EMPOWERING CLIMATE RESILIENCE

Co-funded by the
Erasmus+ Programme
of the European Union

Introduction. CARE Project

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CARE project has been funded by the ERASMUS+ Programme of the European Commission. Following the funding programme aims and nature, it promotes the empowerment of Latin American Universities staff's and students' interdisciplinary skills through the development of innovative educational approaches to planning.

Resilience thinking calls for the interaction among different disciplines (spatial planning, environment, engineering, landscape) and for the collaboration with research, policy making and professionals, in order to properly address the call for the integration of climate resilience within policies at different levels.

For this reason, CARE chose to address professionals and administrations by providing flexible and open e-training modules. In doing so, it aims to deliver a contribution to those who daily engage themselves in urban decision making and planning, providing robust conceptual basis on resilience and sharing case studies and experiences.

Going further from the initial objectives, the CARE consortium established a fruitful and balanced exchange among Latin American and Europe Partners, in terms of climate change urban impacts detection, resilience frameworks and planning experiences and practices.

Challengin climate change by collaboration and networking

By focussing on urban resilience, CARE addresses one of the most urgent topics at European as well at Latin American level. Most LA countries are dealing with climate risk management issues, but they currently lack - despite recent efforts - a holistic and wider approach to resilience. A common frame of action based on proper shared knowledge and inclusion of all resilience issues – from the risk management to the social resilience - is

missing. International cooperation seemed then the best-fit environment where to develop joint learning tools, go in depth on peculiar research topics and deliver support to policy makers.

CARE main objective is to develop innovative educational experiences to enhance the knowledge of urban resilience potential to fight against climate change effects. Thus, the project challenges the wide issues tackled by resilience to climate change at urban level by promoting HEI staff's and students' interdisciplinary skills through the development of innovative educational approaches to planning. Furthermore, it aims to bring the challenge within the core of urban municipalities by directly and indirectly (through empowering HEIs curricula) training professionals and officers to shape resilient policies. It will be based on the interaction among different disciplines (spatial planning, environment, engineering, landscape, etc.) and foster collaboration with research, policy making and professionals, in order to properly address the call for the integration of climate resilience within policies at different levels.

Four further aims have been identified within the project, highlighting the role of conceptual mapping, digital sharing of learning tools and networking embody in the urban resilience challenge:

1. To help the modernisation of higher education curricula and enlarging the ongoing training potential for public officers and professionals, by providing Open Educational Resources on climate and urban resilience integrated issues (by integrating them with issues such as climate risk management, social resilience, strategic planning, monitoring and assessment of plans and policies)
2. To enhance the transferring of resilience conceptual issues into operational capabilities in local government, civil society and professional communities.
3. To establish a network among LA, Europe and outside, with the aim of improving their educational capacities in the field of urban and climate resilience, as well as the transferring of project findings to an operational policy perspective at different territorial levels.

The CARE consortium has been built accordingly, involving different categories of partners who can provide significant contributions following their own perspective and specific expertise.

The partnership engaged partners form different areas in the EU zone and in Latin America in order to get a wide range of climate subtypes including Mediterranean, continental and temperate (EU), humid tropical and subtropical (State of Parà, BR, Chile), tropical (State of Sao Paulo, Brazil), semi arid (Chile) climates. In relation to urban environments, the partnership aimed at covering a large variety of context and situations possibly affecting the climate resilience issue, including middle cities, large metropolis (Sao Paulo) and metropolitan regions.

Universities are the main target of the educational tools produced by the project and the main actors in their development. The 13 selected partner universities provided qualified expertise in a wide number of domains (urban and regional planning, environmental

assessment and management, sustainable development, urban policies, land administration, geo-information tools and techniques, and others). They have been selected due to the existence of specific department and courses focusing on climate change and resilient adaptation strategies for urban environments, and have been extremely interested end engaged in developing and sharing their own research and training methods and findings. Most of them are also engaged in institutional networks working on resilience strategies at different territorial levels.

1. CARE mthods and outcomes

CARE methodology foresaw an alternation of desk activities and workshops aimed at the collective production, testing and practical application of open educational materials, namely the CARE Cmaps and the Open Training Modules (OTM). This combination of activities is needed to properly address a demanding issue such as the urban resilience and to operativise it in order to successfully drive and focus policies at different territorial level.

