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FACING RISK

New Urban Resilience Practices in Latin America

CAF DEVELOPMENT BANK OF LATIN AMERICA

THE NEW SCHOOL

FACING RISK

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THE NEW SCHOOL OBSERVATORY ON LATIN AMERICA

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PRESENTATION

In Latin America and the Caribbean, exposure to disasters has intensified considerably in recent decades. The increase in the intensity and frequency of extreme natural events, largely driven by the effects of climate change, as well as by the impact of human activity on environmental dynamics, accentuate the conditions of vulnerability. This is especially problematic in sectors of socially excluded populations. It is estimated that between 1970 and 2010 the economic losses due to disasters amounted to US$160 billion and caused around 480 thousand deaths in the region. The complexity of these phenomena and their devastating impacts on society demand consistent political prioritization. This entails the definition and implementation of policies aimed at better planning, a significant amount of financial resources, and the technical capacity to execute them.

In this context, cities acquire special relevance since they the home of 80% of the region's population. This percentage is also the same in terms of the number of losses due to disasters in Latin American cities during the last decades. These losses directly affect city economies, and in many cases, those of their countries. The increasing concentration of people in areas that are unsafe for settlement including coastal areas, zones prone to flooding or landslides, physical spaces with acute housing deficits and limited access to services, deepens the social construction of vulnerability. Altogether these factors put at risk the life and assets of the citizens who inhabit vulnerable areas.

In order to face this reality, it is necessary to design integral strategies and differentiated intervention models that allow for risk management

from multiple levels of government, with special emphasis on the urban environment. Fundamental to achieving this goal is understanding the role of local management in generating greater capacity for resilience, not only in the face of natural events and disaster risks, but also as a response to the economic and social tensions that weaken the fabric of Latin American cities.

In this context, the Development Bank of Latin America (CAF), through the Cities with Future initiative and the Observatory on Latin America (OLA) of The New School, join efforts to disseminate knowledge of resilient practices in the region and offer urban management alternatives that strengthen the responsiveness of Latin American cities to events that challenge local sustainability. This publication offers a contextual analysis of six urban management experiences that have integrated disaster management policies to reduce the conditions of vulnerability and contribute to the sustainable and resilient development of the territories. The cases of Manizales, in Colombia, La Paz, in Bolivia, Cuenca, in Ecuador, Santa Fe and Pilar in Argentina, and Cubatão in Brazil, describe different problems and institutional approaches to resilience management, as well as lessons derived from its implementation and recommendations to optimize their impact on society.

In order to strengthen efforts aimed at the construction of more inclusive, productive and resilient cities, the incorporation of tools for mitigation and adaptation to climate change in sustainable urban management constitutes one of the pillars of the vulnerability reduction strategy. Responding to the new challenges posed by disaster risk management, while integrating policies that contribute to the economic sustainability of cities, requires coordination among the multiple institutions and actors involved. As one of the multilateral and regional cooperation organizations, we assume the commitment to supporting this task, not only by financing initiatives, but mainly through technical support and the generation of applied knowledge to the design tools that allow for increased resilience of Latin American cities.

Julián Suárez Migliozzi
Vice-president of Sustainable Development
CAF - Latin America Development Bank

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Michael Cohen, Margarita Gutman
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INTRODUCTION. TOWARDS NEW URBAN PRACTICES

MICHAEL COHEN AND MARGARITA GUTMAN

In the last three years, the international community has successfully established a new set of objectives that should be fulfilled by all nations. Included in these are the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction, and the New Urban Agenda.

It is possible to argue that the innumerable global, national, and local discussions have contributed to the construction of a global consensus on '*what*' needs to be done at each level to improve the welfare and living conditions of a growing population that faces progressive risks triggered by climate change and certain anthropic local processes.

However, this broad global consensus has not been accompanied by the same sense of urgency or concern by the international community when it comes to proposed decisions and concrete actions designed to meet these objectives. Therefore, it is necessary to emphasize that without an urgent focus on the '*how*', there is a very little chance that these well-intentioned objectives can be fulfilled. In addition, the effort put into the construction of various indicators to measure progress in achieving these objectives is not the same as formulating a strategy at the global, national, and local levels.

One of the most notable characteristics of the recently adopted Sustainable Development Goals is their interdependence. For example, the improvement of health levels at a global level depends to a large extent on improving access to drinking water and sewerage systems, whose networks have a direct relationship with sustainable environmental management in specific local communities all across the world. This interdependence

requires focusing attention not only on resolving the implementation to meet each objective, but also on exploring and building integrated urban practices, essential to achieve the desired results.

Therefore, we must deepen and expand effective urban practices while simultaneously seeking to identify new practices across different fields, from infrastructure, to public health, and risk reduction, among others. Simply doing more of the same does not guarantee better results. Rethinking urban practices implies identifying spaces for innovation and new ways of framing problems while respecting knowledge and local histories. In this way, public policies at the national or state level ought to be connected to local needs and demands. We must apply a new approach both to problems that we believe we understand, such as housing (which persists as a complicated area of public policies), as well as other areas that define the complex challenge of building urban resilience.

This book presents a set of six case studies of urban resilience. Six medium-sized Latin American cities have been chosen that represent an array of situations of regional risk disaster. Andean and coastal cities are included, also cities located in the interior of the country with rich agricultural resources, as well as cities with an industrial profile. The selected cities are: Cubatão, Brazil; Cuenca, Ecuador; La Paz, Bolivia; Manizales, Colombia; and Pilar; and Santa Fe, Argentina. Each case analyzes the new local urban practices that were developed to respond to the challenges presented by disasters, many of which were produced by the combination of climate change, topographic conditions, and the social construction of risk.

These studies illustrate the need to think in a more integrated way than routine approaches. For example, physical solutions designed by engineers must be complemented by the social and economic solutions to reap the benefits from material investments. Policies adopted within government offices must include an explicit mobilization of the communities that contribute to implement those policies. Participation cannot just be a slogan, it must be designed as an integral part of each of the steps that make up an urban practice oriented towards risk management.

An important conclusion of this work is the need to extend the concept of management. This implies including a broader set of actors in the management process such as those with diverse, and frequently competing

demands. It requires strategies to publicly share and communicate information to specific communities about risks and to build a foundation of public knowledge supported and enhanced by expert knowledge and advice. Urban resilience cannot be an objective of policies developed outside the community, rather it must be the product of local processes, both formal and informal, responding to threats, vulnerabilities, and real risks of specific communities.

This perspective also applies to the local government, where all involved government departments must concur to build urban resilience. For example, deepening public awareness by the opening of a flood museum in the city, teaching elementary and secondary school students how to respond to disasters, or finding ways to increase municipal resources that can be specifically committed to respond to disasters. Building urban resilience is everyone's responsibility, not just a small group of technicians from the municipal government's environment section.

These conclusions emerged from the field work of these case studies, supplemented by the review of available local documentation. The stories of local risk management in these six cities are current and up to date, but they build future urban resilience.

★ ★ ★

This book begins with a chapter on global priorities of urban resilience in Latin America and a presentation of the theoretical framework used across the selected case studies. Six chapters are devoted to individual case studies. As mentioned, they were chosen to reflect a range of experiences and show a diverse group of effective urban practices. Frequently, studies on urban environmental risk have focused on coastal megacities. This research demonstrates that cities in mountainous and river regions are also subject to increasingly frequent disasters and have important risk management experiences to share. In the same way, cities of all sizes, not only capital cities or megacities, are faced with climate related challenges. The cities chosen for this study demonstrate a variety of urban population sizes, whereas Cubatão has just over 100,000 inhabitants, the metropolitan area of La Paz has a population of more than 2 million. While these cities vary in terms

of geography, size, resources and threats, these studies show that effective urban practice for risk management has many forms, but can overall offer important common lessons for decision-makers.

The case studies begin on Chapter 2 with the experience of the city of Manizales, Colombia, which stands out for its sophisticated technical approach, as well as for a variety of successful resilience practices that have been in place for several decades. Manizales has implemented actions in all stages of risk management: identification, reduction, management, and even risk transfer. In this study, three practices are highlighted. First, the integration of risk management in the Territorial Development Plan (*Plan de Ordenamiento Territorial*), based on the introduction of a probabilistic model for risk assessment. This scientific model used geo-referenced meteorological data from 327 previous events to produce a more detailed and realistic assessment that allowed the development of additional urban areas. The second outstanding practice, unique in the region, is the collective insurance model to protect the poorest population after disastrous events. This program is financed through a voluntary surcharge to the property tax, a strategy that fosters a "social pact" between the wealthiest citizens and those most in need. Finally, the last practice described is the Guardians of the Hillside (*Guardianas de la Ladera*). This is an infrastructure maintenance program carried out by a group of 100 female heads of household. In addition to removing garbage and weeds from infrastructure works, the Guardians help raise civic awareness about risk management both door-to-door and in local schools.

The next chapter deals with La Paz, Bolivia, whose experience clearly exemplifies the issue of the social construction of vulnerability and risk. La Paz has suffered natural catastrophes that decisively marked its policy of risk management. As a result, the city developed an urban policy to manage the risk resulting from the combination of natural hazards and the social production of vulnerability and risk. The urban policy involves the institutional arrangements that combine organizational and financial resources of two programs implemented by the Municipality of La Paz. These programs focus on the infrastructure and social aspects of the problem are: the Municipal Integrated Risk Management Strategy (EMGIR) (*Estrategia Municipal de Gestión Integral del Riesgo*), implemented

by the Municipal Secretariat for Integrated Risk Management (SMGIR) (*Secretaría Municipal de Gestión Integral de Riesgos*), and the True Neighborhoods and Communities Program (PBCV) (*Programa Barrios y Comunidades de Verdad*), implemented by the Municipal Secretary of Infrastructure.

The Cuenca, Ecuador case is analyzed in Chapter 4. It presents an approach to urban resilience characterized, to a greater extent than the other cases, by an environmental component. In the long history of the city of Cuenca, from the pre-Columbian settlement to the present, the population has shown an approach to the risk of flooding that is based on ecological preservation and a high degree of awareness and respect for the variability of rivers. While conventional strategies to manage urban rivers have focused on controlling flows through concrete walls and pipelines, Cuenca has demonstrated a social awareness of the risks and the benefits of the river. Historically and until the present day, rivers have offered a great variety of functions, acting as a meeting point for social interactions. In many ways, its social and cultural importance as a central element of the city has prevented the river from being encroached by development, even before this strategy was formalized in the city land use plans. The city depends on the fluvial system not only for its drinking water, but also for the generation of hydroelectric energy. Likewise, the environmental management of the surrounding mountainous region, whose water currents feed the rivers, is seen as fundamental to the city's long-term development strategies.

The following chapter presents the case of Santa Fe, Argentina, a city that has made significant progress in risk management and the creation of a more resilient city, while capitalizing on the international recognition it has received for its urban resilience practices. In the last decade, Santa Fe's exposure to floods has decreased, and indicators related to poverty, inequality, and unemployment show improvements, reducing social vulnerabilities. These improvements are the result of fundamental changes in the administrative and institutional architecture for disaster risk reduction. Santa Fe shows how unequal and unplanned urban development foster vulnerabilities and increase exposure to risks. It also demonstrates that cities can be the drivers of positive change and that they must play a fundamental role in the implementation of the global objectives of greater sustainability and resilience. Santa Fe's transversal and comprehensive approach to risk

management has received wide and positive recognition: in addition to the mention of UNISDR in 2010, it received the Sasakawa award in 2011. Santa Fe has learned from disasters and has reduced risks through an approach that integrates the entire urban system by creating and understanding of social, ecological, economic, and infrastructure strengths and vulnerabilities.

Chapter 6 addresses the case of Pilar, Argentina, a city that has advanced a process of dialogue between different urban actors on acquired urban rights. The Water Dialogues program (*programa Diálogos Hídricos*), carried out by the Sub-secretariat of Planning and Urban Development of the Municipality of Pilar (*Subsecretaría de Planificación y Desarollo Urbano del Municipio de Pilar*), located in the metropolitan area of Buenos Aires, is the most innovative urban risk management practice among the 14 municipalities that make up the Luján River basin. This program addresses risk management through a framework of dialogue and negotiation with representatives of gated communities to mitigate the impacts of floods in the river basin. The Water Dialogues program is presented here through an analysis of the environmental threats to the region, the socio-territorial characteristics of Pilar county, and the institutional and regulatory framework for risk management. The study describes all involved actors and concludes with an assessment of this new urban practice that includes legal and economic constraints, political decisions, as well as future challenges.

The last case study addresses the challenges and achievements in Cubatão in Brazil, a case that is singular because it addresses the issue of environmental threats arising from air pollution. In 1992, at the United Nations Conference on the Environment and Development in Rio de Janeiro, the city of Cubatão was recognized as an ecological symbol and a successful example of the implementation of pollution control. The Cubatão Pollution Control Program (*Programa de Controle da Poluição*), a combination of technical and community actions, was successful in controlling pollution sources and improving the environmental quality of the city. However, the program was not part of a comprehensive urban planning and development strategy. The new polluting economic activities that arose in the city since, combined with other political and social factors, gave rise to different dynamics and risks. Without the ability to adapt and respond to these new conditions, Cubatão's risk management strategy could merely

maintain environmental quality within acceptable standards, but not lower the pollution levels further. The case of Cubatão shows the challenges and difficulties involved in maintaining successful risk management strategies over time.

After the individual analysis of the experiences in each of the selected cities, Chapter 8 identifies a series of transversal conclusions. Learning across each of the cities studied, this chapter presents a general reflection on various topics such as the inter-sectoral nature of risk management, the way in which environmental systems transcend administrative jurisdictions, the relative importance of history in facing future challenges, and the contribution made by scientific knowledge of the different components of the risk. The book ends with a critical and pragmatic vision. It offers a series of operational lessons that intend to be useful for both public policy makers and urban managers in large, medium, and small municipalities throughout Latin America, as well as in other latitudes.

1. DEFINITIONS AND THEORETICAL FRAMEWORK

BART ORR

Perhaps there is no greater threat to the future of Latin America's cities than disasters resulting from the interaction of local topographical conditions, climate change, and the social production of risk. As explained below, the combination of physical hazards has created historically unprecedented risks and vulnerabilities for residents of selected Latin American cities. Not only is physical infrastructure at risk, but the hard-earned gains in human development and economic prosperity that the region's cities have fueled over the past decades may slow down or even be undone. Paradoxically, the economic growth and related urbanization of the past have created the climatic conditions that now threaten the future. Urban growth and population density have already exposed greater numbers of people to the hazards and risks of natural disaster, but with continued climate change many of these disasters are expected to increase in both magnitude and frequency. Coupled with the continued growth and expansion of Latin America's urban areas, the risks posed by climate change threaten countless lives, property, and future GDP growth.

As the world's most urbanized region, Latin America has much to lose in the future. Yet, at the same time, the region's cities also have much to offer, drawing on a richness of local experience in dealing with urban environmental risk. In this study, we present six case studies highlighting not only the challenges, but the successes of managing the risks of urban disaster. The lessons of how these cities have dealt with risks in the past can be invaluable for the future, as Latin America and the world moves towards a period when ongoing risk management, rather than just disaster response,

must be integrated across all urban management frameworks and tools to confront environmental hazards that are likely to increase in both severity and frequency.

GLOBAL OBJECTIVES AND LATIN AMERICA

The urban practices highlighted in these case studies reflect a global emphasis on risk management that is recognized in both the New Urban Agenda (NUA) and the Sustainable Development Goals (SDGs). The New Urban Agenda, adopted at the United Nations Conference on Housing and Sustainable Urban Development, Habitat III in Quito, Ecuador, was welcomed by the UN Secretary General's Special Representative for Disaster Risk Reduction as "a significant contribution to focusing attention on the risks of rapid urbanization and the importance of taking concrete measures to build cities in a way that reduces exposure to disasters and improves the quality of life for urban dwellers" (UNISDR, 2016). The importance of managing natural disaster risks, particularly in light of climate change, was a recurring theme in the document, beginning with the "shared vision" of cities in the opening pages, which calls on cities to "adopt and implement disaster risk reduction and management, reduce vulnerability, build resilience and responsiveness to natural and human-made hazards and foster mitigation of and adaptation to climate change." In total, the NUA mentions risk almost thirty times throughout the document. Likewise, the SDGs recognize the urgent need to address disaster risk in Goal 11: "Make cities and human settlements inclusive, safe, resilient and sustainable," which calls for sound, risk-informed planning and management of cities.

The Sendai Framework for Disaster Risk Reduction 2015-2030 outlines four priorities to prevent new and reduce existing disaster risks: i) Understanding disaster risk, ii) strengthening disaster risk governance to manage disaster risk, iii) investing in disaster reduction for resilience, iv) enhancing disaster preparedness for effective response, and v) to "Build Back Better" in recovery, rehabilitation, and reconstruction.

As these international agreements emphasize, cities are at the forefront of global climate change—in term of both emissions and impacts. This is particularly relevant for Latin America—now one of the most urbanized regions in the world, having grown from an urban population of around 69 million in 1950 to a projected 575 million by 2025 (World Economic Forum, 2016). Though cities cover only around two percent of the earth's surface, they consume 78% of the world's energy and are responsible for over 70% of global CO_2 emissions. Cities are also often most at risk to the consequences of climate change, with around 90% of the world's urban areas located on coastlines, making them vulnerable to sea level rise and violent storms (C40, 2018). At the current rate, CO_2 levels will reach 500 ppm by 2050, raising temperatures above 37.4°F—a point at which scientists estimate will result in catastrophic damage, endangering food supplies and causing significant loss of lives and damage to property (Jones, 2017). In many cases, the same geographic features that originally attracted settlement and made cities prosperous, such as coasts and rivers that facilitated trade and commerce are at risk of becoming liabilities as sea levels rise, precipitation patterns become more extreme, and storms grow more frequent and intense.

Based on the climate models cited by the Intergovernmental Panel on Climate Change (IPCC), by the end of the 21st century Latin American countries will experience a mean warming ranging from 33.8 to 42.8°F, with the potential to convert tropical forest to savanna, threaten coastal areas with sea level rise and storms, deplete mangrove forests, and impact drinking water availabilities on the Pacific coast and Rio de la Plata estuary. The rural areas are home to sources of agriculture and freshwater that sustain Latin America's urban areas are projected to undergo potentially devastating changes. By the 2050s, half of the region's agricultural land could be threatened by desertification, with other areas experiencing increased soil salinization. A 2013 report by the Brazilian Panel on Climate Change predicts that Brazil alone will incur agricultural losses of around US$3.1 billion annually after 2020. In the Andes, glacial melting already threatens hydroelectric power generation (which accounts for 60-70% of the region's power generation), urban water supplies, and agricultural production. In the tropical Andes, glaciers have shrunk 30 to 50 percent in the

past forty years, with Colombia expected to lose all glaciers by the end of the century (Edwards and Roberts, 2015).

The adverse effects of climate change on Latin American cities are not only a humanitarian concern, but are also expected to have deep economic impacts, as several studies from the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and the Inter-American Development Bank (IDB) have shown. According to one IDB report, by 2050 the damages in the region associated with a 35.6º F rise in temperature over pre-industrial levels will approach US$100 billion annually (Vergara et al., 2014). Such impacts threaten not only to undo the significant gains made in development in the region, but also cripple efforts to achieve future regional and national development goals and targets.

However, the vulnerability of Latin American cities cannot be viewed as purely a product of geography. The six case studies in this report show that risk and vulnerability have been socially produced, either directly through shortsighted environmental policies, or indirectly, through a failure to plan for urban growth. The rapid urbanization of the region went hand in hand with economic shifts and increases in productivity as economies shifted towards services and industry in urban areas, but the benefits have not been distributed equitably, resulting in social exclusion in many Latin American cities. The economic inequality of many Latin American cities has manifested itself spatially, with the poorest living not only in less than adequate dwellings, but also situated in more precarious areas of the city. In some cities, such as La Paz, Bolivia informal settlements of self-built homes occupy unstable hillsides on the periphery of the city, while in others like Santa Fe, Argentina the poor have been relegated to low-lying areas most prone to flooding. The catastrophic impacts of rapid-onset disasters such as flooding and landslides draw attention, but the slow violence of environmental injustices, such as air pollution, frequent small-scale flooding, and water contamination, is an everyday issue for many urban poor, and remains out of the public eye.

DEFINITIONS, OBJECTIVES, AND RESEARCH FRAMEWORK

While urban resilience has become a focal point of policy research in anticipation of the growing threat of climate change, the emphasis on infrastructural and technical interventions has a tendency to overlook the critical role of governance practices in risk reduction and resilience. These six case studies illustrate significant examples of effective urban practice with regard to strengthening the resilience of urban areas when confronting risks from natural, or "socio-natural", disasters in the region. It is hoped that these case studies will be useful for CAF member countries and the CAF itself in the implementation of the New Urban Agenda.

The term "resilience" has diverse understandings, each with different implications. For this project, resilience is understood to be more than "bouncing back" after disaster. Instead, drawing on socio-ecological definitions developed by Folke (2006) and others, resilience is understood to be the ability of a complex urban system—including social, ecological, and infrastructural systems—to absorb shocks and disturbances and maintain basic functionality across the system. Additionally, in contrast to the idea of "bouncing back" to a previous state, resilience entails an element of learning and reflexivity.

Although urban socio-ecological resilience as a concept is fairly new, the case studies presented here show that Latin American cities have long histories of risk management that offer valuable lessons that can be used for creating effective policies to address future threats.

This research focused on a rigorous comparative analysis of risk management practices in six Latin American cities selected to represent a diverse sample in terms of population size, geography, and environmental hazards faced, drawing lessons from the unique place-specific conditions of each city. The research is qualitative, consisting of case studies based on semi-structured interviews with public officials, technical experts, representatives of civil society, as well as local residents and community members, in addition to reviews and analysis of relevant publications and planning documents.

This research aims to address a series of core issues both within each case study, and comparatively across case studies: risk and vulnerability

assessment; the selection of appropriate policy responses; governance processes and partnerships; and future adaptive capacity.

1. Risk and vulnerability assessment

Even when facing similar environmental threats, cities conceptualize and prioritize risks differently, including which specific populations within the city are considered vulnerable and why. For example, the threat of urban riverine flooding can be understood as a geographic-spatial issue that disproportionally impacts a range of vulnerabilities, including those vulnerable because of socioeconomic status, legal status, social exclusion, housing quality, or age. Historically, many cities have failed to address the full range of dimensions of vulnerability that interact to transform a natural hazard into a disaster. The framing of these hazards, risks, and vulnerabilities determines which policy responses are deemed appropriate in each context.

The case studies draw on Birkmann et al.'s framework for vulnerability, risk, and response (Birkmann et al., 2013). This framework is intended to specifically address what is described as multi-dimensional vulnerability, comprising social, economic, physical, cultural, environmental, and institutional dimensions that interplay in urban systems. This framework proposes the following definitions:

- HAZARD is used to describe the potential occurrence of natural, socio-natural, or anthropogenic events that may have physical, social, economic, and environmental impacts in a given area and over a period of time.
- VULNERABILITY refers to the propensity of exposed elements such as physical or capital assets, as well as human beings and their livelihoods, to experience harm and suffer damage and loss when impacted by single or compound hazard events.
- RISK, in contrast to vulnerability, is defined as the probability of harmful consequences or losses resulting from interactions between hazard and vulnerable conditions. It is the potential for physical, social, economic, environmental, cultural or institutional consequences or losses, in a given area and over a period of time.

- EXPOSURE describes the extent to which a unit of assessment falls within the geographical range of a hazard event. Exposure extends to fixed physical attributes of social systems (infrastructure) but also human systems (livelihoods, economies, cultures) that are spatially bound to specific resources and practices.

In addition to the above definitions from Birkmann et al. (2013), we use the following definition of adaptation from Pelling (2001). *Adaptation* is a continuous property, with levels of adaptive capacity changing over time as the status of vulnerability components identified above change and the demands of a shifting risk environment alter the appropriateness of particular asset bundles for risk reduction.

2. Strategies and responses

Built infrastructure continues to often be viewed as the most important defensive measure against natural hazards and disasters, even as in many cities aging urban infrastructure is increasingly inadequate for protecting vulnerable populations. Our framework for analyzing adaptation and disaster risk reduction strategies draws from an emerging conceptual framework that views urban areas as a social-ecological-technical/built system (SETS). SETS, as put forth by McPhearson et al. (2016) builds on previous urban ecology frameworks that focus on social-ecological systems (SES) to link social sciences with biophysical sciences.

Social-ecological systems approaches have been successful at bringing together social and ecological sciences but have tended to overlook the technical aspects of cities (Grove et al., 2006). The SETS framework aims to emphasize the important role of technology in urban built infrastructure. However, policies aimed at making urban areas resilient to environmental hazards can draw on couplings within the three domains of the SETS framework, utilizing ecologically based elements such as parks and green infrastructures, and social initiatives to disseminate information and build networks for disaster preparedness and response, for example. By comparing resilience strategies across cities through the lens of the SETS framework, the case studies identify both successful integrations of social, ecological, and technical dynamics in addressing disaster risk reduction, as

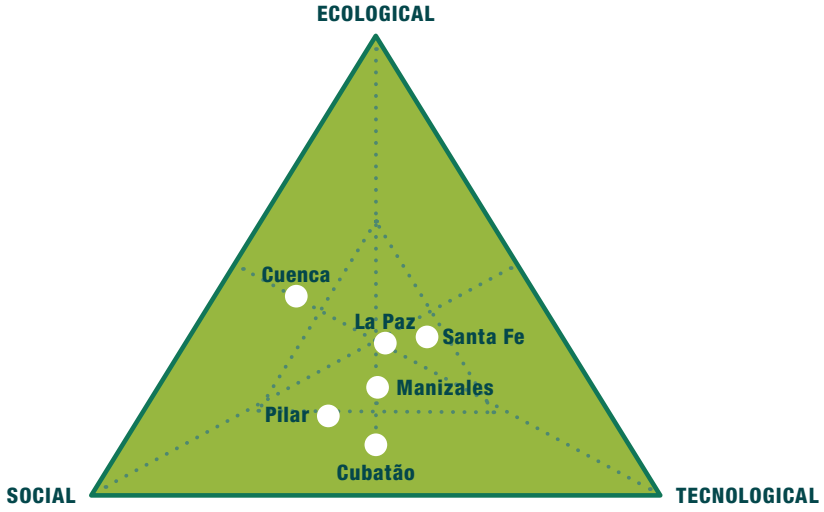


Figure 1

Mapping the case studies in the SETS framework.
Source: prepared by the author.

well as potential barriers. The way of understanding the problems in each of the cities varies. Figure 1 depicts the weight of the different urban practices implemented in the six cities in relation to three components of the SETS framework. La Paz is an example of equilibrium between the three components, while Cuenca gives more relevance to the ecological and social components rather than the technological one. On the other hand, in Manizales the ecological has less weight and there is more of a balance between the social and technological elements.

3. Governance processes and partnerships

Similar or identical desired outcomes in response to disaster risk and vulnerability can involve very different pathways and processes, some more participatory than others. The governance of risk is linked to decisions and actions by formal stakeholders such as governments or governmental institutions and informal stakeholders. This governance component is well illustrated in the cases of Pilar, Argentina and Cubatão, Brazil and includes tasks on risk reduction, management, mitigation, and also preparedness and disaster response.

These six case studies compare implementation strategies across the sample cities in terms of centralization of risk management versus mainstreaming within and across government agencies, and the use of partnerships with civil society and/or the private sector.

4. Adaptive capacity

In applying resilience to urban socio-ecological systems, to adaptive capacity has emerged as a central element to understand how they react and respond to shocks. Adaptive capacity is not limited to a measure of the ability of an urban system to change or maintain itself within critical thresholds required for functioning, it also refers to a long-term learning process. Adaptive capacity is the ability to learn lessons from past shocks and disruptions and use them to prepare—in terms of response and resources—for future events.

These case studies look not only at historical examples of responses to risk, but also evaluate those response strategies in terms of their forward-looking ability to adapt and respond to future risk. As the threat of climate change continues to grow and natural hazards are expected to increase in both severity and frequency, urban disaster risk management policies that are built around past threats will be unsuitable for future risks unless they incorporate a degree of future uncertainty. This research process specifically interrogates the extent to which city managers and stakeholders incorporate future uncertainty and projections of changing risk into planning, and the adaptability of current institutions to changing environments.

2. MANIZALES, COLOMBIA. RISK CULTURE WITH A SCIENTIFIC BACKBONE

MARÍA CARRIZOSA

Colombia has one of the highest rates of natural disasters in Latin America: the highest in terms of annual mortality rate, production loss, and one of the lowest indicators of fiscal resilience[1] (GAR, 2015). Although earthquakes represent the biggest risk in terms of annual losses, flooding and landslides are more prevalent, both of which will continue to increase because of climate variability and climate change. Manizales is especially prone to landslides due to its steep topography, occupying hillsides that seem to defy urbanization. In Manizales, some experts argue that it is "necessary to build the plot before building the house" (Franco, 2017), a process which often does not meet the technical or environmental requirements needed to guarantee the stability of constructions, and that disproportionately affects low-income residents.

Manizales' urban resilience, or in other words, the capacity of its environmental, social, and institutional systems to respond to extreme events throughout history, has been closely linked to its risk management capacity. Both experts and residents state that repeated exposure to disasters has promoted, along with other social and institutional factors, a true *culture* of

[1] "Given the limited nature of government resources to absorb losses due to disasters, it is important to calculate fiscal resilience. In this case, this has been done by quantifying relationship between available resources and the magnitude of direct expected losses due to disasters for different return periods. If expected losses exceed available resources, then there is a financial gap" and thus a lack of fiscal resilience. (GAR, 2015, in: *Risk Data Platform*).

risk management. With time, Manizales has developed innovative technical, theoretical, institutional, legal, and financial mechanisms to manage risk. Of these mechanisms, this chapter will expand on three: 1) the incorporation of risk management in the zoning plan, 2) a collective insurance scheme, and 3) the Guardians of the Hillside program (*Guardianas de la Ladera*). It is important to understand that the development of these urban practices was made possible by two favorable conditions, one financial and the other institutional.

In order for the city to align its technical and human efforts and to strengthen its resilience, it was necessary for the administration to count with sufficient economic resources to mobilize various agendas, policies, programs, and projects. To ensure this, the city implemented an urban-environmental tax collected as a voluntary surcharge to the property tax. This environmental tax raises approximately US$8 million annually, a considerable amount for a city of less than 400,000 inhabitants. Undoubtedly, there would be little progress with these resources if they were not properly invested, but Manizales appears to be doing this well.

An important factor for success is the inter-institutional partnership between the local government, the environmental agency, and the national public university. The university has played a leading role, constantly providing this partnership with scientific initiatives committed to the city's positive performance in facing its seismic and environmental hazards. As a result, the Manizales case is interesting not only because of the urban practices described in this chapter, but also because of the strategies that ensure the technical and economic conditions necessary for its success. In sum, Manizales could innovate because it had enough financial and also institutional resources.

I. URBAN CONTEXT

a) Historical background

Manizales was founded in 1849 almost four decades after independence. In its beginnings, the city followed the grid layout of the Spanish

urban ordinances. However, this pattern became blurred as the city grew demographically and new settlers occupied the steep slopes. Due to its particular location, throughout its history the city has been prone to constant threats, which have marked its development trajectory and its attitude towards disasters. In the 19th century, Manizales developed a particular construction style distinct from the colonial tradition of earth-construction that used adobe bricks, rammed earth walls ("tapia pisada"), and wattle and daub walls (woven reeds covered with mud, or "bahareque"). The city pioneered a unique style of earth construction adapted to its seismic conditions, known today as "trembling style": wattle and daub walls that replaced reeds with tin sheets. While during the 19th century other cities such as San Francisco, California, (which was also founded in 1849 and is located on the same geological fault line) denied their seismic fate, Manizales embraced this reality early on by developing a "local seismic culture." Experts say that Manizales can be considered the resilient city of the 19th century, one that replaced the common construction technologies of the time with its own variant of earth construction as a locally-adapted seismic technology (Cardona, 2017). By 1970, Manizales had built its cathedral using entirely this type of innovative construction. The exposure Manizales had to many strong earthquakes (1938, 1961, 1979) pushed forward the development and adoption the country's first seismic code in 1981 (based on the North American ATC06), which served as the basis to create the national regulation.

At the beginning of the 20th century, the city suffered a series of fires (1922, 1925, and 1926) that affected many buildings. After these fires, the city established a municipal fire department and ensured its permanent funding, decisions that positioned Manizales as a national frontrunner in these matters.

In addition to fires and earthquakes, Manizales is located in the area of influence of the Nevado del Ruiz volcano, which in 1985 caused the greatest volcanic tragedy in Colombia, with more than 20,000 deaths and enormous economic losses, estimated at a fifth of the national budget for that year.

However, the most frequent hazards Manizales faces are landslides caused by rain (on average 15 per year in the province) with major events in

1993 and 2003. Data collected since 1956 shows a tendency of increase in the annual accumulated precipitation (IDEA, 2010), which indicates that extreme climatic events seem to be increasing their frequency and intensity either due to the effects of *El Niño* and *La Niña* (climate variability), and/or due to climate change. Whatever the scenario, it can be said that the scientific community monitors closely the 46 meteorological stations spread throughout the city ("fortunately, we know how it rains in the city by neighborhoods" (Cardona, 2017)), and that the citizens are extremely familiar with the fact that heavy rains frequently lead to emergency situations.

b) Geographic and socio-economic environment

Manizales is located 7,064 feet above sea level in the central strand of the Andean mountain range. The city has a tropical Andean climate, with average temperatures of approximately 62°F year-round. Total monthly precipitation amounts to 5.2 inches and since the 1970s, whenever rainfall levels surpass 7.9 inches and 11.8 inches, the authorities activate the early warning system. Manizales sits on steep slopes that exceed 60% inclination. The city's fertile soil of volcanic origin reinforces its agricultural vocation. In fact, Manizales is part of the "coffee axis", a socioeconomic region known for its homogeneous cultural landscape dedicated to coffee crops, which was recognized as a World Heritage Site by UNESCO in 2011.

Manizales, the capital of the Caldas province, has approximately 400,000 inhabitants, 93% of whom reside in urban areas. Manizales is one of the first cities in the country to experience a demographic transition, but today it has an almost stationary growth (MCV, 2017:11). However, analysts agree that the official population projection of 398,874 for 2017 is low. Four other municipalities comprise a metropolitan area of 555,000 inhabitants in total, but this area lacks a legal and administrative framework. The city is divided into 11 districts. Of these, Ciudadela Norte has the highest levels of low-income inhabitants, informal settlements, and insecurity indicators.

According to the analysis of official data on quality of life indicators made by Manizales Como Vamos (MCV, 2017b), after a decade of the improvement in the country's general social and economic conditions, Colombia experienced a breaking point in 2016 of which Manizales was not

Figure 2

Map of the metropolitan areas of Manizales. Source: Wikimedia Commons, 2014

exempt. In six years, the city reduced the proportion of poor citizens by 45%, but then this percentage receded five percentage points in 2016. Nevertheless, Manizales has reduced its percentage of vulnerable population from 38% in 2008 to 27% in 2016 (MCV, 2017b:25). Compared to the national level, the city statistics are remarkable. Manizales is the third city in the country with the lowest proportion of poor people after Bucaramanga and Bogota (monetary poverty of 14.6) and the second lowest in terms of proportion of population in extreme poverty (2.5%). In terms of incomes, in 2016 Manizales was the fourth city with the highest per capita income (US$295.50) and although the middle class has increased (60% in 2016), inequality did so as well (it had a Gini of 0.48 in 2016). In terms of employment, in 2016 the labor participation rate of the city was one of the lowest in the country at 60% and unemployment increased two percentage points to 10.3% (MCV, 2017b).

In education, Manizales "has worked on quality issues, but still has drastic and persistent challenges in terms of coverage, which may be related to the aforementioned problems with population projections. Although gaps in education quality have shrunk, they remain pronounced. For instance, a ninth-grade student in a private school in the city is twice as likely to have better results in mathematics than a student from a public school, and is five times as likely to have better results than a student from a rural area" (MCV, 2017b:16).

In terms of the environment, Manizales has seen a reduction in residential electricity consumption per person from 455 kW in 2008 to 403 kW in 2016. Similarly, per capita water consumption has decreased from 29.1 gallons per day per person in 2008 to 25.2 in 2016 (MCV, 2017:93). However, it is difficult to establish if these statistics are necessarily good news, or if they instead reflect problems of accessibility or affordability. In addition, waste management has deteriorated. The waste production per citizen is 1.9 pounds per day per person, which is a 40% increase with respect to what was produced in 2003 (MCV, 2017b:96). In addition, although the levels of air and water pollution are below the national maximum, they do not meet international standards.

In terms of mobility, the Manizales Como Vamos report highlights a contradiction between the goals of the Territorial Development Plan (POT, *Plan de Ordenamiento Territorial*) and the current figures. While the POT proposes a "pyramid of inverted mobility" paradigm, that is, greater priority for more sustainable means of transport, the figures show an accelerated increase in individual car ownership and a decrease in the average number of passengers that use public transport (from 215,800 in 2007 to 192,400 in 2016 (MCV, 2017b:107)). The data also shows setbacks in terms of travel time expenditures. Between 2010 and 2014, population in the periphery increased their travel time by 33% (exceeding 1 hour and 15 minutes), price (transport represented 15% of the income of an average household, it increased 5.33% from 2015 to 2016), and accidents (the rate of fatalities per 100 thousand inhabitants is 13.1, with a high rate of motorcycle victims of 38%) (MCV, 2017b:103-115).

With regards to municipal finance, Manizales has a positive situation, especially considering its size. The total city revenues were US$161.6 million in

2016, amounting to a 17% increase from 2015, which inflation alone cannot account for. Tax collection (of which property taxes constitutes almost half) was 2% higher in 2016 than in 2015. The amount of national treasury transfers increased while maintaining its percentage of 49%, which demonstrates a favorable performance because the city also increased its own-revenues. The distribution between operation and investment expenses reveals that investment is at 83% (below the 89% national goal for "sustainable cities") and expenses are at 13% (with a debt level of 4%) (MCV, 2017b:136).

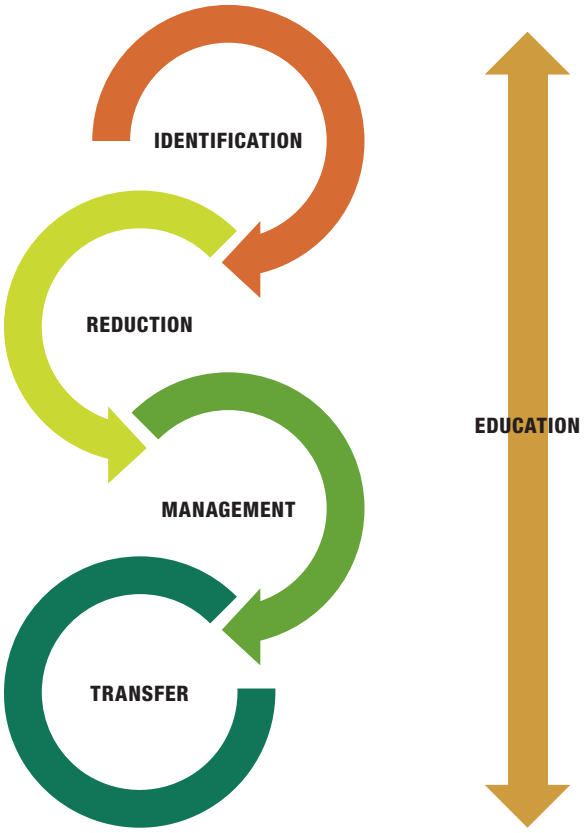
This general review of quality of life indicators based on official statistics is revealing if they are compared, like Manizales Como Vamos does, with citizens' perceptions regarding quality of life in their own city. The 2017 survey revealed that 85% of respondents feel proud of Manizales and 90% consider it a good city to live in (MCV, 2017a). In general terms, it can be said that quality of life in Manizales has a higher level—both under objective and subjective indicators—than what would be expected from a city with this level of the public investment per capita (US$290.50/capita in 2016). This seems to indicate that public administration "has efficiently managed its allocations" (MCV, 2017b:239). Citizens live comfortably in Manizales and the general urban conditions are not far from those of larger cities with greater resources, such as Medellin.

c) Conceptual definitions adopted in Manizales

Risk is defined as the result of the interaction between a hazard (a latent threat either natural or social) and conditions of vulnerability ("fragility or predisposition of the population and their assets to suffer damages in the event of a dangerous phenomenon" (Risk Management Manizales, 2015)). The Law 1523 of 2012 defines risk management as: "a social process geared to the formulation, implementation, monitoring, and evaluation of policies, strategies, plans, programs, regulations, instruments, measures, and permanent actions for knowledge, reduction, and management of risk, with the sole purpose of contributing to security, well-being, quality of life, and sustainable development" (Republic of Colombia, Law 1523, 2012, Article 1). In short, risk management is composed of a set of practices for: a) identification, b) reduction, and c) risk management. However, in Manizales, both local government and communities have

Figure 3

Components of Risk Management in Manizales. Source: Prepared by the author.

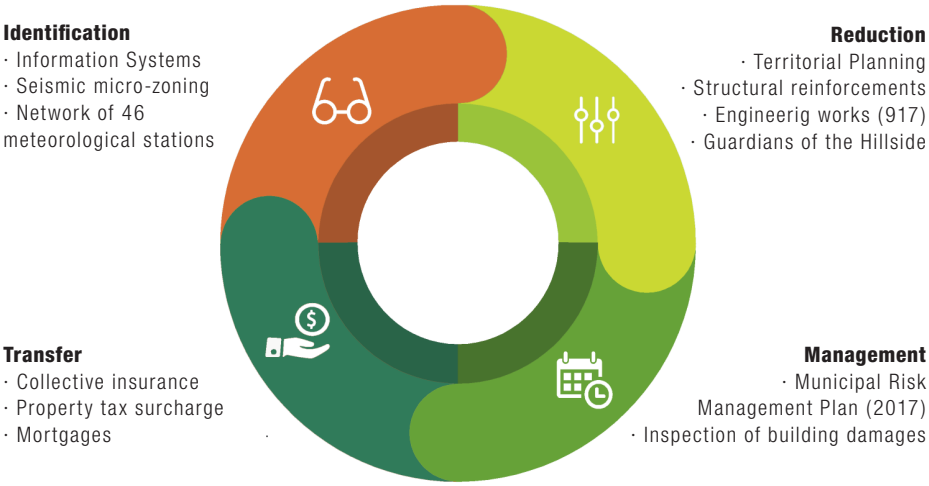


pushed for a fourth category (López, 2017, and others): d) risk *transfer*; consolidating what many refer to as a scientific culture of risk.

Manizales has made progress in all components of risk management. In the issue of identification, the following stand out: a seismic micro-zoning (which informs the municipal building code and the SISMAN Seismic Information System) as well as the network of 46 weather monitoring stations. In terms of risk *reduction*, the following stand out: 917 stabilization works (with high levels of innovation in civil engineering designs, use of local materials, and maintenance strategies), the incorporation of risk management in development and territorial plans, among others. In risk *management*, the city issued a municipal risk plan, an integrating policy

Figure 4

Instruments for Risk Management in Manizales by Component. Source: Prepared by the author.



instrument that coordinates the emergency plan, the development plan, the zoning plan, and the national plan for climate change adaptation. This Municipal Risk Plan is of course in line with the risk management law, as well as with the main international action frameworks. Additionally, in terms of risk *management*, an innovation that stands out is a smartphone app that facilitates the inspection and evaluation of building damages according to pre-established protocols. Finally, there is the issue of risk *transfer*, unique to the Manizales' approach. The main risk transfer instrument is a collective insurance scheme. It consists of a voluntary micro-insurance purchased by the wealthier property-owners that allows, via cross-subsidization, to protect the poorest 45% of the population living in the city (Cardona, 2017).

