Urban Risk and Climate Change Adaptation in the Reconquista River Basin of Argentina

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Abstract

This working paper explores climate change adaptation as it is occurring in the Reconquista River Basin (RRB) in Argentina. The authors examine urban risk and the extent to which adaptation is occurring, considering key adaptive capacities and challenges throughout the RRB. The analysis is based on previous studies complemented by key informant interviews and an online survey developed by the authors and administered to municipal government representatives of the RRB. Findings show that climate hazards are increasing and that vulnerabilities are compounded by urban growth in the region, including throughout nearly 300 informal settlements. Investment in vulnerability reduction programs and environmental clean-up strategies has been exponential over the past decade, leading to widespread improvement in key areas of infrastructure provision. Climate change adaptation discourse is gradually emerging and the overall trend is for risk reduction to be subsumed and aligned with vulnerability reduction.

Despite important advances, the complex, multi-level governance structure—involving national, provincial, regional, municipal, and community-level stakeholders—combined with a history of unplanned urban expansion—presents challenges for coordinated adaptation planning, including in relation to information management and comprehensive risk assessment. At the community level, various types of spontaneous adaptation were observed, particularly in informal settlements and mostly in response to flooding, through both individual and collective strategies. These initiatives show that informal settlements appear to display a level of dynamism and a flexible adaptive capacity which is sometimes lacking in the 'formal' city.

Considering future possibilities, the authors developed scenarios aimed at stimulating debate around possible change for adaptation planning. These are based on scenarios of: incremental change through a business-as-usual approach, incremental change through climate mainstreaming, abrupt change post climate-related catastrophe, and transformative change through integrated adaptation planning. Of these, transformative change offers the best possible scenario for adaptation planning and its implementation would require enhanced coordination of planning efforts as well as deeper engagement of civil society.

Keywords: Climate change adaptation; Reconquista River Basin in Argentina; challenges facing climate change adaptation; planning scenarios for climate change adaptation; vulnerability of informal settlement to climate change hazards.

Research Team

Dr. Flavio Janches is an architect, researcher, and Associate Professor of Architecture and Urban Design at the University of Buenos Aires. In 1986, he co-founded BJC Architecture Studio, specializing in project management and urban design. Since 2001, Flavio has worked as a professor of urban design related fields. His work focuses on the transformation of public spaces and the integratione of marginalized areas. Flavio also established the PlaySpace Foundation in Argentina, an organization dedicated to strengthening 'unslumming' in greater Buenos Aires. Flavio holds a PhD from TUDelft.

Hayley Henderson has experience in urban planning across Australia and Argentina. In Argentina, Hayley worked as a consultant on planning strategies for a number of municipal government areas within the Province of Buenos Aires, including a Cities Alliance – World Bank project between 2010–2013 entitled 'A Way Forward — City Development Strategies for three Municipalities of Buenos Aires Province.' Hayley worked as a tutor in urban planning at the University of Buenos Aires, where she was also involved in research activities. Most recently, she participated in an investigation project funded by the Lincoln Institute of Land Policy and led by Alfredo Garay on Puerto Madero as a large-scale redevelopment project in Buenos Aires. Hayley holds a Bachelor of Urban and Town Planning as well as a Master of Development Practice from The University of Queensland, Australia. She is currently a PhD candidate in urban planning at The University of Melbourne, Australia.

Leslie MacColman is a PhD student in Sociology and Peace Studies at the University of Notre Dame's Kroc Institute for International Peace Studies. Prior to beginning her doctoral studies, she resided in Buenos Aires, Argentina for eight years, during which time she worked for the Environment and Natural Resources Foundation (FARN), the Civil Association for Equality and Justice (ACIJ), and as an independent consultant. Leslie's professional experience is deeply-rooted in the non-profit sector and spans various countries, including Panama, Bolivia, Mozambique, Sierra Leone, and the USA. She holds a B.A. in Anthropology and Spanish from the University of Montana, an M.A. in International Relations, Peace and Conflict Studies from the Universidad del Salvador, and a Graduate Certificate in NGO Management from the Universidad de San Andrés.

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The analysis of interviews would not have been possible without the diligent work of Sofía Meyrelles. Carolina Ipes provided instrumental assistance in the production and analysis of GIS mapping. The team would also like to thank the Lincoln Institute of Land Policy for their support of this research project.

Not lastly, we wish to express our gratitude to the many individuals who, despite their busy schedules, generously made time for interviews. Their commitment to improving the quality of life in the Reconquista River Basin is extraordinary and their collective knowledge contributed a great deal to the research agenda and the final report. However, any mistakes are the sole responsibility of the research team.

This report is dedicated to the residents of the Reconquista River Basin and, in particular, the inhabitants of its informal settlements, whose dignity, creativity, and formidable resilience are essential building blocks for equitable development and climate change adaptation in the region.

Executive Summary of Key Findings

Key Findings

This research project sought to explore some of the links between conceptual classifications of climate change adaptation and real adaptation as it is occurring in the Reconquista River Basin (RRB). Specifically, it aimed to examine urban risk and the extent to which planned adaptation is occurring in the RRB, how, and by whom, as well as to highlight parallel processes of 'autonomous' adaptation, mainly in informal settlements. Based on the review of literature and relevant policies on climate risks, vulnerability, and adaptation, qualitative engagement with government authorities, academic researchers, and affected communities of the RRB, the research team has compiled a characterization of local urban risks and an appraisal of key adaptive capacities and common challenges.

Using the framework developed by Mehrotra et al, the study considered urban risk as a function of three discrete elements: climate hazards, vulnerability, and adaptive capacity (Mehrotra et al 2009). Climate hazards are defined as climate-induced stresses, such as heat waves, droughts, sea level rise, and floods. Vulnerability refers to the physical and socio-economic attributes which determine a city's degree of susceptibility, including flood-proneness, land area, elevation, population density, economy, and percentage and composition of its low income populations. Adaptive capacity refers to the city's ability to respond to climate-related stresses. In addition to the framework developed by Mehrotra, the study was informed by Matthews's research (2013) on how climate change can act as a 'transformative stressor' influencing institutional change in urban governance. Case study analysis conducted by Carmin et al (2012) and presented in 'Urban Climate Adaptation in the Global South: Planning in an Emerging Policy Domain,' was particularly illuminating and helped guide project conception; as did the work of local researchers, such as Barros and Natenzon.

In addition to the above-mentioned data-collection processes, the team developed an online survey, which was administered to the 18 municipal governments of the RRB. This survey was inspired by a similar project carried out by the Massachusetts Institute of Technology (MIT) Department of Urban Studies and Planning, and constructed based on the UN Habitat on Planning for Climate Change: A Strategic, Values-Based Approach for Urban Planners. Finally, the research team employed an adapted version the World Resources Institute's National Adaptive Capacity Framework (NAC) to organize information about challenges to adaptation in the RRB.

The key findings of this study are briefly summarized below.

Climate Hazards and Vulnerability

- The population of the 18 municipalities that comprise the RRB is 4,601,190 (INDEC 2010). This represents approximately one third of the Metropolitan Region of Buenos Aires (MRBA) and nearly 11% of Argentina's national population.

- In the RRB, there are approximately 95,000 households distributed among 284 informal settlements. Many of these households are particularly vulnerable to climate change due to their physical location in environmentally hazardous areas (low-lying, contaminated, subject to storm surge, etc.) and their low socio-economic status (11% of the population of the RRB has unmet basic needs,[1] this reaches 90% in some informal settlements).

- Climate hazards in the RRB are becoming more serious. There has been an increase in average annual precipitation and in the frequency and intensity of extreme weather events over recent years (Barros 2005; Mehotra et al 2009). Climate variation combined with high urbanization rates cause harmful environmental consequences. Increased river flow and discharge negatively impact low-lying communities, and the most immediate risks faced by communities in the region relate to large-scale flooding.

- A rise in average annual temperatures has also been registered and climate change will likely lead to further increases of up to 2 °C over the longer term, exacerbated by heat islands. High temperatures pose health risks to the general population.

- In light of increasing climate hazards, the majority of municipal representatives surveyed, as well as the Committee of the Reconquista River Basin (COMIREC), saw informal settlements *as highly or somewhat vulnerable* to the following problems: damage to property or goods (88.9%), exposure to pathogens or diseases (77.8%), and exposure to the elements (66.7%). However, the economic impacts of large-scale flood events on local economies and food security was generally underestimated or difficult to determine.

- The potential impacts of climate change on vulnerable settlement communities can be understood in part based on the effects of a recent, large-scale flood, which occurred in April 2013. This flood was discussed extensively at workshops held in the Municipalities of San Fernando and General San Martín, where local impacts included: emergency evacuations and congregation in 'safe houses,' such as churches or schools, damage to housing structures, appliances, and informal infrastructure connections, electrical fires, the drowning of work-animals, and the loss of two lives. Residents also cited the loss of work and school days, the interruption of caregiving regimens, and health problems due to the proliferation of mosquitos and rats, the contamination of drinking water, and the accumulation of solid waste in public areas.

Climate Change Adaptation

- The RRB has a complex, multi-level urban governance structure, which includes national, provincial, regional, municipal, and community-level stakeholders. The inter-jurisdictional nature of the basin region—combined with its long history of unplanned urban expansion—presents challenges for coordinated adaptation planning. Nonetheless, there are a number of important advances nationally, regionally, and locally which bode well for climate change adaptation.

[1] The 'unmet basic needs' index (*necesidades básicas insatisfechas*, in Spanish) is based on five indicators: residential overcrowding (more than three people per room), precarious housing materials, households without toilets, school age children out of school, and reduced household subsistence capacity.

- Argentina has ratified the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Hyogo Framework for Action, UN Convention on Biological Diversity, and other international agreements. These agreements have been a strong exogenous force for the development of national standards, policies, institutions, and plans of action to address various aspects of climate change.

- The National Secretariat of the Environment and Sustainable Development (SAyDS) is the implementing authority for UNFCCC and the Kyoto Protocol, and its Climate Change Unit, previously understaffed and inexperienced, has grown to occupy a leadership role in recent years. Other significant advances at the national level include the creation of a Climate Change Commission within the Federal Environmental Council (COFEMA) in 2009, and the incorporation of climate change consideration in the Strategic Territorial Plan published by the Federal Ministry of Planning in 2011.

- In the Province of Buenos Aires, where the RRB is located, the maximum environmental authority is the Provincial Organism for Sustainable Development (OPDS), which created a climate change office in 2006.[2] This office is promoting an early warning system to reduce the negative impacts of climate-related hazards. This system is currently under development. The OPDS is also responsible for authorization, permits, and enforcement of environmental standards for industrial plants located in the RRB.

- The COMIREC is the principal provincial government led organism for multi-jurisdictional coordination and management in the RRB and works closely with the Buenos Aires Provincial Ministry of Infrastructure. These two institutions are responsible for the large IDB-sponsored project 'Sustainable Environmental and Urban Management in the Reconquista River Basin' (PMUAS), with an overall investment of approximately $US 287, 500, 000. This project includes hydraulic infrastructure works (channeling, rectification and transversal ducts) aimed at reducing flood risks and laying the groundwork for eventual extension of potable water and sanitation networks to neighborhoods which currently lack these services. It also includes a new transportation route to promote mobility and connectivity of underserved neighborhoods. Parallel components which are also being developed by the Ministry and the COMIREC include the reduction of clandestine waste sites and the generation of new public green spaces.

- Explicit discourse about climate change mitigation or adaptation is gradually emerging among large-scale territorial planning efforts, such as the PMUAS. In many cases, and at times without being explicitly linked to climate change, existing activities are intimately related to planned adaptation and are being modified to incorporate changes that mitigate the effects of climate change in some way (i.e. planning for higher capacity stormwater infrastructure). Overall, risk reduction is subsumed and aligned with vulnerability reduction.

[2] See website: http://www.opds.gba.gov.ar/index.php/paginas/ver/area_cambio_climatico.

- Municipal governments throughout the RRB also play an important role in adaptation due to their formal administrative competencies and proximity to local populations. Of the eight municipalities which responded to the team's survey, only one (Tigre) reported having a specific plan to respond to climate change. All eight (100%) reported having an approved plan in Public health, seven (88%) reported having plans for Economic development, Water and sanitation, and Solid waste, while six (75%) reported having plans for Land use and land management, Transportation, and Improvement of informal settlements. Most of those lacking plans said that they were currently being developed. The survey showed some advances in Stormwater and wastewater management and Emergency response, for both of which five municipalities (63%) had approved plans. Only four municipalities (50%) reported having Energy plans. Formal plans can provide an organizing framework and specific parameters for locally-appropriate adaptation planning.

- Municipal authorities tend to manage the consequences and perceived future risks of climate change through other sectoral plans that address urgent questions. Survey results point definitively towards *vulnerability reduction* as the main adaptation strategy among the municipalities of the RRB, with the most frequently-cited examples of 'climate-sensitive activities' in informal settlements being infrastructure improvement (extension of water and sewerage networks), resettlement and public housing programs.

- In the area of public health, a number of municipalities reported work to identify the specific risks of climate change, but the research team found no publicly available information to this effect. In the area of emergency response, four municipalities (Marcos Paz, Morón, Tigre, and Tres de Febrero) reported efforts to identify and quantify climate-related risks. While such efforts are still new, they are promising because increased knowledge about the costs of non-adaptation offers incentives for preventative measures.

- Municipal responses to climate change consist largely of small-scale adaptations, such as individual creek channelling or stormwater policy changes. Such responses are neither purely ‘spontaneous’ nor ‘planned’ in response to climate change, but instead resemble a form of autonomous adaptation within the public sector. In this regard, the binary categories of ‘spontaneous’ and ‘planned’ adaptation appear ill-fitted to the RRB, where state-led land use, emergency response, and vulnerability reduction help mitigate the negative impacts of climate change without explicitly forecasting it as a problem.

- Some external actors and initiatives are raising public awareness and municipal attention to climate change in the RRB. One is the Network of Municipal Governments on Climate Change, a national group of which two municipalities (Vicente López and San Isidro) are members. One RRB municipality (Tigre) has been working closely with the Latin American office of the International Institute for the Environment and Development (IIED-AL) on a project to measure and address local climate change vulnerability, and hosted the first annual meeting of mayors against climate change, in June 2013. Such examples point to a growing awareness about climate change hazards and locally-appropriate response options.

- At the community level, various types of 'autonomous' or 'spontaneous' adaptation were observed in the RRB, all in response to flooding. Some consisted of short-term solutions to emergencies (informal protocols, 'safe' congregation zones, housing modifications, and public transport route changes). Others consisted of medium-term preventative measures (elevation of houses on stilts, informal drainage paths, use of piled up construction waste as a flood barrier, elevation of informal electricity connections, household relocations). Most could be classified as 'unconscious' adaptation responses insofar as they address the impacts of climate change without any explicit knowledge of or reaction to future climate projections.

- Community-driven 'autonomous' climate change adaptation was shown to be both individual and collective in the neighborhoods of the RRB. Individual strategies were often necessary, but could also be problematic (when one house's flood barriers deflect enough water to inundate their lower-lying neighbor). Collective strategies—including in situ risk management by heavily-invested non-profit organizations or businesses—tended to be more ambitious and more costly, but also more sustainable. Another important aspect of autonomous adaptation found within one of the communities studied (Independencia and the surrounding José León Suárez area) is the out-migration of middle-income households and the subsequent abandonment and decay of urban spaces.

- Despite their vulnerabilities, informal settlements appear to display a level of dynamism and a flexible adaptive capacity which is sometimes lacking in the 'formal' city. Innovative responses as well as local organizations are beginning to emerge on the issue of adaptation, demonstrating possible pathways to overcome some common challenges, such as the incorporation of climate change in public discourse.

Challenges to Climate Change Adaptation

- Despite the advances described previously, planned climate change adaptation in the RRB faces a number of challenges common to many large cities in coastal zones. In order to characterize these challenges, the research team employed a modified version of an analytical tool called the National Adaptive Capacity Framework (NAC), focusing on four key functions: information management, risk and vulnerability assessment, prioritization of climate change adaptation, and horizontal and vertical coordination.

- Information management consists of “collecting, analyzing, and disseminating knowledge in support of adaptive activities” (WRI 2009). Three main challenges were identified in the RRB with respect to this function were: lack of systematization and analysis, insufficient information sharing, and inadequate public dissemination. While there is ample high-quality data available in Argentina to initiate a concerted analysis of climate adaptation options in the RRB, this information has not been extensively systematized for this purpose which limits the scope for analysis. At this stage, there isn’t a system of indicators to monitor climate change or measure its effects in the RRB. Information sharing between government institutions and offices isn’t always fluid, a common challenge experienced in many cities around the world. Finally, with few exceptions, there is scarce information available to the general public about climate

hazards or adaptation strategies in the RRB. This is particularly true for the residents of vulnerable informal settlements.

- Assessment is “the process of examining available information to guide decision-making” (WRI 2009). In the context of climate change, assessments are needed for all elements of risk, including climate hazards and impacts, vulnerability, and adaptive capacity. Few such assessments have been carried out for the RRB and even fewer are in the public domain. Some researchers, particularly Barros, have attempted to estimate the economic costs of sea level rise or extreme precipitation in the region. But the team found little evidence of quantified impact measures in the public sector. The IIED-AL project in the Municipality of Tigre was the only exception, but at the time of the study it was not yet available for review.

- Prioritization means “assigning special importance to particular issues, areas, sectors, or populations” (WRI 2009). For adaptation planning, prioritization may take into account the geographic distribution of climate change impacts and the differential vulnerability of different populations to them. One major challenge identified in the RRB was the lack of recognition of climate change as a threat to development and human wellbeing. Climate change adaptation is not an explicit priority in the RRB and competes with an already crowded agenda of political priorities and social demands. Even commitments to sustainable long-term planning are often overshadowed by the need to deal with ‘urgencies,’ for example related to public safety, unemployment, or public demands to improve health and education services. However, catastrophic events—such as the April 2013 floods—can act as ‘transformative stressors’, rallying political commitment and public demand for risk reduction or improved emergency response. Thus, the tragic effects of recent flood events may actually help overcome challenges to prioritization.

- Coordination refers to material and communicational linkages that help “avoid duplication or gaps, and can create economies of scale in responding to challenges” (WRI 2009). Linkages should be both horizontal (for example, among ministries or municipal level actors) and vertical (for example, between national governments and international organizations or sub-national authorities). Numerous experts noted that the difficulty of coordination between public sector institutions is one of the obstacles to effective climate change adaptation in the RRB. The competing logics of government and non-governmental organizations, their strengths, weaknesses, competencies, timelines, priorities, and bottom-lines, also makes coordination among stakeholders difficult.

- Coordination challenges derive, in part, from the fragmented nature of investment and planning action in the RRB, between for example the diverse areas of transport, housing, health and sanitation infrastructure. They also reflect the absence of a clear 'leader' or coordinating organism in terms of climate change adaptation. The National Secretariat for the Environment and Sustainable Development (SAyDS), is the national authority of issues of climate change, but has limited influence over provincial decision-making across a number of sectors. The COMIREC is the organism best positioned to coordinate strategic planning efforts in the RRB, but climate change adaptation functions exceed its past experience, current mandate, institutional structure, and budget. De facto leadership

for bio-regional planning in this case is the national-provincial-COMIREC matrix, with most progress being advanced via the sanitation improvements and vulnerability reduction strategies of the IDB-sponsored project 'Sustainable Environmental and Urban Management in the Reconquista River Basin' (PMUAS). This project is focused on the provision of essential infrastructure and does not explicitly address broader climate change considerations.

- Closer to the ground, municipal governments of the RRB face horizontal and vertical coordination challenges. Provincial or national organisms often hold the purse-strings for large-scale investments, which leads municipal authorities that are dependent on the transfer of resources to have clear strategies in place to address the local order of priorities in land use planning and to maximize positive outcomes. This also means that municipal governments have less direct involvement in the planning and implementation of regional projects. Similar to many metropolitan experiences, the MRBA doesn't have a metropolitan level of government and faces challenges in integrating the distinct facets of urban governance which can lead to gaps or the duplication of efforts. Coordination between adjacent municipalities is vital, but hard according to interviewees because local budgets don't account for this kind of integrated planning. Political leaders and technical specialists at the municipal level have growing incentives to act preventatively, adopting a more holistic perspective on climate change adaptation and coordinating with other institutions.

- The aforementioned challenges to climate change adaptation are diverse and complex. Due to the historical urbanization process of the region, development has often occurred before infrastructure provision and this has resulted in the occupation of flood-prone land or risk affected areas. The rapid growth of informal settlements, the ongoing development of gated communities in wetland, floodplain or other low-lying areas, and other projects that alter hydrological systems make the RRB an increasingly dynamic system.

- State investment in infrastructure has grown exponentially over the past ten years, improving network coverage and addressing specific questions, such as localised flooding. Furthermore, there are other positive baseline conditions for adaptation planning, including improved technical proficiency, enhanced articulation between different levels of government in some cases through specific agreements, projects or entities such as the COMIREC, and better quality baseline information on climate-related risks.

Scenarios

- Based on research undertaken on adaptation planning in the RRB, possible future scenarios were presented that attempt to take into account some factors that can stimulate structural and institutional changes. They included:

    1. Incremental change through a business-as-usual approach would see significant improvement in the quality of life for many RRB inhabitants through ongoing government-led improvement projects (such as the PMAUS Project), infrastructure

upgrading as well as other discrete policy changes. Community-based adaptation is also likely to increase, particularly where established and emerging communities do not have the opportunity to migrate from hazardous locations and are advancing bottom-up 'unslumming' initiatives. However, increasing (precarious) urbanization, worsening climate change conditions and existing challenges—for example in addressing historical infrastructure deficits or in overcoming the 'silo' mentality of policy development and implementation—combine to undermine the strengths of a business-as-usual approach. Barros et al. (2008) suggest that a business-as-usual scenario would result in annual cost of damages of US$80 and US$300 million by 2030 and 2070 respectively, without accounting for other affects such as health impacts, productivity losses, tax-payer (or otherwise) funded emergency relief, etc. Overall, while a business-as-usual scenario presents some challenges to holistic adaptation presently, it demonstrates that there are some strong foundations in place for future climate change adaptation.

2. Incremental change through climate 'mainstreaming' envisages the integration of climate change considerations into relevant social, economic and environmental policies and actions. Mainstreaming presents an opportunity to build on the extensive work that has already been undertaken in the RRB, for example, expanding infrastructure networks, improving population health and reducing poverty. Additionally, new opportunities may arise to access funding for climate change adaptation related initiatives, for example with multilateral organizations that already have an operating presence in the RRB and MRBA like the IDB and the World Bank, as well as to participate in international forums on related issues. Existing governance structures, like the national Climate Change Unit and the COMIREC, are already in place and provide scope for program extensions to incorporate risk assessments and specific adaptation measures. Mainstreaming may also provide the impetus for broader and integrated adaptation strategies over the long term. Advancing mainstreaming, would require concerted efforts to overcome some of the existing challenges in the sphere of urban governance in the RRB, particularly relating to information (availability and access, communication, etc.) and institutional capacity (resourcing, managing competing priorities, leadership on climate change, etc.). Such advances, however, may not be enough to holistically and sustainably prepare for climate change over the long-term.

3. Abrupt change post climate-related catastrophe is a possibility that would see a severe climatic event act as a 'crisis moment' to trigger a process of institutional change and a reorientation of governance structures to address adaptation planning. In this regard, climate events, according to Matthews, can act as the impetus for "episodic institutional change" and the "operationalization of climate adaptation" through the incorporation, codification and implementation of climate change adaptation as "a central tenet of urban planning governance" (2012: 1090–1091). Under circumstances of an extreme climate event, new approaches to adaptation planning may be institutionalized and operationalized in the RRB. Whilst there is demonstrated international experience of transformative institutional change through crisis, some cases also highlight the challenges of sustaining change due to limited resources,

dependency on higher-level agencies or weak institutional structures. Taking into account these issues, as well as the devastating impacts from international experiences like tsunamis and hurricanes, it is not considered a desirable option for adaptation planning to be advanced abruptly in a post-crisis scenario.

4. Transformative change through integrated adaptation planning. Research shows that effective adaptation planning requires addressing climate risks in an anticipated, planned and integrated way. Better aligning the parallel initiatives of government agencies as well as engaging civil society, represent important prerequisites for integrated adaptation planning. Other variables that seem pertinent are political leadership on climate change, creative resourcing, a capacitated workforce to assess and interpret climate behavior and a commitment to raising awareness about climate change. Advancing an agenda that is broadly encompassing of adaptation faces both challenges and opportunities for the RRB. On the one hand, an understanding of climate risk would unquestionably strengthen existing motivations to improve coordination in urban governance and to enhance environmental management. Argentina in general, and the RRB specifically, benefit from high-level scientific knowledge as well as the capacity to undertake risk assessments and to build on links between research and public policy. Furthermore, there are emerging manuals and policies from the national and provincial governments that support the framing of climate change adaptation. Advancing holistic adaptation planning in the RRB would rely on some of the abovementioned factors to be in place. It would also require a commitment to addressing existing challenges that obstruct sustainability planning and integrated urban governance, as well as increased citizen engagement on climate change adaptation planning. In general terms, this kind of transformative change represents an ideal scenario for adaptation planning.

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Urban Risk and Climate Change Adaptation in the Reconquista River Basin of Argentina

Section 1: Research Project Description

This report presents the findings of research undertaken on urban risk and climate change adaptation in the Reconquista River Basin (RRB), Province of Buenos Aires, Argentina. This research project was supported by the Lincoln Institute of Land Policy, Program on Latin America and the Caribbean. The project was carried out between November 2012 and January 2014. It included three major components:

1. The first component was a review of literature on climate risks, vulnerability and integrated adaptation responses, including reports produced by international institutions, such as the Inter-governmental Panel on Climate Change, UN Habitat, the World Bank, the Inter-American Development Bank, and articles and case studies by leading scholars from around the world, as well as many from universities and think-tanks in Argentina.

2. The second component was a review of policies and procedures adopted by various levels of government in Argentina and, particularly, in the RRB, with particular attention to interventions targeting vulnerable, informal settlements. Research included the review of reports and studies published by Argentina's national government (including the Ministry of Planning, the Ministry of the Environment, and the Disaster Response Authority), the Province of Buenos Aires, COMIREC, and municipalities of the RRB.

3. The third component involved direct engagement with community actors from informal settlements in the RRB, in an attempt to guage perceptions of climate risk and spontaneous adaptation measures. This included site visits, interviews, and community workshops in Barrio Independencia (Municipality of San Martín) and Barrio San Martín (Municipality of San Fernando), participation in two COMIREC/ IDB-led community meetings (in Tigre and Tres de Febrero, respectively), and a Climate Risk Reduction workshop organized by IIED-AL in San Fernando. Community engagement allowed the team to gather first-hand testimonies about the impacts of precipitation and extreme weather events on informal settlements and the spontaneous adaptation strategies they employ.

To supplement the information gleaned from published documents and grassroots workshops, the team carried out in-depth interviews with experts from different levels of government, international organisms, representatives of civil society, and academics. Interviews were conducted in order to develop a detailed understanding of climate hazards, vulnerability and existing approaches to climate change adaptation in the RRB, but also served to sensitize interviewees, identify challenges and bottlenecks, and elicit suggestions for a more integrated approach to climate risk reduction. In total, the project included 20 semi-structured interviews with experts from the following institutions: University of Buenos Aires — Faculty of Architecture, Design, and Urbanism (UBA-FADU), United Nations Development Program, Water and Sanitation of Argentina (AySA), CEUR-CONICET, World Bank, National Ministry of Planning - Disaster Risk Reduction Office, National Secretariat of the Environment - Office

for Climate Change Adaptation, Province of Buenos Aires - Ministry of Public Works, COMIREC, Municipalities San Martín and San Fernando, Fundación ProTigre, the Environment and Natural Resources Foundation (FARN), and the International Institute for Environment and Development Latin America (IIED-AL).

Finally, the team administered an online survey to the 18 municipal governments which form part of the Reconquista River Basin, with support from the COMIREC. The survey targeted municipal planning authorities and addressed three main topics: local climate change risk and impacts, urban planning responses to climate change, and the unique situation of informal settlements, in terms of vulnerability, impacts, and municipal planning. Among municipalities there was a 47% response rate: eight local authorities completed the survey, including three from the Upper basin (Morón, Marcos Paz, and General Rodriguez), four from the Middle basin (Hurlingham, Malvinas Argentinas, Tres de Febrero and Ituzaingó), and one from the Lower basin (Tigre).Additionally, the COMIREC provided responses applicable to the entire RRB.

This report is divided into seven sections. This section provides an introduction to research goals and methods. Section two offers an overview of issues and concepts related to climate change, climate-related risks, vulnerability, and adaptation in urban coastal areas. Section three provides a detailed characterization of the RRB, including its population, institutional framework, environmental conditions, and urbanization patterns. Section four presents a critical evaluation of urban risk, climate hazards, and vulnerability in the Reconquista River Basin while section five discusses recent advances in adaptation, at the national, provincial, regional, and municipal level. After acknowledging these advances, section six puts forth a critical assessment of the challenges faced. The final section presents conclusions and outlines possible future scenarios for climate change adaptation in the RRB based on existing trends and research.

Section 2: Climate Change, Vulnerability, and Adaptation in Urban Areas

Global Climate Change

Climate change refers to the rise of the Earth's average atmospheric and oceanic temperatures. Also known as global warming, it accounts for observed increases in average surface temperatures over the last century and projected warming trends in the future. As reported in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[3], the world's leading international authority on this topic, climate change is associated with a number of direct biophysical effects, including the rising of sea levels, the melting of glaciers and permafrost, regional variations in the amount and intensity of precipitation, the expansion of deserts, and the growing frequency of extreme weather events, such as heat waves, droughts, and storms (IPCC 2007). The secondary effects of these changes include increased oceanic acidity, ecological disruptions, and impacts on human health, due to reduced agricultural yields, stress on water supplies, diseases, and habitat damage from flooding (Ibid).

[3] The Fifth Assessment Report is currently available in draft format. Whilst it is not available for full reference purposes, the findings have been considered as part of this report.

Most scientists agree that global climate change is in some measure driven by anthropogenic forces, namely the burning of fossil fuel use and land use change due to agriculture and deforestation. These human activities have resulted in the emission of a high volume of greenhouse gases (GHGs), such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and halocarbons (gases containing fluorine, chlorine, and bromine). The accumulation of these gases and aerosols in the Earth's atmosphere alters the balance between incoming solar radiation and outgoing infrared radiation, thereby 'trapping' heat within the climate system. There is "unequivocal evidence" that demonstrates the increase of atmospheric concentrations of greenhouse gases such as carbon dioxide, methane, and nitrous oxides over the last few centuries (IPCC 2013, 1-2). Some scientific skeptics accede that the Earth's climate is growing warmer, but negate the role of anthropogenic forces, instead attributing climate change to natural climate cycles and variations. This report adopts the definition of climate change used by the IPCC, which refers to "changes in the mean and/or variability of the climate which persist for an extended period of time, regardless of their cause[4]" (IPCC 2007, 30).[5]

The IPCC Third Assessment Report published in 2001 identified five key 'reasons for concern' associated with climate change: 1) risks to unique and threatened systems, 2) risk of extreme weather events, 3) inequalities in the distribution of impacts, 4) aggregate impacts, and 5) risks of large-scale discontinuities (such as deglaciation of Greenland ice sheets). According to the 2007 IPCC report, the Earth's annual global surface temperature is likely to rise by at least 2 °F (1.1 °C) over the next century (IPCC 2007). This prediction is based on a series of growth and emissions scenarios detailed in the IPCC Special Report on Emissions Scenarios (SRES 2000). The report explores a range of alternative development pathways and resulting GHG emissions under current climate policies. It shows that temperature increases may vary significantly, depending on global consumption patterns and technological evolution. Nevertheless, the IPCC sustains that "even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1 °C per decade would be expected" (IPCC 2007, 37).

The most dramatic estimate of SRES shows an average temperature rise of 2.4 °C – 6.4 °C by the end of the 21st century. The widely-cited Stern Review, published in 2006, explores the potential climate-related and economic impacts of business-as-usual (BAU) development, warning that "under a BAU scenario, the stock of greenhouse gases could more than treble by the end of the century, giving at least a 50% risk of exceeding 5° C global average temperature change during the following decades" (Stern 2006, iv). More extreme predictions indicate an increase of up to 11 °C over the next 50 -100 years is possible (Stainforth et al 2005). As of 2007, global emissions were as high or higher than the highest IPCC scenarios previously set (A1F1) and CO2 concentrations were increasing more than registered over previous decades (IPCC 2007).

