base from which to formulate national water plans and specific river basin plans, which are coherent, well aligned and integrated with national policies in relation, for example, to the environment, agriculture, energy, trade, foreign affairs and development cooperation (Hoekstra et al., 2011). Ideally, economic values and also energy implications would also be taken into consideration, as discussed in the next section.

Table 15.3 **Total water footprint and total virtual water flows in Latin American countries**

	TOTAL WATER FOOTPRINT				TOTAL VIRTUAL WATER FLOWS											
					VIRTUAL WATER IMPORT				VIRTUAL WATER EXPORT				NET VIRTUAL WATER IMPORT			
	Green Water Mm³/yr	Blue Water Mm³/yr	Grey Water Mm³/yr	Total Wf Mm³/yr	Green Water Mm³/yr	Blue Water Mm³/yr	Grey Water Mm³/yr	Total Import VW Mm³/yr	Green Water Mm³/yr	Blue Water Mm³/yr	Grey Water Mm³/yr	Total Export VW Mm³/yr	Green Water Mm³/yr	Blue Water Mm³/yr	Grey Water Mm³/yr	Total Net VW Mm³/yr
ARGENTINA	176,194	5,708	9,189	191,091	4,285	266	1,116	5,667	93,307	1,863	2,875	98,045	-89,022	-1,597	-1,758	-92,377
BELIZE	677	14	177	868	70	14	22	105	445	19	67	530	-375	-5	-45	-425
BOLIVIA	31,559	601	284	32,444	1,212	134	182	1,528	3,551	23	38	3,613	-2,339	111	144	-2,084
BRAZIL	135,966	13,826	31,930	481,722	29,475	2,368	3,701	35,544	105,427	1,944	5,121	112,492	-75,952	424	-1,421	-76,949
CHILE	9,143	2,797	3,888	15,828	4,720	369	987	6,076	1539	600	851	2,990	3,180	-230	135	3,085
COLOMBIA	50,173	2,384	7,210	59,767	8,065	742	1,714	10,521	11,778	190	1,286	13,254	-3,713	552	428	-2,733
COSTA RICA	5,412	428	1,437	7,277	2,240	386	488	3,114	4,638	246	606	5,489	-2,398	141	-117	-2,374
ECUADOR	26,444	2,443	3,366	32,253	2,192	207	410	2,809	6,362	399	396	7,156	-4,170	-191	14	-4,347
EL SALVADOR	5,202	134	879	6,215	2,025	346	335	2,705	3,305	101	252	3,657	-1,280	245	82	-953
GUATEMALA	13,248	378	1,030	14,656	2,359	424	481	3,264	6,964	177	1,133	8,273	-4,605	247	-652	-5,010
GUYANA	1,632	257	135	2,024	251	58	48	357	719	135	34	888	-467	-77	14	-530
HONDURAS	7,573	182	600	8,355	870	195	223	1,288	6,723	108	284	7,115	-5,853	87	-61	-5,827
MEXICO	109,021	16,453	23,053	148,527	65,407	14,169	12,724	92,299	13,128	8,870	4,107	26,105	52,279	5,298	8,617	66,194
NICARAGUA	5,877	230	333	6,440	751	113	158	1,022	2,389	69	68	2,525	-1,638	44	90	-1,504
PANAMA	2,556	141	478	3,175	805	106	246	1156	1,137	248	164	1,549	-332	-143	81	-394
PARAGUAY	32,845	323	655	33,823	437	44	134	616	12,520	56	153	12,729	-12,082	-12	-19	-12,113
PERU	18,040	4,553	3,022	25,615	6,983	526	971	8,479	2,499	559	474	3,532	4,484	-34	497	4,947
SURINAME	290	80	74	444	96	12	24	132	92	31	27	151	4	-19	-4	-19
URUGUAY	11,504	888	344	12,736	975	61	193	1,230	6,652	732	203	7,587	-5,676	-671	-10	-6,357
VENEZUELA	23,341	1,926	4,844	30,111	6,832	607	1,102	8,542	1,425	128	497	2,051	5,407	479	605	6,491
TOTAL	966,697	53,746	92,928	1,113,371	140,048	21,148	25,256	284,597	284,597	16,498	18,635	319,730	-144,548	4,649	6,620	-133,279

Source: own elaboration based on data from Mekkonen and Hoekstra (2011)

15.3 The 'I' in IWRM

This section discusses issues linked to sectorial integration – or rather coordination – and the future challenges and trade-offs. It thus looks first at the nexus between food–water–energy and new concepts such as ecological boundaries and environmental security by looking at the human footprint (ecological, carbon and water) and how it fares when compared with the human development index. Both the nexus and the green economy offer important emergent sectorial themes for IWRM.

15.3.1 The water–food–energy nexus

The need for integration is particularly relevant in relation to the water, food and energy nexus to ensure water, food and energy security in the LAC region. This is because energy, food and water security partly pivot around successfully managing the interactions and potential trade-offs in the nexus. For example, the interconnections as discussed in detail in Chapter 9 are evident: the use of dams and waterfalls for hydroelectricity production and storage (water-energy); the need for energy to pump water for irrigation (Scott, 2013); the use of food crops or crop residues to obtain biofuels (food-energy); or the high water consumption required by food production (water-food) (Lundqvist et al., 2008; Hoff, 2011) (see Figure 15.4).

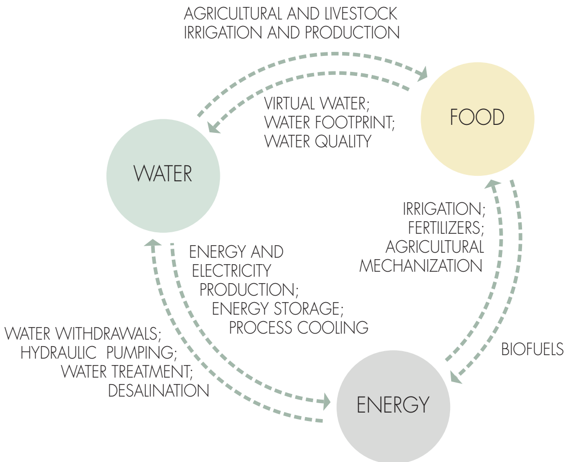


Figure 15.4 Understanding the nexus. The water, energy and food nexus. *Source: own elaboration.*

Within the energy–food–water nexus context, LAC is a region with abundant resources yet with important choices in terms of the prioritization of resource use. As Allan (2011) shows, this is particularly important in the case of Brazil. For example, in relation to the food/energy nexus, i.e. biofuels/soybean crops will have consequences not only for Brazil or the region but probably also impact other regions in the world. In terms of energy, in the Andean, Amazonian and Southern Cone regions, the sector is dominated by hydropower (see Box 15.2), which accounts for 60% of the total energy mix (Meisen and Krumpel, 2009). Meanwhile, Brazil is the world's second biggest producer and exporter of ethanol fuel (see Chapter 9). These energy sources are strongly dependent upon water and land availability, making these regions vulnerable to climate variations (extreme events, severe droughts, rainfall and temperature oscillations) and climate change, thus it will be necessary to consider in more depth the implications of different development models on local energy security, economic development, and food security.