Of all the risk management instruments (i.e. urban resilience), this chapter will focus on three urban practices: 1) the incorporation of risk management in the Territorial Development Plan, 2) the collective insurance, and 3) the program Guardians of the Hillside.

d) Stakeholder analysis

The institutional architecture for risk management has been key to the achievements in Manizales. In this sense, it is worth highlighting Wilches'

argument when comparing Manizales with other similar cities, or making reference to the same city at different moments of its institutional environment: "The institutional articulation is not important. It is the single most important thing" (Wilches, 2017). Fortunately, Manizales has a strong institutional triad: the Mayor's Office, the environmental agency (Corpocaldas), and the university, which have been jointly working on this issue for decades. In this group of institutions, the university plays a integrating role (Franco, 2017). The university has established itself as the "technical soul" (Cardona, 2017) of the group, offering technical, environmental, and social support to the public administration in all aspects of risk management. Despite being a national public university, the Manizales campus of the National University of Colombia (*Universidad Nacional de Colombia*) has not adopted an anti-establishment attitude common in other public universities. Rather, it has become an active partner of the local government in urban development and management. "This has generated a virtuous circle in which the administration wants the university to work for the city, and the university is interested in the city" (Cardona, 2017).

Of course, there are other universities in the city: the Catholic University (*Universidad Católica*), the University of Manizales (*Universidad de Manizales*), the University of Caldas (*Universidad de Caldas*), and more. In fact, Manizales is promoted nationally as a "university-city." Within the National University the Institute of Environmental Studies (IDEA, *Instituto de Estudios Ambientales*) located at the School of Civil Engineering, acts as the technical backbone for the city's risk management. IDEA's Dean and most of its researchers are civil engineers. Naturally, Manizales has felt this emphasis. The important role IDEA has played for the local government and Corpocaldas has shaped the accent of the contributions made by other universities on the subject of urban resilience. While IDEA focuses on the technical aspects and is concerned with maintaining the highest scientific standards that can be useful for public service objectives, other institutions have developed complementary approaches with a greater emphasis on social and environmental aspects: psychosocial care, architecture and cultural heritage, rural life, or environmental management. It is true that IDEA has absorbed spaces for interaction with the local government, but at the same time it has opened the way for other universities to position their specific areas of expertise

and services. Undoubtedly, the public university serves as a stable technical support node, allowing for long-term service provision that outlives changes in local, regional, and national administrations.

Within the Colombian public sector, risk management has undergone a profound and innovative change "in risk governance, to integrate horizontally across different ministries and government departments, as well as vertically throughout regional, departmental and local governments, and also to give certain functions to scientific and technical institutions like the Red Cross and other non-governmental organizations" (GAR, 2015: 32). Manizales, like all Colombian municipalities, has a Risk Management Unit (UGR, *Unidad de Gestión del Riesgo*), which is the local cell of the national system, and is directly responsible, among other actions, for coordinating the direct response to emergencies.

Apart from the public sector and academia, it is important to emphasize the private sector's involvement. On one hand, firms pay an environmental surcharge with the industry and trade tax, and the issue of "business resilience" is slowly gaining traction (Peralta, 2017) as the link between risk management and competitiveness becomes more evident (Cardona, 2017). Unlike other municipalities, risk management in Manizales has benefited from a budget allocation of at least one percentage point (more allocation than for housing). Risk actually touches all sectors of society in Manizales. You can ask any citizen of Manizales about disasters and you will find that each person has something to say. Everyone has been affected in one way or another, and the general perception is that risk is an important issue in Manizales that affects society as a whole.

The institutional culture surrounding risk management had a high level of development in Colombia and particularly in Manizales before the narratives on urban resilience, associated with climate change, gained currency. For this reason, specialists and administrators in Manizales resist conceiving urban resilience as a separate issue from that of risk management. Instead, they understand resilience as a narrative that can be incorporated into the set of theoretical, scientific, and institutional capacities already present. Ultimately, the lens used to address these urban practices must adjust to the local realities and respond to the priorities of the local government. In certain cases, a *positive* discourse in favor of strengthening

resilience will be more appropriate, while in others a *negative* discourse that fights risk and insecurity will give more results (Cardona, 2017). Some governments prefer to focus their efforts on strengthening local capacities, while others fight to reduce hazards. Some local experts believe that there has been a clash between the two tendencies (Suárez, 2017), while others insist that risk management has already incorporated the climate change discourse: "adaptation is no different than risk management" (Pérez, 2017). This tension seems to be present in other countries as well (see Rivera, 2014 for an example in Nicaragua). Although there is not much consensus on which concept is more comprehensive than the other (most likely this depends on the expertise of the person or institution being addressed), every day there are more efforts to harmonize these two narratives. These efforts have been pointed out in the Fifth Assessment Report of the Intergovernmental Panel of Experts on Climate Change (IPCC) points out: "adaptation is related, fundamentally, with risk management" (IPCC, 2014).

In Manizales, the notion of risk management is so consolidated that it is essentially understood as one of the municipality's fundamental contributions to international urban practices. This contribution was recognized by the Hyogo Framework in 2005: "The creation of the Colombian national system simultaneously with the declaration of the International Decade for the Reduction of Natural Disasters, marked a paradigm shift in the governance mechanisms adopted by countries to manage disaster risk (Government of Colombia, 1988; World Bank, 2012) and symbolized the emergence of a special sector for disaster risk management. This paradigm shift got anchored with the adoption of the Hyogo Framework for Action in 2005" (GAR, 2015: 32).

e) Performance and indicators

Manizales' progress within integral risk management has been recognized by circles of national, regional, and international specialists. Key to this progress is the capacity to understand and monitor the city's general performance over time, which is synthesized in the Risk Management Index (RMI). This statistical tool emerged from the holistic risk assessment proposed by Cardona in the 1990s, then it was further developed

Identification	Reduction	Management	Transfer and Governance
Systematic inventory of disasters and losses	Integration of risk in the definition of land use and urban plans	Organization and coordination of emergency operations	Inter-institutional, multi-sectoral, and decentralized organization
Hazard monitoring and forecasting	Watershed intervention and environmental protection	Emergency response planning and early warning systems	Reserve funds for institutional capacity-building
Hazard evaluation through maps	Protective infrastructure and control of hazardous phenomena	Provision of equipment, tools, and infrastructure	Audits and mobilization of budget resources
Vulnerability and risk assessment	Housing upgrading and relocation of settlements in hazard prone areas	Drills, updates, and testing of institutional response	Implementation of social safety nets and social security funds
Public information and community participation	Update and control of the application of norms and building codes	Community training and preparation	Insurance and strategies to transfer losses of public assets
Capacity-building and education in risk management	Structural reinforcement and retrofitting of public and private buildings	Planning for rehabilitation and reconstruction	Assets' insurance and reinsurance in the private sector

Table 1

Indicators of the Risk Management Index by Component. Source: Carreño et al. (2009).

by Carreño et al. in 2004, and finally it was disseminated via the Risk Indicators and Risk Management System for the Americas of the Inter-American Development Bank (Carreño et al., 2009). The Risk Management Index takes into account four components of risk: identification, reduction, management, and transfer and governance. It is a composite index that qualitatively measures each component based on six indicators, which are rated on a range of 1 to 5 (one being the lowest level and five the highest), using diffuse qualitative descriptors: low, incipient, appreciable, notable, and optimal. The weight of each of the components is assigned by groups of external experts and representatives of relevant institutions. "The Risk Management Index allows for a quick overview of the management process, but it is also formulated in such a way that issues and areas that still require attention and investment, or those not yet considered, can be reviewed in detail" (Carreño et al., 2009).

This RMI at the urban level is well positioned in the region. There are several measurements available over time and also in different cities, which although not strictly comparable, allow for a general overview of performance. A parallel study carried out in three cities: Manizales and Bogotá in Colombia and Manila in the Philippines, allow for an understanding of the city's progress in historical terms as well as an examination of its development and evolution from a comparative perspective.

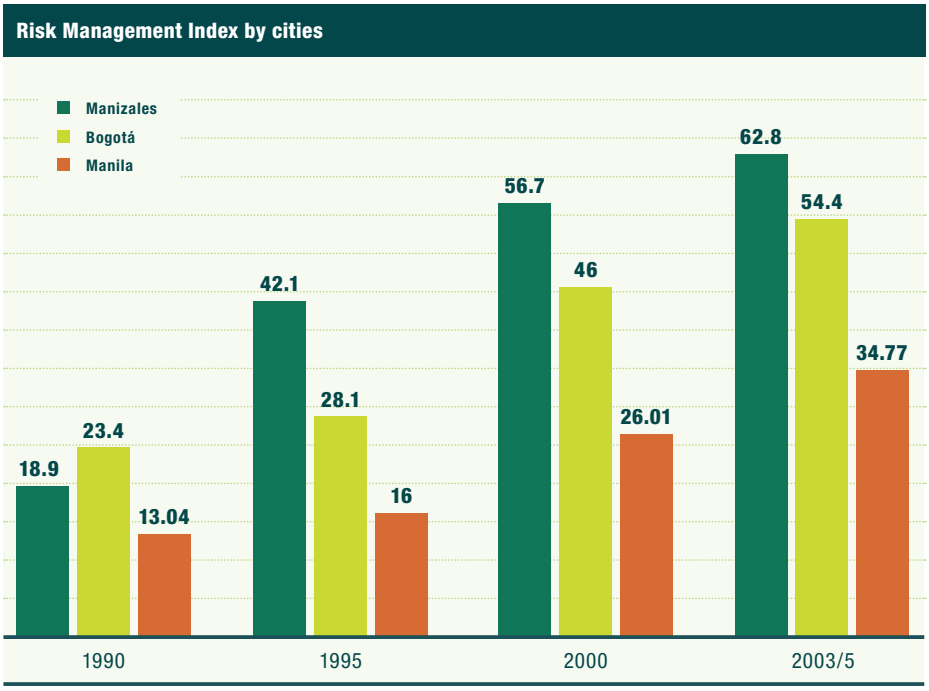
The graphs in Figure 5 reveal how these cities have worked on this issue consistently over the last decade showing no setbacks in any of the components. The most significant changes in Manizales have been in terms of transfer and governance, which coincides with the collective insurance implemented in 1999. An even greater effort is noticeable for the year 2000, when the first Territorial Development Plan was implemented and investments were made as a result of the environmental surcharge.

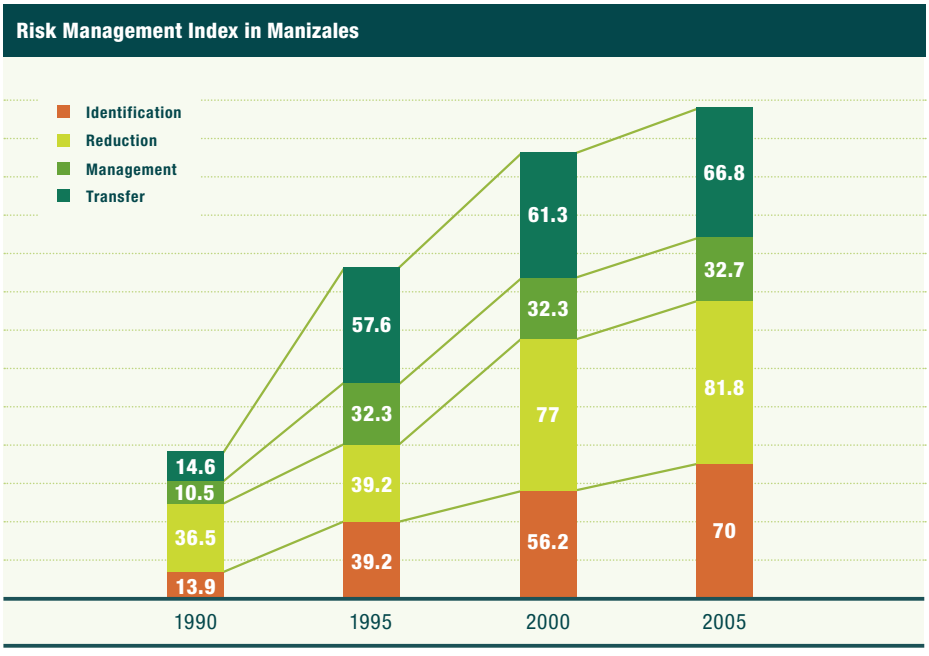
Another urban risk measurement exercise that was carried out in Manizales incorporates risk aggravation factors due to "social fragility" (share of informal settlements, mortality rates, crime rates, social disparity index, population density), as well as "lack of resilience" (number of hospital beds, human resources in health, area of public spaces, relief personnel, share of high income residential areas) (Suárez, 2009). This work confirmed that districts 2 (San José) and 5 (Ciudadela Norte) have the highest levels of socioeconomic vulnerability, which, when overlaid with physical risk levels, accentuate the total risk.

Notably, a comparison between the City Resilience Index (CRI) (Arup, 2016) and the Risk Management Index (RMI) (Carreño et al., 2004 and 2009) shows that both are based on qualitative methodologies (weighting by experts) evaluating a series of indicators grouped by dimensions. While the CRI has 52 indicators aligned to 12 objectives, and organized in four dimensions (people, organizations, place, and knowledge); the RMI is composed of 24 indicators, six for each conceptual component of risk management (identification, reduction, management, and risk transfer). It can be said that the CRI has a broader spectrum and does not prioritize any dimension over any other. For this reason, it can be more difficult for a municipal administration to use the CRI index programmatically. On the contrary, the RMI is more targeted towards disasters. It

Figure 5

Risk Management Index. Source: Prepared by the author based on Carreño et al. (2009).





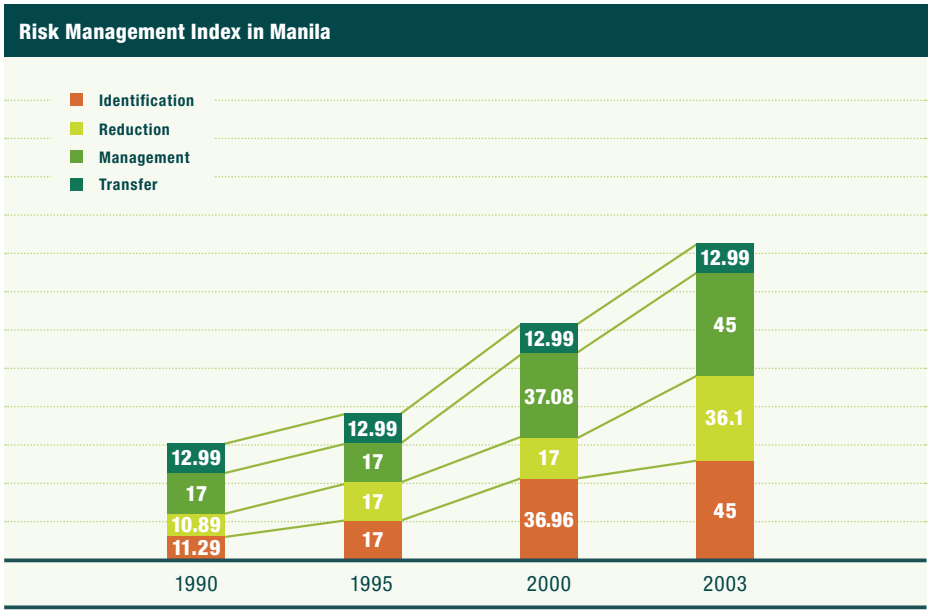
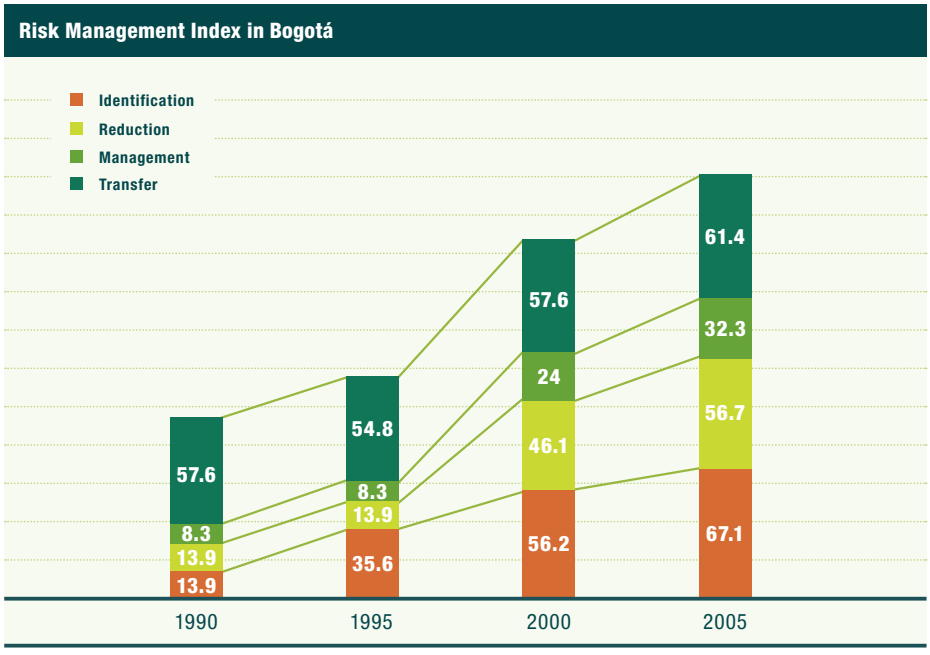


Figure 5 *(cont.)*

Risk Management Index. Source: Prepared by the author based on Carreño et al. (2009).



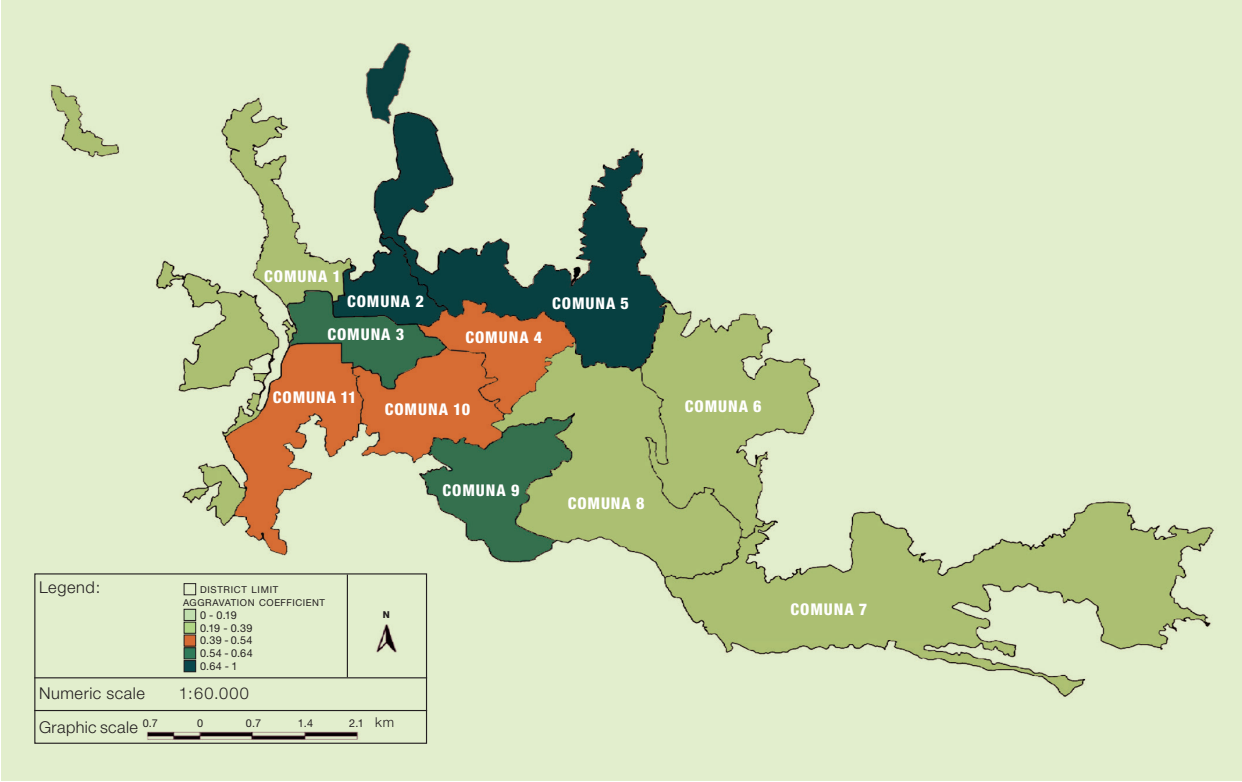


Figure 6

Aggravation Coefficient Map of the Urban Risk Index by Districts (*Comunas*). Source: Suárez, 2009.

is fair to say that the URI assumes that certain qualities are desirable in all urban systems: inclusion, integration, reflexivity, recursion, robustness, redundancy, and flexibility. The RMI, in turn, implies directionality between its components, which means that risk must be *identified* in order to be *reduced*, when reduced it is *managed* better, and ultimately it may be *transferred* to allow for a more effective management. Both indexes are intended to measure *urban performance* (the RMI has also been applied to other territorial scales). The CRI prioritizes knowledge sharing rather than city ranking or competition between cities. The RMI, in turn, facilitates performance tracking over time, monitoring of different components, comparisons between different locations, and setting effectiveness targets.

II. URBAN RESILIENCE PRACTICES

Three urban practices in Manizales illustrate the socio-environmental-technical assembly (McPhearson et al., 2015) of risk management that strengthen resilience. In all cases, these practices are a socio-technical-environmental assemblage. First, the Territorial Development Plan will be addressed, highlighting how technical developments have allowed risk management to be understood as an ally of urban development. The second practice is the collective insurance of properties, which collects voluntary contributions from the upper classes to protect the assets of the most vulnerable population. The collective insurance does not imply any cost to the municipality (outside of the technical studies to calculate the insurance premiums). It is a practice that links the private sector, provides citizen security, and helps the local government in its mission to assist those most in need. Hence, the collective insurance is also a socio-technical-environmental assemblage. Finally, this section will describe the "Guardians of the Hillside" program, which employs single mothers to perform preventive maintenance of the city's mitigation infrastructure.

a) Manizales' Territorial Development Plan

The integration of risk management within urban planning instruments in Latin America does not have a long or successful tradition. In Colombia, one of the countries in the region with the most developments in this area, risk management was only integrated into territorial development plans after the Decree 1807 of 2014, which established the minimum conditions to do this effectively and defined the scale of detail required for analyses of hazard (1:2000). Too often, when these spatial analyzes of hazards and risks are carried out, they have an insufficient level of detail, and hence, they become "inoperative": they do not differentiate clearly the levels of risk, so they do not facilitate urban development decision-making (see Ruiz Rivera et al., 2015 for the Mexican case). As a rule, the lack of precision in these studies leads to excessively restrictive zoning regulations, which creates a false antagonism between risk management and urban development. However, Manizales has a different story to tell in this respect.

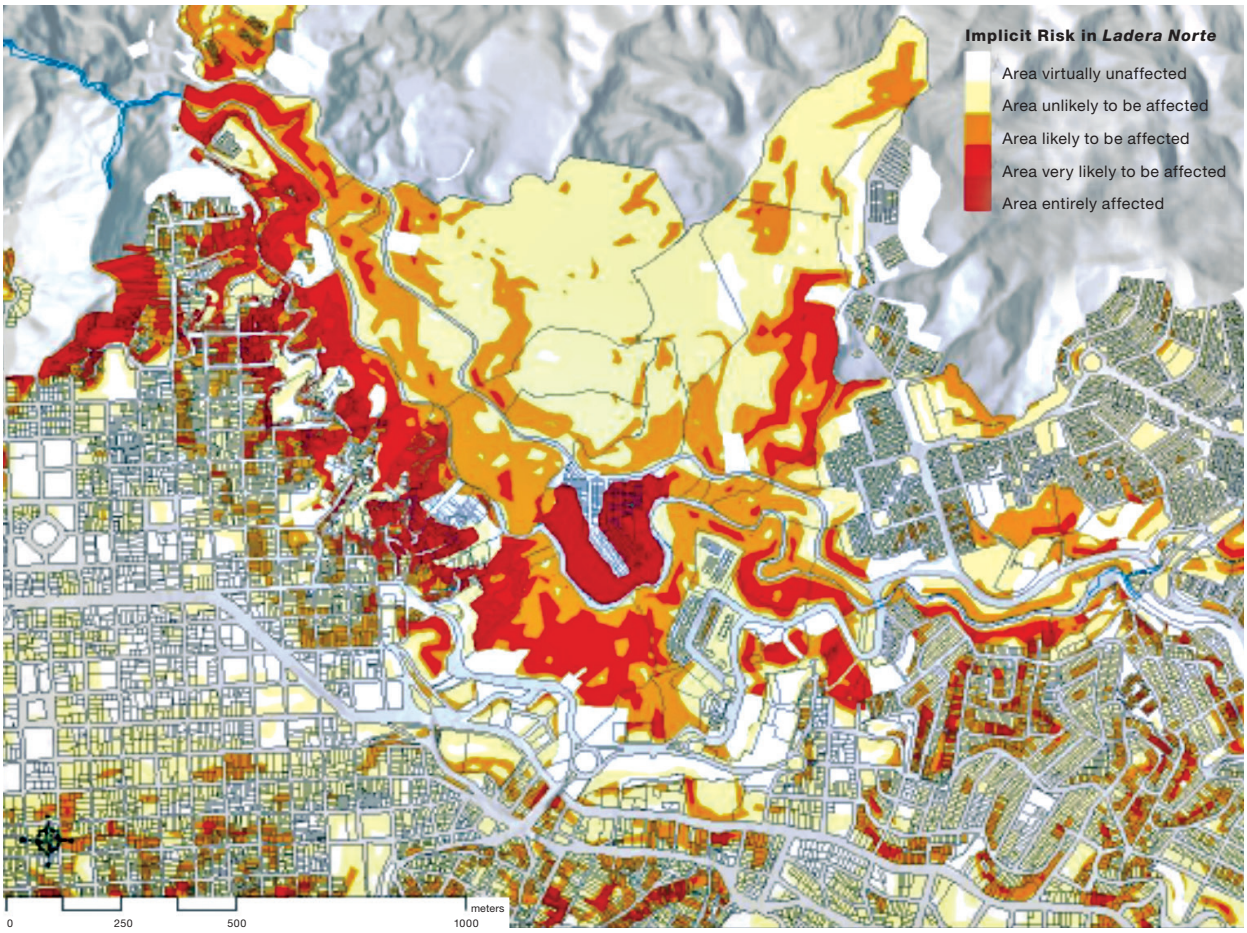


Figure 7

Map of Implicit Risk in "Ladera Norte" District, Manizales. (Ingeniar-IDEA, 2017).

First, it is necessary to clarify that the city incorporated risk management into its planning instruments before the nation made it mandatory by law. Before the Territorial Development Plans were regulated in Colombia (with Law 388 of 1997), Manizales incorporated this topic into its municipal budget and development plan, a fact that earned it recognition in 1996 at the United Nations Human Settlements Conference, Habitat II (Hardoy and Velásquez Barrero, 2014). Later on, the city also incorporated risk management in its Territorial Development Plan even before the Law 1523 of Risk Management was issued in 2002. In fact, the experience of

Manizales in this respect was decisive in the very conception of the national law. Such awareness of the importance of giving priority to the issue of risk by the municipal government is so entrenched in Manizales, that experts remember that on one occasion, the Municipal Council would not approve the Municipal Development Plan of an incoming Mayor, until risk management was made one of the key pillars of municipal urban management (Pérez, 2017; Cardona, 2017).

The high level of detail achieved in the risk studies that informed the latest update of the Territorial Development Plan of Manizales (2017) has not only a political background, but more importantly a scientific one. The city has a robust technical capacity and an ample collection of geo-referenced meteorological data from 327 previous events that allowed to "calibrate a probabilistic model to produce more a detailed, realistic, and above all, *useful* risk map" (Pérez, 2017). Here the merit is three-fold. First, there must be a consistent collection of historical data; second, the city must have capacity to produce detailed analyses with impeccable scientific rigor (Cardona, 2017); and third, for these technical studies to be useful, they must be translated from a specialized language into a common language that facilitates political decision-making (Franco, 2017).

The risk maps of the Manizales' Development Plan are innovative because they incorporate 29 factors of "proneness to risk" (including aspects such as: geological classification, slope gradient, distance to drainages, population density, density of constructions, socioeconomic level, etc.) in an artificial neural network called "multilayer perceptron", which allows for the analysis of problems that are not linearly separable. Put simply, the risk maps make use of artificial intelligence in their analysis of variables. Also, the cartographic cadaster was complemented with LIDAR images (Laser Imaging Detection and Ranging), which basically allowed for a comprehensive three-dimensional and categorized scan of the surface of the city, with an unprecedented level of detail.

In conceptual terms, the importance of these technical developments is the incorporation of a probabilistic analysis into the risk assessment. That is to say, it is not only a matter of knowing *what* the hazards and vulnerabilities of each property in the city are, but also of calculating the probability of their occurrence. This model allowed Manizales to calculate *how much*

risk the city is able to cope with and *where*. With this, Manizales' Territorial Development Plan could go beyond shading red, orange and yellow areas of 'high', 'medium' or 'low' risk levels, and opened the possibility of categorizing certain areas as having a "conditional development" potential. In practical terms, this increased real estate values of certain tracts of urban land and allowed the city to consider more types of land as being potentially buildable, as long as "the owner assumes the costs of the all the studies and projects necessary to reduce the threat" (Ingeniar-IDEA, 2017). In this way, the detailed technical knowledge of risk made risk Manizales a true "partner of urban development" (Cardona, 2017).

This coupling of risk management and urban development had an important precedent in Manizales: the building permit for the Fundadores shopping center (*Centro Comercial Fundadores*). In 2000 real estate developers approached the administration with interest to develop a very steep plot of land holding the first stabilization structure in Manizales. The city decided to authorize the development, as long as the developers constructed a deep foundation of unusually high specifications and as long as the building itself would fulfill the same containment functions as the existing infrastructure. This mitigation infrastructure was in need of repair, as it was reaching the end of its lifespan (50 years). Thus, the city allowed the construction of a shopping center in a strategic location and at the same time provided a new mitigation structure free of cost. The Fundadores shopping center is almost 700,000 square feet, has 200 shops, 500 parking spaces, offers 900 direct jobs, and is visited by 650 thousand people each month (Fundadores, 2017).

It is important to emphasize that these technical developments could be carried out because the administration prioritized risk management and incorporated in 2009 an environmental surcharge of (0.5 per thousand) in the property tax. In 2016, the Municipal Council approved an additional increase of 0.5, so the current environmental surcharge in Manizales is of one per one thousand. With this environmental surcharge to the property taxes of one per thousand, Manizales is able to raise US$8 million per year, an important amount for a city of less than 400,000 inhabitants, which has a modest public investment per capita of US$290. In the period between 2009 and 2016, US$28.4 million were raised (Manizales Municipal Council,

2017), a budget executed by the departmental environmental agency, Corpocaldas. As a result of this strategy, together with a national credit, the city managed to invest US$3 million in a set of 18 technical studies (Franco, 2017) and US$45.4 million in stabilization works (Manizales Municipal Council, 2017), which gave a notable qualitative leap forward to risk management in the city.

b) Collective insurance

Ever since 1999, Manizales offers a voluntary collective insurance to protect its population against disasters (particularly against the most devastating, earthquakes). The voluntary insurance policy is charged via the property tax. This strategy encourages the insurance of private property *en masse* to the wealthier citizens, while simultaneously deploying a cross-subsidy to properties that, because of their value, are exempt from this tax. "The insurance premium has a deductible of 3% in case of an earthquake and of 10% for other types of natural phenomena or events such as strike, riot, rebellion, civil or popular commotion, malicious acts of third parties or terrorism" (Marulanda, 2015). This practice offers protection to the low-income population, which is a means of protecting public resources. This financial protection instrument is based on the probabilistic risk assessment mentioned earlier, which took advantage of the seismic micro-zoning of the city and calculated the maximum probable losses. Then, with the technical and financial information available, pure risk premiums were calculated property by property, and then were distributed proportionally among the insured.

The insurance company issues a master policy, whose policyholder is the Municipality of Manizales, but the company establishes a direct contractual relationship with each insured individual. Therefore, the insurer is the one who solves and processes the claims whenever an incident occurs (Manizales Risk Management, 2015). The master policy document is available for anyone's review. There are copies at the Mayor's office, at a public notary office, and at the insurance company branch in the city.

Manizales has become an innovator nationally and internationally with this system of financial protection that acts as a complement to the actions of the state in the field of risk management. In order to implement this practice successfully, it was necessary to carry out a complete inventory of

Figure 8

View of Manizales from the cable car. Source: Photo: Maria Carrizosa, 2017.

properties, which, together with the seismic micro-zoning and the probabilistic risk analysis, allowed for the development of a study of potential losses of all the properties in the city. If at least 20% of the properties that must pay property tax buy the voluntary insurance, then the city can guarantee the effective coverage of all properties that are not obliged to this payment (Risk Management Manizales, 2015). The detailed technical risk studies carried out with resources from the environmental surcharge mentioned above, allowed the municipality in 2015 to refine the calculations of potential losses and to adjust the insurance premium. Hence, the city was recently able to renegotiate with the insurance company, lowering the cost of the master policy. "Despite the significant increase in the number of properties from 85,816 to 113,064 in a period of less than 10 years, it is notable that there was a reduction of the pure risk premium of the city, with a 3% deductible, from 1.98% to 1.63% (…) It is seldom possible to measure the seismic risk of a city with the same metric. It is even more interesting to note that there is a risk reduction, which in the case of Manizales could be expected as a result of the many efforts made in risk management (Marulanda, 2015).

During the last emergency on April 18-19 of 2017, the voluntary tax paid for by the dwellers of properties in the higher income levels (4, 5, and

6 strata), automatically covered all the properties of residents from lower income levels (1, 2, and 3 strata), properties whose cadastral valuation does not exceed 39 legal monthly minimum wages (just under US$10,000). As such, citizens whose properties were partially or totally affected could claim a lumpsum payment from the insurer (AXA Colpatria). The collective insurance included 23,179 properties, and the number of properties that could voluntarily sign up for the insurance was 105,829 (BC News, 2017).

This mechanism of risk transfer is a successful experience, which allows the state to protect the most vulnerable populations without mobilizing additional resources. The implementation of this practice shows that cross-class solidarity exists. It also reveals that voluntary micro-insurance, when supported by detailed and rigorous technical studies, has the potential to align public and private interests for the benefit of the city, without creating additional burdens on the municipality. "The cost-effectiveness [of this practice] is clear from the perspective of sustainability, prevention, socio-economic welfare, financial protection, and contingent macroeconomic liability" (Marulanda, 2015). This important practice has been documented in detail and shared with other cities in the country as well as internationally. For more details see the technical report (ERN-Manizales, 2005).

c) Guardians of the Hillside

Manizales has more than 900 land stabilization civil works (terraces, canals, channel covers, containment screens with active or passive anchors, walls in gabions, channeled basins, "shotcrete" with mesh, drainages, grasses and bamboo poles), which must be maintained so they can fulfill their protection function. Before 2003, officials observed that much of the city's infrastructure, although of good quality, was not operating properly and was generating more problems than solutions due to the lack of maintenance: garbage deposited in the drains, rubble spilled on banks and slopes, channels covered by brushwood, etc. This situation of public disinvestment motivated the administration to face the problem. The Guardians of the Hillside program began in 2003 by the initiative of the then director of Corpocaldas (environmental authority in charge of civil works), after some high impact landslides. The program is designed to guarantee proper maintenance of the city's stabilization works, 95% of which are located in areas with informal settlements.

Figure 9

Guardians of the Hillside. Photos: M. Carrizosa, 2017.

In 14 years of operation, the program has managed to survive five municipal administrations of very diverse political factions. Undoubtedly, the continuity of the project across the political and financing swings is an achievement in itself. Some experts consider that its institutional architecture is key to this success and celebrate the fact that an organization that is independent from the Mayor's Office (FESCO, the NGO Foundation for the Integrated Development of Children, Youth, and the Family, in Spanish *Fundación para el Desarollo Integral de la Niñez, la Juventud y la Familia*), "has prevented the program from politicizing" (Sipaguari, 2017). This has secured its operation and kept its dual fundamental purpose intact: to support low-income women who are heads of households and, simultaneously, to perform preventive maintenance of the city's mitigation infrastructure. FESCO has more than 30 years of experience with social and environmental projects in the region, 95% of which are contracts with the local administration (Sipaguari, 2017). Within the FESCO portfolio, the Guardians of the Hillside is a very visible program. It has inspired similar programs in other sectors such as "Guardians of the Parks" and "Pacts for the Basin".

The program "Guardians of the Hillside" hires 110 women using part of the funds collected through the environmental surcharge to the urban property tax. In its 14 years of operation it has benefited 1,000 female heads

of households with formal contracts and social protection (for most of the year). The funds are managed by the environmental agency Corporaldas, which signs an agreement with the NGO FESCO every year. FESCO is responsible for the technical and social coordination of the whole program, which truly integrates technical, environmental, and social components. Guardians of the Hillside is a maintenance program for civil infrastructure (specifically cleaning and monitoring), but at the same time it also "engages in environmental education processes and in the promotion of a culture of risk prevention (due to landslides) in the citizens" (FESCO, 2017b). Its specific objectives are: to generate knowledge in the community about the proper management of the slopes; to strengthen in the citizens a sense of belonging of the hillsides; to promote a constant community monitoring of proper slope management; and to generate formal employment for vulnerable populations such as single mothers who are household breadwinners (FESCO, 2017b). As expressed by one of the coordinators: "the physical work is the most visible, but the social work is the most important" (Castro, 2017).

Guardians of the Hillside logo.

The Guardians prune and remove the plant material (weeds, grass, stubble, and bushes) that clogs the channels obstructing water runoff through the city's 851 geotechnical areas. In addition to carrying out this physical work on the hillsides, they also perform dissemination and awareness-raising activities to the community through two activities. The first one is a "door to door" outreach method. After the cleaning work is done, they go house by house and present a "record of delivery" of the work performed to the community. They also explain the proper management of slopes to the neighbors. This work is done in 119 neighborhoods across the city's 11 districts. The second activity is called the "Guardians for a Day". It is a pedagogical activity aimed at children in public and private schools in the city. Through games, conversations, audiovisual material, and demonstrations, this program explains the importance of the work of the Guardians of the Hillside and how the children can contribute as citizens. To date, more than 8,500 children have been trained.

It is also worth noting that the Guardians themselves receive monthly trainings on occupational safety issues, safety protocols for working in heights, civil engineering, environmental studies, and other topics of interest and of use to them. Some training topics are:

Social	Technical	Environmental	Others
Communication	Basic hillside concepts	Environment concepts	Family planning methods
Leadership	Basic erosion concepts	Nature as a system	Vaccination opportunities
Values	Civil projects for erosion control	Waste management	Self-care
Team work	Areas with geotechnical treatment	Slopes in the natural environment	Community education on disaster prevention
Spaces for coexistence	Tool handling		
Mechanisms for citizen participation			

Table 2

Training Topics for the Guardians by Component. Source: Mejía, Giraldo, and Trujillo, 2006.

The risk-prevention role the Guardians perform on the hillsides in Manizales lies in the daily monitoring of the mountains. They are able to supervise on a small scale, centimeter by centimeter, parts of the city that are seldom visited. As the director of the program argues, the Guardians become "a thousand eyes of the administration on the territory" (Sipaguari, 2017). Their oversight work is quite comprehensive. This group of women formally reports to the administration the existence of dumps, wastewater discharges, informal settlements, damage to works, overgrazing and clean crops (crops with shallow roots with furrows that leave the soil exposed), which increase the risk of landslides. The monitoring of informal settlements is further supported with a census of properties and construction in high-risk areas that FESCO permanently updates. Such a detailed population, cartographic, and cadastral census proved to be of vital importance "locating missing persons in times of disasters and also preventing the undue collection of subsidies" (González, 2017). This monitoring task and especially the census have been instrumental in some relocation processes led by FESCO which have been completely voluntary and successful processes, leading to "607 demolished houses in 82 neighborhoods" (FESCO, 2017a). In sum, the work

of monitoring the hillsides is an invaluable contribution to: raise community awareness 'door to door' ("the 'voice to voice' is the best outreach strategy" (López, 2017)), financially support vulnerable populations ("this program is an oasis, because it does not discriminate by age, nor by the level of training of female employees" (Castro, 2017)), inform emergency-response actions, and to prolong the life of the city's land stabilization infrastructure.

III. CITY-SPECIFIC RESULTS

a) Expected and unexpected outcomes

It is impossible to ascribe to a single component or practice a successful response to a multilevel impact. Instead, what are needed are comprehensive multilevel responses and solutions. In this sense, it should be acknowledged that risk management and urban resilience are absolutely transversal. A good way to evaluate the results of urban risk management practices in Manizales is to detail how the city responded to the latest emergency caused by intense rainfall which resulted in multiple landslides. Extreme events test the capacities in place and, if interpreted properly, can reveal what works and what does not work. What follows is a description of the opinions of the main the city experts regarding what happened during this event.

The rain began at 11 p.m. on April 18, 2017. The intensity of the rain exceeded the thresholds established in the city's early warning system: basically "in four hours it rained the amount that it rains in a month" (López, 2017). In addition, the weather stations, despite having an "impeccable record" (Suárez, 2017), were not being monitored at that time of the night, reminding this highly prepared city that "risk never sleeps or goes on vacation" (López, 2017). It was an episode of rain without precedents in the last 100 years (Franco, 2017) "that exceeded the capacities of measurement and of timely reaction" (Suárez, 2017).

The suddenness of this episode reiterates what "climate change scenarios affirm: models indicate that in Manizales accumulated rains will

likely be less, but that events will be greater in intensity and more frequent" (Cardona in Wilches-Cardona, 2017). In terms of risk knowledge, the event demonstrated the importance of updating the early warning system and adapting it to climate variability and climate change. It also demonstrated the need to integrate national climate forecasts with local measurements in real time (Franco, 2017).

According to official reports, the landslides caused 14 casualties, nine missing persons, 23 injuries, and affected 15 roads in 18 neighborhoods. The emergency situation was decreed at 2:30 a.m. and the emergency response operations were immediately deployed (López, 2017). In total, 500 families were evacuated. Over the next five days the city concentrated on recovering from this severe event. The schools closed, and many served as temporary shelters. During these days the Manizales community had time to reflect on what was happening (Escobar, 2017). The inter-institutional and citizen responses revealed that there was "a culture of unity in the city, disinterested, that quickly became activated to address the situation" (López, 2017). The people reacted in solidarity and common citizens "trusted in the efforts of the Mayor's Office, recognizing that there was no populism in the aid provided" (Suárez, 2017). In addition, people "could see for themselves that Manizales has worked a great deal on this issue" (Escobar, 2017).

The event also showed that "there was no negligence on behalf of the local government and that the infrastructure did not fail" (Sipaguari, 2017). "Land stabilization projects do work. Comparing the effects of the events of 2003 and 2017, it was evident that the proper maintenance of the infrastructure done by the Guardians makes a real difference" (Suárez, 2017). The Guardians themselves proudly reported that: "in Aranjuez and Sancancio, we had worked eight days ago. The landslides were much less serious because of our work… I feel proud and happy because with our work we saved many lives" (Guardians, 2017).