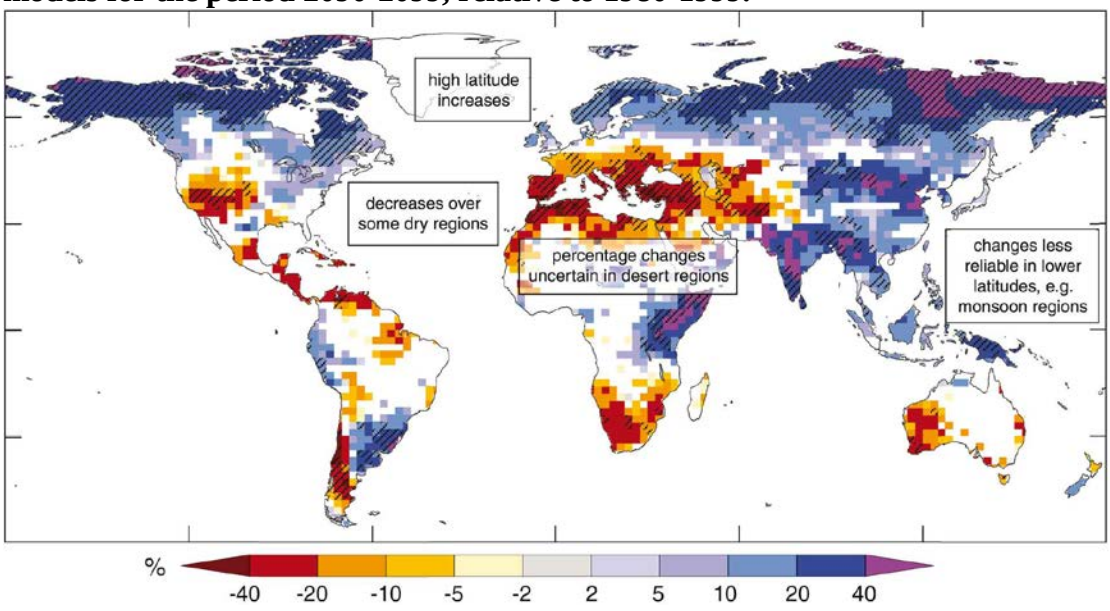
The recent IPCC 5th Assessment Report (draft only), states that the frequency of warm days and warm nights will likely increase over the coming decades, while the number of cold days and nights will decrease. Model projections suggest increases in the "duration, intensity and spatial

[4] This definition differs from that used by the UN Framework Convention on Climate Change (UNFCCC) and UN Habitat, which refer to changes that can be "attributed directly or indirectly to human activity."

[5] While the authors are in agreement about the anthropogenic causes of this phenomenon, any potential debates about this topic are secondary to this study, which recognizes climate change as a fact and focuses on adaptation.

extent of heat-waves and warm spells" in the near-term (IPCC 2013, 11-4). Furthermore, the "frequency and intensity of heavy precipitation events over land will likely increase on average in the near term" (Ibid). The report concludes that "it is more likely than not that the mean global mean surface air temperature for the period 2016–2035 will be more than 1°C above the mean for 1850–1900, and very unlikely that it will be more than 1.5°C above the 1850-1900 mean (medium confidence)" (Ibid).

Figure 1. Percentage changes in average annual runoff projected by four climate models for the period 2090-2099, relative to 1980-1999.



Source: IPCC, 2007 Climate Change 2007: Synthesis Report. Intergovernmental Panel on Climate Change. Figure 3.5, p. 49.

The wide variability of temperature estimates is, in part, due to the difficulty of forecasting global economic growth rates and associated GHG emissions (global scenarios). It is also fuelled by the scientific community's incomplete understanding of climate and water cycles (system responses) and their accumulated impacts at the local level (site-specific consequences). Further uncertainty stems from the paucity of data sets, information about historical weather patterns, and environmental baselines, particularly in developing countries. However, scientists are generally in agreement that climate change will be unequally distributed around the globe.

Warming is expected to be greatest over land and at high northern latitudes, while temperatures in the Southern Ocean, near Antarctica, and the northern North Atlantic may remain relatively constant (IPCC 2007). The melting of glaciers and ice sheets of the Arctic region and the upper latitudes of Europe, North America, and Asia and the shrinking of glaciers in high-altitude zones worldwide will alter the equilibrium of glacier-fed streams and river systems, with significant impacts on downstream ecosystems and human settlements. According to the latest projections by the IPCC, "precipitation will very likely increase in high and some of the mid-latitudes, and will more likely than not decrease in the subtropics" (IPCC 2013, 11-3). Furthermore, increases in "near-surface specific humidity over land are very likely and increases in evaporation over

land is likely in many regions (Ibid). Regional trends may mitigate or exacerbate the effects of climate change at national and sub-national levels.

Uncertainties about the nature of climate change and its impacts within geographically-bounded political and administrative jurisdictions make it notoriously difficult generate balanced policy responses and 'no-regret' adaptation options (Mehotra et al 2009). Climate change is thus a high-stakes exercise in risk management, in which policy-makers must consistently weigh the costs of action with those of inaction. This report focuses on climate change tendencies and response measures within urbanized coastal regions. Where possible, it focuses on the experience of the Plata River region of Argentina and proximate areas to the Reconquista River Basin, which is the subject of this research.

Climate Change, Coastal Urbanization, and Cities

In the context of global climate change, coastline and delta regions are considered particularly vulnerable, due to their sensitivity to ocean tides and their exposure to tropical storms. Sea levels could rise between 18cm and 59cm by the end of the 21st century (UN Habitat 2011). Coastal systems are among the most productive but also the most highly threatened natural systems in the world (UNEP 2005). Urbanization has degraded ecosystems, such as wetlands and mangroves, which have historically served as buffer zones and as regulators of ecological services. Climate change will exert further stress on these systems, increasing flooding, accelerating erosion, altering sediment deposits, and enabling seawater intrusion into freshwater systems (IPCC 2007). Ecosystem changes alone are worrisome in terms of long term sustainability and species survival. But, due to human settlement patterns, climate change will stress the economic, social, and political systems of many coastal and delta regions as well.

Coastal regions are home to a large and growing proportion of the global population. Nearly three billion people - or approximately 50% of the Earth's population - live within 200 kilometers of a coastline, and by 2025 this number is likely to double (Creel 2003). Likewise, 40% of the world's people live within 100 kilometers or less of the coast (McGranahan et al 2007). The average population density in coastal areas is about 80 persons per square kilometer, twice the world's average population density (Creel 2003). Furthermore, a large share of the coastal population is concentrated in low-elevation coastal zones (LECZ), 10 meters or less above sea level.[6] The LECZ covers only 2% of the world's land area but contains 13% of the world's urban population (McGranahan et al 2007). The rate of sea level rise may also exceed the global average in heavily populated deltaic areas due to subsidence and human activities (Hunt and Watkiss 2007).

Human population along the Earth's coastlines is not only extensive, but highly urbanized. A detailed analysis of elevation and land contours, urban footprints, and population grids for the year 2000 was carried out by the International Institute for Environment and Development (IIED), the Institute for Demographic Research at the City University of New York (CUNY),

[6] Different indicators can be used to define coastal zones, depending on the focus of analysis. Distance-based standards may range from 60 to 200 kilometers of the shoreline and may include coastal floodplains, mangroves, marshes, tideflats, beaches, dunes, and coral reefs (Creel 2003). In general distance-based measures are best utilized to denote coastal pressures, while elevation-based measures are best suited for hazard vulnerability (McGranahan et al).

and the Centre for International Earth Science Information Network (CIESIN) at Columbia University. This analysis shows that approximately 600 million people inhabit this zone, of whom 360 million are urban dwellers. The urbanization level of coastal zones (60%) is significantly above the world average (50%). The same analysis shows that urban populations are more likely to be in the LECZ than rural populations, and that larger urban settlements are more likely to overlap with the LECZ than smaller urban settlements. "While only 13% of urban settlements with populations under 100,000 overlap with the LECZ, this rises to 65% among cities of 5 million or more" (McGranahan et al 2007, 34). These estimates coincide with figures published by UN Habitat in 2009.

Population density in the LECZ tends to be higher in developing nations than in developed nations. In wealthy countries, approximately 10% of the total urban population lives in the LECZ. This number is closer to 14% in developing nations, although there is wide variation. Asia alone accounts for 61%, due to its large population and unique geography. It has more than 235 million people living in the LECZ, concentrated in megacities such as Shanghai, Bangkok, Karachi, Kolkata, and Chennai (UN Habitat 2009). Nevertheless, Sub-Saharan Africa and Latin America and the Caribbean are not far behind, with 9% and 8% of their urban populations in the LECZ, respectively (Ibid). There are an estimated 3,351 cities in the LECZ worldwide, and nearly 64% are in developing regions. Asia accounts for more than half of the low-lying cities most vulnerable to climate change, followed by Latin America and the Caribbean (27%) and Africa (15%) (UN Habitat 2009).

Figure 2. Urban Population at Risk from Sea Level Rise

Region	Urban population (000s)	LECZ Population (000s)	Urban population in LECZ (000s)	% of LECZ urban to total urban	% of urban in LECZ
Africa Total	282,143	55,633	32,390	11.5%	58.2%
Northern Africa	88,427	30,723	15,545	17.6%	50.6%
Sub-Saharan Africa	193,716	24,911	16,845	8.7%	67.6%
Asia total	1,430,917	449,845	235,258	16.4%	52.3%
Eastern Asia	709,199	159,969	109,434	15.4%	68.4%
Southern Asia	415,209	140,964	56,023	13.5%	39.7%
South-Eastern Asia	169,099	137,245	61,201	36.2%	44.6%
Western Asia	102,655	11,472	8,482	8.3%	73.9%
CIS Asia	34,756	194	119	0.3%	61.0%
LAC	319,629	33,578	24,648	7.7%	73.4%
Oceania	2,017	852	442	21.9%	51.9%
Developing Total	**2,034,706**	**539,908**	**292,738**	**14.4%**	**54.2%**
Europe (inc. CIS Europe)	500,943	50,200	39,709	7.9%	79.1%
N.America	255,745	24,217	21,489	8.4%	88.7%
Japan	101,936	29,347	27,521	27.0%	93.8%
Australia & New Zealand	18,002	2,846	2,421	13.5%	85.1%
Developed Total	**876,627**	**106,611**	**91,140**	**10.4%**	**85.5%**
World total	**2,911,333**	**646,519**	**383,878**	**13.2%**	**59.4%**

Source: UN Habitat 2009

Development and growth patterns in low-elevation coastal zones are of vital concern because it is LECZ infrastructure and inhabitants which will be most affected by global climate change.[7] In

[7] The effects of climate change on delta and coastal cities may include 1) effects of sea level rise; 2) infrastructure damage from extreme weather events, such as wind, storm surges, floods, heavy precipitation events, heat extremes and droughts; 3) health

reference to this phenomenon, UN Habitat's 2011 Report on Human Settlements warns that "the effects of urbanization and climate change are converging in dangerous ways" (UN Chronicle 2012 website). Coastal and delta cities have long been sensitive to sea level rise and extreme weather events such as storm surges and hurricanes (Ericson et al 2006; Woodroffe et al 2006). But, as evidenced by recent climate events, like typhoon Haiyan in the Philippines, low-income nations are not well-equipped to resist or recover from such events. Other extreme weather events, like hurricanes Katrina and Sandy, show that even high-income nations, like the United States, are ill- prepared to withstand the impacts of climate change. In low and middle-income nations, settlements in deltas and coastal areas are likely to suffer greater impacts due to cumulative environmental stress, weak infrastructure, urban development characteristics, and economic constraints to adaptation planning.

The same factors which have driven coastal population growth - enterprise clustering, shipping routes, access to natural resources, and employment opportunities - will be adversely impacted by climate change. As reported by the IPCC, the impacts of climate change on coastal and delta cities can be conceptualized using three main groupings, 1) market dynamics, 2) physical infrastructure, and 3) human health (IPCC 2001; 2007). Physical assets, such as buildings and water, sewage, energy, and transportation systems, and will likely suffer damages, increasing the cost of raw materials, production, and services. This economic burden will, in turn, impact the performance, competitiveness, and employment patterns in these cities (Hunt and Watkiss 2007). Population density will elevate the risk of air-born and water-borne diseases, particularly in the case of flooding and rising water tables, increasing morbidity and placing large burdens on public health systems.

Climate change impacts and threats differ according to geographic location and features, as well as the quality of urban development. A given city's degree of risk, as discussed more extensively below, depends on a number of characteristics, including but not limited to its proximity to the sea, topography, and physical attributes, as well as social and institutional factors (Mehotra et al 2009). Urban conditions influence how climate change affects communities. For example, heavy rainfall in areas with high levels of impermeable surfaces or with poorly designed sewer and drainage systems are more adversely affected by flooding. And, due to the heat island effect, urban areas are more profoundly impacted by temperature increases due to the retention of solar heat through paved areas and buildings (UN Habitat 2011).

According to survey results published by the Massachusetts Institute of Technology (MIT) in 2012, 79% of cities (among the 468 surveyed) already perceive differences in environmental conditions due to climate change. These include alterations in temperature, precipitation levels, sea level, and natural hazards. In the context of increasing growth in urban areas, climate change compounds existing social and environmental challenges facing cities, such as managing public health, providing adequate housing, and implementing water management strategies. Studies from around the world suggest that climate-related hazards in urban areas, including storm surges and natural disasters, will stress urban infrastructure and threaten livelihoods, especially for vulnerable groups (Norman 2010; Gremillion 2011; Carmin, Anguelovski and Roberts 2012).

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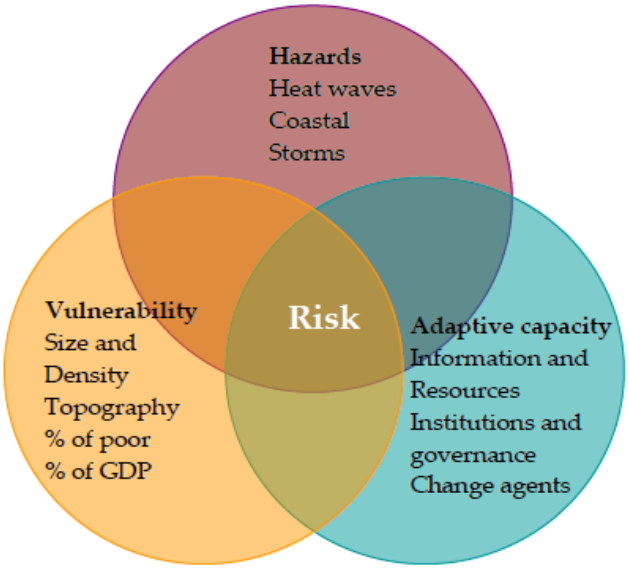
risks from higher average temperatures and extreme events; 4) effects on energy use; 5) effects on water availability and quality; 6) effects on tourism and cultural heritage; 7) effects on urban biodiversity; and 8) ancillary effects on air pollution (IPCC 2001, 2007; Hunt and Watkiss 2007).

Climate Risk and Informal Urban Settlements

Using the framework developed by Mehrotra et al, this study considers urban risk as a function of three discrete elements: climate hazards, vulnerability, and adaptive capacity (Mehrotra et al 2009). Here *climate hazards* are defined as climate-induced stresses, such as heat waves, droughts, sea level rise, and floods. *Vulnerability* refers to the physical and socio-economic attributes which determine a city's degree of susceptibility, including flood-proneness, land area, elevation, population density, economy, and percentage and composition of poor populations. *Adaptive capacity* refers to the city's ability to respond to climate-related stresses. Among others, this is determined by institutional structure, resources, information, analysis, political willingness, public participation, and other governance-related considerations.

Figure 3. Urban Risk as a Function of Hazards, Vulnerability & Adaptive Capacity



Source: Shagun Mehotra, Claudia Natenzon, Ademola Omojola, Regina Folorunsho, Joseph Gilbride, and Cynthia Rosenzweig, "Framework for City Climate Risk Assessment" Fifth Urban Research Symposium 2009.

This conceptualization differs slightly from that of the IPCC, which uses the single term *vulnerability* to discuss both biophysical hazards—"the character, magnitude, and rate of climate change and variation to which a system is exposed"—and inherent qualities of a system—its "sensitivity and adaptive capacity" (IPCC, Climate Change 2007: Impacts, Adaptation and Vulnerability).[8] The Mehotra et al. definition instead disaggregates these components, allowing for independent evaluation and measurement of the external, biophysical hazards a city is likely to face as a result of climate change, and the characteristics which will exacerbate or mitigate hazards when they occur. Vulnerability takes many shapes (geographic, economic, social), predates climate change, and mediates the impacts of natural phenomena. Vulnerability is

[8] For an exhaustive discussion of vulnerability, risk, and adaptation as they related to climate change, see Nick Brooks (November 2003) "Vulnerability, risk and adaptation: A conceptual framework," Tyndall Centre for Climate Change Research, Working Paper 38, available at: http://www.tyndall.ac.uk/sites/default/files/wp38.pdf.

countered by adaptive capacity, which includes resources, institutions, local knowledge, and social networks that increase a city's capacity to anticipate, survive, and recover from shocks.

A given city's level of climate-related risk, among other things, on the percentage of the population living in informal settlements or households which lack improved water supply and sanitation, sufficient living-space, structurally sound dwellings, or security of tenure (UN Habitat 2003). According to recent figures, an estimated 20.6% of the world's population currently resides in informal settlements (World Bank 2010). There is a stark contrast between informal and formally-planned areas of the city, and this is a key determinant of the differential vulnerability of the poor (UN Habitat 2008). In the context of climate change, informal settlement populations are particularly vulnerable because their dwellings are often located in areas prone to flooding or landslides (Sierra 2010). Other physical attributes which make informal settlements particularly susceptible to hazards, such as floods or storm surges, are the low-quality building materials of homes, precarious electric connections, and lack of adequate sanitation infrastructure.

Informal settlements in urban areas typically face compound vulnerability to climate change due to their socio-economic characteristics. Households which subsist at or below the poverty line often have limited income-earning capacity, savings, and job security. They also have low levels of education and health, relative to other groups. These same characteristics reduce the adaptive capacities of informal settlements, where residents have limited access to civic organizations and other valuable avenues for information, advocacy, and public resources. The social networks of settlement residents are typically comprised of individuals of similar socio-economic status and may be limited to a small geographic area. When a whole community has been impacted by an emergency, these characteristics make it harder to mobilize outside resources for short-term survival and long-term recovery. In short, climate change risk for the urban poor "is compounded by their more limited ability to cope with the consequences of any climate change impact (i.e. illness, injury or loss of income, livelihood or assets)" (UN Habitat 2011).

Certain subsets of the urban poor experience compound disadvantages. For example, women are further affected by "gender-based inequalities in terms of property rights, resources, access to information, and socio-economic roles," while the elderly and the young "are less able to avoid the direct and indirect impacts associated with climate change due their age and physical abilities" (Ibid). Women, the elderly, and the young are, therefore, characterized by even higher degrees of vulnerability in the face of global climate change and concomitant urban hazards.

Responses to Climate Change: Mitigation vs. Adaptation

There are two broad categories of response to climate change risk: mitigation and adaptation. Mitigation aims to stabilize global GHG concentrations in order to avoid catastrophic climate disequilibrium and decrease the overall severity of impacts. According to UNEP, climate change mitigation "can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior" (UNEP). Mitigation measures center around emissions reductions and include cap and trade schemes, voluntary and involuntary carbon markets, energy efficiency initiatives, attempts to replace fossil

fuels with ‘green’ energy sources (wind, solar, geothermal, hydroelectric, etc.), and the reduction of emissions from deforestation and land degradation (REDD), among others.

Climate change mitigation policy is a politically and socially contentious topic because GHG emissions are closely associated with productive activities that spur economic growth, like mining and industrial manufacturing. GHG emissions are unevenly distributed around the globe, with high levels of emissions occurring in rapidly developing countries like China, but per capita GHG emissions are highest within high-income countries, like Australia (Garnaut 2008). International agreements make reference to the ‘common but differentiated responsibilities’ of developed nations (largely responsible for past GHG emissions) and developing nations (responsible for a large and growing share of current GHG emissions). Negotiations harbor fierce debates about developing nations’ right to growth and about the financial obligations of developed countries for past emissions. These debates are far from being resolved.

Cities play a major role in mitigation because they represent cluster areas of resource use (cooling, transportation), contamination (waste disposal, industry), and land development (land clearing, impermeabilization). Spatial planning plays a fundamental role in promoting resilient development forms. Stern suggests that “buildings, transport, infrastructure and urban design must all be simultaneously climate resistant, energy-efficient and low-carbon” (Stern 2009, 72, in Wilson and Piper 2010). At the same time, the majority of the world’s population is now urban and cities have strong incentives to implement spatial, institutional, and economic adaptation measures, given their strategic importance as centers of global business and the high costs of reacting to climate-related emergencies in densely populated areas. As suggested by Wilson and Piper, the effective integration of mitigation and adaptation requires “a cross-disciplinary approach, awareness of the socio-economic context, involvement of all relevant stakeholders, and consideration of multiple timescales and cross-boundary effects” (2010, 43).

Many environmental advocacy organizations’ have focused their awareness-raising efforts on mitigation—rather than adaptation—and, as a result, this concept has gained significant social traction. There have even been deliberate attempts by some stakeholders to avoid the topic of adaptation, which is perceived as a “less valid solution because it focuses on the consequences of climate change and not on its causes, and even as a dangerous solution since it could stand in the way of the discussion on mitigation” (Hallegatte et al 2011). Mitigation is essential in order to avoid dangerous accumulations of GHGs. However, adaptation is also increasingly relevant as some degree of climate change is now inevitable and its effects are already being felt.

With the process of climate change already underway, the second cluster of responses revolves around adaptation. Adaptation constitutes “a set of organization, localization and technical changes that societies (…) implement to limit the negative effects of climate change and to maximize the beneficial ones” (Hallegatte et al 2011, 5). By definition, adaptation refers to a broad array of activities, which may include flood control in areas subject to rising sea levels, the adoption of heat-resistant crop varieties, the reconfiguration of energy networks, or investments in preventative care to avoid public health problems due to heat and disease outbreaks. In urban areas, sectors such as water and sanitation, transportation, energy, and health are particularly sensitive to climate change. They merit special consideration, taking into account the “differential impacts [of climate change] on the poor and the non-poor” (Mehotra et al 2009, 2).

The differential impacts cited here are particularly relevant in the context of the Reconquista River Basin, where there are a large number of informal settlements are vulnerable to physical, economic, and social impacts of climate change.

As defined by the IPCC, climate change adaptation includes both "planned" adaptation and "autonomous" adaptation. Planned adaptation is "the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state," and most frequently involves the public sector, whereas spontaneous adaptation may occur at an individual or community level with little or no government coordination. Planned adaptation is, presumably, anticipatory, resulting in strategies to address climate change before impacts are observed.

These notions are contrasted with "reactive" adaptation, which occurs as a response to the tangible impacts of climate change. As described by Hallegatte et al in The World Bank Policy Research Paper 'Designing Climate Change Adaptation Policies: An Economic Framework,' "anticipatory adaptation uses resources that exist today to prevent possible crises in the future … reactive adaptation uses resources to deal with events at the time they occur" (2011, 5). Conceptually, the difference between anticipatory and reactive adaptation is temporal. Autonomous adaptation, on the other hand, is defined based on intent or purpose. According to the IPCC, it "does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems" (IPCC 2007, glossary). Autonomous adaptation is normally associated with smaller systems and is almost invariably reactive (Smith et al 2000).

Reactive adaptation refers to interventions which emerge as a response to changes that have already occurred or damages which have already accrued. These include responses to extreme weather events, such as floods or storms, as well as the gradual degradation of natural and man-made environments which must, at some point, be addressed. Reactive adaptation is thus closer on the continuum to emergency response, and often—though not always—has its genesis in weather-related crises with high public visibility, such as the 2003 European heat wave. But the line between reactive and anticipatory planning is never entirely clear. France's Climate Plan, for example, can be interpreted as a reaction to the 2003 event, as well as a means to anticipate (and mitigate the effects of) similar events in the future (Hallegatte et al 2011). While reactive adaptation is, arguably, the most common response to climate change, particularly in developing nations, the predominant focus of most literature continues to be on anticipatory approaches.

Anticipatory adaptation is, by definition, planned. When led by the public sector in urban contexts, it is inextricably linked to policymaking and urban governance. Planned adaptation invariably requires a combination of 'soft measures,' such as policies, institutions, knowledge, and social cohesion, to generate an enabling environment, and 'hard measures,' such as capital investments in flood protection, climate-proofing infrastructure, and resettlement, to effectively mitigate climate-related risks (World Bank 2010). The type of interventions chosen and the degree of importance placed on 'soft' and 'hard' measures vary based on the perspective of the planning agency in question. Some focus on 'pure' adaptation, with an emphasis on impact predictions and risk reduction. Others take a more holistic development-based approach, arguing that "while the adaptation approach only focuses on climate impacts, the vulnerability reduction

approach addresses the fundamental reasons for vulnerability, many of which are about broader development" (Shipper 2007, cited in Malik et al 2010, 8).

Spontaneous or autonomous adaptation is, perhaps, the most nebulous term associated with patterned responses to climate change. The IPCC defines such adaptation based on intent, highlighting its "unconscious" character and decoupling it from climate stimuli themselves. It focuses on responses to the *impacts* of climate change (reductions in agricultural productivity, increased levels of flooding, etc.) without presupposing knowledge of present or projected climate behavior. Autonomous adaptation is also associated with private agents, such as individuals, communities, and businesses, rather than public sector authorities (Malik et al 2010). Relevant examples of autonomous adaptation may include the adoption of new production technologies by private firms, the introduction of makeshift or long-term solutions to rising tides or land pressures by individuals or households, and bottom-up advocacy movements spearheaded by environmental groups to address threats to biodiversity. Most often, spontaneous adaptation refers to responses initiated by private actors to preserve their economic livelihoods in the face of environmental changes.

What is notably absent from existing definitions of autonomous adaptation is the idea that it can and does occur within the public sector; this emerged as a central finding of the present study. Adaptation is thought of as a continuum with "pure" spontaneous (reactive) adaptation by private agents on one end and planned (anticipatory) adaptation by government on the other (Malik et al 2010). However, as evidenced by research in the field, these categories are ill-fitted to some urban contexts, like the RRB, where state-led land management, development, and emergency response initiatives may lack explicit references to climate change but may nevertheless constitute a type of autonomous state-led adaptation to changing climatic conditions. Emerging literature on the nature of institutional change relating to climate change in urban contexts, particularly by Matthews (2013), offers insights into how such processes of incremental adaptation unfold.

A common thread is that many types of climate change adaptation respond to exogenous pressures, only some of which are related to the physical effects climate change. For urban agencies, pressures include the (presumably negative) impacts of extreme weather events as well as positive incentives, such as financial support from multilateral agencies, foundations, or banks, changes in national climate policy, or access to new information or ideas about climate change (Carmin et al 2012). Another driver may be "a perceived lack of progress at international and national scales to secure significant reductions in GHG emissions," which encourages locally-led initiatives to respond to climate through adaptation (Measham et al 2011, 890). Political forces which promote adaptation include public opinion and pressure from lobby groups. In this regard, there are also important endogenous factors. Carmin et al suggest that a critical endogenous force is often "a local champion or entrepreneur who is instrumental in initiating institutional change" (2012, 20). In the private sector, firms respond to a similar array of exogenous and endogenous forces, in the form of government regulations, tax breaks, consumer demands, and considerations of long-term profits.

Analyzing and Measuring Climate Change Adaptation

There are multiple frameworks for analysis and measurement of climate change adaptation. Some place more emphasis on practical steps and tangible outcomes, others on adaptation as a process (Harley et al 2008). When viewed in terms of outcomes, all three types of adaptation - anticipatory, reactive, and autonomous - are convergent. Whether they focus on reducing vulnerability or bolstering adaptive capacity, they are still different means to the same end of reducing climate-related risk. As processes, however, they are very distinct. This study conceives of adaptation as a *process*, involving the complex and often conflictive interplay of ecological, social, political, and economic forces. It is therefore equally concerned with the internal dynamics of change as with the eventual outcomes. Following the "anatomy of adaptation" presented by Smith et al, this research is concerned with questions like: Adapt to what? Who or what adapts? and How does adaptation occur? (Smith et al 2000).

Research conducted by Matthews (2013) is illuminating in this regard; it offers a framework for understanding how climate change adaptation may become incorporated as an important aspect of urban governance. Matthews suggests that climate change is a "transformative stressor" that compels and requires institutional changes within urban governance structures (2013: 1090). Essentially, "crisis moments" can trigger social stresses that lead to processes of institutional changes via new or amended approaches to governance (Ibid). Importantly, such stressors may induce immediate effects whilst others may coalesce over time encouraging incremental change. Change, however, is conditioned by two important factors according to Matthews: 'change-oriented preferences' and institutional capacity (Ibid). These factors are explored in relation to the RRB across the range of adaptation approaches identified. Other pertinent studies on current approaches to climate change adaptation planning in cities have also been used to help frame this research.

Current Approaches to Climate Change Adaptation Planning in Cities

Approaches to adaptation planning vary greatly across regions, depending on local conditions, perceptions of climate change, and availability of resources, among other factors. In 2011, the Massachusetts Institute of Technology (MIT) Department of Urban Studies and Planning undertook a survey of 468 cities worldwide to gather information about changing weather and precipitation patterns, risk and vulnerability assessment, and local adaptation planning. Fifty four of the cities surveyed were in Africa, Asia, or Latin America, while the rest were in high income nations. Notably, the majority of cities (79%) reported "changes in temperature, precipitation, sea level, or natural hazards that they attribute to climate change" (MIT 2012, 1). Eighty-one percent registered an increase in hazard events with 41% reporting higher intensity of storms, 31% longer periods of drought, 30% inland flooding, and 13% coastal flooding (Ibid). The most common impact attributed to climate change was disasters leading to the damage of government property. Increased stormwater runoff and stormwater management were identified as the main issues which will need to be addressed in the future (Ibid). The MIT survey indicates that there is a growing awareness about the localized impacts of climate change across many local governments worldwide.

Awareness has generated new spaces for discussion and action related to climate change adaptation and urban planning. Most cities surveyed by MIT (37%) reported being in the 'preparatory phase' and the four most common types of adaptation activities reported were: 1) Meeting with local government departments on adaptation; 2) Searching the web or literature for information on adaptation; 3) Forming a commission task force to support adaptation planning; and 4) Developing partnerships with NGOs, other cities, businesses, or community groups (MIT 2012). Planning approaches vary widely and MIT reports that there is "a great deal of experimentation taking place" (Ibid, 16). Around the world, noteworthy anticipatory adaptation activities include climate modeling, impacts, adaptation and vulnerability (IAV) analyses, scenario planning,[9] and ecosystems services approaches.[10] In Latin America, the majority of cities surveyed by MIT indicated a preference for strategic plans, as opposed to detailed sector plans, which is the inverse case for other regions of the world, like Australia and New Zealand.

Advanced climate change adaptation planning has been undertaken in some countries such as The Netherlands and Sweden, as well as some cities from the Global South, such as Guangdong, China, Johannesburg, South Africa, Quito, Ecuador, and Durban, South Africa. The latter two cities merit special mention here, given their distinction as pioneers in the realm of adaptation planning and their unique social, political, and economic contexts, which are different from those of the Global North but comparable, in terms of institutional development, to those of the RRB. Furthermore, information about these cases, gathered by Carmin et al (2012) and discussed in the article 'Urban Climate Adaptation in the Global South: Planning in an Emerging Policy Domain,' was collected using a methodology similar to that of this study, through semi-structured face-to-face interviews with high-level experts in the field. In this regard, the results of this study were found to be particularly illuminating and therefore helped guide the framing of this research project.

Not unlike the planning authorities of the RRB, those of Quito and Durban face challenges when balancing competing demands for poverty alleviation, economic growth and long-term sustainability. These cities have experienced the impacts associated with recent climate events, including flooding and severe storms. Governance dynamics in both places have traditionally favored immediate responses to acute problems, inevitably leading decision-makers to prolong addressing chronic problems, such as environmental degradation or climate change. Quito and Durban also face challenges associated with the scarcity of resources and the instability of funding flows towards local level public institutions. Nevertheless, both cities have successfully developed comprehensive adaptation plans. How has this happened?

Authors explain that these two cities have "altered their priorities to balance economic vitality with improvements in environmental quality and social justice" (Carmin et al 2012, 19). In Quito for example, rather than creating new city planning frameworks, departments, or initiatives, they utilized existing disaster, environmental, and infrastructure plans as a foundation for pursuing climate adaptation (Ibid). Local leaders championed the climate change agenda and were able to

[9] The main aim of scenario planning is to inform decision-makers in the face of deep uncertainty (i.e. in situations in which predictions are not reliable within the time frame of relevance to the planning issue at stake) (Baar et al 2012).

[10] "The ecosystems approach recognizes the need to manage land and water for multiple purposes in order to respond to human needs. This approach, finding ecological solutions and innovation, involved seeking non-technological routes to resolving problems. Managed realignment (setting back sea-walls) is often given as an example of this" (Wilson and Piper 2010).

leverage international support for current goals, plans, and programs (Ibid). One city planner in Quito described this dynamic saying, "the long-term vision [in our office] is sustainable development of the territory. There is no direct discourse of adaptation. Our logic is to promote high quality of life and sustainable management of the environment, including the water, the air, and the hillsides while addressing risks" (Ibid, 27). In addition to important exogenous factors, the authors explained that there were three important endogenous factors that helped drive adaptation:

> First, adaptation was influenced by the efforts of champions who were inspired to push the agenda forward and creatively navigate an ambiguous domain. Second, as the cities learned about climate impacts, they came to the realization that they were highly vulnerable and began to interpret natural hazards as a consequence of climate change. This realization led them to further recognize the importance of protecting residents and assets. The third critical endogenous driver of action was the advancement of local priorities. In both Durban and Quito, adaptation was seen as a means to secure the cities' development paths while promoting sustainability and resilience by addressing the projected impacts of climate change (2012, 28).