Most relevant for policy makers is to make the potential synergies and trade-offs in these inter-linkages as explicit as possible. These can provide water and energy managers with new tools and cleaner paths towards sustainability and efficiency (solar decontamination, application of renewables for irrigation, dry cooling, energy production from water treatment plants, etc.).

It has been estimated that in LAC water for energy will increase by 50% in 2050 (WEC, 2010), although it should be noted that there is a high level of uncertainty around the water consumption data of primary energies (Figure 15.5). The high unitary water footprint of biofuels and their share in some of LAC's countries energy mix (especially relevant in the case of Brazil), allows bioenergy to be identified as by far the highest water consumer within the primary energy matrix, and thus highlights the importance of starting to produce some approximate numbers on this variable.

From the perspective of the nexus it is important to increase knowledge on how to achieve the balance between development, environmental sustainability and social equity. For the primary energy matrix, an IWRM 'nexus thinking' would look at synergies and trade-offs in the soybean dichotomy in terms of energy/food for countries like Argentina and Brazil who are global world producers. Furthermore, the nexus, under green growth and geographical constraints, would look in much greater depth at a gradual move to a low carbon economy, renewable energy (Meisen and Krumpel, 2009) and energy options that have a low water footprint (in terms of consumption). Costa Rica is spearheading this approach after deciding to stop the exploration and exploitation of oil and start the development of an energy matrix with 92% of the production based on renewable resources.

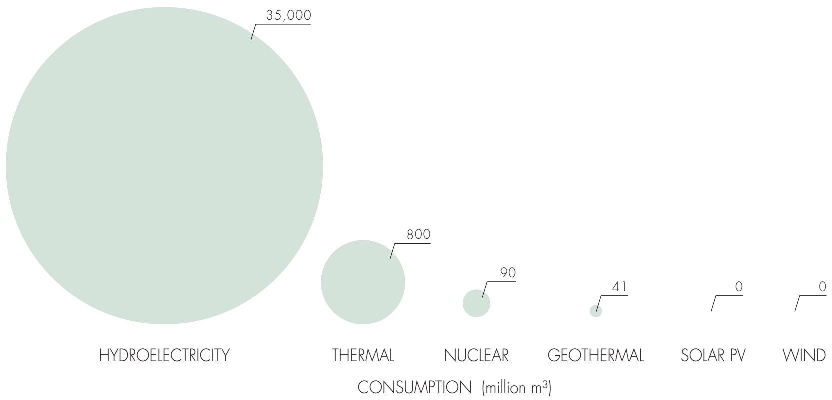


Figure 15.5 Water footprint of electricity production in Latin America. Note: biofuels footprint is not considered here as it is part of the primary energy mix. *Source: own elaboration.*

Box 15.2a Brazil: an example of energy–food nexus or trade-offs?

Brazil is the best example of the need to integrate water, energy and food trade-offs caused by the country's elevated production of biofuels. It has the greatest quantity of accessible blue and green water resources in the world and has enough technology to compensate for its lack of arable land. Moreover, it is the leading producer of sugar, second largest producer of soybean and the third largest producer of maize (Allan, 2011). Therefore, Brazil is likely to become a main exporter of virtual water embedded in food commodities globally, as well as in the raw materials of first-generation biofuels.

However, especially in the last decade, there have been side effects to this policy. Since the oil price rise in 1975, Brazil has opted for the development of nationalized biofuels production as a means to secure energy independence and give a boost to the country's economy. This process was conceived at the outset, considering land use, energy and food issues together and culminated in 2007 with the launch of the 'economic-environmental zoning' plan for the state of Minas Gerais (Coehlo et al., 2012). It consisted in the elaboration of studies about the social, economic and physical conditions (type of soil, climate, water availability, ecological values, etc.) of geographical regions in order to determine the most suitable areas to grow sugar cane with maximum yields and minimum impacts and then limiting the activity to those areas. First-generation biofuels are options for Brazil at least in the medium-term, due to its considerable availability of land and water resources. (Allan, 2011). How much this shift from food commodities exporter to biofuels exporter will impact on global food security, especially in those countries which depend on Brazil's food imports for national supply, is yet to be seen.

Box 15.2b The water–electricity (energy) nexus: what is the water footprint of electricity production in LAC?

The main sources of electricity generation in LAC are hydropower and thermoelectric power, together with biofuel production for transportation, heat and cooling. The key issue for the water–energy nexus is to determine whether increasing energy use affects water use or water consumption. For example, cooling from thermoelectric energy refers mainly to use while bioethanol refers more to consumptive use. In most of LAC, hydroelectric production plays a major role in the electric mix (see Figures 15.6 and 15.7), reaching some 100% in Paraguay, 83% in Brazil, 77.8% in Venezuela or 71.7% in Colombia (IEA, 2013). Those countries are therefore especially vulnerable to rainfall variability, such as the El Niño and La Niña phenomena and to climate change predictions reported by the IPCC's Climate and Water report (Bates et al., 2008). This variability should therefore also be taken into account for future management of the electricity sector. For the whole of LAC the total water footprint or consumptive use, estimated on the basis of IEA (2013) for the different energy technologies, is around 35,000Mm^3 per year, from which almost 97% of consumptive use comes from hydroelectricity. Meanwhile, thermoelectricity and nuclear energy, the other main contributors to the electricity mix in the Andean and Amazonian regions, account for only 0–3% of the total water consumption from electricity. Coincidentally, water use for the whole of LAC accounts for 35,800 million m^3, almost the same as water consumption. However, there are some aspects that must be taken into consideration. First, water use for both thermal and nuclear energy vary considerably depending on the type of cooling system used – i.e. the average value of water use can range from 68,000 million m^3/yr with once-through cooling down to 1,160 million m^3/yr for closed loop systems. As cooling processes are the main water requirements for nuclear and thermal energy, clear data in this respect would be crucial for accurate water use estimations, especially within the Mesoamerican region (Mexico, 82.9%; Nicaragua, 79.6% or Guatemala, 76.7%). Along with thermal power, some other sources of renewable energy are emerging in the Mesoamerican region, such as geothermal in El Salvador (26.3%), Costa Rica (12.8%) or Nicaragua (8.6%), which for LAC in general only represents some 3% of total generation. Wind and solar photovoltaic, which have a low water footprint, are barely developed, despite their potential to decouple the water–energy nexus.