It is telling to compare the resilience of Manizales facing this event to that of Mocoa, another Colombian capital city very similar in size, where heavy rains caused rivers to overflow leading to mudslides only 15 days earlier. Although the rains in Mocoa were of lower intensity and volume, their impact was harsher. In Mocoa, 323 people died, 103 disappeared, 332 were

injured, and more than 5,800 families were affected (UNGR, 2018). The official figures show that in Mocoa there were 30 times more fatalities and 10 times more disappeared and affected families than in Manizales. This rather unfair comparison showed that Manizales is better prepared and in better condition to recover faster from extreme weather events.

Undoubtedly, Manizales is aware that its work in all the components of risk management: identification and knowledge, reduction and prevention, response, and also transfer, indeed saves lives (López, Suárez, Pérez, Sipaguari, Cardona and Wilches, 2017). Measuring results in terms of lives saved, "avoided disasters, or mitigated disasters" (Wilches-Cardona, 2017) has methodological and conceptual difficulties, but without a doubt, it could be a good indicator of sustainable development. "I believe that a good way to measure the true progress towards sustainable development could be the "Indicator of Disasters Avoided". This might be a way to make evident that, faced with the same dynamics that previously generated emergencies or disasters in a territory, or that generated them in others, a particular territory has managed to absorb, without negative consequences, the effects of these dynamics" (Wilches, 2017).

When risk management works well, it is not seen. In this sense, "environmental management and risk management have the same problem as housework: when it is done well, it goes unnoticed. Risk management only makes the news when it fails to avoid an emergency or disaster" (Wilches, 2016a). Although what happened in the city on April 18-19 was a disaster, there seems to be consensus around the fact that many landslides were avoided, and the effects of the disaster were mitigated. The perfect example is the case of the preventive and voluntary relocation of the La Playita neighborhood on the Sancancio hill, in which almost 300 families were relocated between 2006-2009 (Sipaguari, 2017; FESCO, 2017a). Had the neighborhood not been relocated, with April 2017's heavy rains, all those families and their homes would have suffered irreparable damages.

b) Reflection on transferability

One of the most echoed urban success stories in Latin America and throughout the world has been the mass Bus Rapid Transport system (BRT) that began in Curitiba, Brazil. Jaime Lerner, the mayor responsible for

implementing this project, usually states that in the administration of a city, a solution that only responds to only one problem is not a good solution. Effective solutions, those that are worth repeating, are those that respond to several problems simultaneously. This is a message of great importance because there is an increasing awareness about the interrelatedness of urban problems, which means that solutions must also be interconnected (Cohen et al., 2016). In an "urban agenda all the objectives are interdependent and problems cannot be solved one by one, but rather as a whole, in a network" (Carrizosa, 2016: 459).

The three urban practices presented in this chapter have this condition. In the first one, scientific developments allowed the incorporation of risk within the Territorial Development Plan, not as a restriction for development but rather as an engine of urban development. In the second one, a financial tool that stimulates the local micro-insurance market is at the same time a social protection measure that guarantees the early recovery of a vulnerable population after a disaster. The third practice, the "Guardians of the Hillside" program, is the most emblematic case of this interdependence. In essence, this is a preventive maintenance program for the gray infrastructure in the city, which simultaneously protects green infrastructure and, above all, strengthens the city's social infrastructure. By responding to these three components concurrently, environmental solutions are linked to the solution of social problems. If an urban practice is truly integral, then it multiplies the benefits, optimizes the resources, and results are clearly visible to the community. It, then, is also suitable to be transferred elsewhere.

The "Guardians of the Hillside" program has been replicated at the local, national, and international levels. The department of Caldas (region to which Manizales is the capital) has already incorporated this practice in ten other municipalities: Anserma, Pensilvania, San José de Caldas, Belalcázar, Victoria, Villamaría, La Merced, Samaná, Aránzazu and Neira. FESCO has also shared the experience with public officials and development entities in Japan, Costa Rica, Panama, and Ecuador, among other countries. Another clear recognition of the many accomplishments of Manizales in integral disaster risk management is the fact that the best students of a virtual course offered by Florida International University and the University of Catalunya are granted an internship at the IDEA institute in Manizales, to see real

solutions in practice. With the support of USAID (United States Agency for International Development), ten consecutive cohorts of professionals from around the world have held internships in Manizales and have taken this experience to their places of work across the world.

Many experts wonder to what extent the experience of Manizales is unique or to what extent it can be replicated in other places. Some believe that the trajectory of the city is unique, and that despite the fact that certain institutional arrangements can be copied, behind these institutions lies an exceptional group of people who have committed themselves for decades to promote these issues (Suárez, 2017 and Cardona, 2017). Several interviewees confirmed the existence of a handful of people acting in pursuit of the urban resilience of Manizales and encouraging the academic, civil, and government institutions to keep up with this work in the long run (Pérez, 2017 and Franco, 2017). "The city would not have responded so well to the last event, if it had not done everything it has done. It is crucial that certain lines of work have been maintained over time, despite the political fluctuations across different administrations" (Pérez, 2017). Of course, there are ups and downs in the attention given to the topic and the general performance of the city, but to a certain extent, efforts have been sustained over time, which has rendered clear benefits. Due to its topography and climate conditions, Manizales has been and will continue to be exposed to disasters. Since relocating the whole city is not an alternative, the population has no other option but to learn to live with the risk. In short, we can speak of a risk management culture in Manizales that is *long in term* (at least 70 years old), *broad in scope* (outside of infrastructure works it has financial, environmental, civic, psychosocial and computational instruments), and *deep in reach* (beyond the government, academia, private sector, civil society, and communities are actively involved).

In sum, we highlight two conditions for a risk management culture to develop and to enable the transferability of this experience. One condition is that the public administration sets aside exclusive economic resources to invest in a detailed knowledge of risk, and the second one, that there is enough social capital to tap into. Regarding the first condition, it is evident that Manizales has been effective. Manizales is not a wealthy city yet it does not depend on national transfers nor international contributions

to invest in risk management. Both the environmental surcharge to the property tax and the voluntary collective insurance are excellent examples of this. However, it is possible that the second condition, social capital, is even more fundamental than having financial resources. In this regard, Escobar states: "coffee represents a more redistributive economy than others and, even at a small scale it promotes formality. Around the coffee industry there is a strong institutionality" (Escobar, 2017). The coffee economy that has developed in Manizales for more than a century, represents the basis of this culture of respect for institutions and appreciation for individual entrepreneurship within a collective spirit of solidarity.

IV. PRELIMINARY CONCLUSIONS ABOUT THE MANIZALES' CASE

This final section gathers a series of messages from the different experts and various members of the community in Manizales, directed to city mayors and local governments in Latin America and worldwide.

As a starting point, it is important to emphasize that it is not necessary for a city to be wealthy in order to have outstanding results. Manizales, a success story internationally recognized for its risk management culture, is a city "that invests half as much per capita as the city of Medellín, and yet it has very similar results in urban management and citizen satisfaction" (Escobar, 2017). Another important message is that urban resilience is a matter of life and death, so, as "human life is above all everything else, then *investment in knowledge saves lives*" (López, 2017). In what kind of knowledge do we need to invest? In a knowledge with the highest technical rigor, but knowledge that can still be translated into a clear simple language so that it facilitates decision-making. In this sense, it is advisable to "trust the university, but it must be a university that is dedicated to and concerned with the city" (Franco, 2017).

In terms of urban administration there are also some key messages for other local governments. For example, that "whatever is not addressed

ahead of time, costs more" (Sipaguari, 2017). Or that successful experiences have a long development process and will never be replicable if they are not based on the local culture (Suárez, 2017). In public management "what is not measured cannot be managed" (Cardona, 2017). That is why experts such as Cardona and Suárez have worked on the Risk Management Index, which they insist should be implemented repeatedly, so it can serve as an urban management instrument for evaluation, monitoring, and visualization of tasks already carried out and those yet to be fulfilled. The coordinators of the Guardians program maintain that mayors "must believe in the people" (Sipaguari, 2017), and also that urban managers should recognize that "the focus on women is vital, since they can play an integrating role in sustainable development programs" (Castro, 2017). Territorial planning experts, in turn, call for an understanding of "risk management as a strategic partner in urban development, generating opportunities and facilitating decision making, rather than as something restrictive" (Pérez, 2017).

Of course, each actor offers a vision from his or her perspective and prioritizes particular approach as being the fundamental axis of successful urban practices. In this sense, it is interesting to note that there is a wide spectrum of approaches, disciplines, and action initiatives that contribute to Manizales being a resilient city, capable of managing the risk to which it is frequently exposed. However, in the path that Manizales has taken one can recognize that some approaches have had less of a hold. Environmental management, for example, is and must run parallel with risk management, they should be a continuum (Wilches, 2016b), but in Manizales it seems to be rather silenced under the leadership of the technical-engineering emphasis. The fact that through nature-based environmental management the city can further strengthen its risk management has been a less explored topic in Manizales. On the contrary, Bogotá, during the administration of Gustavo Petro, had great progress in this regard (Wilches, 2017; Zeiderman, 2016, and others). Making a "pact with nature" has the potential to reduce risk and to guarantee the governability of a territory (Wilches, 2016b), and this is an area that has opportunities yet to be explored in Manizales. This is much more than a discussion on different ways to express the same issue, or disciplinary protocols. Rather, the main point worth highlighting is the importance of maintaining a caring approach

toward urban governance. "There are symbiotic interactions between ecosystems and humans, and these reciprocities can be of mutual benefit" (Wilches, 2016b), so it makes sense not to waste them but to take advantage of them. As mentioned above, in the topic of sustainable development and urban resilience it is the connections between actors—including nature—, the relationships between dimensions, and nexus between systems, what guarantees successful experiences.

Undoubtedly, taking a path implies not taking others. The Manizales case showcases the importance of technical knowledge, scientific progress, and rigorous analysis. But when disasters (which are never natural, but always anthropic) are recurrent, it is important to contemplate the idea that "all complex systems [such as a city, a neighborhood, a community, or even the human body] … have capacity for self-regulation allowing them to adjust in response to certain tensions to which they are subject" (Wilches, 2016b). That is why by understanding the place of cities in nature, it is possible to develop an attitude, hopefully transversal to professional silos, of respect for our place in the world, and co-responsibility for our urban footprint. Ultimately, we intend with this case and with others in this book, to invite local governments to "fully embrace new integral urban practices. Practices that weave functional networks between actors and that sow roots in their place. Practices where the solutions are enmeshed in symbiotic systems between different administrative and disciplinary sectors. Practices that invite collective intelligence to be at the service of fair and sustainable urban development" (Carrizosa, 2016: 461).

3. LA PAZ, BOLIVIA. THE SOCIAL CONSTRUCTION OF VULNERABILITY AND RISK

DAVID LÓPEZ GARCÍA

In recent years, the city of La Paz has suffered natural catastrophes that have decisively marked its risk management policy. La Paz has developed a resilience policy that combines organizational and financial resources around risk management and that integrates two programs implemented by the Autonomous Municipal Government of La Paz (GAMLP, *Gobierno Autónomo Municipal de La Paz*) focusing on the infrastructure and social aspects of the problem. One of these programs is the Municipal Integrated Risk Management Strategy (EMGIR, *Estrategia Municipal de Gestión Integral de Riesgo*), implemented by the Municipal Secretariat for Integrated Risk Management (SMGIR, *Secretaría Municipal de Gestión Integral de Riesgos*). The other is the True Neighborhoods and Communities Program (PBCV, *Programa Barrios y Comunidad de Verdad*), implemented by the Municipal Secretariat of Infrastructure. The urban resilience policy of La Paz can be considered successful in terms of reducing the short-term vulnerability of the population to the occurrence of natural hazards. However, the challenge of combating the structural processes behind the social production of vulnerability and risk still remains.

This study is based on 12 semi-structured interviews conducted with experts on urban resilience issues in La Paz, Bolivia, carried out during a field visit in September 2017. In addition, direct observations were made in some of the at-risk areas of the city, as well as document analysis of laws, policy communication documents, and academic articles.

I. URBAN CONTEXT

a) Historical background

The city of Our Lady of La Paz was founded on October 20, 1548 by the Spanish conquistador Alonso de Mendoza. The name of the city commemorates the end of the civil wars of the Vice-Royalty of Peru, and since its founding La Paz has been an eminently political territory where conflicts are discussed and resolved. The city is located at 11,975 feet above sea level, which makes it one of the highest cities in the world. According to the Population and Housing Census of 2012, the population of the municipality of La Paz is an estimated 766,468 inhabitants while its metropolitan population is 1.8 million. Despite not having a formal metropolitan institutional structure, the metropolitan areas includes the municipalities of El Alto, Viacha, Achocalla, Laja, Mecapaca, Palca, and Pucarani. La Paz is located 42 miles from Lake Titicaca, in western Bolivia, and is located on a canyon formed hundreds of years ago by the Choqueyapu River as well as five other hydrographic basins.

The city of La Paz has suffered at least three catastrophes that have decisively marked its risk management policy. First, an intense rainstorm with hail occurred on February 19, 2002, and is considered a historical milestone. This 90-minute event caused the flooding and overflow of the Choqueyapu River. This caused what in La Paz is known as a "riada", or the sudden appearance of a river above the built environment of the city. With 110 gallons of rain per square foot in 90 minutes, the "riada" of 2002 resulted in 68 deaths; 14 missing and 130 injured persons; 342 homes and 62 businesses affected. Ninety-three formal shops and 735 informal businesses were washed away by the river current; and 86 public transportation units were damaged.

During the 2008 rainy season, a second catastrophe of extreme waves in the Huayñajahuira River surprised the authorities and population alike. The river gathered rainwater and descended the high-altitude mountain at great speeds causing waves of up to 23 feet. The waves violently overflowed the channels through which the river was directed, where vehicular and pedestrian bridges cross it, putting the population that passing through the site at risk. Finally, despite the fact that landslides are common in La Paz,

on February 26, 2011, a third catastrophe known as the "mega-landslide" took place. Seven neighborhoods on the eastern slope of La Paz slipped away leaving more than 6,000 people homeless. The mega-landslide took place in a risk area, where the population had initially settled informally, but, was eventually formalized as the city grew. The inhabitants were evacuated in a timely manner preventing casualties, however, the event demonstrated the continuous and serious risk faced by inhabitants living on hillsides where the land is unfit for construction.

b) Geographic and Socio-Economic Environment

The city of La Paz is located in the basin of the La Paz River, a high mountain hydrographic basin composed of six sub-basins. The hydrographic area occupies 308.4 square miles while the urban area of La Paz sits on 54.6 square miles in the basin and is crossed by 364 rivers that join the southern part of the city. In addition, the rainy season lasts for six months of the year (data provided by SMGIR).

Moreover, La Paz is located in a canyon known as "*la hoyada*", a geological depression caused by two factors. The first is the circulation of water through 6 hydrological basins and the 364 rivers that cross the city, mainly by the Choqueyapu River. The second is the predominance of sand-like material on which the city sits, which facilitates erosion caused by the water flow from the rivers. As a whole, the natural hazards intrinsic to the site where the city is located are caused by spontaneous floods from rainfall and river growth, and by the potential displacement of soil caused by underground water currents and soil erosion.

Initially, the construction of urban space of the city began with settlements along the Choqueyapu River, which respected the river's natural floodplains. Over the years, construction invaded the Choqueyapu River's floodplain, until the river was finally channeled, and urban space was built over the river. More recently, the lack of horizontal space suitable for construction, coupled with the intense urbanization processes of the 1980s (Antequera, 2015), have led to the extension of urban sprawl towards the slopes of *la hoyada*. The expansion of the urban sprawl has been characterized by the appearance of informal settlements on the hillsides surrounding the city, settlements without planning or the approval of the

Figure 10

Geomorphology of La Paz, Bolivia. Source: SMGIR.

municipality of La Paz, which often lack basic urban services (Vargas, 2014; Schoop, 2007).

The processes of spontaneous and uncontrolled urbanization have given rise to what in La Paz is known as "the social construction of vulnerability". The natural hazards related to the geomorphology of the city—floods due to flooding of rivers and landslides—together with the spontaneous and disorganized appearance of houses on the slopes of *la hoyada* have combined the ecological and the social aspects shaping vulnerability. This problem mainly affects the poorest sectors of the population (Salamanca, 2007). The processes of social construction of both social vulnerability and risk in La Paz have been previously documented (UNDP, 2007). However, the field research for this report allows for the identification of four trends in the social construction of vulnerability. First, informal settlements tend to be located on *la hoyada* slopes or land unsuitable for construction. Second, the lack of infrastructure and basic services forces the new residents to self-build their sanitary infrastructures, generally discharging wastewater into

the hillsides, which infiltrates the land and contributes to downhill subsoil erosion. Third, as informal settlements are not endowed with infrastructure, such as paved streets and sewage, rainwater does not filter naturally into the subsoil and instead runs downhill above the built space. This accumulation of water causes what in La Paz are known as *riadas*, that is, sudden increases in the amount of water that runs downhill, causing the formation of spontaneous rivers that run through the streets. Fourth, the self-construction of urban space on the slopes of *la hoyada* has led to the emergence of infrastructure for the movement of people and vehicles that does not meet minimum quality standards. The roads and the self-built terraces, in combination with natural hazards, have put the population at risk.

The value of land and the political economy of housing also contribute to the emergence of these trends. On the one hand, the low and flat land of the city, which is suitable for building, has a high value and is accessible only to sectors of the population with high purchasing power. On the other hand, the land in the hillsides, with greater natural hazards, has a lower value, and is therefore more accessible for the lower income sectors. In addition, the political economy of the hillside housing also plays an important role. The hillside urbanization process has been characterized by the presence of "*loteadores*", informal agents who illegally occupy the fields, divide them and sell them outside the legal environment to people who will settle and build homes. The people who buy land from the *loteadores* build their house and additional housing units vertically, which are then rented to other residents. In this way, the construction of housing in irregular settlements becomes in itself a source of income. Housing itself becomes a savings bank and a source of retirement pension. Similarly, when irregular housing is legalized, it also becomes a source of tax revenue for the municipality due to the fact that the budget of Bolivian municipalities is allocated based on number of inhabitants (Antequera, 2012).

In theory, risk is the conjunction between natural hazards and vulnerability. In La Paz, natural hazards and the social construction of vulnerability are combined, putting the majority of the population at risk. The city has a risk map that was prepared in 2011. The methodology for its preparation consisted of superimposing a map of socio-natural threats—understood as natural hazards due to floods and landslides associated with human settlements—on

Figure 11

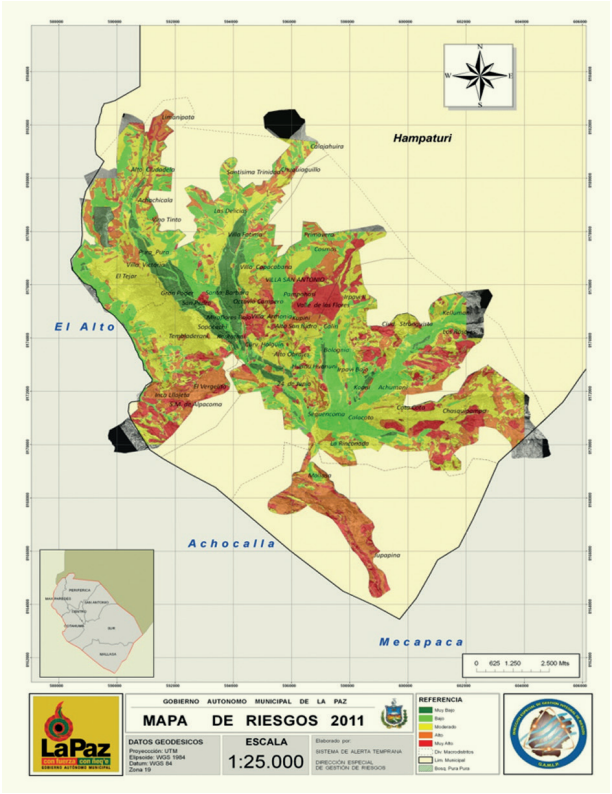
The Social Production of vulnerability and risk. Source: SMGIR. Photo by: D. López García.

a map of vulnerabilities. On the side of socio-natural threats, the geological, geomorphological, geotechnical, and slope factors were considered. On the vulnerability side, population, physical, economic, institutional and basic public service factors were considered. The result was the risk map shown below (Figure 12).

According to the map, 6% of the urban area presents a very low risk, 22% a low risk, 41% has a moderate risk, 21% a high risk, and 10% of the territory suffers a risk very high. The surprising fact was that, as a whole, 72% of the urban area of La Paz presents some type of risk, be it moderate, high, or very high. This is the scenario the city faces in terms of the design and implementation of its urban resilience policy. While it is an internationally celebrated policy, it was only initiated 15 years ago, due to natural

Figure 12

Risk Map 2011.
Source: SMGIR.



catastrophes that managed to bring the issue of risk management to the highest levels of attention in the government's agenda. La Paz borders the municipality of El Alto, which, according to the 2012 census, has a population of almost 850 thousand inhabitants. La Paz and El Alto are economically integrated, but not in the aspects of urban governance or public administration. It is estimated that 350 thousand residents from El Alto commute daily to *la hoyada* in La Paz daily to work, which implies an important burden on the public transportation system. However, public management processes are practically independent and each city designs and implements its own urban practices. This study's fieldwork led to the observation that the municipality of El Alto does not face natural hazards in the same proportion as the municipality of La Paz, a mismatch, this paper intends to learn from.

II. URBAN RESILIENCE PRACTICES

La Paz has developed an urban policy to manage the risk created by the combination of natural hazards and the social production of vulnerability. This urban policy integrates through institutional arrangements that seek to combine organizational and financial resources around risk management, mainly through two programs implemented by GAMPL. These programs focus on organization and management to address the infrastructural and social aspects of the problem: The Municipal Strategy for Comprehensive Risk Management (EMGIR), which oversees the SMGIR, and The True Neighborhood and Communities Program (PBCV), under the responsibility of the Municipal Infrastructure Secretariat.

a) Strengthening Institutional Arrangements

One of the first steps of the policy has been to strengthen the institutional environment for risk management. At the national level, comprehensive risk management is one of the priorities of the Economic and Social Development Plan 2016-2020 (PDES, 2016). In order to comply with this objective, Law No. 031/2010 establishes the framework for municipal autonomy and decentralization, and Law No. 602/2014 deals with risk management. As a whole, this legislation created and now regulates the National System of Risk Reduction and Disaster and Emergency Care (SISRADE, *Sistema Nacional de Reducción de Riesgos y Atención de Desastres y Emergencias*), defined as "the set of entities at the central level of the state and autonomous territorial entities (…), social organizations, natural and legal persons, public and private, that interact (…) to achieve objectives" in risk reduction.

Law No. 602/2014 also gives rise to the National Council for the Reduction of Risks and Disaster and/or Emergency Care (CONARADE, *Consejo Nacional para la Reducción de Riesgos y/o Emergencias*), chaired by the President of the Plurinational State of Bolivia and composed of his or her ministers of Defense; Development Planning; Environment and Water; Public Works; Housing and Services; Health; Rural Development and Land. CONARADE is responsible for proposing policies and strategies for risk management, as well as advising the president when to declare a national emergency situation. Law No. 602/2014 also establishes the creation of

Departmental and Municipal Committees for Risk Reduction and Disaster Assistance—CONARADE in the case of departments and COMIRADE in municipalities—that coordinate, promote and recommend risk management actions in their respective territorial, departmental and municipal areas. In addition, Law No. 604/2010 establishes the creation of Emergency Operations Committees for the national, departmental, and municipal levels. The National Emergency Operations Committee (COEN) is headed by the Vice Ministry of Civil Defense. Each department must have a Departmental Emergency Operations Committee (COED), and each municipality must have a Municipal Emergency Operations Committee (COEM). According to Law No. 602/2014, the COEDs and COEMs "will be formed, activated and led by the departmental and municipal autonomous governments through their functional areas or organizational risk management units in coordination with the Vice Ministry of Civil Defense."

At the municipal level, in December 2010 the Autonomous Municipal Government of La Paz approved the Autonomous Municipal Law No. 005/2010, which regulates the city's comprehensive disaster risk management. The purpose of the law is to integrate disaster risk management as a cross-cutting element in the public administration of the municipality of La Paz, as well as to foresee mechanisms to reduce effective risks, improve the institutional capacity of the municipality, and the capacity of the population to overcome emergencies. Law No. 005/2010 also establishes three processes in risk management: prevention, response to emergencies or disasters, and reconstruction.

b) Comprehensive Municipal Risk Management Strategy (EMGIR)

The Risk Management Law of Bolivia establishes that each municipality in the country must have a Risk Management Unit, a functional area of local governments responsible for implementing the actions in this area. However, one of the first decisions of the GAMLP was to elevate its Risk Management Unit to the category of Government Secretariat. The Municipal Secretariat for Integrated Risk Management (SMGIR) has designed and implemented a Municipal Strategy for Comprehensive Risk Management, which, based on Municipal Law No. 005/2010, consists of four action areas: Evaluation, Reduction, Response, and Reconstruction.

Figure 13

Measuring Instruments and the SAT monitoring room. Source: SMGIR.

The *Evaluation* area aims to tackle and understand the processes of the city's social production of vulnerability and risk, and to evaluate and identify the risks that will guide the program's efforts. On the one hand, in 2011 SMGIR developed and published the city's risk map. This map allowed for the identification of 36 cataloged areas with "very high" risk, which are now the city's priority areas as well as components of the Comprehensive Risk Management Strategy. On the other hand, SMGIR implemented an Early Warning System (SAT, *Sistema de Alerta Temprana*) that allows for the anticipation of socio-natural emergencies. The information generated by the SAT is transmitted in real time to a monitoring room installed in the SMGIR headquarters. The monitoring room has permanent staff members

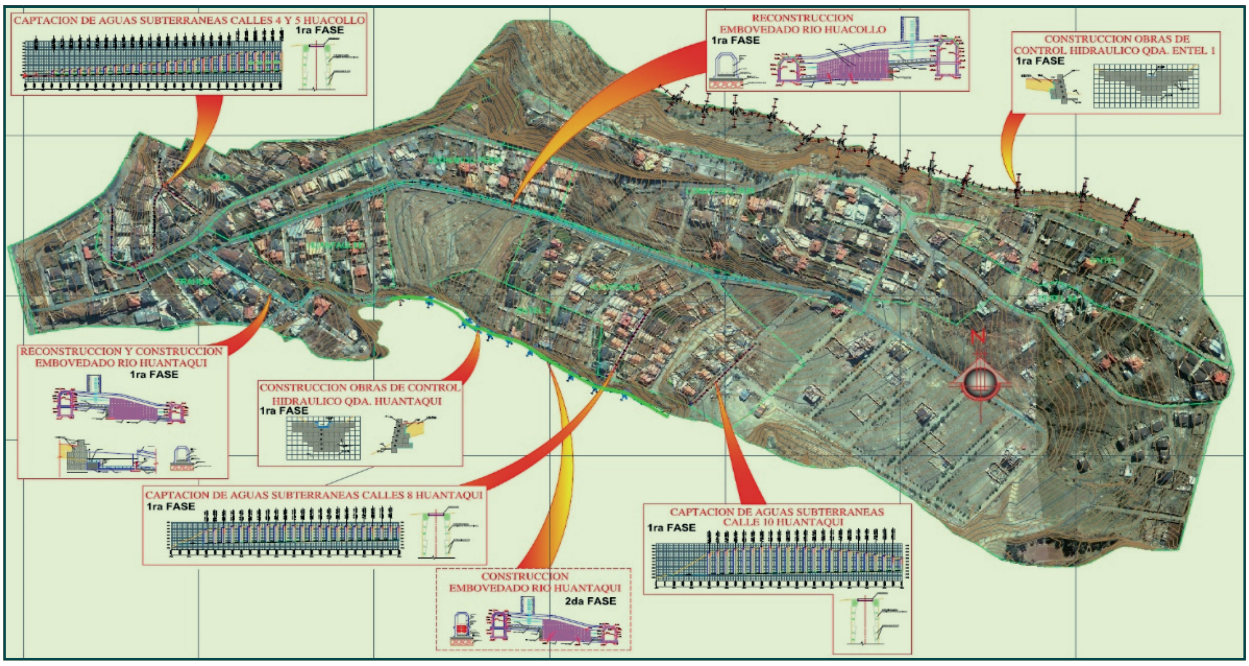


Figure 14

Intervention map of the Zonal Stabilization Program.
Source: SMGIR.

who in cases of emergency activate the SAT. This system allows for the communication of timely alerts to residents as well as to the authorities in charge of these types of events caused by socio-natural hazards.

The *Reduction* area aims to intervene in the urban ecology of the city and strengthen the institutional capacities of the GAMLP, with the goal of reducing the population's vulnerability. In terms of urban ecology interventions, the Zonal Stabilization Program (PEZ, *Programa de Estabilización*) allows for comprehensive technical studies of high-risk areas as well as the construction of infrastructure works that reduce the area's vulnerability. The PEZ focuses on serving the 36 high-risk areas identified by the 2011 Risk Map. In addition, through the Storm Drainage Program, the city's river vaults are built and maintained, the sediment is removed from the canals, and the city's rain infrastructure is prepared for storms. The Storm Drainage Program has allowed investments for US$22 millions between 2003-2013, and US$15 million between 2014-2018. In terms of strengthening GAMLP's

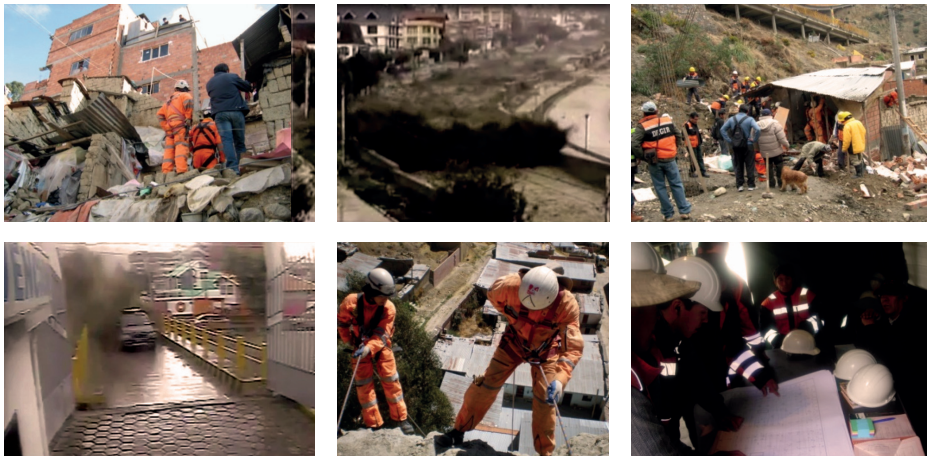


Figure 15

Emergency Response. Source: SMGIR.

institutional capacity, the strategy includes the integration of a Municipal Emergency and Operations Committee (COEM, *Comité de Operaciones y Emergencia Municipal*), the preparation of an Emergency Plan, and the design of action protocols that guide the GAMLP during emergency situations. Finally, through the creation of Neighborhood Emergency Operations Committees (COEB, *Comités de Operaciones de Emergencia Barrial*), White Brigades—senior groups—, and Emergency School Committees, the SMGIR seeks to raise citizen awareness of the processes of social construction of risk, raise awareness to the risks people face, and assist in forming part of SAT in order to monitor and react to hazards.

The *Response* action area is activated when an adverse natural event occurs and consists of performing a Damage Assessment and Needs Analysis (EDAN, *Evaluación de Daños y Análisis de Necesidades*), activating the specific protocols according to the type of emergency, and carrying out urgent rehabilitation works in the city's critical infrastructure. In the case of an adverse event, the COEM and the SMGIR implement service protocols according to the specific case and activate the Bravo Bases in the jurisdiction closest to the hazard site. Furthermore, they provide the first response services to crises, perform evacuations of affected areas, and rescue those in danger. The strategy includes carrying out urgent rehabilitation

works in the city's critical infrastructure, which in La Paz are known as "essentials". In coordination with other areas of the GAMLP, the COEM and the SMGIR carry out the immediate essentialities such as food safety, communication channels, drinking water and sewage, electricity, telephone lines and other communication infrastructures. On the other hand, they also install urgent services for the population such as first aid, psychological care, and emergency shelters.

Lastly, the *Reconstruction* area involves working on the infrastructural, social, and environmental restoration of the city, as well as the relocation of the resident population away from affected areas. Infrastructure reconstruction works are complemented by social work and community integration activities, which seek to rebuild the social fabric while simultaneously rehabilitating affected areas. In terms of relocation, the strategy consists of either preparing land for urbanization, or in the construction of housing complexes to relocate the affected population. The 2011 mega-landslide of Pampahasi Bajo Central is an example of the implementation of this component, when 109,551 square feet of land were rehabilitated for the construction of a new urbanization, which includied building a Bicentennial Complex. The families affected by this mega-landslide were relocated into this building which consisted of 86 apartments in 8 blocks.

c) True Neighborhoods and Communities Program (PBCV)

The True Neighborhoods and Communities Program (PBCV) began in May 2005 and launched an annual call to select the neighborhoods that would benefit from the program. The PBCV is comprised of two components: one physical and the other communitarian. The physical component program includes the construction of a community space; sports facilities; leisure areas such as squares, parks and playgrounds; stabilization works such as retaining walls and special works; rainwater drainage installations, the provision of drinking water, sewerage, and sanitary infrastructure; road improvements both for pedestrians (through the construction of bleachers) and for vehicles (through street pavement); as well as the provision of street lighting. Meanwhile, the community development component of the program includes the development of skills within the community through trade training workshops; regularization of property rights for residents;

Figure 16

Relocation works for affected families. Source: SMGIR.

community spaces to strengthen the social fabric; provision of sanitation facilities for housing; and tree planting and afforestation works.

As of the date of this report, the GAMLP has created 97 True Neighborhoods and Communities, and it is expected that during the next months this number will reach 100. Each neighborhood requires an investment of approximately US$800,000, financed through the GAMLP budget, as well as loans from the Inter-American Development Bank (IDB) and the World Bank (WB), and a donation from the government of Venezuela. In total, the PBCV has held 9 calls for new projects, in which 136 neighborhoods have been selected for intervention. Of these selected neighborhoods, 36 are in the pre-investment stage, when final designs are prepared and are ready for implementation when funds are secured. The execution of the work generates 60 jobs per neighborhood intervention. It is estimated that in total the program has directly benefited 100 thousand inhabitants of the city. In the community development component, the PBCV has benefited more than 6,000 families with the delivery of sanitary equipment for their homes, and more than 5,000 families from the regularization of homeownership.

Despite the fact that PBCV is an autonomous program, it is also a key element in GAMLP's comprehensive risk management strategy. On the one hand, the program focuses on solving some of the social construction of risk problems in the city's built environment. The provision of sewage and storm drainage infrastructure mitigates the effects of water infiltration and soil erosion, which diminishes landslide hazards. The construction of

Figure 17

Before and after the True Neighborhoods and Communities Program. Source: PBYCV.

terraces and adequate infrastructure for pedestrians and vehicles reduces the risk of accidents when traveling through neighborhoods, and also reduces risk during the rainy season. On the other hand, the installation of retaining walls and hillside terraces strengthens the solidity of the terrain and reduces the probability of landslides. Finally, PBCV's community development component contributes to the construction of the social fabric necessary for the implementation of SMGIR's Integrated Municipal Risk Management Strategy (EMGIR). The activation of the Neighborhood Councils for nomination in the PBCV, as well as the construction and activation of community spaces create an environment conducive to the advancement of the social component of risk management.

III. CITY-SPECIFIC RESULTS

a) Expected and unexpected results

One of the main results that should be emphasized is the pairing of the institutional, organizational, and budgetary environment that GAMLP has managed to weave around its EMGIR. Institutionally, the Autonomous Municipal Government of La Paz created and approved the Risk Management Law No. 602/2014 at the national level as well as the Municipal

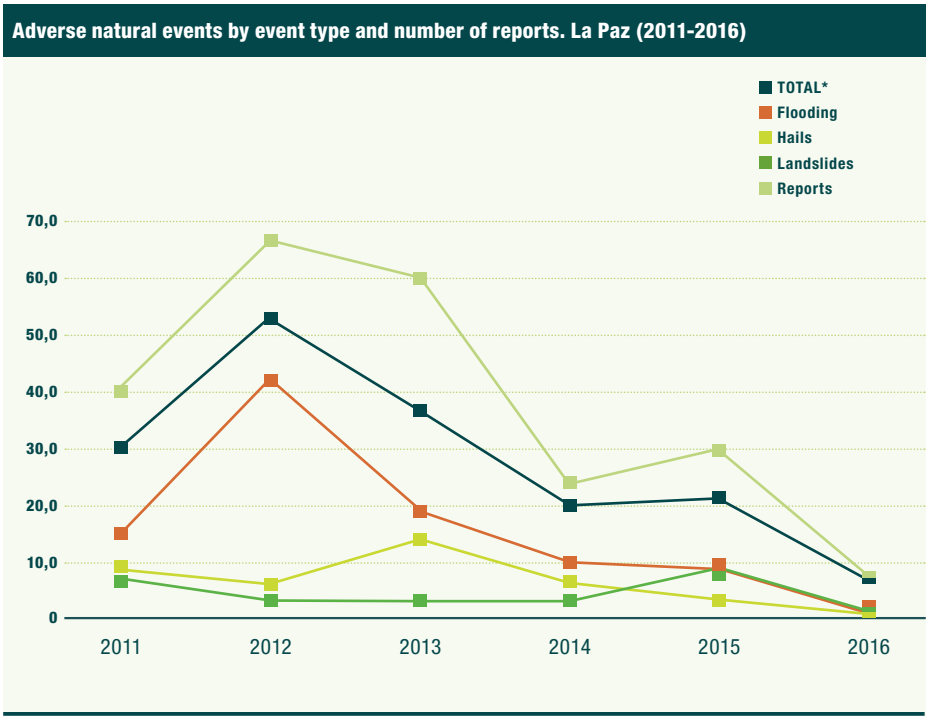
Autonomic Law No. 005/2010. These two laws—national and local—create an adequate institutional environment that coupled the organizational and budgetary elements. In terms of the organizational environment, GAMLP has raised its risk management unit to the level of an autonomous government secretariat. The SMGIR has more than 300 public employees and is responsible for 20% to 30% of GAMLP's annual budget. The implementation of the EMGIR entails the construction of a broad organizational framework that involves the majority of GAMLP's organizational structures. The COEM meets regularly and has been responsible for generating and continuously updating a series of procedures and action protocols that are implemented by EMGIR's organizational members.

Another result to highlight is the sustained decrease in the number of adverse events of natural origin, the number of citizen reports, and the number of families affected by disasters. Since the mega-landslide of 2011, La Paz has not experienced another adverse event of natural origin of similar magnitude. The improvement in the indicators, however, cannot be solely attributed to GAMLP efforts. The decrease in the proportion between the number of adverse events and the number of citizen reports suggests that preventive actions may have contributed in reducing the number of situations reported by citizens as emergencies. Figure 18 shows the number of adverse events of natural origin and citizen reports. With the exception of a slight increase in 2012, the absolute number of events and reports has consistently decreased. Flooding reports have decreased the most in absolute terms.

In terms of the number of families affected by natural events, Figure 19 shows a considerable decrease in absolute terms. In the years 2012 and 2013 the families affected by floods raised the statistics, but in 2014 and thereafter, the number of families affected by floods decreased. The graph also illustrates that the number of families affected by landslides has consistently declined since the 2011 mega-landslide. One of the results achieved has been the gradual and positive transformation of the city's built space. The EMGIR and the PBCV have intervened in the urban space to reverse the social construction of risk process. First, the rainwater infrastructure and the shoring up of the hillside create a safer urban space that is better adapted to the specific conditions of the urban ecology of the hillsides. Second, the community development strategies of the two

Figure 18

Prepared by the author with information from the National Institute of Statistics.



* Total flooding, hails, and landslides.

programs have managed to build a social fabric suitable for the implementation of risk management strategies.

With regard to the unexpected and negative results of the programs, the following results are highlighted. First, some of the interviewees during the elaboration of this study explained that it is possible that the construction of infrastructure with public resources has affected land values in the city. In some cases, the increased prices of land benefitted neighborhoods and in other cases, real estate developers. This point should be investigated in greater depth to assess whether this value capture actually happened, the degree to which it has been presented, as well as its implications for the urban economy and the city's urban development processes. Second, the high degree of political polarization between the central and municipal government levels (Prado, 2009) has led to a competition to implement

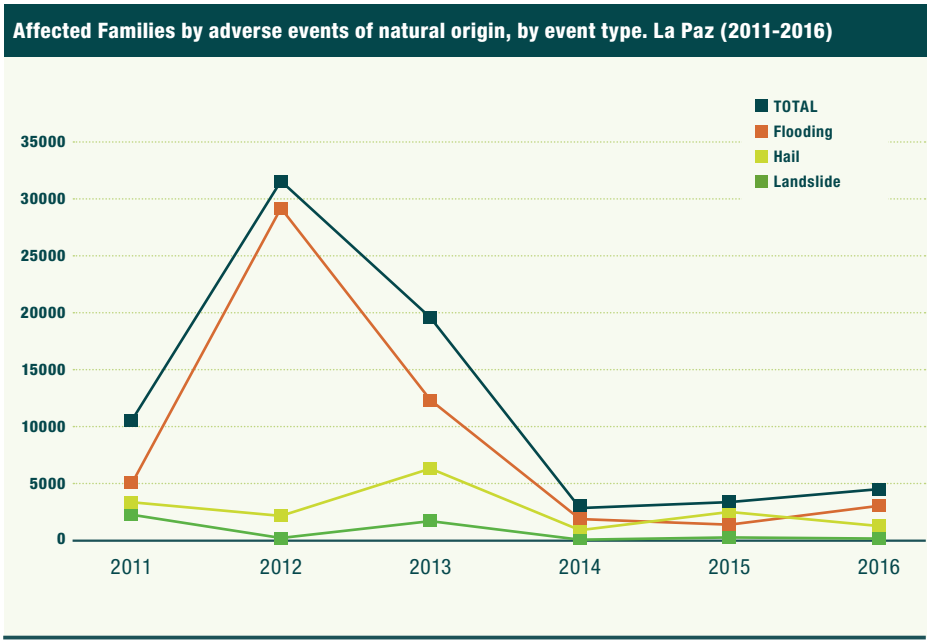


Figure 19

Prepared by the author with information from the National Institute of Statistics.

more and better risk management programs, as well as to provide better public services to vulnerable populations. The central government operates a strategy of risk management from the Vice Ministry of Civil Defense, which has come into conflict with GAMLP, contesting which party is to respond to an emergency situation. Third, hillside infrastructure projects have had a positive effect on citizen security levels. The provision of sanitation infrastructure in homes has prevented people from having to go out at night to the streets to carry out their physiological needs, which in combination with the improvement of public lighting have contributed to improving the security conditions in neighborhoods. Finally, some of the interviewees during the elaboration of this study reported that the improvement of neighborhoods on the hillsides has attracted new informal urbanization. The intervention projects are planned for a specific polygon, but by the time the projects are finished, the urban area around the intervened neighborhood has normally grown due to these new informal settlements. These findings could also become a future topic of investigation.

b) Transferability Analysis

The field work in this study allowed for the identification of specific factors in La Paz that could hinder the diffusion of its urban resilience policies. First, it is important to highlight that very few cities in Latin America share the environmental characteristics of the territory in which the city of La Paz is located. The fact that the city is located in a canyon, that 364 rivers cross it, that it rains for six months of the year, and that the soil is made of a sandy material very susceptible to erosion processes, makes it a city whose characteristics are rarely seen in other urban areas. Second, the political economy of land and housing in La Paz constitutes a very particular factor of the city, which is not common in other cities. Cities usually have logics of expansion with wide availability of land to expand. The city of La Paz differs in the sense that it is imploding due to the lack of suitable ground for expansion. La Paz has to modify its urban ecology inward, transforming the territory to enable vertical expansion. The vertical transformation of the urban space generally happens without taking into account or complying with the zonning regulations, producing informal neighborhoods that must later be regularized. Third, a cultural factor plays a very important role in the urban fabric. The majority of the urban population has its origin in one of the indigenous nations of the Plurinational State of Bolivia, which—in the opinion of the experts interviewed for this research—has an effect on the way of life and the results of public policies. According to the interviewees, the population of La Paz has a high degree of tolerance to natural threats, vulnerability, and risk, at the same time that it has a very close relationship with the land, the hillsides, and for them it is normal to bear high levels of risk in their daily life.