As shown here, exogenous factors are necessary but insufficient to promote an agenda of anticipatory adaptation. Adaptation planning is contingent upon the awareness of risk and vulnerability, leadership and creativity (often outside the domain of formal normative and institutional structures), and linkages between climate change and development agendas. Nevertheless, this convergence has not yet occurred in most cities and tangible advances in urban adaptation planning are still fairly limited. Some exceptions around the world may be found, especially where the impacts of climate change have been particularly severe, for example in Sri Lanka, Australia or The Netherlands. Whilst not all cities are advancing climate change adaptation strategies, many are starting to explicitly identify the impacts of climate change.

In this regard, all of the cities which participated in the 2011 MIT survey identified near-term climate impacts, notably increased stormwater runoff, changes in electricity demand, and/or disruptions to transportation systems. Nevertheless, only 19% indicated that they had completed an assessment on risk and vulnerability. Why is this? Major challenges to climate change adaptation planning were grouped into four categories by MIT: resources (including funding, staff time, scientific data), commitment (among political officials, local staff), communication (to generate interest among stakeholders and communicate needs), and information (how to carry out risk assessments, learn from other cities, connect international agencies). Based on these categories, 85% of cities worldwide - and over 90% of Latin American cities - identified the difficulty in securing funding for adaptation work as their principal challenge. Other major challenges to adaptation identified by survey participants included reallocating resources, allocating of staff time, generating interest among businesses, communicating the nature of the problem, and mainstreaming (MIT 2012).

The categories utilized by MIT to characterize city-level challenges to climate change adaptation planning, may not however, be appropriate to all contexts. Certainly, the scarcity of human and financial resources and the lack of commitment from staff, elected officials, and central governments are barriers to strengthening the adaptation agenda. However, there are other

process-related factors, including conflicts between city stakeholders, inadequate legislative frameworks, and the failure to generate linkages with standard 'development' practices (like Quito and Durban were able to do). A 2013 report on the state of climate change adaptation in the United States sheds light on the issue of barriers to adaptation planning, explaining that,

While there has been some systematic planning leading to climate change problem identification activities (impacts and vulnerability assessment), the majority of adaptation activities have been more ad hoc. In the absence of top-down directives, a coordinated national effort, or even widespread national recognition of the significance of projected climate change and the urgency of preparing for it, adaptation actions have tended to occur in isolation and often without recognition or connection to other efforts. In isolation, interested groups have recognized the potential problems climate change will bring and have tried addressing them—sometimes learning from and sharing the results of their experiences with others sometimes not. Some adaptation efforts occur under the radar as a result of the political polarization of the issue and lack of public support for addressing climate change. Finally, adaptive actions are often undertaken to meet existing challenges that have not necessarily been recognized as climate change issues. It is difficult to identify these adaptation activities because even those undertaking them don't realize that they are. In these cases it is hard to share the lessons or link the actors to the larger adaptation community (Hansen et al 2013, 5).

The dynamics described above are not unique to the United States, but common in cities across the developed and the developing world. This passage highlights the gap between technical knowledge and political will, citing the influence of public opinion, institutional leadership, and national policies over local adaptation planning. It shows the disconnect between the rhetoric of planning and the discourse of climate change, underlining the need for harmonization to account for adaptation efforts which may not be formally labeled as such. Not lastly, it alludes to the lack of coordination between local demands and national agendas. As discussed in the sections following, these all constitute major challenges to adaptation planning in the context of the RRB.

Section 3: Characterization of the Reconquista River Basin

History, Geography, and Administration of the Reconquista River Basin

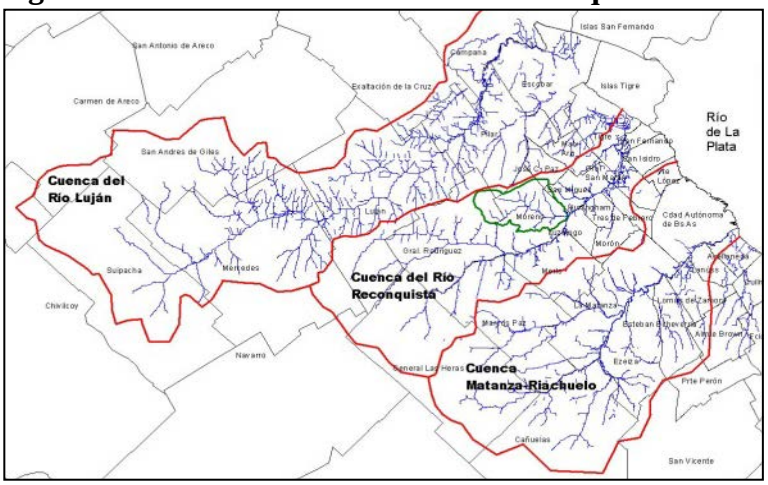
Introduction

The Metropolitan Region of Buenos Aires (MRBA) is among the largest cities in the world with approximately 15 million inhabitants (INDEC 2010). The MRBA was originally a modest Spanish port colony, then an agro-export powerhouse of independent Argentina, attracting different waves of European immigration in the 19th and early 20th centuries. The transportation infrastructure of the MRBA, first rail and then roads, made for an easy transition to an industrial city in the 20th century and facilitated widespread (sub)urbanization through programs like the 'loteos populares' (popular settlements) from the 1940s onwards. Today, the MRBA reflects the contrasts of many mega-cities, with a diversified economy and enduring socio-spatial inequality. The following section includes a general characterization of the Reconquista River Basin (RRB).

Geography

The RRB is located within the northern areas of the MRBA. There are three main river basins in the MRBA, the Luján River Basin in the far north, the Matanza-Riachuelo River Basin to the south and west, and RRB in the north and west (Figure 4). These adjacent basins cover less than 1% of Argentina's total landmass but concentrate over 25% of its total population.

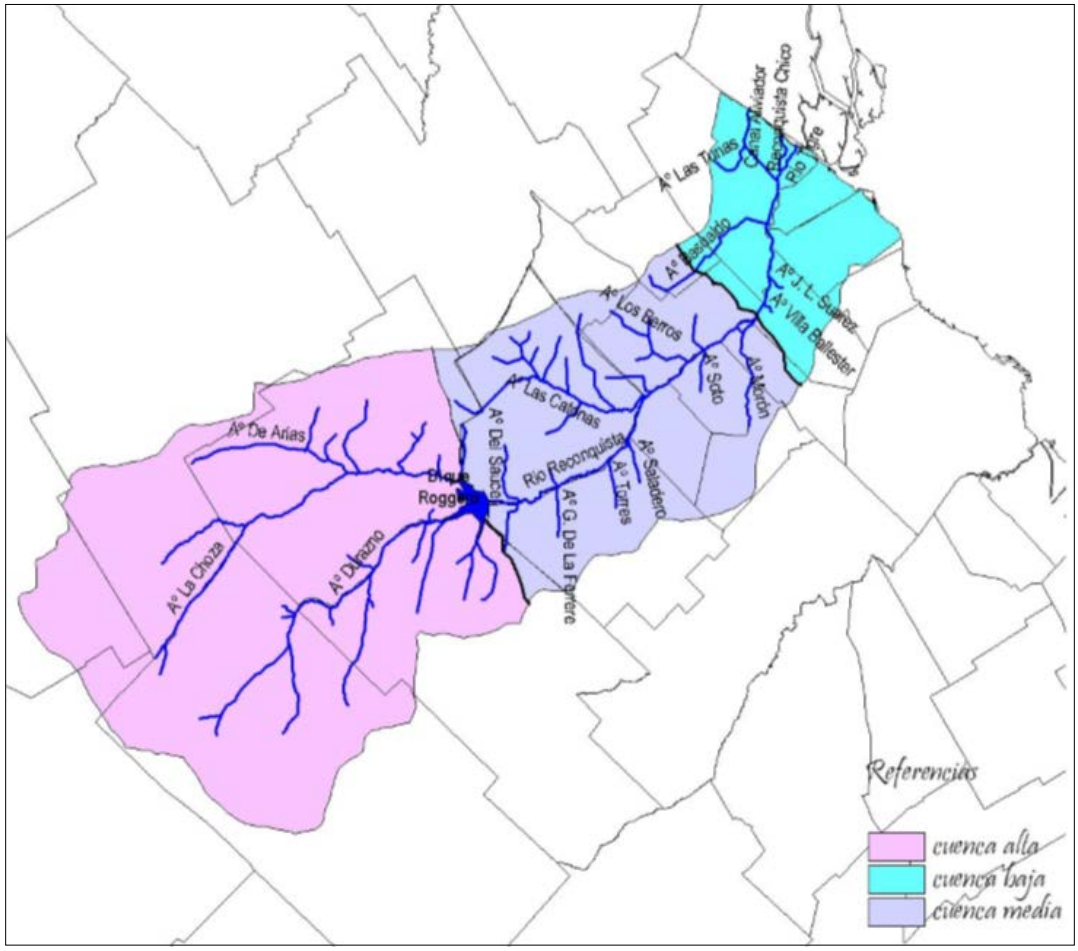
Figure 4. Sub-Basin Divisions of the Reconquista River Basin



Source: tierra.rediris.es

The source of the Reconquista River is in the rural area of the Pampean region. The river then flows through a heavily industrialized and populated segment of the northern metropolitan area until it meets the Lujan River and finally drains into the estuary of the River Plata. The river basin comprises a total of 134 water courses, of which the Reconquista River makes up 82 kilometers. The main tributaries that feed into the Reconquista River are Las Catonas and Morón Creeks (Figure 2). The Reconquista River, not unlike the adjacent Matanza-Riachuelo River, has been significantly modified from its natural state, especially through projects funded by the Inter-American Development Bank (IDB) for large-scale flood control, which were partially finalized in 2006. Almost all of the waterways of the RRB have been modified through human activity, including through open and closed channeling, rectifications, and paving (IMAEPNUMA 2005).

Figure 5. Tributaries, Reconquista River Basin

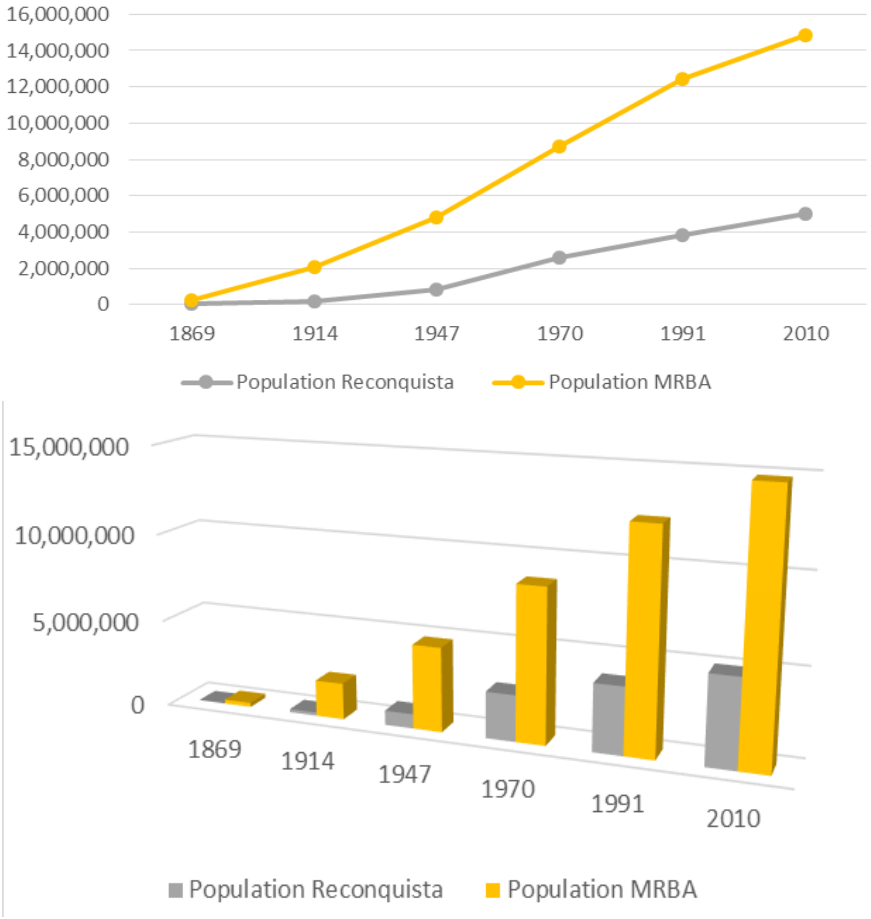


Source: Lastra, G. (2007) "Problemática del Río de la Reconquista y sus consecuencias socio-ambientales" Buenos Aires: Universidad de Flores

Population

Population growth within the RRB has been steady to exponential over the past 150 years. The total number of inhabitants increased from 22,591 in 1869; to 182,049 in 1914; to 820,596 in 1947; to 2,624,134 in 1970; and to 3,800,000 in 1991 (see grey line Figure 6 below). Today, the population of the 18 municipalities that comprise the RRB is nearly 4,601,190. This is approximately one third of the entire population of the MRBA and nearly 11% of the national population (INDEC 2010). Over 70% of the total population of the RRB is located in the middle section (Figure 8) and this population is highly urban, with over 93% of all inhabitants living in urban areas. However, population densities range from extremely high in the urban contexts of the middle and lower sections of the RRB (over 200 habitants per hectare in some places) to very low, in rural areas of the upper section of the RRB. Very high population densities are often found within informal settlement areas that lack basic infrastructure, such a potable water or networked sewerage.

Figure 6. Population Growth in the Reconquista River Basin & Metropolitan Region of Buenos Aires.



Source: Table based on national census data (INDEC) and Atlas Ambiental Buenos Aires

There is no official data about the precise population of informal settlements within the RRB.[11] According to official statistics for the MRBA, the population of informal settlements grew by 41% between 1981 and 1991, from approximately 290,000 to 410,000 inhabitants (Cravino, del Río, Duarte 2007). By 2006 this number had more than doubled, with an estimated 1,065,884 people - or approximately 11.5% of the total population of the MRBA - lived in informal settlements (Ibid). A survey[12] conducted in 2012 by the non-profit housing organization TECHO provides further information on informal settlements in the MRBA. The following figure summarizes census data from 2010 and information from the TECHO report in order to provide an estimate of the percentage of households inhabiting informal settlements in 17 of the 18 municipalities of the RRB (General Las Heras in the rural Upper basin was excluded from the TECHO survey). It also shows RRB land area coverage as a percentage to provide an indication of the number of settlements potentially impacted by flood-related climate risks.

[11] The 2010 census provides reliable statistics about the population of each municipality, but, as noted previously, some municipalities lie almost entirely within the basin while others have only a small territorial overlap.

[12] The Techo report provides details for almost all of the municipalities which comprise the RRB, including the number of informal settlements, their names, and the total number of households (though not their population).

Figure 7. Population, Households, and Informal Settlements in the RRB

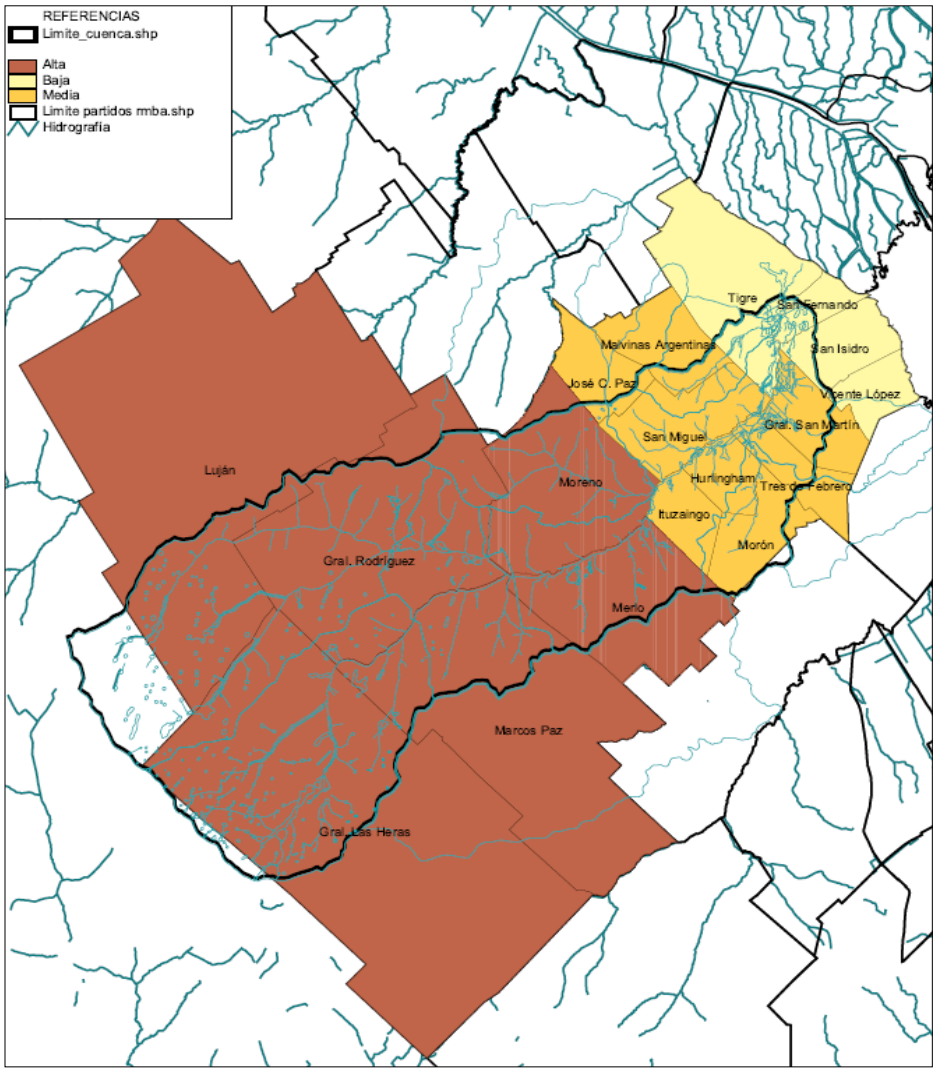
Basin	Municipality	Total Population (2010)	Total Number of Households (2010)	Informal Settlements (2013)	Households in Informal Settlements (2013)	Estimated % of Households Residing in Settlements	% of Municipal Territory in the RRB
Upper	General Las Heras	14,870	4,651	*no data*	*no data*	*no data*	41.8%
	General Rodriguez	85,820	24,926	16	4,525	18%	91.5%
	Lujan	103,217	32,524	6	1,660	5%	22.6%
	Marcos Paz	51,935	14,656	3	115	1%	35.6%
	Merlo	526,908	147,716	26	8,515	6%	58.5%
	Moreno	451,170	124,016	42	9,895	8%	94.6%
Middle	General San Martín	411,786	133,202	38	20,260	15%	69.5%
	Hurlingham	180,360	55,122	14	2,685	5%	100.0%
	Ituzaingó	164,759	51,444	15	1,245	2%	100.0%
	Jose C. Paz	265,167	71,722	24	12,800	18%	25.4%
	Malvinas Argentinas	320,647	89,338	19	8,865	10%	30.0%
	Morón	317,820	106,902	5	525	0%	72.8%
	San Miguel	274,613	80,627	15	8,315	10%	100.0%
	Tres de Febrero	337,408	112,588	12	2,290	2%	53.6%
Lower	San Fernando	161,673	49,384	7	1,325	3%	4.7%
	San Isidro	290,675	97,213	9	4,055	4%	96.6%
	Tigre	375,042	108,558	26	6,660	6%	37.7%
	Vicente Lopez	267,320	99,286	7	2,215	2%	14.4%
Total		**4,601,190**	**1,403,875**	**284**	**95,950**	**7%**	

Source: Table data from 2010 sourced from INDEC, Table data from 2013 sourced from TECHO Survey of Informal Settlements, Table data on RRB Territory Sourced from National Ombudsman Special Report on the Reconquista River (2007)

Inter-Jurisdictional Governance and the COMIREC

The RRB covers an area of 1,738 km2 and comprises 18 municipal government jurisdictions. The municipalities of Hurlingham, Ituzaingó, Moreno, San Miguel and General Rodriguez are located almost entirely within the river basin area. The remaining municipalities have reduced land areas within the basin and include San Isidro, San Fernando, Morón, General San Martín, Merlo, Tres de Febrero, Las Heras, Tigre, Marcos Paz, Malvinas Argentinas, José C. Paz, Luján, and Vicente Lopéz. For the purpose of this research project, and in order to align with the institutional divisions of the basin area, the Reconquista is divided into three sub-regions: Upper, Middle and Lower basins (Figure 8). In Spanish, these are referred to as the *Cuenca Alta*, *Cuenca Media*, and *Cuenca Baja*.

Figure 8. Municipalities & Sub-Basin Sections of the Reconquista River Basin



Source: Base data provided by COMIREC, Gobierno de la Provincia de Buenos Aires

The RRB constitutes a functional unit of analysis, based on bioregional characteristics, urban continuity, transportation routes, and economic inter-connectivity. It also constitutes a single ecological unit, subject to hydrological phenomena, such as flooding, changes in water tables, and micro climates, which ignore administrative boundaries. At the same time, the RRB is a collection of multiple political-administrative jurisdictions (municipalities), with diverse characteristics inter alia. The municipalities of the RRB vary in size from 36 km2 to 924 km2 (Defensoría del Pueblo 2007). They also differ widely in population density, urbanization patterns, and wealth, leading to a multitude of planning strategies, citizen demands, priorities, and internal capabilities. Municipalities often rely on provincial and national governments for funding, technical assistance, and/or project authorization.[13]

[13] Since a detailed analysis of each constituent municipality exceeds the scope of this project, the report will attempt to identify regional commonalities and highlight important differences where necessary.

The Unit of Coordination for the Reconquista River Project (UNIREC) was the first organism mandated with inter-jurisdictional governance of the RRB. The UNIREC was created as an independent organism in 1995 for the purpose of executing a $150,000,000 loan from the Inter-American Development Bank (IDB). This project, entitled '797/OC-AR - Restoration and Flood Control in the Reconquista River Basin,' was partially finalized in 2006 and generated improved flood protection in some sections of the basin. Other components, such as additional treatment plants, control of industrial pollution, and infrastructure expansion, were not undertaken as originally planned. Notably, it also led to a series of 'unwanted' effects, including the "irregular occupation of vacant lands generated by the project, due to the lack of adequate urbanization projects along the banks of the river" (IDB 2012, 7). Following dissolution of the UNIREC, a new coordinating organism was formed in 2006: the Committee of the Reconquista River Basin (COMIREC). Today, the COMIREC is the main body responsible for the inter-jurisdictional governance of the RRB. The COMIREC provided valuable institutional backing for the current research project.

The COMIREC is mandated with the holistic management and preservation of hydrological resources (water quality and quantity) in the RRB (Law 12.653). Its responsibilities include planning, coordination, and supervision of the basin management; coordination with the national government, other provinces, municipalities, and non-governmental organisms; the implementation and administration of public works; the creation of information systems to inform provincial authorities about RRB management; compliance control for BID project 797/OC-AR; the formulation of environmental policies for the preservation of hydrological resources in coordination with other, legally-competent institutions; the enforcement of environmental protection laws; and the leadership of expropriations or resettlements necessary to achieve its objectives (Ibid). None of the provincial legislation pertinent to the COMIREC (Law 12.653, Decree 3002, Resolution 3709) makes explicit mention of climate change or climate change adaptation, nor is this topic presently addressed on the COMIREC website.

The COMIREC is governed by a seven-member Directory Council, composed of four individuals designated by the Executive Branch of the Province of Buenos Aires (normally representing the Ministry of Government, Infrastructure and Public Works, and the Environmental authority) and three individuals designated by municipal governments of the RRB. Municipal representation comes from the Upper, Middle, and Lower basin. The COMIREC's day-to-day activities are managed by an Executive Director and five thematic units: Planning and Restoration, Integrated Management of Hydrological Resources, Administration and Finance, Institutional Relations, and Legal Affairs. It also has a Consultative Council which aims to promote community participation in the activities of the COMIREC by organizations and individuals active in the RRB.

Presently, the COMIREC's main area of focus is the new IDB-sponsored project entitled 'Sustainable Environmental and Urban Management in the Reconquista River Basin' (PMUAS), made up of two loans worth approximately $740.000.000. The dual objectives of the PMUAS project are: 1) to give continuity to the planning and activities already underway by the COMIREC in priority areas, including those deficient in potable water, sewage, and waste collection services and/or subject to extreme environmental degradation and 2) to advance towards a new planning scenario through the development of an Integrated Management Plan for

the RRB. Phase one of the project focuses on basic infrastructure in areas of high "social and sanitary risk," development of a comprehensive management plan, and institutional strengthening of the COMIREC. Phase two will presumably support the implementation of the RRB management plan. As part of the project, the research team participated in two community meetings about the PMUAS organized by COMIREC and IDB to solicit feedback from civil society representatives of the Upper and Middle Basin.

Some moderately scaled projects have been undertaken by the COMIREC in parallel with the PMUAS project, with technical support from IDB and through collaborative efforts with municipal governments. Activities to date include creek enclosures and channeling, street paving, waste collection and, in conjunction with the water authority AySA, the expansion of networked water and sewerage networks across some neighborhoods. At the time of writing this working paper, the final terms of the IDB loan were still being negotiated, so the project has yet to be formally initiated. Documents made public in reference to the IDB project make no mention of adaptation to climate change.

History of Urban Expansion & Socio-spatial Patterns

Until the late 19th century, the RRB was a sparsely populated region of sheep and cattle farming. An urban population emerged following railroad expansion in the 1880s, including the San Martín (northern) and Sarmiento (western) lines that traverse the northern MRBA. In accordance with the agro-export economic model, the railroad developed in direct lines from south, west and north towards the port, without radial connections within the region. This transportation system served the "basic needs of an export economy" (Scobie 1964, 137) of beef and wheat in the 20th century, and directed a lineal urbanization pattern from the 19th along the railroads. After 1930, the road network expanded, facilitating the interconnection and suburbanization of the metropolis at a time when land was relatively cheap and abundant.

Both World Wars and the Great Depression encouraged the expansion of local industry in the MRBA (Scobie 1964). Between 1930 and 1960 industrial developments emerged to form a ring around the Capital City of Buenos Aires and were densely located within the RRB, including for example in the Municipalities of San Martín and Tres de Febrero. Industrial development expanded further north towards Tigre with the development of the 'Acceso Norte' highway, helping to conform the 'Industrial Axis' which stretches north-south from the city of Rosario to the city of La Plata. In the years immediately following World War II, "manufacturing industries contributed 24% of the GNP, surpassing the agricultural sector's 19%" (Scobie 1964, 186). This attracted increasing numbers of rural laborers to the RRB and produced a need for rapid housing development. This was facilitated in large part through low-cost subdivisions, often without basic infrastructure of networked water and sewerage services.

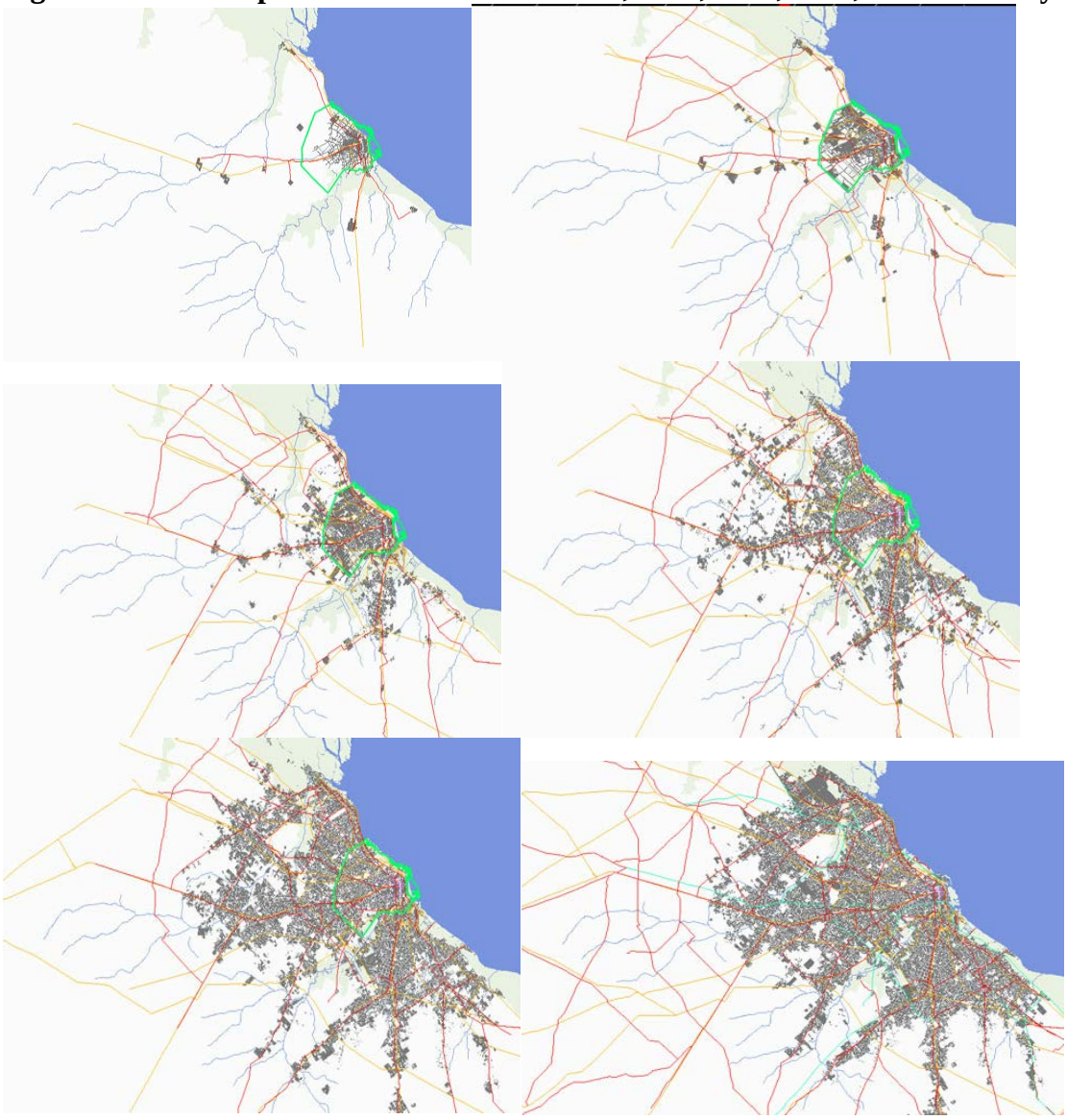
From the mid-1970s, new economic policies led to the de-industrialisation of the MRBA (Gutman & Hardoy 2007). The military dictatorship of 1976-1983 and the following neoliberal period (1989-2001) led to significant structural adjustment of the economy, changes in modes of employment (labor flexibilization and decreased job security) and an undoing of many traditional social protection measures. Local industries in the RRB, particularly within the industrial corridor of the first metropolitan ring area (surrounding the central city), were dismantled and

unemployment rose steeply: it reached a national high of 25% in 2001, compared to approximately 7.5% at present (INDEC 2013).

De-industrialization processes severely affected the neighborhoods where traditional industry and its workforce were located. This was true of the middle section of the RRB, especially in the Municipality of San Martín, were there was substantial job loss and closure of small to medium sized industrial enterprises in the last decades of the twentieth century. Closing industry and rising unemployment not only contributed to conditions of poverty in the region, but also to the decline of the built environment with factories and other facilities closing down and to a general lack of investment in infrastructure such as roads and rail. In many cases, new informal settlements have sprung up on abandoned public lands previously set aside for infrastructure.

Improved road accessibility and a changing regulatory framework with minimum infrastructure requirements for residential subdivisions and land development introduced in 1977 (Law 8912) led to increased land costs and, consequently, to increased socio-spatial fragmentation over the following decades. The privatization and construction of the tolled suburban highway network between 1990 and 1998 facilitated increased private urban development within the outer areas of the RRB (Gutman & Hardoy 2007). A new trend of privately-led, high-income urban developments in the form of ‘gated communities’ has emerged in the MRBA over the last few decades. Simultaneously, lack of employment opportunities and increasing land prices have progressively led low-income earners to find informal housing solutions in peripheral and often environmentally unsuitable areas of the MRBA. Both formal and informal settlements, along with many government social housing projects over recent years, have produced widespread urban expansion. The following images broadly depict this historical urban expansion process.