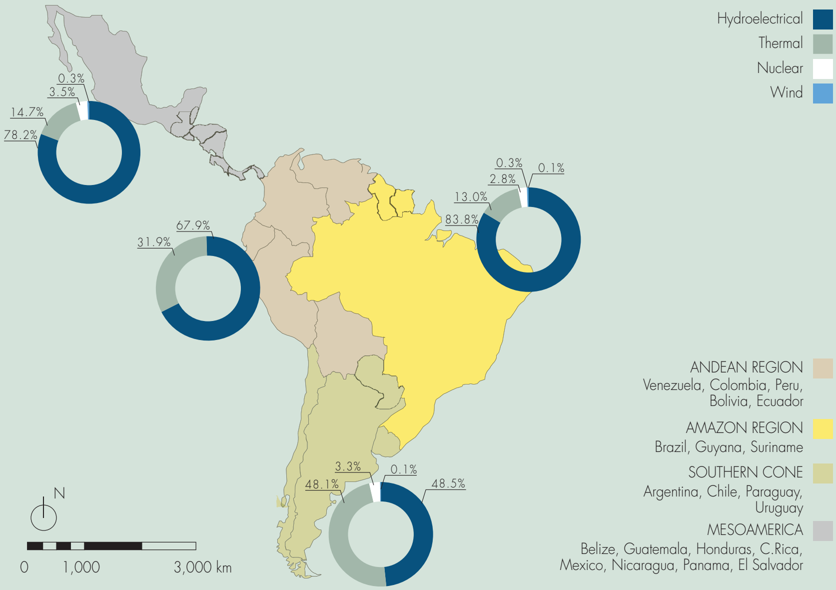


Figure 15.6 Electricity generation by source and per sub-region (Southern Cone, Mesoamerican, Amazon and Andean) in Latin America. *Source: own elaboration based on electricity data from 2009 in IEA (2013).*

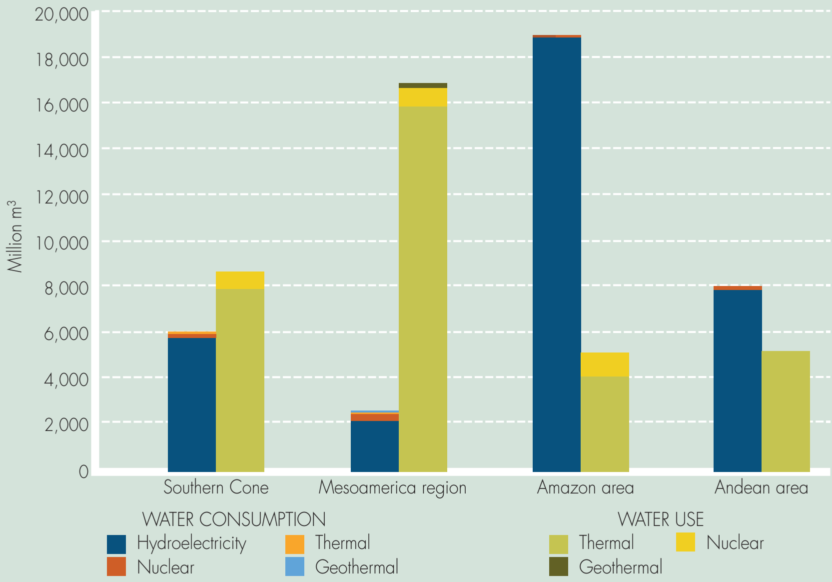


Figure 15.7 Water consumption and water use for electric generation per sub-region (Southern Cone, Mesoamerican, Amazon and Andean) in Latin America. *Source: own elaboration based on electricity data from 2009 in IEA (2013).*

15.3.2 Green growth and green economy in LAC

IWRM includes guaranteeing environmental sustainability as one of its three targets, together with efficiency and equity. At the Rio +20 meeting in June 2012, one of the main issues centred on water and green growth. In this context, the idea is to create a virtuous circle of economic incentives, able to generate the funds necessary for good water management. For example, where water is scarce – like in large parts of Mexico or Chile – incentives could focus on the rational use by agriculture as the dominant sector, via economic tools that support innovation in the use of water and force the internalization of external costs – i.e. valuation of water under realistic water prices. Environmental policy in countries such as Brazil is fairly advanced but its implementation is very slow while degradation continues in terms of deforestation (see Chapter 3) or water pollution increases. Meanwhile Costa Rica has adopted a green growth state policy, resulting in 26% of its territory being designated as areas for nature conservation and the implementation of a ban on open cast mining for heavy metals. In order to provide (financial) sustainability to these political measures, a series of economic instruments have been generated, such as a tax on fuel which is paid to environmental services producers in exchange for carbon. Meanwhile, 25% of the water tax (see Chapter 14 for more detail) is dedicated to the protection of public protected areas, and 25% for a payment of water environmental services on private lands.

In recent years, economic growth has been linked in many ways to high commodity prices (see Chapters 4 and 5), achieved at the expense of the intensification in the use of land, energy and water resources, leading to an increase in the levels of pollution and the loss of ecosystems and biodiversity (UNEP, 2009; UNEP, 2011; UN-Water, 2012a). A different development model based on a green growth approach ought to rely on a more efficient use of resources that decouples GDP growth from environmental degradation (UNEP, 2011). In LAC there has been an effort to transition towards IWRM as a framework that could help overcome this challenge (UN-Water, 2006; UN-Water, 2008; UNEP, 2012a). More generally, and as explained in Khan (2010), as countries shift to a greener set of economic arrangements, the costs of more traditional hard engineering approaches to water management become less profitable. In contrast, the cost of operating ecosystem payment schemes are much less likely to increase, providing that property and use rights and governance arrangements can ensure water-supply utilities whilst maintaining access to ecosystem services (Khan 2010; UNEP, 2011; UN-Water, 2012a). Clearly, some level of relative decoupling levels is already happening, meaning less environmental impact per unit of production (UNEP, 2011).