In this regard, the experts interviewed in this research agree that there are at least two aspects that can be applied to other Latin American cities. The first is that the coupling between the institutional, organizational and financial environment that the EMGIR and the PBCV have managed to assemble should be transferred. Providing the city with an adequate institutional environment for linking a large organizational assembly and ensuring financial resources for the implementation of the programs, are aspects that other cities could emulate. In the case of La

Paz, this coupling began with the flood of February 19, 2002, which claimed the lives of dozens of people. Subsequently, local and national governments set out to reform their existing regulatory frameworks and create new laws to combine efforts in disaster prevention. As a result, Bolivia has managed to design and put into operation national, departmental and municipal councils and committees for risk reduction and disaster and emergency management. This institutional and organizational environment has favored the implementation of risk prevention and mitigation programs such as those discussed in this chapter. International cooperation has also played an important role, as it has supported the operation of the EMIGR Management and the PBCV with financial resources. Other Latin American cities could proceed preemptively to create an institutional and organizational environment similar to that of La Paz, and not wait for the occurrence of a trigger mechanism, such as the flood of 2002. Second, interviewed experts recommend the dissemination of infrastructure and technological components of the EMIGR. The Early Warning System (SAT), the Monitoring Room of the SMGIR, and the action protocols are aspects that other cities could import. Finally, the interviewees also recommend that other cities should closely observe the work of the Zonal Stabilization Program (PEZ), which has managed to transform and adapt the existing urban ecology to mitigate the vulnerability to adverse events of socio-natural origin.

IV. PRELIMINARY CONCLUSIONS ABOUT THE CASE OF LA PAZ

Using the framework proposed by McPhearson et al. (2016), as presented in Chapter 1, this chapter analyzed the way in which the ecological, social and technological-infrastructural systems in the city of La Paz, Bolivia, combine three different aspects in the construction of new urban spaces and urban resilience policies: first, the creation and distribution of risk, second, the reaction method towards adverse events of socio-natural origin, and third, the way the city prepares to face future risks.

With regard to the creation and distribution of risk, this study's field research identified that it is constituted through a process that in La Paz is known as the social construction of vulnerability and risk. The political economy of land and housing has generated informal urbanization processes on the hillsides of *la hoyada*. Due to the natural characteristics of the territory, land suitable for human settlement is very scarce. While other cities have a wide range of land and tend to expand, the lack of land in La Paz forces processes of expansion within the city bounds. Some of the interviewees referred to this process as the conquest of the hillsides, an informal conquest in which agents called "*loteadores*" occupy the unoccupied territory and sell it informally to low income residents of the city. The new owners begin to build their homes themselves and their basic urban infrastructure, including roads, sidewalks, terraces, and drinking water and sewage infrastructure. This spontaneous urbanization is done outside of city norms, without meeting any quality or safety standards. The process of the self-construction of urban space intervenes in the urban ecology in ways that often put the population in a position of vulnerability to socio-natural threats, socially constructing risk. The process of spontaneous urbanization may be the result of weak institutions, which reveal the lack of regulation and control over the urban space, as well as the inability of the state to generate an affordable housing supply.

In reacting to the occurrence of adverse events of socio-natural origin, the GAMLP response is above all technological-infrastructural. The reactive strategy involves the implementation of exemplary technological and organizational elements. The Early Warning System deploys state-of-the-art technology for monitoring critical points in the city. The information generated by the SAT is permanently monitored within the SMGIR, which, when it identifies the presence of an active threat, action protocols efficiently deploy a complex organizational framework for reaction. However, although there have been important efforts to socialize and build citizen culture, such as the Neighborhood Emergency Operations Committees, the White Brigades, the Emergency School Committees, or the ECHO Disaster Preparedness Strategy (DIPECHO) of the European Commission in Bolivia, one of the areas of improvement identified by experts is the social component of the reaction strategy. For example, when the satellite identifies

a threat, the technology installed at the critical points of the city activates alarms and blocking the access to the risk area. However, in many cases, the population ignores these systems and continues to put themselves at risk. This suggests that the technological-infrastructural elements are a necessary but not sufficient condition to minimize risk in the city. The technological-infrastructural elements have to be complemented with a social component that enables the proper functioning of the risk management systems. According to experts interviewed, the social component continues to be a pending task in the Municipal Integrated Risk Management Strategy (EMGIR).

In terms of the way in which the city prepares to face these risks in the future, the strategy focuses mainly on the intervention of the urban ecology through technological-infrastructural elements and in the coordination of the SMGIR with other instances of the GAMLP. The Zonal Stabilization Program makes important investments in the transformation and adaptation of the city's built environment and on the land's natural conditions. Based on the 2011 Risk Map, the SMGIR has focused on stabilizing 36 priority zones identified therein. Stabilization usually consists in building and maintaining the drainage infrastructure, and in supporting the hillsides to enable their slopes to become suitable to become suitable for human settlement construction. The True Neighborhoods and Communities Program consists of the intervention of the urban ecology of the neighborhoods, but it also includes a social component because it is the community itself that organizes and decides the type of infrastructure works that their neighborhood needs. With regard to coordination, the SMGIR leads the efforts of the Municipal Emergency Operations Committee, which is constantly reviewing the Emergency Plan and GAMLP's action protocols in case of adverse events of natural origin. This constant coordination has inspired other parts of the public administration of GAMLP to have risk prevention and mitigation very present in their work agendas.

The experts interviewed asserted that it is this type of social component that is absent from the EMGIR. In addition, although the strategy of adapting to the future is exemplary in terms of its technological-infrastructural component, it is nonexistent when facing the structural causes of the social construction of vulnerability and risk. The processes of spontaneous

urbanization, outside the land-use regulations and territorial planning, is constant. According to experts, as long as the social component of the construction of vulnerability and risk is not addressed, future adaptation strategies, especially those infrastructural, will not be able to keep up with new generations of urban population facing conditions of vulnerability and risk.

4. CUENCA, ECUADOR. HISTORIAL LEARNING AND CULTURES OF RESILIENCE

BART ORR

Cuenca is Ecuador's third largest city, situated in the Andean mountain range in the southern part of the country. As the name suggests, Cuenca—Spanish for basin or watershed—is located in a high-altitude valley intersected by four rivers, and as such is susceptible to sporadic seasonal flooding. Along the city's long history from pre-Columbian settlement to the current time, the population has demonstrated an approach to flood risk that is reliant on ecological preservation and a high degree of respect and awareness of the variability of the rivers. While many conventional strategies for managing urban rivers have focused on controlling flows through concrete walls and channelization, Cuenca has exhibited a social awareness of not only the river's risks, but also its benefits, as the rivers have historically provided a range of services and, continuing in present day, act as a meeting point for social interactions. In many ways, the social and cultural importance of the rivers as central to the city have prevented encroachment of development even before being formalized in land use planning.

Today, Cuenca's four rivers are part of what can be considered a broader socio-technical system linking the city to the surrounding area. The city is reliant on the broader river system not only for drinking water but also for hydroelectric power generation, and there is a recognition that management of the surrounding mountain region, from which runoff feeds the rivers, is critical to the city's long-term development strategies.

However, despite the historical evolution of social and ecological strategies for mitigating the risks posed by the city's four rivers, rapid urban growth in recent decades is presenting the city with new challenges it is

much less prepared to deal with. While historically the urban population has resided in the valley, recent population growth coupled with rising real estate prices is pushing development onto the steep hillsides surrounding the city, resulting in increasingly frequent landslides. Likewise, climate change has the potential to not only intensify Cuenca's existing threats of riverine flooding and landslides but pose new ones as well.

Nevertheless, the city is actively working toward assessing and confronting both existing and future challenges. Current efforts towards advancing risk assessment and data collection, and a willingness to acknowledge the challenges ahead, are putting the city of Cuenca on a path towards a resilient future.

The case of Cuenca presents three important lessons for urban disaster risk management: first, the conserved green space along the river banks show how social norms around environmental stewardship can be codified into formal policy to provide not only disaster mitigation, but a range of ecosystem services that benefit the urban population; second, urban expansion exposes the city to new risks, but at the same time, technological advances and university partnerships provide new tools for confronting these risks; and third, managing larger functional ecological areas, such as watersheds, rather than solely municipal boundaries, is critical to risk management. In terms of the social-ecological-technical/built system (SETS) framework, Cuenca is a case study in utilizing primarily social and ecological interventions, with less reliance on gray infrastructure for risk management relative to other cities.

The findings in this study are based on ten confidential semi-structured interviews with current and previous staff of government agencies, environmental consultants, and academic researchers in Cuenca in September 2017.

I. URBAN CONTEXT

Formally known as "Santa Ana de los Cuatro Ríos de Cuenca", Cuenca is an intermediate city, capital of the Azuay Province, located in the Andean

highlands of southern Ecuador, at approximately 2500 meters above sea level. The population of the canton of Cuenca (Municipality of Cuenca) is roughly 580,000, of which around 400,000 live in the urban parishes (city proper), making it the third largest city in Ecuador by population, after Quito and Guayaquil. The Cuenca Metropolitan Area includes the cities of Azogues, Biblian and Deleg in the Cañar Province and the cities of Paute and Gualaceo in the Azuay province with a total population of 730,000 inhabitants.

Cuenca's origins are pre-Columbian. The area's location in a fertile river basin supported by four rivers led an early settlement by the Cañari people around 500 A.D. It then was conquered by the Inca prior to its founding as a Spanish colonial settlement in 1557. Today, the historic center of Cuenca is classified as a UNESCO World Heritage Site.

Many of the city's inhabitants started migrating to the United States in the 1950s in pursuit of better economic opportunities, as well as to Spain after the economic crisis of the 1980s, (Albornoz & Hidalgo, 2007). Migration from Cuenca in the second half of the twentieth century is attributable in part to the economic downfall that affected the local Panama hat manufacturing industry (Kyle, 2000). A second wave of out-migration took place at the end of the century, caused by the national banking crisis in 1999 and the dollarization of the economy in 2000, raising prices of basic goods. This second wave of out-migration occurred across regions and included men and women alike (Jokisch and Pribilsky, 2002). As of 2002 roughly 15 per cent of the population (over two million people) were estimated to be working abroad (Hall, 2005), resulting in higher levels of remittances entering the local economy relative to other Latin American countries (Fajnzylber and López, 2008).

More recent economic downturns have reversed these migration trends. The global financial crisis of 2008 and declining labor opportunities have resulted in more Ecuadorians that were working abroad, returning to Ecuador (Pesántez, 2011). Additionally, the city of Cuenca is experiencing an influx of North American retirees in search of a low-cost retirement destination (Hayes, 2014). These flows of international migration to the city combined with urban population growth and intra-country rural to urban migration are fueling the expansion of the city.

The remittances economy in the city of Cuenca has been very heated, adding US$91.8 million in the fourth trimester of 2008, and continuing to rise to US$116.4 million in the fourth trimester of 2017 (BCE, 2008 and BCE, 2017). As a consequence, real estate prices rose turning Cuenca into the most expensive city in Ecuador. This mass inflow of remittances also increased consumer prices. Klaufaus (2012), using the National Institute of Census and Statistics of Ecuador (INEC, 2009) data, shows that Cuenca's basic basket of goods was set at US$543 per month in 2009, superseding the national average, which was set at US$523 per month. At least US$165 was needed to pay for necessary household expenditures such as rent, energy bills, and home maintenance.

Currently Cuenca has a few dozen informal settlements, some of which are recognized as parts of the urban territory. These settlements are primarily located on the hillsides in areas originally labeled as 'red areas by the city government, meaning they were geographically unfit for habitation. In 1998 Ecuador introduced the Housing Incentives System (SIV, *Sistema de incentivos para la Vivienda*) to promote low-income housing in urban areas based on three components: *Ahorro* (savings), *Bono* (subsidy) and *Crédito* (credit), the renowned ABC system. In the peripheral neighborhoods of Cuenca, the SIV program encountered obstacles primarily because it was almost impossible to build a new house with a total value of less than US$8000, the upper limit of the SIV system at that time in the early 2000s, due to the upward pressures on prices as a result of the inflow of remittances. The result was that few grants for a new housing were issued under the program (Klaufus, 2010).

Cuenca's Risk Characteristics

Cuenca's geography exposes it to a range of natural hazards, while urbanization has both exacerbated existing environmental risks and created new hazards, such as air pollution. Cuenca is susceptible to flooding from the four main rivers passing through the city—there is the River Machangara that makes the northern boundary of the city, the Tomebamba River that separates the old part of the city with the new to the south, the Yanuncay River that is essentially the southern boundary of the new part of town, and the River Tarqui in the far south that joins the Yanuncay in the

Figure 20

The Río Tomebamba separates the historic center of Cuenca from the newer city. Photo: B. Orr (2017).

Eastern part of the city. With the exception of the Machangara, the city's rivers originate in the *páramo* (an Andean alpine tundra ecosystem) in the Cajas National Park, a protected area of 110.21 miles² between 10,170.6 feet and 14,599.74 feet above sea level.

II. URBAN RESILIENCE PRACTICES

According to the Global Facility for Disaster Reduction and Recovery (GFDRR), the example set by the capital city, Quito, has led the national government of Ecuador to shift the focus of disaster management from responding to emergencies to better understanding, and ultimately reducing,

Figure 21

The preserved banks of the Rio Tomebamba serve as a social gathering and recreation area in addition to providing flood resilience. Photo: B. Orr (2017).

vulnerabilities to disaster. Quito's Disaster Risk Management (DRM) plan, which has served as the inspiration for national level policies, identifies priorities as "(i) strengthening compliance with codes and building standards in order to reduce vulnerability of the built environment; (ii) reducing the social and economic vulnerability of people living in high risk zones; and (iii) strengthening the institutional capacity for DRM both in the public and private sectors, including raising awareness and preparedness of leaders and the community in general." (GFDRR, 2014).

At the city level, the city government collaborated with the Inter-American Development Bank (IADB) to produce a sustainability plan and assessment for the period of 2014-2019. Within this plan, the primary natural hazards identified were:

- FLOODS: Cuenca has been regularly affected throughout the city's history by flooding of the city's four rivers as a result of rain. The IADB

found that in regard to flooding, in the case of a return period of 200 years, the maximum loss is estimated likely to exceed US$11 million. However, when taking into consideration potential climate change scenarios, this estimate may increase dramatically, to more than US$12 million through 2030 and US$13 million by 2050.

- EARTHQUAKES: The greatest vulnerabilities, geographically, are found in the western part of the Canton of Cuenca with slight decreases to the east of the city. For a 200-year period, the probable maximum losses exceed that of floods, at US$4.5 billion, an amount roughly equivalent to more than of a quarter of the entire infrastructure of the city.
- LANDSLIDES: The aforementioned report analyzed landslides in the Cuenca metropolitan region and identified areas of low, moderate and high susceptibility. According to the analysis, the highest value of infrastructure exposed in areas of high susceptibility to landslides is located in the housing sector (US$1.7 billion), the productive sector (US$405 million), and public markets (US$325 billion). It is estimated that 63,074 citizens are located in areas designated as moderately susceptible and 48,830 are located in areas judged to be highly susceptible to landslides.
- DROUGHT: As concluded by the cited report, the threat of drought was low relative to other threats. According to the results of the study, the southwestern areas of the region have a greater likelihood of moderate and severe drought conditions for a given 6-month time window, while the northeast region has a greater probability of moderate and severe drought conditions for a 12-month window. In both cases, however, the report puts the odds at less than 0.1% (IADB, 2014).

Using a framework established by the Emerging and Sustainable Cities Initiative (ESCI), the report jointly produced by the municipality and the IDB assessed a range of indicators. ESCI's methodology is organized in a two-stage, five phase process beginning with identifying the city's sustainability challenges, followed prioritizing to identify issues that pose the greatest challenges in a city's future sustainability. Then, these different issues—such as water, air quality, transparency, and others—are prioritized through the use of different filters (environment, economics, public opinion, and specialized sector knowledge) in order to identify the main challenges the city faces in

Figure 22

A recent landslide in Ciudadela Jaime Roldos that destroyed six homes. Photo: B. Orr (2017).

its path towards sustainability. These prioritized sets of intervention points lead to the creation of an Action Plan which includes a set of strategies for their execution across the short-, medium- and long-term. In the second stage, the phase of executions starts with the elaboration of pre-investment studies for the prioritized interventions and the implementation of a citizen monitoring system.

Of all the cities analyzed by the ESCI methodology, Cuenca was found to have significant challenges in terms of both presently existing risks and future risks, given the projected increase in risk factors based on current trends of urban growth and expansion. The findings of the study underscore the importance, and urgency, of managing future urban growth in a

Figure 23

Buildings encroach upon a creek in Ciudadela Jaime Roldo.
Photo: B. Orr (2017)

way that takes disaster risk into account. The city is likely to double its population by 2050, yet the report finds that 52% of the land that is potentially developable has growth constraints as a result of natural hazards, putting severe restrictions on the city's options to manage growth in a way that is both safe and sustainable. To avoid catastrophe, it is imperative that the city develops a range of short, medium, and long-term strategies to manage disaster risk in the context of continued population growth. Specifically, the following ten actions, which would constitute a first step in identifying areas of investment to manage risk effectively, are proposed: (i) To develop maps of threat and risk of landslide, (ii) To conduct an infrastructure vulnerability analysis (iii) To create an information system for disaster risk management; (iv) To develop an investment plan to reduce the risk of critical infrastructures and neighborhoods at risk; (v) To review the regulations on the topic. (vii) To review the local building code and adapt it to the level of seismic risk, (vii) To develop an early warning system for landslides,

(viii) To develop contingency and post-disaster plans, ix) To analyze insurance options for the city; and (x) To improve the budget allocation for the management of risk of disasters. These studies were the first step to define the necessary investment and achieve a more effective risk management.

In total, 144 sustainability indicators were evaluated using the ESCI methodology. On most of these indicators, the city of Cuenca fared quite well, keeping with its current stated mission of making sustainability a primary goal for the city. The 144 indicators were divided into three categories: environmental sustainability and climate change; urban sustainability; and fiscal sustainability. The results were highly favorable. Color coded by performance, 70 of 144 indicators were green, meaning performing well, 37 of 144 were yellow, and 25 were flagged red for poor performance.

While in general the city fared well along indicators of environmental sustainability, red flags were given for disaster preparedness. Speaking to the administrator involved in coordinating the report, the reason for the failing grade for disaster preparedness was clear—the city at that time simply had no disaster preparedness plan nor any budget to get it started. Likewise, for climate change adaptation, the city received a failing grade due to the absence of a plan.

Though discouraging, the city's awareness and recognition of shortcomings around disaster preparedness and climate resilience has spurred interest in correcting these shortfalls. The city is in the process of creating a mitigation plan by first identifying areas of geographic risk. Led by a team at a local university, researchers are using Geographic Information Systems (GIS) to create predictive models to evaluate landslide risk in the *ciudadelas* surrounding the city. In the past, such evaluations were site-specific and often conducted by various consultants using inconsistent methodologies, resulting in conflicting assessments of the degree of hazard present. This new university-led initiative is city-wide, and it applies a consistent set of criteria to identify those areas most prone to landslides. While the project is still in early stages, meaning the model identifies vulnerability purely in terms of geography, the team hopes to be able to at some point include overlapping multi-dimensional vulnerabilities to the model that could take into account quality of existing structures and spatial data on socio-economic vulnerabilities.

III. CITY-SPECIFIC RESULTS

MESSAGE 1. SAFE-TO-FAIL RIVER BOUNDARIES

What might be considered Cuenca's greatest achievement in terms of disaster mitigation is a cultural and social awareness of the variability of the city's four rivers. As one official noted, Cuenca was settled centuries ago precisely because of its relation to the four rivers, and those rivers have continued to play a vital role in the city. Cuenca has always been a city "with its face to the river, rather than its back," and the reliance on the rivers for drinking water, washing clothes, and social gatherings, fostered an awareness of and a respect for the fact that the rivers periodically flood. Rather than build up to the rivers, Cuenca has always kept a large green natural area alongside the river banks, allowing the water levels to rise and fall without threatening neighboring structures. A recent proposal to channelize the main river met with strong opposition, so it was quickly dropped.

As a former city manager said, "I think something that is very important in Cuenca is that we do not live with our backs to the river. As we often say, '*No le damos la espalda al río*.' For us, the river is at the front and is very important. Despite being small rivers, even though now you see them, and they are very nice, they were not always so pretty, they were dirty. That is, they have been improving. But I believe that, contrary to other cities that have forgotten their rivers, for us it is like the center. For decades, people have bathed in the river, many people still wash their clothes in the river, fish, rest, walk, sell things. I think that is very important, because it makes us always be aware of the river. Anything that happens, good, bad, is very close to us. And I think that helps for many situations. For example, you see cities that live with their backs to the river. The river is a garbage dump that you fill with things, the banks do not matter, biodiversity does not matter. And that creates opportunities for many more accidents, because people start to build their homes very close to the water, forgetting that the river is there. That is not the case here because the river is so important in Cuenca. The river's space has been respected." He also added that "there has been this idea of respecting at least 50 meters on each side. Not only because of security, but because that space is a public space, a space that you and I can go, sit down—that's very

important. I believe that this awareness of the people on the river helps resilience issues in a very important way."

Other interviewees concurred that the city's socio-cultural connection to the four rivers running through it has proven to be perhaps its greatest source of resilience to flood risk. Conserved areas along the river banks evolved organically as a result of a consciousness of the river's seasonal fluctuations and uncertainty. Over time the conserved spaces along the river banks became codified into city plans. The riverbanks function not only as an environmental buffer zone to rising floodwaters, but in other times they function as a public space where residents relax and congregate. This exists alongside the natural state of the riverbanks, that preserves river ecosystems and maintains a permeable surface to mitigate flooding. In this way, the green spaces provide various eco-system services beyond just mitigating flood damages.

While other cities have historically focused on technical interventions to manage flooding, and many times recognizing the important role of ecological interventions only recently, Cuenca's rivers have historically relied on social and ecological strategies for flood management. Cuenca's conserved green spaces along river banks might be understood as an early example of safe-to-fail infrastructure (Ahern, 2011). In contrast to fail-safe infrastructure, which aims to prevent flooding through methods such as concrete channelization, safe-to-fail methods allow for flooding but in such a way that the city's vital infrastructural systems continue to function. Cuenca's river banks allow for seasonal flooding with minimal disruption or damage to property.

MESSAGE 2. LEVERAGING TECHNOLOGICAL ADVANCEMENTS AND UNIVERSITY PARTNERSHIPS

Cuenca's growth has pushed settlement from beyond the historic boundaries and increasingly into to the steeper, and less stable, hillside areas—a trend that is likely to continue and expose greater populations to risk of landslides. While urban growth and expansion into these areas is presenting new risks for the city, the technological advances in hazard mapping and assessment is also offering new opportunities to confront these challenges. Researchers at the Azuay University (*Universidad*

de Azuay) are at the forefront of developing comprehensive geospatial risk assessment for the city of Cuenca using computer modelling to apply and adapt methodologies developed at North American universities, the United States Geological Survey, and the Delphi Method (a way of aggregating expert opinions on the likelihood of future events). As a lead researcher noted, the risk of landslides in the area has not been mapped in a methodologically consistent way across the city. Various consulting agencies have produced assessments for smaller areas that have rendered inconsistent results. As a result, some areas have been categorized as medium risk in one assessment and high risk in another.

The research will be invaluable for city decision makers and planners. In addition, the university research team also works directly with vulnerable populations, disseminating information to improve social awareness of landslide risks and how to manage them. One researcher noted "the idea is to start working in a small area at the university to develop this methodology, test it and further develop it, and put that methodology to work. We can, in this small area, develop small books for the people, so they can understand what the risk is, what their vulnerability is, if they have vulnerability, where is their evacuation route, who they have to talk to if they have any problems, things like that."

While the university is able to produce important knowledge around risk and vulnerability, the ultimate responsibility for physical and infrastructural interventions, as well as assistance in relocating vulnerable household from high-risk zones, and other actions, ultimately lies with the municipality: "You see, we always end up with a part of the municipality taking charge of the intervention in the territory. Actually, universities are in a technical area, mainly information. That seems to be how it is come to work. But most of the projects have a social inclination, where we give information to help the municipality understand the problem, to actually manage the problems better, and develop laws and policies and things like that for the community. In that way, says a researcher from a local university: "we do intervene, but it is not a direct intervention."

Keeping a permanent focus on risk, however, is a challenge both in academia and policymaking. Attention to geographic risk peaks after a major event—landslide or flood—and gradually wanes over time. The

goal is to make risk assessment and management an ongoing focus and one that is anticipatory of future events rather than primarily a response to recent episodes.

MESSAGE 3. BEYOND MUNICIPAL BOUNDARIES, THINKING IN FUNCTIONAL AREAS

Though the already cited sustainability report ranked drought as a relatively low risk to the city, regional droughts have had a major impact, and have underscored the importance of the conservation areas in the surrounding mountainous areas to the city, particularly for electric power generation. A reservoir that is 78 miles outside of Cuenca feeds the Paute Dam hydroelectric power plant, a facility that generates almost one third of the Ecuador's electricity. The reservoir is dependent on rainfall in the surrounding Paramo mountains. A severe drought led to the 2009 Ecuador Electricity Crisis, resulting in electricity outages and power rationing across the region and the purchase of electricity from Colombia and Peru. Several models have suggested that loss of glacial masses in the high Andes as a result of climate change may have severe hydrological impacts on the region, potentially reducing runoff to levels that threaten both hydroelectric power generation and agricultural production in downstream areas, both of which the city of Cuenca depends.

IV. PRELIMINARY CONCLUSIONS ABOUT THE CUENCA CASE

While many cities have relied on purely technical strategies for managing urban rivers that have focused on controlling flows through concrete walls and channelization, Cuenca has benefited from an early social awareness of not only the river's risks, but also benefits, as the rivers have historically provided a range of services and, continuing in present day, act as a meeting point for social interactions. In many ways, the social and cultural importance of the rivers as central to the city have prevented encroachment of development even before being formalized in land use planning.

Nonetheless, despite the historical evolution of social and ecological strategies for mitigating the risks posed by the city's four rivers, rapid urban growth in recent decades is presenting the city with new challenges it is much less prepared to deal with. While historically the urban population has resided in the valley, recent population growth coupled with rising real estate prices is pushing development onto the steep hillsides surrounding the city, resulting in increasingly frequent landslides. Likewise, climate change has the potential to not only intensify Cuenca's existing threats of riverine flooding and landslides but pose new ones as well.

However, the city is actively working toward assessing and confronting both existing and future challenges. Current efforts towards advancing risk assessment and data collection, and a willingness to acknowledge challenges ahead, are putting the city of Cuenca on a path towards a resilient future.

5. SANTA FE, ARGENTINA. RISK MANAGEMENT: INTERSECTORIALITY, MEMORY, AND GLOBAL PLATFORMS

LENA SIMET

Risk reduction, disaster management, and resilient and sustainable development are increasingly on governmental agendas worldwide, as one can see when reviewing the outcome documents of the COP 21 (United Nations Climate Change Conference 2015), the Habitat III Conference, or the 2030 Agenda. This is partly due to the fact that internationally, the number of natural disasters, and especially weather-related events have more than doubled since the 1980s (Munich Re, 2012). Extreme weather events related to processes of climate change do not only occur more frequently but have in many cases also intensified (Field, Barros, Stocker & Dahe, 2012). Many of these so-called natural disasters are directly related to conditions of vulnerability as the result of inequality, poverty, political instability, corruption, environmental degradation, or negligence on behalf of the state.[2]

Disasters often occur in response to uneven development, as certain paths of development can produce unintended consequences that foster the catastrophic results of a disaster. Cantos (2008) argues that the level of risk has increased in the last decades not because of increased dangers, but because we occupy territory that is more exposed to such risks. The process of urban expansion in high risk areas, especially with improper infrastructural

[2] For literature on this topic, see Maskrey 1989, Jones and Murphy 2009, or Wisner, Gaillard, and Kelman 2011.

development, is likely to channel catastrophic effects of natural disasters. For example, informal settlements that lack formal sewage and drainage connections are particularly prone to flooding. In turn, repeated exposure to disasters reinforces already existing structural and poverty-related problems (Beckman, 2006). This suggests that disaster and development are closely interrelated, and that disasters cannot be analyzed without understanding the developmental context of the affected population.

When speaking about risk, it is important to note that the concept refers to a complex problem to which no unique perspective and solution exists. In general, it can be agreed that risk represents the probability of damage to a society in the case of an event, which has been socially constructed in a continuous process ahead of the catastrophe itself. When speaking about disasters, risk is defined as the probability of damage between a natural threat and the number of people that are vulnerable and exposed to the risk (Wisner, 2003; Viand and González 2011). This is in opposition to the traditional perspective which places the catastrophe at the center of the stage, concentrating all efforts on prevention and mitigation towards the control of hazardous processes that led to a disaster.

Although the discussion of risk is difficult, it can be said that today's society is a "risk society", as Beck (1992) describes it, one that is predominately urban, and which has a differentiated character considering that it does not affect everyone equally. The latter refers to vulnerability and social, economic, or cultural conditions that expose certain parts of the population to much greater risks than others. Viand and Gonzalez (2012) argue that this was the case in Santa Fe, where social conditions exposed the population to risk and created the disaster of 2003. One can therefore speak about the disaster's "*social character*".

The concept of *adaptability* in disaster studies is problematic because of its inherent notion of recovery, which "unintentionally impl(ies) a return to normalcy after disaster—instead of a reduction of future vulnerability (McEntire et al. 2002, p. 270)." Returning to normality is not appropriate if the status quo is of high vulnerability and exposure to risk. The concept of *resiliency* on the contrary is more appropriate, as it implies reducing vulnerability and risk to better absorb shocks that are likely to reoccur. The concept of resiliency goes beyond the notion of "bouncing back" after disaster and involves learning and reflexivity (Folke, 2006).

When speaking about "urban practice", I refer to an instrument to intervene in an aspect of the urban reality with the intention of transforming it. Every urban practice is subject of different interests and logics and is part of a techno-political process called urban management (Godoy, 2007). For the longest time, urban planning did not incorporate and address risk and disaster related questions, Instead, but environmental risks were seen as a tradeoff to economic and urban growth. But due to the three components of disaster (threat, vulnerability, and risk), urban and territorial planning is key, as it clearly identifies different parts of the urban fabric, such as its economic activities or quality of life, giving insight into a community's level of vulnerability. This makes urban planning "the tool per excellence to prevent disasters" (Viand, 2014:2).

While uneven urban development can foster vulnerability and the exposure to risks, cities can also be the drivers of positive change and play a critical role in achieving the global goals of greater sustainability and resilience. Santa Fe is an excellent example of a city that experienced uneven development and single-sectored risk management, leading to catastrophic consequences that came to the surface in the floods of 2003 and 2007. Since then Santa Fe has "learned from disaster" and has achieved the reduction of risk through an approach that includes the entire urban system understanding the existing social, ecological, economic, and infrastructural strengths and vulnerabilities. A review of Santa Fe's historic and recent risk management is a valuable contribution to the global discussion about how to implement international sustainability agendas. This chapter presents three practices that have demonstrated positive effects in Santa Fe, in the hope to inspire cities that are facing similar threats and challenges.

I. URBAN CONTEXT

a) Characterization of risk

With a population close to 403,097, Santa Fe is the ninth largest city in Argentina (Santa Fe Government, 2015). Santa Fe City is home to about

80% of the population of its metropolitan area, which includes 26 additional municipalities and counts a total of 501,166 inhabitants (Ibid). Since the turn of the 20th century, population growth has been relatively stable. From the 2001 to the 2010 census, the population increased by just about 3%.[3] Santa Fe is the seat of three national universities, counting more than 50,000 students. Its function as the provincial capital and its history as a port city shape Santa Fe's particular economic and social context.

Although the city's economic situation has significantly improved in the last years, significant challenges persist. In 2017, the city's official unemployment rate was with 5.1% lower than the national unemployment rate (7.6%), however, it is estimated that one out of three people of working age is unemployed or is not a job seeker. This figure is even higher in the case of women and young people. The primary sources of formal employment are business (23%), teaching (13%), industry (10%), personal services (10%) and construction (9%) (Santa Fe Government, 2016). As of 2016, 99% of all households have access to electricity, 95% have access to drinking water, 64% count with natural gas connections in their homes, and about 62% have formal sewage connections.

Crime and violence is one of the city's critical challenges. For about 16 years, Santa Fe Province has had the highest homicides rates of the country, with Santa Fe City, Rosario, and a few of its surrounding municipalities counting the highest homicides rates in the province. In 2015, the recorded homicide rate in the city was 22.3 per 100,000 people, which is significantly higher than the provincial average of 12 and the national average of 6.6.[4] 96.4% of the victims are male, of which 53% are younger than 26 years old (Santa Fe Government, 2015).

According to the disaster inventory "Desinventar Argentina,"[5] Santa Fe's most frequent disasters between 1970 and 2015 were related to floods,

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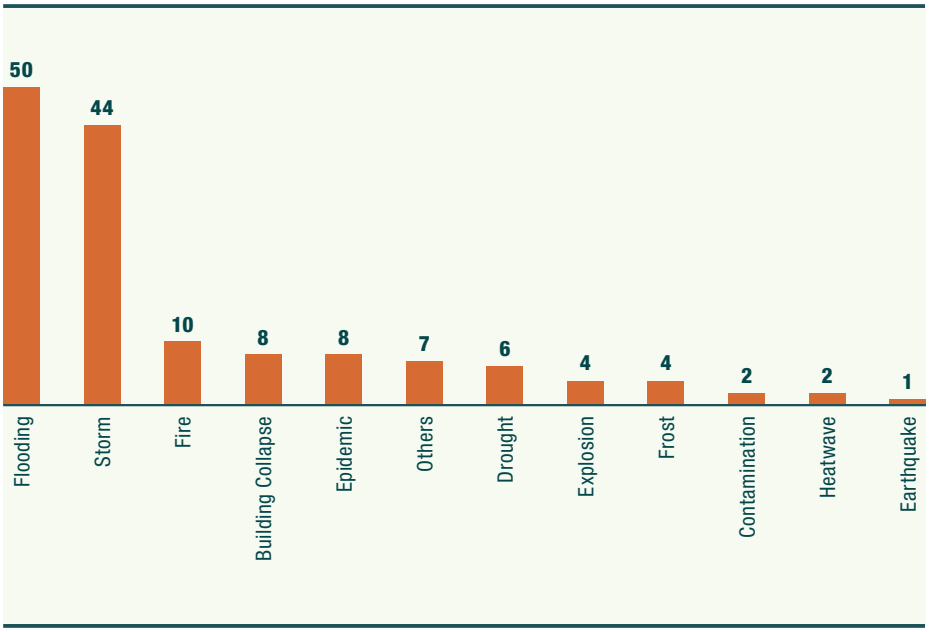
3 In the Census of 2001, 369.589 people were registered in Santa Fe City (INDEC, 2001).

4 In an international comparison, in 2016 Chicago's homicide rate was 27.7, New York City's was 3.92 (NYPD, 2016).

5 DesInventar is an inventory of information on characters and effects of disasters of different scales, from earthquakes to floods to storms. Information comes

Figure 24

Type and frequency of disasters in Santa Fe from 1970-2015. Source: Prepared by the author based on DesInventar, Argentina, 2017.



see Figure 24. Storms were the second most reported type of disaster. In fact, according to local reports, these two types of disaster often occurred at the same time, reinforcing one another

In regard to the vulnerabilities shaping disasters, Santa Fe faces significant challenges in the following three categories that require further evaluation:[6]

from official institutes, academia, and social actors. https://www.desinventar.org/es/database.

6 The city faces a series of physical shocks and stresses due to poor infrastructure and service networks in vulnerable neighborhoods. In 2015, the city started to work on the preliminary assessment and the design of resilience-driven initiatives, as part of the 100 Resilient City Strategy. Some of the additional stresses identified in this assessment are a significant housing deficit, habitat degradation, obsolete infrastructure, environmental problems, social exclusion and the lack of personal, social and economic development opportunities.

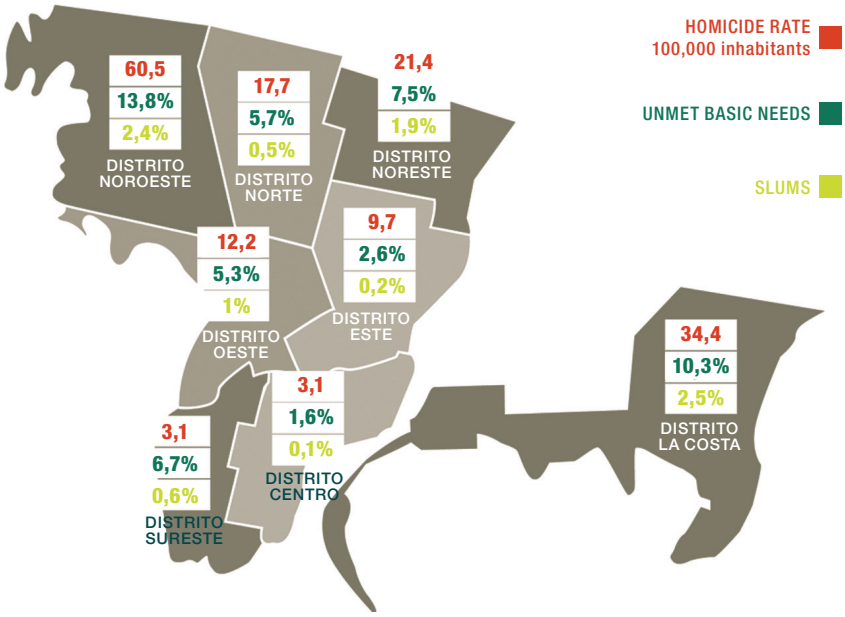


Figure 25

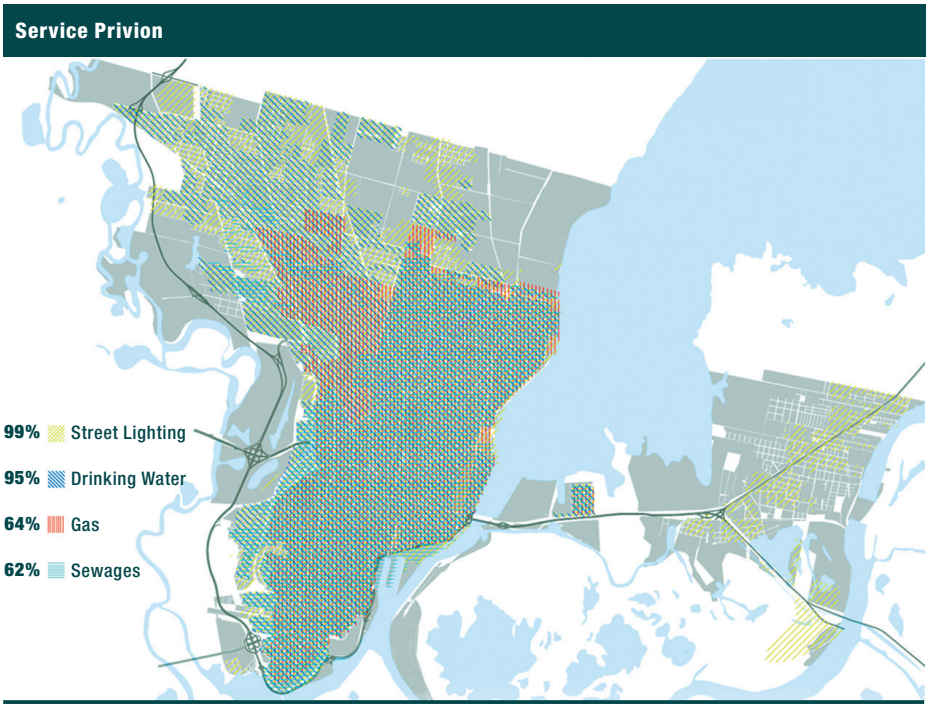
District map: Homicide rates, unmet needs, and slums. Source: Santa Fe Government (2016).

- NATURAL VULNERABILITY, due to the city's geographic location
- CONSTRUCTED VULNERABILITY, in relation to shortcomings in urban and territorial planning
- SOCIAL VULNERABILITY, such as high unemployment, inflation, violence, poverty, and inequality

When studying vulnerability in Santa Fe, its spatial component is particularly important to consider. Figure 25 demonstrates the differences across city districts in terms of crime rates, unmet needs, and slums. As depicted in the map, the Northwest, the Coastal District, and the Northeast, all areas that have traditionally been the most affected by floods, fare worst in these three categories. Crime for example has very high concentrations in the Northwest and the Coastal district. Similarly, the access to basic services is very low in these three districts, with little sewage and natural gas connections, see Figure 26.

Figure 26

Map of Access to Basic Services. Source: Santa Fe Government (2016).



In an attempt to identify vulnerability by census tract, Cardoso (2017) designed a socio-environmental vulnerability index, which she applied to Santa Fe. The resulting risk map, see Figure 27, includes indicators on the age of the population in the census tract, educational levels, access to basic services, the quality of housing, access to communication systems (phone or internet), and socio-economic indicators such as income, over-crowding, or basic needs. In her definition of vulnerability, the concepts of vulnerability and poverty are closely linked but nevertheless different. While a middle-class individual can have economic capacity, but may be poorly informed; the poor are particularly vulnerable, so poverty becomes a significant risk factor.

