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Climate Change Adaptation

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Water Resources Management and Adaptation to Climate Change: A Discussion Document for the Latin America and Caribean Region Towards the VII World Water Forum

1. Introduction and Context

This document has been written to provide a starting point of discussion towards an articulated strategy for increased engagement in water resources activities in the countries of the Latin America and Caribbean (LAC) region, in preparation fot the 7th World Water Forum (WWF7-Korea, 2015). A vision, mission and associated strategic objectives have been developed based on an analysis of projects financed in water resources over the past five decades (1960-2010), and a coupling with emerging issues in the region that are being driven by challenges such as climate change.

The document has been written to reach a broad audience. In addition to serving as a guide for planning purposes within WWF7, the document can be used as input to country strategies and other water resources sectoral documents. For the readers across sectors and a variety of institutions and organizations, this document aims to provide insight into water resources issues in the LAC region, particularly from the perspective of proposed strategic lines of action that can be put forth in WWF7.

Water Resources Problems and the Development Challenge in the LAC Region

Since the Earth Summit in Rio in 1992 when the concept of Integrated Water Resources Management (IWRM) was widely embraced, and particularly in the last decade, evidence has accumulated worldwide and in the LAC region on experience with implementing the IWRM approach. First, experience shows that the Dublin Principles have provided inspiration and direction for many water reform processes, and that the principles remain appropriate and relevant, e.g., Mexico's 2030 Water Agenda (CONAGUA, 2011). Second, a major review by the United Nations (UN Water, 2008) has concluded that progress in IWRM implementation has been difficult, slow and uneven and that in most countries, even the ones that are most advanced in implementation, are far from compliance with the IWRM approach. Third, another recent review of the water sector needs in the LAC region coordinated by the Inter-Amerian Development Bank with participation of a broad range of organizations (Regional Policy Dialog in LAC, 2010) concluded that, while the IWRM principles remain appropriate and relevant, the major challenge was developing context specific, prioritized, sequenced, realistic and climate change - adapted approaches to implementation.

This objective of this discussion document is to tackle these identified implementation challenges in water resources management efforts in the LAC region. This *implementation* approach of this strategy focuses on the main water resources problems that continue to constitute a barrier to development throughout the LAC region as follows:

- *Supply, Distribution and Sustainability of Water Sources*: For example, most countries in the Caribbean face water scarcity and/or unavailable access, where demands generally match or exceed supplies and increasing demand driven by population growth and development exacerbates the problems. A similar situation is found in many areas in larger countries such as Mexico, Brazil, Chile and Peru. Even in countries with ample water resources to supply their population, the distribution of water is carried out in an unsustainable fashion in most cases, with impacts from climate change threatening sources even more.

- *Contamination and Degradation of Water Quality*: While problems of water availability afflict a subset of countries in semi-arid and arid regions, problems of poor water quality afflict widely all countries of the region. Many more insidious problems exist as well, revealed in degraded freshwater that undermines the ecological integrity and the very life support ecosystems on which people of the region depend, e.g., the Amazon river basin and a large fraction of the Atlantic and Pacific coastlines of countries in the region. Examples include pollution caused by wastewater disposal system, groundwater pollution due to agricultural and industrial practices and salinization of near coastal aquifers.

- *Water Resources Management Infrastructure*: Problems found here are widespread throughout the region as well, ranging from aging drainage and treatment systems to inadequate operation and maintenance, to planning design and construction of new facilities. Every year, destructive floods inflict harm and stifle development. Here too, the problems are largely present in poor regions of higher population density (e.g. Rio de Janeiro, Nicaragua and throughout Haiti). Inadequate infrastructure also affects lesser developed rural areas, which become more vulnerable to natural disaster events and climate change.

- *Governance and Institutional Strengthening*: Across the LAC region, incipient or poorly funded water resources management institutions (e.g., ministries, national and local water authorities) struggle with the finer details of water resources management challenges. Although many countries have made significant progress in institutional strengthening (e.g., Brazil, Mexico, Peru, Venezuela), the need for further capacity building efforts is necessary to develop proactive actions to address adaptation to climate change.

2. Water Resources in the LAC Region: An Updated Strategic View

Several IWRM strategies have been put forth in the LAC region, reflecting the broad global consensus that was forged following the Rio Earth Summit of 1992. This consensus stated that modern water resources management should be based on three fundamental principles (known as "the Dublin Principles"). **First** is the ecological principle, which argues that independent management of water by different water-using sectors is not appropriate, that the watershed should be the unit of analysis that land and water need to be managed together and that much greater attention needs to be paid to the environment. **Second** is the institutional principle, which argues that water resources management is best done when all stakeholders participate, including the state, the private sector and civil society; that women need to be included; and that resource management should respect the principle of subsidiarity, with actions taken at the lowest appropriate level, facilitating local actions. **Third** is the instrument principle, which argues that water is a scarce resource and that greater use needs to be made of incentives and economic principles in improving allocation and enhancing its quality.

In 2012, the Inter-American Development Bank (IDB) prepared a Technical Note entitled *Water Resources and Adaptation to Climate Change in Latin America and the Caribbean: Strategic Guidelines and Proposed Lines of Action*[1]. This document articulates a vision, mission and associated strategic objectives that were developed based on an analysis of projects in water resources management at the Bank over the past five decades, an integration to the overall charge of the IDB, and a coupling with emerging issues in the region that are being driven by challenges such as climate change.

2.1 International Evidence of the Efficacy of Water Resources Sub-Sector Policies

Access and Quality of Water Resources: Understanding water availability and use throughout the world is an issue increasingly being pursued worldwide. In this regard, the concept of *water footprint*[2] has been introduced to quantify and map water amounts and different types of water use, providing a clearer picture of the consumption of water resources, its variation with location and over time. Recent research[5] quantifies and maps the water footprint (WF) of humanity at a high spatial resolution. It reports on consumptive use of rainwater (green WF) and ground and surface water (blue WF) and volumes of water polluted (gray WF). Water footprints have been estimated per nation from both a production and consumption perspective. International virtual water flows are estimated based on trade in agricultural and industrial commodities. The global annual average WF in the period 1996–2005 was 9,087 Gm^3/yr (74% green, 11% blue, 15% gray). Agricultural production contributes 92%. About one-fifth of the global WF relates to production for export. The total volume of international virtual water flows related to trade in agricultural and industrial products was 2,320 Gm^3/yr (68% green, 13% blue, 19% gray). The WF of the global average consumer was 1,385 m^3/yr. The average consumer in the United States has a WF of 2,842 m^3/yr, whereas the average citizens in China and India have WF of 1,071 and 1,089 m^3/yr, respectively. Consumption of cereal products gives the largest contribution to the WF of the average consumer (27%), followed by meat (22%) and milk products (7%). The volume and pattern of consumption and the WF per ton of product of the products consumed are the main factors determining the WF of a consumer. This research

[1] IDB (2012), Water and Sanitation Division, *Water Resources and Adaptation to Climate Change in Latin America and the Caribbean: Strategic Guidelines and Proposed Lines of Action*, Technical Note No. 478.
[2] Hoekstra and Mekonnen (2011), The water footpringt of humanity, Proc. Nat. Acad. Sci. 109(9), 3232-3237.

illustrates the global dimension of water consumption and pollution by showing that several countries heavily rely on foreign water resources and that many countries have significant impacts on water consumption and pollution elsewhere. Although the LAC region is a net water exporter, the WF varies widely among countries and there are significant water exchanges within the region, for instance, Mexico is one of the major virtual water importers in the world (91 Gm^3/year)[3].. According to Chapaign and Hoekstra (2004) the LAC water footprint is 1,136 m^3/person/yr and to give an idea of its variability, the WF of Argentina, Brazil, Ecuador, Peru, Mexico, Honduras, Chile, Colombia and Venezuela is 1,404 m^3/person/yr, 1,381 m^3/person/yr, 1,218 m^3/person/yr, 777 m^3/person/yr,1,441 m^3/person/yr,778 m^3/person/yr,803 m^3/person/yr,812 m^3/person/yr and 883 m^3/person/yr, respectively [4].

Governance: Overwhelmingly, governance is continuously cited as a major limitation of policy efficacy in water resources throughout the LAC region[5]. The institutional organization of the water resources sub-sector varies widely across and within LAC countries. Before improving water governance in LAC countries, or in any country or region, decision makers need a clear picture of who does what. A mapping of roles and responsibilities in water resources policy in LAC[4] shows great diversity in the allocation of responsibilities across ministries and levels of government in the water sector, but common trends across LAC countries can be identified: (i) LAC countries have decentralized some water functions: service delivery (water supply and wastewater) is usually devolved to the local level, while responsibilities associated with water resources management are met by higher-tier local governments (e.g. regions, provinces). (ii) There is no systematic relationship between a country's constitutional structure and the institutional mapping of water policy, i.e., institutional organization of water policy is diverse across LAC federal and unitary countries. Some federal countries still retain significant powers at central level (e.g. Mexico) while some unitary countries are moving towards further decentralization in the sector (e.g. Peru). (iii) Many LAC countries surveyed recently[6] have set up river basin organizations depending on institutional factors, hydrological considerations, incentives or regulations. (iv) In some cases (e.g., Chile, there is significant overlap of responsibilities among many institutions and agencies, which creates inefficiencies and even contradictory water resources management actions. The maturity of these systems varies widely; some have been created recently while others date back to decades ago. Their efficiency in contributing to integrated water resource management is intrinsically dependent on the regulatory, planning and financing prerogatives allocated to them.

Sustainability and Financing: The economic value of water is intrinsically linked to governance and management issues in the water resources sub-sector. Conventional wisdom in the LAC region dictates that the problem of water is not one of physical shortage but, rather, one of governance as indicated above. This is not entirely correct. The physical lack of surface or groundwater may not be an issue in many areas of the region, but the widespread notion that the LAC region is water-rich is far from accurate. For instance, two thirds of the region is

[3] Konar, Dalin, Suweis, Hanasaki, Rinaldo and Rodriguez-Iturbe (2011), Water for food: the global virtual water trade network, Water Resources Research 47, doi:10.1029/2010WR010307.

[4] Chapaingn A.K., A.Y. Hoekstra (2004), "Water Footprint and Nations", Value of Water Research Report, No.16, UNESCO-IHE.