However, there are still challenges to achieving a 'greener' IWRM in the region (Scott and de Gouvello, 2013) (see Figure15.8 and Table 15.4.). There is no blueprint: for countries with similar Human Development Indices (HDI), some have higher footprints than others. For instance, the three footprints of Brazil are higher than those of Peru while having the same HDI. Some countries have comparatively higher ecological footprint than others in relation to their HDI, like Costa Rica, Mexico, Argentina or Chile. On the other hand, other countries have a higher water footprint like Colombia and Peru, and Brazil has the highest carbon footprint in relation to its HDI and of all the other countries. As discussed in Chapter 3 this could be explained by changes in land use. Agriculture tends to represent 2/3 of the total water footprint (e.g. see Chapter 7), so it is key for decoupling human footprints (carbon, water and ecological), HDI and IWRM. Galli et al., (2012) propose a combined used of the three footprints in what is called the 'footprint' family, arguing that it shows a more rounded vision on all three aspects. Footprint HDI monitoring could provide a preliminary diagnosis or early indicator of the achievement of the three key elements – economics, social equity and sustainability – which can help flag up areas where further analysis is needed. In many cases, countries with a high HDI have a high ecological footprint, yet this is not the same for the carbon or water footprints.

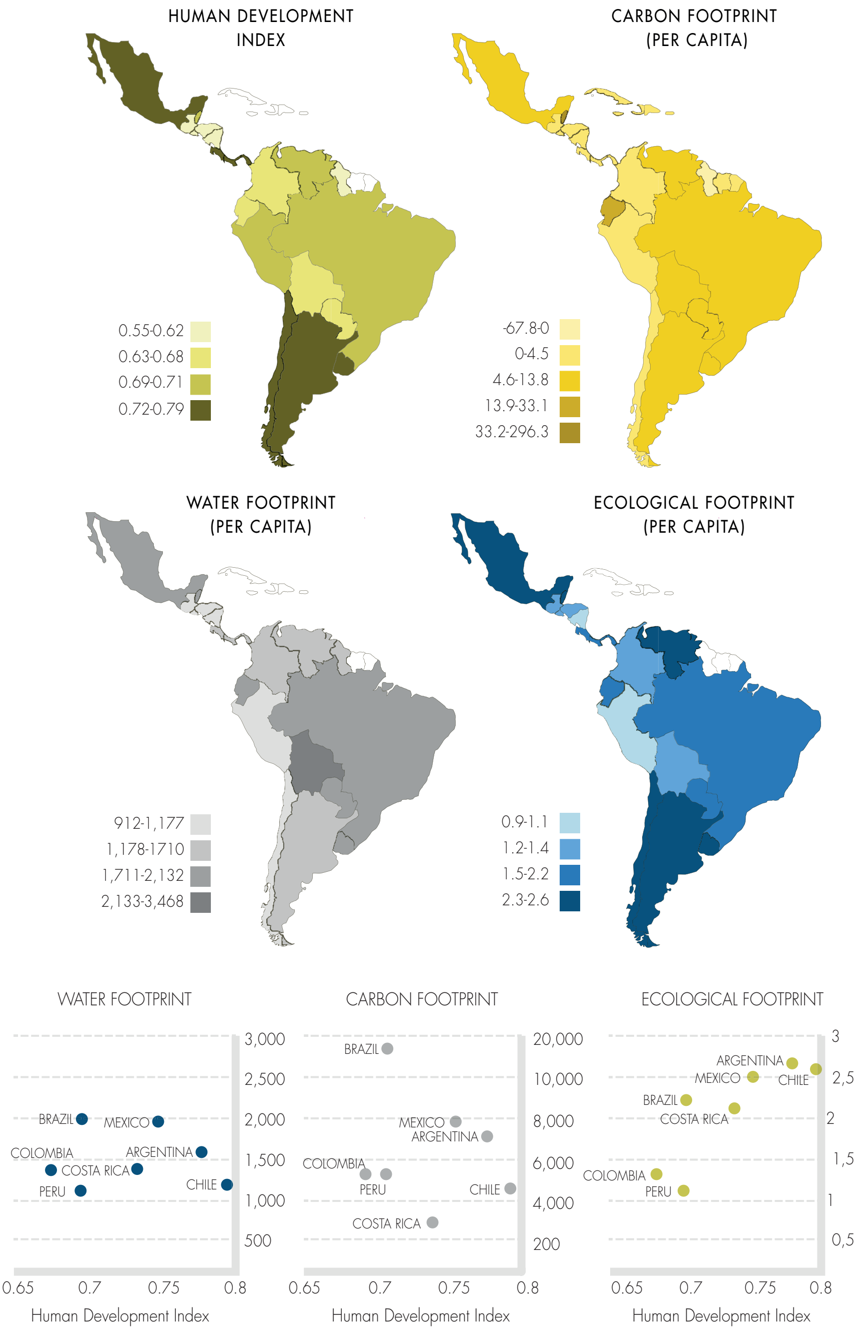


Figure 15.8 United Nations Human Development Index versus Carbon Footprint (tons C per capita per year), Water Footprint (cubic metres per capita per year) and Ecological Footprint (global hectares per capita per year). *Source: UNDP (2005), Mekonnen and Hoekstra (2011) and Ecological Footprint (2004).*

Table 15.4 United Nations Human Development Index versus Carbon Footprint (CF), Water Footprint (WF) and Ecological Footprint (EF)

COUNTRY	HUMAN DEVELOPMENT INDEX	CARBON FOOTPRINT (tC/cap/yr)	WATER FOOTPRINT (m^3/cap/yr)	TOTAL ECOLOGICAL FOOTPRINT (global ha/person)
	2005	2000–2010	1996–2005	2004
ARGENTINA	0.77	6,438	1,607	2.6
BOLIVIA	0.65	5,612	3,468	1.2
BRAZIL	0.70	10,628	2,027	2.2
CHILE	0.79	3,852	1,155	2.6
COLOMBIA	0.68	4,595	1,375	1.3
COSTA RICA	0.73	2,175	1,490	2.1
ECUADOR	0.68	33,151	2,007	1.8
EL SALVADOR	0.66	1,884	1,032	1.2
GUATEMALA	0.55	-1,704	983	1.2
HONDURAS	0.58	1,990	1,177	1.4
MEXICO	0.75	7,135	1,978	2.5
NICARAGUA	0.57	-0.814	912	1.1
PANAMA	0.75	3,249	1,364	1.8
PARAGUAY	0.64	13,864	1,954	2.2
PERU	0.70	4,588	1,088	0.9
SURINAME	0.67	10,479	1,347	-
URUGUAY	0.74	7,884	2,133	2.6
VENEZUELA	0.69	7,214	1,710	2.4

Source: UNDP (2005), Mekonnen and Hoekstra (2011) and Ecological Footprint (2004)

15.4 The 'M' in IWRM

15.4.1 Integration and institutional coordination: allocation of tasks and responsibilities

This final section will look at integration in organizational terms. It draws on a recent study published by the OECD (2011) on multi-level water governance and a brief review of the main tenets of the IWRM paradigm. With a population of 596 million and growing faster than the world average, LAC countries are experiencing increasing pressure on their natural resources due to population growth, intensification of land use, increasing urbanization, climate change and natural disasters. The OECD (2012) argues that achieving water security in the LAC region is not only a question of hydrology and financing, but also equally a matter of good governance. In that framework, institutions and their coordination are essential to designing and implementing efficient, fair and sustainable water policies in the region.