As shown in Figure 27, Santa Fe's vulnerability distribution resembles half-circles around the city center, where the city center has the lowest vulnerability rates (here depicted in white) due to high levels of education, infrastructure, and basic services. In centrifugal lines follow sectors of

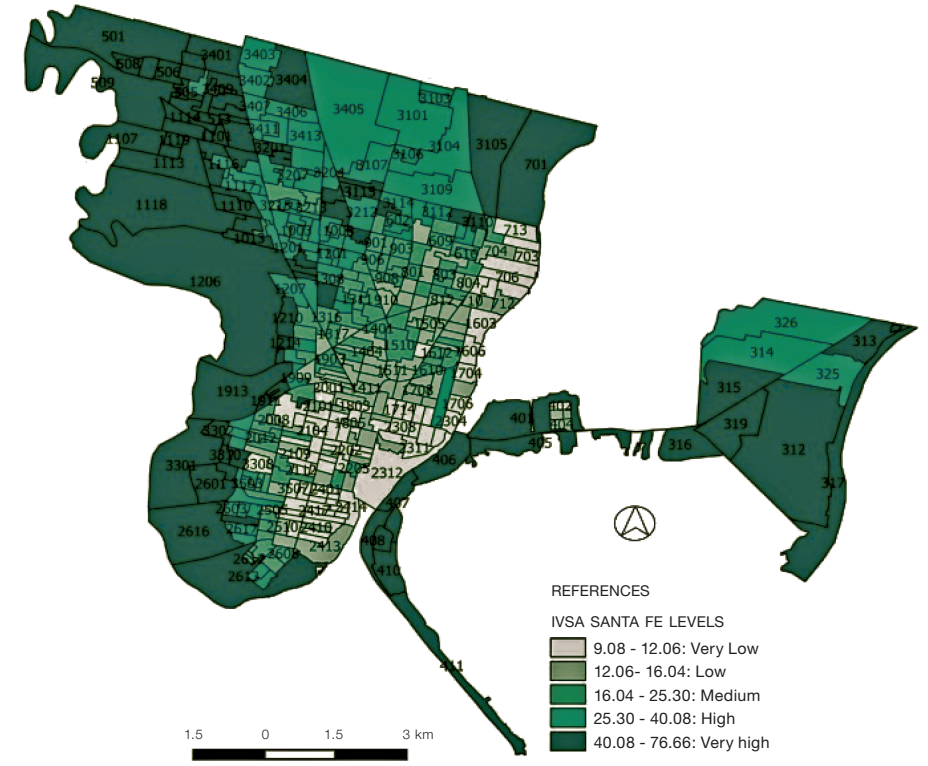


Figure 27

Santa Fe vulnerability map. Source: Cardoso, 2017.

medium vulnerability levels, followed by very high vulnerability along the west side and the northern parts of the city (Cardoso 2017).

An attempt by Santa Fe's resilience office to rank the city's performance in twelve resilience related topics shows interesting findings.[7] Figure 28

[7] The following twelve topics were assessed: Planning, Education and Information, Trustworthy Leaders, Communication and Transport, Flood Prevention and Emergency Plans, Environment and Infrastructure, Basic Needs, Employment, Public Health, United and Engaged Communities, Safety and Justice, and Economy and Finance. The methodology and assessment categories have been provided by the Rockefeller Foundation.

Figure 28

Citizen perception survey, and survey to experts. Source: SFC (2017).

depicts the results of surveys that were conducted with city leaders and experts (see left circle) and the general public (see right circle). According to experts and the public, the city's strongest performing areas are public health, education, and information. In contrast, the worst performing areas are safety and justice, and environment and infrastructure. Interestingly, in many categories the perception of the public differs significantly from that of the experts. This discrepancy in itself reveals important information. For example, while experts perceive the flood protection and emergency plans as very strong areas, about half of the public feels an urgent need for improvement in this category. This may indicate the need for better communication of emergency plans to the public.

b) Geographic context

One way of understanding the problematic around urban floods is to study the history of a given city. Doing so gives insight into the use and appropriation of risk exposed territory—in this case flood prone areas. This chapter assumes that risk in the urban territory includes two components: the social "city-making" on one side, and the natural risk of disaster on the other side. This assumption is based on the idea that a flood-prone urban

area is a system of natural-social complexity, in which historic decisions have significantly affected its exposure to risk (Viand and Gonzalez, 2012).

Santa Fe de la Cruz is the capital city of the Santa Fe province, situated in northeastern Argentina. Santa Fe City has a quite particular geographical context, as it is located at a peninsula-shaped meeting point between the floodplains of the Salado river to the west and the Paraná river to the east.[8] For this reason, most of the city boundaries are marked by waterways, and more than 70 percent of the city's territory is made up of water in the form of rivers, lagoons, and swamps. The city is often described as a pan or a bowl, where the water collects without draining naturally if it rains (Gomez, 2007).

The land around the city is flat and made up of highly dense soil, providing perfect conditions for lagoons and creeks. The downside of this highly fertile territory is its proneness to flooding, due to its reduced drainage capacity. Both rivers have flooded regularly, although the Paraná river does so much more frequently than the Salado river.

These geographical conditions are optimal for farming, dairy and meat industries, that developed the province's strong agricultural economy and shaped urban life in the province. In fact, this province is among Argentina's principal producers of grains, beef, vegetable oils and dairy products (Informacion Agropecuaria: Comercio Exterior, 2016). About 74% of its exports are sub products of soy bean production. Soy bean production has increased significantly over the past years, doubling between 1993 and 2005, providing around 40% of the country's soybean output in this period. Soybean cultivation has replaced farming of other crops as well as livestock, and was boosted with genetically-modified herbicide-resistant seeds. According to scientific and agricultural studies, deforestation, an increase in the cultivation of monocultures, and the use of pesticides affect climate as

8 The Salado River originates in the Andes in the Northern Province of Salta and flows for more than 2,000km before it empties into the Paraná river basin in Santa Fe. The Paraná River, the second largest river in South America after the Amazonas, and the largest river running through Argentina, runs through Brazil, Paraguay, and Argentina over a course of about 2,500km, empties into the Río de la Plata and eventually flows in the Atlantic Ocean at the coast of Buenos Aires. The city Santa Fe is located in its middle basin.

Figure 29

Santa Fe, national agricultural and cattle center. Source: SFC (2016).

well as soil and water qualities, reducing the absorption capacity of the soil (Margin and Gay Garcia, 2007). These changes in agricultural production and forestry have likely contributed to an increased risk of flooding of the province, and the city in particular (Ullberg, 2014).

c) Historical and political context for the territorial development of Santa Fe

Santa Fe City was founded in 1573 near the city of Cayastá, as the Spanish Crown desired to have a port city on the Paraná river to facilitate transport and trade, and to support naval and military activities. However,

by 1650 it was clear that the location was highly exposed to territorial threats, especially heavy floods, leading to the relocation of the city from Cayastá to its current site. In its new location Santa Fe gained strategic and economic importance for its function as a port city. Starting in 1662, Santa Fe began charging port fees and taxes for all passing ships (referred to as Puerto Preciso). This created a steady source of income and wealth and attracted many workers and businessmen to settle in the city (Ullberg, 2014).

Santa Fe continued to grow in political and economic importance during the 19th century. In fact, in 1853 the first constitution of the Argentinian Republic was adopted in the city. Then, in 1860 Santa Fe's port was refunctioned to suit international trade and the export of the region's agricultural goods. At the same time the railway system that was directly linked with the new port, was introduced. Railway and oil companies started operating in the city, fostering a rapid increase in commercial activity that fueled the demand for labor. The construction of the railway system and other infrastructural works also required a significant amount of raw materials. The quebracho timber, originating from the northern part of the province, was the preferred material for construction due to its high quality.[9] As it was also suitable for tanning leather, intensive forestry exploitation in the 19th and 20th century resulted in the disappearance of the forests (Gori, 2006).

The period of economic growth in the late 19th and early 20th century was accompanied by a rapid population growth that resulted in higher density levels in the city and also expanded its footprint. At first, urban construction happened more towards the northern border of the city, as the expansion to the west was limited because of its swampy terrains and the Salado river floodplains. However, due to the west's proximity to the city center and low costs of land, public and residential buildings started to get built on inapt land, with high risks of flooding. During and after the world economic crisis of the 1930s, Santa Fe's population continued to increase, further increasing the need for more urban land. In order to make the western part of the city "inhabitable", a levee was constructed around the southwest, creating a sense of safety from floods.[10] As a response to the newly

[9] In the northern part of the province, which is classified as the semi-arid Chaqueño region, was characterized by forests of Quebracho trees.

constructed flood wall, the city allowed construction even closer to the river (Viand and González, 2012).

In the 1970s, Santa Fe's economy, which was heavily reliant on industry and manufacturing, felt a strong recession that affected its competitiveness on the international market. Many factories closed, and the port lost its economic significance. The resulting unemployment and socio-economic difficulties made the western part of the city more attractive for new developments, mainly due to the affordability and availability of land. Many of the neighborhoods in the west of the city were created and consolidated during that time, as is the case of: Centenario, Chalet, San Lorenzo, Santa Rosa de Lima, and Barranquitas.

During the 90s the city's economic situation became even worse, as structural adjustment programs increased poverty and unemployment. The city's socio-economic contrasts and spatial divisions became more pronounced, reaching a peak during the country's macroeconomic crisis of 2001. While the city center maintained its population over time, invested in services and infrastructure, and experienced improved living standards overall, the more vulnerable west and northern parts of the city experienced a population increase of about 34%, with no infrastructural investments in basic service provision (Gómez, 2007).

d) Urban planning in Santa Fe

The gradual occupation of the Salado floodplains is a sign that urban planning has been carried out "against the river," where the environment had to adapt to human needs, rather than the other way around. It was only after the disastrous flood of 2003, that risk and vulnerabilities started to be considered in urban planning. The absence of a comprehensive risk management system in urban planning was evident in the lack of a proper water and sewage infrastructure, absence of a land use plan, and very punctuated

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10 Levees, in Spanish *terraplenes* or *defensas*, are artificial barriers that run parallel to the coastline, made of soil, clay, and sand that prevent water from entering the city when the river rises. The material used for levees is important because it may have different effects in the case of storms and heavy floods. These types of protection systems are very costly and require permanent maintenance.

(but visible) risk reduction infrastructure projects. Indeed, when tracing the history of flooding and the origins of Santa Fe's largest environmental risk, one can identify a very close relationship between certain infrastructural development projects and increased flooding events.

Santa Fe's first urban plan from 1947 recommended extending the sanitation infrastructure to the west to encourage urbanization. This plan promoted the completion of the levees along the west side of the city, and the construction of social and middle-income houses with funds from the National Housing Fund (FONAVI, *Fondo Nacional de la Vivienda*) to formalize and eradicate some of the existing informal settlements in the area (Viand and González, 2012).

Decades later, the 1980 Plan Director considered for the first time the challenges associated with expanding the city towards the west. Yet, instead of limiting construction in these areas, it introduced a minimum lot size and a maximum height for buildings. Between 1996 and 1998 the *Circunvalación* highway was constructed along the west side of the city along a new levee. These projects led to an even further expansion of the city towards the west, beyond the previously installed levees and railways. In the mid 1990s the Strategic Plan for Santa Fe XXI was put into place. This plan identified several of Santa Fe's challenges and opportunities, yet it paid little attention to the flood prone zones of the city. The plan was edited and re-released in 2002 (Ibid).

In summary, the urban expansion towards high risk areas can be attributed to three causes: 1) economic conditions, 2) infrastructure works, and 3) urban planning and management (or the lack thereof). In the neoliberal period of the 90s, when the economic crisis was already on the way, low-income households that moved to the city were unable to afford housing in the city center, occupying in the western parts of the city. Land in Santa Fe's western corridor became increasingly attractive due to its low cost and proximity to the center. Moreover, infrastructure works set to reduce the risk of flooding made the river less visible and the area felt safer as a result. The first levees that were constructed in the 1940s, gave many residents the feeling that the risk of flooding was reduced thanks to infrastructure works. In 1993, the provincial state, aided by international funding, began to expand the levees around the entire city. These infrastructure

projects reflect the global trend of the time, which considered engineering and structural works as the key solution to water-related risks.

This review of historical events becomes relevant for understanding the social construction of risk in the city of Santa Fe. In Oliver-Smith's words: "a disaster is a historical event—and the aftermath of disaster is process coming to grips with history" (Oliver-Smith, 1979, 96). While Santa Fe was always prone to the risk of flooding, its social, political, and economic spatial configuration—in particular the urban growth towards high risk areas—aggravated the city's risk profile, resulting in the deadly historical floods of 2003 and 2007.

Conditions for change

A) LEARNING FROM DISASTER

Due to its geographic location, Santa Fe was always vulnerable to floods, originating from three water sources: the Paraná river, the Salado River, or heavy rainfall. The first records of floods caused by the Paraná River go back until 1905, when the water volume exceeded three times its average volume and twice the volume of regular overflows, covering a large part of the city.[11] The most significant floods recorded took place in 1905, 1966, 1982/3, 1992, and 1998. The average volume of the Salado river is significantly lower than that of the Paraná. However, during heavy floods the volume increases six to tenfold (Santa Fe Government, 2016) making it a hazard.[12]

While Santa Fe experienced numerous large and smaller floods, the emphasis of this chapter is on the two largest, most recent floods of 2003 and 2007. The rationale for this focus is that these two events represent a break with "business as usual," or in this case, "practice as usual." In the aftermath of these two events, civil society organizations and social movements demanded a political change and a different way of managing risk, and they succeeded.

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11 The Paraná's average water volume is 600349.33 cubic feet per second. In the 1905 flood it increased to 176,5733 cubic feet per second.

12 The average volume of the Salado river is about 5,297 cubic feet per second, during heavy floods this has increased up to 141,259 cubic feet per second.

Figure 30

2003 Flood.
Source: Santa Fe Government (2016).

2003 FLOOD FROM THE SALADO RIVER

The 2003 flood was caused by heavy rainfalls in the upper basins of the Salado river, which increased to its maximum measured height of 141,259 cubic feet per second, with devastating effects. Two thirds of the city were severely flooded, 130,000 people had to be evacuated, and about 180 people died during the flood or through its indirect impacts (Herzer and Arrillaga, 2009).[13] The estimated loss and damage was more than US$3 billion. Santa Fe's entire urban infrastructure was paralyzed, and the city ceased to function over one month.

Particularly traumatizing was the lack of emergency plans and scarcity of information stemming from government sources. On top of that, the disaster management capacities of the city were largely exceeded. When water first entered the city, the incumbent Mayor announced via the radio that

[13] Official and unofficial records vary between 32 and 200 deaths.

evacuation measures would not be necessary, especially not in the west and southwest of the city. According to testimonies, because of this announcement residents refrained from evacuating their homes (Ullberg, 2014). Poignantly, the west and southwest were soon entirely flooded, and it was in these areas where twenty-three people drowned.

It is important to note how the water got into the city. While in theory the entire city was protected by levees, in reality a section of the flood wall had never been completed. Water entered through the missing section and also through the ring road. The highway bridge acted as a channel for water, accelerating the inflow of water and the severity of the flood.

After the disaster, the provincial government created a provisional agency dedicated to reconstruction. The agency's main responsibility was to administer the reconstruction funds, which amounted to US$1,413 per flooded household.[14] Further financial support was available if households went through an administrative process that required waiving their right to pursue legal claims against the state (Ullberg, 2014).

2007 FLOODS FROM HEAVY RAINFALLS

Santa Fe's average annual rainfall is about 1,300 mm, with most rain falling between October and March. Since the mid 2000s, weather patterns have slightly shifted bringing more and intensified rains and storms to the city. In early April of 2007, within only ten days it rained about 437 mm, about a third of the city's usual annual rainfall. More than 27,000 people were affected by the flood and evacuated (Santa Fe Government, 2016).

Just as in the flood of 2003, a defect in the flood protection system exposed the city to greater risk and contributed to the severity of the event. An incomplete drainage and a failure of the pumping system turned the city into a bathtub, with no plug to drain the water. The levees, which had been rebuilt since the 2003 flood, now acted as a dam. About 60% of the pump stations did not function (that is 27 out of 45) due to maintenance failures or lacking electricity, or because they were never fully installed (Calvi et al., 2016). Although this time an emergency plan existed on paper

[14] The reconstruction fund in provided $4,000 ARG per household. The exchange rate of Argentine Pesos to US$ at the time was 2.83.

Figure 31

2007 Flood.
Source: Santa Fe Government (2016).

(the plan was developed in 2006), it had not been communicated to the residents or the emergency agencies. Just as in 2003, the west side of the city was particularly affected, neighborhoods that had just recovered from the previous flood.

Santafesinians refer to the two disasters as turning points in the social and political organization of Santa Fe's management of risk and its urban planning strategy in general. This change, however, did not occur by chance or good nature. Various actors contributed to Santa Fe's transformation, which in the following section will be referred to as *instigators of change*.

Instigators of change: a brief assessment of Santa Fe's key stakeholders

The two disasters described kept the city paralyzed for months and came with huge emotional and financial consequences for all Santafesinians, but especially for those living in the west and northwest. The loss of lives, the financial ruin for many, and the psychological effects on families who lost everything created an air of despair and exasperation. In the

aftermath of the two events, especially after it became apparent that both events were results of government negligence, people took their anger to the streets, demanding social justice and judicial consequences for the politicians in charge. As a professor from the National University of the Littoral (UNL, *Universidad Nacional del Litoral*) states, "never before had I seen that level of social and political mobilization in Santa Fe (2017)."

Soon the disaster became a political issue as civil society organizations raised serious accusations against local authorities and decision makers regarding negligence, corruption, and lack of disaster preparedness. Residents and NGOs joined forces in a movement called the *Asamblea Permanente de Afectados por la Inundación* (Permanent Assembly of People Affected by the Flood) holding regular protests, and also *Marcha Carpa Negra*, that demanded political consequences and financial compensation for victims (Ullberg, 2014).

Political change followed with the election of Mario Domingo Barletta as the new Mayor in September 2007, a hydraulic engineer and dean of the Department of General and Applied Hydrology at the National University of the Littoral (UNL). Barletta represented the Progressive, Civic and Social Front, which signified a change from the incumbent Justice Front for Victory candidate. Responding to increasing pressures and demands made by civil society and the general public, Barletta's first act in office was to declare a "hydrological emergency," followed by a 180-degree shift in urban planning to embrace a new focus on reducing the risk of flooding (*El Litoral*, 2008).

The principal stakeholders involved in transforming Santa Fe's risk management are identified in Figure 32. The pre-2007 municipality (shaded in grey) is the least powerful and perhaps even change-preventing agent. It was long argued that the 2003 flood was a purely natural disaster, with an emphasis on *natural*. In 2007 however, the official stance of denying responsibility and any knowledge of existing risks risk was strongly rejected by civil society, opposition parties, and academia. The stakeholders colored in red are the organizations representing civil society, which had a significant weight in the movement towards a new urban practice on risk management. NGOs, such as the *Movimiento de Los Sin Techo* or *Cáritas*, who have worked in the territory for many years and have significant political

Figure 32

Stakeholders in Santa Fe's transformation in risk management. Prepared by the author.

experience, now joined forces with new political movements like the *Marcha Carpa Negra* or the *Asamblea Permanente de Afectados por la Inundación*, who had never before been involved in politics.

The academia (shaded in blue) and the *opposition party* (in yellow) were important actors towards change too. Barletta, at this point representing both academia and the political opposition, responded to the municipality's stance of "no one knew about these risks," with a press conference in which he listed every risk and flood-related study that had been carried out at the UNL university since the 1990s. This demonstrated that the risk of flooding was nothing new or "unpredictable," as the government claimed.

Instead it made evident that a lot could be learned from historical events. Barletta's involvement in both academia and local politics is not unusual in Santa Fe, where politicians often wear two hats; one of an academic, and one of the government. Another crucial agent in this transformation process was the Provincial Court Prosecutor and a lawsuit referred to as *Causa Inundación*, instigated by plaintiffs after the 2003 flood.

Stakeholders that became more relevant in the years after the political change had occurred are international institutions and donors. In the aftermath of the 2003 and 2007 floods, Santa Fe received important bi-lateral financial support to reconstruct parts of its infrastructure. Later, as the city became part of the United Nations International Strategy for Disaster Reduction (UNISDR), the Mercosur cities program, and the Rockefellers' 100 Resilient Cities, Santa Fe received international exposure that did no longer allow for institutional oblivion in regard to the city's risks and vulnerabilities.

Finally, it should be noted that the private sector did not play a major role in this shift, and generally plays a minor role in risk management in Santa Fe.

II. URBAN RESILIENCE PRACTICES

The societal and political break that occurred in 2007 led to a series of important changes in Santa Fe's risk related policies and practices. This section describes three practices that were instrumental for this transformation and may be relevant for other cities. First, and perhaps most importantly, risk reduction shifted from a sectoral approach to a state policy, through an integration of "risk" in all parts of urban management. For the first time, risk was truly considered in Santa Fe's urban and territorial plans. The second practice relates to the co-existence with the river and the work around memory. The institutional oblivion ex-ante the disaster, and the belittlement of its disastrous consequences ex post, were replaced with transparent processes working with public data and information, the design of a memory museum, educational workshops, and an urban water trail.

Finally, Santa Fe has demonstrated an extraordinary openness to learn from others, and to offer other cities the opportunity to learn from their mistakes and successes. Joining various international campaigns and discussing local challenges of urban management with other local leaders, turned Santa Fe into a global player of sustainable development and an example for the implementation of the Sustainable Development Goals (SDGs) and the New Urban Agenda (NUA).

PRACTICE 1. FROM A SINGLE SECTOR TO AN INTEGRATIVE APPROACH OF URBAN PLANNING

> Infrastructure works are needed but they are not enough. Responding to floods only with an increase of infrastructure works may likely reinforce existing societal behaviors and develop a false sense of security from floods that infrastructure projects often deliver. (Giacosa et al., 2009: 247)

Engineering works were long been perceived the only and final solution to Santa Fe's risk profile. The customary response to floods was the construction of new levees and pump-stations. The disasters of 2003 and 2007 however, turned the city's single-sector approach into a comprehensive state policy, emphasizing the need to include risk management across all dimensions of urban planning. The response-based approach to disaster has thus been replaced with an integrative and transversal approach that understands disaster as a continuum and as a social construct.

After the 2003 flood, Santa Fe's urban plan considered land use in flood prone zones for the very first time. The city government requested technical assistance in assembling this plan from the UNL and PROCIFE, an institutional cooperative program for technical emergency assistance, which took several years to be completed and announced.[15] The resulting Santa Fe's Urban Plan (*Plan Urbano Santa Fe*) 2010", introduced by Mayor Barletta in 2007, was therefore the first urban plan that included a diagnosis

[15] PROCIFE stands for *Programa de Cooperación Institucional Frente a la Emergencia*.

Figure 33

Urban planning highlights in Santa Fe over time. Source: Prepared by author.

of social vulnerability and inequality, and that proposed the rezoning of land use, with special attention to the west side of the city. It also focused on environmental planning, socio-economic inclusion, access to affordable housing, urban parks, and public space. Furthermore, a "Decentralization Plan" was created, dividing the city in eight districts with the objective to increase resident participation and to recognize different levels of vulnerability across the districts.

For the first time there was a transversal and cross-sectional application of risk management appearing in the new urban plan, and also the core of the new state policy. Perhaps the biggest challenges putting this new policy into practice was ensuring cooperation among all departments. The gap between different fields of work and professional groups, combined with a lack of coordination between stakeholders carrying out different programs, can often result in competition, duplication of small-scale efforts, higher investment costs, and incompatibility of program measures. If, however, instead of competition, synergies are created between the different departments so that they complement one another, coordination of risk management can be achieved with much more sustainable and lasting results.

Hence, the structure of the government changed with the objective to encourage cooperation among all municipal departments. The city

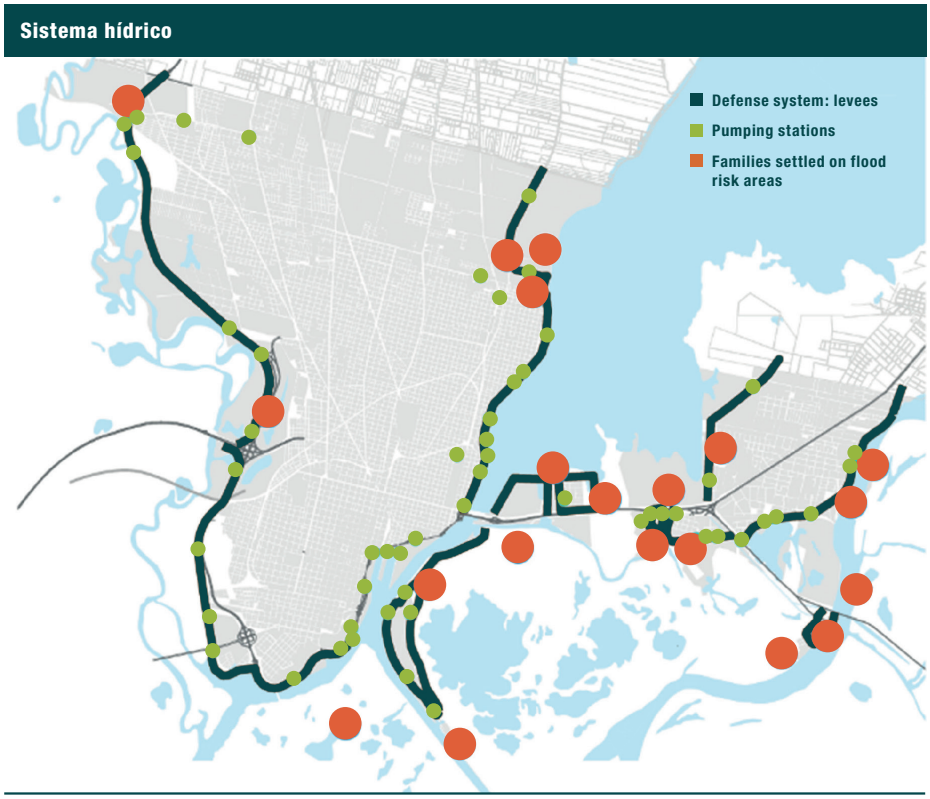


Figure 34

Flood protection walls and pumping stations. Source: SFC (2016).

government, together with the UNL, organized a series of training workshops to create a common and shared outlook on the city's territory and its vulnerabilities. The resulting "Municipal System of Risk Management", a taskforce dedicated to managing risk, collects input from all parts of the local government. The head of this new department is in direct contact with all other departments and directly reports to the mayor. This new institutional design of risk management highlights the relevance of the issue and facilitates cross-sectional collaboration across all departments.

Social transformation is of course a much more complex process than building water infrastructure and cannot be achieved over night. Bearing this difficulty in mind, the government geared its actions and their immediate, medium, and long-term impacts, towards the ultimate objective of reducing

risk, and more importantly, vulnerability. In the words of Carlos Paoli this is important because "the combination of structural and non-structural tools leads to solutions of adaptation to floods that have major socio-economic benefits without further deteriorating the environment" (Paoli, Dondenyaz & Carmona Moreno, 2015, 259). Due to Santa Fe's high level and multi-level vulnerability, a radical change in urban practice in all municipal departments was needed in order to reach the objectives outlined in the 2010 plan. Some of these programs are highlighted below.

As part of the new Risk Management Plan, the National Water Institute (INA, *Instituto Nacional del Agua*) introduced a Storm Drainage Master Plan, which entails waterworks for the city's 26 basins with an investment of US$150 million. Although the municipal budget is insufficient to carry out the full plan, important advancements in the city's drainage systems were accomplished. As the 2007 flood was largely caused by failure of the pumping stations, all stations were fixed, retrofitted, and equipped with electricity generators to account for a potential electricity outage. Moreover, each station is now supervised by municipality personnel 24 hours a day to ensure its proper functioning, and to protect the stations from vandalism.

In 2014, the Urban Planning Department (*Secretaría de Planeamiento Urbano*) decided to repurpose parts of the west side of the city into a 142-hectare natural reserve with three key objectives: to limit the city's expansion towards the river, to improve the absorptive capacity of the soil, and to increase the quality of life of the residents. This project is part of the Rockefeller 100 Resilient Cities Program and funded by the French Global Environment Facility and is currently in its first stages. Aside from the natural reserve, the city's street infrastructure is being repurposed to reduce negative effects of flooding and to facilitate storm water runoff. Here, projects include elevated garbage baskets for household trash,[16] sidewalk buffers (storm-water flow regulators), rain gutters, and the pavement of dirt roads. As part of the *Parks in My City* and the *Green Belts Plan* more than 100

[16] During my fieldwork municipal workers have remarked on multiple occasions that a lot of trash from the streets has clogged the existing drainage in 2007 and contributed to the flood. The construction of the "*Complejo ambiental*" in 2010, a waste treatment complex outside of the city, was sought to address this issue as well.

parks were built or renovated, and 6,000 trees are planted annually. Today, Santa Fe's green space per capita (42.7 ft²) is significantly higher than that of Buenos Aires (6.2 ft²) or Istanbul (22.64 ft²) (Baharash 2017).

Waste management is in fact closely related to the reduction of risk, as unmanaged garbage clogs the drainage system. Increased waste collection efforts, waste sorting, the prohibition of plastic bags in supermarkets and stores, the training of the informal waste pickers to become "urban recyclers," the construction of a new waste facility, and education on the importance of waste collection, are all activities focused on reducing risk.

In relation to the housing policy, the Housing Department (*Agencia Santa Fe Hábitat*) seeks to address vulnerabilities through its Land Tenure Regularization Plan by providing land tenure to residents who have already built a house. Many households, especially in the west side, live in flood-prone zones and in informal conditions without proper access to basic services. The new plan aims to provide tenure security to those not located in flood areas and to relocate those that are situated on land that is unsuitable for residential use. To better understand the severity of the situation, the city surveyed informal areas in 2014, which amounted to about 10,000 households. More than 2,418 families have already received their land titles, while others are in the process of finalizing contracts.

Lastly, other striking practices are collaborative efforts between the Risk Management Office (*Dirección de Gestión de Riesgos*), the Education Department (*Secretaría de Educación*), and the media in the production of educational material and the organization of educational tours. To raise awareness of the city's vulnerabilities and to promote the "living with the river," the *Aula Ciudad* program educates students on the city's natural threats and the human contributions to risk. As part of this program students visit the city's waste treatment plant and one of the water pumping stations (Figure 35). In addition, Risk Communication Program on the collaborates and trains mass-media professionals to ensure a better communication of emergency plans in the case of a disaster. Disaster trainings have also been conducted with teachers and students, as well as with different NGOs and neighborhood organizations.

The interdisciplinary and cross-departmental incorporation of resilience strategies becomes particularly apparent in the city's most recent

Figure 35

Aula Ciudad Program (2017).
Photos: L. Simet.

initiative: the Northern Project that focuses on urban growth in the northern area of the city. Part of this project is the establishment of the Northern Park whose construction aims to recover and transform more than 80 hectares of land previously occupied by the sanitary landfill and the Municipal Botanical Garden, through the use of tactical urbanism. The city government perceives the involvement of local actors and all parts of government as key in the transformation of the city's northern neighborhoods, also as a way of practicing the right to the city, and creating a resilient city.

PRACTICE 2. MAKING THE PAST PART OF THE PRESENT: COMMEMORATIVE ACTIVITIES

Whether a society experienced political oppression, genocide, or natural catastrophes, keeping the painful memories alive is an effective

Figure 36

High Water Marks Urban Trail. Source: Santa Fe Government (2016).

way to work with history. Educating subsequent generations on flood history makes it less likely that a society will repeat past mistakes. In Santa Fe, one can identify several reminders of the floods throughout the city, especially of the 2003 flood. Memories are even embedded in the urban landscape through graffiti or wooden crosses in the main square, reminding of those who died in the flood. Following the 2003 and 2007 floods, the city government, in collaboration with academia and civil society organizations, made the process of remembering part of Santa Fe's formal history.

Over the past ten years more than seven commemorative activities have been designed and are currently in different stages of implementation. Some of the most significant ones are the construction of a *flood memorial*, a museum-like complex situated where the water entered the city in 2003, right at the point where the levee was missing. In preparation of the memorial, exhibitions and events have been organized that showcase flood-related art and encourage residents to share their experiences and

10 /// EL LITORAL
VIERNES, 1 DE MARZO DE 2013

ÁREAMETROPOLITANA

EN LA ZONA DEL HIPÓDROMO

Se construirá un memorial, a 10 años de la inundación

Será un lugar simbólico para reflexionar. Además se harán muestras artísticas para conmemorar la primera década de la tragedia hídrica. Y se generará material de difusión para escuelas.

Figure 37

Flood Memorial.
Source: *El Litoral*, Santa Fe, March 1 2013.

memories. Documentary films have been produced and publicly screened. Educational material about the city and its connection with the river has been created and soon became part of school manuals. Finally, a *High-Water Marks Urban Trail* was created, highlighting the maximum rise of the river during the 2003 flood in various parts of the city.

It is notable that most commemorative activities focus exclusively on 2003, despite the city's long history with floods. While the impacts of that particular disaster were particularly severe emotionally and economically, anthropologist Ullberg (2014) argues that the 2003 flood was one of the few times that middle-income households were affected, which attracted increased media attention. Ullberg warns of the unequal remembering of disasters, which can reinforce conditions of social vulnerability instead of enhancing capacities. The participatory process of creating and recreating history and collective memory is therefore crucial. This is particularly relevant in case of political and institutional change. In this sense, memorials persist despite political changes.

PRACTICE 3. CREATING AND SHARING LOCAL KNOWLEDGE AND BECOMING A GLOBAL PLAYER

Cities are playing a major role in achieving greater sustainability and are key for implementing and localizing the SDGs and the NUA. While many cities remain disconnected from global discussions around urban and sustainable development, Santa Fe has successfully engaged the international sphere, and used this opportunity to its advantage, receiving financial and technical support in return. The third practice relates to Santa Fe's openness to engage with regional and international actors, its efforts in creating local knowledge through cooperation with academia, and its willingness to learn from other cities and their experiences.

The work of disaster risk management is a field where interaction or cooperation between academia and practice can, and must, complement each other so that sustainable solutions for the most vulnerable can be developed. This can be by means of partnerships, by consultation, by employing professional staff, and by changing curricula in courses on risk management as well as hydraulic engineering.

Santa Fe was the first city in Argentina that participated in the "Making Cities Resilient" campaign, launched in 2010 by the United Nations Office for Disaster Risk Reduction (UNISDR). This campaign closely works with local governments to reduce social, economic, and environmental vulnerability to prevent future disasters, with the intention to share progress and experiences with other cities (Santa Fe Government, 2016). Also, in 2010 Santa Fe created a network of cities from *El Litoral*[17] to jointly address questions of risk reduction and resilience, emphasizing vulnerability to flooding. Moreover, Santa Fe became an active member of the Mercocities network, which is formed by 280 South American cities. In this network Santa Fe strongly promotes the inclusion of risk in wider urban management issues.

Seeking financial and technical advice on how to move from integrative risk management to a resilient city, Santa Fe applied to join Rockefeller's "100 Resilient Cities" program in 2013. In 2014, Santa Fe became the

[17] *El Litoral* refers to cities located on the Paraná River, from the provinces Santa Fe, Corrientes, and Entre Ríos.

first Argentine city in the initiative. Buenos Aires followed in 2015. Santa Fe was chosen due to its high complexity and combined risk factors, its location on highly a vulnerable territory, both in environmental and also social. Being part of this network provides Santa Fe with financial and technical assistance to develop a resiliency strategy and conduct regular assessments, the first of which was published in 2017.

In 2016, Santa Fe participated at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) in Quito, Ecuador, presenting its experiences dealing with disaster, vulnerability, and risk. Since 2010, the city has encouraged graduate students to study the case of Santa Fe and offered possibilities for them to collaborate with public entities. Since then, more than 16 graduate theses have been written about the topic.

Moving in an international sphere has opened Santa Fe the possibility to learn from other cities that have faced similar environmental threats and socio-economic challenges. For example, as part of its Resiliency Strategy (2017), the municipality seeks to construct a monitoring and control center in order to integrate a range of electronic measuring and smart metering devices which are currently dispersed among civil society, public sector, and the private sector. The inspiration came from Mexico City, where the most modern surveillance center of Latin America opened its doors in 2011. Another source of inspiration was Medellin in Colombia, a city with much work on resettlement of families that reside in flood-prone areas. The priority to social interventions of Territorial Development Plan and the adoption of a resilient approach, was of significant success in Medellin. Moreover, Santa Fe is planning to construct a park inspired by the Gentilly Resilience District in New Orleans, USA, and to support small and medium sized enterprises to improve unemployment and poverty rates, just as Byblos, Lebanon did quite successfully.

In 2017, Santa Fe held the first "Resilience School" in Latin America, which brought together representatives from 21 cities from Argentina, Bolivia, Brazil, Chile, and Uruguay to exchange experiences and receive training in the subject. The initiative was proposed by Santa Fe and became part of a cooperation agreement between Rockefeller's 100 Resilient Cities Program and the Mercocities network. The objective of this training is for other cities to incorporate resilience strategies in local management

policies. As Santa Fe's Resilience Director Valsagna states (2017), "it is not only about overcoming critical situations, but about developing strategies that allow us to be better prepared for different situations."

III. CITY-SPECIFIC RESULTS

a) Expected and unexpected outcomes

It is not an easy and straightforward task to assess Santa Fe's achievements in becoming a resilient city, considering the high level of complexity involved. As was outlined in the first section of this chapter, Santa Fe juggles three types of vulnerabilities: 1) natural vulnerability due to its geographic location, 2) social vulnerability due to high levels of poverty and inequality, and 3) constructed vulnerability which refers to single sector approaches to risk. Considering these complexities and layers of vulnerability, it would be naïve to expect a "risk-free" city only a decade after change began. Adding to these local complexities, there are global and macroeconomic forces that affect Santa Fe's socio-economic vulnerabilities, such as high and increasing inflation (reaching around 27% in 2017) cuts in welfare and energy or transportation subsidies (Economist 2017; Reuters 2017). Nevertheless, improvements can be noted when reviewing trends in poverty, unemployment, and inequality. Outcomes can also be assessed in the light of heavy rains that occurred in 2015, through the increased awareness of residents, as well as the name recognition that Santa Fe received in response to its international activities.

In 2004, after the 2003 flood and Argentina's macro-economic crisis, almost half of all Santafesinians lived in poverty, 19% lived in extreme poverty (see Figure 38). In 2012, poverty decreased to 6.8% and extreme poverty dropped to 0.4% (Instituto Provincial de Estadísticas y Censos, 2017). A similar trend can be noted in the unemployment rate, which dropped from 27.6% in 2004 to 12.6% in 2008, and then to 5% in 2015. Income inequality declined too, with a reduction in the Gini coefficient from 0.455 to 0.399 (ibid).

Figure 38

Poverty and extreme poverty lines in Santa Fe from 2003-2015. Source: Prepared by author based on IPEC and Census 2017.

RAINS OF 2015—A FIRST TEST

Just as in 2007, 2015 was marked by heavy rains at the end of February and the beginning of March, when "the city did not see the sun for 20 days." During these twenty days, it rained one third of the annual precipitation rate, meaning about 16.53. These heavy rains were a first test for the city's efforts in reducing vulnerabilities to floods and water management. While the rainfall was about the same as in 2007, the consequences were drastically different. Unlike in 2007, in 2015 all levees were in place and pumping-stations were functioning perfectly. In the neighborhoods with completed drainage systems, water was absorbed quickly and as a result fewer neighborhoods recorded flood damages. The neighborhoods that were most affected in 2015 were those with missing drainage infrastructure and without access to basic services. While in 2007, 27,000 people were forced to leave their homes, in 2015 about 500 had to do so. Of course, 500 are still too many, but this difference demonstrates that over the past ten years the city has achieved remarkable improvements in its physical infrastructure.

Moreover, evacuations occurred much more smoothly and less chaotically than in 2003 and 2007. In 2015, every community had an emergency

plan in place, and several meeting points in each neighborhood had been established to provide shelter and assistance. Despite the fact that many residents self-evacuated, which could be an indicator for lacking awareness of the meeting points, important work with neighborhood representatives and NGOs has been ongoing. As a representative from the *Movimiento de Los Sin Techo* states (2017): "what is different in recent years is that we are included in the risk management process, and that our knowledge and opinion counts."

LOCAL, REGIONAL, AND INTERNATIONAL RESPONSES TO SANTA FE'S NEW VULNERABILITY PRACTICES

A reduction in the number of homes affected and people evacuated provides hard evidence for effective engineering works. Yet, it is much more difficult to quantify the effects of educational and training programs, and of the many communication campaigns that the city has launched since 2007. However, the increased interest from residents, schools, and local neighborhood organizations can be seen as an important result. Just to mention a few, in 2015, ten workshops on emergency plans took place, and more than 650 people participated in the *Ruta del Agua*, which guides students through the city's drainage system and urban water infrastructure.

Santa Fe has also received wide and positive recognition for its transversal approach to risk management. In 2010, as part of the UNISDR campaign, Santa Fe was granted the "City Role Model" status for its comprehensive and participatory approach to risk management. In 2011, it was awarded the Sasakawa Award by UNISDR for the city government's active efforts in reducing risk and creating more sustainable communities. Since, Santa Fe has shared its experiences in handling risk with a series of cities across Latin America and other regions. In 2014, Mayor Jose Corral received special recognition as the "Champion of UNISDR's Making Cities Resilient Campaign."

Santa Fe's efforts and advancements have also been recognized by other cities in the region, who are seeking advice on how to mitigate the effects of disaster and create resilient infrastructure. In 2013, for example, the city of La Plata in Argentina experienced a catastrophic flood with a death

toll of more than 50 people and thousand displacements. Soon after the catastrophe, the Governor reached out to Santa Fe, requesting advice on how to reduce future risks successfully. In the following months, Alegrete in Brazil, and Cartago in Colombia, also sought advice from Santa Fe on how to create more resilient cities.

b) A note on transferability

As Santa Fe's practices are being praised by international agencies and other cities are showing interest in replicating its risk management practices, a brief reflection on the transferability of practices is inevitable. Is it appropriate to replicate Santa Fe's practices in Alegrete, a city with 80,000 inhabitants in southern Brazil, where several hundred people died a 2015 flood, and where the financial resources to put in place extensive investment in infrastructure projects do not exist? Or, are Santa Fe's experiences in building levees and pumping stations truly helpful for Cartago, a small city with 132,000 people in southwestern Colombia, about 187 miles west of Bogotá?

When thinking about the appropriateness of the transferability of practices, the main criteria should not be whether the cities have the same geographical features, a similar population size, speak the same language, or even that they have the same type of risk. Instead, it seems much more appropriate to think in terms of vulnerability and the existing network infrastructure involved in risk management. In sum, contemplating the utility of Santa Fe's experience for other cities, there are three factors relevant to consider: a) the existing stage of disaster planning (and the need for pre-disaster planning), b) the need for institutional reform, and c) the participation of a wide range of actors.

As the title of a publication by Santa Fe's government states very clearly, "Learning from Disaster," catastrophes were Santa Fe's principal instigation for change. The combination of an economic crisis, high social vulnerability, environmental disaster, and political denial created an explosive mix that forced the government to change business as usual. It also created an institutional void that provided an opportunity for institutional change. Representatives from academia, civil society, and the government used this moment to their advantage, pushing for the inclusion

of risk management in all levels of government. This is not to say that a disaster is necessary for radical policy change. However, it highlights the need for institutional reform and collaborative efforts to design and implement vulnerability-reducing practices that go beyond the capacity of the housing department or the risk office alone. Ideally, such reforms can take place preemptively, without the financial costs and emotional burden that Santafesinians faced. Santa Fe's lessons may therefore be particularly transferable to cities that currently lack the comprehensive focus that Santa Fe achieved.

In addition, the transferability of some of the practices mentioned in this report is heavily dependent on the level of participation of a wide variety of actors. Urban disaster governance structures need to foster equality of participation in decision making across gender, ethnic groups, and income levels. They also need to engage with the local knowledge of individuals and communities at risk and combine such knowledge with scientific information and academic studies. Finally, the key is to reform governance practices that inadvertently generate vulnerabilities.