[5] OECD (2012), *Water Governance in Latin America and the Caribbean: A Multi-level Approach*, OECD Studies on Water, OECD Publishing. *http://dx.doi.org/10.1787/9789264174542-en*

[6] OECD (2012), *Water Governance in Latin America and the Caribbean: A Multi-level Approach*, OECD Studies on Water, OECD Publishing. *http://dx.doi.org/10.1787/9789264174542-en*

classified as arid and semi-arid such as the center and northern part of Mexico, the Brazilian northeast, Argentina, Chile, Bolivia and Peru[7]. In fact, the problem is one of matching demand with supply, of ensuring that there is water at the right location, and the right time of year, and at a cost that people can afford and are willing to pay for. The difficulty in accomplishing this is partly institutional and certainly includes issues of governance. However, the problems of governance have to some extent an economic explanation, because the capital intensity and longevity of water and the significant economies of scale create a need for collective action in the provision and financing of water supply, and the looming presence of fixed costs make cost allocation among individual beneficiaries highly problematic. In short, while there clearly are some distinctive emotive and symbolic features of water that make the demand for water different from most other commodities, there are also some distinctive physical and economic features that make the supply of water different and more complex than that of other goods[8]. Sustainability of provision and as a consequence of service is tied to the adequate management of the upper watersheds adding a retinue of benefits to the water and sanitation value chain[9]. The experience of financing IWRM at upper or whole watersheds varies from country to country and in cases of large countries like Brazil it may vary according to the diversity of the water users in the watershed.[10]. The revised methodologies do not take into consideration the intrinsic or value of no use of the water and neither the scarcity. In December 2013, The Nature Conservancy (TNC) proposed a methodology that incorporates the value of scarcity, costs of upstream watershed conservation and payment for ecosystem services in the water tariffs in Latin America[11]. The implementation of such approaches is still to be seen.

Social Aspects and Community Management: This involves support of watershed-based structures for water resources management, which places shared responsibilities on entities such as local watershed councils. We are working with national water agencies in served countries to help establish these structures with information, data and communication systems. Watershed councils need to develop planning, protection, problem-solving and restoration capabilities in a complementary manner. At the watershed level, sub-basins are delineated as special areas for protection of water supply source areas, irrigation districts or hydropower reservoirs, for example. The watershed council can have responsibility for day-to-day and ongoing involvement and oversight of watershed programs. National water resources management planning should be a dynamic process capable of assisting local watershed councils and river basin commissions with support and resources. We have initiated work in strengthening of the institutions in charge of public policies through IWRM tools adapted to respond to the effects of climate change in the sector. For example, we are working with the Autoridad Nacional del Agua in Perú to establish, train and implement watershed councils across the country. We are also working with the Dirección Nacional del Agua in Uruguay to develop a first for the region: a national level IWRM plan that is climate-adapted. Common to all the experience is the need to work with the community of water users and the population at large; which need effective communication strategies in search of efficiency. According to the *Pulse of*

[7] Comprehensive Assessment of Water Management in Agriculture (2007). Water for Food, Water for Life, International Water Management Institute, London, Earthsean.

[8] Hanemann (2006), The economic conception of water, in: *Water Crisis: myth or reality?* Eds. P.P. Rogers, M.R. Llamas, L. Martinez-Cortina, Taylor & Francis plc., London.

[9] OECD (2011), Benefits of Investing in Water and Sanitation, an OECD Perspective, OECD publishing. http://dx.doi.org/10.1787/9789264100817-en

[10] Autoridade Nacional de Aguas – ANA (2009), Boletim sobre Cobrança pelo uso de Recursos Hídricos, V.2, n.1, 2009.

[11] TNC (2013) Metodología para la Internalización de costos de conservación en las tarifas de agua en dos países de América Latina:: Propuesta Perú.

the Profession™ In-Depth Report: The Essential Role of Communications, by the Project Management Institute (May 2013), for every 1 US$1 billion spent in a project, US$135 is at risk, of which US$75 million (56%) is due to ineffective communication. With this knowledge, Bank's projects are relying in thorough consulted methodologies to prepare watershed management plans and to implement institutional structures for IWRM [1213]. This approach was used to prepare the watershed management plans of six Peruvian watersheds (IDB operation PE-L1070).

Management of Services and Private Participation: Even in locations where there is better understanding of water availability and use, water use efficiency continues to be a management challenge in most countries around the world, and certainly in the LAC region. As droughts have received increased attention lately (e.g., the Caribbean drought of 2009-10, Argentina in 2011, Mexico in 2011-12), the efficiency in the use of a scarce resource as water provides for a push in needed reforms in the water resources sub-sector. Even in countries that may have experienced scarcity (Argentina being an example), infrastructure projects are designed to increase water production, with a lesser focus on improving the efficiency of existing systems. On one hand, the gains of such reforms are expected to continue the containment of costs, productivity growth and consistency in meeting service standards. On the other, the water sector as a whole is expected to en- courage much greater efficiency in the use of water, since it is now perceived as a scarce resource. Water utilities, public and private, are expected to simultaneously provide a reasonable return on assets while encouraging customers to purchase relatively less of the good that provide utilities with a significant share of revenue. There has been difficulty in measuring the relative performance of the various players in the sector over time. It has also been argued that the disaggregated institutional structure has decoupled decision making and implementation institutions to such an extent that highly inefficient and long-lived urban water supply augmentation investments have been made without sufficient rigor or analysis. The moves toward integrated urban water cycle management and water sensitive urban design have entrenched within water delivery institutions the water use efficiency objective, encapsulated by the ubiquitous catch cry of *every drop counts*[14]. Throughout the Region water losses approaches or surpass the 50%[15] and in the agriculture sector, responsible for almost 80% of the water used in countries like Peru, losses approaches 65%[1617]. High water losses are directly related to lack of operation and maintenance and tariffs that do not reflect scarcity and the real costs of operation and maintenance.

Environmental Aspects and Climate Change: An important looming problem in water resources that is receiving increasing attention is climate change, but not necessarily in relation to impacts in water availability which is amply documented in numerous studies and most notably in the IPCC Assessment Report series. Currently, the literature offers little guidance on the extent to which the prospect of climate change will alter key operational and management issues in water resources, such as: (a) the level and structure of water supply costs and economic value; (b)

[12] US. Army Corps of Engineer, www.sharedvisionplanning.us
[13] Chaman, Karla, Strategic Communication and Stakeholder Engagement, Department of External Relations, IDB, 2008.
[14] Byrnes, Joel (2013), A short institutional and regulatory history of the Australian urban water sector in Utilities Policy: water utility regulation in developing countries, Vol. 24, March 2013.
[15] Ministerio de Economia y Finanzas (2010); information to prepare the Water Resources Policy Based Loan PE-L1024.
[16] http://www.slideshare.net/hugogc/per-el-agua-en-cifras
[17] Intendencia de Recursos Hídricos (actual Autoridad Nacional del Agua) (2010); information to prepare the Water Resources Policy Based Loan PE-L1024.

reliance on non-price water conservation mandates, incentives, and other policies; (c) legal property rights regimes for water (d) the allowable extent of and constraints on transferring and leasing water among users, within and across basins; (e) investment in water supply infrastructure; (f) water supply infrastructure operations; and (g) water allocation institutions in transboundary river basins[18]. This is an area in which research and analytical work is warranted, and certainly the case for the LAC region.

2.2 Water Resources Problems and the Development Challenge in the LAC Region

The strategic context in this discussion document for water resources seeks to address these identified implementation challenges in water resources management efforts in the LAC region. This implementation approach of such a strategy focuses on the main water resources problems that continue to constitute a barrier to development throughout the LAC region as follows:

Access and Quality of Water Resources: The LAC region has relatively plentiful surface and groundwater sources. However, these sources are under risk in many cases. For example, most countries in the Caribbean face water scarcity and/or unavailable access, because of inefficiency in the management of the resource (combined with where demands generally match or exceed supplies and increasing demand driven by population growth and development) exacerbates the problems. Some countries of the region (e.g., Suriname, Uruguay, Venezuela) still operate with no real separation between the water resource authority and the water utility which implies that the water rights and/or water abstraction permits are given by the same institution that requests the resources. There is also limited and out-of-dated catchment information that limits the decision making process in the use to water resources. A similar situation is found in many areas in larger countries such as Mexico, Brazil, Chile and Peru. Even in countries with ample water resources to supply their population, the distribution of water is carried out in an unsustainable fashion in most cases, with impacts from climate change threatening sources even more. Disputes between upstream and downstream uses are spread all over the Region indicating in some cases a lack of understanding and dialogue between users such is the case of the Peruvian watersheds: Santa, Piura and Tacna. In Brazil, the 2014 drought of São Paulo brought to the discussion an old idea of reverting part of the the Paraiba do Sul river to supply the megalopolis. A long discussed is expected since the Paraiba do Sul is used to supply most of the water to the city of Rio de Janeiro and suburbs downstream.

Governance: Across the LAC region, incipient or poorly funded water resources management institutions (e.g., ministries, national and local water authorities and river basin commissions) struggle with the finer details of water resources management challenges. Although many countries have made significant progress in institutional strengthening (e.g., Colombia, Brazil, Mexico, Peru, Venezuela), the need for further capacity building efforts is necessary to develop proactive actions to implement water resources management at the watershed level and address adaptation to climate change. Furthermore, even though most of the LAC countries have developed water resources legislation tuned to the idea of water resources management using the watershed as management unit (Brasil, Peru, Mexico etc), there is still a need to consolidate the concept in some countries and to harmonize water resources with environmental legislation and the respective institutional responsibilities (e.g., Brasil, Panamá, Argentina). Lack of clear responsibilities and effective coordination between institutions have

[18] Olmstead (2013), Climate change adaptation and water resources management: A review of the literature, Energy Economics doi: 10.1016/j.eneco.2013.09.005.

been the causes for poor implementation of IDB water resources management projects in LAC, which in most cases is due to a lack of an integrated, multisectoral and cutting-edge approach by decisions makers when planning WR management and designing WR related infrastructure. In addition, there is a need to strength the technical capacity of institutions and Sector's decision makers (human and technical resources). Furthermore, the recent privatization of water utilities in countries such as Brazil and Chile added a number of operators to the discussion of IWRM and the need to coordination increased.

Sustainability and Financing: A sustainable provision of water resources in a demographically and economically dynamic growing region like LAC hinges on adequate financing of water resources management infrastructure. Problems found here are widespread throughout the region as well, ranging from aging conveyance, drainage and treatment systems to inadequate operation and maintenance practices, energy efficiency, to insufficient and poor-quality data and decision support tools, to planning, design and financing of new facilities. Every year, destructive floods inflict harm and stifle development. Here too, the problems are largely present in poor regions of higher population density (e.g. Rio de Janeiro, Recife, São Paulo, Buenos Aires, Nicaragua and throughout Haiti). Inadequate infrastructure also affects lesser developed rural areas, which become more vulnerable to natural disaster events and climate change. The Bank has recently engaged with financing mechanisms such as *water funds*[19], which generate revenue by charging downstream water users for upstream water source protection and improved management practices in the watershed. Although in some countries (Brazil, Mexico, Peru, Chile, Colombia) resources are generated to cover the IWRM they are far from sufficient. There is a growing need to attract public and private investments to the sector and the correspondent generation of revenues to support the IWRM activities in a sustainable manner.