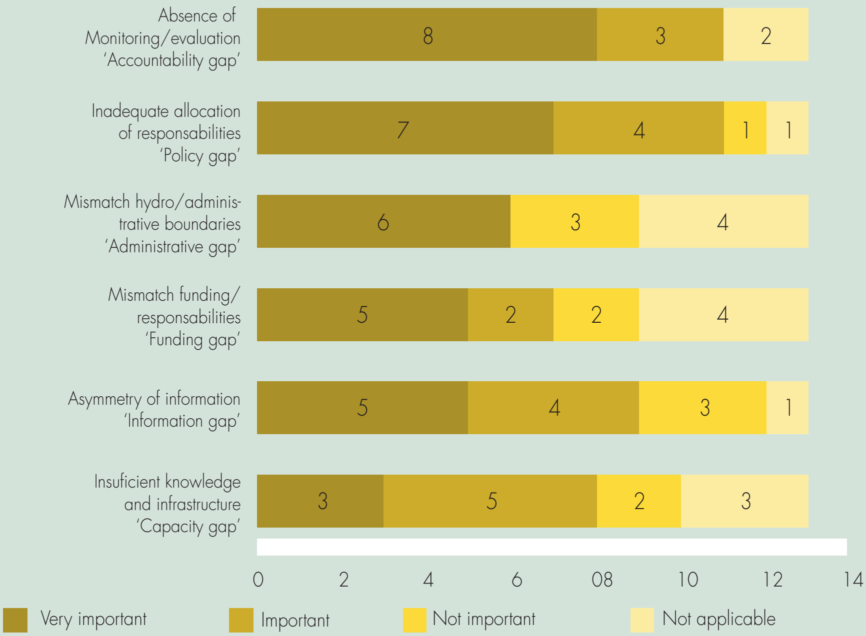
Analyses on water governance are not new to LAC. The first studies on the topic date back to the end of the twentieth century. They highlighted the lack of governance strategy in the LAC water sector and revealed why most LAC countries lag behind in sustainable water management. Such reasons included the lack of political leadership, inadequate legal frameworks, poor utilities management structures, insufficient stakeholder involvement and limited financial resources. In most LAC countries, decentralization of water policies has resulted in a dynamic and complex relationship between public actors across all levels of government. To varying degrees, LAC countries have allocated increasingly complex and resource-intensive functions to lower levels of government, often in a context of economic crisis and fiscal consolidation. Yet, despite these greater responsibilities, sub-national actors were not given the financial resources to carry out their duties properly and hence coordination failures between sub-national and national governments and sub-national budgetary constraints have led to policy obstruction in several countries of LAC.

In 2011–2012, using the Multi-level Governance Framework 'Mind the Gaps: Bridge the Gaps' (OECD, 2011), the OECD carried out a survey on water governance across thirteen LAC countries (Argentina, Brazil, Chile, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama and Peru) in order to identify key governance obstacles to effective water management, as well as good practices for managing vertical and horizontal coordination of water policy (see Box 15.3). These countries cover a wide spectrum of options in terms of institutional settings (federal, unitary), the organization of the water sector (centralized, decentralized), water availability (water-rich and water scarce countries) and economic development (least advanced, developing and emerging countries). The survey had a particular emphasis on multi-level governance in order to analyse how public actors articulate their concerns, decisions are taken and policy makers are held accountable. The OECD defines multi-level governance as the explicit or implicit sharing of policy-making authority, responsibility, development and implementation at different administrative and territorial levels, i.e. i) across different ministries and/or public agencies at central government levels (upper horizontally); ii) between different layers of government at local, regional and provincial/state, national and supranational levels (vertically); and iii) across different actors at sub-national level (lower horizontally).

Box 15.3 Gaps to achieving effective water governance based on OECD multi-level governance challenges

Key findings were published in the report 'Water Governance in Latin America and the Caribbean: A multi-level approach' (OECD, 2012) which shows that despite a variety of situations, LAC countries share common governance and institutional challenges:

1. Sectorial fragmentation of water-related tasks across ministries and between levels of government is considered a policy gap, an important challenge to integrated water policy in 92% of countries surveyed;
2. The lack of public participation and limited involvement of water users' associations in water policy generates an accountability gap in 90% of the countries surveyed;
3. The funding gap remains a significant challenge in ten of the thirteen countries surveyed, due to unstable and/or insufficient revenues of sub-national actors in order to build, operate and maintain infrastructure;
4. In two-thirds of LAC countries surveyed, the capacity gap is a major obstacle for effective implementation of water policy at central and sub-national levels, which refers not only to the technical knowledge and expertise, but also to the lack of staff and obsolete infrastructure;
5. The information gap remains a prominent obstacle to effective water policy implementation in two-thirds of the countries, in particular regarding inadequate information generation and sharing amongst actors, as well as scattered water and environmental data;
6. Half of the countries surveyed see the mismatch between the administrative and hydrological boundaries (administrative gap) as a significant challenge to effective water management, despite the existence of river basin organizations in some of them;
7. Several LAC countries struggle to strike a balance between the often conflicting financial, economic, social and environmental agendas for the collective enforcement of water policy (objective gap).



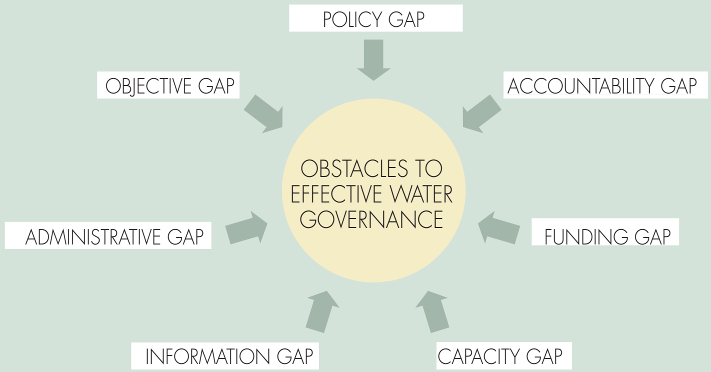


Figure 15.9a and 15.9b Multi-level governance gaps in LAC countries' water policymaking.
Source: based on the results from OECD (2012).