The perhaps most obvious, but at the same time most relevant and universally applicable advice was given by the city's Planning Secretary: "A mayor should know her city. A city government must know every part of the city like their own backyard, the nice parts, the historic parts, and also the dirty parts" (Pascualón, 2017). Appropriate tools can only be identified and implemented by recognizing the specificities and vulnerabilities of each neighborhood. Without a clear understanding of local vulnerabilities, cities cannot effectively manage risks. Risk analysis and assessments are essential prerequisites for informed decision-making, prioritizing projects, planning for risk reduction measures and identifying high, medium or low-risk areas, according to their vulnerability and the cost-effectiveness of potential interventions. Prioritized actions based on zoning, investment decisions, and worst-case scenarios for emergency preparedness require careful planning and detailed mapping of risks.

IV. PRELIMINARY CONCLUSIONS OF THE SANTA FE CASE

When thinking about disaster, we need to move beyond the one-way, cause-and-effect relationship that has long dominated not only this particular field, but urban planning and public management more broadly. The perception that disasters are the uncontrollable cause, and the destruction of the built environment is the effect, ultimately results in disaster management that exclusively focuses on infrastructural and physical works. Such responses are insufficient and only regard the post-disaster context. In addition, such works often ignore, and sometimes even harm, all three risk components: hazard, vulnerability, and a community's coping capacity.

Merely developing and implementing hazard-proof measures is therefore inadequate. Structural adaptation needs to be combined with a transversal risk management system that includes residential as well as institutional levels, that includes structural and nonstructural components, as well as short, medium, and long-term actions. An integrative approach should encompass a variety of actors, including academia and research institutes, governmental and non-governmental organizations, other local stakeholders working on program implementation, and also donor organizations.

In territories where urban plans and land use have long ignored risk management—not to mention resilience, such an implementation is particularly challenging. Santa Fe is an excellent example of what to do, and what not to do. Until 2003, urban plans disregarded social vulnerabilities and environmental threats, with the belief that infrastructural works would 'do the trick'. The floods of 2003 and 2007 however demonstrated that this is not the case and that a more comprehensive, city wide approach to managing risk is needed. The economic and social break with "business as usual" that the two disasters caused, opened the door for a new set of practices focused not only on improving existing infrastructure, but also on reducing vulnerabilities and a greater inclusion of all sectors of society.

The case of Santa Fe demonstrates that land use planning that incorporates a risk perspective is one of the most effective practices to prevent disasters. The key to solving this issue in the long run is to start thinking about cities together with their risks. As Santa Fe has demonstrated,

this requires transversal and comprehensive strategies that go beyond mere technical steps in risk reduction. While "there has been much progress in disaster risk reduction policies," many challenges remain before Santa Fe is turned into a truly resilient city. For instance, violence and unemployment are still rampant in some parts of the city. Santa Fe still has a long way to go to become a resilient city across the board. However, its efforts and eagerness to learn and adapt are important lessons for other cities and the international community at large.

6. PILAR, ARGENTINA. DIALOGUE AS A TOOL FOR RISK MANAGEMENT

ILEANA VERSACE AND JULIA NESPRIAS

The Municipality of Pilar, one of the 40 that make up the Metropolitan Region of Buenos Aires (RMBA), launched the Water Dialogues program (*programa Diálogos Hídricos*) at the end of 2015. This is the most innovative urban environmental risk management practice of the 14 municipalities located in the Luján River Basin, which crosses the northern part of the RMBA. Implemented by the Sub-secretariat of Urban Planning and Development, this program aims to mitigate the socio-territorial impact of frequent flooding affecting the municipality and the region.

The Risk Management Directorate, under the Ministry of Coordination and Public Management of the province of Buenos Aires (*Dirección de Gestión de Riesgo y Emergencias del Ministerio de Coordinación y Gestión Pública de la Provincia*), defines risk management as "the set of actions developed by a community to adequately manage the possible hazards to which it is exposed, which can be of a natural, anthropic or man-made nature, or of a mixed nature, in order for potential risks not to become disasters." According to the same source, with the aim of reducing vulnerability and susceptibility to threats, these actions include both prevention and preparedness for possible emergencies, as well as post-disaster response and recovery. Hence, the concept of risk is composed of the relationship between vulnerability and hazard.

Under these precepts, which do not seek to control but manage risk to mitigate its consequences, the Water Dialogues program is presented as an exemplary case of risk management in the whole area of the province of Buenos Aires. This urban practice seeks to strengthen the city's resilience by

reducing vulnerability to hazards. In the Municipality of Pilar, the greatest hazards come from the frequent flooding of the Luján River. This situation is aggravated by the fact that private neighborhoods are located in the flood valley of the river basin.[18] Specifically, the program's biggest innovation is to raise the issue of environmental risk management that affect rights acquired by private neighborhoods, who occupy almost a quarter of the total area of the municipality. It is also important to highlight that vulnerability goes beyond a social class perspective in Pilar. Both low income households and the working middle class are exposed to threats.

The analysis and evaluation of this program considers the environmental, territorial, institutional, legal-normative, and political frameworks in which it is set. The work methodology used includes semi-structured open interviews as a data collection tool. The selection of interviewees was determined by the equal representation of the different sectors involved. In this way, interviews were held with municipal government officials, affected members of the community, NGO leaders, private development administrators, and subject specialists.

This chapter is organized in four parts. The first describes the context of the Luján River Basin and the Municipality of Pilar, providing information about the environment, land, and the population. The second part analyzes different aspects of the practices, starting with the institutional and normative framework of the Water Dialogues program (the main measure carried out by the Secretariat of the Environment of the Municipality of Pilar (*Secretaría de Medio Ambiente*) since the beginning of its current management in December 2015). Then, the urban risk management practices in Pilar are presented, among which the Water Dialogues program stands out. The origin of the program, its objectives, methodology, degree of progress, financing, and monitoring tools. After that the text describes achievements, lessons, and future plans. The third part analyzes the results from a

18 Hereafter, we will call private residential neighborhoods "private neighborhoods" or "gated neighborhoods". Their development and regulation are established by real estate developers and they are defined by physical boundaries that separate them from rural areas or from open urban areas, their access is guarded through strict security measures.

multi-actor perspective, including the voices of the different actors involved and affected by the program. The last section addresses and analyzes the main observations, the successes, and the limitations and the challenges that lie ahead.

I. URBAN CONTEXT

Hazard and vulnerability: flooding risk in the municipality of Pilar

This case study focuses on the Municipality of Pilar, in the region of influence of the Luján River basin. In its totality, the basin covers more than 1,553 square miles and can be divided into three sectors of terraces: high (from the source of the river to the town of Jáuregui); intermediate (up to Route Nº 8 in Pilar); and low (up to the Paraná de las Palmas River). This river basin is composed of rivers and streams of serpentine channels where water runs slowly, and with wide flood valleys due to the scarce slopes in the Pampas region.

In its entire extent, the river basin crosses 14 municipalities: Suipacha, Mercedes, General Rodríguez, Luján, San Andrés de Giles, Exaltación de la Cruz, Pilar, Belén de Escobar, San Fernando, Tigre, Campana, Moreno, Malvinas Argentinas and José C. Paz. [Figure 39]. Of these, Pilar has the highest percentage of surface area affected by the river. The Luján River's length is 280 miles and crosses the municipality along mile 19 together with other large streams such as Pinazo, Escobar, Garín, Larena, and Burgos, and others of smaller volume such as Toro, the Burgueño and the Carabassa (CICLAU) [Figure 40].

Due to the fact that the Luján River is located on a plain, its floods occupy a wide valley, made up of wetland areas that regulate variations. These wetlands form a complex ecosystem, which has been altered by private urbanizations, among other factors. Adriana Anzolín, representative of the Advisory Commission of the Luján River basin Committee states that the most conflictive cases are those that were built on the flood valley, obstructing the natural drainage of the water system, and also those with

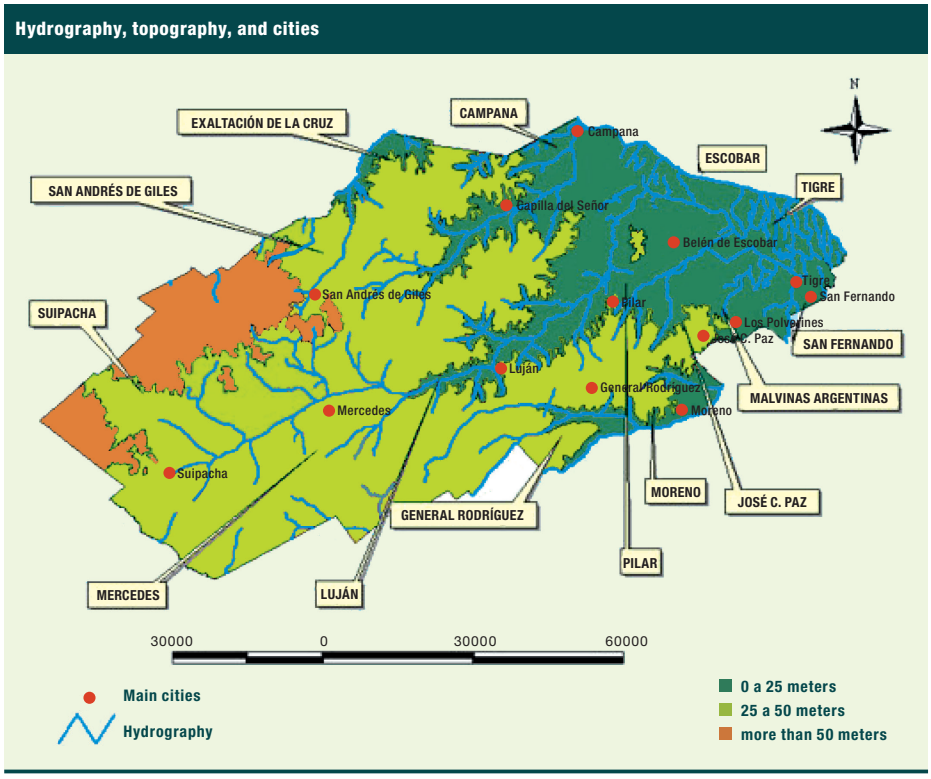


Figure 39

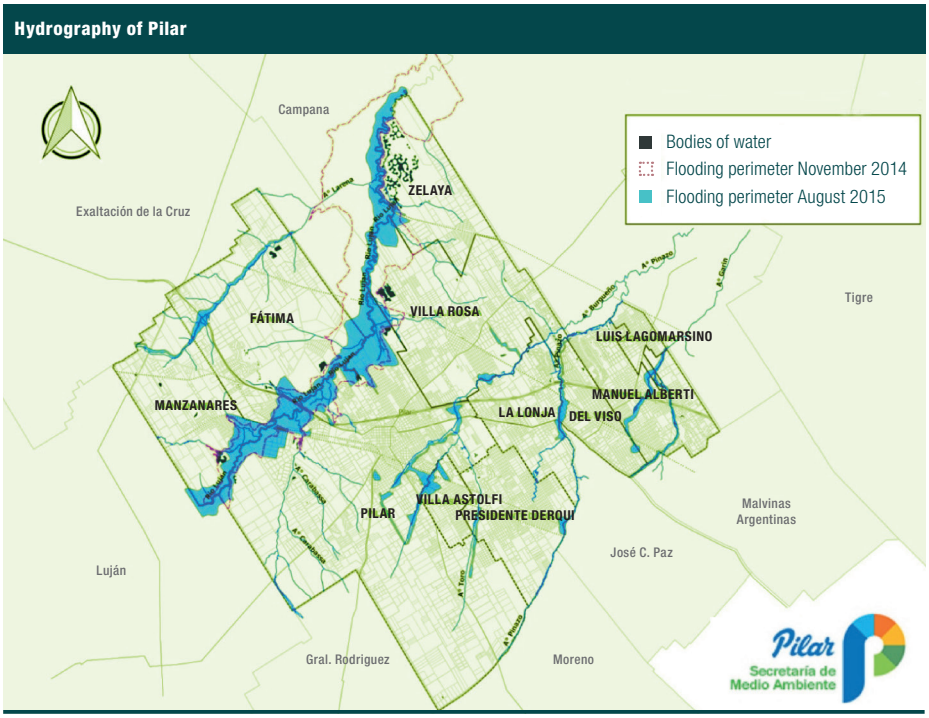
Map of cities, waterways, and topography of the Luján River.
Source: Environmental Information Center of the Luján River Basin (CICLAU), National University of Luján and Regional Committee A of the Luján River Basin.

dikes or excavations for artificial lagoons, canals, and land fillings which significantly reduced the earth's absorption capacity (2017).

In particular, this problem becomes critical in the Municipality of Pilar. The Luján River, which until a few years ago was the natural frontier between urbanized and rural territory, was incorporated into the metropolitan area of Buenos Aires. In a rapid process of urbanization, it promoted the creation of private neighborhoods and the settlement of new inhabitants in adjacent areas. According to the National Institute of Statistics and Census (INDEC), in 2010 the Municipality of Pilar had approximately 300,000 inhabitants, 28.7% more than in 2001, compared to the 12.7% average growth of the Province of Buenos Aires (Observatorio Metropolitano, 2017). Presently, there are 210 private neighborhoods installed in the municipality, of which 65 (together with other open neighborhoods) are affected by the

Figure 40

Map of hydrography's in the Municipality of Pilar. Source: Secretary of the Environment, Municipality of Pilar.



dynamics of the Luján River. According to the Secretariat of the Municipal Environment, of the 239 square miles occupied by the Municipality of Pilar, the closed urbanizations extend over 55 square miles, affecting 23% of the total area of the municipality. [Figure 41] (2017).

Initiated in the 1990s, this process was encouraged by investment in metropolitan highways, that improved accessibility of the north corridor to the city of Buenos Aires. Land values were low in this area, which attracted the attention of real estate investors. The construction of new private developments in the area drew in residents with high purchasing power, as well as other residents of lower resources, motivated by new employment opportunities. Although this is one of the reasons why many inhabitants (even those harmed by the floods aggravated by the construction of closed neighborhoods) view these real estate ventures in a positive light. Environmentalist Graciela Capodoglio (2017) points out that these

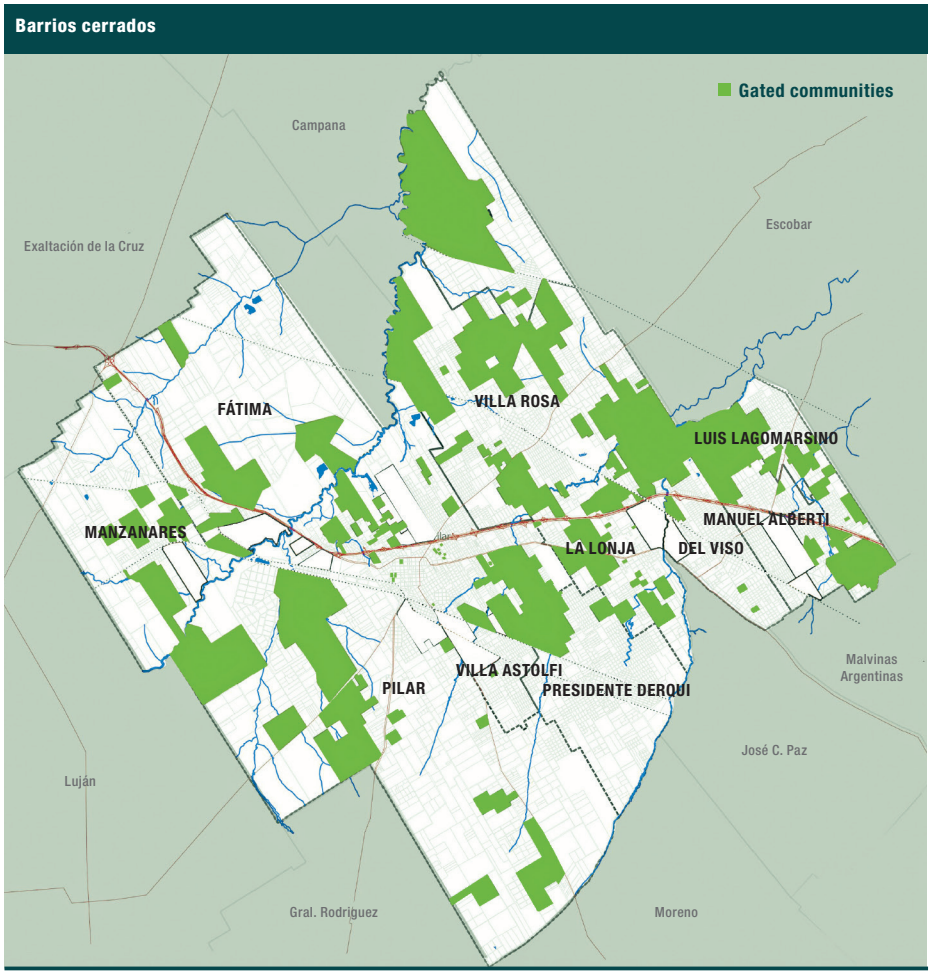


Figure 41

Private neighborhoods in the Municipality of Pilar. Source: Modified map from documentation provided by the Municipality of Pilar.

are unprotected, precarious, and unstable jobs. Although the job creation argument is strongly put forward by real estate entrepreneurs, municipal officials argue that employment opportunities could change so that the labor market is not only economically but also environmentally sustainable (Corcuera, 2017).

The situation of people who live at the expense of private urbanizations is combined with economic and environmental vulnerabilities. According to the INDEC, the population with Unsatisfied Basic Needs (UBN) amounts

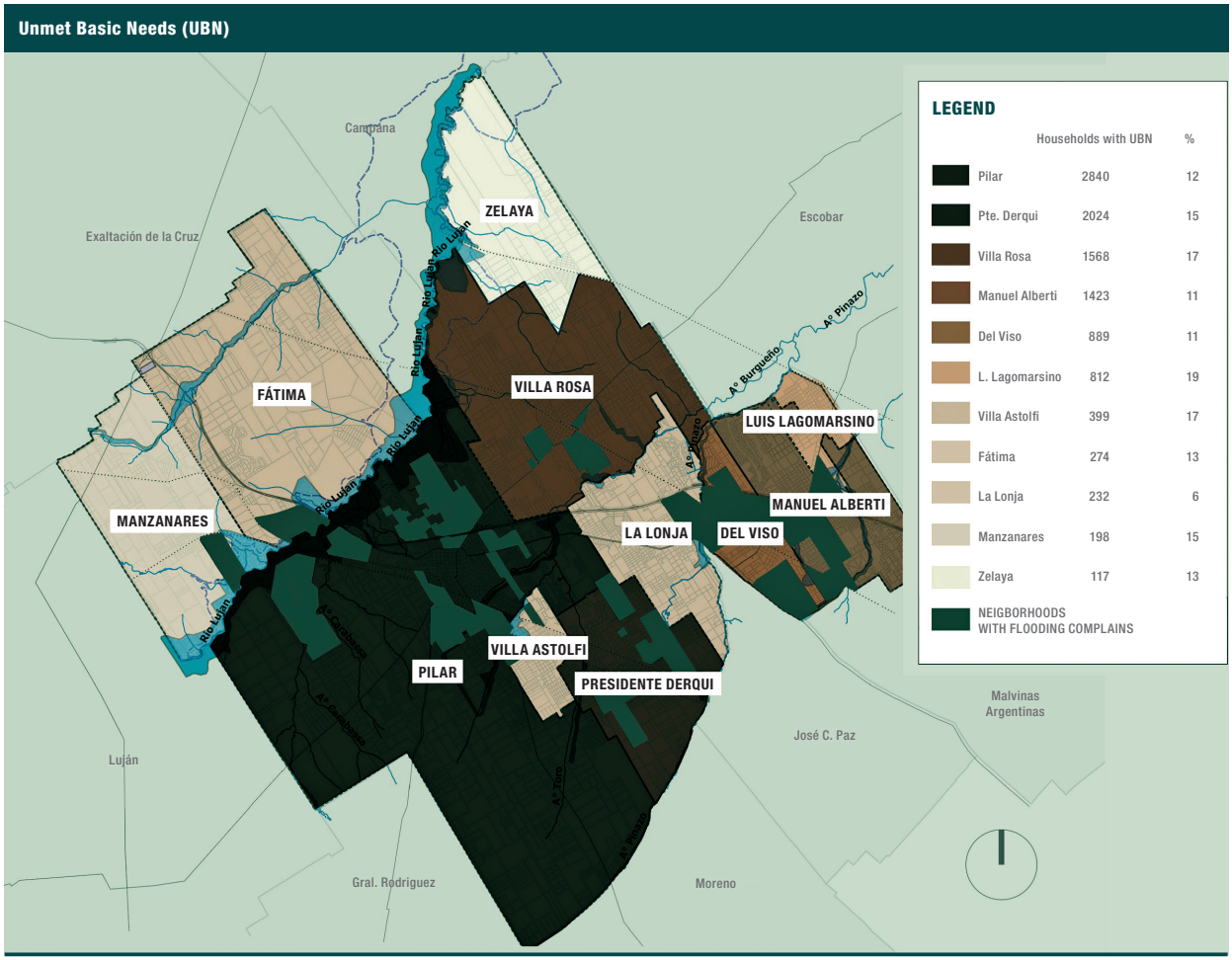


Figure 42

Flooding zones and homes with UBN by neighborhood. Source: Modified map from documentation provided by the Municipality of Pilar.

to 13% in the Municipality of Pilar. The Luis Lagomarsino neighborhood has the highest percentage of households with UBN, totaling 19%. As shown in Figure 42, this is an atypical case, given that there is not necessarily a direct relationship between households with UBN and those vulnerable to natural hazards.

The last major floods that affected the municipality occurred in May 2014. Thirteen zones were the most affected and two of these evacuated between 170 and 260 people. However, the rest of the 30 impacted

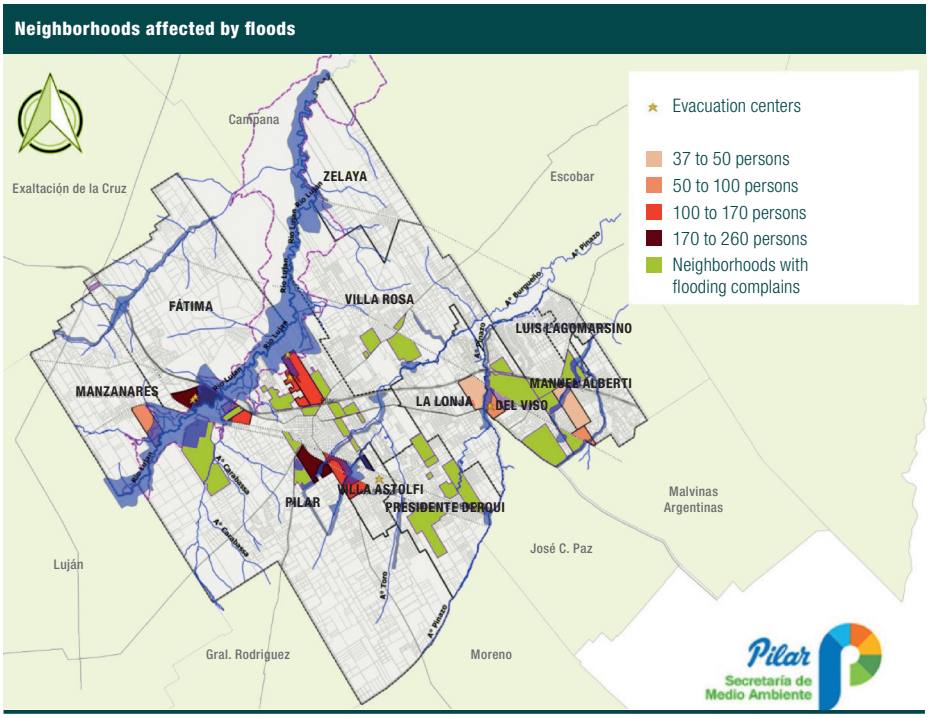


Figure 43

Map of neighborhoods affected by floods. Source: Map provided by the Municipality of Pilar

neighborhoods presented claims to the municipal government. [Figure 43]. These neighborhoods are not only exposed to the environmental risk related to extraordinary floods, such as those of May 2014 or September 2017, but they also suffer frequent waterlogging, even through the average volume of rainfall is within normal thresholds (between 31 and 39 inches per year).

II. URBAN RESILIENCE PRACTICES

a) Institutions and regulations for risk management

In order to present the institutional framework of environmental policies carried out by the Municipality of Pilar, it is necessary to give an

account of the institutional and regulatory environment that, from the international, national, provincial, and interjurisdictional perspectives, conditions local decisions.

The Wetlands Convention (RAMSAR Convention) is an intergovernmental treaty that serves as a framework for national action and international cooperation for the conservation and sustainable use of wetlands and their resources. Signed in Iran in 1971, this treaty is one of the oldest environmental international agreements.[19] The convention did not have effect in the Argentine Republic until 1992. Currently, there are a total of 22 sites designated as wetlands of international importance in the country. In the Luján River basin, the only protected site is the Otamendi Nature Reserve, located in the Municipality of Campana. At the national level, a National Law for the Protection of Wetlands is currently underway, which has preliminary approval from the Chamber of Senators, and is under consideration in the Chamber of Deputies.

However, the General Environmental Law (N° 25,675) enacted in November 2002, defines minimum budgets for the achievement of sustainable and adequate environmental management, the preservation and protection of biological diversity, and the implementation of sustainable development (Ministry of Public Works of the Province of Buenos Aires, 2017). Under this law, different claims for the protection of wetlands are upheld and managed by different NGOs, such as those within the Network of Organizations and Neighbors in Defense of the Luján River basin (*Red de Organizaciones y Vecinos en defensa de la cuecca del río Luján*), among others.

In order to regulate the national management of water resources, laws such as the one determined by the Environmental Management of Water Regime (N° 25,688) was adopted in December 2002. It establishes the creation of plural organisms to manage interjurisdictional basins and stipulates the conformation of the National Water Institute (INA), dependent of the Sub-secretariat of Water Resources of the Nation (*Subsecretaría de Recursos*

[19] Under this Convention a wetland "encompasses all lakes and rivers, underground aquifers, swamps and marshes, wetland grasses, peatlands, oases, estuaries, deltas and low tides, mangroves and other coastal areas, coral reefs, and artificial sites such as fish ponds, rice fields, reservoirs and salinas".

Hídricos de la Nación), continuing the tasks initiated in 1973 by the National Institute of Water Science and Technique (INCYTH, *Instituto Nacional de Ciencia y Técnica Hídricas*). The purpose of the INA is "to meet the requirements of study, research, development and provision of specialized services in the field of water use and preservation" (2017).

At provincial level, key legislation for environmental regulation is the Decree/Law on Territorial Regulation and Land Use (N° 8,912), adopted in 1977 during the last military civic dictatorship. In its article 7, this law establishes "reserve areas" as sectors determined by specific interests oriented to the common good (Government of the Province of Buenos Aires, 2017).

Regarding the institutional architecture, the relevant agencies in these matters are provincial. Among them, two autarchic entities stand out: The Provincial Agency for Sustainable Development (OPDS, *Organismo Provincial para el Desarollo Sostenible*) created in 2007 through the Law of Ministries (N° 13,757) and the Water Authority (AdA), formed the same year by the law that regulates the Water Code of the Province of Buenos Aires (N° 12,257); and the Provincial Office of Water Works and Sanitation, successor to the Provincial Hydraulic Office, under the jurisdiction of the Ministry of Infrastructure of the Province of Buenos Aires. Regarding risk management, it is worth noting that the actions of the Provincial Office of Risk and Emergency Management are under the jurisdiction of the Ministry of Coordination and Public Management.

The OPDS exercises authority in environmental matters at the provincial level. Its responsibilities include the planning, formulation, and control of environmental policy; the preservation of natural resources; the conservation, protection, and the recovery of reserves, protected areas and forests. Furthermore, its responsibilities include seeking a rational use of the land and its recovery; designing and implementing policies for the protection and preservation of biodiversity; carrying out actions conducive to the control of all elements that may cause air pollution, water, soil; and in general, anything that may cause air, water, and soil pollution, and in general, anything that may have an environmental impact (OPDS, 2017). At the same time, the AdA is the multidisciplinary agency responsible for planning, registration, constitution, and protection of rights, as

well as the policing and the execution of the missions established in the Water Code of the Province of Buenos Aires (Government of the Province of Buenos Aires, 2017). The actions of the Provincial Directorate of Risk and Emergency Management run along two lines: risk analysis, centered on the generation of mechanisms for knowledge, and the coordination of emergencies, which includes activating plans and protocols, in coordination with the different ministries and provincial agencies.

Inter-jurisdictionally, the Luján River Basin Committee (COMILU), operates with the Provincial Executive Power (PEP) and the Infrastructure Ministry of the Province of Buenos Aires. Created in June 2016 by Law N°14,817, this body is made up of a seven-member board: a president appointed by the PEP; three directors also appointed by the PEP who are each appointed by the Ministry of Coordination and Public Management, the Ministry of Infrastructure and Public Services, and the OPDS; and three other directors appointed by the municipalities that make up the river basin, through a mechanism proposed by the municipalities themselves (Government of the Municipality of Buenos Aires, 2017). Moreover, in article 7 of the law establishing the PEP, it asserts that the PEP, will establish an Honorary Consultative Council in order to guarantee citizen participation, with diverse representatives including users of services, professionals, NGOs, and academics. Although it has not yet been regulated, representatives of different NGOs have expressed criticisms of the Council's powers as their decisions are not binding. COMILU's main capacities include the planning, coordination, execution and control of an Integral Management Plan; integral administration of the river basin; the planning of the environmental territorial plan of the affected territory; formulating the environmental policy in coordination with other competent bodies in the matter; and the promotion of expropriations and relocations that comply with its mandates.

In terms of the inter-jurisdictional management of the river basin, the Integral Plan and Project for Regulation and Sanitation Works of the Luján River (also known as the Serman Plan due to the study that developed it (Consultora Serman & Asociados)) is the only working plan for the region's water resources. Although the plan was prepared by the Buenos Aires government in 2011, its presentation was only ready in 2015. The

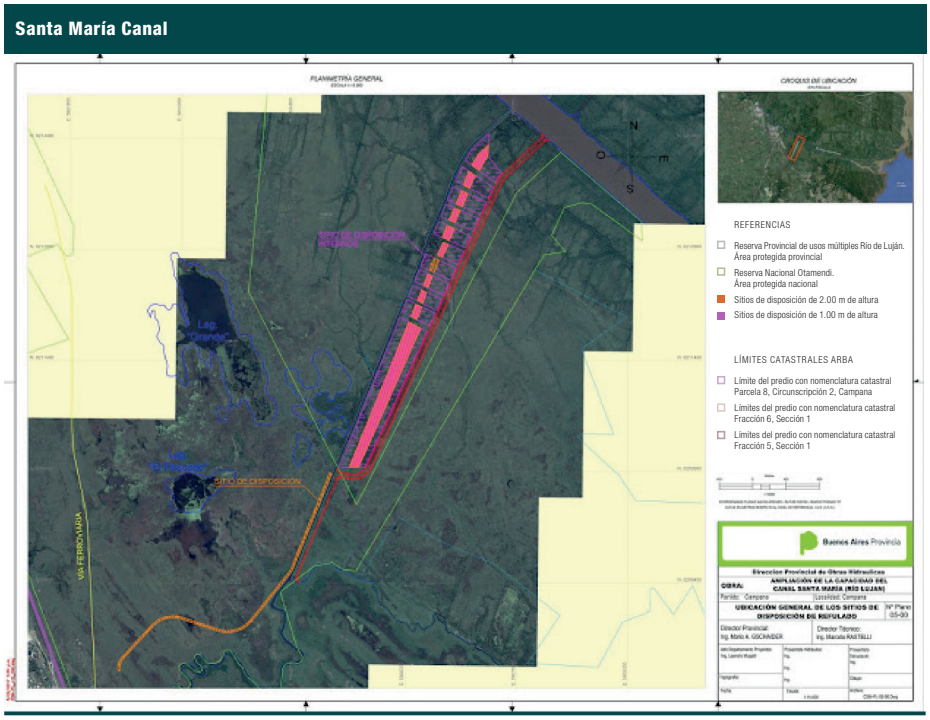


Figure 44

Plans of the Santa Maria Canal Works. Source: Neighbors of The Wetlands. "Works on the Santa Maria Canal. What is Behind the Bidding? (2017).

plan recommends the creation of areas for the temporary retention of excess water in the upper river basin; the expansion of the channel between the municipalities of Luján and Pilar; and the widening of some bridges that function as funnels when the flow of the Luján River increases.

Although some of the measures included in the Serman Plan have been welcomed, the decision to expand the river channel has been criticized by environmentalists. According to Adriana Anzolín, the plan was exclusively designed as a hydraulic engineering work, with little environmental consideration of the impact on the river basin's ecosystem (2017). An example of this orientation is the expansion of the Santa María Canal located in the Municipality of Campana, an artificial course connecting the Luján River with the Paraná in an area of seven kilometers [Figure 44]. The Network of Organizations and Neighbors in Defense of Río Luján claims that the aforementioned route crosses wetland areas corresponding

to the Otamendi Nature Reserve (Grande, 2017). However, as Graciela Capodoglio asserted, the real estate ventures associated with these infrastructure works should be the source of great concern. Another planned work, not contemplated in the study carried out by Serman & Asociados, is a channel parallel to Santa María, whose land (contaminated with heavy metals, hydrocarbons and other industrial wastes) would be used to refill private lots for future a real estate development, announced as "*Bahías del Paraná*" (2017).

The aforementioned network expressed its position on these projects and requested the provincial authorities to confirm the existence of an Environmental Impact Assessment. The demands for the protection and non-urbanization of wetlands are in currently in litigation in San Isidro, Mercedes, and Campana. On June 30, 2017, "the Official Bulletin published the modification of Resolution 29/09 issued by the OPDS, through which the Environmental Impact Evaluation Process for this type of urban development project falls under municipal jurisdiction" (Neighbors of the Wetlands, 2017).

The Municipality of Pilar does not have regulations that limit the construction of private housing developments that may affect the absorption and runoff of the Luján River floods, even with the consequent increase in the area's flooding risk. Municipal ordinance 99/12 was repealed in 2014. Among other measures it prohibited excavations for new caves or lagoons, made it mandatory to waterproof existing artificial lakes to mitigate the damage to aquifers, and ordered constructions to be elevated to allow the passage of water through the wetland.

However, the municipality has recently signed a declaration of interest on the protection of wetlands, in line with the guidelines of the new Urban Planning Code of Pilar. This code was developed with the collaboration of the School of Architecture, Design and Urban Planning of the University of Buenos Aires (FADU, UBA) and it was approved in February 2018. Due to the contributions of the Water Dialogues Program, the new law incorporated the protection and sustainable management of wetlands, by means of the environmental regulation of the territory. The innovations that stand out include the establishment of special floodplain zones, restrictions to private urbanization [Figure 45], and the recommendation of construction

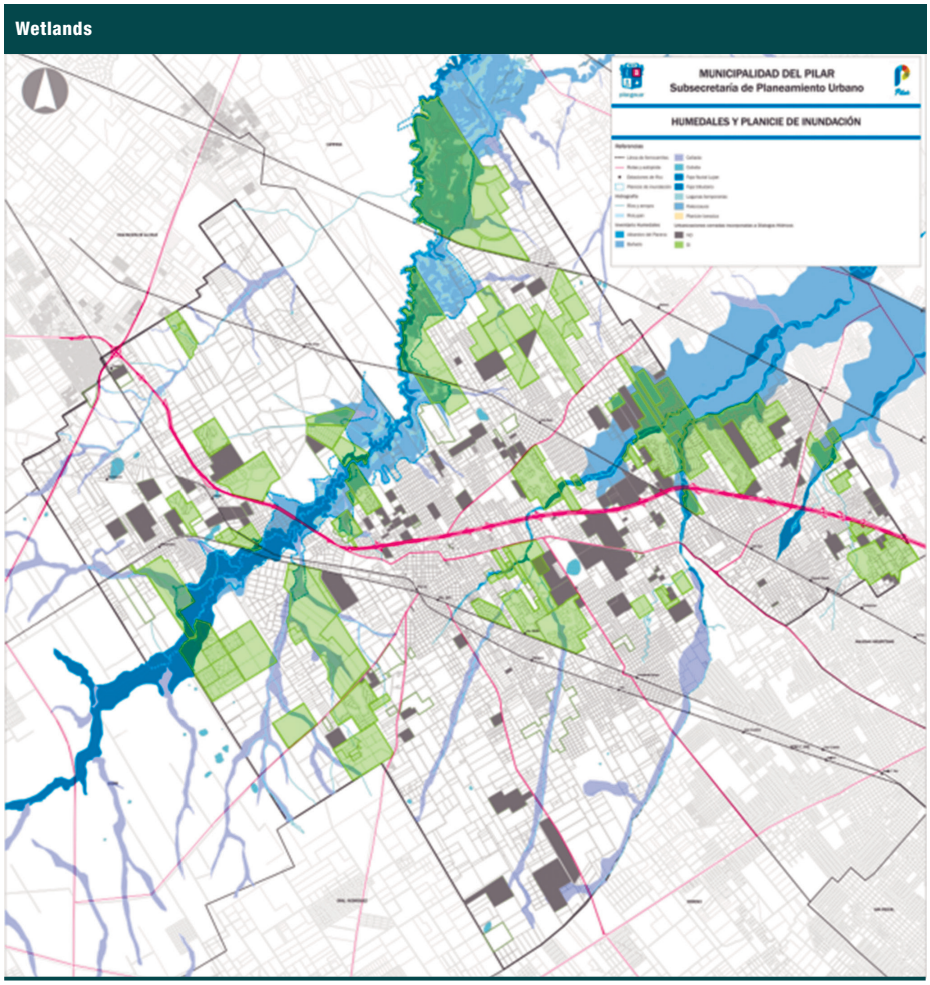


Figure 45

Map of the wetlands and the floodplain.
Source: Sub-Secretariat of Planning and Urban Development, Municipality of Pilar.

on pillars on higher geomorphological areas. Also, the construction of a riverside promenade and afforestation with native plants is planned. In this way, it seeks to significantly increase the permeability of the soil and the proper functioning of these wetland ecosystem.

The environmental policies carried out in the Municipality of Pilar are carried out within a complex institutional and regulatory architecture, at the international, national, provincial and municipal levels, which regulate and manage the watersheds and their ecosystems.

b) The Water Dialogues Program

The current management of the Secretariat of Environment of the Municipality of Pilar has addressed, since December 2015, a series of public policies aimed at preventing and mitigating the consequences of the frequent floods of the Luján River and its tributaries. According to their statements, flooding is a priority in the agenda. As such, the Water Dialogues program, among other actions, were created in order to renegotiate the occupation conditions of private neighborhoods that altered the original permeability of the soil. Since December 2017, due to the restructuring of the municipality, this program became part of the Sub-Secretariat of Planning and Urban Development, and continued under the coordination of its previous director, Jerónimo Valle.

Among many actions, this chapter highlights three main measures that deal with flooding issues at different stages. The most long-term solution seeks to collect data regarding the impact of private urbanizations on the Luján River basin water system. The then Secretary of the Environment signed an agreement with the INA through the National Government's Sub-secretariat of Water Resources, to model hydraulics in all of Pilar, producing a virtual reconstruction of the Luján River. The purpose of the model was to reproduce and forecast the river's behavior, perform tests, and define solutions. In this tripartite agreement, the Sub-secretariat provides the funds while the INA provides the technical expertise.

The aforementioned Water Dialogues program has addressed medium-term solutions. As noted by specialist Patricia Pintos, beyond the initiative's achievements, Pilar is the only municipality of the region that has addressed the problem of private urbanizations. This effort is worth noting because private urbanizations consider their location an acquired right despite their potential negative impacts on the territory (2017). This program arises in response to the legal vacuum on the subject and is based on building bonds of trust and commitment with the private neighborhoods based on an expanded concept of corporate social responsibility. However, both Patricia Pintos and Adriana Anzolín agree that the state cannot be equated to the private sector and that coercive actions should be foreseen in the case that these agreements, supported by the good will of the parties, are not successful (2017). An example of this is the municipality's difficulty in

reversing the resistance that the San Sebastián polderized mega-urbanization has to participate in the program. This mega-urbanization is developed by EIDICO and affects the municipalities of Pilar, Campana, and Exaltación de la Cruz. Hence, is has a strong impact on the river basin system (Pintos and Sgroi, 2012).

Finally, the development of an early warning system serves as a short-term measure. This system includes of the installation of hydrometers that measure floods and allow for timely evacuations of the most affected neighborhoods. The municipality also has two emergency evacuation centers, and agreements with various associations, such as the Confiar canteen, that can accommodate those affected by floods.

These actions work synergistically under the concept of "hydraulic transparency", coined by Javier Corcuera, former Secretary of the Environment of the Municipality of Pilar. This concept, refers to forms of urbanization and building systems that allow the natural course of water below the construction zones while guiding both current measures and future policies. While the agreement with the INA provides an objective tool to identify critical cases and possible solutions and negotiate commitments with private neighborhoods, the Water Dialogues Program has strengthened the Early Warning System. It is expected that, as agreements with the neighborhoods progress, more measuring points can be added to the system.

The Water Dialogues program articulates the municipal actions that manage the risk of flooding in Pilar. It also conducts a series of negotiations where the private neighborhoods that have an impact on the river basin are committed to carrying out works to mitigate frequent waterlogging. In these negotiations, private urban developments are requested to: install a meteorological power station and measurement protocols including cameras connected to the municipal system; carrying out works that eliminate obstructions to water drainage; the provision of certain sectors for public use, such as golf courses, to allow self-flooding in case of extraordinary floods; ditching and construction of riverbanks; and the investment of the necessary works outside the limits of the neighborhood. Moreover, the program promotes sustainable construction of new developments and the regulation of existing ones. With regard to the issue of self-reliance, Graciela Capodoglio argues that there is no reliable data to determine that the area allocated

for this compensates for the environmental damage caused by the movement of land from real estate ventures (2017).

c) The Program in Action

One of the first issues that accounts for the progress of Water Dialogues Program is the program's limited budget. In the 2017 budget, the resources allocated to the former Ministry of the Environment corresponded to 1% of the total of the Municipality of Pilar, with little more than US$1,750,000 (Open Data Municipality of Pilar, 2017). Another issue is administration's time frame, which still has two years to go. That is, on top of the normative restrictions mentioned in the previous section, there are economic and political issues. However, recent negotiations have secured private financing for flood mitigation works (US$1,227,500 from private neighborhoods) and national financing for the development of hydraulic modeling (US$410,000 from INA).

The program, which began in December 2015, first determined the most affected private neighborhoods in the flood valley of the river basin. According to those responsible for the program, 65 cases were included in Water Dialogues (62 built and 3 under construction) [Figure 46]. Agreements were signed with 15 private neighborhoods,[20] five of which agreed to construction commitments,[21] and another 30 are in the process of being signed. Given that the Pilará neighborhood was the first to participate in the program, it became the pilot case.

According to Jerónimo Valle, director of the Water Dialogues program, the neighborhoods that had received the largest number of complaints from the affected neighbors were given priority (2017). Pilará had received complaints from its neighbors, but additionally, its representatives were willing to collaborate. As a result, Pilará became the first case that signed an agreement and initiated corresponding works. [Figure 47]. However, according to the framework agreement, it was in the interest of municipal management to

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20 Pilará, Martindale, Sausalito, Sociedad Hebraica Argentina, La Casualidad, Las Condes, Chateaux Pilar, Olivares, Haras La Pradera I y Haras La Pradera II, Santa Guadalupe, Santa Lucía, Santa Elisa, Casas del Este, and Tortugas.