Social Aspects and Community Participation: Although the countries of the region are signatories of international agreements related to water resources management and conservation, devised strategies and action plans to prevent and/or adapt to critical events, have not reached decision makers outside the sector neither the affected population. There is a clear need to develop local as well as regional communication and participation strategies to implement water resources and climate change initiatives that permeates all levels of the LAC society.

Management of Services and Private Participation: Since 1998 when this strategy was endorsed by the Bank, and particularly in the last decade, evidence has accumulated worldwide and in the LAC region on experience with implementing the IWRM approach. First, experience shows that the Dublin Principles have provided inspiration and direction for many water reform processes, and that the principles remain appropriate and relevant (e.g., Mexico's 2030 Water Agenda (CONAGUA, 2011). Second, a major review by the United Nations (UN Water, 2008) has concluded that progress in IWRM implementation has been difficult, slow and uneven and that in most countries, even the ones that are most advanced in implementation, are far from compliance with the IWRM approach. Third, another recent review of the water sector needs in the LAC region coordinated by the IDB with participation of a broad range of organizations (Regional Policy Dialog in LAC, 2010-2013) concluded that, while the IWRM principles remain

[19] Water funds gather investments from water users and direct the funding toward conservation of key lands upstream that filter and regulate water supply. At the same time, habitat for native plants and wildlife is preserved. http://www.nature.org/ourinitiatives/habitats/riverslakes/water-funds-investing-in-nature-and-clean-water-1.xml

appropriate and relevant, the major challenge was developing context specific, prioritized, sequenced, realistic and climate change - adapted approaches to implementation.

Environmental Aspects and Climate Change: While problems of water availability afflict a subset of countries in semi-arid and arid regions, problems of poor water quality afflict widely all countries of the region. Many more insidious problems exist as well, revealed in degraded freshwater that constantly undermines public health, threatens the ecological integrity and the very life support ecosystems on which people of the region depend, e.g., wetlands in the Amazon river basin and a large fraction of the Atlantic and Pacific coastlines of countries in the region. Examples include pollution caused by inadequate wastewater disposal system, groundwater pollution due to agricultural and industrial practices and salinization of near coastal aquifers. The urban rivers of the Region's metropolis are heavily polluted by untreated or poorly treated sewage, urban runoff and improper solid waste disposal. Urban rivers Such as Tiete in São Paulo, Guaire in Caracas, Bogotá in Bogotá, Rimac in Lima, Reconquista y Matanza-Riachuelo in Buenos Aires represent a complex challenge for IDB action since it requires efficient management of the upper watershed, extensive coordination between institutions and different levels of governments, revision of urban planning paradigms, expensive engineering solutions and clever financing mechanisms to regain their quality and ability to supply water for different uses including scenic appreciation by the population.

2.2 Lessons Learned and Proposed Lines of Action

It is quite clear that there is synergistic relationship between water resource management and service sectors. While within country governments the details of the water-using sectors are managed at the sector level, it is important to recognize that a water resources strategy that does not integrate across sectors would make little sense in this day and age. Strengthening the linkages between water resources and the service sectors, and infusing climate change adapted principles and practices, are central to overall resource management and thus to the focus of our work. Throughout countries in the LAC region, the implementation of this integrative principle is a continuing challenge. Since use of water always precedes concerns with resource management, the culture and principles of the major water-using sectors have a profound influence on the ways in which LAC countries approach the challenges of water resources management.

When specific water-using sectors make heavy use of water resources such as the agricultural sector, improved management efforts must closely examine the internal workings of those sectors. It is then pertinent for this discussion document to highlight the main challenges and opportunities in the area of water resources in its integrated and adapted interaction with such sectors. In the year ahead, focus will be placed on the links between the activities of water-using sectors to the management of water resources.

Access and Quality of Water Resources: Conservation and restoration of water sources and associated ecosystems that reduce the vulnerability to climate change, by offering security in the availability of water resources, as well as natural resistance to extreme climate-related events. In this regard, the World Wildlife Foundation lead a nationwide pilot study in Mexico to identify "water reserves" for more efficient water use that balances ecosystem services with ecological conservation. The integral perspective taken when development watershed management plans in Peru by the country's national water authority (ANA) includes source conservation and the sustainability of distribution and use of the water. Conflicts between water

users are registered in watersheds of Peru and Chile where management structures are absent and usually involve mining and hydroelectric power plants and traditional farmers and/or indigenous populations. The implementation of IWRM improves the dialogue between the actors and has contributed to the decrease in the number of conflicts in Peru.

Governance: The lessons learned with the adoption of the IWRM concept in countries of LAC are of two different levels: (i) general, conceptual, almost philosophical; and (ii) practical, represented by the lack of instruments, financing and an effective methodological approach to induce user's engagement in the implementation of prioritized actions at the watershed. According to the definition posted by the Global Water Partnership (GWP), IWRM is defined as a process that promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare without compromising the sustainability of ecosystems and the environment[20]. This highlights the important role of institutional coordination and the need to have them strengthened and focused at the same objectives. At this first level what has been identified is the existence of responsibilities gaps between institutions involved with water resources management making it difficult to implement fully the IWRM concept. For instance, countries like Chile, Costa Rica and El Salvador, have multiple actors at the central level and few to implement the actions at the sub-national level, making it difficult the coordination across ministries. On the other hand, countries like Brazil, Mexico and Peru have multiple actors at central and sub-national levels raising the need to coordinate across ministries, between levels of government and with local actors. Finally, countries like Argentina and Panama have few central government actors and multiple sub-national authorities raising the challenge to coordinate across sub-national actors and between levels of government (OECD, 2012)[21]. The prescription of the reference study is to perform a multilayered gap analysis and proceed to the integration of functions duly funded and strengthened. This apparently logical prescription encounters tremendous barriers because of uncounted factors such as: (i) the IWRM institutional and capacity requirements represent a relatively novel concept and most of the time are exogenous to the country's constitutional structure (OECD, 2012) requiring an in depth analysis of the cultural ties embedded in the institutions to design flexible transition structures before moving into full-fledged operational ones[22]; and (ii) sectorial planning is not clearly thought as a fundamental part of the country's development programs.[23].

Sustainability and Financing: Regional efforts should focus on increasing and optimizing the sources of financing in order to favor the appropriate planning and implementation of water resources projects, especially towards the attention of vulnerable groups. In addition to the water funds initiative, MDBs working in the region are partnering with donors and investors to identify and conceptualize water resources management soft and hard infrastructure activities in cities (e.g., the IDB's Emerging and Sustainable Cities Initiative). Financing or cost recovery

[20] Global water Partnership, Policy Brief in Water Security for Development: Insights from African partnership action, March 2010.
[21] OECD (2013), Water Governance in latin America and the Caribbean: A Multi-level approach, in OECD Studies on Water.
[22] Beck, Don E and Cowan, C; (2005);Spiral Dynamics, Mastering Values, leadership and Change; Blackwell Publishing
[23] Global Water Partnership, Policy Brief in Water Security for Development: Insights from African partnership action, March 2010

mechanisms need to be easy to implement and be understood by the users[24] to avoid being discarded by the decision makers.

Social Aspects and Community Management: At the implementation level, the main lessons learned are broadly represented by: (i) lack of trained personnel in IWRM; (ii) lack of accountability at the institutional level; (iii) lack of funding to implement priority actions; (iv) deficient information and data gathering systems; and (v) need to need to objectivize decisions establishing clear milestones towards IWRM implementation. The particular lessons learned vary from case to case but they are concentrated in: (i) how to conform a watershed committee (case of Peru); (ii) pathways to prepare a watershed management plan (cases of Brazil and Peru); (iii) mechanisms to finance the watershed management plan (cases of Brazil, Peru and Mexico); (iv) effective communication strategies to motivate participation and empowering of stakeholders and the general population; and (v) strategies for data gathering and building of open water resources and environmental information systems. Realizing this strategic vision requires a coordinated mission to develop and implement best practices, ensure equitable governance with strong public participation, increase economic opportunities for stakeholders, and sharing tools and lessons learned with partners in the LAC region and beyond. Following the experience with the strengthening of the ANA-Peru, it is clear the need to promote the creation of departments or sections dedicated to develop cultured based communication strategies to implement activities that produce a shift in the culture of water use towards more sustainable practices.

Management of Services and Private Participation: Generation and mainstreaming of more specific and usable hydrological and climate information in decision-making processes. This requires a greater effort of co-production of this information, in order to direct it to different sectors of users, by those institutions that generate knowledge, those that measure it and report data, and those that apply it through public policies and management activities. The IDB is working with the Skoll Global Threats Foundation to develop a pilot regional drought information system for the La Plata basin, comprising Argentina, Bolivia, Brazil, Paraguay and Uruguay. In Mexico, visualization and communication tools for adaptive water resources management have been developed in the Río San Juan watershed through an effort led by Tec de Monterrey. The IDB has also developed a LAC region-wide hydrological modeling tool (*Hydro-BID*) to conceptualize and design water resources infrastructure that is adapted to climate change and variability. Representatives of the private sector through the International Commerce platform have raised the issue of water availability to meet the project economic growth especially in developing countries. To answer the question raised, the 2030 Water Resources Group is promoting the alliance between private and public sectors in target countries such as Peru, South Africa and Mexico to identify potential water management issues that could hinder the project economic growth and dwarf the role of the private sector in this process. This involvement of the private sector in the IWRM should be continued to be promoted from different fronts.

Environmental Aspects and Climate Change: Incorporation of climate change in the re-definition of proposed development infrastructure in the countries of the region for water availability and use. In this regard, a series of pilot studies in Ecuador (adaptation of water utility reservoirs and conveyance infrastructure to accelerated glaciar melting), Perú (re-designing

[24] INECON (2012), *Metodología para determinar el valor económico del agua y las retribuciones económicas por el uso del agua y por vertimientos de agua residual*. Project financed by IDB to support Peruvian ANA in the establishment of the economic return for water use.

irrigation canals and groundwater wellfields in response to increasing drought conditions), Uruguay (adaptation of urban drainage and stormwater management infrastructure to increased rainfall intensity), Nicaragua (regulation of Lake Managua's level to prevent flooding), Honduras (embankments for storm surge and re-design of groundwater wells due to aquifer salinization caused by sea level rise), and Trinidad and Tobago (siting and building updated wastewater treatment plants in Port-of-Spain to account for sea level rise) have been carried out recently to illustrate potential adaptive solutions to water resources problems that are originated by climate change. In each of these cases, work is focused towards site-specific adaptation measures for current and projected water problems for which climate adaptation is critical. It is important to consider that knowledge about climate change and it's mainstreaming into adaptation measures in water resources in general is still in its infancy throughout the world. In the LAC region, there is a clearly identified significant need for both scientific and implementation know-how of adaptation, coupled with a growing demand from institutions in the public and private sectors. It is then clear that coordinated action by the Bank in this area is both timely and needed. The strategic actions proposed in this document therefore focus on an agenda in water resources and adaptation to climate change, with increased funding levels, considering strong initial investments in the area of knowledge, institutional strengthening and planning, prioritized as initial products to be delivered to our member countries. Complementarily, effective and locally based IWRM should be pursued to reduce pollution and enhance the quality of the urban rivers.