In this sense, several workshops have been organised:A 8-days intensive workshop in Quevedo (UTEQ, Ecuador), aimed at the collective production of CARE Cmap 2.0 and resulting from exchanges among teachers and other experts involved in the project, and a 12-days workshop in Medellin (UNAL, Colombia) for the testing of the CARE Cmap 2.0 through interaction with students and get ting an operational tool to introduce a more professionalizing approach to resilience issues within the academic training.

Open training modules (OTM) for specific targets groups (municipalities staff; experts; post graduate

2. Planning for climate resilience: the use of concept mapping in interdisciplinary learning activities

Planning for climateresilience requires boundary-crossing skills, which can be described as “the ability to change perspectives, to synthesize knowledge of different disciplines, and to cope with complexity” (Spelt et al. 2009). Such ability must be trained for higher education students who are likely to be future researchers, professionals and decision makers in this field.However, boundary-crossing skills are seldom fostered by traditional, domain-specific higher education, where ordinary classroom activities and academic curricula are normally unfit for such purposes (Banchetti et al. 2012).

Therefore, studentsshould be trained, whenever possible, through additional, dedicated activities, where specific support and learning tasks help them in developing interdisciplinary thinking (Spelt et al. 2009).Concept mapping as a learning tool has been positively connected to interdisciplinary learning by various authors (Banchetti et al. 2012; Borrego et al. 2009; Mikser et al. 2008; Sibilla 2017).Starting from these premises, the CARE project brought together two elements intended to promote and achieve interdisciplinarity in teaching and learning, namely: the involvement of teachers and students in intensive, interdisciplinary workshops; and the use of concept mapping as a tool for fostering interdisciplinarity.

A concept map is a graphical tool showing concepts and their relationships, and representing a person’s cognitive structure about a given topic. It is often used as a means to convey meaningful learning, a process in which the learner constructs new knowledge by making active connections to what he/she already knows.Concept mapping is not new in teaching and learning; however, it is not widely known and practiced, and needs to be introduced to – and accepted by –both teachers and students before it can be used at its best. For the CARE project, teachers from the participating Latin American universitieswere trained in concept mapping during a preliminary workshop, held in Ecuador in 2017; they were in turn able to tutor the studentsfrom the same universities in the following workshop, held in Medellín in 2018. For both workshops,building interdisciplinarity and getting to master the use of concept mapping were intended as two parallel, strictly related tasks.

The latter workshop, held in Medellín, was organised as an intensive, 8-day event, and hosted100 students of different academic backgrounds and levels from universities of Brasil, Chile, Colombia, Ecuador, and Uruguay. A main assumption for this workshop was the necessity to bring togetherstudents from different academic fields – as diverse as architecture, spatial planning, environmental engineering and management, geography, and agronomy –and make them collaborate in a path towards understanding the essentials of planning for climate adaptation, based on the use of concept mapping and interdisciplinary group work.

The workshop was organised as a series of concept mapping exercises with a growing degree of complexity, which helped students to break the barriers of their disciplines and learn to collaborate for the sake of climate adaptation. Students were assigned to four, parallel groups of around 25 persons of different academic fields, each tutored by three/four