21 Pilará, Santa Elisa, Santa Lucía, Santa Guadalupe, and Casas del Este.

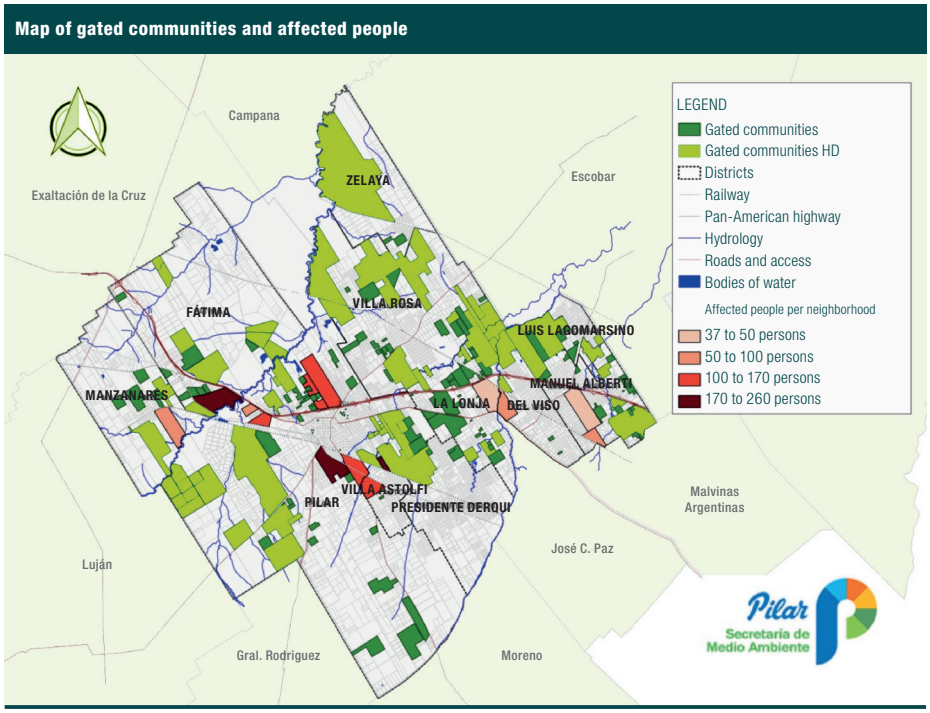

Figure 46

Map of closed neighborhoods, closed neighborhoods affected by the Water Dialogues Program and people affected in open neighborhoods. Source: Ministry of the Environment, Municipality of Pilar.

carry out an assessment at the micro-basin level, a requirement that the Pilará neighborhood also meets, since it is located on the area of influence of the Carabassa stream.

The works included in the agreement signed between the representative of Pilará and the former Secretary of the Environment of the Municipality of Pilar on October 18, 2016, are endorsed by the Sub-secretariat of Hydraulic Infrastructure of the Ministry of Infrastructure of the Province of Buenos Aires and by the AdA. The stated objective of this agreement is to carry out joint work in order to mitigate the effects of flooding in the most vulnerable neighborhoods.

To define the works to be carried out, each party convened experts in hydraulic engineering, who had the support of the Hydraulic Department of the Public Services Secretariat of the Municipality of Pilar. The experts evaluated the available hydro-climatic information for the site

Figure 47

Image of flooding in neighborhoods surrounding Pilará, in August 2015. Source: Photograph provided by Johnathan Villanueva, a neighbor affected by the Pilará venture.

occupied by Pilará and its immediate surroundings. This included flows, geomorphological profiles, and hydrographs of various recurrences. Also, the analysis took into account the volume of excess water stored in natural conditions prior to the venture, as well as the volume displaced by new constructions carried out by Pilará. On the other hand, the actions to be executed were included in the aforementioned Integral Plan and Project for Regulation and Sanitation Works of the Luján River. They consist of the following:

- THE CONNECTION, in charge of Pilará, of the internal lagoons with the expansion valley of the Carabassa stream, to increase their volume capacity so they may function as a transitory retention area;
- THE IDENTIFICATION of the need to increase the lighting on the Los Naranjos street bridge—outside of Pilará—as a priority action to be carried out by the Municipality of Pilar;
- THE COMPLETION by Pilará of two complementary works of hydraulic regulation on two tributaries of the Carabassa stream that are within the neighborhood, enabling certain public areas to flood when necessary;
- THE INSTALLATION, also in charge of Pilará, of three limnimetric scales to measure stream levels and a meteorological station monitored by cameras connected to the Municipal Monitoring Center (COM), as part

of an early warning system integrated with the COM and Civil Defense through the municipality.

In the same framework agreement, Pilará presented a roadmap with deadlines for the execution of the above action items. Likewise, the parties agreed to create a commission to monitor the works, integrated by an agent of the then Secretary of Environment, another of the Directorate of Hydraulics, another of Civil Defense, a representative of Pilará, and an representative of the corresponding district designated by the Chief of Cabinet of the Municipality, as a liason with the inhabitants of the surrounding vulnerable neighborhoods. However, some affected neighbors expressed criticisms as they were not well represented in the Water Dialogues program (Boero and Villanueva, 2017).

During the first interviews with those in charge of the program, limnimetric scales and meteorological stations were installed. However, according to the neighbors affected by the Pilará gate community, the Municipal Monitoring Center, which receives the information that is released at those points, did not inform them about the risk of flooding. Flooding eventually occurred on the first weekend of September 2017 (Boero and Villanueva, 2017).

As for the rest of the actions set out in the framework agreement, residents of the surrounding neighborhoods (Los Grillos, Manantial, Comercial Villa, San Jorge, Panchito and Carabassa) prepared a letter, dated June 7, 2017 and addressed to the Governor of the Province of Buenos Aires, María Eugenia Vidal, the President of the Directory of the Water Authority of the Province of Buenos Aires, Pablo Rodrigué, and the Mayor of the Municipality of Pilar, Nicolás Ducoté. The letter included 120 signatures from neighbors requesting the authorities to expedite the agreed works inside the Pilará neighborhood (the construction of two small dams for the temporary retention of excess water and the interconnection of the internal lagoons for the reception of the floods of the Luján River) and in the outskirts (extension of lighting to the bridge over the Naranjos street), as well as the extension of other bridges that block the drainage of the water, which where outside of the agreement signed between Pilará and the Municipality of Pilar (Boero and Villanueva, 2017).

After this first pilot case, four work commitments were signed by other neighborhoods. The cases of Santa Lucia and Santa Elisa, both under construction, were closed after neighbors affected by the flood of 2017 filed complaints and it was found that they did not have the proper documentation. In this way, the company EIDICO decided to channel the negotiation through the Water Dialogues program. The other two cases are Santa Guadalupe and Casas del Este, also prioritized due to the impact caused in the aforementioned flooding.

In these new agreements, the program included the lessons learned in the Pilará case. First, mechanisms were generated for the participation of the affected neighbors from the beginning of the negotiations in order to reach agreements prior to the signing of the commitments. The election of the representatives of the neighbors was achieved through participatory round tables. However, the possibility that private neighborhoods finance works outside their limits (like relocations or carrying out revisions of previous agreements, such as in Pilará), is still under evaluation.

III. CITY- SPECIFIC RESULTS

Perspectives and prospective of the Water Dialogue Program

It is possible to agree with those responsible for Water Dialogues on a favorable evaluation of the program, given that within this framework, it has been possible to question certain rights acquired by private neighborhoods. This was represented under the slogan "if you are part of the problem, you must be part of the solution" (Corcuera, 2017; Díaz Alberdi, 2017). Moreover, the Municipality of Pilar has been able to carry out an hydraulic modeling of the basin, which will allow to obtain objective data on the Luján River floods and the impact of the private developments in this area. Finally, an early warning system is being strengthened to manage flood risk (Corcuera, 2017; Valle, 2017).

Regarding forthcoming changes yet to be implemented, the indicators that evaluate the program's degree of progress are under considerations.

Instead of accounting for signed agreements, the Municipality seeks to report on the areas covered by each of the dialogues in progress, with the purpose of measuring the impact of these interventions. In the same way, they propose to account for indirect impacts. Here new concepts to which the technical bodies are subscribing, like that of "hydraulic transparency" or "flood spot" (area bounded by the towpath, which defines the territory that should be kept open for the Luján River's natural flooding (Corcuera, 2017; Valle, 2017)), might be useful.

Another of the observations provided by municipal officials in the first series of interviews, that was presented as a pending issue, is the problem of population relocation into areas at great risk of waterlogging. Although the current agreements with private urbanizations include the possibility of financing relocations of affected homes in open neighborhoods, Adriana Anzolín points out the difficulty of questioning the status quo, since the possibility of relocating private neighborhoods is not considered (2017).

Independently of the program's own evaluation, the Water Dialogue program was also considered a positive initiative by Adolfo Díaz Alberdi, a representative of the Pilará neighborhood. In particular, the idea of generating trust between the public sector and the private sector was valued over the usual finger pointing that occurs frequently after catastrophes. In this regard, it is important to highlight that the same municipal officials recognize, given the new information provided by hydraulic modeling, that closed neighborhoods are not always responsible for waterlogging in the municipality. Another well-evaluated point was the inclusion of a specialized technical body, allowing negotiations to take place within scientific parameters. Faced with the question of what changes would have been implemented or should be implemented in the future, Díaz Alberdi regretted not being represented as a real estate entrepreneur in the process of developing the Urban Planning Code despite knowing that that these decisions were beyond the control of the then Secretary of the Environment. Furthermore, he was surprised at the absence of municipal planning during the installation of a large industrial park that in the medium term would require residential land (2017).

The issue of participation was also questioned by the residents affected by the Pilará enterprise. From another angle, they claimed their place

both in the dialogues between the Municipality of Pilar and the closed neighborhood, and during the monitoring stage of the agreement. In the first stage, residents did not have any type of participation while in the second stage the participation was indirect and mediated by a municipality appointed representative. While the construction of a space of trust was valued in the dialogue between the private urban developments and the Municipality of Pilar, this perception was not shared by the affected residents who considered themselves relegated actors in the Water Dialogues program. The limited participation in the decision process meant that these residents could not evaluate the compliance with the stated commitments, nor the effectiveness of the measures taken (Boero and Villanueva, 2017). As mentioned, this criticism was taken up by municipal officials, for the redesign of participatory strategies in the subsequent negotiation processes. These changes are being implemented in four new neighborhoods that have signed work commitments.

Although the program is very young and there are still no results to be seen in terms of mitigating the impact of private neighborhoods in the floods of the Municipality of Pilar, the strategies and tactics implemented to achieve that goal are noteworthy. The first includes negotiation with the private sector and local territorial planning body. The second includes citizen participation and dialogues with technical teams. As previously mentioned, there are promising signs of the effectiveness of the dialogue tool, given that to date five, work commitments have been signed and another fifteen are in negotiation processes. Similarly, the program's lessons learned have been incorporated into the recently approved Urban Planning Code. Finally, it is important to highlight the changes made in the participatory process. Affected residents have become active partners in negotiations from inception. Other changes have allowed advances in the agreements with the INA, that facilitates the hydraulic modeling of the area, generating scientific data for a better evaluation of the impact of private urbanizations and of the works implemented from these dialogues.

IV. PRELIMINARY CONCLUSIONS ABOUT THE PILAR CASE

The Water Dialogues Program, initiated by the Secretariat of the Environment and continued by the Sub-secretariat of Urban Planning and Development, should be evaluated from several angles in order to determine its impact as the main urban practice to mitigate the effect of floods through risk management. First, there are regulatory limitations to address this problem, given that 30% of private urban developments approved by previous administrations are responsible for the city's environmental risk. Second, there are also economic restrictions to consider, since in 2017 the then Secretariat of the Environment had only allocated to this issue 1% of the municipal budget. However, the decision to implement a retroactive policy, aimed at reversing (at least partially) some of the damage caused by the development of private neighborhoods in the Luján River's flood valley basin is notable. Ultimatelly, it is difficult to evaluate the efficiency of these measures, especially in relation to the adaptability of a city affected by flooding risk and with part of its population in a vulnerable situation. The vulnerability is not limited to segments of the population with less resources, but affects the majority of the working middle class residents.

Due to the fact that the cases that are partially protected by previous approvals and by the absence of specific legislation that limits their territorial impact, one of the most positive and novel aspects of this program is the use of dialogue as a risk management tool. This resource deepens the bonds of trust between the public and the private sector, while expediting the resolution of conflicts in cases where parties willingly agree to participate in the Water Dialogues Program. The program has a certain degree of uncertainty in regard to those that refuse to engage in dialogue. In other words, the state's role in the real estate market as guarantor of environmental and urban rights is at stake.

In spite of the low municipal budget, the current management has obtained resources from the state and from the private neighborhoods partly responsible for the increased risk of flooding in the area. Likewise, it has committed to promote municipal investments in infrastructure works. As mentioned, among the program's achievements is the hydraulic modeling of the river basin through an agreement with the INA. The Water Dialogues Program has also managed to ensure that the private neighborhoods finance the necessary works to mitigate environmental impacts to the extent

possible. This is achieved regardless of whether the interventions have to be done inside or outside the boundaries of the gated communities.

With regard to the political perspective, it is promising that the municipality has decided to act on what has been built already, calling into question the building rights previously attributed to private neighborhoods. In this way, beyond the specific achievements that the program can achieve, part of the value of the proposal lies in the symbolic impact that this reassignment of responsibilities may have in the region to address issues shared with other municipalities in the basin. This new urban practice could be transferred to other cities affected by similar problems, where dialogue can become a strategic tool to address environmental conflicts. Moreover, the program has sparked interest in representatives from Panama and the Netherlands, in the different international arenas in which it has been presented.

Given that it is a relatively young program, running for over two years with about five cases in execution out of a total of 65 selected, any evaluation regarding efficiency in terms of urban resilience is biased. There is still no scientific information available that can provide enough accurate data regarding the impact of private neighborhoods in the river basin. The results of the interventions within the framework of the program are still unknown. It should also be noted that the Water Dialogues Program does not intend to solve the problem of floods, nor to return an original situation prior to the installation of private developments in the wetlands, rather to mitigate the effects of flooding in the Luján River.

Some of the lessons learned in the Water Dialogues Program have resulted in the inclusion of the social actors directly affected by the planning, decision-making, and monitoring of the program. On the other hand, this initiative has managed to influence the development of the New Urban Planning Code and to incorporate this program in the Sub-secretariat of Urban Planning and Development.

Returning to the lines of action proposed by the Provincial Office of Risk Management and Emergencies, urban practices carried out by the Municipality of Pilar are strongly oriented to the prevention of and preparation for possible threats, where the responsibility does not fall strictly on state intervention, but rather it is assumed collectively, integrating actors from civil society and the private sector.

7. CUBATÃO, BRASIL. THE REBIRTH OF "THE VALLEY OF DEATH"

FLÁVIA LEITE

In the 1980s Cubatão became known as the "Valley of Death" and "the most polluted place on earth". A few years later, in 1992, at the United Nations Conference on Environment and Development in Rio, Cubatão was recognized as an ecology symbol and a successful example of pollution control. This significant transformation was a result of the Pollution Control Program (*Programa de Controle da Poluição*) led by São Paulo State's environmental agency. The Program, a mix of technical and community-based projects, ensured that by 1994, 90% of the identified pollution sources were regulated. However, two decades after the Cubatão Pollution Control Program started, the average annual concentration of PM_{10} in the town remains considerably above the guidelines set by the World Health Organization (WHO). The poor air quality indicators in the town may be attributed to factors such as the change of the economic profile of Cubatão, the decrease of community involvement, and the lack of infrastructure and of political will of municipal authorities. Cubatão's case demonstrates the challenges involved in sustaining successful risk management strategies over time.

This study is based on semi-structured interviews conducted in São Paulo and Cubatão, as well as on-site visits, and desk review and analysis of relevant publications and planning documents.

I. URBAN CONTEXT

a) Urban history and pattern of growth

The municipality of Cubatão was created in 1949. Previously, the town was part of Santos, a city 15km away. Cubatão's creation is related to the construction of Brazil's largest and most ambitious highway project at the time, the Via Anchieta, connecting São Paulo and Santos. The project boosted trade and immigration to the town, prompting Cubatão's population to ask for its political emancipation (Couto, 2003). Thus, in 1949, the town of Cubatão, for the first time, was able to elect its own mayor and council members.

Cubatão is located in the Brazilian State of São Paulo, at the base of the coastal mountain range (*serra do mar*). The town sits between Santos, the city with the busiest seaport in Latin America, and São Paulo, Brazil's largest metropolis. It is part of the metropolitan region of Santos Lowlands (*Baixada Santista*), which includes nine municipalities[22] and more than 1.8 million people. The town has an area of 57.1 m² and a population of over 128 thousand inhabitants (IBGE, 2017).

The majority of Cubatão's area consists of mangroves, mountains, and hills. Only 18% of its territory is comprised of plains, a narrow land strip of around 10km long crossed by rivers and waterways. The climate in the region is tropical, hot, and humid. The prevailing vegetation is the tropical forest on the mountains, and the tropical vegetation of Coastal Plain (*vegetação de restinga*), which extends from the mountain bases to the mangroves.

By its very nature, conditions for urban and industrial development in Cubatão are difficult. The town not only has few plains to accommodate urban growth, but its plains are surrounded by mangroves and other submersible lands (Ab'Sáber, 1982). Cubatão is also an environmentally unstable area, subject to periodic flooding from rivers and sea tides, and thus, unsuitable for construction. Moreover, the climate and the wind regimes of the region, coupled with its topography (coastal mountain range of 2,296.6 feet),

[22] Bertioga, Cubatão, Guarujá, Itanhaém, Mongaguá, Peruíbe, Praia Grande, Santos, and São Vicente.

Figure 48

Aerial visual of Cubatão. Source: Google Earth.

hinder the dispersion of pollutants and the renewal of the local atmosphere. This issue is especially troublesome during the dry winter season because of *thermal inversions* (a process through which the cold air remains trapped below a layer of warm air, preventing the rise and dispersal of pollutants from the lower layers into the atmosphere).

Although the geographical conditions of Cubatão seemed rather unsuitable for its urban and industrial development, the town always had an alluring particularity: its location. Cubatão sits 15km from Santos in the seacoast and 57 km from the plateau where the city of São Paulo is located. Since the sixteenth century the area was considered economically strategic for both the distribution of final products to São Paulo and the reception of raw materials from Santos (Peralta, 1979). Years later, its privileged location would determine its industrial development.

After the Second World War, Brazil entered an era of national developmentalism, in which successive governments strove to make the state an engine of growth supporting national autonomy (Kathryn Hochstetler & Keck,

2007). In the pursuit of rapid industrialization, President Getúlio Vargas created the state-owned oil company Petrobrás and in 1954 the government installed the Presidente Bernardes oil refinery in Cubatão. The settlement of the huge oil refinery of Petrobrás in the area represented the first phase of Cubatão's industrialization process and was the development core of this future petrochemical center (CETESB, 1983).

It is worth noting that, at that time, Cubatão was not only an attractive area due to its location. The town also had many other advantages in the eyes of the industrial sector, such as: the large supply of electricity (due to the construction of the hydropower plant of Henry Borden in 1926), the existence of major transport infrastructure (Anchieta-Imigrantes road complex and railways), a large amount of available land; and an ample supply of clean water (Couto, 2003). These particularities together with the establishment of Petrobras' oil refinery, attracted many industries to the area. Four large capital-intensive industries stand out: Union Carbide, Brazilian Company of Styrene, Alba (titanium, aluminum and zirconium castings) and Copebrás (phosphate fertilizers).

The consolidation of Cubatão as an Industrial Park would come in the 1960s and 1970s, with the establishment of the large state-owned steel company Paulista Steel Company (COSIPA, Companhia Siderúrgica Paulista) and the subsequent arrival of fertilizer and chlorine industries, as well as other companies that would supply materials and inputs. It is worth highlighting that the majority of the industries at that time were either owned by the Brazilian government or by international capital. Private national capital had a relatively small role in Cubatão's consolidation as an industrial pole (Couto, 2003).

By the 1980s, Cubatão was the home of 23 large industries in the sector of oil processing, refinery, chemicals, and fertilizers, as well as many other secondary industries. In the same decade, this town of only 80,000 inhabitants had one of the highest per capita incomes in Brazil and became responsible for 2.6% of the country's GDP (Kucinski, 1982).

b) Risk and vulnerability assessment

Cubatão's industrialization and economic growth were not, however, accompanied by social and environmental protection measures. In

the 1980s, the town, which ranked sixth in terms of tax collection in the country, lacked basic services for its inhabitants. At that time, 35% of Cubatão's population lived in slums, only 25% of the town's housing units were supplied with clean water, and 20% with sewage services. Close to 80% of the workers of the industrial complex lived below subsistence levels (Gutberlet, 1996). The conditions were so alarming that out of the town's 55,000 workers, only one-third lived in the city (Hodge, 1980). Anyone who could afford to live elsewhere would, including Cubatão's mayor at the time, whose home was in Santos.

Social issues deepened with the intense migratory movements that started in the 1950's. Immigrants, especially from the Northeast region of Brazil, flooded Cubatão in search for jobs in the construction and the expansion of new industries (Figure 49). However, after the construction period ended, many of these immigrants became unemployed, as the new industries required only a small number of workers and a skilled labor force (Ferreira, 2007). The workers that managed to remain at the industries, on the other hand, were not well paid since the Brazilian industrialization model favored a policy of low wages (Lemos, 1998). In this context, low-income population, without available affordable lands to settle, formed squatter settlements (favelas). The favelas were not only characterized by the lack of basic services such as water and sanitation, but also by hazard-prone conditions, since they were located around highways, railways, marshes, and steep hill slopes. Some even settled on top of urban waste dumps and oil pipelines (Lemos, 1998).

The industrial expansion in Cubatão not only affected its population but also its environment. In the early 1980s, the town's atmosphere was being bombarded daily with 7,000 tones of 75 different types of pollutants, including sulfur dioxide and trioxide, benzene, and heavy metals like mercury and cadmium (Ciencia Hoje, 1982). The detrimental effects of these hazardous air pollutants were worsened due to Cubatão's topography and climate, which lead to the accumulation of polluted air masses between the town and the coastal mountain range. The polluted air trapped above Cubatão often resulted in thermal inversions that damaged the region's vegetation. Pollutants would precipitate over the mountains as acid rain, affecting the tropical vegetation. Ultimately, without plants'

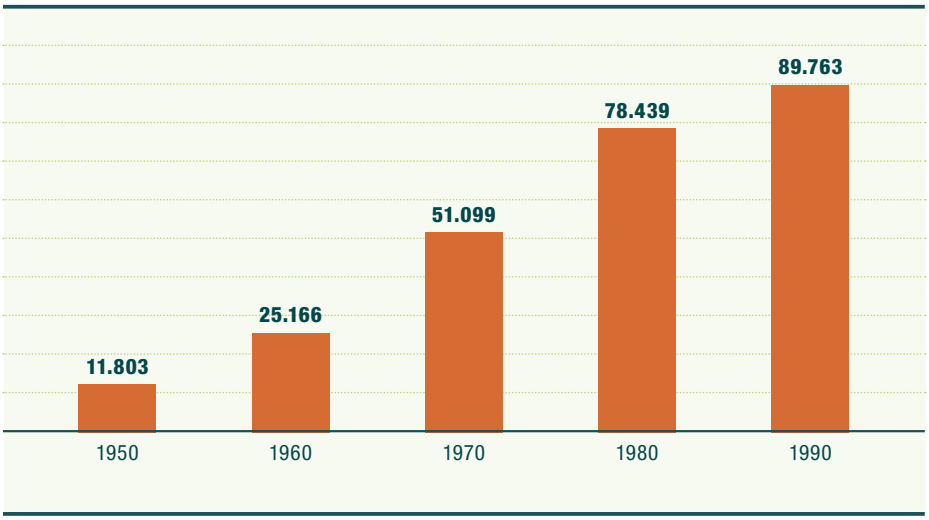

Figure 49

Population growth in Cubatão. Source: SEADE (2017).

roots soil cohesion was compromised (Ab'Sáber, 1982). The loose earth on the slopes, in its turn, increased the likelihood of landslides and, thus, the risk of communities that lived on the hill slopes. It also produced sediments that accumulated in the bed of the rivers prompting hydrological disorders, such as siltation and water overflows (CETESB, 1981).

The industrial pollution also contaminated the region's soil and underground water, harmed animal species, and damaged the vegetation on the coastal mountain range and along the rivers that crossed the region. With this disturbing environment, respiratory problems, skin disorders, and hematological and cardiovascular diseases were frequent. The environmental chaos of Cubatão was encapsulated by its titles: "the Valley of Death" and "the most polluted place on earth."[23]

An emblematic case that symbolized Cubatão's issues was Vila Parisi. The community of over 15,000 people (mainly industry workers and their families) was surrounded by three large industries, including the huge Paulista

[23] The nickname "The Valley of Death "was given by Randau Marques on a series of articles written and published in *Jornal da Tarde*, the third largest circulation newspaper in Sao Paulo at the time.

Figure 50

Industries in Cubatão during the 1970's and the impact of the air pollution on the vegetation of Cubatão's mountains. Source: CIESP (2008).

Steel Company. The neighborhood, the most polluted of Cubatão, suffered with constant emissions of 42,377.6 particulates per cubic foot, more than twice what the World Health Organization (WHO) says produces "excess mortality" after 24 hours of exposure (Hodge, 1980). Environmental issues were aggravated by social vulnerabilities. The basic infrastructure in the community was very poor, there were virtually no social services and the population was not aware of how troublesome their living conditions were. As Zumbi, the current Social Assistance Secretary and former resident of the neighborhood, described: "we would think that the smell and the dust were normal" (2017). Zumbi described that residents could not hang white clothes on the clothesline because of the dust and that during the nights, pollution would become even worse since the industries would take advantage of the dark to release heavy particulate matters, nitrogen and sulfur dioxide, through their chimneys. Vila Parisi's conditions were so alarming that industries and Federal Authorities proposed moving its inhabitants to a less noxious place in the city. The relocation, which began in 1986, was a means to expand the industrial area and according to representatives of the industry and government "a way to solve the pollution problem" (Lemos, 1998).

Figure 51

Vila Parisi in the 1970s. Source: Municipality of Cubatão.

It is worth highlighting that, at that time, local, state, and federal authorities would ignore any environmental and social consideration in order to promote the so-called "economic miracle" (Ferreira, 1993). This logic was particularly true during the years of dictatorship (1964-1985), when Cubatão was designated "Area of National Security Interest" (*Área de Interesse para a Segurança Nacional*), implying that the town's mayor would be appointed by the governor with the approval of the President and that any economic activity developed in Cubatão was also of national security's interest. From 1969 to 1986 Cubatão remained politically subordinated and for most of these years the appointed mayors would come from other cities or states, having no real commitment to local development (*Novo Milênio*, 2000). For a long period of time, official bodies simply denied that health statistics were anomalous, arguing that infant mortality and malnutrition were as likely due to other diseases rather than pollution-related (Kathryn Hochstetler & Keck, 2007).

c) The turning-point

In the 1980s, Cubatão's situation was critical. However, its problems would only start to receive attention after the media covered two polemic cases. The first one concerns the media's condemning of public health conditions in Cubatão. In the early 1980s, national and international newspapers, radio and TV stations reported the greatly accelerated rates

of stillbirths and fetuses with deformities in the city. From 1979 to 1982, Cubatão recorded 18 births of anencephalic children, but experts assure the numbers were probably much higher (Acayaba & Reis, 2008). The alarming data shocked the country and the world, finally drawing the attention of public authorities to these problems.

A second case that was decisive in attracting public action was the accident at Vila Socó. In early 1984, a broken pipeline at the Petrobras refinery caused a fire that wiped out almost entirely the Vila Socó neighborhood. According to the official numbers the tragedy killed 93 people and left another 3,000 homeless. However, some estimates ran well into the hundreds, as the fire was strong enough to incinerate whole bodies (Siqueira, 2004). This tragedy marked a turning point in Cubatão's history. From that moment on, industrialists lost their ability to set the terms of debate and had no alternative but to find a solution to the risks they had created (Kathryn Hochstetler and Keck, 2007).

In parallel to the media exposure of these cases, grassroots organizations emerged, calling for stronger actions against the industries and highlighting the connection between social economic vulnerabilities and pollution hazards (Ferreira, 2007). The first and perhaps the most powerful of these community-based organizations was the Association of the Victims of Pollution and Bad Living Conditions (AVPM) of Cubatão. AVPM was formed by parents of children with birth defects and Vila Parisi residents resisting the relocation of their neighborhood (Lemos, 1998). Its creation was highly supported by progressive members of the Catholic Church, academics, the scientific society, environmental groups, and other critics of Cubatão's growth model. As Lemos describes, by calling attention to the social consequences of environmental degradation, the AVPM placed pollution control in the public agenda and paved the way for the implementation of a pollution control program.

It is worth highlighting the role of local grassroots leaders and scientists on influencing the agenda building. Grassroots leaders, such as Romeu Magalhães and Dojival Vieira dos Santos (names frequently cited in the interviews), even though belonging to opposing political parties, worked with the communities to gather information and denounce pollution-related cases of children with deformities. At the same time, the scientific

community, represented by the Brazilian Society for the Advancement of Science (SBPC) played an important role in publicizing the story of Cubatão and supporting civil society's claims. As Hochstetler and Keck argue: "In a discussion in which the portrayal of issues as highly technical had made it easier to exclude dissenting voices, the scientists lent the unquestioned legitimacy of their credentials to the Association" (2007:195).

Another decisive actor, who helped shaped the responses to these developments in Cubatão, was Governor Franco Montoro, elected in 1982. These elections were the first ones in which governors were elected directly since 1965. Montoro, a member of the Brazilian Democratic Movement Party (PMDB), made the environmental cleanup of Cubatão a priority and stood against the military project of boundless economic growth without environmental concerns. Montoro appointed Werner Zulauf to the presidency of the State's environmental agency (CETESB). He was a former director of the agency that previously worked for COSIPA. Zulauf's appointment was an important move, since he was a negotiator that both industries and the municipality in Cubatão would accept (Kathryn Hochstetler & Keck, 2007). In this context, by the beginning of the 1980s, the implementation of a pollution control strategy for Cubatão was only a matter of time. After all, the problem was critical and proposals to address it already existed and were implemented abroad. The election of Governor Franco Montoro marked a moment when there was finally enough political will to place a risk management proposal for Cubatão higher up on the policy agenda.[24]

II. URBAN RESILIENCE PRACTICES

In Brazil, the federal government establishes a minimum level of compliance regarding environmental regulations and standards. Then, states have

[24] Kingdon describes that in order for an idea to move higher up on the policy agenda three processes are needed: problems, proposals, and politics (Kingdon, 1995).

the option of making the regulations more stringent, and municipalities have further leeway still. In this context, CETESB, the State's environmental agency, was the first state agency in Brazil to strengthen environmental regulations in Brazil, setting forth for the first time standards that reflected the actual costs of pollution (Shaman, 1996).

In 1983 CETESB began the implementation of the Cubatão Pollution Control Program (CPCP), a program constituted by three interdependent projects: the Stationary Sources of Pollution Control Project (SSPC), the Technical Support to Control Actions Project (TSCA), and the Community Participation and Environmental Education Project (CPEE).

a) The Stationary Sources of Pollution Control Project

The SSPC Project was the main element of the whole Program and it was essentially based on a command-and-control approach (Rei & Ribeiro, 2014). Through this regulatory approach São Paulo's State Government "commanded" pollution reductions (by setting environmental standards) and "controlled" how these reductions should be achieved by Cubatão's industries (through the implementation of specific technologies for pollution-control).

The SSPC started doing a survey of pollution sources in Cubatão and an analysis of these sources in regard to the amount and type of pollutants emitted. Later, CETESB engineers defined which sources should be prioritized, taking into account the pollutant and a control strategy compliant with the environmental legislation. By 1983 the agency's technicians had identified 320 prioritized pollution sources in 110 industrial plants belonging to 23 industries (Table 3). In 1984, all the industries of the area were fined by CETESB.

Next, CETESB requested a pollution control plan from each industry. The industries' pollution control plan had to set reduction targets for all the polluting sources identified by the agency. The plans were required to follow four guidelines: i) adopt the best technology available, ii) comply with the pollution standards and regulations set by CETESB, iii) follow a specific implementation schedule; and (iv) identify the funding sources needed to pay for the cost of the new systems and technologies (Ferreira, 2007).

Pollution	Number of sources identified and fined
Air	230
Water	44
Soil	46
TOTAL	**320**

Table 3

Number and type of pollution sources identified and fined in 1985. Source: CETESB, 1990.

An important element of the industries' pollution control plan was its flexibility. Polluters were allowed to discuss with CETESB the technologies, implementation schedule, and feasibility of their own plans (Campos, 2018). This allowed each plan to be tailored to different conditions, making the adoption process smoother for both parties.

Despite their flexibility, the plans presented challenges related to their implementation. One of the difficulties was the actual implementation of the new technologies mandated by CETESB. During the mid-1980's, filters and other pollution-control technologies were not easily available in Brazil and their import cost was extremely high. Industries argued that "the best technology available" was insufficient to reach the standards and regulations imposed by the Agency.

In order to settle this issue, the state government created a credit line named PROCOP that provided subsidized resources from the World Bank and from São Paulo's State Government. PROCOP provided funding to import the equipment required to comply with CETESB's standards. The World Bank loan to PROCOP amounted to US$34 million (Kathryn Hochstetler and Keck, 2007). Nevertheless, the bulk of the funding came from the industry itself. According to the Center of Industries of the State of São Paulo (CIESP), from 1983 until 2015 the industries spent US$3 billion dollars of investments in the environmental management control systems required by the program (CIDE, 2015).

Another challenge for the implementation of the pollution control plans was the lack of technical capacity of the industry's staff. As pointed out by many interviewees, at that time, companies did not have an environmental

department, and hiring environmental consultants was neither easy nor cheap. In this sense, employees from the production and operation departments (and in more critical cases Directors) were responsible for developing and negotiating the industries' plans, but they required close supervision from CETESB engineers. CETESB engineers were the most qualified professionals and maybe the only ones available in the market to provide guidance and recommendations on environmental issues. Thus, they were ultimately responsible for guiding the whole process from designing the plan all the way to its actual implementation. After providing technical support to the elaboration of the plan of each industry, the agency's technicians were responsible for analyzing and approving the plans and monitoring the installation of pollution control equipment. Through periodic visits to the industrial plants, and fining noncompliant industries, CETESB managed to push the industries to comply with the plans that the industry itself had agreed on following.

It is worth remembering that pollution standards and regulations were not part of the industries' concerns at that time. It was only in 1976, with the approval of the State Law 997, that CETESB was given the authority to sanction polluters who did not comply with the environmental standards. However, environmental licensing for industries functioning before 1976 was inexistent.[25] Thus, it was only through the implementation of the SSPC Project in 1983 that all the plants of the industrial pole began taking actions to comply with environmental regulations.

Finally, the SSPC project also prevented the establishment of new pollution sources and the expansion of older ones. The project also established a citizen service hotline to register complaints about pollution levels. Through this hotline, the frequency, the origin, and the type of pollution source would be registered by CETESB staff, which would then be communicated to technicians. Depending on the frequency of the complaint, CETESB technicians would intervene by going to the communities, doing surveys to assess the extent of the problem, and eventually fining those responsible (CETESB, 1985).

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[25] In 1978 only 15 plants of Cubatão had some sort of pollution monitoring and only one had pollution-control technologies (World Bank 2006).

b) The Technical Support to Control Actions Project

The second project of the Cubatão Pollution Control Program was the Technical Support to Control Actions (TSCA) Project, designed to provide technical support to the SSPC. Through studies, research projects, and data analysis the TSCA would reorient or adjust SSPC's actions. For example, studies included those conducted on toxicity and epidemiological assessment of the effects of pollution in public health; detailed inventory of sources of pollution in Cubatão; and adequate final disposal of solid waste. CETESB technical staff conducted most of these studies and some of them were done through cooperation agreements with other institutions, such as the São Paulo State University (UNESP) or the Federation of Industries of the Sate of São Paulo (FIESP).

c) The Community Participation and Environmental Education Project

The third part of the Program was the Community Participation and Environmental Education Project. The CPEE was established to inform Cubatão's residents about the environmental issues faced, empowering individuals so they could participate in the decision-making process and contribute effectively to the program design. This aspect of the program emerged because CETESB realized that in order to produce social benefits they would have to go beyond technical solutions and guarantee a permanent engagement of the community along the process (Lemos, 1998).

In July 1983 CETESB started reaching out to local leaders in order to identify the problems from their point of view. CPEE's objective was not to organize the population but to approach already mobilized groups (Lemos, 1998). The agency concentrated its efforts among the following organizations: Church, Neighborhood Associations, and Unions (CETESB, 1985).[26]

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[26] It is worth noting that, at that time, CETESB also tried to bring together the municipal school system, since it was considered a key player for the effectiveness and sustainability of the Program. However, the Municipal Secretary of Education clarified that it could not participate on the program due to political issues. The Municipality was associated with the PSD Party, while CETESB, a State agency, was aligned with the PSDB Party. CETESB also tried to reach out to the City Council through meetings and working groups. However, the few council members that showed up during these meetings "clearly demonstrated that

Through continued planned meetings with these groups CETESB would receive proposals on how community engagement could be enhanced, how information on the program results and initiatives should be disseminated, as well as suggestions on how the SSPC Project could be improved. Besides community meetings, CETESB engaged in the preparation of educational brochures explaining Cubatão's environmental problems and the actions taken to solve them, as well as in the organization of periodic public meetings at the City Hall or City Council, where CETESB and the industries informed the community about the progress of the Program (Lemos, 1998).

What distinguished CPEEP's approach from traditional models of public participation was that the program not only established specific points of participation. Beyond that, CETESB's social workers actively pursued public participation by going to the communities themselves (Lemos, 1998). In other words, the program was not only based on spontaneous complaints coming from public meetings or from the free citizen service hotline, but it was also grounded in an active search for public participation. In a dictatorship period marked by lack of transparency and public accountability, it was the community, and not only the regulations imposed by technicians, that urged the industry into compliance. The engagement and support of civil society provided the political clout that was needed to make industries follow the new standards. Thus, public participation was a critical element to the program's success.

d) General reactions to the Program

As previously mentioned, in Brazil municipalities have the option of making federal and state regulations and standards more stringent, but the federal and state-level mandates must serve as a minimum level of compliance for municipalities. However, cities have other objectives that compete with federal and state dispositions. Cubatão's situation was no different. The economic crisis Brazil during the 1980's and that extended until the 1990's, had serious consequences for the city. Thus, the municipality faced a tradeoff: either to keep the industries and maintain their tax revenue, or to make

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the local government officials were not motivated to partner with CETESB on its Community Participation and Environmental Education Project." (CETESB, 1985).

environmental regulations more stringent and risk losing them (Campos, 2018).[27] In this context, the city government did little to strengthen environmental regulations beyond what was being implemented by the State through CETESB and by the Federal Government. While the Municipality provided all the space needed for the implementation of CETESB's initiatives, the city government make little effort to further integrate the Pollution Control Program into a comprehensive urban planning and development strategy.

As recalled by many interviewees, the city would create a Municipal Environmental Agency only in 1992, leaving environmental and risk management in charge of the State government. At the same time, until 1998 the municipal zoning would remain unchanged: the left bank of Cubatão's river was an industrial zone and the right bank, the urban area (Campos, 2018). It was only in 1998 that a new zoning legislation limited the industrial area and included open space reserves, encouraging the preservation and restoration of urban green areas. Also, as Marcos Campos recalled, the municipality itself was punished by CETESB during the first phases of the Pollution Control Program for maintaining a dumping ground near a residential area. In this context, one can say that the Municipality was not a protagonist of Cubatão's pollution control strategy. The fear of losing industries, their jobs, and their tax revenue turned city authorities into bystanders of Cubatão's environmental cleanup.

The State-level government and the Cubatão's citizens were the main agents responsible for developing and implementing a successful risk management strategy. The State's Pollution Control Program went beyond a command-and-control project, introducing innovations related to community engagement. Traditionally, command-and-control programs involve the direct regulation of industries by enforcing legal emission standards and establishing punitive sanctions for non-complying industries (Rei & Ribeiro, 2014). Merging this traditional CETESB's model with an innovative approach to community engagement produced outstanding results. As Hochstetler and Keck suggest (2007), the mix of technical and community-

[27] In 1986 Cubatão had 44.311 formal jobs; by the 2000s the municipality had 21.286 formal jobs, a 52% loss. (World Bank 2006)

based programs was an innovation at CETESB, in Brazil, and unusual even worldwide at that point in time. The community participation was a fundamental component of the agency's implementation plan, especially because the civil society became a watchdog of the program and its support was critical to the agency's ability to push the industries into compliance with the new requirements (Lemos, 1998).

III. CITY-SPECIFIC RESULTS

The success of the Cubatão Pollution Control Program was indisputable. By 1987 the emissions of particulate matter had dropped by 87%, hydrocarbon emissions by 74%, sulfur dioxide emissions by 38% and nitrogen dioxide emissions by 16% (see Graph below). By 1994, 290 of the 320 prioritized pollution sources were controlled (CETESB, 1994). In 1992, at the United Nations Conference on Environment and Development in Rio, recognized Cubatão as an ecology symbol and a successful example of effective pollution control.

As Figure 52 illustrates, from 1987 to 1996 emissions of all four major pollutants (particulate matter, hydrocarbon, sulfur dioxide, and nitrogen dioxide) remained relatively stable. In 1997 there was a considerable increase of the emissions of particulate matter and sulfur dioxide, primarily a result of a rise in the total number of industries monitored by CETESB.[28] The emissions of particute matter dropped sharply in 2002, while the sulfur dioxide emissions showed a smoother decrease over the years. Ever since the year 2008, the emissions of the four major pollutants have remained relatively stable. It is worth highlighting that in 2016 there was a considerable decrease in the total estimated emissions. This was mainly a result of closure of USIMINAS (formerly named COSIPA), one of the largest companies of the industrial park.

[28] In 1996 CETESB closely monitored 18 industrial plants, this number increased to 21 in 1997 and to 22 in 1998.

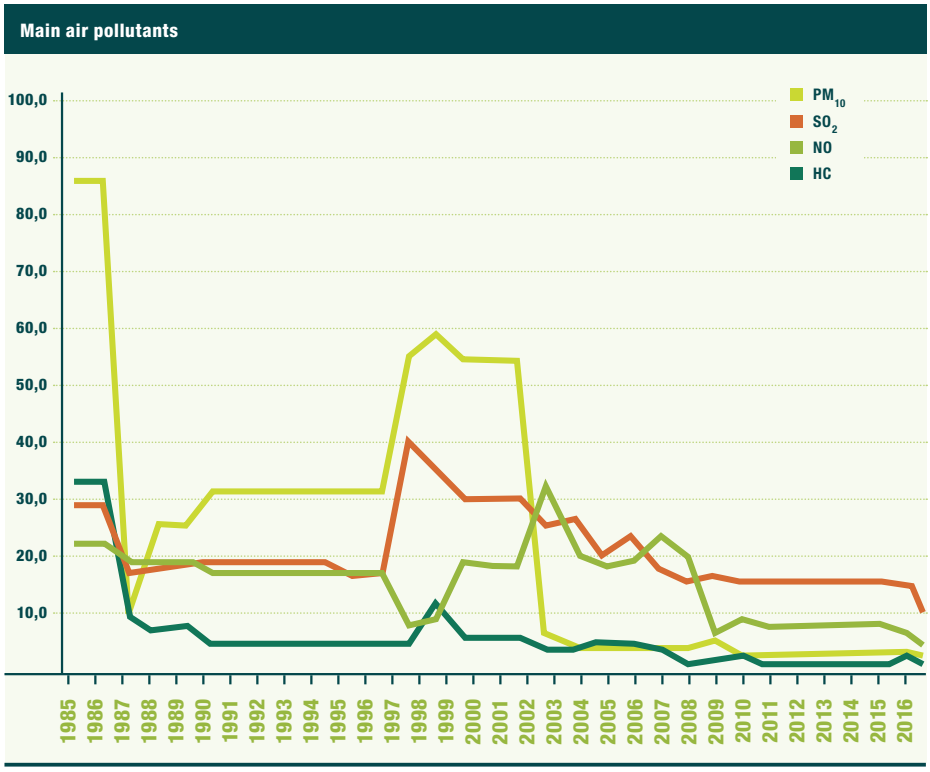

Figure 52

Estimate of air pollution emissions for major pollutants (1000 tons/year). Source: CETESB (2016-1985).