Figure 9. Urban Expansion in the MRBA: 1887, 1895, 1910, 1948, 1966 & Today



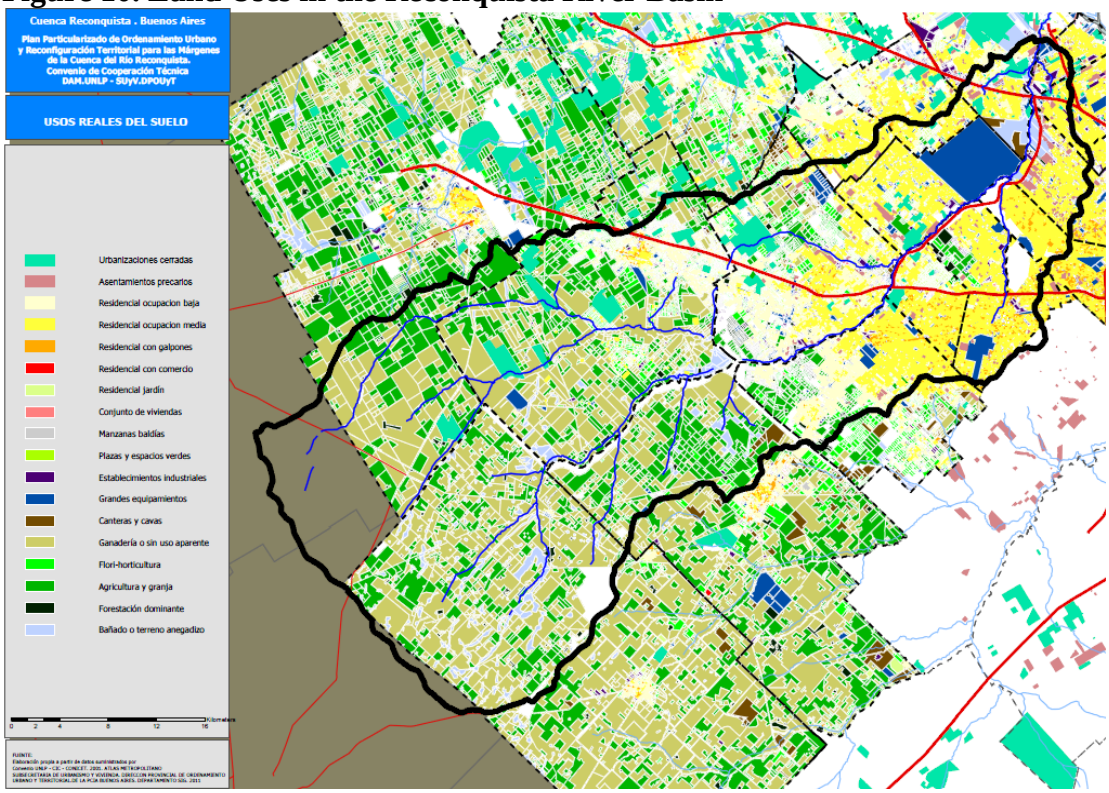
Source: Atlas Ambiental de Buenos Aires

Urban Conditions in the Reconquista River Basin

Land Use & Accessibility

The present land use composition of the RRB may be broadly summarized into three categories (as shown in Figure 10); urban (yellow), rural (greens) and large-scale urban infrastructure (blue). As discussed above, low-density gated communities (turquoise) and 2) high-density informal settlements (pink) can also be detected in the make-up of uses in the RRB. There are a number of large urban infrastructure facilities, such as the Campo de Mayo and other military training grounds (see in dark blue). Adjoining the Campo de Mayo is the largest waste facility in the metropolitan region, the CEAMSE (light blue and brown). Figure 10 shows a broad overview of use composition in the RRB.

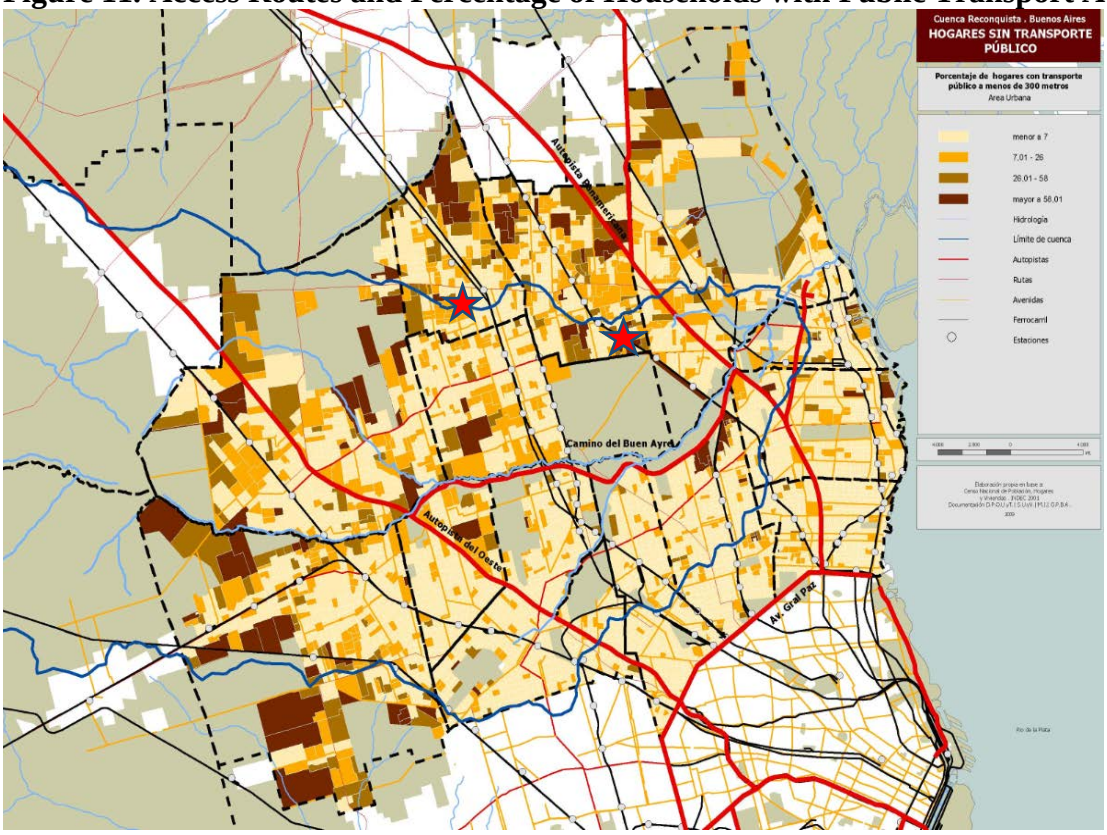
Figure 10. Land Uses in the Reconquista River Basin



Source: Image provided by the COMIREC and elaborated by Provincial Government of Buenos Aires.

Figure 11 highlights the major access routes (highways in red, rail in black, railway stations are highlighted with grey circles) as well as the percentage of households within 300 meters of public transport within the RRB. Generally, the outer areas (darker shades) have lower access to public transportation, as well as some larger areas in close proximity to the Reconquista River, for example in San Martín which aligns with the location of some informal settlements. These areas are highlighted with stars in Figure 11. Many of these areas also do not have paved streets, which is one of the reasons that public transportation offers limited coverage.

Figure 11. Access Routes and Percentage of Households with Public Transport Access

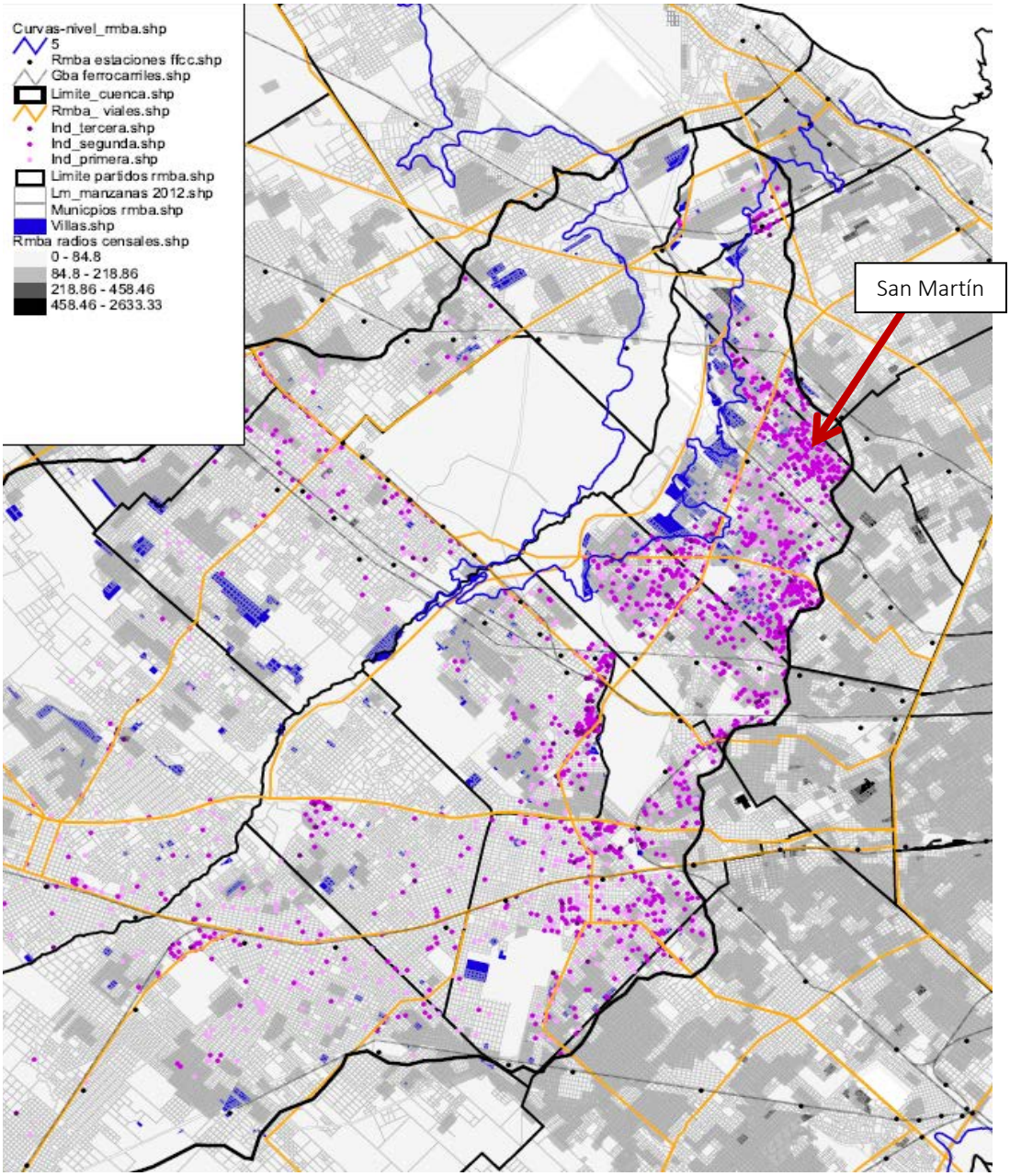


Source: Image provided by the COMIREC and elaborated by Provincial Government of Buenos Aires.

Industry

As previously mentioned, industrial activity has traditionally been a large source of employment and one of the main guiding aspects of urban development in the RRB. Even during de-industrialization processes, industry continued to be the most significant source of employment for the local population. There were approximately 12,838 industrial establishments in 1996, with an annual employment figure of approximately 193,000 people between 1980 and 1990 (Instituto Provincial de Medio Ambiente 1996). Five municipal government areas of the RRB had the largest share of industrial employment (85% of 193,000): San Martín (30%), Tres de Febrero (16%), Morón (14%), San Isidro (13%) and Tigre (12%) (Ibid). Similar concentration of industrial activity is true of the RRB today (Figure 12), with the highest concentration of establishments in San Martín which also corresponds with the largest concentration of informal settlements. There is also a strong relationship between the location of industry and access routes (in orange in Figure 12). The blue line in the below image indicates the 5m contour line, accepted as a general rule of thumb for flooding according to provincial land use regulations. Also highlighted in blue are the locations of informal settlements, many below the floodline.

Figure 12. Industrial Establishments and Informal Settlements in the Reconquista River Basin



Source: Base information provided by the COMIREC, Provincial Government of Buenos Aires

Infrastructure coverage

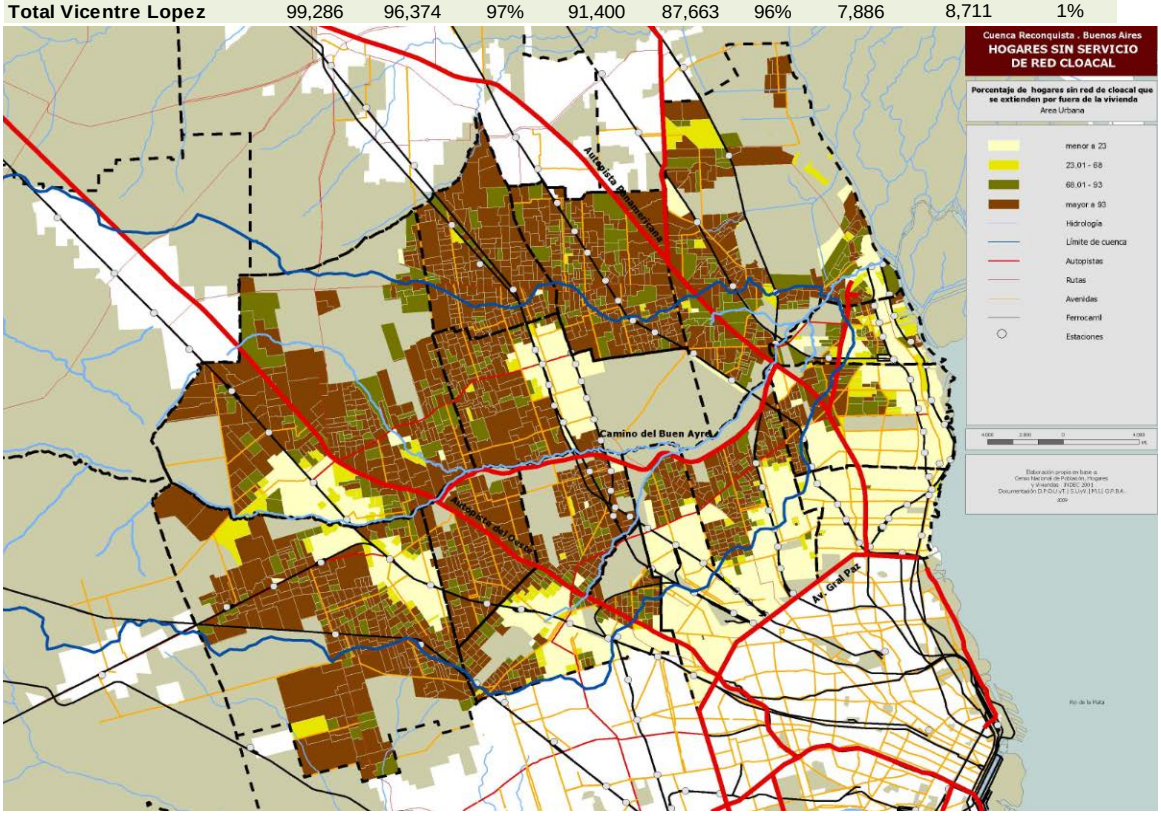
Networked water and sewerage are provided in the RRB through a concession arrangement with private companies under government regulation. According to data from the 2010 National Census, approximately 41% of homes are connected to networked sewerage services within the MRBA, an improvement from 37% in 2001. Potable water coverage is much higher. Where networked infrastructure is unavailable, households tend to access groundwater supplies through extraction wells and discharge wastewater into septic tanks. The below graphic shows the

increase in networked sewerage coverage between the last census periods for each municipality of the RRB: the largest improvement in terms of percentage of households connected to sewerage services was in the lower basin, and in particular in the Municipality of San Fernando.

Delivery of water infrastructure services is split in the RRB between three providers (AySA, ABSA and, in some cases, municipal governments such as Marcos Paz and Lujan, or work cooperatives, for example in some localities of Tres de Febrero and General Las Heras). The split mode of infrastructure provision represents a challenge for integrated governance of water resources and particularly for the coordinated works required to complete service networks. Within comparable river basin areas, such as the Riachuelo-Matanza, sanitation services have only one provider (AySA).

Figure 13. Sewerage Infrastructure Coverage in the RRB 2001 and 2010

Municipality of the Reconquista River Basin	Total House-holds 2010	Networked Sewerage Services	%	Total House-holds 2001	Networked Sewerage Services	%	Absolute household increase	Absolute difference	Coverage variation in %
Upper Sub-Basin Area									
Total General Las Heras	4,641	999	22%	3,743	435	12%	898	564	10%
Total General Rodriguez	24,926	6,720	27%	18,107	4,942	27%	6,819	1,778	0%
Total Lujan	32,524	12,891	40%	26,176	9,074	35%	6,348	3,817	5%
Total Marcos Paz	14,656	4,432	30%	10,755	2,463	23%	3,901	1,969	7%
Total Merlo	147,716	30,414	21%	119,620	22,551	19%	28,096	7,863	2%
Total Moreno	124,016	23,435	19%	95,525	16,510	17%	28,491	6,925	2%
Middle Sub-Basin Area									
Total General San Martín	133,202	70,422	53%	119,097	58,574	49%	14,105	11,848	4%
Total Hurlingham	55,122	6,175	11%	47,902	2,086	4%	7,220	4,089	7%
Total Ituzaingo	51,444	4,334	8%	44,401	332	1%	7,043	4,002	8%
Total José C. Paz	71,722	4,272	6%	56,004	636	1%	15,718	3,636	5%
Total Malvinas Argentinas	89,338	1,859	2%	72,950	900	1%	16,388	959	1%
Total Morón	106,902	59,187	55%	93,972	47,138	50%	12,930	12,049	5%
Total San Miguel	80,627	27,485	34%	65,689	19,945	30%	14,938	7,540	4%
Lower Sub-Basin Area									
Total San Fernando	49,384	38,356	78%	42,048	19,545	46%	7,336	18,811	31%
Total San Isidro	97,213	78,794	81%	88,039	59,301	67%	9,174	19,493	14%
Total Tigre	108,558	18,624	17%	79,792	7,606	10%	28,766	11,018	8%
Total Tres de Febrero	112,588	91,831	82%	102,204	80,999	79%	10,384	10,832	2%
Total Vicentre Lopez	99,286	96,374	97%	91,400	87,663	96%	7,886	8,711	1%



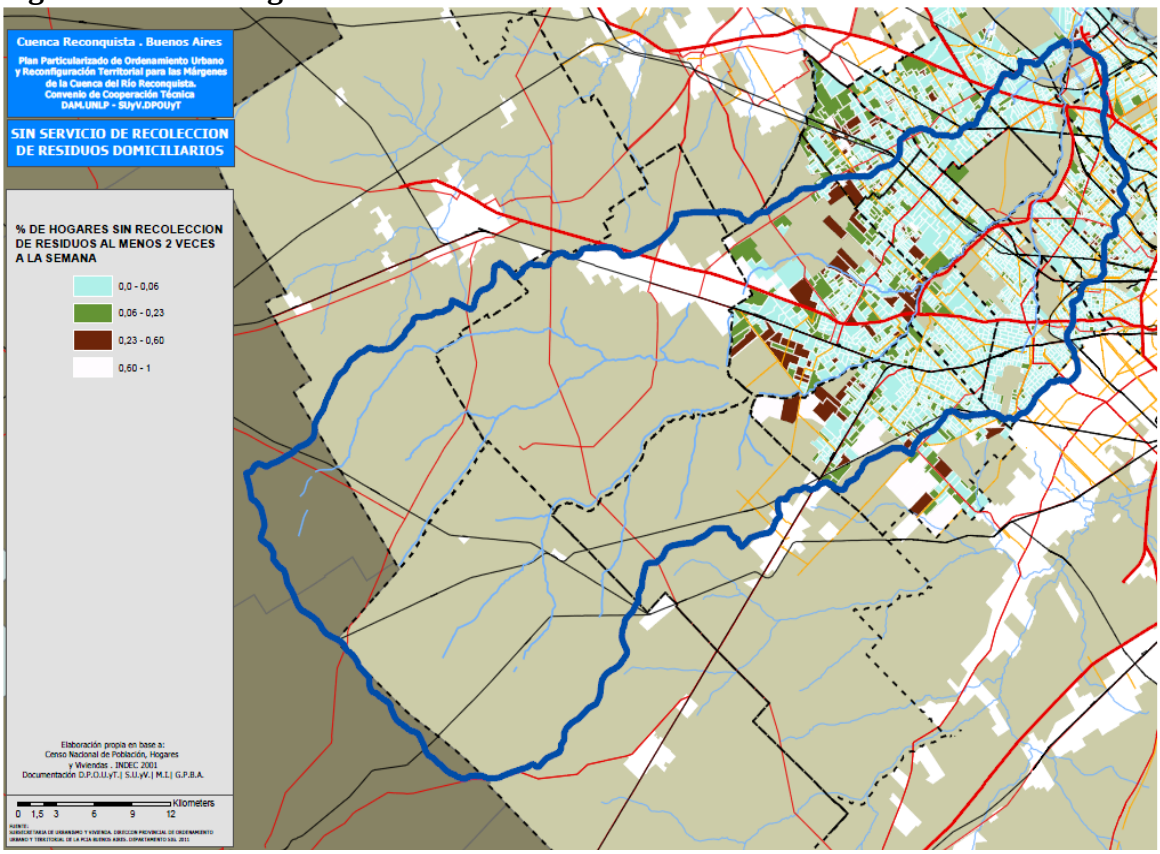
Source: Table data sourced from INDEC, Image provided by the COMIREC, elaborated by Provincial Government of Buenos Aires.

Waste Collection and the CEAMSE

In the latter half of the 1970s, the military government created the State Enterprise for Ecological Coordination in the Metropolitan Area (CEAMSE) to manage solid waste in the City of Buenos Aires and its 34 surrounding municipalities. The CEAMSE, along with the Camino del Buen Ayre road, transformed the urban development pattern of the RRB, creating a large impenetrable area in the region. CEAMSE has the largest waste disposal facility in Argentina in the RRB; it abuts the Campo de Mayo military training grounds; and runs parallel to the Reconquista River. It receives approximately 11,000 tons of waste per day.

The policy to create a centralized treatment facility has faced a number of challenges. Some municipalities of the RMBA, for example, are unable to pay for waste disposal in this facility or unable to reach all households within their jurisdiction, which has led to the creation of many unauthorized waste disposal sites (clandestine garbage dumps). Informal settlement areas within the RRB typically do not have reliable waste collection services, nor do the outer areas of the region (Figure 14). Furthermore, the CEAMSE has been criticized by environmental groups for poor environmental management, problems of contaminant leaching, and high fees, with some groups going so far as to propose a government take-over of the CEAMSE in order to advance more sustainable waste management policies in the MRBA (COMIREC Workshop, June 2013).

Figure 14. Percentage of households without Waste Collection Services



Source: Image provided by the COMIREC and elaborated by Provincial Government of Buenos Aires.

Contamination of the Reconquista River Basin

The Reconquista River is the second most contaminated water source in all of Argentina. It is surpassed only by the adjacent Matanza-Riachuelo, which is subject to many of the same overlapping social, environmental, and climate-related challenges. The upper section of the RRB is not significantly contaminated, although there are some emerging concerns about runoff from pesticides and fertilizers used in rural areas (Gobierno de la Provincia de Buenos Aires 2012). The middle and lower sections of the basin show high levels of pollution from industrial discharge, domestic effluents, accumulated rubbish (clandestine dumps), and stormwater runoff, to the point that there is little or no dissolved oxygen present in the river (Lastra 2007). According to one 2008 study, the Reconquista contains levels of arsenic four times higher than recommended for the protection of freshwater aquatic life, cadmium levels 40,000 times greater, chrome levels 150 times greater, copper levels 65 times higher, and zinc levels 27 times higher, as well as high concentrations of pesticides (Vasquez 2008, cited in Goldschmidt 2012).

According to José Dadon (Interview 2013), industrial effluents are the principal source of contamination in the RRB and they are extremely difficult to treat. Of concern for water quality is a proliferation of new industrial activities in the RRB over the last few years associated with the reactivation of the local economy (local economic development itself, however, has been of central importance to improved quality of life for many households in the RRB over the last decade). In relation to contamination, other more isolated phenomena such as malfunctioning treatment plants in social housing developments or the emptying of septic tank vacuum trucks directly into waterways also lead to the deterioration of water quality in the RRB. Certain creeks - including Morón, Torres, and Las Catonas - contribute more than others to the contamination of the Reconquista River. Soil contamination is also a concern in the RRB due to ageing infrastructure, industrial activities and water contamination. Overall, contamination presents compound concerns to human health in the RRB.

Section 4: Urban Risk

Climate Hazards and Vulnerability in the Reconquista River Basin

Introduction to Urban Risk

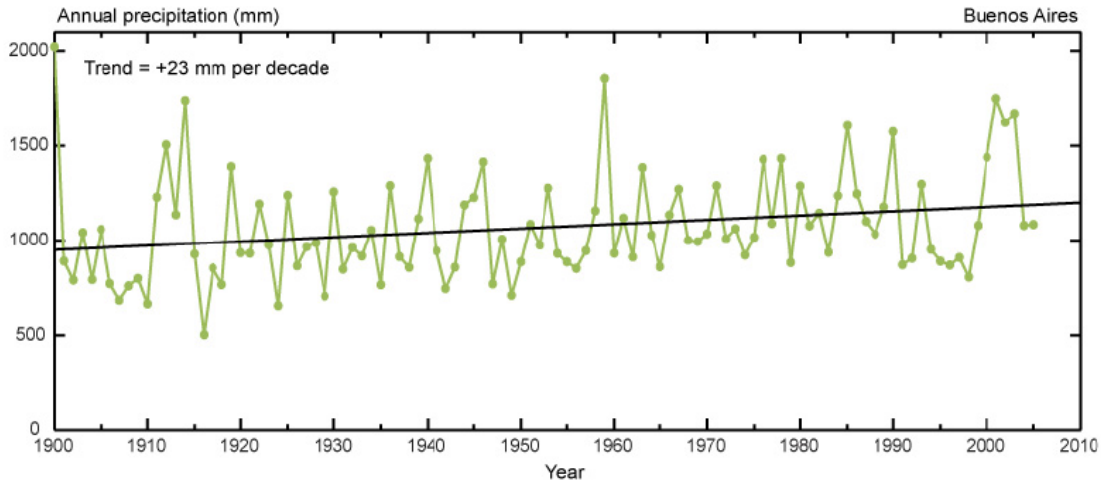
As outlined in Section 2, this research is guided by the framework of Mehrotra et al. (2009), which considers urban risk as a function of three discrete elements: climate hazards, vulnerability, and adaptive capacity. Climate hazards are defined as climate-induced stresses, such as heat waves, droughts, sea level rise, and floods. Vulnerability refers to the physical and socio-economic attributes which determine a city's degree of susceptibility, including flood-proneness, land area, elevation, population density, economy, and percentage and composition of poor populations. Adaptive capacity refers to a city's ability to respond to climate-related stresses. Climate Hazards and Vulnerability in the RRB are explored below, whilst adaptive capacity is in relation to the RRB is analyzed in more detail in Section 5.

Climate Hazards in the Reconquista River Basin

Argentina is affected by climate change and is among the countries worst affected by flooding (World Bank 2001). In general, 'reasons for concern' include the growing risk of extreme flood events; inequalities in the distribution of impacts; as well as aggregate impacts (IPCC 2001). As a product of climate change, precipitation patterns in Argentina are changing and there is an ongoing displacement of the agricultural front towards the west, south and north (Interview Dadon 2013). A kind of "pampeanisation" of the Patagonia is occurring towards the south, bringing more humidity and rainfall (Ibid). In this regard, Argentina is one of few countries that may experience an increase in arable land as a result of changing climate conditions.

On the other hand, the coastal areas in the Province of Buenos Aires are already experiencing greater rates of erosion, exacerbated through anthropic modification of coastal ecosystems (Ibid). There is an increasing trend in the mean sea level, which may lead to a rise of about 60cm by the end of the present century (Barros 2005). In the MRBA, increasing temperatures have been observed (Servicio Metereológico Nacional de Argentina), as well as increased localized precipitations and storm intensities in the area (Interviews Dadon, Cano 2013). The climate of the RRB is warm and temperate, with maximum temperatures registered in January (average 25ºC) and minimum temperatures in July (average 11ºC) (Servicio Metereológico Nacional de Argentina). The average annual temperature is 17ºC and it rains all year round, with an average precipitation of 1,100 mm annually. The RRB demonstrates a trend of increased annual precipitation (See Figure 15 for precipitation rates in Buenos Aires 1900-2100). While precipitation patterns vary along the length of the RRB, Mehotra et al (2009) report that precipitation in the neighboring City of Buenos Aires has increased by an average of 22.8 mm per decade.

Figure 15. Annual Precipitation Rates in Buenos Aires: 1900–2010



Source: Mehotra, Natenzon, Omojola, Folorunsho, Gilbride, and Rozenzweig, "Framework for City Climate Risk Assessment" (2009)

In conjunction with increased precipitation, the MRBA—including the RRB—has seen an increase in 'extreme weather events.' According to Barros (2005), the frequency of rainfall events exceeding 100 mm has multiplied three-fold over the last 40 years. Mehotra et al (2009)

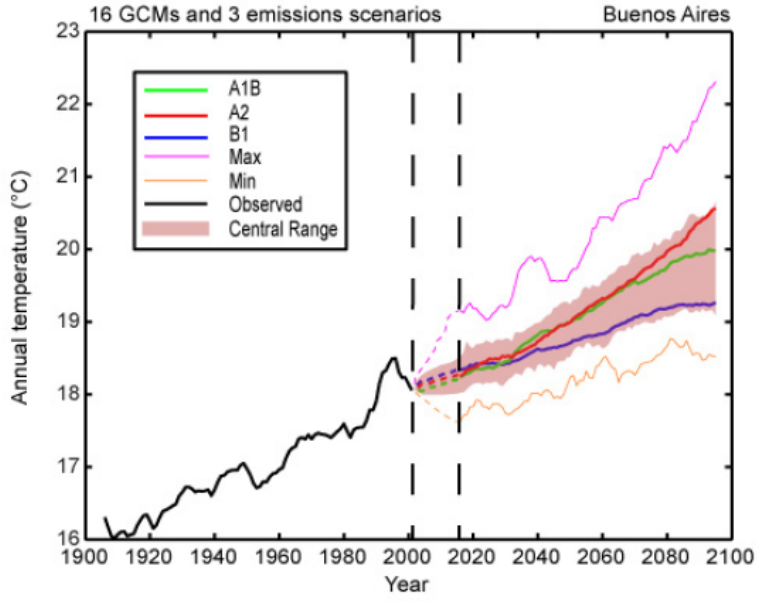
report that there were at least 32 such events from 1980 to 2000. More frequent and severe precipitation causes harmful environmental consequences, such as increased river discharge, which negatively impact low-lying communities and informal settlements which are highly vulnerable to flooding (Inter alia AIACC Working Paper No.26; Nesbitt & Zisper 2001; Barros, Clarke & Davis 2006; Various Interviews 2013; Community Workshops 2013).

Drawing on existing data and interviews conducted as part of this study, the hazards produced by these climate conditions are explored herein. Particular focus is placed on flooding, which is the most significant effect felt by populations in the RRB. Associated factors, such as water and soil contamination, are considered as further contributing factors of risk for the population of the RRB, especially in areas without networked sewerage and water services. Whilst the following analysis relates predominantly to flood hazards, it is worthwhile briefly mentioning issues surrounding increasing temperatures, particularly summer heat waves. This is an emerging and increasingly topical concern for communities in the RRB that have been negatively affected in recent summers.

Heat Waves and High Temperatures in the Reconquista River Basin

A significant rise in average annual temperatures has already been registered in Buenos Aires and surrounding areas, including the RRB. As shown in the figure below, climate change will likely lead to further increases of up to 2 °C. High temperatures pose a risk to the general population and particularly to the residents of informal settlements who have precarious housing, lack basic infrastructure, and face ongoing health risks related to clandestine garbage dumps and contaminated water sources. Increasing temperatures also influences the migration of tropical insects and disease vectors towards the MRBA (Interview Dadon 2013).

