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Climate services: a tool for adaptation to climate change in Latin America and the Caribbean

Action plan and case study applications

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Abstract

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 decisionmaking 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.

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1. Introduction: 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 decisionmaking 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 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.

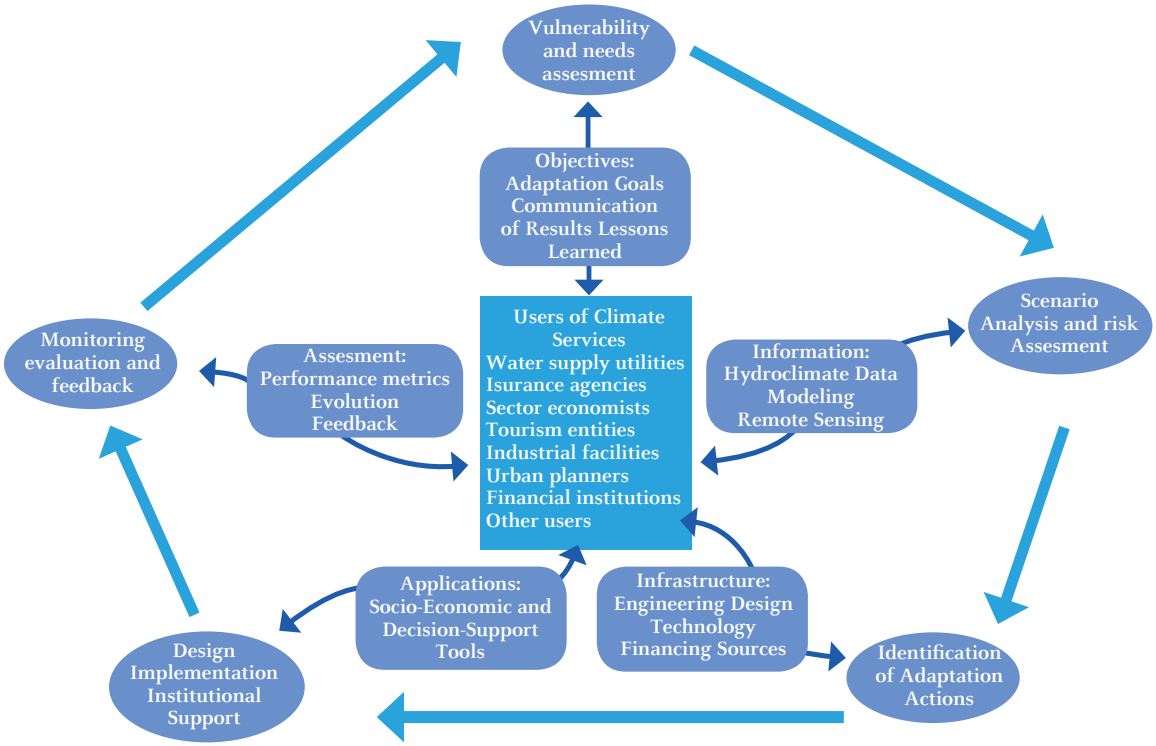

Figure 1: Regional Policy Dialog (RPD) conceptual approach: climate services (blue bubbles) are co-developed with users to support and feedback each stage of the adaptation cycle in development-centered projects (yellow ovals). Infrastructure and Information components of climate services have been highlighted.

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.

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?

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 1.

Table 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, eutrophication, dead zones, coastal rapid urbanization, and land use changes.	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 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.

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 leverageexisting 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.

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, meetings, 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.

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.

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.

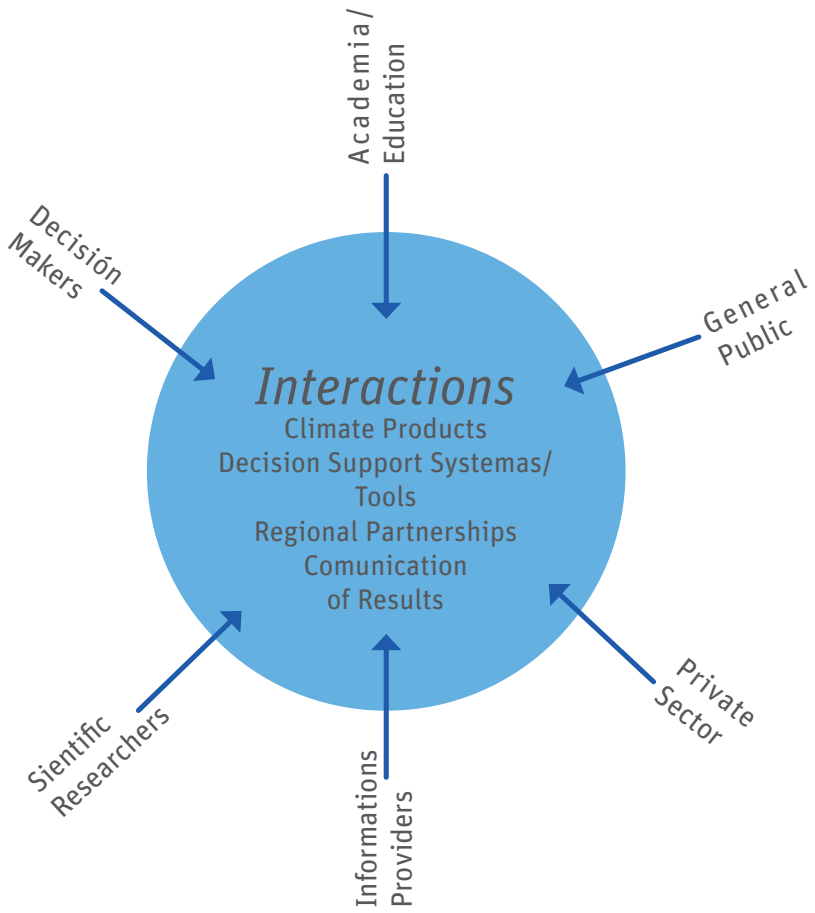

Figure 2: Role of Interactions as a facilitator of communications across actors in the climate dialog, and linking scientific research to societal applications.