Note: It is worth mentioning that these emissions are derived from the stationary sources of pollution identified by CETESB at the industrial plants and not the total amount of contamination of Cubatão's atmosphere.

The good results of this program also helped improve the water quality of some of Cubatão's rivers and waterways. This in turn helped with the restoration of the vegetation on the coastal mountain range and the return of the Guará-vermelho, a bird typical of the region. More importantly, there were no new records of anencephaly in the city. It is worth highlighting that all these improvements were accompanied by a steady growth in the economic output of Cubatão. According to the CIESP, from 1997 to 2008 the production in the industrial park rose by 39%, while the emissions of the same time period kept decreasing (CIESP, 2008).

a) The Cubatão Pollution Control Program and its positive developments

In 1989, after the end of the period established to control the stationary pollution sources, CETESB began a second phase of the Pollution Control

Program. The new phase was aimed at curbing secondary sources of pollution and fugitive emissions,[29] it also intended more punitive fines to non-complying industries,[30] as well as the monitoring and the inspection of the equipment and processes set during the first phase of the program (CETESB, 1985).

The continuity of the Pollution Control Program had other positive developments. In 2002, São Paulo's State government published the Decree 47,400 of 2002, establishing expiration dates for each type of environmental permit and setting the conditions for permit renewal. According to Marcos Cipriano, the manager of CETESB's field office in Cubatão, the Decree forced industries to renew their operating permit every two years. This became a great preventive tool for CETESB, since it could continually encourage improvements in companies (2017). Then, in 2013 industries started to adopt additional measures in response to the Emission Reduction Plan for Stationary Sources, a new plan lead by the agency in response to the new air quality standards established by the State Decree 59,133 of 2013 (CIDE, 2015).

In sum, from 1989 onwards, during the second phase of the Pollution Control Program, the CETESB engaged in new environmental regulatory actions that were followed through by the industries. However, as the next paragraphs describe, these actions seem to have addressed only the low-hanging fruit, since Cubatão's problems continue.

b) Emissions' reduction versus air quality

Although nowadays 100% of the identified pollution sources are under control, air quality in Cubatão is still inadequate. More than 20 years after the Cubatão Pollution Control Program started, the average annual concentration of particulate matter in the city remains considerably above WHO's Air Quality Guidelines (AQG). In fact, Cubatão's levels of particulate

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29 Secondary pollution sources are not industrial sources but, together, may cause environmental quality changes. Fugitive emissions are industrial emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases.

30 Out of the 320 pollution sources, 34 industries were still not in compliance with the new regulations.

matter are "associated with about a 15% higher long-term mortality risk relative to the AQG level." (WHO, 2006).[31]

CETESB often asserts that the high concentrations of air pollutants in Cubatão are observed almost exclusively in the industrial area (Vila Parisi), and not in the city center where the concentration levels of most of the pollutants are similar to those observed in some neighborhoods in the metropolitan area of São Paulo (CETESB, 2016-1985). However, a closer look to the annual PM_{10} concentration at the Cubatão's center reveals that even though they are much better than the level at the industrial area, they are still above WHO's AQG (Figure 53). At best, the concentration levels of pollutants at the center of Cubatão remind us how inadequate is the air quality observed in some neighborhoods of São Paulo.

Finally, it is worth highlighting that the high air pollution levels in Cubatão have disparate and cumulative impacts. Pollution effects fall disproportionately on poor individuals and minorities who work in the industrial area or that live in the poorest peripheral neighborhoods, where pollutant concentrations are higher. Besides, air pollution levels also have accumulated impacts. As Professor Paulo César Naoum, a biomedical scientist and retired professor of São Paulo State University (UNESP), described: "People in Cubatão are chronically ill" (2017). Naoum, who was responsible for proving the connection between the Cubatão's pollution levels and cases of stillbirths as well as babies' deformities, argues that 30 years is a very limited time period to evaluate the complete public health consequences of years of exposure to high levels of contamination. This means that Cubatão inhabitants will feel the impacts of its past for many generations. If pollution levels are still not under adequate control, public health problems will persist.

c) Cubatão's risk management strategy and its challenges

The data showed above reveal that having a pollution control strategy did not guarantee adequate environmental indicators for Cubatão. The paragraphs below briefly describe some of the barriers that compromised

[31] Interim target-1 (IT-1) for PM_{10} = 70 μg/m³ and Air Quality Guideline (AQG) = 20 μg/m³.

Figure 53

Average annual concentration of PM_{10} and WHO standards (µg/m³). Source: CETESB (2016-1985).

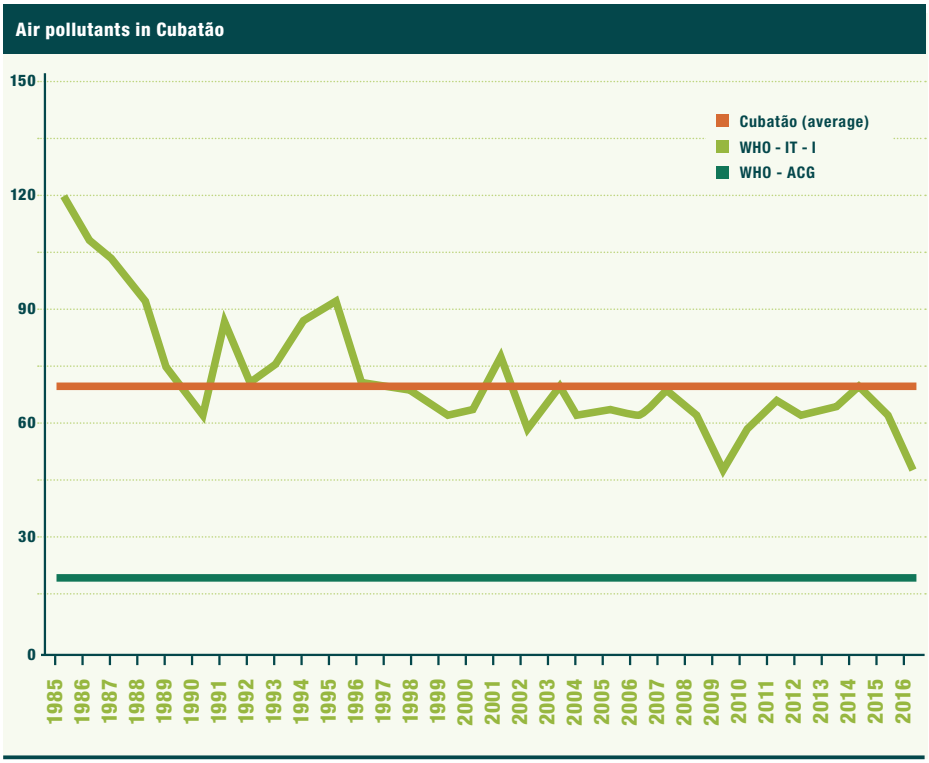
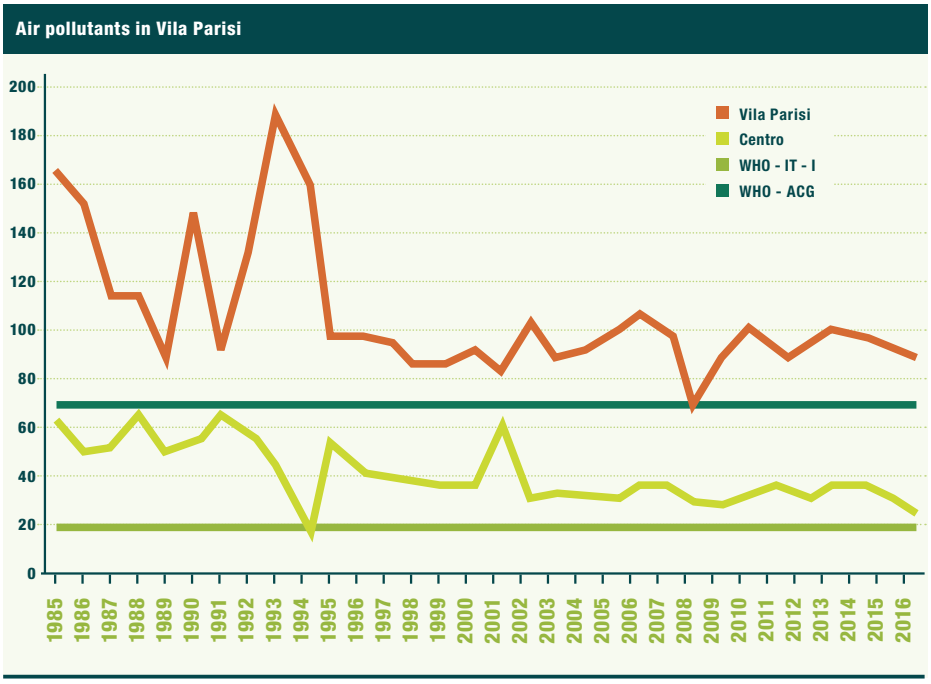


Figure 54

PM_{10} Annual Concentration levels and WHO Standards (µg/m³). Source: CETESB (2016-1985).



Cubatão's risk management strategy and prevented the city from achieving better outcomes.

· COMMUNITY PARTICIPATION CEASED

The transition to the second phase of the Pollution Control Program in 1989, brought some detrimental changes to Cubatão's pollution control strategy. The conclusion of the first phase of the Program coincided with the beginning of a new administration in the State and in CETESB. The Agency's new executives terminated the Community Participation and Environmental Education Project, transferring most of its personnel to different sectors of CETESB or to the State Environmental Secretariat (Lemos, 1998).

While the State is largely to blame for weakening community engagement, other factors also played a role. After the Pollution Control Program's goals were accomplished, community leadership dispersed, and civil society organizations ceased to operate. Many interviewees argued that as time passed, Cubatão's population began framing the problem differently. Their main issue became not Cubatão's environmental conditions, but the lack of sanitation, the unemployment, and the poor public health system of their city. It was to be expected that community participation would lose momentum as environmental conditions improved. However, the fact that the community no longer had interlocutors within CETESB, weakened the Program's accountability and discouraged community involvement.

· INSTITUTIONAL SHORTCOMINGS: CETESB OVERBURDEN AND A DISENGAGED MUNICIPAL GOVERNMENT

Another challenge that undermined Cubatão's pollution control strategy refers to CETESB's capacity to perform its core duties. Over the years the responsibilities of CETESB's field office in Cubatão have increased, whereas its personnel reduced. In 2009, after a change in the São Paulo's State legislation, the whole environmental licensing process that used to be executed by CETESB and three other state agencies, was ascribed to CETESB alone.[32]

[32] CETESB started to manage issues not only related to the prevention and control of environmental pollution, but it turned responsible for matters that were previous

At the same time, the Cubatão's field office became responsible for the oversight of another municipality, Bertioga. However, as CETESB's responsibilities increased, personnel decreased. In the beginning of the Program, CETESB had four managers in Cubatão's field office overseeing many technicians. Nowadays it has only half the number of technicians responsible for inspections that it had before. As the current manager of CETESB field office in Cubatão argues, "the demands are always larger than what the staff is able to perform" (Cipriano, 2017).

While the changes described above undermined Cubatão's risk management strategy, the Municipal government offered limited assistance. Despite the fact that in Brazil the enforcement of environmental legislation is under the jurisdiction of the state and federal governments, the involvement of the Cubatão Municipality in the matter was restricted due to the lack of infrastructure, resources, and political will.

The case of the Municipal Environmental Secretariat is a good example. The Secretariat was only created until 1992 and it still does not have an environmental code or an inspection team to monitor all the projects and actions that directly affect natural resources. For instance, the Environmental Secretary, Mauro Nieri, holds two other simultaneous positions in the Municipality, one as Secretary of the Tourism Secretariat and another one in the Sports Secretariat. As Nieri explains "the Environmental Secretariat has a small structure given the demands, especially when one takes into consideration the environmental problems that Cubatão had and still has" (2017). Another common complaint refers to the municipality's lack of infrastructure and personnel. Workers of the Social Assistance Secretariat argue that it is hard to attract people to work in an institution that has not raised public servant's wages over the last 10 years. However, as most of the interviewees asserted, the lack of infrastructure, resources, and political will are not exclusive to Cubatão, it is rather an endemic problem of Brazil, one that undermines the solution of its environmental and social issues in general.

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duties of the State Department of Natural Resources Protection, the Department of Environmental Impact Assessment and the Department of Metropolitan Land Use.

Figure 55

EcoPatio logistic facility. Source: *Indústria Hoje*, 2015, SINDICAM, 2013.

· NEW ECONOMIC ACTIVITIES IN CUBATÃO

Notably, Brazil's exports increased at almost twice the global rate between 2000 and 2010 (World Bank, 2013). But this economic boom was not accompanied by infrastructure investments, such as upgrades in the Santos Port, the biggest container gateway in South America. From the very beginning of the period of economic boom, Cubatão supported the Santos Port operations, creating port related-uses such as parking lots for container trucks and other logistic facilities. Quite representative of this change in Cubatão's approach was the creation of the facility *EcoPatio*, located in the area that once was the Vila Parisi neighborhood.

The new approach in Cubatão brought about new problems. The port related-uses flooded the municipality with thousands of trucks that together with the logistic activities of the already existing industries, generated frequent and massive traffic jams (Figure 55). These activities also contributed to higher concentrations of particulate matter, due to vehicle emissions and to the re-suspension of dust associated vehicular traffic. As CETESB describes:

> The concentration of particulate matter] increases in winter but it is not noticeable because pollution levels remain high even in the hottest months. (CETESB, 2007: 133)

Figure 56

Traffic Jam near one of Cubatão's access. Source: SINDICAM (2013).

> The main concern in Vila Parisi (industrial area) is the high concentrations of particulate matter. […] The levels dropped significantly in the 1980s and 1990s. More recently, the movement of trucks in the vicinity of the air-monitoring facility has led to higher levels than those observed in the late 1990s. (CETESB, 2006: II)

However, since the container patios are not industrial activities, CETESB is not responsible for their regulation and for issuing environmental permits for most of them (Cipriano, 2017). Also, since the trucks were mobile sources of pollution, coming from different parts of the country, monitoring their emission is difficult.[33] In this context, the issues brought by the port-related activities in Cubatão are not accompanied by public actions at the same pace (Cheng, 2015).

More recently, CETESB along with the industries began the implementation of preventive measures to address these recent challenges. As part of the program Operation Winter, industries introduced street sweeping, periodic cleaning campaigns, and daily wetting of access roads from May to October (CIDE, 2015). CETESB also mandated the container trucks' facilities to be paved

[33] Most of Brazilian cities and states either do not have or have a poor system of vehicle inspection.

in order to avoid dust re-suspension. Interestingly, the decision to implement this program also came from the industry. As Valdir Caobianco, CIESP's director, described: "it is very difficult to mobilize the managers of the trucks parking lots to act. However, if they do not do anything, the industry will be the biggest loser, since with higher pollution levels, industries may have to stop activities (….) so we decided to finance this action" (2017).[34]

When the dynamics in Cubatão changed, actions taken to minimize particulate matter emissions were not adopted in a systemic and planned way. Rather, authorities took mainly corrective actions, after the conditions were already extreme. Annually, 3.3 million vehicles are estimated to pass annually through the roads across Cubatão, a fact that cannot be overlooked, even if the industries are still the main air polluting sources (Cheng, 2015).

IV. PRELIMINARY CONCLUSIONS ABOUT THE CUBATÃO CASE

The success of the Pollution Control Program in Cubatão is indisputable. The results show that in less than 10 years 90% of the identified pollution sources were controlled and in less than two years the concentration of particulate matter was reduced by more than a half. The Program was also responsible for of restoring the water quality of some of Cubatão's rivers and waterways, recovering the vegetation on the coastal mountain-range, and reducing the health problems in the city.

Although the Cubatão Pollution Control Program followed a traditional command-and-control approach, community participation was a fundamental component of the CETESB's plan. Civil society support was critical to the Agency's ability to put pressure to the industries, so they would comply with the new requirements and ultimately, achieve the program's goals. The mix of technical and community-based programs was an innovation of CETESB. For Brazil and even worldwide, this was unusual at a moment in time.

[34] The Operation Winter program entailed the temporary interruption of productive processes of the industries, in case of severe particulate matter concentration.

However, although nowadays 100% of the prioritized pollution sources are under control, environmental quality in Cubatão is still inadequate. More than 20 years after the Cubatão Pollution Control Program, the average annual concentration of PM_{10} in the city remains considerably above WHO's guidelines. The poor air quality indicators in the town may be partially attributed to factors such as the change of the economic profile of Cubatão that brought more and different types of pollution sources, the decrease of community involvement after the end of CETESB's Community Participation and Environmental Education Project, as well as the lack of human resources and political will in municipal authorities.

The level hazards in Cubatão will always be high. After all, we are considering a high-polluting industrial complex associated with unfavorable topographic and climatic conditions. Moreover, as the last years have demonstrated, challenges may increase and change over time. New dynamics and risks have emerged in Cubatão since the beginning of the latest phase of CETESB's Pollution Control Program, showing that risk management policies that are built around past threats are unsuitable for new risks.

In 1992 at the United Nations Conference on Environment and Development in Rio, Cubatão was recognized as an ecology symbol and a successful example of its effective implementation pollution control measures. The Cubatão Pollution Control Program has reached its goals in the short term, controlling the prioritized pollution sources and improving environmental quality in the town. However, the program did not foresee a comprehensive strategy of municipal planning and urban development, thus, in the long term, pollution levels were merely kept under acceptable standards, but not adequate ones.

In this context, one can say that a risk management strategy cannot be evaluated merely by its ability to maintain urban functions within acceptable levels. It also needs a forward-looking capacity to adapt over time and respond to new risks. Thus, if Cubatão aims to achieve a sustainable development, it needs to develop the ability to constantly respond to new evolving threats. Unavoidably, for generations, Cubatão's environment and population will feel the impact of its past, but if nothing is done, they will also feel the impact of its present.

8. TRANSVERSAL CONCLUSIONS: GLOBAL PRIORITIES, LOCAL RESPONSES

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The six cities represented in this study show that just as the conditions that create risk and vulnerability vary from city to city, so does the range of risk management strategies available to decision makers. Even among cities that share commonalities in geography and hazards, effective mechanisms for dealing with risk vary. The Andean cities of La Paz, Bolivia and Cuenca, Ecuador, for example, face similar challenges in dealing with urban flooding and landslides, yet have developed a range of different responses. While Cuenca has relied on conserved areas and historical memory of the river's variability, La Paz has utilized institutions at the municipal and neighborhood level to develop intervention strategies that are more technical in nature prioritizing grey infrastructure. Pilar, located in the flatlands of Buenos Aires, has also dealt with flooding in a very different geographic context from the Andean cities, and developed its own set of responses. In order to mitigate the consequences of the periodic flooding of the Luján River, they created the Water Dialogues Program, oriented to renegotiate existing rights of gated communities that altered the original conditions of the land.

Thinking beyond engineers

The responses to risk in these cities emphasize that urban adaptation should not be seen as solely the realm of engineers. Some of the most effective strategies and measures to mitigate disaster in these case studies

required relatively few resources or technical expertise. These case studies have approached disaster risk mitigation as combinations of social, technical, and environmental interventions, and the diversity of strategies represented across these three domains illustrate that there is no one right way to respond to urban disaster risk. In fact, the degree to which these cities have relied on social and environmental responses may come as a surprise, as many North American and European cities, especially during the 20th century, have come to rely heavily on engineering projects, such as dykes and levees, to manage risk while treating the social and environmental aspects as secondary. Santa Fe, for example, is using a social strategy through commemorative activities that shed light on flood related experiences to ensure that past mistakes will not be repeated. Likewise, the example of Cubatão shows that risk management can come down to an issue of political will rather than resources. By the beginning of the 1980s, the enactment of a pollution control strategy for Cubatão was inevitable. The problem had reached a critical level and proposals to address it already existed and were implemented in other cities around the world. The election of Governor Franco Montoro, from the state of São Paulo, marked a moment when there was finally enough political will to place a risk management proposal for Cubatão higher up on the policy agenda. On the other hand, Manizales demonstrates the high impact of simply weeding and cleaning of infrastructure works, when they are also done with a sense of community. In this case, the institutional infrastructure supports the social infrastructure, and the social infrastructure prolongs the life of the physical infrastructure.

Risk management cannot be relegated to a single agency or sector

These cities have also shown that effective risk management cannot be the responsibility of a single agency or sector but involves continued multi-sectorial collaboration. From universities in Cuenca, NGOs in Cubatão, local community groups in Manizales, or government agencies in La Paz, these case studies all show the importance of partnerships in identifying specific vulnerabilities and the sources of risk, and developing comprehensive strategies to address them.

However, such cooperation across agencies and sectors need not always be formal partnerships. For example, Cubatão's risk management strategy

did not entail a formal partnership with the private sector. Without signing any official partnership agreements, CETESB (the state agency) worked closely with the industries in the implementation of their pollution control plans. The agency's technicians were responsible for analyzing these plans, for providing technical support to the companies and monitoring the installation of pollution control equipment. CETESB's objective was not to organize the population but to approach already mobilized groups, such as churches, neighborhood associations and unions. The community participation was a fundamental component of the program, since civil society support was critical to the agency's ability to pressure the industries to comply with the new requirements.

Environmental systems do not start and stop at municipal boundaries

While cities may be able to delineate clear borders, environmental systems do not start and stop at municipal boundaries. Addressing downstream flooding requires an awareness of upstream water management practices and processes, and air pollution in places such as Cubatão is not confined to the immediate area where it's produced. Cooperation with surrounding areas and regions in environmental and resource management is critical to long-term risk management strategies. Likewise, deepening knowledge of the broader ecological system within which cities are situated is a first step towards better understanding, and adapting to, the hazards present, as in Pilar, Argentina, where they are doing an hydrological model to understand the upstream and downstream consequences of flooding.

History matters, but is not enough to confront future challenges

The current state of ecosystems is a product of history. The current environmental situation in cities is the product of long histories of decisions that have resulted in unique geographies, institutions, and cultures, but also trajectories and path dependencies that can be difficult to reorient. La Paz's channelization of waterways in the past has put it in a very different position from Cuenca, where riverbanks have largely remained untouched. Adaptation and risk management strategies require context specificity and an awareness of existing norms and institutions.

But, at the same time, learning from history is not in and of itself sufficient to confront future challenges. New risks, which are likely to become more severe in the future, will require new approaches and novel ways of thinking at the city level. Many of the cities in this study have learned to successfully adapt to specific recurring hazards, such as flooding. The combination of urban expansion and a changing climate are exposing Latin American cities to risks that have historically been seen as minor or inconsequential but whose impacts and frequency are on the rise. In Santa Fe, for example, the city grew westwards toward the river in flood-prone zones, as the land was cheaper and more affordable for low-income households. But, the city did not acknowledge this trend, instead categorizing the development as informal and neglecting them basic infrastructure, such as roads and sanitation, which aggravated the situation. If the growth of the city was more planned, and areas were made affordable for low-income families, this could have been prevented. The families most affected by the flood are of course situated in that part of the city.

Andean cities that in the past have been focused primarily on the threat of flooding are now grappling with an increasing likelihood of drought, and hazards that in the past were seasonal and fairly predictable are becoming more erratic. New risks are also not only the product of environmental changes. In the case of Cubatão, new economic activities brought new problems too. The port-related uses (container trucks parking lots and other logistic facilities) flooded the municipality with thousands of vehicles, which together with the logistic activities of the already existing industries, contributed to even higher particulate matter concentrations. These new issues were not, however, followed by responses from public authorities at the same pace. Since the container patios were not industrial activities, CETESB was not responsible for the issuance of permits for most of them. Also, since the trucks were mobile sources of pollution, coming from different parts of the country, monitoring their emission was difficult. In Manizales, for example, there is an early warning system that helped prevent numerous disaster events for 40 years, however, changes in the intensity of rains are forcing a recalibration of these warning thresholds. Looking forward, Latin American cities will need to look at their own pasts, but also learn from the experiences of other cities to develop imaginative solutions to new threats.

The power of technical knowledge

Perhaps the most important and universally transferrable lesson from these case studies is that cities must learn from each other and share their unique experiences with disaster management. Santa Fe, Argentina, is a city that has historically been affected by floods and heavy rains and is now increasingly recognized internationally for successful risk management policies that can be used as a model for other cities facing similar challenges. Santa Fe's approach to managing risk radically shifted after two heavy floods in 2003 and 2007 paralyzed the city and its citizens. As a result, the city's approach evolved from a single sector response-based approach to an integrative and transversal approach of urban planning that understands disaster as a continuum and that is related to a range of social factors. As a result, the city's exposure to floods has decreased, while social vulnerabilities such as poverty, inequality, and unemployment have improved. Santa Fe's approach to risk management has earned the city numerous accolades, including being awarded "City Role Model" status in 2010 by UNISDR. Santa Fe's knowledge and experience around risk management has been sought out by other cities, such as the city of La Plata in Argentina, Alegrete in Brazil, and Cartago in Colombia. The power of technical knowledge is eloquent in the case of Manizales, where a probabilistic and micro-zoned analysis of urban risk has reduced the cost of the collective insurance policy, and has helped increase—rather than reduce—the potentially buildable areas.

It has been argued that not only is knowledge a powerful determinant of adaptive capacity (the ability to adapt to the current and future effects of climate change), but that framing adaptive capacity in terms of knowledge empowers actors to define adaptation on their own terms (Williams et al., 2015). It is hoped that just as the cities in these case studies are pursuing knowledge exchanges with other cities at various institutional levels, the case studies presented here can be useful for other decision makers and policymakers in cities both in Latin America and elsewhere in planning for safer, more equitable, and prosperous urban futures.

The most expensive option is inaction

While the cost of large-scale interventions in urban disaster management may seem daunting for Latin American cities, the cost of inaction is

higher. In 2017, rainfall in Peru, was more than 10 times that of normal levels, and resulted in widespread flooding that displaced over 150,000 people. That is projected to have reduced annual GDP growth from 3.4% to 2.9% (Colyns, 2017). At the same time, new research is revealing just how high the return on investment for disaster mitigation spending can be. To give an example, a report by the National Institute of Building Sciences (NIBS) estimates that, in the United States, every dollar of government expenditure on hazard mitigation results in six dollars saved in future disaster costs (NIBS, 2018). These case studies show that there is a range of options available to cities to mitigate disaster risk, include social, environmental, and technical strategies. For cities looking to learn from these six case studies, some strategies may be more applicable than others, but one common element is that all six of these cities are taking active steps to identify and deal with hazards that lead to natural disasters. While there may not be one right strategy for disaster mitigation, inaction is certainly the wrong strategy.

9. OPERATIONAL LESSONS: NEW MODES OF SEEING, THINKING, AND ACTING

Having presented the six case studies of effective risk management in Latin American cities, this section offers a toolbox of strategies for operationalizing those lessons for urban practice to manage disaster risks. These strategies are not meant to be universally applicable to all cities, but our hope is that many can be adapted to serve as starting points for decision makers to develop disaster management policies appropriate for local contexts and circumstances.

Ways of seing

LESSON 1. HARNESS TECHNOLOGY FOR RISK ASSESSMENT

Technical and scientific knowledge, in particular probabilistic risk assessment, is an investment in terms of urban development. As the case of Manizales shows, a detailed knowledge of risk not only helps to avoid urban development in high-risk areas, it can also allow urban development in areas where risk can be mitigated. City governments can set high safety standards for specific micro-zones, and if developers agree to meet these standards at their own expense, then more land can become available for development. Likewise, Cuenca's universities are replicating computer risk mapping models used in North America to apply a uniform methodology to better understand the hazards of hillside development in the metropolitan area.

LESSON 2. CONSIDER MULTI-DIMENSIONAL VULNERABILITY AND MULTI-DIMENSIONAL RESPONSES

A city's natural exposure to disaster is significantly amplified through social and constructed vulnerabilities. These layers of vulnerability often overlap and have spatial characteristics that need to be recognized and understood. For example, in Santa Fe, neighborhoods with high social vulnerability—meaning elevated rates of unemployment, poverty, and crime—face much greater exposure to natural disasters. This suggests that urban and territorial planning needs to include risk management, and vice versa, managing risk requires a spatial understanding of all types of vulnerability, including the social and the constructed. Mapping and monitoring such vulnerabilities can create a better understanding of risk and helps identify areas that require particular attention.

In contexts in which risk and vulnerability are socially produced through informal urbanization, adapting the urban ecology *post facto* to support human settlements is key to prevent disasters. Cities must constantly update their risk maps to identify the urban spaces with the highest vulnerability, which in turn should be used as a roadmap to prioritize their interventions. The resilience policy in priority urban spaces can take many forms, ranging from grey infrastructure works, to locating emergency response facilities, to working with the community to make sure they know how to proceed in the case of an emergency, among other strategies. The counter-argument can be made that cities should not invest in informal settlements because, through that action, the city would make them formal. However, resilience policy should go beyond the debate between the formal and the informal and protect all city dwellers regardless of their legal status. In this regard, it is key that risk maps acknowledge informal settlements because it is usually the case that risk and vulnerability are disproportionately distributed among the poorest populations.

LESSON 3. LEVERAGE NETWORKS FOR CROSS-CITY LEARNING

The work of risk management is a field where interaction and cooperation between academia and practice can and must complement each other to develop sustainable solutions. This can be by means of partnerships, by consultation, by employing professional staff, and/or by changing current

curricula in courses on risk management as well as civil and hydraulic engineering. Moreover, city to city networks encourage the exchange of experiences—including mistakes and solutions. Such learning networks can be global, regional, or national. Finally, local reminders of the past help create a conscience for change. Educational programs, excursions, commemorative activities, memorials, or museums can act as such reminders of history.

Ways of thinking

LESSON 4. PLAN FOR UNCERTAINTY

A risk management strategy must be able to adapt itself, shaping its requirements and specifications to different cases, circumstances, and actors. The work of risk management is a field where cooperation and adaptation is key to ensure the feasibility of the strategy and its sustainability over time. For example, in Cubatão, the industries' pollution control plans were notable for their flexibility. Polluters were allowed to discuss the technologies, implementation schedule and feasibility of their own plans with the state agency. This allowed each plan to be tailored to different conditions, ultimately making the adoption process smoother for both parties.

Likewise, moving from fail-safe to safe-to-fail approaches, such as the conserved green buffer zones along the banks of Cuenca's rivers, allows for damages to be minimized when and if flooding extends beyond predicted or expected levels. Another example is the use of golf courses by the gated community of Pilará in Pilar, which absorb some of the flooding of the Luján River.

LESSON 5. THINK OUTSIDE THE BOX

Cities are using creative unconventional strategies for risk management. For example, Manizales shows how voluntary premiums on property taxes can help city governments protect the poorest families in the event of disasters without affecting their budgets. The resources from the surcharge to the property tax paid for by the higher classes pay for the contract between the city government and the insurance company. The insurance company establishes individual policies with all property owners, covering

those whose properties are valued below a predefined threshold. In the case of Manizales, 20% of the richest property holders pay for the collective insurance protecting 45% of the poorest population. This way, the local government can help protect those most vulnerable after a disaster strikes, without any further burden on the municipal budget.

LESSON 6. CONSIDER LARGER ECOLOGICAL ZONES BEYOND MUNICIPAL BOUNDARIES

City managers may have clearly delimited jurisdictions for their administrations, but many sources of environmental risk cannot be dealt with entirely through strategies within city boundaries. Just as environmental problems do not start or stop at political boundaries, solutions must think in terms of larger ecological areas, often involving coordination and partnerships with a range of agencies at the regional and state level. For cities threatened by flooding—the most common hazard across the six case studies—poor land management practices both far upstream and downstream can impact the severity of flood events in the city. Likewise, cities dealing with airborne pollution, such as Cubatão, can suffer from poorly regulated industrial practices upwind from the city. In a dramatic example of the interconnectedness of urban and regional environmental risks, the city of Cuenca was threatened in 1993 by a landslide, La Josefina, 12.4 miles outside the city, but that blocked a river and rapidly created a massive lake that destroyed over a thousand homes and claimed over 100 lives before subsiding just before reaching the borders of the city. In this case, the event led to the passage of new legislation regulating mining in the mountain areas, which was thought to be a cause of the landslide.

Ways of acting

LESSON 7. USE EARLY ALERT SYSTEMS TO SAVE LIVES AND PROPERTY

Early warning systems can save lives and properties if they are well calibrated, if they acknowledge different types of threats, and if people know them well. In La Paz, the city is using risk mapping to identify urban spaces where populations are most at risk, resulting in early alert systems to be deployed throughout the city and continuously monitoring potential

emergency situations. Cities must have emergency protocols known by city officials and the public, which should be activated when the early alert system identifies the likelihood of an emergency. Constant monitoring, early response, and emergency protocols are key to securing the population in the case of an emergency.

LESSON 8. INFRASTRUCTURE IS NOT A ONE-TIME INVESTMENT

Infrastructure is not completed with its construction but requires constant quality control on its operations and maintenance. Thus, neglected infrastructure exacerbates natural risks. Santa Fe's flood in 2007 demonstrates the effects of poor maintenance particularly well, as defective pumping-stations prevented the rainwater from draining, leading to disastrous flooding. However, the case of Manizales shows that the lifespan and performance of physical infrastructure can be extended and improved by complementary social infrastructure. In Manizales' Guardians of the Hillside program the city government hires female heads of households to maintain the infrastructure works, while also helping with urban control, and community awareness.

LESSON 9. ENGAGE ACTORS ACROSS GOVERNMENT AND ALSO OUTSIDE GOVERNMENT

Risk cannot be managed by one agency alone and it should not be a purely response-based approach. Instead, risk management must be integrated in all parts of urban government. From housing to urban planning to education and waste management, all agencies should work together in understanding and managing existing and future risk. As in Santa Fe, weekly risk management meetings with the Mayor and the heads of all departments can encourage dialogue across agencies, demonstrate the urgency of the matter, and help identify collaborative projects.

Cooperation between government agencies and civil society is also crucial. Local authorities need to be proactive in strengthening their engagement with civil society networks. Instead of just providing spontaneous channels of communication between the authorities and civil society, leaders must encourage active participation through other means, such as: meetings between the local government and the community, media events, and public hearings. Risk management initiatives should be of priority

interest to local communities and provide opportunities for citizens to take action to address these local issues. What distinguished Cubatão's risk management approach from traditional models of public participation was that it not only established specific points of participation, but the state's social workers actively pursued public participation by going to the communities themselves. The program was not only based on complaints coming from public meetings or from the free Citizen Service Hotline, but also actively reached out to communities to encourage public participation.

Outreach around risk management may be focused on both formal and informal networks. However, traditional institutions or networks of organized civil society, such as non-governmental organizations, labor leaders, or faith-based organizations, may provide an easier path to engaging with the complaints, interests and needs of civil society. For example, the objective of Cubatão's risk management strategy was not to organize the population but to approach already mobilized groups. The state agency concentrated its efforts among churches, neighborhood associations, and unions. During continued meetings with these groups, the agency received proposals on how community engagement could be enhanced, how information on the program results and initiatives should be disclosed, as well as suggestions on how the risk management strategy could be improved.

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This list does not presume to be exhaustive. Instead, the lessons presented here suggest that a problem cannot be acted upon unless that problem can be seen. This is why we started this list of lessons with those focused on different "ways of seeing". Also, when urban managers face problems that seem to have no solution, this only means that it is time to think about the situation in new way. Policymakers should never forget that there will always be alternative "ways of thinking", some more fertile than others. The cities we study throughout in this book are far from being unique, atypical megacities. Instead, they are cities that represent the average size and capacity of the vast majority of Latin American cities. This is why learning from their "ways of acting", is of particular interest for our region. These are possible, viable, realistic, and effective actions.

10. COMPARATIVE MATRIX OF CASE STUDIES

	CHALLENGES	RESPONSES	LESSONS
PILAR, Argentina	Pilar forms part of the water system of the Luján River Basin. It is one of the cities in the region most exposed to the risk of flooding. In the 1990s it became the metropolitan area preferred by real estate investors for the development of gated communities. It currently houses 210 private developments, 62 of which are directly affected by the flood valley. However, the institutional and regulatory architecture for managing environmental risk is still very weak.	The Secretariat of the Environment of the Municipality of Pilar signed an agreement with the Sub-secretariat of National Water Resources and the National Water Institute to carry out a hydraulic modeling of the river basin. In addition, it created the Water Dialogues program, with the aim of renegotiating the conditions of land occupation and investment in construction works with the private neighborhoods. Finally, Pilar is working on strengthening an early warning system for the evacuation of the affected population in case of floods.	One of the most important lessons is the use of dialogue as a tool for questioning acquired rights, through the development of bonds of trust between the public and private sectors. It remains challenging for those neighborhoods that refuse to participate. In addition, there is a need to include all social sectors in the dialogues, in order to generate bonds of trust with the affected neighbors. Finally, it's important to note the potential advantages of articulating these urban practices with a comprehensive plan for the municipality.
CUENCA, Ecuador	Main hazard: floods and landslides. While the flooding of the four rivers of Cuenca has been the main historical danger, the expansion of the urban area to the surrounding hillsides is increasing the city's exposure to landslides.	Three practices stand out: 1) Historical and social awareness of river variability. 2) Conservation of green space along the river 3) Partnerships to model risk assessment in the surrounding areas.	Past lessons contribute to producing a culture of risk management. Early socioecological practices become preventive measures for flood management. Cultural capital is important to respond to new risks and soft capital may be more durable than hard infrastructure.

	CHALLENGES	RESPONSES	LESSONS
MANIZALES, Colombia	The most frequent events in Manizales are the landslides caused by heavy rains. The most recent high-impact events in Manizales took place in 1993, 2003, and 2017. Data collected since 1956 shows an average of 15 high-impact events per year in the region, data also shows a tendency for annual accumulated precipitation to increase. As rain frequency and intensity increases the level of risk rises.	Three responses stand out: 1) Integration of risk management in the Territorial Development Plan. Manizales adjusted its spatial risk assessment using a probabilistic model which allowed for the calculation of disaster occurrence. This assessment enabled land for "conditional urban development". 2) Voluntary collective insurance (1999-present). Higher-income property owners can buy an insurance to protect their property which cross-subsidizes the insurance for the lower-income population of the city. 3) Guardians of the Hillside (2003-present): Maintenance program for infrastructure works. A group of 100 single mothers, remove garbage and weeds and raise door-to-door awareness.	Manizales has had the means to advance on these issues. In 2009 the city implemented an "environmental surcharge" that represents 1% of the property tax and that annually collects approximately US 8 million, an important amount for a city of less than 400,000 inhabitants. These resources have been effectively invested due to an inter-institutional partnership between the Mayor's Office, the environmental agency, and the national public university.
CUBATÃO, Brasil	Cubatão in the 1980s became the largest petrochemical center in Brazil, accommodating large and highly polluting industries. Industrialization and economic growth were not, however, accompanied by social justice and environmental protection: 80% of the workers of the industrial complex lived below subsistence levels and the town's atmosphere was being daily bombarded by 7,000 tones of 75 different types of pollutants.	The Cubatão Pollution Control Program joint a traditional command-and-control approach to community-based projects. The community engagement project was a fundamental part of the Program, since the civil society support was critical to the CETESB's ability to pressure the industries to comply with the new requirements.	In the short term, the Program was successful since it achieved its goals, managing to control the prioritized pollution sources. However, in the long term, pollution levels were merely kept under acceptable standards, but not adequate ones. In order to sustain a successful risk management strategy over time, Cubatão needs to be able to adapt and respond to new risks and dynamics.

	CHALLENGES	RESPONSES	LESSONS
LA PAZ, Bolivia	The processes of informal urbanization in La Paz favors 'the social construction of vulnerability and risk'. The urban ecology is intervened with informal human settlements that build their own urban infrastructure, which puts the population in a situation of vulnerability to natural disasters. The main threats are "*riadas*" or the spontaneous appearance of water currents through the city's streets. Landslides on the hillsides are also frequent.	After the February 2002 *riada*, La Paz developed an urban resilience policy, integrated by: institutional arrangements by the Municipal Integrated Risk Management Strategy; the Municipal Secretariat for Comprehensive Risk Management; and the True Neighborhoods and Communities Program implemented by the Municipal Secretariat of Infrastructure.	Fundamental aspects of the resilience policy in La Paz include: establishing institutional arrangements that clarify mandates, promoting coordination, and the enablement of resource flows. The answer has mainly been technological-infrastructural, intervening in urban ecology to reduce the population's situation of vulnerability. However, the city still needs to fully face the processes of social production of vulnerability and risk.
SANTA FE, Argentina	Main hazard: floods. The combination of natural, constructed, and social vulnerabilities have increased Santa Fe's risk of flooding and intensified negative impacts.	After the historic floods of 2003 and 2007, Santa Fe radically changed its approach to managing risk. Three practices are particularly relevant: First, the city moved from a single sector to an integrative approach to risk management. Second, it initiated commemorative activities that shed light on flood related experiences to ensure that past mistakes won't be repeated. Third, though collaborative projects with academia, foundations, and NGOs, it created valuable local knowledge and emerged itself into global discussions.	The main lesson that can be learned from Santa Fe is that integrative urban planning as a key instrument to managing risk. Single sector, infrastructure-based works are insufficient and only scratch the surface of multiple layers of vulnerabilities. In addition, successfully managing risk does not equal the creation of a resilient city, particularly in the context of cities where vulnerabilities go beyond environmental hazards. A first step is the recognition and understanding of vulnerabilities and its spatial components, as well as a strong participation of all parts of society.

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CHAPTER 8. TRANSVERSAL CONCLUSIONS

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Facing Risk provides answers to some dilemmas faced by the sustainable development agenda established by the international community. While there is an evident broad consensus, attention, and sense of urgency about what ought to be done, there is not enough clarity, consensus, nor energy devoted to how actions ought to be done to meet these objectives.

In this context, this book presents effective urban resilience practices put in place to address the risks of natural and anthropic disasters in six Latin American cities: Manizales, Colombia; La Paz, Bolivia; Ecuador basin; Santa Fe and Pilar, Argentina; and Cubatão, Brazil.

Frequently, studies on urban environmental risk have focused on coastal megacities. This research demonstrates that populations in mountainous and river regions are also subject to increasingly frequent disasters and have important risk management experiences to share. In the same way, cities of all sizes, not just capitals or megacities, are facing the challenges related to climate change. The cities that are part of this study show a variety of sizes, geographic conditions, and threats. Taken together, these cases reflect on a range of effective urban practices for risk management but offer important common lessons for decision makers.

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PILAR
CUBATÃO
LA PAZ
SANTA FE
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