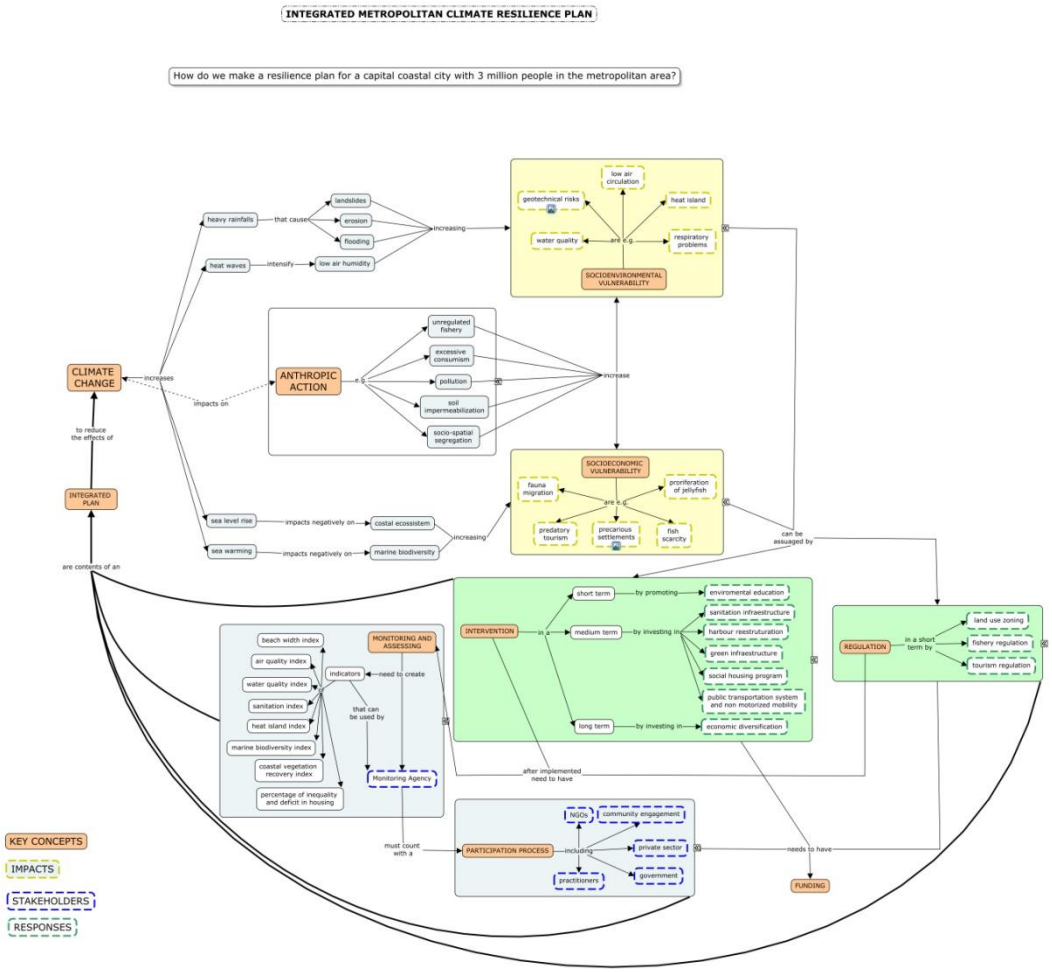
teachers. A coordinator provided tutors with a guide to the general method and the single exercises, intended to even out the process in each group; tutors could apply modifications to the programme, yet preserving the general approach and the most important rules concerning the process of concept mapping. The coordinator acted as supervisor to all groups, making sure that the exercises remained on track despite the modifications applied by tutors. The last, and most important, exercise required students to conceive an adaptation plan applied to a given geographic, economic and social context, and describe it through a concept map.

For this final exercise, students were informed that they would have to present their work in a plenary session on the following day, where a jury would choose the best three. This was intended to ensure additional dedication and commitment, since many learnersdo not immediately grasp the usefulness of concept mapping as a learning tool but rather see it as a useless, additional effort (Daley and Torre 2010). A jury composed of members from the same workshop's teaching staff evaluated the works upon a simple evaluation guide proposed by the supervisor, consisting in a series of qualitative statements to be checked by the jury members during the single presentations, and discussed at the end of the session in order to choose the best three works. Given the constrained time available, we decided to avoid applying complex, time-consuming analytical evaluation methods such as those proposed and tested by many authors (such as Moni and Moni 2008, Prats 2014, Rice et al. 1998, Sibilla 2017, West et al. 2000, Cañas et al. 2013).The outcomes of the final exercise were quite surprising in terms of appropriateness of contents, mastery of the tool, and enthusiasm by the students, despite the initial difficulty shown by manyof them in approaching both concept mapping and interdisciplinarity.

Indeed, although simple, concept mapping can be difficult to apply, depending on each student's reasoning and learning inclinations. However, only the basic rules were explained to students on the first day – mainly concerning syntactic correctness and the importance of "cross links" connecting different parts of the maps.This was intended to ensure that the maps remained as authentic as possible, suitable to reveal the students' reasoning and learning abilities, in compliance with the theoretical premises of concept mapping (Novak and Cañas 2008). On the other hand, little importance was given to the necessity to include a strict reading direction or hierarchy in the maps, as expressed by some authors such as Cañas et al. (2015): planning is a "recursive" activity, and a map describing an adaptation plan is likely to be "circular" rather than "directional". As a matter of fact, the best maps among the ones shown by students in the last day were those demonstrating that their authors understood such recursive characteristic of planning.