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 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 multiway dialogue mechanisms.

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.

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.

3.3.1 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 timescales.

- *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.

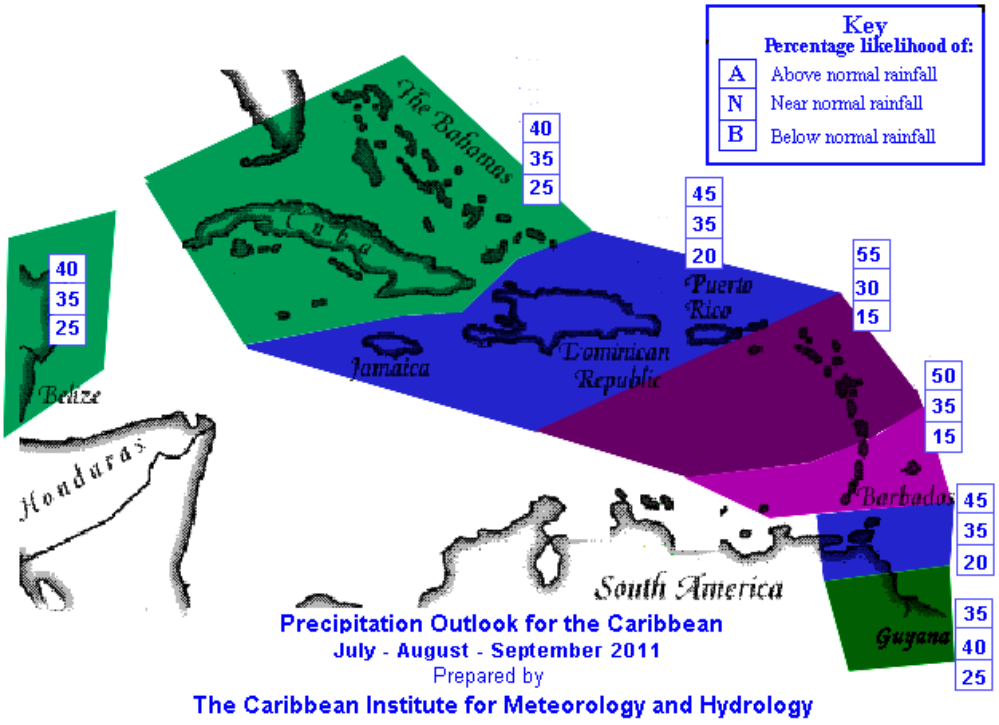

Figure 3: The Caribbean Water Monitor (concept stage, 2011)

The *Caribbean Water Monitor* is a web-based service currently being developed by the CIMH (**Figure 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. 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.

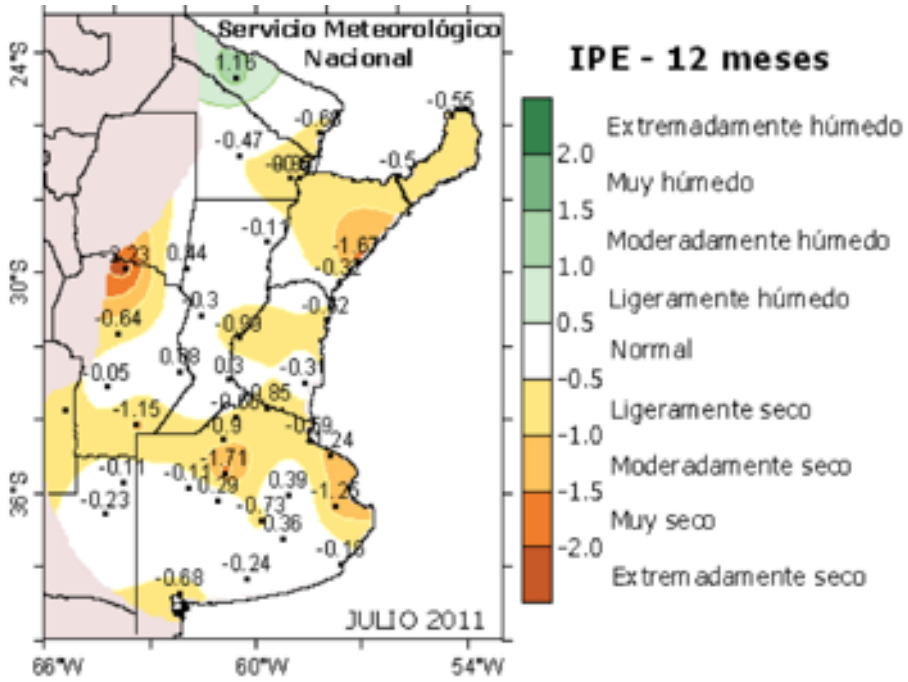

Figure 4: Drought and general precipitation is monitored and reported on two scales: (i) regional, encompassing the entire country and (ii) local levels at higher resolution. Indices such as the Standardized Precipitation Index (SPI) provide indicators of normal or abnormal rainfall.

3.3.2 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 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 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. 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. 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 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, 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 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. Concluding Remarks

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.

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