Aside from laying out the vision, mission and guiding principles, guidance for implementation is really the focus of the discussion document. Its preparation has relied on reviews and public consultations of on-the-ground experience in implementing water resources projects in LAC countries. These reviews and consultations contributed to identify areas where technical assistance has gone well and others that were less successful, and then honed in on practices that need to change towards improvement of climate change considerations in water resources issues in the region.

In these consultations, the main challenge that has emerged relates to these identified challenges and opportunities; this discussion document offers four coordinated strategic objectives:

a. *Recognize, at a regional level, water resources as a "Strategic Asset"*, and focus on solutions to the water resource problems identified in the region (water quantity, quality, infrastructure and governance) across a range of geographic, climatic, cultural, and socioeconomic settings, from pilot studies to full scale investment projects, incorporating adaptation to climate change. It is particularly important to strength the governance issues in infrastructure projects. For instance, in the Caribbean it is very frequent that there is no separation between water authority and utility. This implies that there is no rationality when using water resources since they are not sufficiently studied before new abstractions are approved. This requires an approach to water resources where institutional and inter-sectoral issues are managed in an integrated manner.

b. *Knowledge and Capacity Building*: Invest in building knowledge and capacities in key economic sectors to design, implement, and manage integrated water resources projects; particular efforts should be placed on the climate adaptation component, where scientific and implementation know-how is starting to emerge, and where there is significant interest throughout the region. Given the MDB's institutional commitment to promote capacity building and knowledge along the region, this discussion document, this discussion

document promotes the development and/or implementation of innovative and world class technology-based tools for water resources planning and management, such as smart infrastructure, e.g., remote sensing, integrated modeling tools, data analytics and visualization, flood forecasting.

c. *Cross-Institution Integration*: In response to the need of an integrated and multi-sectorial approach, consolidate, integrate and streamline expertise, knowledge, and implementation activities in the area of water resources across sectors in countries of the region. The "strategic asset approach" proposed above should integrate across wáter related sectors (water and sanitaiton, irrigation, ecosystems and natural disasters, roadway drainage, hydropower), all weaved together through adaptation to climate change. This approach can take advantage of the know-how consolidated along decades working through sectoral agendas (going from "the sum of the parts" to "the whole" approaches).

   Examples of proposals under this approach will be the design of inter-sectoral projects that meet the Water-Energy-Food Nexus' criteria, and supporting infrastructure Project with "big-data" capabilities in water resources management.

d. *Visibility Raising*: The LAC water resources community needs to assume a leadership role in national and global forums by sharing lessons learned and advising other national and international actors on innovative and viable directions for future activities, particularly in the area of water resources and adaptation to climate change.

This approach has been designed to be catalytic and transferable, where viable water resources projects are designed and piloted in key areas of the LAC region, and associated activities facilitate the adoption and spread of knowledge and experience to other national and international actors in water resources in the LAC region and beyond.

3. Financing of Water Resources Projects (IDB: 1990-2010)

3.1 Background

This section summarizes an analysis of experience accumulated by IDB projects within the general water sector, through a selection of those which have a closer relationship with the area of water resources. While, as in any institution, water resources is carried out in a multi-sectoral fashion involving multiple units at the IDB, an effort has been made to inventory projects where the focus is water resources in itself, or those that have a significant water resources component.

In addition to this, because of the recent emphasis placed by the IDB on climate change, a special focus is placed in this analysis on those water resources (or related) *projects that present opportunities for analysis of adaptation options*, even if it is in a retrospective sense.

To this end, we reference recent internal documents and publications by the Bank, which have made an effort to gather and analyze historical projects in the water resources in recent decades. There are two main documentes considered for that purpose: *Support from the Inter-American Development Bank Group 1990-2005* (IDB, 2006), and *El reto de la Gestión Integral de Cuencas Hídricas* (IDB, 2010c), which updates the first document for operations which fall within the field of watershed management.

The list of projects considered in this document is an update to the one presented in IDB (2010c). We list these projects in Appendix A. An effort has been made to also include projects that though are not strictly centered on watershed management, including backbone components (e.g., infrastructure) or actions in water resources projects that could well be considered measures of adaptation to climate change.

The methodology used to assemble this inventory of projects is based on including water resources projects that relate to the four problem areas identified in Section 1: (i) *water quantity* (supply, distribution and sustainability of water sources), (ii) *water quality* (contamination and degradation of water quality), (iii) *water resources management infrastructure*, and (iv) *governance and institutional strengthening*. Project data used to assemble the inventory is based on the study for the entire sector for the period 1990 - 2005 (IDB, 2006), updated to 2010. Within these categories, watershed management, which concentrates the largest number of operations, includes both direct intervention projects (e.g., soil conservation, water resource protection, reduced use of agrochemicals, pest control, and others), operations and structural changes and institutional and technical capacity in river national and multinational entities (e.g., creation or strengthening of committees, commissions and watershed councils, environmental education aspects). Also the category of infrastructure projects includes dams and reservoirs operations, levees, flood plans, zoning, and stormwater drainage.

This yields, as a first conclusion, that *the IDB has extensive experience in water resources projects that lend themselves for adaptation to climate change*. This statement may be taken as a working basis for this strategy document. The intent is to articulate and organize all this know-how to lay the ground on the coordinated actions that the Bank may take in this area over the coming years.

3.2 Experience of the IDB in the Water Sector

An analysis of the experience and the Bank's project portfolio within the water sector in general, shows that from 1971 to 1975, a peak of 35 percent of total Bank lending was allocated to water sector projects. Investments in the water sector fell progressively from that time, to 7 percent in the period 2001 to 2005, due to a fragmentation of the loans, from loans with a higher volume in investments in infrastructure, to smaller loans with a higher social and environmental investment volume.

From 1990 to 2005, 432 operations were approved in the water sector with a total cumulative investment of 13.2 billion USD. Of this total, 251 consisted of *Technical Cooperation* projects (59% of total number of operations), and 181 were investment loans (41% of projects in the sector). In terms of investments, loans in this period accounted for almost 99% of total investments in water, with 13 billion USD. Water sector projects accounted for 11% of the Bank's portfolio, with an average investment of 826 million USD annually.

Considering that in the 30 year period of 1961 to 1990, the Bank invested about 937 million USD per year (roughly 25% of the Bank's operations) in the water sector, this continued and consistent level of investment reflects a long-term commitment to the sector as a whole. In fact, when considering the entire 1961 – 2005 period, the resulting annual average of investment in the water sector is 907 million per year (18% of the total of Bank operations).

During this time, the Bank gained positioning in IWRM in the LAC region, including the report *Lineamientos para la Preparación de Proyectos de Manejo de Cuencas Hidrográficas* [IDB, 1996], which formally incorporated in a Bank issued document the concept of integrated watershed management (although, since the early 1990s, the Bank issued its first approvals of operations for plans and programs in IWRM). Also, the Bank published the document "Strategy for Integrated Water Resources Management" in 1998 [IDB, 1998a], embodying the concept of Integrated River Basin Management.

4. Water Resources and Adaptation to Climate Change: Need for *Climate Services*

A variable and changing climate where uncertainties exist regarding its future extremes requires better quantity, quality and accessible information that support planning and decision-making processes, as well as infrastructure that can take changing conditions into account. New advances in science and technology have provided higher reliability in climate information, more resilient infrastructure and better insights into managing climate risks and opportunities. New practices and tailored climate information and adapted infrastructure – *Climate Services* - would be able to accelerate and strengthen the process in order to meet the growing demands for useful and usable climate information. In the LAC region, a vision for the development and implementation of climate services has been developed with a vision of integrating climate information into decision-making in socioeconomic sectors, through an effective dialogue between providers and users on the range, timing, quality, content and delivery format of climate products and services. Developing and effectively deploying climate information and climate-adapted infrastructure is an important challenge for the water sector in the LAC region. An effective response to this challenge must integrate meeting the needs of the users of such climate services and building capacity in the existing and next-generation of scientists, practitioners, managers and policy makers. With this in mind, this paper focuses on information and infrastructure activities within the overall framework of climate services for the LAC region.

4.1 Relevance and Vision

Recently, and particularly over the past decade, there has been increasing global recognition of climate as an issue that is central to human wellbeing. Societies have evolved in part by managing the impacts of climate on livelihoods, natural resources and built environments, as well as by taking advantage of opportunities given by climate and natural resources in general. Climate is central to the conditions that can generate prosperity. It can also create unfavorable conditions such as water scarcity and natural disasters that can have negative and multiplicative impacts on major societal issues such as health, poverty, food security and infrastructure. In addition to the direct costs in lost lives, property and livelihoods, these events also cause a range of indirect impacts, including decreased private sector investment and productivity associated with economic and environmental uncertainty.

New advances in science and technology have provided higher reliability in climate information, more resilient infrastructure and better insights into managing climate risks and opportunities. For example, seasonal forecasts, satellite observations, and long-term climate projections can help guide socioeconomic investment decisions, enhance productivity, and reduce risks and vulnerabilities to disasters. However, despite the global attention that has been placed on climate, much of this information is not used to its full potential. This disconnect between climate information producers and information users can be attributed to a variety of factors: prospective users often find climate information difficult to understand; the information has typically not been adapted or evaluated for their needs; and linkages between researchers, information producers and decision makers are often weak or non-existent, hindering the development of new knowledge and decision support mechanisms. However, new practices and tailored climate information and adapted infrastructure – *Climate Services* - would be able to accelerate and strengthen the process in order to meet the growing demands for useful and usable climate information.

Climate Services have a history that dates back to the early 1990s, including experiences in the LAC region (Podestá et al. 1999, 2009). The concept itself was proposed by the World Meteorological Organization (WMO), adopted at the 3rd World Climate Conference in 2009, and embraced by the UNFCCC at COP16 last year. WMO's *Global Framework for Climate Services* (GFCS) promotes the use of

relevant science-based climate information and prediction for practical applications throughout the world.