The above teaching method, applicable to any subject but particularly fit for practices,such as planning, whichincreasingly need an interdisciplinary, holistic and integrated approach, has been viable thanks to the possibility of bringing together many teachers and students in specially designed intensive workshops, beyond the ordinary academic curricula offered by universities.Concept mapping proved to be a flexible tool capable of supporting group work, interdisciplinary teaching and learning, and the practice of planning; and despite the initial perplexities, by the end of the workshop most teachers and students showed to appreciate its effectiveness.

Image 1 – The final concept map made by one of the students' groups that received a mention.



3.Working on resilience definitions

The term resilience is now widely used in various scientific fields and professions. In this section we briefly examine the origins of the term, and how it has been used in the three fields most relevant to the CARE+ project, namely engineering, ecology and what we might term a socio-ecological systems perspective. We then briefly reflect on how these definitions relate to processes that are connected to the notion of planning for climate change.

The origins of resilience can be found in the Latin term, resilire, a word with a variety of possible meanings such as “to jump back, to retire, withdraw, to recoil, shrink, to bounce back, rebound, to spring back, to return to a smaller size, in post-classical Latin also to go back on, repudiate” (Oxford English Dictionary online). It therefore refers to a quality and can be applied to multiple systems, objects or subjects. In engineering, resilience usually refers to the properties of a material that enable it to return to its previous form without loss of strength after having been exposed to some form of stress or pressure. As such it is an important property to be considered by mechanical or civil engineers who endeavour to design infrastructures or machines thatcan withstand certain pressures or forces and to

return to a prior steady-state without loss of basic performance characteristics. The time taken to return to the previous state becomes a measure of resilience (Davoudi, 2012). The ability to “bounce back” in a given period of time is therefore central to the engineering view of resilience. However appealing the notion of “bouncing back” may be, it does not question the desirability of theprevious statein the light of long-term considerations, such as those associated with climate change. Is it wise to recreate a situation when experience has shown us that it entails significant risk of future losses or damages?

By contrast, ecological resilience looks at (natural or socio-ecological) systems and acknowledges that a system can change to a different state when subjected to external forces. Systems are seen to have a set of states representing different states of equilibria. If a system changes from one state to another, we can speak of a regime change. Holling (1996, p.33) refers to ecological resilience as “the magnitude of the disturbance that can be absorbed before the system changes its structure”. A system is therefore not ‘unresilient’, but resilient to different degrees. Systems may therefore either “bounce back” to a previous state or ”bounce forth” to a new state. In other words, they persist and adapt (Adger, 2003). The concept of adaptation is central to many issues raised by climate change and the role of spatial planning, in its various forms and guises, in realizing adaptations that seek to enhance resilience, also to likely future conditions.

A third view of resilience is termed evolutionary resilience, which is grounded in notions of complexity, uncertainty and the very unpredictability of systems. This view recognises that systems may change of themselves, without the need for a specific external force or shock to trigger change. Such emergent behaviour is typical of a complex systems’ perspective that encompasses non-linear processes and principles of self-organization. Rather than being about returning to a previous “normal” state, it concerns issues of how systems change, adapt, and, transform in relation to internal and external stimuli (Carpenter et al, 2005). However, it also raises new challenges for planning for resilience, whether in relation to climate change or more immediate crises often associated with hazardous events and disasters. It challenges planning to move beyond a short-term focus on emergencies and disaster response, to longer-term issues that may address structural constraints and vulnerabilities in a community or area, and to seek out ways to generate significant transformative changes that may emanate from such an approach.

UNISDR (2009) defines resilience as “The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.” Seen in the light of climate change, this definition encompasses both mitigation and adaptation measures, and implicitly incorporates issues of vulnerability, which are an essential element of understanding how climate change is likely to affect a given community or system. However, the definition is more aligned with the notions of engineering resilience and ecological resilience, rather than the transformation implied by evolutionary resilience.

In contrast the IPCC (Agard et al., 2014) defines resilience as “The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.” In that sense the IPCC definition aligns more with the evolutionary understanding of resilience including incremental, small-scale changes of a system and addressing longer time-scales.