LAC countries have a set of policy instruments for addressing coordination and capacity challenges, but progress remains to be made in order to achieve IWRM. Meeting water governance challenges calls for more synergies to mutually reinforce actions across government, departments and agencies, as well as between researchers and decision-makers to forge science-policy dialogues (Regional Process of the Americas, 2012; Scott et al., 2012). An overview of LAC countries' experiences shows that there is a wide variety of mechanisms and instruments for integrating water policy. All LAC countries surveyed had adopted institutional mechanisms for upper horizontal coordination of water. These tools mainly consist of ministries (e.g. the Ministry of Environment in Brazil, the Ministry of Public Works in Argentina, etc.), inter-ministerial bodies or mechanisms, or specific coordinating bodies. Most countries have also engaged in efforts to coordinate water with other policy areas including regional development, agriculture and energy (see Table 15.5).

In recent years, river basin organizations have also been proposed in LAC countries as tools for effective governance, though their missions, constituencies and financing methods vary across LAC countries. While all LAC river basin organizations have functions related to planning, data collection, harmonization of water policies and monitoring, none have regulatory powers, contrary to OECD ones. The maturity of river basin organizations also varies across LAC countries especially in terms of managing competing water uses, which requires conflict resolution mechanisms in the political and legal arenas. In Brazil, the 1997 National Water Resource Strategy established river basin committees to promote multi-actor dialogues on water and arbitrate conflicts of use and implement basin management plans. In 2010, Peru started to conduct pilot exercises in six river basins. Two river basin councils have been implemented thus far and the National Water Authority (ANA) is carrying out programmes to stimulate the creation of ten additional ones, while tackling remaining challenges such as financial sustainability, capacity building, civil

Table 15.5 **Ministries and institutions responsible for the management of water, energy and food resources in different Latin American countries**

COUNTRY	WATER	AGRICULTURE	ENERGY
MEXICO	National Water Commission (CONAGUA) Department of Environment and Natural Resources.	Department of Agriculture, Livestock, Rural Development, Fishing and Feeding	Department of Energy Secretary of Energy
BRAZIL	National Water Agency	Ministry of Agrarian Development Ministry of Agriculture, Fishing and Supplying	Ministry of Mining and Energy
ARGENTINA	Department of Public Works Sub-department of water resources	Ministry of Agriculture, Lvestock and Fishing	Ministry of Federal Planning, Public Investment and Services Department of Energy
COSTA RICA	Ministry of Environment and Energy Water Direction	Ministry of Agriculture and Livestock	Ministry of Environment and Energy
PERU	Ministry of Agriculture. National Water Authority	Ministry of Agriculture	Ministry of Energy and Mining
CHILE	Ministry of Public Works Water Department	Ministry of Agriculture	Ministry of Energy

Source: own elaboration.

society representation and the long-term contribution of the river basin councils to national development.

LAC countries employ a wide range of mechanisms to manage the interface between actors at the sub-national level and to build capacity. Public participation is also used as a tool to increase transparency and citizen compliance in order to influence environmental protection. In Chile, when several citizens share the same groundwater drilling infrastructure, they can form associations (Asociación de Canalistas) to communally build, operate and maintain aqueducts as well as to fairly distribute water among members. A bi-national management committee was established in the Goascorán river basin between Honduras and El Salvador to engage stakeholders in the development of a basin management plan. Other tools for coordination across sub-national actors include inter-municipal collaboration, metropolitan or regional water districts, specific incentives from central and regional governments, joint financing between local actors, as well as ancestral rules.

By comparing the allocation of roles and responsibilities at the central and sub-national level in the LAC countries surveyed, the OECD has defined three models of water policy organization (Figure 15.10). These categories highlight the different coordination challenges raised by a given institutional organization, related to the frequent trade-off of decentralization; customization of water policy according to territorial specificities; and policy coherence. Within each category, the degree to which governance challenges have an impact on the performance of water policy may vary from one country to another.

In most cases, countries have developed a series of mechanisms to address the institutional challenges in their water sectors, but when other dimensions are added (e.g. capacity gaps, variety of tools in use, etc.) it would be helpful to link each model with policy objectives and desired outcomes.

Figure 15.10 Preliminary categories of LAC countries. *Source: based on results from OECD (2011).*

While many technical, financial and institutional solutions to LAC water challenges exist and are relatively well known, the rate of uptake of these solutions by government has been uneven. No governance tool can offer a panacea or a one-size-fits-all response to water governance challenges in the LAC region, and local policies that take territorial specificities into account can help in many cases. Even if an optimal level of governance cannot be defined, peer dialogue and bench-learning across LAC countries facing similar challenges and with equivalent institutional organizations can help to bridge governance gaps (see Box 15.4).

Box 15.4 IWRM: information flow amongst actors and the influence of their decision-making in Costa Rica's in water policy

One of the characteristics of water management in Costa Rica is the presence of both the public sector and civil society organizations as dominant actors, e.g. the Ministry of Environment and Energy (MINAE), Regulatory Authority for Public Services (ARESEP), the Costa Rican Institute of Aqueducts and Sewage (ICAA), which supplies fresh water for 50% of the population and the presence of approximately 1,542 Associations for Administration of Rural Aqueducts (ASADAS), which are distributed throughout the country and provide drinking water to 26% of Costa Rican people, in areas where the

ICAA cannot provide that service. The diagram in Figure 15.11 displays the analysis for official functions in strategic actors. The characterization of dominance is given by the presence of Power, Interest and the Legitimization (Chevalier, 2006).

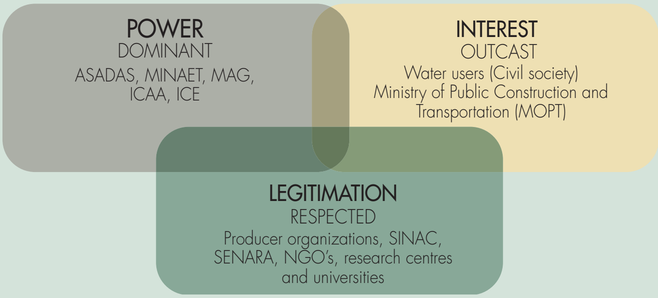


Figure 15.11 Venn Diagram of dominant, outcast and respected actors in Costa Rica's water management. *Source: LA-Costa Rica (2012).*

The decision-making in Costa Rican water management is strongly related to the official information flow amongst actors and thus the influence of these actors in the IWRM process. The result has been a convergence map (see Figure 15.12) with levels of power (high, medium and low). The upper red polygon contains academic institutions. The upper right green polygon contains civil society organizations such as NGOs supervising and executing management plans, i.e. actors with medium power, no actual vote in the decision-making process, but their opinion is taken in account. The purple polygon contains actors that regulate the availability of water for agriculture; and the brown polygon contains a critical mass of decision-making actors at the three levels of power: operators of domestic usage, hydroelectric and other productive activities.