In the LAC region, a vision for the development and implementation of climate services has been developed so that it is well aligned with the GFCS guidance on integrating climate information into decision-making in socioeconomic sectors, through an effective dialogue between providers and users on the range, timing, quality, content and delivery format of climate products and services. This vision is inspired on the "adaptation cycle" concept, which has been generated through a regional policy dialogue (RPD) , which has taken place over the past two years (RPD, 2010). The conceptual approach for this effort is outlined in Figure 4-1. The GFCS is structured along five elements: (i) a climate services information system; (ii) a user interface platform; (iii) observations and monitoring; (iv) research, modeling, and prediction; (v) and capacity building. The RPD in LAC approach further tailors these elements into five entry points for different types of climate services to be produced as deliverables by our team, connecting and enabling users to tackle each stage of the adaptation cycle.

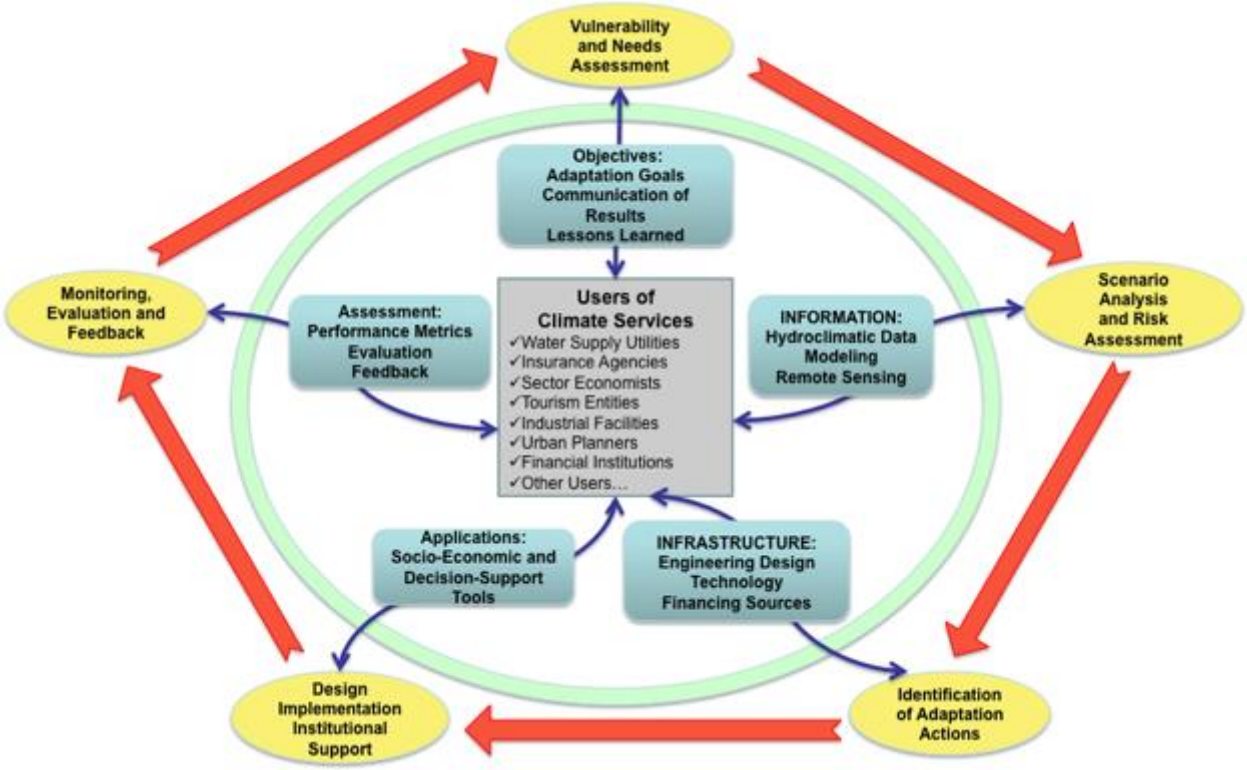

Figure 4-1*: Regional Policy Dialog (RPD) conceptual approach: climate services (blue bubbles) are co-developed with users to support and feedback each stage of the adaptation cycle in development-centered projects (yellow ovals). Infrastructure and Information components of climate services have been highlighted.*

This approach is driven by a vision of providing ***comprehensive climate services*** corresponding to major ***storyline elements in a regional place-based setting***. Comprehensive climate services are those that: (i) span time scales from seasonal, to inter-annual to decadal and beyond; and (ii) include not only climate science knowledge and tools (e.g., data, models, decision-making tools) but also ancillary climate products that are necessary to effectively support adaptation infrastructure projects and help manage climate-related risks, e.g., communication approaches, institutional strengthening, assessment mechanisms, stakeholder engagement, facilitate access to financial resources. Other such examples of

these climate services are shown inside the blue bubbles in Figure 1. The RPD's *storyline elements* are ***Good Governance, Financing Water for All,*** and ***Enabling Environments.*** *Place-based* climate services will be developed in the region through activities that make measurable improvements to the storyline elements.

4.2 Driving Questions

We propose activities responsive to the different adaptation needs within the LAC region, and that is able to assimilate, support and leverage ongoing efforts to develop climate services as these needs unfold and evolve. This approach is driven by three user-centered questions:

- What are the *key needs* in the provision of climate services along the storyline elements and geographical locations throughout the LAC region?
- What are the *challenges* (i.e., barriers, limitations) that each location is facing in addressing these needs?
- What *activities* (deliverables) can be proposed and implemented to address these challenges?

4.2.1 Identification of Key Information and Infrastructure Needs

We will center our climate service development and implementation efforts on major climate-related issues in the water sector: water resources management, coastal planning and management, and disaster prevention and risk reduction, which hinder socioeconomic development in the LAC region. These climate-related problems also generate broader scale impacts such as those on the economy, food production, energy reliability, ecosystem services, social and political stability. Major impacts due to climate variability and change are already being observed across the region, and include the examples summarized in **Table 4-1**.

Table 4-1: Example climate service needs identified in the LAC region

	Water Resources	**Coastal Planning and Management**	**Disaster Prevention and Risk Reduction**
Caribbean	High-resolution drought monitoring and early warning systems for small island countries to counter already stressed water supply.	Sea level change monitoring and modeling for impacts on coastal infrastructure (urban and tourism purposes) development.	Vulnerability mapping under different downscaled rainfall and temperature scenarios, applied to increasing storm surges, tropical cyclones and flood damage.
Andean	Glacier mass dynamic monitoring with lead time for lake outburst floods and seasonal changes in water availability.	Coupled ecohydrologic-climate modeling to simulate changes in mangrove forests, salt water intrusion and higher storm surges (flooding), increased sediment and nutrient loadings,	Hydrologic modeling to simulate changes in runoff generation cycle and assess increased exposure to coastal inundation and storm surges, exposed population centers and infrastructure, water

		eutrophication, dead zones, coastal rapid urbanization, and land use changes.	quality and fisheries and aquaculture loss.
Mexico and Central America	Development of climatological "normals" for meteorological and hydrological variables. (e.g. temperature, precipitation and river discharge). Flood forecasting. Improved reservoir and irrigation operation at seasonal timescales.	Monitoring and improved seasonal forecasts for precipitation, temperature, soil moisture; reservoir levels and river discharge in coastal areas.	Drought monitoring and seasonal forecasting; Crop monitoring and seasonal forecasting; Projection of future drought risk and water availability for various sectors (water supply, crop needs).
Southern Cone	Modeling of intensity and frequency of extreme events, runoff changes, cyclone frequency changes combining with sea level rise, warming, and water demands.	Urban planning and decision-making tools for infrastructure expansion, replacement and new systems.	Improved engineering designs for drainage systems, water storage and conveyance. Revisions of return period calculations and impacts on hydrologic design parameters.

4.2.2 Challenges: Climate Services as Key to a Sustainable Development Agenda

Limitations and barriers to the development and implementation of climate services have been amply documented in scientific literature and other reports. These issues range from insufficient/inadequate climate science information and tools, to social, cultural, political, economic and other gaps [e.g., Miles et al. 2006; Giorgi et al. 2009; RPD, 2010; Gifford 2011]. The proposed approach will focus on developing climate services in a collaborative approach with users (Figure 1), contributing to bridge these gaps through tailored services that address specific needs. This approach will also enable us to obtain feedback and guidance on where the opportunities are to continue to generate and improve the locally specific climate services that can have increased beneficial impacts on the vast and varied problems that exist in the different regions and thematic areas.

As a starting point, we have identified the following *common major challenges* that need to be faced in addressing the climate service needs within our priority geographical regions and thematic areas:

- ***Good Governance****:* Develop and foster networks and communication channels: to facilitate knowledge transfer, informing the public about the outcome and practical application of climate services, and providing vehicles for active public participation. Effective partnerships can a combination of human, knowledge and financial resources, with an emphasis of coupling local scale resources (e.g., on-the-ground partners with local presence and capacity) to global scale

ones (e.g., academic and professional partners, donors, grants and multilateral investment institutions).

- ***Financing Water for All***: Procure sources of financing and leverage existing funds to augment resources for development and implementation of climate services in the region.
- ***Enabling Environments***: Improve local research, education and development capacity through the co-production of applications, decision-making processes and tools: developing and implementing "hardware" (e.g., infrastructure) and "software" (e.g., policy and institutional support) climate products. This will be achieved by creating an environment where local stakeholders are joint partners in the conception, co-production, and implementation of these climate services, contributing significantly in every stage.

4.2.3 Proposed Information and Infrastructure Climate Services Activities

We have assembled a set of proposed activities into the following categories, to address the three challenges identified.

(1) ***Good Governance - Analysis and Communication of Results***: translate the findings of research, applications, workshops and other activities into practice-based guidance for the provision and use of climate services for adaptation, with feedback to other regions of the world. For this purpose, *workshops, m*eetings, briefings, and other exchanges should be hosted to take advantage of the connections being made with practical management societal challenges.

(2) ***Financing Water for All - Facilitation of Access to Financing Mechanisms for Climate Services and Large-Scale Investments in Adaptation:*** Through our partnership with MDBs, provide improved means of access to several existing adaptation funds and contribute to develop new sources of financing and risk-sharing (e.g., private sector) mechanisms for larger-scale adaptation projects.

(3) ***Enabling Environment – Climate Information Products and Infrastructure Applications***: interpret climate information and forecast products for adaptation, planning and risk management in the key societal sectors of water resources, coastal management and disaster/risk reduction. Interactive tools with alternative scenarios should be developed to provide a range of options for managers and stakeholders, enhancing the capabilities for delineating tradeoffs and facilitate decision-making.

4.3 Proposed Action Plan

A proposed work plan to be carried out over an estimated five-year period is described through some examples of specific deliverables for each of the five major climate service activities outlined above.