Figure 16. Projected Annual Temperatures in Buenos Aires: 2000–2100



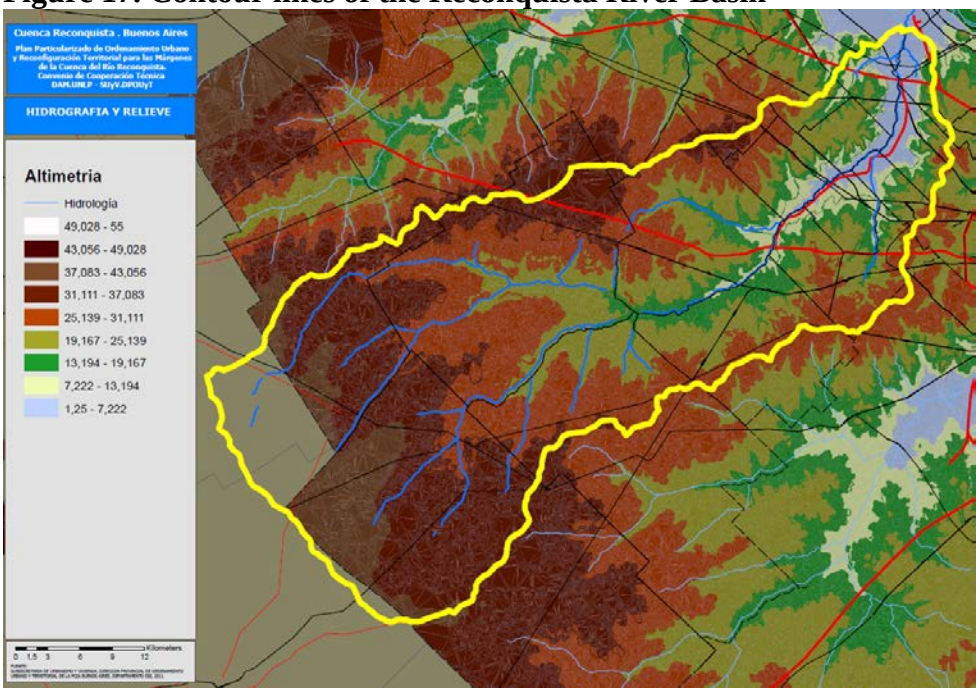
Source: Mehotra, Natenzon, Omojola, Folorunsho, Gilbride, and Rozenzweig, “Framework for City Climate Risk Assessment” (2009)

Summer heat waves in the MRBA are increasing in frequency and intensity. In December 2013, Buenos Aires experienced the most recent heat wave. It was the worst on record, lasting over 20 days with consistent temperatures of 30 °C (86 °F) or more. In December 2013, the national warning system reached a 'level red' for the first time ever leading to various flow-on impacts: the MRBA experienced record-high demand for electricity, which it was unable to meet; more than 800,000 inhabitants of the city registered prolonged blackouts of up to 10 days; the city health service, SAME, registered a peak in emergency calls relating to heatstroke symptoms and worsening health indices of already ill patients throughout Buenos Aires.

Flood Hazard in the Reconquista River Basin

The Reconquista River flows relatively slowly given the flat geography of the region, however its flow can increase rapidly after heavy rain. According to Lastra (2007); the flow can vary from 69,000m^3 per day to 1,700,000m^3 per day under flood conditions. Major storm surges are one of the principal causes of flooding along the coastal region of Buenos Aires, particularly in the areas of San Fernando and Tigre in the RRB (Barros 2005). According to a report published by the Argentine National Planning Ministry in conjunction with the UNDP, one of the most significant climate phenomena affecting the region relates to compounded flooding impacts by southeasterly winds in the coastal region (2010). This occurs principally between April and August, sometimes resulting in dramatic increases in water levels. Southeasterly winds push against the Plata River waters and create what the report describes as "a kind of hydraulic plug", which in turn inhibits discharge of the Reconquista River towards the estuary of the Plata River causing flooding in low-lying areas (Ibid). This effect when combined with other climate variables, such as sea level rise, intense rainfall or storm surges, contributes to worsening flood conditions.

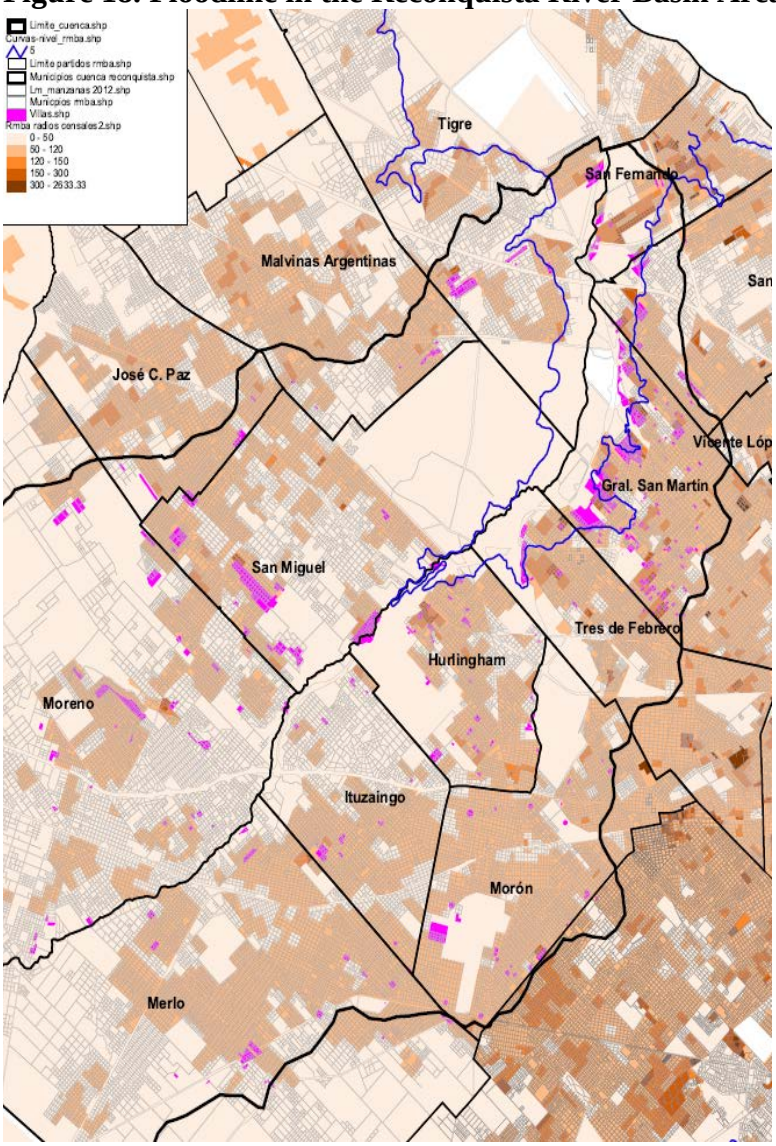
Figure 17. Contour lines of the Reconquista River Basin



Source: Image provided by the COMIREC and elaborated by Provincial Government of Buenos Aires.

Figure 18 shows the floodline (under 5 meters according to Provincial Law 8912/77), along with the population density and location of informal settlements in the RRB as a current baseline. According to Mehotra et al (2009), the average water level of the Plata River has increased by approximately 1.7mm per year over the last century. This hydrological dynamic contributes to erosion and flood proneness, especially when coupled with 'extreme weather events.' Under projected conditions of sea level rise, all areas of the MRBA that are below 5m over the mean sea level would be potentially threatened by extraordinary storms over the coming century (Barros 2005). Flood hazard is further compounded by anthropic modifications in the RRB, including the impermeabilization of the surface areas and loss of green spaces, changes to waterways through channeling or rectifications that increase water flow, modifications of land masses (through for example excavation for soil, earthworks for new residential estates or industrial parks, etc.), the occupation of floodplains by development (informal and otherwise), the presence of waste in waterways that restricts flow as well as the saturation and rising of groundwater sources (Various interviews 2013; Lastra 2007).

Figure 18. Floodline in the Reconquista River Basin Area



Source: Information provided by the Gobierno de la Provincia de Buenos Aires

Flood hazards - although they are increasing - are not entirely new. The Reconquista River has always flooded during times of high rainfall and there are registers of widespread flooding dating back to 1911. Given the ongoing threat of property damage and risks to human life, there have been various attempts to modify the natural conditions of the RRB, for example the construction of the Roggero Dam, in 1971-1972. In 1985, however, the area suffered from an extreme flood event, reaching up to 300mm in 12 hours and leading to the relocation of a number of communities (Nacion & UNDP 2012). In 1988, there was another severe flood, causing the evacuation of 70,000 people (Lastra 2007). In 2000, a third flood, was caused by heavy precipitation and, at least partially, by the IBD-sponsored interventions, which involved large earthworks and embankments that “hindered normal water flow” (Miriam Rodriguez, Sergio López, Analía Rodriguez, Silvia Merolla, and Marcelo Piergiacomi). The 2000 flood, affected approximately 1.7% of all urban residential land in the RRB and 6% of informal settlements, as

well as close to 50 hectares (123 acres) of waste disposal lands in the CEAMSE (Ibid). Ongoing works relating to the RRB have been discussed above. New infrastructure planning takes into account worsening flood conditions (See Section 5 for more information).

Many experts interviewed as part of this study confirmed that floods "will hit harder and harder," "especially in the most vulnerable settlement areas" (Interviews Lara, Cano 2013). Mara Anselmi, the Executive Director of the COMIREC pointed out during an interview that the "intensity and frequency of precipitation is increasing in the Reconquista River Basin" and that recently, communities have has to "live through extreme climatic situations, particularly in relation to flooding" (Interview 2013). Measurements taken at the hydraulic pump stations throughout the Reconquista River confirm worsening flood conditions (Anselmi 2013). In this regard, the RRB is considered an area of "maximum social risk" (AIACC Working Paper No.26, 2009), due to its high levels of poverty, unemployment, and informality. The rapidly expanding urban settlements of the RRB and the historical deficiencies of infrastructure provision add complexity to understanding climate change hazards in vulnerable settlements (See below Vulnerability). Although there is still uncertainty about localized impacts, Barros (2005) contends that social vulnerability to floods in will become worst along the margins of the Reconquista and Matanzas-Riachuelo rivers.

In order to improve the understanding of local climate change risks, vulnerability and adaptation capacity, the research team implemented an online survey to gauge municipal and provincial government perceptions of climate change impacts and urban planning responses in the RRB.[14] The survey was inspired by the study carried out by MIT and ICLEI and informed by the UN Habitat publication 'Planning for Climate Change.'[15] It targeted municipal employees, who were asked to provide information for their specific territorial jurisdictions within the RRB. Within the survey pool of 18 municipalities and the COMIREC, there was a 47% response rate: eight municipalities completed the survey, including three from the Upper basin (Morón, Marcos Paz, and General Rodriguez), four from the Middle basin (Hurlingham, Malvinas Argentinas, Tres de Febrero and Ituzaingó), and one from the Lower basin (Tigre). The COMIREC provided responses applicable to the entire basin. The descriptive statistics provided here refer only to the entities surveyed and do not constitute general findings for the entire RRB.

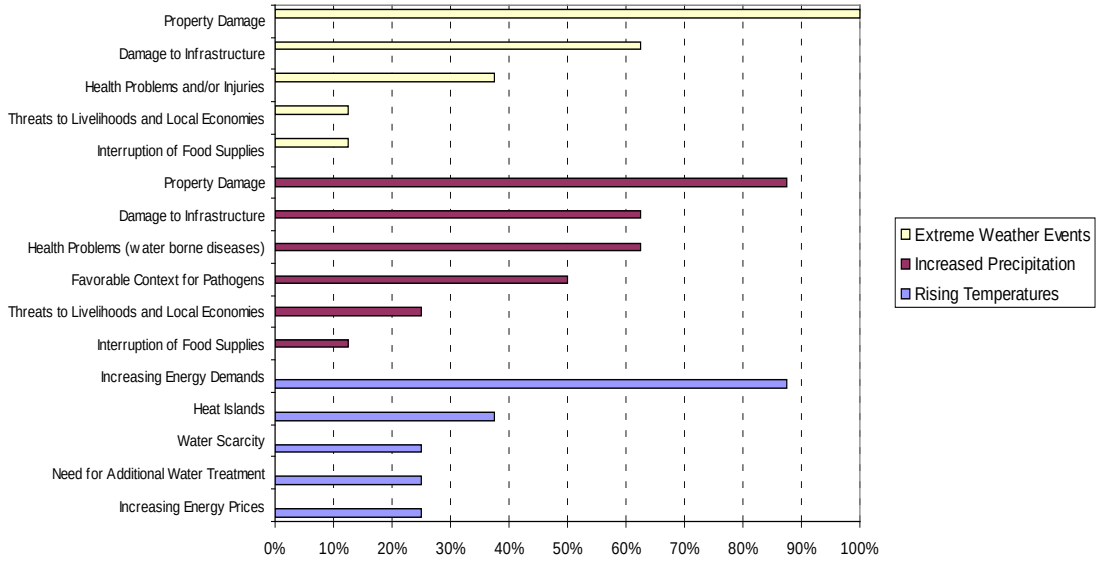
In terms of perceived climate change hazards (vulnerability and adaptive capacity are addressed in subsequent sections), the increase of precipitation and the increase of severe meteorological events were of great concern to respondents. Seven out of eight municipalities (87.5%), as well as the COMIREC, reported these phenomena as affecting their territories. Temperature increases, on the other hand, were only reported by three municipalities. Two respondents said that their respective jurisdictions were not at risk from climate-related temperature increases, while three were uncertain. While scientific data points to the fact that most of the RRB region is already experiencing higher average annual temperatures than in decades prior, these changes are subtle

[14] Secondary objective of the survey was to sensitize municipal administrators and planners to the relationship between climate change and territorial management.

[15] Section one, Impacts of Climate Change, was modeled after Table 2: Climatic Changes, Possible Impacts, and Potential Impacts on Cities (pg 28), in turn adapted from Developing Local Climate Change Plans, UN-HABITAT/International Institute for Environment & Development (2010) and Willbanks et al (2007). Section two, Territorial Planning in the Face of Climate Change, was modeled after Table 4: Urban/Town Plans and Climate Change (pg 40-41).

enough to have escaped the perception of some administrations. The figure below summarizes survey data about the impacts of climate change, as reported by municipal representatives from the RRB.

Figure 19. Perceived Effects of Climate Change, Reconquista River Basin



Source: Interview responses from 8 RRB municipalities and the COMIREC

Consistent with the hazards reported previously, property damage emerged as an overwhelming locus of concern among municipalities of the RRB.[16] All eight municipalities surveyed (100%), as well as the COMIREC, reported damage to government property, private residences, and businesses as a problem associated with extreme weather events. Seven municipalities (87.5%) and the COMIREC identified property damage as a problem associated with increased precipitation. Climate-related phenomena were perceived as a threat to infrastructure by five out of eight municipalities (63.5%) and the COMIREC. Most respondents (87.5%) and the COMIREC identified rising demands for energy as a problem associated with temperature increases, although few expressed concern about rising energy prices. Similarly, temperature increases were not perceived as a threat to local water supplies and few respondents foresaw the need for additional wastewater treatment capabilities.

There was less agreement among municipal respondents about the effects of climate change on the health and wellbeing of their populations. At least half of those surveyed expressed concern about exposure to pathogens or communicable diseases as a result of precipitation increases. Three identified injuries and diseases as problems associated with extreme weather events. Another three highlighted urban heat islands - and, presumably, their impacts on human health - as a problem related to temperature increases. The perceived impacts of climate change on local economies were limited. Only one of the eight municipalities (12.5%) reported concern about the resilience of food supply networks as a result of increased precipitation or extreme weather events. Similarly, only two (25%) believed that local livelihoods and economic subsistence were

[16] These concerns are also consistent with the results of the MIT/ICLEI survey, in which "damage to local government property" was the most widely reported impact of climate change among the 468 respondents.

threatened. While the COMIREC expressed concern about short-term displacements and long-term migration as a result of changing climate conditions, none of the municipal respondents identified these as problems in their respective jurisdictions.

Vulnerability in the RRB

In keeping with the vulnerability framework laid out by Mehotra et al (2009), informal settlements in the RRB have a number of inherent characteristics which place them at higher risk than the overall population. These characteristics are independent of external climatic stimuli, but tend to multiply their impacts among settlement communities, creating larger 'shocks' and demanding a longer period of recovery. Vulnerability in the RRB can be characterized into three main categories: economic, geographic and spatial, and socio-political. These distinct but inter-related characteristics are dynamic and, in fact, changing dramatically thanks to local initiatives and government investment in infrastructure and public services. Nonetheless, patterns of marginalization remain, and structural inequalities related to land and housing, access to employment, and participation in the public decision-making continue to elevate the vulnerability of informal settlements in the face of climate change.

A broad poverty index used by the Argentine national census authority (INDEC) constitutes a useful measure of vulnerability in the RRB. This index, called 'unmet basic needs' (*necesidades básicas insatisfechas*, in Spanish) is based on five indicators: residential overcrowding (more than three people per room), precarious housing materials, households without toilets, school age children out of school, and reduced household subsistence capacity. In 1980, an estimated 780,512 inhabitants of the RRB (24% of the total population) had unmet basic needs (INDEC). Local conditions have generally improved since the economic crisis of 2001-2002 as a result of increased public investment in basic infrastructure and services. However, nearly 11% of the population in the RRB still has unmet basic needs, making them exceedingly vulnerable to economic shocks (including those unrelated to climate change). The highest percentage of households with unmet basic needs are in the Upper Basin municipalities of General Rodriquez (18%) and Marcos Paz (17%), the Middle Basin municipalities of José C. Paz (16%), Moreno (16%), and Merlo (15%), and the Lower Basin municipality of Tigre (14%). The following table collates the percentage and real population with unmet basic needs in the RRB based on 2010 INDEC census data.

Figure 20. Population with Unmet Basic Needs (BUN) in Municipalities of the Reconquista River Basin, 2010

	Municipality	Total Population	Without BUN	With BUN	% With BUN
1	General Las Heras	14,870	13,441	1,429	**9.6**
2	General Rodríguez	85,820	70,693	15,127	**17.6**
3	General San Martín	411,786	374,005	37,781	**9.2**
4	Hurlingham	180,360	164,264	16,096	**8.9**
5	Ituzaingó	164,759	154,082	10,677	**6.5**
6	José C. Paz	265,167	224,128	41,039	**15.5**
7	Luján	103,217	94,185	9,032	**8.8**
8	Malvinas Argentinas	320,647	272,120	48,527	**15.1**
9	Marcos Paz	51,935	43,256	8,679	**16.7**
10	Merlo	526,908	448,397	78,511	**14.9**
11	Moreno	451,170	376,988	74,182	**16.4**
12	Morón	317,820	302,886	14,934	**4.7**
13	San Fernando	161,673	142,813	18,860	**11.7**
14	San Isidro	290,675	275,251	15,424	**5.3**
15	San Miguel	274,613	245,155	29,458	**10.7**
16	Tigre	375,042	324,134	50,908	**13.6**
17	Tres de Febrero	337,408	316,925	20,483	**6.1**
18	Vicente López	267,320	258,768	8,552	**3.2**
	Total	**4,601,190**	**4,101,491**	**499,699**	**10.9**

Source: Table information from Census 2010, INDEC, Argentina

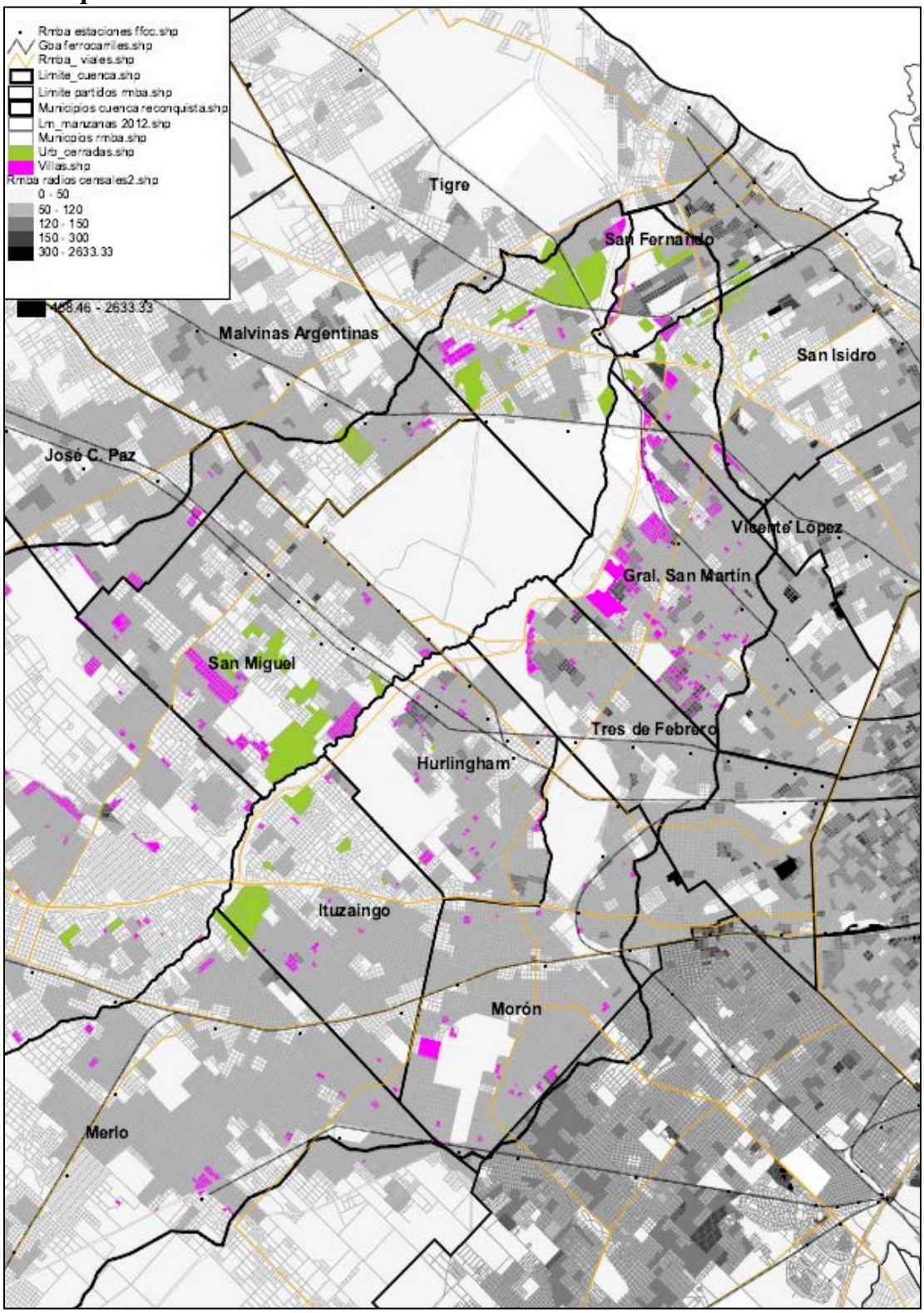
The percentage of households with unmet basic needs tends to be the highest in informal settlements, where a large portion of the population lives below the poverty line. As discussed earlier, there are approximately 284 informal settlements containing an estimated 95,950 households within the 18 municipalities of the RRB. In the San Martín neighborhood, the Municipality of San Fernando carried out a survey of 363 families as part of a neighborhood improvement strategy. The study found that 65.8% of families live below the poverty line, while 95% have unmet basic needs, and 79% do not have basic sanitation infrastructure (Informe Barrio San Martín, San Fernando Municipality). The survey also showed that 39% of families live in overcrowded conditions and that the population is exceedingly young, with only 1% of inhabitants being over 65 years old. Barrio Independencia (San Martín Municipality) has similar demographic characteristics and rates of poverty. Its unique labor dynamics, however, are conditioned by its proximity to the CEAMSE (metropolitan landfill) and the community's economic dependence on informal waste collection and resale. Low and insecure employment statistics in both neighborhoods are indicative of household economic vulnerability and a limited capacity of most households to withstand and recover from external shocks, such as economic crises or floods. Images below of the Independencia neighborhood show typical housing and infrastructure conditions for informal settlements of the RRB. Notably, the photo on the left features the contaminated creek which has recently been enclosed and channeled.

Figure 21. Photos of Barrio Independencia, San Martín Municipality

Source: Photos property of Playspace Foundation

The geographic and spatial characteristics of informal settlements constitute another important aspect of their vulnerability. The socio-spatial expression of recent processes of urban expansion in the RRB reflects a fragmented development model, echoing the region's large income disparities. In addition to the settlements studied as part of this research project, the RRB has traditional, middle-income suburbs, dependent on public infrastructure networks and public and private transportation. A more recent phenomenon in the RRB is the development of high-end residential complexes (gated communities or 'countries') with private infrastructure provision and car-oriented transportation. The National Ombudsman's Special Report on the Reconquista River Basin (2007) notes that over 87% of gated communities in the metropolitan region are located in the RRB. Figure 22 shows the location of high-income gated communities (in green) and low-income informal settlements (in pink).

Figure 22. Gated Communities (urb_cerradas) and Informal Settlements (villas) in the Reconquista Basin



Source: Base information provided by the COMIREC

For high income groups, location choice for housing tends to be directly related to highway accessibility, contributing to land development in peripheral areas of the metropolitan region, which has also been stimulated through legislative and fiscal incentives. New technology has allowed for the proliferation of gated communities and residential mega-complexes on previously undevelopable land, including flood-prone areas, wetlands, and coastlines of the RRB. These high-income developments are separated from the traditional city by gated perimeters and contain no thoroughfares or shared public spaces.

The Special Report on the Reconquista (2007) explains how large-scale private urbanizations have involved earthworks on previously flood prone lands or building channels or floodgates to divert water flows, noting their negative environmental impacts. They have "transformed the landscape in environmentally fragile areas in order to gain new land for urbanization" (Sfich 2013). Ríos and González explain how "the combination of new gated communities, real estate speculation sites, and illegal plots in the flood plain targeted toward the housing needs of the poor" converge in the RRB and conclude that "the vulnerability of this part of the city is increasing" (Ríos and González 2005, in Mehotra et al 2009, 15).

On the other hand, traditional neighborhoods and informal settlement areas in the RRB were historically located close to industrial employment nodes and regional public transport corridors, particularly the railway. Informal settlements (*asentamientos* or *villas*, in Spanish) first emerged during the import substitution industrialization era of the 1940s, but became more prevalent from the late 1970s onward with the introduction of the Land Use and Territorial Planning Law (8912/77), which required all new developments to include infrastructure, thereby increasing land prices and excluding a large portion of the population from the real estate market.

Since then, housing location choices for low-income households in the RRB has been more influenced by access to cheap land than to employment. This is also true of social housing programs, which have exponentially increased since the early 2000s, resolving part of the housing deficit mostly through low-density housing in peripheral metropolitan locations. Informal settlements emerged through the 'irregular' occupation of land and self-built housing (often precarious), without secure land tenure. In some cases, land tenure, connections to networked water and sewerage, and public services, such as rubbish collection, have been granted to residents. Notwithstanding, infrastructure and public services are still limited in many informal settlements. Thus, the socio-spatial characteristics of neighborhoods contribute to a cycle of disadvantage which increases the vulnerability of informal settlement residents to external shocks.

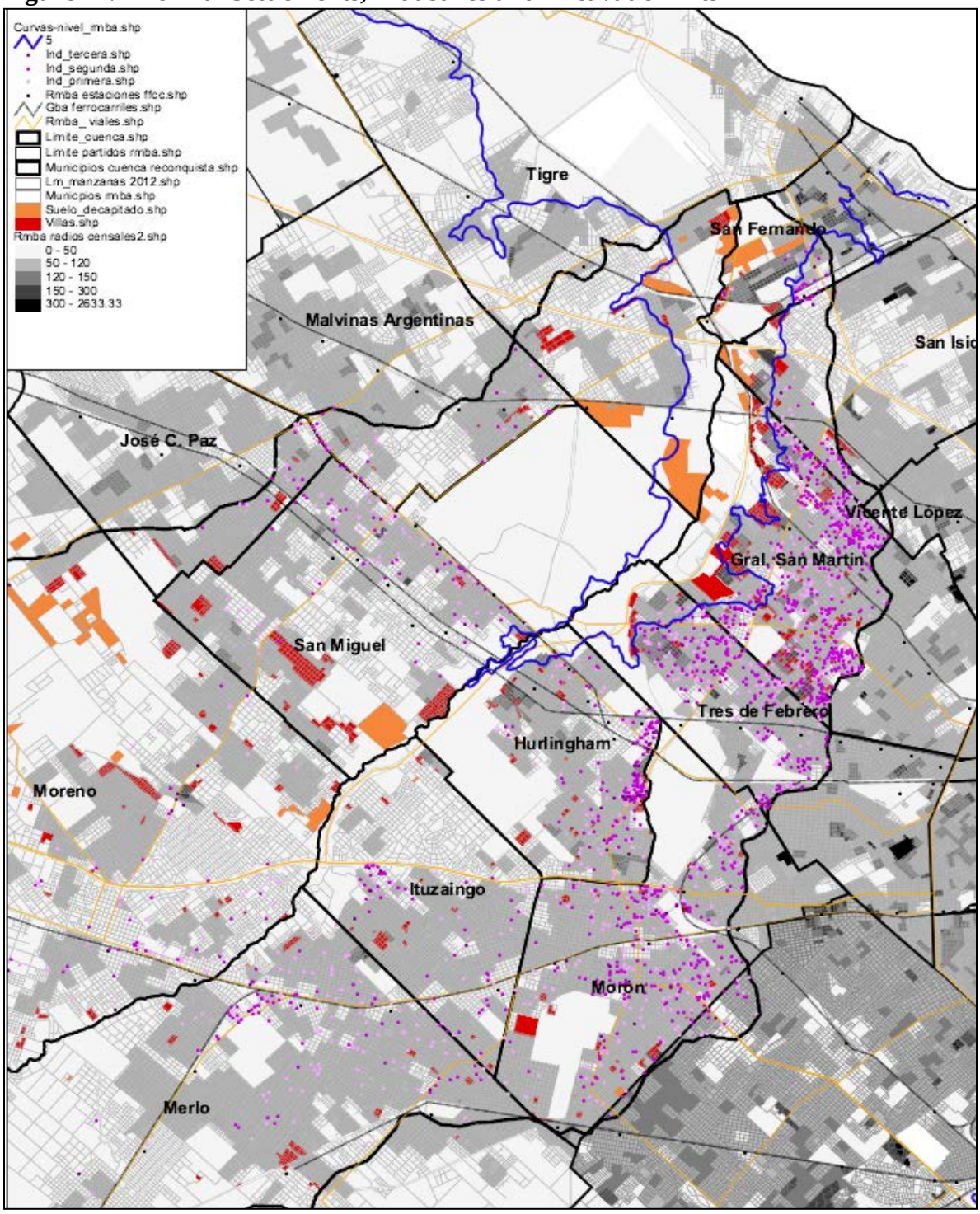
Figure 23. Photos of San Martín Community, San Fernando Municipality

Source: Photos provided by the San Fernando Municipality

Another notable characteristic of settlements in the RRB is their high exposure to environmental risks, including natural flooding and industrial contamination. Due to the land use dynamics discussed above, much of the land available to early squatters was vacant because it was undesirable. Some areas were beneath the natural floodline, while others were close to waste facilities, heavy industry, or excavation pits. As informal settlements grew, they expanded into areas of ever-increasing environmental risk, until houses literally teetered on the banks of creeks, streams, and other tributaries, and the Reconquista River itself. Images above of the San Martín neighborhood (case study for this research) are indicative of the precarious location of some informal settlements in the RRB.

More recently, settlements have begun to 'reclaim' undeveloped marshes and excavation pits, filling them with mixed materials to increase land area for further informal urbanization. Broadly speaking, the location of informal settlements places them at much higher risk of environmental hazards than other populations of the RRB. This is displayed in Figure 24, which shows informal settlements (in red), industries in purple and excavation pits in orange within proximity to the current floodline of 5 metres in the RRB (blue line). Based on the projected impacts of climate change, in terms of rising temperatures and extreme weather events, these vulnerabilities may result in grave threats to property, infrastructure, and human health.

Figure 24. Informal Settlements, Industries and Excavation Pits



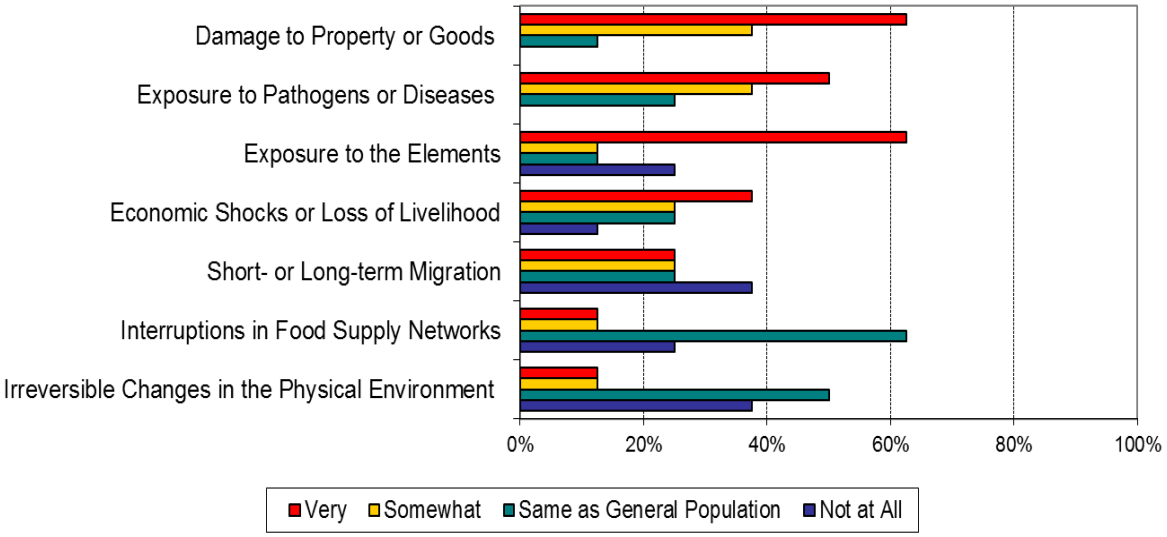
Source: Map prepared based on information from the COMIREC

As part of the survey carried out in the context of this research project, government planners were asked to rank the vulnerability of informal settlements within their jurisdictions to specific, climate-related impacts. While survey respondents generally perceived them as being more

vulnerable, the evaluations were quite uneven among municipalities. The majority of municipal representatives, as well as the COMIREC, saw informal settlements *as highly or somewhat vulnerable* to the following problems: damage to property or goods (88.9%), exposure to pathogens or diseases (77.8%), and exposure to the elements (66.7%). Most often, they attributed this to precarious housing conditions and the lack of physical infrastructure, including sewage systems, potable water, and storm water drainage. A few respondents qualified informal settlements as not at all vulnerable to these problems, citing municipal resettlement efforts or plans to provide low-income public housing in the near term future.