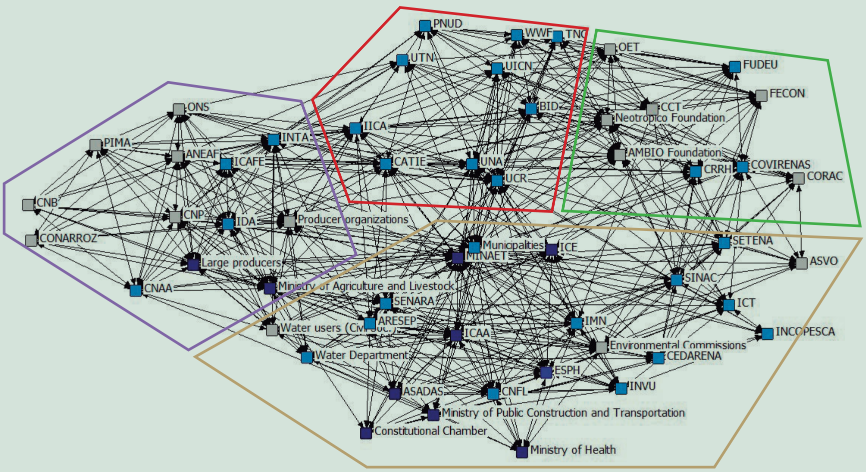


Figure 15.12 Social networks of actors in Costa Rica: connections, level of centrality and ease of access. *Source: Costa Rica FB National Report.*

15.4.2 Information technology for integrated management

Improved and more integrated water management should rely on the collection, provision and dissemination of more reliable and accurate data, to be transformed into better information, which in turn will yield better and more comprehensive water-related decisions. The key constraints and barriers to this approach are: first, the unavailability of systematic and consistent raw data compiled on adequate temporal and spatial scales; second, the lack of transparency of public bodies and private companies for sharing and allowing the open use of water data and finally, a lack of standardized methods for the audit and integration of water data; into more general accounting and decision systems. As a result, this absence of 'transparent' and assessed water information, in most countries, impedes regular reporting and evaluation of water resources and water-use trends (UN-Water, 2012b). The lack of water data and accounting and the asymmetry for different stakeholders remain pivotal issues to be tackled in IWRM. Regular demands for information come from institutions and regulators in the socio-economic, environmental or energy sectors looking for more effective and integrated data flows about water in order to monitor whether related policies are achieving the pursued goals in various dimensions. Further, there is also increasing pressure from private investors and businesses for clear and well-structured information in order to avoid or mitigate risks related to water services and water resources (see UN Global Compact CEO Water Mandate, 2007).

In LAC's least developed countries, the available funds for water activities are usually devoted to basic supply and the costs of data acquisition through conventional techniques are difficult to be met. In these cases, and also for richer countries, technological advancements could help to fill the gaps in water information via an improved cost-utility ratio. The growing availability of low-cost metering devices, the improvement in coverage and affordability of mobile handsets and the development of remote sensing (both in methodologies for generating specific data and an increased number of operating satellites) can help to monitor and record the status and dynamics of water and the environment. The potential applications of these technologies for IWRM include: the estimation of water use (especially for agriculture), the definition of water balances over large basins, the characterization of floods and other natural disasters, the analysis of water bodies' variability, the compiling of supporting information about soil moisture and groundwater levels and the monitoring of water quality (ESA, 2012; SELPER, 2012). Technology – from ground accurate sampling and conventional networks of remote sensing to ICT tools – is making the cost of water information more affordable and is becoming the key driver for a broader integration of water data and the transformation of a monopolistic, business-oriented system into a more transparent, open access and integrated vision of water information, thus benefiting IWRM.

15.5 Conclusion: IWRM as a means to a water security end?

IWRM runs the risk of being perceived as an elusive process – a nirvana (Molle, 2008) – unless the goals and targets are clearly established. Thus it could be useful to link IWRM as a process to the end goal of water security, defined as 'the sustainable availability of adequate quantities and qualities of water for resilient societies and ecosystems in the face of uncertain global change' (Scott et al., 2013). According to Allan (2003) the river basin became the central organizing unit in late modernity, even when there was evidence that global food trading processes were just as important as local hydrology in facing serious local water challenges. Yet IWRM can only be deployed if one aspect is recognized, i.e. that IWRM is seen primarily as a political process to forge and implement effective water sharing. To succeed, IWRM has to engage with what is politically feasible, thinking beyond the watershed and out of the water box, which in fact opens the realms of possibilities beyond the basin to address problems across many scales. This final concluding section will thus look at the six key policy and political ingredients for the IWRM process to succeed in the pursuit of water security.

First, one of the aspects relates to integrated planning and in particular to coordination with land use and urban planning. This was discussed in relation to footprints and HDI. For example,in the case of Brazil there is no forum for discussion of land use planning at the local level which generates serious problems with water quality, erosion and flooding. Here for example river basin authorities could provide a framework for management and planning. There is a similar case in Peru, where water councils formed on basin lines could become a permanent mechanism for coordination and dialogue between the different actors and stakeholders involved in the planning processes.

Second, from a more technical and functional perspective, a clear allocation of roles and responsibilities is very important. This must be accompanied by having the right means – financial and human – to implement policies and by fostering stable jobs, less exposed to political changes. In Peru, for example, the national and local water authorities at the moment have a lack of sufficient qualified personnel to deal with both technical and administrative issues. Brazil is similar: there is scope for additional training and institutional strengthening at all levels.

Third, in terms of economic and financial means, the case of Mexico shows there is scope for the introduction of incentives for the modulation of consumption patterns for all sectors (primary, secondary and tertiary). Furthermore, there is a need to think more deeply about the anthropo-hydrogeological cycle and the potential cost savings from internalizing ecosystem services such as storage provided by aquifers. Thus the logical sequence for IWRM could be based on strengthening the knowledge and capacity to fully record and monitor water uses, as well as to develop a holistic set of incentives targeted at the different uses.