4.3.1 Analyses and Effective Communication of Results

Communications between climate scientists and decision makers, across regions, sectors, governments, institutions and stakeholder groups has been identified as a major limiting factor for effective use of climate information [RPD, 2010; Gifford, 2011]. Therefore, a significant focus of the LAC regional effort needs to occur in the development of mutual communication channels that will enhance the base of users of climate information, while at the same time deepening the understanding of the climate services and products delivered through various channels in the region. In each application, we must learn what decisions need to be supported and to supply information that prospective users find helpful in their decision processes. Ways to significantly improve communication of results needs to occur in each of the regional undertakings and translate the findings into practice-based guidance for the provision and use of climate services for adaptation, with feedback to other regions of the world.

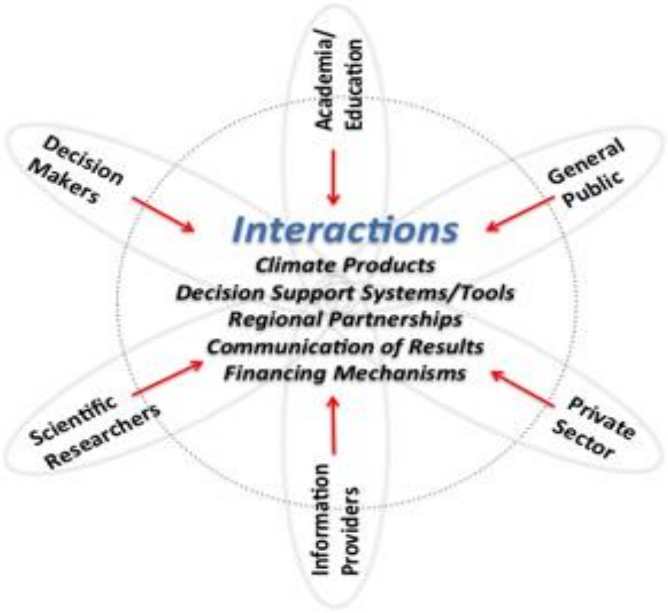

Figure 4-2: *Role of Interactions as a facilitator of communications across actors in the climate dialog, and linking scientific research to societal applications.*

For this approach to be successful, it needs to occur at the intersection of multiple actors that can use climate communication products that are tailored to their needs, while at the same time being consistent across all such actors. This concept is illustrated in Figure 4-2.

For this purpose, we will host meetings, briefings, and other exchanges between climate researchers and users of climate services. Specific activities in this context are such as the following:

- Standard scientific forums with a balanced participation of policy makers, decision-makers and generators of climate information.
- Training and capacity-building that increases understanding of the climate services (e.g., projections of droughts or extreme storms, climate-related patterns) and associated uncertainties, and how such services can be used (e.g., changes in crop management or varieties) and not used (e.g., as “accurate” predictions).
- Training and capacity-building that increases understanding of the decision contexts in which climate information may have value, especially, e.g., for specific timeframes, engineering requirements, and locations.
- Partnerships with development agencies and NGOs to understand the regional and local contexts in which climate services can play a significant role.
- Two-way communication with a broad range of local and regional technical decision-makers and policy-relevant organizations, such as web-based Climate Information News (research and model results, sharing of successful response strategies, etc.).
- A feedback forum that utilizes in-person workshops and meetings to gain user perspectives of the usefulness of climate services and products, both current and planned. Ongoing experiences such as the RPD workshops will be used to identify effective multi-way dialogue mechanisms.

4.3.2 Facilitating Access to Financing Mechanisms for Adaptation

The availability of financial resources is widely identified by climate services' stakeholders as a key limiting factor for adaptation projects and practices worldwide [e.g., UN-Water, 2010; RPD, 2010]; this is certainly the case in LAC. Beyond availability, access and eligibility issues with funding sources, further hinder engagements in adaptation. At the same time, limited funding sources, through cooperation between public and private sector entities, can grow and be sustainable. This combination of factors has made the development of constructive interfaces between adaptation financing providers and stakeholder recipients a challenge.

Recognizing the facilitation of access to final resources for adaptation as a climate service in itself, we have engaged multilateral development banks as partners in the RPD. In addition to the IDB for the LAC region, we have engaged the World Bank and the Alliance for Global Water Adaptation (AGWA, alliance4water.org) as partners. In the case of the World Bank, it has been charged by the UNFCCC and their contributing governments with the task of both developing mechanisms for increasing adaptation funding and facilitating access to financial and risk sharing mechanisms for adaptation. For instance, it administers the Global Environmental Facility (GEF) adaptation funds, as well as several others (SCCF: Strategic Climate Change Funds; LDCF: Least Developed Countries Fund, CIF: Climate Investment Funds, http://www.climateinvestmentfunds.org/cif/). We propose that incorporating adaptation financing into our portfolio of climate services is useful to all users of climate services and an opportunity to provide a boost to adaptation actions in our target applications.

This service aims at providing comprehensive guidance on financial options available for adaptation grants and investment loans in LAC countries. Information will be provided on where (and how) to access the wide range of funds available from multilateral and institutions, as well as public and private sources. Users will also be invited to be a resource to share their experiences with investment projects and offer feedback and comments on ongoing projects.

Examples of specific financing facilitation tools that will be provided to users are:

- Identify funding sources that are available for adaptation projects that reduce vulnerability and impacts of climate change. Users can determine whether a given project is eligible, how the fund is structured, and how an organization in the region can access financing.
- Assist with grant and loan application documents where appropriate, including workshops to engage stakeholders in the details of the various sources of financing.
- Learn about projects from across the world and a range of sectors that have accessed these funds successfully. Experiences (e.g., case studies, lessons learned) using a mix of financial sources innovatively can serve as case studies for those waiting to hit the ground.
- Access and leverage the latest climate finance information with a library of targeted financial documents and project guides, a compilation of online tools for financial and project analysis and a feedback forum for users.
- Develop tailored financial instruments to mainstream climate change adaptation and increase resilience of adaptation projects
- Identify and develop lending and technical assistance for climate action in key sectors, scaling up investments, addressing financial gaps and leverage options for private sector investments.

4.3.3 *Climate Information Products and Infrastructure Applications*

A key focus of our RPD approach is the co-development of research products and services with our regional and global partners, as well as stakeholders in each location of implementation. Working in parallel with partners and stakeholders, and obtaining in-depth and frequent feedback from both, will allow us to produce outputs that integrate across disciplines, socio-economic sectors, and institutions.

Climate Information Products

Regional efforts in LAC on interpreting climate information, forecasts, and capabilities across multiple time scales, beginning with seasonal-to-interannual, and extending to decadal and multi-decadal timescales are outlined here. To this end, we will consolidate and integrate a wide variety of high-resolution observational datasets in each region, using available information from regional sources, as well as data available from our local partners in each location. For instance:

- *Socioeconomic:* Gridded maps of population estimates; map livelihood patterns (rural/urban); income and consumption patterns; food grain prices and trends over the long-term; variations in prices during extreme climate events.
- *Meteorology:* Gridded objective analysis of daily rainfall, surface temperature and other quality-controlled data for mapping extreme events (e.g., droughts, floods, heat waves) and identifying vulnerable zones; develop high-resolution aridity anomaly indices, drought severity index, standardized precipitation index based on the long-term climate and satellite-based precipitation data; quantifying SST and other circulation anomalies associated with El Niño/La Niña impacts on extreme climate events.
- *Hydrology:* Map watersheds, stream flow, runoff, infiltration, evapotranspiration, surface water and groundwater elevation. Long-term soil moisture distribution for assessing long-term droughts.
- *Agriculture:* Quantify and map sown area, crop vigor and variations using long-term vegetation indices; crop moisture index, change in cropping patterns, irrigation area, yield and productivity to relate to climate and changing hydrology over decadal time-scales.
- *Infrastructure and Investments:* mapping of water and energy utilities, public health facilities, industrial systems, as well as natural infrastructure (e.g., wetland delineation).
- *Interactive Tools:* with on-the-spot, what-if scenarios will be developed to provide a range of options for managers and stakeholders, enhancing the capabilities for delineating tradeoffs and facilitate decision-making.

We discuss further some ongoing efforts to illustrate specific applications of climate information services in the LAC region.

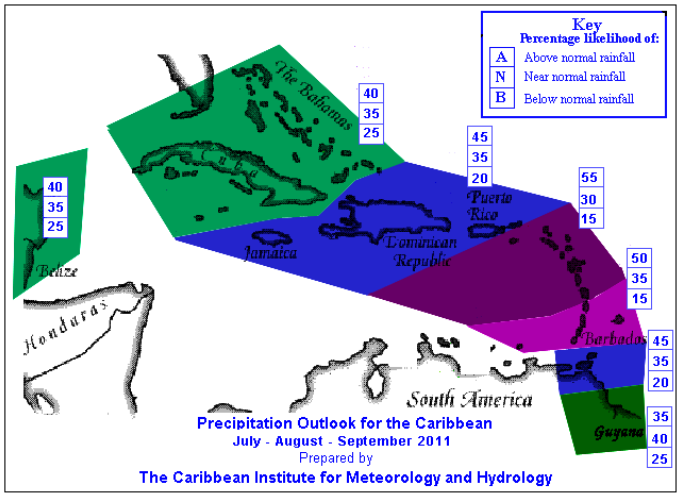

***Figure 4-3**: The Caribbean Water Monitor (concept stage, 2011)*

The *Caribbean Water Monitor* is a web-based service currently being developed by the CIMH (Figure 4-3), where climate/rainfall indices are automatically calculated and mapped using open access geographical information system (GIS) software (Grass). At a two-day workshop in Trinidad and Tobago sponsored by the IDB in March 2011, this concept was presented to a group of technical/scientific staff and decision makers and administrators from the CB region.

In Argentina, the National Meteorological Service (Servicio Meteorológico Nacional, http://www.smn.gov.ar) issues forecasts of the Standard Precipitation Index (SPI) with 1, 3, 6, 12, 18 and 24 month lead times (Figure 4-4). This hidroclimatological data product can be further integrated to drive numerical hydrological models, decision-support tools and other climate service applications. Also, similar products can be developed at higher spatial resolution and accuracy at other locations throughout the LAC region.