The degree of perceived vulnerability to short- or long-term migration and climate-related economic shocks varied among municipalities, with approximately equal numbers of respondents qualifying them as very vulnerable, somewhat vulnerable, or the same as the general population. The majority of respondents (77.8%) reported informal settlements in their jurisdictions as having *low levels of vulnerability* to irreversible changes in the physical environment or interruptions in food supply networks. Notably, the COMIREC demonstrated a high degree of awareness of general vulnerability patterns throughout the RRB, perhaps because of its panoramic perspective and recent work with the IBD. Results of survey questions are summarized in the figure below.

Figure 25. Perceived Vulnerability of Informal Settlements to Climate Change, RRB



Source: Developed based on survey responses by 8 municipalities and the COMIREC

As evidenced by survey results, municipal opinions are far from unanimous. Their different perceptions regarding the vulnerability of informal settlements are partially a reflection of real variations on the ground. However, what also became clear over the course of the study is the lack of standardized frameworks and measurement tools with which to gauge local vulnerability. Since few formal vulnerability assessments have been carried out in the RRB, there is limited concrete information with which to plan and prioritize. This information gap is a problem in and of itself, but also sustains the perception of climate change adaptation as a 'low priority' or even a luxury in some municipal governments of the RRB. The implications of these perceptions are discussed more thoroughly in Section 5.

Climate Change Impacts in the Reconquista River Basin

Impacts can be understood as the product of hazards and vulnerabilities. Immediate impacts include property damage and damage to infrastructure, the disruption of economic productivity and household livelihoods, interruptions in caregiving regimens and other social obligations, threats to human health, and, in extreme cases, the loss of human lives. Longer term impacts may include impoverishment, ongoing health problems, or migration to alternate sites. In communities with lower levels of vulnerability, the same natural hazards may produce fewer or less severe impacts. Conversely, in vulnerable communities, such as the informal settlements of the RRB, the impacts of climate hazards are often greater due to the geographic factors discussed previously, as well as residents' lack of savings and assets, informal employment, and heavy reliance on public transportation, among other things. While certain imprecision exists with respect to the climate hazards the RRB will face in the future (the precise increase in temperatures and the strength and frequency of extreme weather events), their impacts can be partially gauged by events which have already occurred.

The research team's literature review uncovered limited official data and few studies quantifying the potential impacts of climate change in the RRB on public and private property, human health, or local economies. Some of the costs of flooding in the MRBA have been studied by Barros (2005) and include aspects such as damage to water supply plants, damage to public and other buildings, overflow of sewage, rising of water tables, submersion of vast tracks of railroads, higher energy consumption for treatment plant operation, and reduced water quality by concentrations of pollutants. Projections conducted by Barros explore the consequences of 0.4 m sea level rise for the 2070 decade. According to Barros (2005), under conditions of moderate population growth and no major changes to population distribution and without any new flood defenses, “the population with risk of some flood (recurrence every 100 years) will amount to about 1,700,000, more than three times the present population in such conditions.” Also, “those with risk of flood every year will be about 230,000, six times the population that suffer now such recurrence” (Ibid). Without adaptation measures, Barros estimates that the cost of losses in terms of built structures in the coastal region of Buenos Aires “for the period 2050-2100 would range from 5 to 15 billion US dollars” (Ibid).[17] Between 1970 and 2004 approximately $US 400,000,000 was lost to disaster efforts in the entre MRBA, more that 50% can be attributed to flood events (Nacion and UNDP 2012).

In addition to findings from the literature review, all interviewees were asked how and by whom the potential impacts of climate change had been quantified. The research team found no projections of possible health or development impacts for the region. However, interviews and community workshops indicated that flooding is widespread within both formal and informal settlement areas of the RRB. Community participants in both workshops cited worsening flood conditions as their main concern. Floods were reported to be both more frequent and more devastating in recent years (Community workshops Independencia and San Martín 2013).

[17] The mean cost of the current damages to the coastal infrastructure was estimated by Barros as approximately US$24 million per year.

In the neighborhoods of Independencia and José León Suárez (San Martín Municipality), local residents described the short-term impacts of flooding. They said that unpaved streets “turned into rivers” after high rainfall and highlighted the saturation of the existing stormwater infrastructure. In the San Martín community (San Fernando Municipality) residents recalled the impacts of a 2010 flood, in which houses along the Fate Creek were destroyed after the land beneath them collapsed. The primary impacts of one recent large-scale flood (April 2013) were discussed extensively in both community workshops; they included emergency evacuations and congregation in 'safe houses' such as churches or schools, extensive damage to housing structures and household appliances, damage to informal infrastructure connections, electrical fires, and the drowning of work-animals, such as horses and mules. The floods of April 2013 also led the loss of two human lives in the Independencia and Carcova neighborhood due to drowning and electrification respectively (Community Workshop José León Suárez 2013).

Other impacts noted by residents were the loss of work days (due to lack of transportation, the inability to perform onsite work, or the need to attend to household emergencies), students missing school, and the interruption of caregiving regimens for children, the elderly, and handicapped dependents. Not lastly, workshop participants described the health-related impacts of large flood events, which are associated with stagnant water and the proliferation of mosquitos and rats, the contamination of drinking water, the accumulation of solid wastes in public areas, and, generally, increased exposure to pathogens. Specifically, they noted increases in skin rashes, diarrhea, and general malaise which were particularly acute among children.

In settlements of the RRB characterized by high density and high growth, it is impossible to attribute increased flooding to a single cause. Urbanization and frequent modifications of local hydrological systems are as much (or more) to blame as changing climatic conditions. However, their combined effect is of concern. In the communities where workshops were conducted, flooding impacts were largely attributed to physical obstructions and anthropic modifications. In José León Suaréz (San Martín Municipality), recent partial channeling of a creek has led to increased water flow downstream. Additionally, informal waste and the carcasses of stolen cars litter the creek at one end of the neighborhood, obstructing water flow and exacerbating flood risks during heavy rains. Furthermore, the high-density precarious housing in this neighborhood does not have stormwater infrastructure, and a large natural lagoon that served as a natural retention and drainage area has recently been filled to elevate land above the floodline for the construction of an industrial park adjacent (downstream) to the neighborhood.

In San Martín (San Fernando Municipality), the neighborhood is located in an area adjacent to the old Reconquista River, which was modified as part of previous flood protection and infrastructure improvement projects in the late 1990s. This area is very low-lying and residents commented that floodgates do not function properly leading to water infiltration and stagnation in some parts of the neighborhood. Industrial discharge adjacent to the community into the old watercourse appears to worsen water quality (no formal test results were sighted as part of this research, however visual inspection of the old Reconquista River confirms the presence of unnaturally occurring substances). The below image shows the location of the old Reconquista River course, with informal settlements and industrial uses abutting the old waterway, and the new watercourse following rectifications during the 1990s (Figure 26.)

Figure 26. New and Old Reconquista River Watercourses

Source: Image supplied by the San Fernando Municipality

Both sites examined as part of the study (the neighborhoods of San Martín and Independencia) are located in low-lying areas in proximity to the Reconquista River and major rail and highway infrastructure. Whilst not representative of all informal, urban settlements in the RRB, these characteristics are common to many. Both neighborhoods have been severely impacted by recurrent flooding and, consequently, have become the targets of new government-led improvement projects. In Independencia (San Martín Municipality), the aforementioned creek has recently been channeled and partially closed, while in the San Martín neighborhood (San Fernando Municipality) basic infrastructure is currently being built (water, stormwater and sewerage) as part of the PROMEBA program. Also, some of the worst-affected households have been relocated through new social housing programs funded by the national government.

Overall, based on the information collected as part of this study, there appears to be growing awareness about the impacts of changing climate conditions in the RRB. Impacts, however, are often attributed solely to localised anthropogenic modifications, including incomplete basic infrastructure networks, land filling, watercourse modifications, and urbanization characteristics, and there is limited understanding of how urbanization processes (planned or unplanned) interact with regional climate hazards. Similarly, the secondary effects of flooding and heat waves—including the disruption of the local economy or population health impacts—are not well specified. Adaptation therefore tends to be decoupled from climate stimuli and is lead through reactive and autonomous strategies: acute problems are addressed as they arise, through creek channelling, modifications to stormwater infrastructure, or municipal responses to emergencies. Further analysis of adaptive capacity in the RRB is discussed below in Section 5.

Section 5: Climate Change Adaptation in the Reconquista River Basin

Advances in Climate Change Adaptation and Planning at the National Level

Legal and Institutional Framework for Climate Change Adaptation

International conventions have been essential in guiding Argentina's normative and institutional responses to climate change. Argentina is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), which was adopted at the 1992 Earth Summit and came into force in 1994. The objective of the Kyoto Protocol is to stabilize greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system," without jeopardizing food production or economic development.[18] The UNFCCC gave way to the Kyoto Protocol (1997), which shares the same objectives and institutions but goes a step further by setting internationally binding emission reduction targets.

The UNFCCC and the Kyoto Protocol were ratified by the Argentine National Congress in 1993 and 2001, respectively.[19] Argentina is also a signatory of other international agreements which make explicit references—and carry specific obligations—in relation to climate change, namely the Hyogo Framework for Action, which focuses on building resilience to disasters, the UN Convention on Biological Diversity (and associated protocols), and the UN Convention to Combat Desertification. For all activities related to the UNFCCC and the Kyoto Protocol, the National Secretariat of the Environment and Sustainable Development (SAyDS) is the implementing authority.

The obligations assumed under international agreements have spurred normative advances and institutional changes within Argentina. Under the auspices of the SAyDS, new administrative bodies have been formed: the Climate Change Program (2001), the Climate Change Unit (2003), the National Advisory Commission on Climate Change (2003), the Civil Society Liaison (2004), and the National Climate Scenarios Program (2005). Additionally, a multi-sector Government Committee on Climate Change was formed (2009) and, within the Federal Environmental Council (COFEMA), a separate body which acts as a bridge between national and provincial environmental authorities, an 'ad hoc' Commission Climate Change was established (2009).

Among these institutions, the one which has taken a clear position of leadership is the Climate Change Unit (CCU) of the SAyDS. Resolution 58/ 2007 (2007) details the role of the CCU, which includes the coordination of all actions relative to compliance with the UNFCCC and the Kyoto Protocol, policy advising on climate change mitigation, the identification of priority

[18] For more information on the Kyoto Protocol and the UNFCC see: http://unfccc.int/key_steps/the_convention/items/6036.php.

[19] The UNFCCC and the Kyoto Protocol were approved by the National Congress via Law 24.295 and Law 25.438, respectively. The Secretariat of the Environment and Sustainable Development (*Secretaría de Ambiente y Desarrollo Sustentable* or SAyDS) was designated the institution responsible for implementation and enforcement via Decree 2213/2002. See: http://www.ambiente.gov.ar/?aplicacion=normativa&IdSeccion=29.

sectors, and the establishment of mitigation guidelines.[20] While climate change *adaptation* is not explicitly highlighted in its original legislative mandate, the CCU has adopted it as one of four main lines of programmatic work, along with international negotiations, education and training, and mitigation.

Climate Change Adaptation and the National Secretariat for the Environment and Sustainable Development

The CCU provides overall coordination, assistance, and advising to other ministries and government offices in the sectors of Agriculture, Industry, Transportation, Finance, and Disaster Response, among others. The Coordinator of Adaptation at the CCU describes the role of his office, saying "climate change is an issue which must be addressed in a multi-disciplinary fashion, building synergies and maximizing budget allocations. We see that [the Ministry of] Planning is dedicated to land use management, Civil Defense has its role, and we do Climate Change. But we need to coordinate. These offices shouldn't go their own way, duplicating efforts. We need to work together to ensure that [the impact of] every peso is multiplied by three" (Interview Di Pietro 2013). The institutional consolidation of the SAyDS Climate Change Unit (CCU) has facilitated knowledge-sharing and discussion of climate-related policy considerations at the national level. The importance of this process cannot be understated since, as noted by numerous interviewees "the issue of Climate Change is still at an early stage in Argentina" (Interviews Di Pietro, Ryan). As such, the discourse around adaptation is still evolving and has yet to be fully appropriated at sub-national levels.

Perhaps the most vital contribution of the CCU to date has been the coordination of Argentina's UNFCCC-mandated national communications on Climate Change. The First National Communication was developed with a grant from the Global Environmental Facility (GEF)—the designated financial mechanism of the UNFCCC—and submitted in 1997/ 1999. The Second National Communication was finalized in 2007 and received support from GEF and from the United States Environmental Protection Agency (EPA). These two reports are the only publicly-available, government-endorsed documents which provide a synthetic overview of Argentina's GHG Inventories, Vulnerability to Climate Change, Adaptation to Climate Change, Capacity to Mitigate GHG Emissions, UNFCCC Compliance Measures, International Cooperation, Obstacles and Limitations for Adaptation and Mitigation, and Funding Needs, among other things. While the National Communications are, by definition, broad in scope, and offer limited detail on climate change vulnerability or adaptation at the sub-national level, they nevertheless constitute an important tool for decision-makers and civil society by establishing a baseline against which to measure advances and setbacks.

Argentina's Third National Communication (TNC) is currently under preparation, with support from the World Bank and a GEF grant for approximately U$S 2.5 million. This project, entitled 'Third National Communication to the United Nations Framework Convention on Climate Change Project, AR-TF098640, P116974,' is actually broader that its name implies, with the largest component focusing on strengthening the national adaptation agenda by developing feasible proposals for policies and measures to enhance climate change adaptation in relevant

[20]For more information on the Climate Change Unit and SAyDS see: http://www.ambiente.gov.ar/?aplicacion=normativa&IdNorma=851&IdSeccion=29.

sectors, including urban planning.[21] This initiative is aligned with the main objective of the Third National Communication which, as detailed in the guiding project document, "is to design climate change policies and measures that could be integrated into sectoral development strategies and assess their economic, environmental and social impacts. This will offer a scientific-based decision making tool for policy makers across different sectors of national, provincial and municipal governments" (GEF Document for Project 3964 2010). This project was due to be finalized in May 2013, but has recently been extended until 2014. Simultaneously, Argentina is developing a National Climate Change strategy. The cumulative results of this work, will undoubtedly contribute to further consolidation of adaptation planning within the SAyDS and participating ministries.

Alongside Argentina's National Communications, the Climate Change Unit has recently been involved in a number of adaptation-focused projects with support from UNFCCC Adaptation Fund. These projects include 'Increasing Climate Resilience and Enhancing Sustainable Land Management in the Southwest of the Buenos Aires Province Project' and 'Enhancing the Adaptive Capacity and Increasing Resilience of Small-scale Agriculture Producers of the Northeast of Argentina.' These projects are still in their initial phases and are not intended to meet the needs of the country as a whole. Nevertheless, they constitute an important starting point. As described by the Adaptation Coordinator of the CCU, "little by little this office is acquiring a capacity for production previously unknown, because before there were fewer of us, we didn't have projects, we had limited financial resources. We have requested a great deal of support from GEF and the Adaptation Fund so now we are in a situation of relative wealth and experiences which are only just beginning. I think that after three or four years of implementation we'll gain a great deal of knowledge about effectiveness, barriers, mistakes, how we can achieve greater impact, and how we can ensure that our projects don't depend on international funding but are instead internalized by different areas of government" (Interview 2013).

The CCU has not undertaken any projects related to adaptation in urban areas. However, it recently made an incursion into the domain of climate change and planning through production of a short manual entitled 'Vulnerability and Adaptation to Climate Change for Local Management and Planning.' This manual, published in 2012, was jointly developed by the SAyDS, the Sub-Secretariat for Provincial Development and the Sub-Secretariat for Territorial Planning, with additional support from other relevant ministries. The manual targets local (municipal) decision makers, presenting simple explanations climate change adaptation and mitigation strategies, sources of information, and—most significantly—a methodology for participatory vulnerability assessment and adaptation planning, meant to be used at the

[21] Expected outputs include of the project include: Compilation and downscaling of climate models; Specific studies on climate change vulnerability and impact scenarios conducted for eco-regions and their potential environmental services, and key sectors: health, tourism, agriculture, energy, urban areas, fisheries and water resource management as well as employment aspects of possible response measures; A technical report including proposals of potential adaptation actions in areas/sectors identified as particularly vulnerable to CC; A discussion paper to set plausible policies and measures for adaptation to climate change, including design of regulatory frameworks, implementation strategies, and institutional arrangements; strategies and courses of action to address identified barriers to enforcing policies and measures laid out in national communication; Technical reports with economic, social and environmental impact assessments of the implementation of the designed policies and measures based on the socioeconomic baseline scenario. Full project document available at: http://www.thegef.org/gef/sites/thegef.org/files/documents/document/09-02-2010%20ID3964%20Council%20letter_0.pdf.

community level. The Manual offers free and easy to access information relevant to urban planning questions.

The CCU made two attempts to pilot the methodology on the ground (in the Municipality of La Costa, Province of Buenos Aires, and in the Province of Salta). After carrying out successful events in these two locales, efforts were discontinued and energies were channeled elsewhere, leaving the initiative to lose force (Interviews Di Pietro, González 2013). It is unclear which municipal governments—if any—have independently attempted to carry out local vulnerability assessments using the manual. The research team did not identify any in the Reconquista River Basin.

Climate Change Adaptation and the Federal Ministry of Planning

The last five years have seen some important advances in formulating strategic policy to guide national development processes and concomitant investments. In 2011, the Ministry of Planning subscribed to a cooperative agreement with the CCU and with the Office of Civil Defense (responsible for disaster management). This agreement was a prerequisite to the publication of the aforementioned manual on vulnerability and adaptation to climate change. It also led to the development of "methodological guidelines to incorporate risk reduction and [climate change] adaptation in territorial planning and in the evaluation of public investment projects" (PET 2011, 67). These guidelines, however, were never made public due to changes in government decision-making structures (Interview 2013).

Importantly, the Federal Ministry of Planning has incorporated climate change as a strategic issue in the national Strategic Territorial Plan (PET). Silvia González, a researcher and technical advisor at the Subsecretariat of Territorial Planning, describes the process by which climate change began to penetrate the agenda of the Planning Ministry, saying "we began to work on a risk reduction project in 2006, with funding from the United Nations … and the first project was on risk, simply risk. But then questions began to emerge within our team, among our provincial counterparts, and with colleagues at United Nations Development Programme, about the relevance of climate change in hydro-meteorological processes. So we started to generate knowledge about the issue. We approached the CCU and started to work with them to incorporate climate change into the revised PET. Since then, it has been incorporated as another element to consider, in terms of environmental risks. So, it was the PET on the one hand, but at the same time we decided to explore—together with the CCU and Civil Defense—the points of contact between planning, risk reduction, and adaptation to climate change… These points of contact are fairly evident but they need to be made explicit in order to start working in that direction" (Interview González 2013).

The citation above highlights the importance of organic information-exchange and capacity-building in the institutionalization process, as well as the critical role played by exogenous forces, in this case, international project financing. While there has been only recent take-up of climate change as an issue for central planning, the inclusion of climate change in the PET constitutes an enormous strategic advance which will, undoubtedly, have secondary effects in the coming years. As stressed by González in the interview with this research team, the Ministry of Planning is most often associated with public works and when it comes to climate change there is

growing public demand—particularly by those affected by flooding—to "build something to solve the problem." But the role of the National Ministry, in terms of adaptation planning, should not be guided simply by what's visible. "We've adopted the perspective of prevention and we try to stay a few steps ahead of things actually happening in order to avoid the largest amount of damage… this is a long-term strategy in which you don't see results from one day to the next" (Interview González 2013).

Adaptation Planning in the Reconquista River Basin

The Buenos Aires Provincial Authority for Sustainable Development

The maximum Environmental Authority in the Province of Buenos Aires is the Provincial Organism for Sustainable Development (OPDS). In 2006, the Province of Buenos Aires became the first in Argentina to create an office dedicated solely to Climate Change. The mandate of this office, housed within the OPDS, includes the compilation and systematization of information, to create baselines and develop adaptation strategies, as well as training and public outreach on issues of climate change vulnerability, mitigation measures, and adaptation tools.[22] In particular, the climate change unit of the OPDS has promoted the implementation of an early warning system to reduce the negative impacts of climate-related hazards. In principle, the vision of this system includes a real-time observatory of precipitation, temperature, soil saturation, and river flows, short-term weather and climate predictions, hydrological models for at-risk river basins, contingency plans, and public awareness-raising programs (Casanovas 2013). In practice, this system is still under development given the large degree of coordination necessary between the OPDS and relevant local, provincial, and national organisms.

In addition to its climate-related functions, the OPDS is responsible for authorization, permitting, and enforcement of environmental standards for industrial plants located in the RRB. After the dissolution of the UNIREC, the OPDS also began monitoring water quality in the Reconquista River through periodic sampling procedures (National Ombudsman's Special Report on the Reconquista River 2007). Finally, the OPDS oversees solid waste management across the entire RRB. All three functions are of vital concern in relation to adaptation planning, given the high degree of flood hazards in informal settlements and the compound impacts of improper waste disposal and industrial contaminants. The Executive Director of the COMIREC, Mara Anselmi, also informed the research team that the OPDS is planning to develop a monitoring program for climate change throughout the Buenos Aires Province (Interview Anselmi 2013).

Provincial Ministry of Infrastructure and the Committee of the Reconquista River Basin

As mentioned previously, the Committee of the Reconquista River Basin (COMIREC) is the principal state organism responsible for multi-jurisdictional coordination and management in the RRB. The COMIREC works closely with the Buenos Aires Provincial Ministry of Infrastructure and, together, these two institutions are responsible for the IDB-sponsored project entitled 'Sustainable Environmental and Urban Management in the Reconquista River Basin' (PMUAS). Although the final terms of this project have not yet been finalized (at the time of publication),

[22] See website: http://www.opds.gba.gov.ar/index.php/paginas/ver/area_cambio_climatico.

the Provincial Ministry is already receiving technical support from the IDB and from the consulting firm Halcrow and is in the process of planning and implementing a series of large infrastructure projects in the RRB. The PMAUS project represents an integrated approach to planning and the COMIREC is responsible for coordinating all actions in the Reconquista River Basin and maintaining links with municipal governments, provincial authorities and non-government organizations (Interview Anselmi 2013).

The activities underway revolve around two central axes. The first is public water works, including channeling, rectification and transversal ducts. These water works will alter hydraulic dynamics of the Reconquista River and its tributaries, reducing flood risks, and eventually allow AySA to extend potable water and sanitation networks to neighborhoods which currently lack these services. The second is a new transportation route that borders the Reconquista River to promote mobility and connectivity between neighborhoods. Parallel components which are also being developed by the Provincial Ministry of Infrastructure and the COMIREC include the reduction of clandestine waste sites and the generation of new public green spaces. The Ministry's role is primarily technical, coordinating the overall intervention strategy and soliciting information and advice from Provincial offices of Housing, Land Management, Water and Sewage, Hydrology, and Roads. The COMIREC is responsible for coordination and acts as a liaison with municipal government and between provincial authorities.

Many of these activities form part of an integrated planning approach and clearly fall within the realm of interest for planned adaptation, including for example the reduction of clandestine waste sites, the generation of new green spaces, and the improvement of public transportation infrastructure which will undoubtedly make positive contributions to climate change mitigation and adaptation efforts in the RRB. Provincial representatives informed the research team that parallel studies have been undertaken to ensure that the public works contribute to solving existing problems, rather than generating new environmental or territorial imbalances (Interview Larivera 2013). When asked how climate change had been taken into account, they explained that rainfall and flood patterns over the past two decades had been considered when designing infrastructure projects. They warned, however, that it is difficult for all scenarios to be anticipated, citing as an example the torrential rains of April 2013 which caused extensive damages in the City of La Plata and parts of the RRB (Interview Anselmi 2013).

Climate change adaptation—conceived of as such—appears to be an incipient area of action for the Provincial Ministry of Infrastructure and the COMIREC: it is an area that doesn't hold an explicit place in strategic plans, but, where practicable, becomes incorporated within existing competencies relating to infrastructure provision and vulnerability reduction. According to the Executive Director of the COMIREC, climate change is addressed through an "integrated approach to planning," that holistically addresses water management and also takes into consideration other factors like accessibility (Interview Anselmi 2013). In sum, adaptation is subsumed within existing practices as an additional consideration. This marks a slight contrast in approach with the Inter-Jurisdictional Authority for the adjacent Matanza-Riachuelo River Basin, the ACUMAR, which "is beginning to contemplate (separate) long term plans and projects relating to climate change, such as a continuous water quality and quantity monitoring system throughout the Matanza-Riachuelo River Basin" (Interview Cano 2013).

Municipal Governments of the Reconquista River Basin

There are 18 municipalities that form part of the RRB: General Rodriguez, General San Martín, Hurlingham, Ituzaingó, José C. Paz, Las Heras, Luján, Marcos Paz, Malvinas Argentinas, Merlo, Moreno, Morón, San Miguel, San Isidro, San Fernando, Tres de Febrero, Tigre, and Vicente Lopéz. As noted previously, some lie entirely within the basin, while some have only a small territorial overlap. Nonetheless, given that all form part of the same ecosystem and participate in the inter-jurisdictional management of the basin, under the auspices of the COMIREC, they have all been included in this study.

Municipal governments play an important role in urban planning and local environmental management. All municipal governments of the RRB are subject to the Provincial Law of Territorial and Land Use Planning (Law 8912), as well as various national and provincial norms on water, environmental protection, and industrial regulation. However, article 70 of the law states that "the primary responsibility for land use planning falls on municipal governments and each municipality is required to have a sectoral instrument for this purpose."[23] As such, the municipal governments of the RRB have ample decision-making power over residential, commercial, and recreational zoning, as well as the overall territorial dynamics of growth. The Provincial Water Law (Law 12257) regulates basin-wide management committees, such as the COMIREC, and mandates the participation municipal representatives in them.[24] As such, the COMIREC's activities must be communicated to and authorized by the representatives from each of the 18 constituent municipalities. Not lastly, municipal governments of the RRB are, in most cases, responsible for solid waste collection and disposition. These competencies, among others, provide opportunities for locally-led climate change adaptation.

As mentioned previously, this study included an online survey on climate change risk, vulnerability, and adaptive capacity in the RRB. Eight municipalities completed the survey, including three from the Upper basin (Morón, Marcos Paz, and General Rodriguez), four from the Middle basin (Hurlingham, Malvinas Argentinas, Tres de Febrero and Ituzaingó), and one from the Lower basin (Tigre). One part of this survey asked respondents to indicate the status of municipal planning efforts in sectors relevant to climate change. These sectors were: Land use and land management, Economic development, Energy, Transportation, Water and Sanitation, Storm water and wastewater, Solid waste, Public health, Upgrading/ improvement of informal settlements, Emergency response, and Climate change. For each sector, they reported whether their municipality had an official plan, was currently developing one, planned to develop one in the future, or did not plan to develop one. Results are summarized in the table below.

[23] Full text of Law 8912 available in Spanish at: http://www.gob.gba.gov.ar/legislacion/legislacion/l-8912.html.

[24] Full text of Law 12257 is available in Spanish at: http://www.gob.gba.gov.ar/legislacion/legislacion/l-12257.html.

Figure 27. Status of Municipal Planning in Climate-Related Sectors in the RRB				
	Plan Already Approved	**Plan Being Developed**	**Intent to Develop Plan**	**Percentage of Municipalities with Approved Plans**
Land use and land management	6	2	0	75%
Economic development	7	1	0	88%
Energy	4	2	2	50%
Transportation	6	1	1	75%
Water and Sanitation	7	0	1	88%
Stormwater and wastewater	5	3	0	63%
Solid waste	7	1	0	88%
Public health	8	0	0	100%
Upgrading/ improvement of informal settlements	6	2	0	75%
Emergency response	5	2	1	63%
Climate change	1	3	4	13%
TOTAL	62	17	9	
Source: Survey responses from 8 RRB municipalities				

As evidenced above, many of the municipalities surveyed have developed or are currently developing plans in climate-related sectors. The only sector in which 100% of respondents reported having an approved plan was Public health. However, seven of the eight municipalities (88%) reported having plans for Economic development, Water and sanitation, and Solid waste, while six of the eight (75%) reported having plans for Land use and land management, Transportation, and Improvement of informal settlements. Most of those lacking plans in these sectors said that they were currently being developed. The survey showed marginal advances in Stormwater and wastewater management and Emergency response, for both of which only five municipalities (63%) had approved plans. Notably, only four municipalities (50%) reported having Energy plans and only one (Tigre) reported having a specific plan for Climate Change.

Formally approved plans are an important element of municipal resource administration and governance; they can also provide an organizing framework and specific parameters for locally-appropriate adaptation and mitigation planning. In this regard, the lack of formally approved plans for Land use and land management in two of the municipalities surveyed presents a challenge for adaptation possibilities. Similarly, the absence of formal plans for Storm water and wastewater, Emergency response, and Informal settlement upgrading in some municipalities is likely a constraint on discussions about the links between these sectors and climate-related concerns. Given that most municipalities of the RRB lack integrated plans on the issue, the research team was particularly interested in how decision-makers are managing the existing consequences and perceived future risks of climate change through other sectoral plans. Thus, the survey asked respondents to indicate how the municipal plans of their jurisdiction accounted for climate change or otherwise promoted local adaptation capacities. Their responses are discussed below.

- In the sector of Land use and land management, the most frequently cited strategies for addressing climate change were the analysis of land capability, suitability, and the feasibility of different development alternatives to determine appropriate spatial relationships and future land use maps (87.5%) and the identification of development "hot spots" or "no development areas" where climate change impacts are likely to be most severe (50%). This is consistent with the broader debate about development in the RRB and, particularly, with concerns about the environmental impacts of large-scale gated communities.

- The most common strategies in the area of Economic development were the reduction of poverty among key groups vulnerable to climate change (75%) and guiding investments based on predicted physical, economic, and social impacts (50%). Notably, only three of the municipalities (37.5%) reported promoting opportunities for 'green development' or 'climate friendly' growth, indicating that this crucial aspect planning is, as yet, under-developed in the RRB.

- In the Energy sector, the only planning response cited by multiple municipalities (62.5%) was climate change mitigation, such as green energy, waste reduction, and alternative fuels. While one municipality (Ituzaingó) reported identifying climate-related risks to the generation and distribution of energy, any attention to adaptation (as opposed to mitigation) was otherwise absent.

- For Transportation, the most frequently cited strategy was the prioritization of improvements that benefit vulnerable groups (62.5%), although a number of municipalities (37.5%) reported focusing on "weak links" in transportation networks, such as bridges or streets, which stand to be impacted by climate change. Only two (General Rodriguez and Tigre) reported linkages between transportation and emergency response planning, through the identification of alternate routes and distribution networks.

- With respect to Stormwater and wastewater management, the majority of municipalities (87.5%) cited the identification of hazard areas - at risk from heavy rains and inadequate drainage - as a strategy for addressing climate change. Many also identified the prioritization of investments that reduce impacts on vulnerable groups (62.5%) or flood defenses that protect existing development and infrastructure (50%). This pattern is consistent with perceptions of flooding as the most tangible and near-term impact of climate hazards and provides evidence of incremental change through sectoral adaptation, even in the absence of integrated climate change plans.

- In the Solid waste management sector, there was an extraordinary degree of consistency among survey respondents. Eight municipalities (100%) cited mitigation through reuse and recycling, as well as public education. The majority also cited the elimination of clandestine dumps / open garbage pits which obstruct water flow and increase local flooding (87.5%). While solid waste management continues to be a significant challenge for many municipalities of the RRB, these results highlight the commitment of local governments to this issue.

- In the area of Public health, eight municipalities (100%) reported prioritizing the needs of vulnerable populations. Many also cited tracking changing morbidity and mortality rates (87.5%) and identifying the specific risks of climate change on public health (87.5%). Results notwithstanding, the research team found no publicly available information about the forecasted impacts of climate change on human health in the RRB or the adaptation measures being taken. This is highly consistent with the same emphasis on vulnerability reduction seen elsewhere.