Fourth, it is essential to play on one of the strengths of Latin America: its civil society, which at present might not be fulfilling its full potential and yet it is the key piece in the puzzle for strong political will. In a deepening of democratization processes, civil society is the cornerstone to strengthening the local population and giving a voice to local actors in shared management. Yet this also means looking at who are the main policy beneficiaries, as highlighted by levels of vulnerability to extreme events or political decisions when there are potential trade-offs e.g. in the case of food/energy. In Brazil, for example, as discussed in Chapter 14, a greater presence of local actors means a deeper questioning of inertias. Equally in Costa Rica the participation of different actors is low since there are no adequate or clear mechanisms that favour effective public participation. Oftentimes the public is informed but do not actually partake in decision making. Meanwhile in Peru the increased level of awareness about water scarcity – on the Peruvian Coast where most of the population lives – combined with clear signals of global warming, have contributed to strengthening conscience that freshwater is a scarce resource that has to be protected.

Fifth, a deeper level of institutionalization implies a modern water law, which includes key areas like the human right to water (see Chapter 11), economic instruments for a green economy and its full implementation (thus again political will). Political will could be reflected, for example, in a clear and explicitly stated water policy that identifies financial resources to be allocated (e.g. to water infrastructure) and presents clear policy and political goals at national level in order to incorporate other elements, beyond a purely technological paradigm, thereby acknowledging the resource base and its environmental functions as discussed in the section on green growth. Inevitably this will mean, on occasions, confronting vested interests, like for example in Mexico, where discussions with big users like livestock and industry need to occur in order to negotiate a reduction in their privileged incumbent position in terms of water consumption, towards more equitable use. In other cases, such as in Costa Rica would imply greater transparency, improved governability and further involvement of users in the decision on the balance of allocations, through the elimination of *Juntas Directivas* – made up by businesses to be replaced by a competition commission.

Finally, when IWRM is seen as a process it is fundamental to identify clear goals or targets as well as the sequencing or prioritization of reform (see Box 15.5). Along the lines of 'good enough governance' (Grindle, 2007; López-Gunn et al., 2012), it is about setting priorities with a clear commitment to follow through, with political priorities based on real problems with clear sequencing (Saleth and Dinar, 2004). For example, water quality and sanitation, in Brazil 21% of the population does not have access to basic sanitation (see Chapter 6). Meanwhile in Costa Rica only 4% of wastewater receives treatment. Yet the implementation of a legal decree on wastewater discharges could generate the resources needed to increase the level of treatment; an example of a virtuous circle mentioned above which relies on political will and the approval of a National Policy on Wastewater and Sanitation. Equally in Mexico a major step forward would be to expand the coverage for drinking water and sewerage. Therefore the anticipated SDGs (Sachs, 2012) in relation to water offer a golden opportunity for clear political goals and prioritization.

Political will, which comes from healthy public participation from the base of civil society and a broad civic culture, supported by outside pressure from multilateral organizations are two fundamental elements needed for IWRM to be fully implemented. It is about taking action in areas that have already had their problems diagnosed and which centre on three axes: issues of governability (institutionality, coordination, laws), infrastructure (both hard and soft), and sustainable and equitable use.

For IWRM to succeed in achieving the multiple goals of water security there must be a political will to take strong decisions that may upset the status quo and 'break away' from the traditional instated ways, facing obstacles from sectors and interests which are currently benefiting at the expense of society at large. The way forward is clear: water security through IWRM with a particular focus on social equity and environmental quality – the two pillars required for a resilient, robust future.

Box 15.5 Reflections on IWRM and water security

'IWRM in Costa Rica is understood as: comprehensiveness in resource management, economic value of water, equity in the distribution and sustainability in the use that does not compromise the future for Costa Ricans. IWRM would strengthen institutionality since it clarifies and defines a single institution as a front-runner thus defining leadership and policies. It also raises the different roles of other institutions (SENARA, ICAA, Ministry of Health, etc.) whilst additionally establishing legal, economic instruments (water charges) for resource management, monitoring, protection. Furthermore it also takes into account other areas such as capacity building, research, monitoring and the control of pollution. IWRM is a process by which ecosystems are administered, assigned, and protected and all sectors are integrated into coordinated management, from the local to the national level, from the business to the community level and from the public to the private sector, so as to ensure that every drop of water can be maximized and generate the greatest economic, social and environmental benefits. IWRM is a means to achieve water security. It is likely that there are other water management schemes that also target water security, but they will take more time, more resources, and more effort. Moving towards water security also means directing our steps towards food security, energy security, a reduction in poverty and ensuring growth with environmental sustainability, all of which are fundamental aspects of IWRM. IWRM and water security share the principles of efficient, sustainable and equitable water, thus fostering development, the eradication of poverty and the quality and quantity of the resource.' (Maureen Ballestero, Costa Rica)

'One of the major issues to be resolved is the quality of river water; the other is the need to generate resources for the management and the strengthening of local actors. It is also a strategic issue considering the key elements for water management: water as a human right, the importance to legislate on groundwater, economic instruments towards a green economy and so on. Water security is about meeting basic needs, ensuring food supply and protecting ecosystems. There is a great crossover between policies on water and sanitation, land use and urban planning and so in order to complete the planned cycle for water policy in terms of institutional and management aspects, such as quantity and quality, an essentially political solution is required alongside the political will to enforce it.' (Pedro Jacobi, Brazil)

'IWRM is not a specific action but a public administrative will for a better use of water resources, with or without considering other contexts. They are two different things: water security is a social concept with implications for the overall economy and the rights of citizens. IWRM is a set of rules and techniques for certain objectives, one of which may be water security, but water security, for what? With what priorities? To what degree? At what cost?' (Emilio Custodio, Spain)

'Water security is part of integrated water resources management. Water Security tries to establish a correct balance in the use of resources in terms of quality and quantity for the future, in a way that does not endanger sustainability. IWRM would also seek to maximize economic and social benefits to water users in harmony with the environment.' (Julio Kuroiwa, Peru)

'IWRM is a methodology and water security is a human need. Water security can be seen as an indicator for IWRM. Water security is a specific application that requires appropriate information.' (Maria Josefa Fioriti, Argentina)

'IWRM is a broader concept that, in a way, includes water security. In principle, IWRM must include issues related to water security. Water security traditionally has been treated without regard to the possibilities currently offered by virtual water trade, especially in the food sector. Both IWRM and water security should have many points in common. However, nowadays almost all water security plans only take into account the resources of the region in question, forgetting the great effect that virtual water import could have.' (Ramon Llamas, Spain)

Figure 15.13 The WRM cycle to achieve water security. *Source: own elaboration.*

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