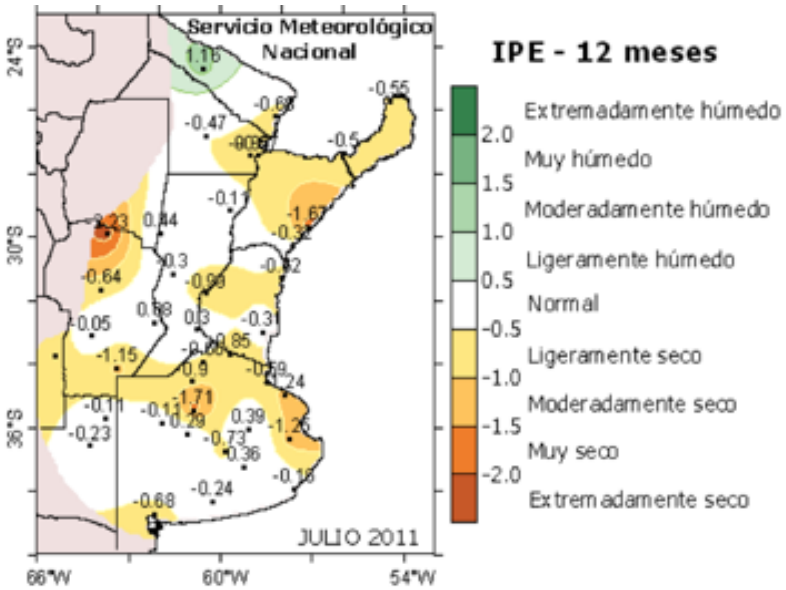

***Figure 4-4**: Drought and general precipitation is monitored and reported on two scales: (i) regional, encompassing the entire country and (ii) local levels at higher resolution. Indices such as the Standardized Precipitation Index (SPI) provide indicators of normal or abnormal rainfall.*

Climate-Adapted Infrastructure Applications

On the ground applications of adaptation measures to existing or planned infrastructure is a next logical step in the assimilation, fine-tuning and dissemination of adaptation practices in the LAC region. These applications need to be focused on building capacities in key economic sectors to design, implement, and manage water resources projects and programs. Here, we briefly outline an initial portfolio of ongoing adaptation case studies that have been designed to respond to requirements and needs identified in LAC countries in establishing specific policies of adaptation to climate change with respect to impacts on water resources in the region.

Sea Level Rise in Trinidad and Tobago

It has been projected that in Trinidad and Tobago, as in many countries in the Caribbean, climate change and climate variability may result in potential impacts, among others: (i) frequent flooding is likely to be exacerbated by climate change induced sea-level rise and anticipated changes in seasonal rainfall patterns; and (ii) loss of freshwater resources as a result of saline intrusion and increased incidence of droughts, less rainfall, and increased evaporation due to higher seasonal temperature.

Given all these potential impacts from climate change, there are many factors or conditions that increase vulnerability to those related to water resources specifically:

- Deficits in water supply exist despite an apparent abundance of water in Trinidad and Tobago; it is expected that pressure over those resources will probably increase, and protection measures should be taken into account.
- Leakage losses and unaccounted for water are greater than 50 percent in the country.
- The water sector is also heavily affected by performance deficiencies of wastewater treatment plants as they impact the quality of surface and ground water sources.

Figure 5*: The Beetham wastewater treatment plant in Port of Spain is the subject of this case study on adaptation to sea level rise impacts on water and sanitation infrastructure.*

The Water and Sewerage Authority (WASA), is the agency responsible for carrying out the government policies related to water and wastewater and for the provision of water and sanitation services in Trinidad and Tobago. Overall, WASA´s wastewater system faces the following challenges: (i) limited expansion of the central sewers; (ii) tariffs below the cost of providing sewerage services; (iii) limited financial and human resources; (iv) poor infrastructure designs; and (v) poor maintenance of the existing infrastructure. As a consequence, the sewerage system is currently in a state of despair and in urgent need of rehabilitation. Currently, WASA is preparing a wastewater rehabilitation program, which has the general objective of improving the (Figure 4-5) environmental conditions in the country, by decreasing the uncontrolled discharge of untreated wastewater into the environment. Since much of WASA's water and sanitation infrastructure is located near the shore in coastal areas of the country, this case study accounts for vulnerabilities of WASA´s water and sanitation infrastructure due to sea level rise expected impacts from climate change. This is

an ongoing project that will be focused on developing infrastructure improvements to the Beetham wastewater treatment plant in Port of Spain.

Glacier Melting in Ecuador

Recent research shows that climate change will be more pronounced in high-elevation mountain ranges. While much attention has been paid to climate change in polar regions, mountains that extend into the troposphere have been warming faster than adjacent lowlands. In particular, climate change has been linked to the accelerated retreat of tropical glaciers in the Andes and to an increase in the weather variability and weather extremes affecting the Andean ecosystems.

Glacier retreat will affect regional water supply that rely on runoff generation driven by the seasonal melting cycle. Severe impacts are expected in populated areas that are already water short, placing millions of already economically and environmentally stressed ecosystems and inhabitants at further risk of inadequate supplies.

Figure 4-6: *Quito, Ecuador is dependent on the seasonal cycle of glaciar melting for its water supply. Changes in glaciar retreat timing and amounts generates adaptation needs.*

Large urban centers such as Quito in Ecuador (pop. 2 million), where glacier basins (Antisana and Cotopaxi in particular) supply two thirds (2/3) of Quito's drinking water need to develop adaptation measures to reduce vulnerability to its water supply to climate change impacts (Figure 4-6). The *Empresa Pública Metropolitana de Agua Potable y Saneamiento* (EMAAP-Q), is Quito´s water utility and is currently working on a project (Environmental Sanitation Program of the Metropolitan District of Quito). Since a large fraction of the water resources of Quito came from glacier basins, designing and implementing infrastructure for flood control, water supply and sanitation should consider climate change impacts and should include adaptation measures in order to improve the sustainability of such investments. Besides climate change impacts to glacier melting itself, EMAAP-Q is also starting to focus on climate impacts over the *páramo*, which is a highly vulnerable high mountain ecosystem (wetland) with a essential role for the natural regulation of the water supply to Quito and other municipalities in this area.

Droughts in Perú

Vulnerability to climate change impacts are especially critical on those cities and communities whose water resources supply depends on Andean high-mountain basins and ecosystems. This is the case of Trujillo, Perú which is fed by the Santa River Basin (Figure 4-7). The Santa River Basin has a total area of about 12,200 Km^2, making it the second largest and most regularly flowing Peruvian river to reach the Pacific Ocean. The Santa River is fed by glaciers of the Cordillera Blanca. On the coastal delta the Santa River feeds the Chavimochic irrigation district, which provides water to the Chao, Virú, Moche and Chicama valleys. Trujillo, which is located at the banks of the Moche River, near its mouth at the Pacific

Ocean, could be seriously affected by drought or water scarcity impacts due to climate change impacts to glaciers on the Santa Basin.

***Figure 4-7**: Multi-sector use of water in Trujillo, Perú is vulnerable to intensifying droughts.*

The *Municipalidad Provincial de Trujillo* has a population of 800,000, and has already developed a first diagnostic study done which shows a negative net water balance (more water used than supplied from sources). About 50% of the water supply is provided by a human-made channel, while the other 50% is groundwater. The channel is fed by runoff from the Río Santa watershed, which feeds off glaciers. Adaptation measures currently under consideration by the municipality, in consultation other stakeholders are: progressive source substitution (increase reliance on groundwater and lesser on the channel), treated wastewater reuse for agricultural purposes, and more efficient water treatment plant operations**.**

Urban Flooding in Uruguay

The city of Montevideo, located on the right bank of the Rio de La Plata (Figure 4-8), is highly vulnerable to climate change. Major issues currently facing the city are urban planning (informal settlements in risk areas), vulnerable population affected by extreme events, coastal vulnerability (sea level raise, extreme events, salt-water intrusion), infrastructure damage, sand-beach erosion under heavy storms, and impacts to water resources, wetlands and other ecosystems.

***Figure 4-8**: Urban drainage in Montevideo, Uruguay is susceptible to higher intensity rainfall, so adapted infrastructure improvements are underway*.

For this case study, the local authority *(Intendencia Municipal de Montevideo*) is focusing on urban planning issues around the *Pantanoso* drainage basin, for which an urban master plan is currently being designed. The Pantanoso basin is a challenging area for the *Intendencia Municipal* since it houses a large concentration of informal population settlements and related issues of soils and water pollution, and solid waste management. The lower part of the basin is also affected by floods from sea level rise events (Río de la Plata Bay). Taking into account all these considerations, it is expected that this study will help the *Intendencia Municipal* to mainstream climate change impacts into

its urban planning process during the designing phase, improving its adaptation capacity and enhancing the resilience of the Pantanoso basin.

4.4. A Path Forward

Developing and effectively deploying climate information and climate-adapted infrastructure is an important challenge for the water sector in the LAC region. An effective response to this challenge must integrate meeting the needs of the users of such *climate services* and building capacity in the existing and next-generation of scientists, practitioners, managers and policy makers. It is these professionals who will be charged with addressing the impacts of climate variability and change on already stressed systems, including the urgent need to adapt to the impacts from climate change.

Through our RPD initiative and the partnerships included within it, this approach to climate services has already been "rolled out" with stakeholders in the LAC region at the COP16 meeting last year (RPD, 2010). ***As a result, the framework already has a cadre of core partners and potential users in the region***. We propose to develop climate services as an iterative process with continuous feedback at the entry points, and a monitoring-evaluation-feedback process embedded in the adaptation cycle itself. This self-assessing process will facilitate the tailoring and assimilation of climate services in our target storyline elements and place-based activities.

From the onset, we recognize that achieving this vision is a broader and different enterprise than anything that exists currently in the climate services arena. It needs to be grounded in natural and social sciences; develop application projects that tie user needs to developers of climate information; support the design and implementation of adaptation actions locally, together with the institutional support that will make these actions sustainable in the long run; secure human and financial resources required to accomplish these actions; and it needs to provide clear and transparent mechanisms for monitoring, evaluation and self-assessment and adaptation. With this in mind, we have focused on information and infrastructure activities within the overall framework of climate services for the LAC region.

5. Proposed Lines of Strategic Action and Target Outcomes

From the analysis of sample projects presented in Section 3, it can be observed that the area of water resources in the LAC region has evolved over the past five decades through a variety of projects, but not clearly connected to a set of strategic goals nor articulated in a way that would lead to a larger and higher impact water resources operation in the LAC region. In Section 4, a vision and mission are proposed to create such a connecting thread to water resources operations through adoption of the WMO climate services concept. Here, an attempt is made to assemble a set of initial actions that address the four objectives that form the mission of this strategy (i) water resources as a regional strategic asset; (ii) knowledge and capacity building; (iii) cross-institution integration; and (iv) visibility raising, work in partnership with organizations in the public and private sector of the LAC region countries and beyond.

The inter-dependent relationship between water resources and human activities, ecosystems, sustainable development and climate change calls for the adoption a holistic approach in water resources projects within the LAC region. This approach should consider aspects that go beyond the traditional engineering approach and cost-benefit relationships that have prevailed in the sector's management and decision-making. Social and cultural aspects should also be considered, as should the differing needs and uses of the population, the health of ecosystems that support water bodies, the potential effects of climate change on these variables, and adaptation to these effects. This implies a pressing need to strengthen water resources projects regionally and at the level of the different countries, through the following actions, which have been articulated along the lines of the strategic objectives proposed in this document.