- For emergencies, the most commonly cited strategies were infrastructure improvement and impact reduction through planning (87.5%), the generation of specific plans to mitigate disasters (62.5%) and the prioritization of critical zones and/or vulnerable groups (62.5%). Notably, four municipalities (Marcos Paz, Morón, Tigre, and Tres de Febrero) reported efforts to identify and quantify climate-related risks. While such efforts are still new, they are promising because increased knowledge about the costs of non-adaptation offers incentives for preventative measures.

- For the climate-sensitive upgrading and improvement of informal settlements, the majority of municipalities cited policies to improve services, infrastructure, and hygiene (75%) while others cited the identification of specific risks (50%). Only two (Tigre and Tres de Febrero) reported education of awareness raising efforts on the risks of climate change. Again, results are consistent with the regional focus on vulnerability reduction and development, as a means for improving the adaptive capacities of low-income communities.

Survey results point definitively towards vulnerability reduction as the most common approach to adaptation planning. When asked for examples of climate-sensitive activities in informal settlements of their jurisdictions, most municipal representatives mentioned infrastructure improvement (extension of water and sewerage networks) or relocation and public housing programs. In the case of San Martín (San Fernando Municipality), where one community workshop took place, local and provincial governments are working on a settlement-wide upgrade, including a relocation strategy for the residents worst affected by flooding. Whilst there are some limitations to this particular resettlement project, such as inter-jurisdictional governance challenges (the houses are located on the limit between Tigre and San Fernando municipalities) and securing appropriate social housing, the overall strategy has greatly improved the quality of housing construction and is currently delivering basic infrastructure to all ‘upgradeable’ houses. Similarly, in Independencia (San Martín Municipality), where the other workshop was held, the provincial government has just completed the channeling and enclosure of a creek that frequently caused flooding in the neighborhood.

As noted previously, the impacts of heavy rains and other climate hazards vary greatly from one neighborhood to the next based on local urbanization conditions. Informal settlements are often—though not always—the areas most vulnerable to impacts, due to their geographic characteristics (location in low-elevation zones), their high population densities, and their precarious residential constructions. The number of informal settlements in each municipality of the RRB ranges from less than 10 (Luján, Marcos Paz, Morón, San Fernando, and Vicente

López) to more than 25 (General San Martín, Merlo, Moreno, and Tigre), with populations of approximately 100 (Marcos Paz) to more than 20,000 (General San Martín). The degree of importance placed on climate-sensitive adaptation planning for informal settlements varies accordingly. Yet, overall, there appears to be a common trend: area-based and issue-based planning mechanisms are being modified by local governments to take into account identified risks. Under this incremental approach, few municipalities of the RRB are considering climate risk and adaptive capacity as a holistic matter requiring integrated planning efforts. Their 'unconscious' responses are a mode of 'spontaneous adaptation' which help mitigate the impacts of climate hazards, but run the risk of being rendered invisible if they are not, eventually, articulated in a holistic and explicit fashion.

Notwithstanding the lack of an integrated vision, climate change adaptation is also occurring independently, spurred by public demand, access to financial resources, or traumatic events, such as the extensive floods which occurred in April 2013. This final point is linked to Matthews' (2013) theory of climate change as a 'transformative stressor.' His research demonstrates how 'crisis moments' relating to climate change can trigger stresses that, in turn, set in motion processes of institutional change. Matthews notes that some stressors may produce immediate effects whilst others may accumulate over time to produce incremental change. Based on the work of the research team, it appears incremental change is slowly occurring through repeated 'crisis moments' as well as through experimental changes to policy and projects to account for different conditions. These changes, however, are usually decoupled from projections on climate change and are more often linked to changing urban development conditions.

Some external initiatives also appear to be stimulating adaptation planning., including the Network of Municipal Governments on Climate Change (*Red de Municipios Frente Al Cambio Climatico*, in Spanish), which is composed of over 40 municipalities, including two from the RRB (Vicente López and San Isidro). Although this network has, to date, focused most of its energies in the area of mitigation, its efforts to promote climate-related knowledge-sharing at the national level are beginning to resonate in the RRB. Similarly, the Municipality of Tigre hosted the first annual meeting of mayors against climate change (the *Primera Cumbre de Intendentes contra el cambio climático*, in Spanish) in June 2013. The municipal government of Tigre was already attuned to the issue of climate change, but has been further sensitized through the IIED-AL project *Riberas Rioplatenses*. The growing articulation between local governments and external initiatives, such as these, points to the growing awareness of climate change hazards and locally-appropriate response options. External initiatives are important spaces for horizontal information-sharing, as non-profit and academic institutions tend to be heavily involved, and may sensitize authorities to the technical and financial resources available from international donors.

As previously mentioned, the devastating effects of recent floods also appear to be a powerful stimulus for climate change adaptation among municipalities of the RRB. This is largely because municipal governments, unlike the provincial or national government, are in permanent contact with their constituencies. These constituencies—particularly those most impacted by floods—demand accountability and tangible action to mitigate flood risks. The political costs of ignoring such demands is high, so risk management and emergency response are gaining ground in many local agendas. Fortunately, municipal governments have a well-developed skill set to deal with

'frontline' problems. As evidenced by fieldwork in communities of San Martín and San Fernando and echoed by most of the experts interviewed, they have deep knowledge about localized urban risks and lasting links with community organizations, such as neighborhood associations, soup kitchens, and other groups. These contacts are normally an advantage, but can be detrimental to climate change adaptation planning. For example, community demands for ‘a solution’ can trap municipal governments in cycles of short-term problem solving, making it difficult to visualize and implement long-term solutions that are more socially or environmentally sustainable. As discussed below, this challenge is aggravated by resource scarcity (including both human resources and funds) which afflicts most municipal governments of the RRB.

Autonomous Adaptation in the Reconquista River Basin

As outlined in Section 2, an important component of adaptive capacity relates to 'autonomous' adaptation at the community level. Autonomous adaptation generally occurs isolated from government policy (discussed above) and constitutes a 'reactive' measure taken by communities or individuals in response to the tangible impacts of climate change. The purpose of this section is to explore autonomous adaptation that has already occurred or is currently occurring in the RRB. Two community workshops were held as part of this research project, one in the neighborhood of Independencia (in the San Martín Municipality of the Middle Basin) and one in the neighborhood of San Martín (in the San Fernando Municipality of the Lower Basin). Semi-structured interviews with experts relating to climate change and government planning included specific questions on spontaneous adaptation in informal settlements, as did the survey of municipal authorities in the RRB. Based on a limited number of cases studied, some autonomous adaptation was observed, particularly in response to worsening flood conditions.

Broadly, there appear to be two kinds of autonomous adaptation strategies occurring in the RRB: firstly, reactive adaptation that constitutes short-term solutions and is closely linked to emergency response (such as housing modifications or public transport route changes); and secondly, autonomous adaptation that goes beyond the short term but is also reactive (such as household relocations or collective drain building). Both shorter-term and longer-term strategies can be characterized by their 'unconscious' character: they address the impacts of climate change (principally worsening flood conditions) but are not explicitly linked to knowledge of present or projected climate change behavior. In some instances, autonomous adaptation is linked to broader processes of institutional-led adaptation, such as housing improvements and drainage constructions. These strategies focus mainly on vulnerability reduction and, like autonomous community-driven responses, tend to omit specific references to climate change, instead referencing the widespread environmental hazards discussed previously.

Informal emergency response efforts serve to mitigate the impacts of large flood events when they occur. In the Independencia neighborhood, for example, workshop participants described how children had been instructed to sit on desks or tables and stay in schools, community soup kitchens, or food halls until water subsided and an adult could collect them. After particularly catastrophic events, three to four days (or more) may pass before communities regain access to water and electricity, so in the meantime they have to find alternative short-term solutions. Unfortunately, as pointed out by Larivera (Interview 2013), such solutions can expose them to risks from the consumption of contaminated water or food which has been left unrefrigerated.

During the Independencia workshop, community members commented on challenges to accessing information during extreme weather events and expressed views relating to coordination difficulties regarding emergency response efforts by public authorities. They also on the widespread solidarity movements which provide relief and aid in the form of mattresses, blankets, food, and medications. These efforts are common to flood-affected areas throughout the RRB, and are generally supported by municipal governments and non-profit organizations. Notably, the most important interlocutors and local coordinators for the distribution of donations after major flood events are community leaders with personal networks that transcend the geographic and social boundaries of the settlement. This underscores previous discussions on importance of 'social capital' as a component of adaptive capacities, particularly among vulnerable communities with limited economic and material assets.

Short-term emergency-related strategies are often combined with forward-looking adaptation. In both communities studied, the impacts of recent floods included damage to housing structures and the loss of vital household possessions, such as furniture, mattresses, and appliances. As noted by one interviewee, “for someone whose home has a mud floor and a tin roof, the absolute value of losses [from flooding] may not be very high, but in relative terms it is, because it's everything they've got” (Interview Di Pietro 2013). In response to costly and periodic losses, households begin to adapt their strategies and behaviors. One person from the Independencia neighborhood, for example, explained that after twice having his house flooded and watching his waterlogged wooden furniture rot, he now only furnishes his house with things made of metal pipes or glass.

The longer-term autonomous adaptation strategies observed in RRB settlements were both individual and collective in character, but all emerged in response to floods. On a household level, strategies included the replacement of furniture with flood-resistant materials, the elevation of houses on stilts, the building of informal drainage paths, the use of piled up construction waste to act as a kind of ‘sand-bag’ for protection, and the elevation of informal electricity connections (Interviews and community workshops). Authorities from the Municipality of General Rodríguez (Upper Basin) described the construction of physical flood barriers in informal settlements, while those from the Municipality of Morón (Middle Basin) reported the use of barriers and the elevation of gates and residential structures.

Interviews with experts from IIED-AL showed that isolated physical adaptations may mitigate flood impacts for some households while exacerbating them for others. They described one informal settlement in the Municipality of Tigre (Lower Basin), where a few residents obtained landfill to elevate their houses by approximately one meter, increasing the flow of stormwater to lower-lying houses which were unable to do the same. They explained that while such problems generate considerable friction, they can be overcome through dialogue and collective problem-solving: “a lot of times, it's just a question of providing the space for change” (Interview Almansi 2013). In this case, the solution hinged on obtaining more fill to elevate the remaining houses.

The research team also observed in situ risk management and autonomous adaptation among institutions - including both businesses and non-profit organizations - heavily invested in the area. These collective adaptation strategies were more ambitious (and more costly). Near the

Independencia neighborhood, for example, a large industrial park recently constructed flood gates to protect their 800 employees and their physical assets in the case of future floods. Unfortunately, this has resulted in stormwater draining into one of the adjacent settlement's main thoroughfares, making foot, horse, and automobile traffic even more treacherous during heavy rainfall. In the same community, the Roca Church has replaced its floorboards 3 times between 2011 and 2013, more than any other time in memory. During heavy rains, water rises from beneath the church, which is located well below the floodline of 5m above sea level. Appropriate longer-term adaptation responses, such as the provision of networked water and electricity, is rarely achievable autonomously by the community (though historically there have been cases of this, such as in Martin Coronado, Tres de Febrero).

Another important aspect of autonomous adaptation found within one of the communities studied (Independencia and the surrounding José León Suárez area) is the out-migration of middle-income households and the subsequent abandonment and decay of urban spaces. Essentially, in the areas worst affected by floods, only low-income households remain and attempt to build their resilience to worsening conditions, while others with more resources eventually relocate. This has led to increasing impoverishment and generated opportunities for squatters. One workshop participant explained that “many people have abandoned their houses; you see more and more houses with the paint and plaster falling off, with rotten doors, etc” (Community Workshop José León Suárez 2013). He said that owners “won’t spend one more cent here because it just keeps flooding” (Ibid). On the other side of the railway tracks, where the informal settlement of Independencia is located, people voiced their frustration; they have limited resources and no options to move elsewhere. They are resigned to find solutions and adapt in situ.

Existing vulnerabilities are further stressed as a result of changing climatic conditions. The relative economic capacity for adaptation is limited, which defines part of community vulnerability and lower levels of resilience in informal settlements. However, Jorge Karol (Interview 2013) also highlights that the experiences of extreme weather events shows a lack of alert systems, contingency plans, and planned adaptation across many urban areas of the MRBA, not just vulnerable settlements. In fact, Karol argues that much can be learned from adaptation within informal settlements, in particular their capacity to “defend their right to life and organize their time and communities” to define and effect change. The informal neighborhood association (the *Mesa de Entidades*) from Independencia is an example of such protagonism, with one community member commenting: “united we are strong, we all have to pull in the same direction” (2013). The capacity of vulnerable informal settlements to adapt to large-scale changes denotes a dynamism which is often lacking in the 'formal' city. However, given the complexity of hydraulic systems, the entanglement of urban, environmental, infrastructural causes of flooding, and the newness of climate change discourse, this creativity and mobilization capacity are only beginning to emerge on the issue of adaptation.

Research indicates that in the RRB, as in other locations, informal settlements bear a disproportionate burden in the face of climate change due to socio-spatial vulnerabilities. However, what is also true is that settlements do not exist in perpetual slum conditions, but contain strong forces of regeneration. They are places where—following Jacobs’ concept—the ‘unslumming’[25] process is constantly underway. It is this ‘unslumming’ process that currently

[25] Jacobs, Jane, *The death and life of great American cities*, Vintage Books Editions, New York, 1992

influences autonomous adaptation in informal settlements throughout the RRB. Informal systems of mutual assistance and reciprocity are a key aspect of community adaptation strategies, since it is through this 'social capital' that a sense of belonging to a group is developed in a network of lasting social and institutionalized relations.[26] Informal settlements in the RRB tend to exhibit socio-territorial structures that support strong ties within the community. Such features of the informal settlements of the RRB are the basis for current autonomous adaptation and will be vital for future advances.

In addition to bottom-up autonomous adaptation in the RRB, it could be argued that a form of autonomous adaptation is also occurring within the public sector. This study has highlighted a commonly occurring trend of small-scale adaptation responses by different levels of government, such as individual creek channelling or stormwater policy changes (Interviews 2013, various). Such responses are neither 'spontaneous' nor 'planned' in response to climate change. Indeed, the binary categories of 'spontaneous' and 'planned' adaptation appear ill-fitted to the RRB, where state-led land use and emergency response planning may overlook or discount links to climate change, but nevertheless constitute a type of autonomous state-led adaptation to changing climatic conditions. Emerging literature on climate change as a 'transformative stressor' of institutions in urban contexts, particularly by Matthews (2013), offers insights into how these processes may occur incrementally within government. Some areas of government policy and projects in the RRB seem to conform to this notion of incremental change that is intuitively influenced by climate change.

In conclusion, autonomous adaptation is occurring in the RRB, particularly among informal settlements and adjacent areas affected by damaging floods. Also, the public sector appears to display a form of incremental autonomous adaptation. Presently, the main influencing exogenous pressure is flooding. The links are still tenuous between national guidelines and diagnoses and locally-developed projects. Communities and municipal governments of the RRB demonstrate growing awareness of trends, risks and vulnerabilities linked to changing conditions. Current responses tend to constitute reactions to lived experiences of a changing climate, in particular increased flood intensity and frequency. Public opinion and pressure on climate change as an issue is only beginning to emerge and clear local 'champions' inside and outside the public sector are yet to emerge. Overall, while autonomous adaptation is occurring within the RRB, it is piecemeal by nature and does not appear to holistically respond to community needs or offer a solution to climate change preparedness over the long-term.

Section 6: Challenges to Adaptation in the Reconquista River Basin

Framework for Analysis

Despite the advances described previously, planned climate change adaptation in the RRB still faces a number of challenges. Consequently, the development of a basin-wide medium or long-term planning framework to effectively mitigate the risks of climate change is, as yet, a fairly

[26] See Bialakowsky, Alberto y Reynals, Cristina, 2001 "Hábitat, conflicto social y nuevos padecimientos", Seminario Internacional "Producción social del hábitat y neoliberalismo. El capital de la gente versus la miseria del capital," Montevideo, Uruguay.

distant goal. The research team identified challenges through the review of literature, through workshops with affected communities, and, through expert interviews, which served to elucidate national, provincial, and municipal decision-making processes. In addition to their discussion of advances and achievements, many informants spoke openly about the structural, functional, behavioral, and resource-related factors that impede the progress on climate change adaptation in the RRB. As discussed previously, diverse factors exacerbate climate change risks in the RRB, ranging from socio-economic concerns to infrastructure deficits, as well as institutional challenges.

Infrastructure deficits apply across hard services (sewerage, potable water, gas electricity) and soft services (health clinics, educational establishments). Deficits are more pronounced in the growing high-density informal settlement areas, many of which are located below the floodline. These geographic and spatial characteristics, as well as the precarious housing conditions of many settlement populations, make them more vulnerable than others to climate hazards and associated effects, namely flooding. Also, because their inhabitants experience high levels of unemployment and sub-employment, they lack the economic means to access alternative housing or make improvements to bolster resilience in situ.

Institutionally, the RRB faces numerous challenges related to regulations, enforcement, and control of development (including, for example, residential and industrial development) as well as challenges to linking up sector-based approaches to transportation, housing and infrastructure. The COMIREC represents an important step in terms of inter-jurisdictional governance. However its competencies are not squarely aligned with climate change and do not extend to the planned coordination of sectorial issues, which lie largely in the hands of different provincial government departments (such as health and education) or with municipal governments. Thus, strategic and integrated planning in the area is challenged by overlapping responsibilities. In this regard, many of the challenges facing adaptation planning in the RRB are common to many other metropolitan regions around the world.

Risks vary among municipalities within the RRB and even among settlements, based on their particular hazards, vulnerabilities, and adaptive capacities. Consequently, so do challenges. An analysis of specific challenges at the sub-basin level lies outside the scope of the study. This section, instead, aims to classify and expand on the climate adaptation challenges faced by the RRB as a whole. For this purpose, the research team has employed an analytical tool developed by the World Resources Institute (WRI): the National Adaptive Capacity Framework (NAC). Although the NAC was designed to evaluate national adaptive capacity, it is considered that its content is equally relevant at a sub-national level, in this case, that of the RRB. Furthermore, because the NAC does not presuppose a given institutional structure—focusing instead on the functions[27] variably performed by different levels and organisms of government, as well as private sector, academic, and community actors—it can be easily be adapted to complex configuration of the RRB. The five key functions around which the NAC is organized—

[27] According to WRI (2009), "NAC takes as its starting point the idea that all national adaptation systems will need to perform a similar set of functions if adaptation is to proceed effectively. These functions include, for example, assessment of vulnerability, coordination of different adaptation actors, and management of climate-relevant information. Of course, in different countries these functions may be performed very differently – in different sequences, by different actors, with different values and emphases – but the core functions will be essentially the same."

assessment, prioritization, coordination, information, management, and climate risk reduction—informed the expert interviews carried out by the project team. Here, the team has used a slightly modified version of the NAC and the UN Habitat on Planning for Climate Change: A Strategic, Values-Based Approach for Urban Planners to organize information about challenges facing adaptation in the RRB.

Information Management

According to WRI (2009), information management consists of "collecting, analyzing, and disseminating knowledge in support of adaptive activities." It varies, but typically includes "climate variables, the status of natural and human systems, and existing coping strategies" (Ibid). Furthermore, good information management ensures that "useful and accessible to stakeholders" (Ibid). Because access to reliable information about hydro-meteorological phenomena, social and economic characteristics, and urban development in the RRB is a necessary prerequisite for all other adaptation activities, this function is of primordial importance for adaptation planning. However, information management constitutes one of the key challenges facing public and private actors at all levels. Based on the research conducted, including in-depth interviews, three main challenges have been identified in terms of information management: insufficient systematization and analysis, information sharing, and public dissemination.

Argentina has relatively advanced environmental and meteorological monitoring systems in comparison to many Latin American countries (AFC Consortium 2009). It has reliable and up-to-date census data and the municipalities of the RRB generally have very good health statistics. Some relevant information is outdated (Interview González 2013), such as the register of industries in the RRB or flood maps. Thus, while there is still space for improvement, there is ample data with which to initiate a concerted analysis of climate adaptation options in the RRB. This has not occurred and one contributing factor is that existing data has not been well systematized for this purpose. For example, a system of indicators to monitor climate change or measure its effects is yet to be developed. Some environmental indicators, such was water and air quality, are separately monitored, but in isolation they cannot offer a complete picture of metropolitan wide or basin-wide trends. Without having a holistic perspective on climate change for the RRB, it is "difficult to establish long-term policy" (Interview Dadon 2013) in relation to adaptation planning.

There are numerous studies on the deteriorating environmental conditions of the MRBA, and some specifically on the RRB, which point to key problems, such as industrial contamination and clandestine rubbish dumps. Municipal governments also produce studies about the changing characteristics of their jurisdictions. These studies provide baseline information about numerous components of climate change risk, but generally do not account into account the interaction effects between them or their compound effects on human health. The representative of a well-known NGO, currently in its third year implementing a large project on adaptation to climate change with the Municipality of Tigre, explained the gap between data collection and analysis, saying "municipal governments know which areas flood periodically and where they have had to provide emergency assistance… they've done a lot of work just based on census data, constructing indices and the like. But we believe that, in addition to this, they need to consider a

number of other things to really understand what's going on. Census data alone doesn't tell you much [in terms of climate change vulnerability]" (Interview Almansi 2013). While base information is, indeed, a fundamental prerequisite for future interventions, effective climate change adaptation planning also requires deeper and more integrated analysis.

Another key challenge, in terms of information management, is that of information sharing across government offices and with external actors (Interviews Lara, Ryan, Karol, Dadon 2013). A number of informants (González, Lara, Ryan, Almansi and Hardoy) agreed that national scientific organisms, such as the National Meteorological Institute (IMN), the National Geographic Institute (IGN), the National Agricultural Technology Institute (INTA), among others, generally do an excellent job of data collection and processing. However, there were concerns that existing data was difficult to obtain in relation to various levels of government due to cost barriers, bureaucratic impediments, or 'inter-institutional rivalry.' One informant who preferred anonymity on this point stated that "there are areas of the government that are very protective of their information and there is information that is unavailable even though it's supposed to be public!" Another informant said that, for many public organisms and offices, information is power, so the question of information sharing becomes a political game. The research team observed barriers to fluid information sharing at all levels of government, making this a universal challenge to adaptation in the RRB and, according to other studies reviewed, in many other metropolitan regions around the world.

Reduced information sharing between government and non-governmental (mainly academic) institutions also emerged as a salient challenge adaptation planning. Three informants (Ryan, Karol, and Dadon 2013), separately made reference to the catastrophic April 2013 flood of La Plata city which led to over 50 deaths, explaining how research generated by universities had predicted some of the impacts of a major precipitation event there. They commented that, unfortunately, this research had not penetrated government or impacted decision-making relating to water and land-use management prior to the flood. Resource deficiencies among the municipalities of the RRB make the production of 'synthesis' studies or other types of complex analysis at the local level a difficult undertaking. Thus, the work of research institutions becomes doubly important as an input for local planning. However, links between these institutions and municipal governments are still tenuous, and there appears to be shared responsibility for this. Albina Lara (2013) commented on this, saying "I think sometimes, universities, and environmental groups too, make the mistake of saying 'they just don't understand.' But why don't they understand? Quite possibly, we've presented the message in a way that's incomprehensible… I think universities - and I include myself here - have to find a way to translate the work they're doing into something that's comprehensible to local decision makers." Moving forward, there are challenges on both sides, in terms of synthesizing findings and communicating them to relevant audiences in order to bolster adaptive capacities.

The final information-related challenge identified by the research team has to do with inadequate public dissemination. There is scarce information available to the general public about climate hazards or adaptation strategies in the RRB. With a few exceptions (notably Morón) the topic of climate change is absent from municipal websites. Even the two municipalities which participate in the Network of Municipal Governments on Climate Change (*Red de Municipios Frente Al Cambio Climatico*, in Spanish) don't employ other measures to disseminate the information

channeled therein to a wider audience via the internet in order to increase awareness and stimulate public debate. Daniel Ryan (2013) explained public debates about climate change are, inherently, complex due to the degree of uncertainty involved and the variable spatial and temporal scales. “This makes it hard to translate things into terms that are meaningful for democratic deliberation, voting, etc.” However, as stressed by the NAC and the UN Habitat Manual on Climate Change Planning, public debate is an essential component of sustainable adaptation planning.

In the informal settlements of the RRB, information dissemination on issues of climate hazards and adaptation is a major challenge. Authorities from the municipal governments surveyed as part of the project affirmed their coordination with settlement communities, citing hydraulic and wastewater treatment projects (Malvinas Argentinas Municipality), waste collection services in situations of heavy rain (General Rodriguez Municipality), and the IIED-AL project *Riberas Rioplatenses* (Tigre Municipality). However, many cases exist in which municipal governments do not or unable to provide basic information about infrastructure, housing, and emergency response. This was a topic of concern at one of the workshops held. There, residents who had recently suffered a major flood event complained about the lack of information from state-led emergency response providers before, during, and after the flood, saying “we’re not informed about what is happening or what we are supposed to do when we have an emergency like this” (Workshop José León Suárez). Among informal settlements which suffer from flooding and associated health problems, public education can contribute to impact mitigation and overall risk reduction. Furthermore, access to information can bolster local resilience and sustainable adaptation planning. As noted by Silvia González (2013) “in critical areas, people need to know the reality of the situation. If you don’t tell them, it’s like you’re denying it, and that puts them doubly at risk because they simply don’t know.”

Many of the experts interviewed as part of this research felt that information was one of the key challenges to adaptation planning. According to them, this challenge can only be overcome by sending a ‘clear message’ on climate change, first by studying how climate change will impact local economies, environments, and populations, and then by communicating these findings to politicians and to the general public, in terms that they can understand. This process has already begun, as evidenced by the successful articulation of researchers and municipal actors as part of the project *Riberas Rioplatenses* (Municipality of Tigre), among other examples. But, in order to achieve lasting effects, this process should be further stimulated. As highlighted by Di Pietro (2013), “like any new branch of scientific inquiry, maybe people didn’t have it at the top of their mind; it seemed more tangential to the issue of development. But now it’s essential to have good information on climate change.”

Assessment of Risk

The NAC describes assessment as “the process of examining available information to guide decision-making” (WRI 2009, 3) and says that “Adaptation is likely to require iterative assessments over time, including assessments of vulnerability, climate change impacts, adaptation practices, and the climate sensitivity of development activities” (Ibid). In the case of the RRB, assessment implies generating a deeper and more comprehensive understanding of existing conditions and risks, as well as a more nuanced picture of how risks are likely to evolve

in the face of climate change. As mentioned above, assessments of all types are contingent on the availability and accessibility of locally-relevant data and analysis of climate-related impacts. Assessment is an iterative process, which requires periodic evaluations. It requires participation by multiple stakeholders, including elected officials and civil servants (technical staff), private sector and business, NGOs and civic organizations, and affected communities. As highlighted by UN Habitat, in order to effectively guide decision-making processes, assessments should address both scientific/ technical knowledge and local, community-based knowledge and values as "perspectives that are important to consider when making climate change decisions" (2011, 95).

In terms of existing risks, one key challenge to climate change adaptation in the RRB is assessing impacts of climate change given the region's current development conditions. Due to the historical urbanization process of the RRB, development has often occurred before planning and infrastructure provisions, which has led to the occupation of flood-prone land or risk affected areas in some places. As detailed in Section 3, the cumulative effects of urbanization (land impermeability, changed drainage patterns, contour elevations through filling, etc.) have radically altered environmental conditions. With the introduction of new planning laws over the last few decades, further challenges have arisen regarding the implementation and control of land-use regulations, as well as the exclusion of many social groups from accessing affordable land and housing, leading to the growth of informal settlements in the RRB. The rapid growth of these settlements, the ongoing development of gated communities, and projects that alter hydrological systems make the RRB a dynamic system in which local assessments quickly become obsolete. Furthermore, it is unclear which impacts are solely attributable to changing climate conditions and which respond to other social, economic, and urban causes.

Assessment refers to all elements of risk, including climate hazards and associated impacts, vulnerability, and capacity, and assessments should include both qualitative and quantitative analyses of climate change impacts. In the words of Albina Lara (2013), "there needs to be a comprehension of how climate change affects everyday life, and the finances, the economy, and the people of a municipality." The research team carried out an extensive literature review, in search of numeric estimates of climate-related impacts in the RRB as a whole, including flood damage to housing and infrastructure, economic or production costs, and public health. With the exception of the Barros study cited previously, it was unable to obtain any estimates. Every person interviewed was asked to describe how the vulnerability of a given settlement, municipality, or region could be assessed and how the potential impacts of climate change could be quantified in the RRB. They were also asked to describe any vulnerability assessments they had done or seen. Although most informants had anecdotes about the problems experienced by settlements, such as health impacts, the loss of work animals, and economic hardships, none were able to identify studies with quantified impact measures. The IIED-AL project in the Municipality of Tigre was the only exception, but at the time of the study it was not yet available for review.

Assessment is not limited to vulnerability, but also aims to inform broader development strategies, by making 'climate sensitivity' a transversal issue for sectoral approaches to land use planning, infrastructure, transportation, environment, and health, among other things. Municipal governments are responsible for most such efforts within their jurisdictions, and therefore play a

central role in assessment. As noted by Cecilia Larivera (2013) municipal governments are also the best positioned to assess the impacts of climate change at the local level, since they are the ones closest to the ground and to citizens' everyday demands. But, as is the case for the RRB, municipal governments also lack planning authority on some large development matters and are resource constrained, which can led to short-term technical fixes rather than strategic and integrated approaches to planning (Brackertz and Kenley 2002; Crabbé and Robin 2006). As part of the team's survey efforts, municipal planners were asked to describe how climate change is being addressed across various sectors of government (see section on municipal adaptation). While there appear to be incipient efforts in this direction, climate change is far from transversal in most settings.

There are ongoing efforts to assess existing conditions in the RRB in order to inform planning and policy decisions. As explained by Larivera (2013) there has been "incommensurable investment" in the RRB over the last 15 years "but there is still a lot more to be done." "There was a long period state withdrawal in terms of planning and infrastructure, which is clearly reflected today in the social and environmental conditions of the RRB" (Interview Larivera 2013). As investment has increased, so has technical proficiency, articulation between different levels of government (national, provincial, and municipal), and the demand for baseline information on development conditions and climate-related risks. However, budget constraints continue to present challenges for integrated planning in the basin (Interview Anselmi 2013). Moreover, despite immense efforts to coordinate land use and infrastructure planning and development throughout the river basin, sometimes specific interventions are applied to address local problems. The cumulative impacts of some of these solutions, such as creek channeling or the filling and elevation of floodplains, combined with widespread unplanned urbanization are very challenging to assess. As climate change adaptation planning moves forward, it will inevitably need to address these challenges. At the same time, it will be important to develop improved measures of hazard, vulnerability, and adaptive capacity, as means for rational resource allocation and transparent public debate about the costs and benefits of risk management.

Prioritization of Climate Change

The NAC describes prioritization as "assigning special importance to particular issues, areas, sectors, or populations" (WRI 2009, 3). For adaptation planning, prioritization may take into account the geographic distribution of climate change impacts and the differential vulnerability of different populations to them. The NAC stresses that effective processes of prioritization must be transparent, engage a wide range of stakeholders, be flexible to adjustment as circumstances change. The prioritization function can be understood on two levels in the RRB. On the one hand, what priority does climate change adaptation have with respect to other public initiatives? Here the main challenge identified by the research team is the lack of recognition of climate change as a threat to development and human wellbeing. On the other hand, within climate-related policies and programs (including vulnerability reduction), how are different issues, areas, and populations of the basin or of a given municipality prioritized? Here challenges are similar, but also include the relative lack of information and resources faced by municipal authorities.

Climate change is beginning to form part of the political agenda in Argentina, but is still not considered a priority issue (Aliciardi 2011; Barros 2009; various interviews). Adaptation is an emerging concern for national policymakers due to external factors, such as international agreements and project funds, and internal factors, including the work of the National Climate Change Office, which has led the development of useful tools, like the Manual on Adaptation and Vulnerability. 'Champions' from the National Ministry of Planning, Civil Defense, and public and private research institutions have also helped to start raising awareness about the climate change issues. Inter-institutional articulation still faces frequent obstacles (Interviews González, Ryan et al. 2013). With the exception of the Ministry of Agriculture, adaptation has not been mainstreamed by other national organisms, such as the Ministry of Health, the Ministry of Economy, or the Ministry of Social Services. While these institutions should not be expected to assume central leadership for climate change adaptation planning, they each have an important role to play in the provision of information, sectoral vulnerability and adaptive capacity assessments, and the development of policy guidelines. Thus, the national debate as a whole would benefit if climate change were assigned a higher priority within their respective agendas.