Figure 5-1 illustrates the conceptual integration of the strategic objectives, the guiding principles that cut across all proposed lines of action, and the associated target outcomes.

5.1 Core Outcomes

These actions are aimed at the development of integrated solutions to water resource problems across a range of geographic, climatic, cultural, and socioeconomic settings, from pilot studies to full scale investment projects. The proposed actions are centered on initiating a number of technical assistance projects and investment projects (likely with the first preceeding the second) that contribute to meet the following target outcomes:

- Climate change adapted IWRM practices developed
- Identified investment opportunities for implementation
- Increased pipeline of adaptive water resources projects (technical assistance and investment projects)

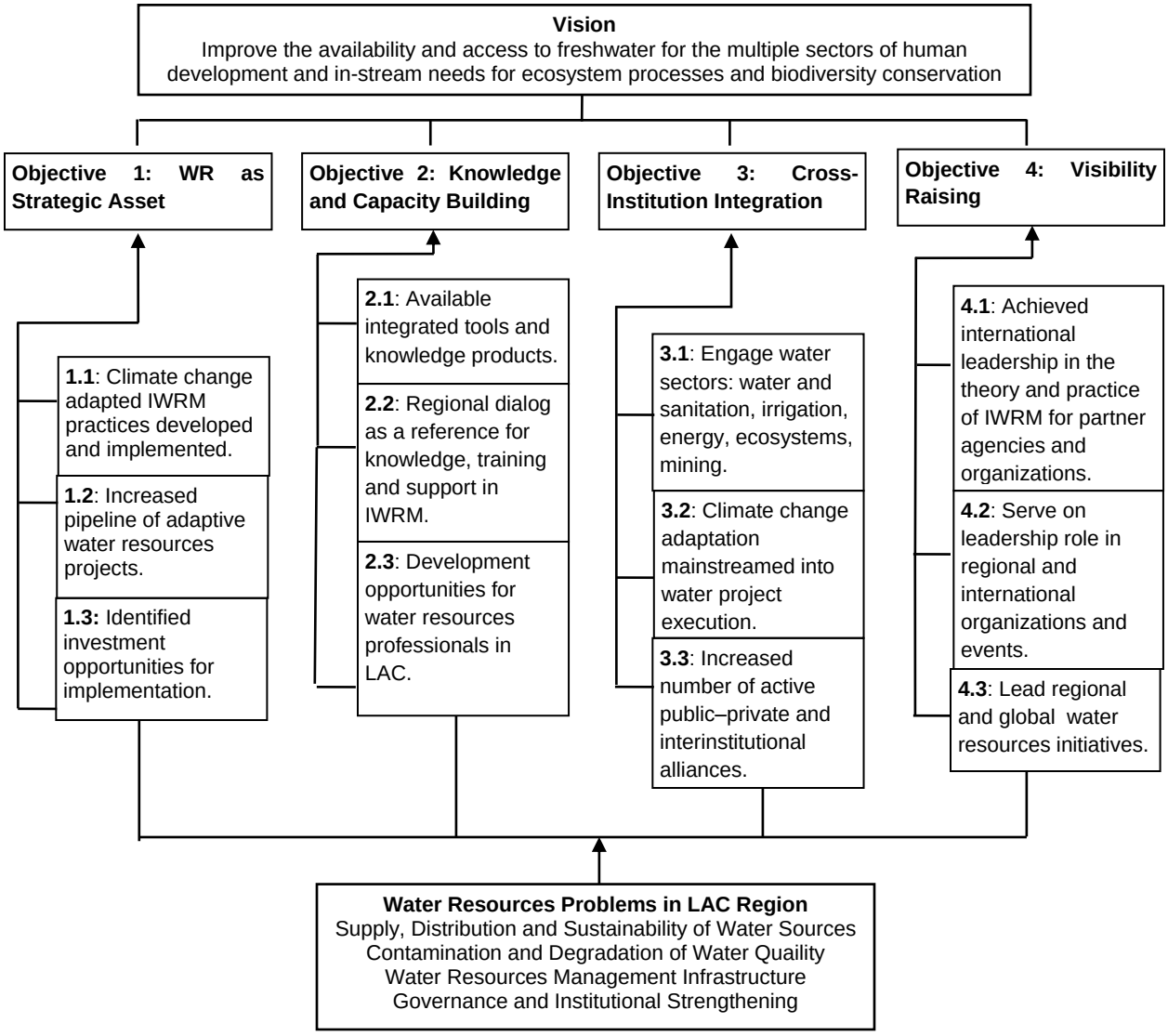

Figure 5-1: *Building up from the problems to the objectives to the vision of the proposed water resources strategy. The itemized boxes under each strategic objective represent examples of measurable outcomes/targets for evaluation of the strategy*.

6.2 Knowledge and Capacity Building Outcomes

These actions are aimed at building capacities in key economic sectors to design, implement, and manage water resources projects and programs. The proposed actions are centered around the development of knowledge products (literature and tools) and initiate an aggressive dissemination campaign through partnerships. Target outcomes for these actions are the following:

- Available integrated tools and knowledge products
- Regional dialog mechanism as a resource reference for knowledge, training and support in water resources
- Development opportunities for water resources professionals in LAC

Cross-Institution Integration Outcomes

These actions aim to consolidate, integrate and streamline expertise, knowledge, and implementation activities in the area of water resources across the region, so better services can be provided to the countries. These actions could be thought of as leading to a virtual *"water resources regional practice"* that will serve the LAC region, and that can contribute to meet the following target outcomes:

- Engage water sectors: watr and sanitation, irrigation, energy, ecosystems, mining.
- Climate change adaptation mainstreamed into water resources project execution
- Increased number of active public – private and inter-institutional alliances

Visibility Raising Outcomes

These actions are focused on taking on a leadership role in national and global forums by sharing lessons learned and advising other national and international actors on innovative and viable directions for future activities, particularly in the area of water resources and adaptation to climate change. Along this line, the proposed water resources regional practice can pursue the following target outcomes:

- Achieve international leadership in water resources theory and practice for partner agencies and organizations
- Serve on leadership role in regional and international organizations and events
- Lead regional and global water resources initiatives

Table 5-1 summarizes ongoing specific example opportunities that are being pursued under the strategic lines of action.

Table 5-1: Summary of Ongoing Opportunities in Strategic Action Areas

Strategic Objectives	Examples of Ongoing Actions
Water Resources as a Strategic Asset	• Case Studies on Adaptation to Climate Change in the Water Sector • Río San Juan Basin Pilot Project on Adapted Water Resources Management • Uruguay National Water Resources Plan • Impacts of Glaciar Melting in Water Resources Vailability • Adaptive Water Resources Managament in the Pantanal (the largest wetland in the world)
Knowledge and Capacity Building	• Development of Integrated Model of Water Resources and Climate Change (e.g., Hydro-BID) • Regional Policy Dialog on Water and Adaptation to Climate Change • Network of Water Excellence Centers
Cross-Institution Integration	• Startup of Bank-wide "Water Resources Regional Practice" • Increase agenda of water resources into regional training efforts • Startup of Climate Service Initiative for the LAC Region
Visibility Raising	• Lead sessions in World Water Week • VII World Water Forum (2015) • Regional Dialog for Water and Climate Change • Conference of the Parties (COPs)

6. Recommendations for Implementation

This document has been written to provide a starting point of discussion towards an articulated strategy for increased engagement in water resources activities in the countries of the Latin America and Caribbean (LAC) region, in preparation fot the 7th World Water Forum (WWF7-Korea, 2015). A vision, mission and associated strategic objectives have been developed based on an analysis of projects financed in water resources over the past five decades (1960-2010), and a coupling with emerging issues in the region that are being driven by challenges such as climate change.

This strategy poses important opportunities for countries in the region in the water resources arena, building on past history of a large portfolio of projects in water resources throughout the region, as well as recognizing the current expanding need for services and the current and potential limitations associated with water resources quantity, quality, infrastructure and governance issues.

The region needs to take on several roles for the implementation of this strategy, which can be of both direct and indirect natures. Its most fundamental direct role is the process that funds planning and construction, operating systems, and other projects in water resources infrastructure investments. In this role, the region needs to embrace water resources as an area of growth for water-based activities in its countries, and to follow up this document with a more detailed multi-year work plan with performance metrics, evaluation procedures, and corrective measures.

The region should facilitate that certain support activities are an element of the project proposal and operations plan, and that they are deemed important and even critical to the successful completion of projects, their efficient operation, and long-term sustainability. An example of this facilitating role is working inter-sectorally, embedding training and knowledge dissemination in project activities and contribute to raise the visibility of water resources projects by engaging in showcasing the project stages/results in high-visibility venues (regional and international meetings, publications and others).

Climate change has become a major area of focus in the region, drawing a great deal of attention in the public and private sectors. Many water resources professionals are engaged in climate change work as evidenced by the increasing volume of climate-related activities, as well as seminars, workshops, and publications. With some exceptions, most of the region's water resources professionals lack practical experience in climate change and variability related to water resources management. Much of the current expertise, information and data related to the impact of climate change and adaptation strategies exist outside of the public sector in the countries. For the region to position itself at the forefront of climate change work in the water sector, it is proposed that in-country expertise be strengthened and to the degree appropriate, complemented by external expertise through easily accessible mechanisms. The following specific actions are suggested as a starting point:

- Expand the water resources core knowledge beyond hydrologic drivers to include economics, and environmental/social aspects of water resources and climate change adaptation.
- Formalize partnerships with leading international, academic, and research organizations that are reputable in the field of climate change in the water sector.
- Develop and implement programs for building capacity based on assessment of the regional knowledge and experience and identified gaps.
- Establish a dialog towards a Water Resources Regional Practice and engage it to a dual purpose: serve as an *integrator* in further developing and implementing a water resources strategy across

the region; and also serve as an *adaptor* to mainstream adaptation to climate change into infrastructure projects in water resources, i.e., operationally implement climate change adaptation options in water resources investments.

It is important to consider that knowledge about climate change and it's mainstreaming into adaptation measures in water resources in general is still in its infancy throughout the world. In the LAC region, there is a clearly identified significant need for both scientific and implementation know-how of adaptation, coupled with a growing demand from countries in the region (e.g., Regional Policy Dialog in LAC, 2010). It is then clear that coordinated action by the region in this area is both timely and needed. The strategic actions proposed in this discussion document therefore focus on an agenda in water resources and adaptation to climate change, with increased funding levels, considering strong initial investments in the area of knowledge, institutional strengthening and planning, prioritized as initial products to be delivered to our countries.

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