Another general challenge to prioritization is the temporal variability of political issues. As previously noted, catastrophic events—such as the April 2013 floods—can act as transformative stressors, rallying political commitment and public demand around a high-profile issue, in this case, risk management. Informants invariably discussed recent flood events, and most agreed that they had served to elevate the profile of climate change in the public agenda. However, many expressed concern that—like the 2003 floods in Santa Fe, which were of equal or greater magnitude—"as soon as the waters subside, so does political interest." Another person speaking spoke anonymously on this point, affirmed that the problem of flooding, which is complex and expensive, has been systematically avoided on the political agenda. They commented that "this problem will never be resolved because each administration only has to suffer through one." Extreme climate events have historically occurred with enough infrequently that they are forgotten and institutional 'unlearning' occurs. Examples of 'unlearning' provided by informants included the debilitation of 'response' capacities, disarticulation and fragmentation, and the overlapping of functions (Interviews Lara, Karol, Dadon 2013). Generally speaking, efforts to integrate climate change into the agenda of 'peripheral' organisms tend to hinge on a few committed individuals (Interviews Ryan, Di Pietro, González, Lara, Almansi and Hardoy 2013). Projects are hard to sustain and often survive based on the capacity of technical support staff despite variable levels of political commitment.

Challenges of political will also emerge in the municipal context, but are slightly different in scope. According to a number of the people interviewed, climate change is not prioritized by municipal authorities mainly due to lack of resources. Given the tough reality of many municipal districts within the RRB, they are consistently overshadowed by 'urgencies' related to public safety, unemployment, union disputes, or public demands to improve health and education services. As Albina Lara (2013) explained, "what is most needed is prevention and proactive planning; but municipalities are forced to put out fires all the time." However, this type of ad hoc response does not necessarily contribute to climate change adaptation, which requires a longer future horizon.

Municipalities face similar challenges to other levels of government in terms of making climate change a priority across sectors. In reference to the April 2013 floods, one informant recalled the complaints of a municipal employee from the Lower Basin of the RRB, who said "I just can't make the other areas [of government] understand that this isn't just our problem, that it isn't just a problem of emergencies, or health, or civil defense, that everyone has something to do with this." Climate change has traditionally been viewed as an 'environmental' problem, meaning that knowledge of the issue has been centralized in the Environmental Management department, which is notoriously resource deficient in many municipalities. The increasing intensity and frequency of floods, particularly in settlement areas, has raised awareness of climate change among municipal offices of Civil Defense (responsible for emergency response) and Social Services (responsible for the welfare of the indigent and often in permanent contact with the populations of informal settlements). But these departments also suffer from resource scarcity and cannot make climate change a political priority in the municipal agenda.

Climate change adaptation has not been explicitly prioritized by most municipal authorities of the RRB. However, as discussed previously, this does not mean that adaptation is not occurring. Indeed, recent investments in public infrastructure and improved housing for informal settlements can be construed as a climate-sensitive response to structural vulnerability. Unregulated urban development, the degradation of natural buffers, and environmental contamination are interrelated problems which can only be addressed through large-scale investment and integrated planning. Cecilia Larivera (2013) of the Provincial Ministry of Infrastructure explained the need for an integrated approach to planning that captures a range of needs, with a focus on vulnerability reduction and the monitoring of socio-spatial imbalances. For example, this department has a transparent mechanism for the prioritization of activities, which involve the resettlement of "critically vulnerable households, in high risk, high complexity situations" (Ibid). Regional water authorities, such as AySA, plan and prioritize interventions taking into consideration precipitation patterns (Interview Lanfranchi 2013) and have made renewed commitments to servicing vulnerable communities that were previously excluded from infrastructure provision due to their location on low-lying lands (Interview Anselmi 2013).

Climate change adaptation is not an explicit priority in the RRB. This is evidenced by the absence of climate change policies among municipalities or at the basin or metropolitan level. Local governments often have less information, fewer resources, and more limited time than their provincial counterparts and tend to prioritize issues which appear the most urgent, "hot potatoes" in the words of one person interviewed. As with national prioritization, there is incipient progress but much work remains in order to make decision-making patterns more consistent, transparent, and sustainable. The primary and secondary impacts of climate hazards on vulnerable settlements and the population as a whole are still poorly understood, so climate change is viewed as something "absolutely secondary and peripheral" (Interview Ryan 2013). It is a "distant and cloudy" issue (Crabbé and Robin 2006) given the already crowded agenda of political priorities and social demands, and is further hindered by difficulties in inter-institutional coordination (Various interviews). Slowly, in response to external shocks and genuine commitment to reducing social vulnerability, a number of climate-related concerns have begun to emerge within existing frameworks of decision-making, especially related to stormwater management, infrastructure planning, and public housing in the RRB. However, in order to overcome challenges related to continuity and transversal integration, and ensure that needs and

vulnerabilities are properly prioritized at the local level, climate change adaptation would need to become more firmly situated in governance frameworks.

Horizontal and Vertical Coordination

Coordination refers to the material and communicational linkages within the public sector and between government and non-governmental actors, including businesses, academic and non-profit institutions, and local community organizations. These linkages are both horizontal (for example, among ministries or municipal level actors) and vertical (for example, between national governments and international organizations or sub-national authorities). According to the NAC, the coordination of activities "helps avoid duplication or gaps, and can create economies of scale in responding to challenges" (WRI 2009, 7). Coordination in the RRB is of particular import, given the multi-jurisdictional character of the region, the multitude of actors involved in planning activities, and the need to maximize scarce economic resources, particularly at the municipal and community level. As noted almost universally by the experts interviewed, the difficulty of coordination between public sector institutions is a major obstacle to effective climate change adaptation in the RRB. Furthermore, the competing logics of government and non-governmental organizations, in terms of strengths, weaknesses, competencies, timelines, priorities, and bottom-lines, makes coordination among them a major challenge.

Difficulties in coordination derive, in part, from the fragmented nature of different development initiatives in the RRB, which has historically been subject to different strategies by national ministries and organisms of the Provincial government (including the OPDS, the Ministry of Infrastructure, and the Ministry of Housing for example). From her position at the Provincial Ministry of Infrastructure in managing some of the infrastructure and re-urbanization projects in priority areas, Larivera (2013) affirms that in general "it is very difficult to advance an integrated approach or plan in a complex area. A great deal of inter-jurisdictional articulation is needed." While this ministry, in particular, has been relatively successful with horizontal and vertical coordination, this success is contingent on the existence of a clear mandate, a high degree of political commitment to improving water and sanitation services in the RRB, and an influx of external financial support. Articulation between the Provincial Ministry of Infrastructure, the basin-wide authority (COMIREC), the main company responsible for water and sanitation (AySA), private consulting firms (such as Halcrow), and municipal governments of the basin has largely occurred under the auspices of the aforementioned IDB project and represents a unique achievement of integrated planning in the RRB region.

In terms of climate change adaptation, one of the main challenges related to coordination is the need for a clear policy direction and greater institutional leadership. Albina Lara (2013) suggests that the obvious coordinating body is the Climate Change Office of the National Secretariat for the Environment and Sustainable Development (SAyDS), which is the nation's authority of issues of climate change. However, in order to be effective, the Secretariat must lead "from a position of strength in order to be able to integrate other government actors" (2013). As noted previously, this is beginning to occur, but the Secretariat's influence over strategic territorial planning is limited by its mandate and by the institutional structure which tends to decouple planning from environment management. Currently, the de facto leadership for regional

adaptation planning lies within the national-provincial-COMIREC complex institutional matrix described above.

Currently, the main focus is on the provision of essential sanitation infrastructure and climate change considerations are subsumed within some existing activities. While the COMIREC is the organism best positioned to coordinate strategic planning efforts in the RRB, climate change adaptation functions exceed its past experience, current mandate, institutional structure, and budget. While inter-institutional coordination in the RRB is a complex issue with no easy solutions, climate change adaptation has the potential to serve as an articulating force to strengthen integrated planning efforts.

Closer to the ground, the municipal governments of the RRB face horizontal and vertical coordination challenges. Because provincial or national organisms often hold the purse-strings for large-scale investments, municipal governments tend to concentrate planning efforts within their own jurisdictions. They often have less direct involvement in planning and implementation of large regional projects. This generates information gaps and difficulties in coordination. As described by one informant, anonymous on this point, "the articulation of municipalities with one other, with the Province of Buenos Aires, and with the National government is tremendously difficult. This is most evident with respect to water management and stormwater drainage systems."

Also noted by Pini et al. (2007), local governments are generally highly constrained to plan for adaptation in terms of their financial capacity, and this very much the case in most municipalities of the RRB. The coordination of planning efforts between adjacent municipalities is hard because "inter-jurisdictional coordination is not accounted for in municipal government budgets in Argentina: there is no money for coordination" (Interview Karol 2013). Political differences further hinder coordination efforts. As a result of these factors, many municipal governments see collaborative action as a potential strain on scarce human and financial resources or as a threat to political allegiances (Interviews 2013). Some authors argue that current institutional designs, in fact, "produce unsustainability" and unarticulated governance mechanisms can reproduce and exacerbate risk, as opposed to creating a solid platform for adaptation (Karol 2013).

In terms of municipal coordination with non-governmental institutions, including universities and think tanks, the business community, and community-level organizations, the principal challenges have to do with resource scarcity and differences in 'operating logics.' Despite inquiries about linkages between municipal governments and businesses on the issue of climate change adaptation, the research team discovered no examples of this. With a few notable exceptions, ties are weak between municipal governments of the RRB, and academic organisms, universities, and non-profit organizations, in part because of differences in operational timelines and management systems. Some municipal authorities are reticent to initiate open consultative processes, for fear of generating expectations that cannot be met (Interview 2013).[28] This is particularly true in settlement communities, whose demands towards the State are overwhelming and cut across issues of employment, housing, education, health, and public security. As

[28] Notable exceptions identified by the research team include the neighborhood improvement project (PROMEBA) being carried out in the Municipality San Fernando and the Riberas Rioplatenses project being carried out by IIED-AL in conjunction with the municipal governments of Tigre. Like these, there are likely other examples in the RRB.

evidenced by survey results, there are few tangible examples of coordination between municipal governments and settlement communities on the issue of climate change adaptation.

Across the board, coordination was highlighted as an acute challenge. This presents challenges for adaptation planning, which requires collaborative and integrated approaches to governance. There have clearly been advances over the past decade, in terms of regional planning and inter-institutional articulation, most notably in the area of infrastructure delivery efforts which account for changing climate conditions to a certain extent. However, a number of obstacles remain. Climate events are strong motivators for change, and may prove to be the 'transformative stressors' needed to spur greater levels of coordination. The first reason for this is that emergency responses, by definition, require high levels of coordination. The second reason is that, due to their devastating impact on vulnerable communities, floods generate intense public demands. Failure to respond carries a high political cost, whilst ex-post relief and recovery efforts require enormous investment of public resources. Thus, political leaders and technical specialists, especially those at the municipal level, have growing incentives to act preventatively, adopting a more holistic perspective on climate change adaptation and coordinating with other institutions. As described by Almansi (2013) "whether or not it's 'their' issue, different areas of government are beginning to realize that they need to deal with [climate change] using whatever tools they have available because it affects them. So, little by little, they are starting to respond."

Section 7. Conclusion & Scenarios of Adaptation in the Reconquista River Basin

This research project has sought to explore some of the links between conceptual classifications of climate change adaptation and real adaptation, as it is occurring in the RRB. Particular attention has been paid to autonomous processes of adaptation for risk minimization. From a review of literature and relevant policies on climate risks, vulnerability and adaptation, as well as through qualitative engagement with policymakers, researchers, and communities, the research team has compiled a characterization of urban risk facing the RRB and an appraisal of existing climate change adaptive capacities.

Overall, the RRB is vulnerable to climate-related hazards, especially flooding. Vulnerability in the RRB is defined by exposure to increasing climate-related hazards, but also relates to the local adaptive capacity. Presently, there is a convergence of different reactive and autonomous actions contributing to incremental adaptation throughout the RRB. There are strengths associated with existing adaptation mechanisms, including the various autonomous community-based strategies that build on strong social capital, reactive responses to changing climate conditions through local level planning tools, such as stormwater planning and infrastructure standards, and emerging higher-level policy and project-based initiatives from both the provincial and national government.

Despite efforts to address poverty and reduce vulnerability generally, adaptation in the RRB faces numerous challenges. Not dissimilar to many other metropolitan regions around the world, there is no overarching strategy for advancing climate change adaptation in the RRB, so piecemeal solutions are implemented to address discrete problems. Development of a more integrated approach to adaptation is hampered by other challenges, for related to information

management, integration and coordination in governance as well as the current low prioritization of climate change on the policy agenda. Furthermore, increasing urbanization rates - particularly in hazardous locations - present further challenges to an already crowded agenda of priorities to address basic unmet needs. In sum, the current panorama of adaptation planning presents various strengths and weaknesses. This is the basis from which to assess looming pressures and opportunities for climate change adaptation in the future.

In this regard, and based on the research findings, the final section of the report presents a series of conceivable future adaptation scenarios for the RRB. For the purposes of this research, adaptation planning—similar to urban governance, more broadly—is conceived of as a process that involves the complex and often conflictive interplay of ecological, social, political, and economic forces. Given this complexity, possible future scenarios account for some factors that can stimulate structural and institutional changes. The scenarios do not reflect clear cut decision-making options[29] but instead alternatives paths, based on pre-existing trends and current climate forecasts. Scenarios have also been developed taking into consideration existing governance frameworks and approaches to planning, which will undoubtedly form the basis of future work in climate change adaptation in the RRB. Given current conditions, historical experiences within the RRB, and lessons from other city regions, four possible paths for adaptation planning in the RRB are presented here:

1. Incremental change through a business-as-usual approach;
2. Incremental change through climate 'mainstreaming';
3. Abrupt change post climate-related catastrophe; and
4. Transformative change through integrated adaptation planning.

Scenario 1: Incremental change through business-as-usual approach

Currently, adaptation within the RRB occurs through piecemeal actions and generally without 'conscious' association to climate stimuli. While overall analysis of climate hazards and vulnerability has not been undertaken nor is there an adaptation plan in place, many discrete initiatives influence a process of incremental change regarding conventional approaches to planning in the RRB. These initiatives, including bottom-up autonomous community-based strategies as well as reactive government intervention to climate change impacts, combine with broader trends of economic development to build resilience and reduce poverty in the RRB. However, there are a range of challenges that inhibit adaptive capacity in the RRB. These are discussed in more detail in the previous Section 6.

In a business-as-usual scenario and in terms of institutional-led initiatives, significant improvement in the quality of life for many RRB inhabitants would be achieved through ongoing neighborhood improvement projects, like PROMEBA[30], as well as larger-scale projects planned

[29] This, however, is an approach used in some planning instruments in Argentina, such as the strategic plan for the MRBA entitled 'Lineamientos Estrategicos para la Region Metropolitana de Buenos Aires' (2006). In 'Lineamientos', for example, future scenarios are presented based on key decisions, like the relocation of the port.

[30] PROMEBA is a neighborhood improvement program that seeks to improve the quality of like and contribute to the urban and social inclusion of poor households, particularly those located in informal settlements. Aspects of the projects can include hard and soft infrastructure provision, such as potable water, sewerage, stormwater, electricity, paving, community houses, and open space facilities.

and executed through the Provincial Government of Buenos Aires (for example the 'Reconquista River Sanitation Environmental Program'[31] (RRSEP) that includes basin wide infrastructure upgrading program) or ongoing housing projects delivered through national government programs, including social housing as well as household credits for low-income earners through the PRO.CRE.AR[32] program. Such strategies have achieved demonstrable advances in poverty alleviation, helping to deliver on unmet basic needs and improve the quality of life for many inhabitants throughout the RRB.

In addition to these initiatives, a business-as-usual approach would see the upgrading of certain infrastructure services as well as other discrete policy changes that reflect a trial-and-error relationship with changing climate conditions (i.e. to account for increased precipitation) in areas such as stormwater management, new standards for infrastructure design or earthworks. According to key informants interviewed as part of this research, some of these changes are already occurring in isolated cases, although the phenomenon of climate change itself is not usually explicitly mentioned or analyzed. Furthermore, it is possible that ongoing efforts to improve inter-jurisdictional governance within the RRB may help overcome some of the challenges mentioned in Section 6, for example regarding information sharing. For example, the current IDB funded PMAUS project is contingent on inter-jurisdictional governance mechanisms and requires 'institutional strengthening' as part of ongoing project funding. Some current projects demonstrate improving collaboration, such as the creek channeling project in Independencia neighborhood that was lobbied for at the local level, then supported and co-funded by the Provincial Government. Where policy aims and agendas align, there appears to be growing scope for inter-jurisdictional collaboration.

Under a business-as-usual approach, community-based adaptation is also likely to increase based on existing trends. Despite many advances in quality of life improvements throughout the RRB, recent years have seen swelling urbanization with increased densities in the RRB, a trend that often outpaces infrastructure and other improvement projects. New informal settlements and expansions are more and more exposed to environmental harm as they occupy residual land such as old waste sites, abutting industrial uses or even through filling lagoons and low-lying areas. These established and emerging communities often do not have the opportunity to migrate from hazardous locations and are advancing bottom-up 'unslumming' initiatives that build local resilience. Under current conditions, or even in a regressive context where the community perceives a lack of progress by government relating to building preparedness of communities to risks, urban social movements will continue to lead various community-based adaptation strategies.

In this regard, there are neighborhood areas dispersed throughout the RRB and MRBA more broadly that have achieved extensive improvements without government involvement. An extreme illustration of this movement is the Cooperative 'COMACO' that continues to operate

[31] For more information on this program refer to Sections 3-5 of this report and the Inter-American Development Bank project website: http://www.iadb.org/en/projects/project-description-title,1303.html?id=AR-L1121 .

[32] PRO.CRE.AR is a National Government initiative that proposes to allocate 400,000 low-interest rate loans for the construction, remodeling or extension of houses in order to meet the basic housing needs of many low-income earners throughout Argentina, stimulate economic activity and generate employment. For more information see: http://procrear.anses.gob.ar/programa .

within the localities of Martín Coronado and partially within Lomas del Palomar, Municipality of Tres de Febrero within the RRB. Initially, COMACO was created in the 1970s by members of the community to find a way to deliver basic infrastructure in an area outside of coverage by public services. Through the implementation of innovative funding and management mechanisms, the initiative delivered universal infrastructure coverage over a relatively short time period and today has taken on new aspects of neighborhood improvement, including housing, health and community facilities. It is a community controlled organization that serves as a model for bottom-up, community-driven adaptation in the RRB. Other smaller initiatives, such as replacing weathered materials with more resilient constructions, or local drain building, are also occurring throughout the RRB (some of these were discussed in Section 5).

In some cases, community-led adaptation subsequently links up with government-led initiatives for support and expansion. The above-mentioned Cooperative COMACO is a case in point; it is now the site for inter-jurisdictional meetings held between COMIREC stakeholders in the middle basin, facilitating knowledge exchange in this local area on best practice approaches to environmental management. Regardless of the scale of community-based adaptation strategies, the ability to link up to government-led policy and action presupposes institutional structures that can respond, integrate and assist coordinate such strategies. There is some evidence of this within the RRB, although not all community-based strategies have links back to government. Others remain independent or may connect with other non-profit organizations, committees (such as Chambers of Commerce), university groups or businesses in their local areas.

Despite the strengths of the existing model, the continuation of a business-as-usual approach presents many of the same challenges discussed above (Section 6) and limits the scope for holistic climate change adaptation in the RRB. Increasing (sometimes precarious) urbanization, worsening climate change conditions and existing challenges -for example in addressing historical infrastructure deficits, in overcoming the 'silo' mentality of policy development and implementation or in improving risk analysis- combine to undermine the strengths of a business-as-usual approach. Some authors have discussed the nature of worsening vulnerability (Natenzon et al; Barros 2005; Barrios et al. 2008). Based on a simulation to assess population vulnerability solely to sea level rise in the MRBA, Barros et al. suggested that

> Assuming little change in population density and distribution, under the scenario of maximum sea-level rise during the 2070 decade (…) the number of people living in areas at flood risk with a return period of 100 years is expected to be about 900,000, almost double the present at-risk population (2008).

Based on an assessment of damages to public and private assets, Barros et al. (2008) suggest that a business-as-usual scenario, which takes into consideration a 1.5 percent annual growth in infrastructure and construction and no adoption of flood-protection measures, would result in annual cost of damages of US$80 and US$300 million by 2030 and 2070 respectively. These estimates do not include an assessment of less-tangible impacts, such as health impacts, productivity losses, tax-payer (or otherwise) funded emergency relief, or the compound impacts to be felt by vulnerable groups living in highly exposed informal settlement areas.

Overall, a 'business-as-usual' approach would see a broad continuation of current trends of responding to critical situations and autonomous adaptation within the community and by government. Under such a model, piecemeal solutions undertaken by government agencies, the private sector and communities may address critical issues and improve emergency responses. However, a business-as-usual approach to adaptation planning through piecemeal and incremental changes to urban development and governance practices in the RRB faces limitations in achieving genuine adaptation to climate change. In this regard, and similar to many other cities, long-term adaptation is unlikely to occur as the summation of independent and at times coordinated actions without an overarching and implementable adaptation strategy for the RRB. Current conditions, however, demonstrate many positive advances for adaptation and also lay the ground for the consideration of other possibilities for adaptation in the future.

Scenario 2: Incremental change through climate 'mainstreaming'

Another alternative would entail slow reform through the successful 'mainstreaming' of climate change adaptation within existing governance structures. The mainstreaming process "requires a well-thought-out and carefully planned strategy demonstrating strong technical knowledge of the impacts of Climate Change" (UNDP website). Through the involvement of a range of stakeholders, mainstreaming seeks to integrate climate change considerations into relevant social, economic and environmental policies and actions. Integration involves the modification of normal activities to align with climate change adaptation. This approach has been adopted to differing degrees in a number of cities, for example across India (Sharma and Sanjay 2010), to an extent in the Ho Chi Minh City Master Plan 2025, and to a greater extent in Quito, Ecuador (Carmin et al 2012). These experiences show creative approaches to integrating the climate change adaptation agenda with existing plans and processes.

The abovementioned cities share some elements in common with the RRB context; for example they face ongoing challenges with poverty alleviation and basic infrastructure provision, and they have also experienced climate-related impacts, such as floods or droughts. In these cities, varying attempts have been made to use existing plans (infrastructure, planning, emergency, public health, etc.) as a platform for introducing climate change adaptation. Essentially, once a commitment has been made to introduce climate adaptation measures, linkages are created between existing and new agendas. Often, incremental change in these contexts is triggered by endogenous factors, like changing climate conditions, 'crisis' or 'shock' moments, or external incentives (Carmin et al 2012; Matthews 2013). Sometimes, endogenous forces, like strong leadership or a local climate 'champion' can also influence change (Carmin et al 2012). Overall, it seems that a combination of both may be important for climate mainstreaming.

In some cases, like in Quito, this process of incremental change has culminated to date in the introduction of a city wide adaptation strategy (Evidence and Lessons from Latin America-ELLA 2013). Quito's Climate Change Strategy (QCCS) now includes a host of innovative measures that successfully combine existing goals—like citizen participation and economic development—with risk reduction and adaptation. It should be noted that Quito already had a range of environmental programs, like hillside managements and flood control, which were built upon to create a more integrated disaster preparedness strategy that takes into account climate change. Authors suggest a range of endogenous and exogenous factors contributed to the

mainstreaming and then integrated adaptation planning approach, including existing partnerships with civil society organizations and a willingness to enter into new partnerships, outdated planning mechanisms to cope with new and growing development challenges and the percieved lack of national-level leadership on adaptation (ELLA 2013) as well as "visionary local officials, the desire to be regarded as a national and regional leader, and the intent of serving as an example for other cities or countries" (Carmin et al 2012, 26). Quito presents a strong example of how mainstreaming climate change can lead to transformative change over the long term.

Despite its gradual pace, mainstreaming climate change offers a pathway of many opportunities for the RRB. An opportunity exists to build on the extensive work that has already been undertaken - for example, expanding infrastructure networks, improving population health, and reducing poverty in the RRB - without necessarily demanding specific climate change adaptation strategy for every municipality. Carmin et al (2012) explain how this unfolded in Quito:

> For instance, Quito could have developed a comprehensive adaptation plan or had each department develop its own adaptation strategy. However, the Environmental Office elected to take an incremental approach so that municipal agencies would have the autonomy and flexibility to learn and adapt as they moved forward. The result is that rather than focusing on creating new plans, the city has been linking adaptation to existing plans and programs in the belief that this will increase the likelihood that adaptation measures will be successfully developed and implemented.

Additionally, new opportunities may arise to access funding for climate change adaptation related initiatives, for example with multilateral organizations that already have an operating presence in the RRB and MRBA like the IDB and The World Bank, as well as to participate in international forums where knowledge is exchanged on issues such as linking climate change and development goals (i.e. MDGs). On the other hand, existing governance structures, like the national Climate Change Unit and the COMIREC in the RRB, are already in place and provide scope for program extensions to incorporate risk assessments and specific adaptation measures. Mainstreaming may also provide the impetus for broader and integrated adaptation strategies over the long term.

Advancing mainstreaming, and climate change adaptation in general, would require concerted efforts to overcome some of the existing challenges in the sphere of urban governance in the RRB, particularly relating to information (availability and access, communication, etc.) and institutional capacity (resourcing, managing competing priorities, leadership on climate change, etc.). Mainstreaming would represent a significant advance in addressing urban risk and has the potential to lead to the development and implementation of an integrated climate change adaptation strategy over the long-term. Such advances, however, may not be enough to holistically and sustainably prepare for climate change over the long-term. An umbrella strategy could therefore be an important goal of mainstreaming climate change adaptation through incremental institutional change.

Scenario 3. Abrupt change post climate-related catastrophe

Another possible scenario is that a severe climatic event impacts the RRB, acting as a 'crisis moment' that triggers a substantial process of institutional change and a reorientation of governance structures towards a process of adaptation to climate change. In this regard, Matthews refers to climate change as a "transformative stressor" and suggests that it has "the capacity to compel institutional change, irrespective of the influence of institutional actors and institutional capacity" (2012: 1089). The kind of change that may be experienced is, however, conditioned by existing "change-oriented preferences and institutional capacity" (Ibid). Climate events, according to Matthews, can act as the impetus for "episodic institutional change" and the "operationalization of climate adaptation" through the incorporation, codification and implementation of climate change adaptation as "a central tenet of urban planning governance" (2012: 1090-1091). Under circumstances of an extreme climate event, it is considered possible that new approaches to adaptation planning may be institutionalized and operationalized in the RRB.

Various places have experienced this process, notably those most impacted by climate change such as cities within southern Sri Lanka like Aceh that were profoundly impacted by the 2004 Tsunami. City-wide adaptation is backed by the National Climate Change Adaptation Strategy for Sri Lanka 2011-2016. Another example is New Orleans, where government planning and implementation has been reoriented to address climate change adaptation, from public health departments and water management planning through to the New Orleans City Planning Commission. Local government action as well as community-based adaptation is supported by federal agencies, particularly the Environmental Protection Authority. Whilst these examples demonstrate significant opportunities for improved adaptation planning, they also highlight the risks that can be associated with the lack of anticipatory planned action on climate change adaptation.

Whilst there is demonstrated international experience of transformative institutional change through crisis, some cases also highlight the challenges of sustaining change due to limited resources, dependency on higher-level agencies or weak institutional structures. In Argentina, there are a number of lived experiences that demonstrate the difficulties associated with transformative change in conditions of post-climate catastrophe. Severe flooding has affected Santa Fe, Buenos Aires and La Plata cities over recent years and, according to key informants interviewed as part of this research, there have been few sustained experiences of institutional learning. Despite evidence underscoring the importance of planned adaptation action over the long-term to improve resilience to climate change, existing demands combine with already-stretched institutional capacity, prompting relapse into reactive and shorter-term problem-solving in the RRB context (similar to many other urban regions around the world). Taking into account these historical trends in Argentina, as well as the devastating impacts from international experiences like tsunamis and hurricanes, it is not considered a desirable option for adaptation planning to be advanced abruptly in a post-crisis scenario.

Scenario 4. Transformative change through adaptation planning

Some nations and cities have responded to climate change forecasts through the realization of periodic risk assessments and the development of long-term adaptation strategies. Research shows that effective adaptation planning requires addressing climate risks in a planned and integrated way. Adaptation planning means that the various facets of urban governance - from water management and transportation, to housing and economic development - integrate adaptation strategies within policy and action frameworks under the guidance of a 'lead' agency or policy responsible for adaptation planning. Better aligning the parallel initiatives of government agencies to overcome the 'silo' mentality and engaging civil society are important prerequisites for integrated adaptation planning. In this kind of scenario, adaptation planning is typically positioned as a centerpiece of government action and necessitates early action to improve preparedness and build resilience.

Some examples are in Melbourne and Adelaide, Australia, where in the latter case the Climate Change Adaptation Action Plan 2011-13 linked the Principal Role and Functions of Council under the Local Government Act (1999) to climate change "risk management and adaptation" (Adelaide City Council 2011). In the case of Melbourne, the Climate Change Adaptation Strategy 2006 presents results from climate modeling, risk assessment, as well as statutory adaptation measures for the city proper. One of the first cities to holistically address climate change adaptation was Cape Town, South Africa through the City Adaptation Plan of Action; it is also one of the South African regions most at risk of climate change. Durban is another case where a 2006 report 'Climatic Future for Durban' presented climate change forecasts for 2100 that showed development goals would be compromised by impacts from extreme weather events, like flooding and sea level rise, jump-starting a holistic adaptation planning process. In Latin America, some examples include Rio de Janeiro, Sao Paulo and Quito, where, in the latter case, integrated adaptation planning occurred in a staged way beginning with climate mainstreaming initiatives (see discussion above 'Scenario 2').

Achieving transformative change through adaptation planning is considered an ideal scenario for any city seeking holistic and sustainable adaptation to climate change. Through an analysis of existing applied examples, Matthews' (2013) claim that climate change adaptation is conditioned by 'change-oriented preferences' and institutional capacity appears to stand true: each place takes a unique path based on different combinations of historical experience as well as endogenous and exogenous forces. Some of the constant variables are the positioning of adaptation as a central aspect of urban governance and a capacity to integrate and coordinate action across different spheres of (urban) governance. In this regard, where there is political will to advance adaptation planning in a holistic way, achieving 'integrated' urban governance among the diverse stakeholders concerned becomes a heightened imperative. In this regard, holistic adaptation also requires broad-base participation and support. In addition to furthering integrated approaches to urban governance with an adaptation take, other variables that seem to become pertinent are political leadership on climate change, creative resourcing, a capacitated workforce to assess and interpret climate behavior and a commitment to raising general awareness about climate change.

Advancing an agenda that is broadly encompassing of adaptation faces both challenges and opportunities for the RRB. On the one hand, an integrated understanding of climate risk would unquestionably strengthen motivations to improve coordination in urban governance of the RRB as well as to enhance environmental management: it is not inconsistent with these existing umbrella objectives. Argentina in general, and the RRB specifically, benefits from a plethora of high-level scientific knowledge and capacity to undertake risk assessments and to build on links between research and public policy. Furthermore, the RRB and the MRBA do not exist in a void of climate change policy; there are emerging manuals and policies from the national and provincial governments that support the framing of climate change adaptation. Despite overwhelming evidence and pressure from exogenous forces—including higher-level climate change policy as well as lived experiences of devastating climate events—it appears that a scenario of broad scale adaptation would require impetus of change from within. Research by Carmin et al., demonstrated that this to be true in the cases of Durban and Quito.

As mentioned previously, research conducted by Carmin et al. is highly useful for understanding possible pathways of institutional change to support holistic climate change adaptation as both case study cities, Durban and Quito, present certain similarities to the RRB. Carmin et al. identified three endogenous factors important for influencing change in these cities:

> First, adaptation was influenced by the efforts of champions who were inspired to push the agenda forward and creatively navigate an ambiguous domain. Second, as the cities learned about climate impacts, they came to the realization that they were highly vulnerable and began to interpret natural hazards as a consequence of climate change. This realization led them to further recognize the importance of protecting residents and assets. The third critical endogenous driver of action was the advancement of local priorities. In both Durban and Quito, adaptation was seen as a means to secure the cities' development paths while promoting sustainability and resilience by addressing the projected impacts of climate change. A further priority for Quito was to enhance city visibility and to be viewed as an environmental leader in the Andean region. Climate action in general and adaptation in particular were seen as ways to advance these goals.

Therefore, it is considered likely that advancing holistic adaptation planning in the RRB might involve some of the abovementioned factors. It would also require a commitment to addressing existing challenges that obstruct sustainability planning and integrated urban governance for climate change adaptation, including improved risk and vulnerability assessment, information management, coordination and prioritization of particular issues and vulnerable populations in the context of climate change.

While the challenges to integrated climate change adaptation in the RRB are numerous and complex, they are not insurmountable. Any decision *not to act* in the face of increased climate hazards will jeopardize recent progress in vulnerability reduction, while a more explicit commitment to climate change mainstreaming will leverage existing momentum. Overall, there is a sense of forward-looking progress, which should be sustained and channeled in order to minimize the risks of an otherwise uncertain future.

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