Challenges therefore abound when thinking of long-term climate change and resilience. Our knowledge of the climate system itself is wrought with uncertainties and scaling problems, as global and regional climate scenarios need to be scaled down to the local level in order to become inputs into local spatial planning practices. At the same time, planners must realise that their plans will never be perfect instruments for the guidance of development. Yet, despite the well known failures of master planning (Davidson, 1996; Healey, 1988) in many parts of the world, planning systems are anything but geared up to be flexible, adaptive and transformative. In part, this is due to the slow rate of change in legal frameworks for spatial planning and environmental management. But, it perhaps also reflects a lack of understanding on what a more transformative planning system might entail and how it could be attained. Rather than focussing on blueprint-style master plans, it is increasingly clear that scenario based spatial planning processes that are inclusive and collaborative may provide a more useful basis for responding to future climatic and developmental challenges. Furthermore, it must be recognised that planning and plans for climate change must be aligned with other societal interests if they are to gain ground in practice.

4.CARE project definitions

In the framework of the definitions proposed in the previous paragraph, the CARE Project preliminary worked on sharing a set of definitions to describe climate-related issues. They have been crucial in order to deliver CARE further activities and outputs.

Climate resilience	The ability of a social or ecological system to absorb disturbances deriving from climate-related phenomena, while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (adapted from IPCC 2007).
Climate risk reduction	Action taken to reduce the risk of disasters and the adverse impacts of climate-related natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events (adapted from ISDR 2008 – United Nations).

Climate adaptation	Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects (IPCC 2007).
Climate mitigation	Implementing policies to reduce greenhouse gas emissions and enhance sinks (IPCC 2007).
Climate exposure	The nature and degree to which a system is exposed to significant climatic variations (IPCC 2007).
Climate sensitivity	The degree to which a system is affected, either adversely or beneficially, by climate variability or climate change (IPCC 2007).
Adaptive capacity	The whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures (IPCC 2007).
Climate impacts	Consequences of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential and residual impacts, respectively all impacts that may occur given a projected change in climate without considering adaptation, and those that would occur after adaptation (IPCC 2007).
Climate vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC 2007).

Please remember that the following relations among some of the above concepts are the most frequent in literature:

Equatioin 1$Impact \ = Exposure * Sensitiviy$

Equatioin 2$Vulnerability = Impact * Adaptive\ Capacity$

The mentioned concepts relations could also be considered, as developed in the EU Commission FP7 funded project “ENSURE” 2008-2011.

Equatioin 3$Vulnerability = Weaknesses\ (or\ Sensitivity) * Impact$

Equatioin 4$Resilience = Adaptation * Exposure * Vulnerability$

Imagen 1 – CARE Cmap 1.0 on resilience definitions

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Towards a Latin American resilience framework.

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1. Climate change in Latin America

Latin America is responsible for a relatively low proportion of global emissions of greenhouse gases (12%) - relatively close to its global demographic weight (8.5%) (EPA, 2017), however, it will be one of the most severely affected by climate change during this century. This can already be seen in the advance of desertification in the northeast of Brazil and central-south of Chile, heat waves, severe droughts and reduction of water resources in these countries, and others, or the increase of extreme rainfalls and flash floods at the South of Brazil and in Colombia, among other locations[1](Marengo et al., 2011; AdaptChile, 2018).

This situationhighlights the issues of justice and responsibility in terms ofclimate change and resilience from a Latin American perspective, also the urgency of an adequate response. Curiously, one of the greatest paradoxes of the concept of resilience applied to Latin American realities is that, while the concept was popularized worldwide over the last two decades, it is possible to appreciate a deep-rooted resilience in previous periods of Latin American settlement, from which valuable lessons can be drawn. However, as the twentieth century progressed, indigenous knowledge about how to face disasters through simple actions, such as fleeing to higher places after an earthquake, or how to confront flooding in the Brazilian Amazon by the use of raised wooden floors, seems to have been marginalised in favour of modern technological solutions; the Bolivian government opposition to signing the Cancún Agreement at COP16 was also a rejection of this form of modernist, technological diplomatic agenda. Comparisons between reactions to the Chilean 2010 earthquake (8,8° Richter) and to the earthquake occurred in Talca, one hundred years before, in 1928 (7,9°), have shown that increased priority was given to reconstruction technologies rather than to prevention and warning systems. Although this was a tectonic phenomenon, many of the same lessons apply to the challenges of climate change.

[1] Hazards become risks when there is a possibility of physical, economic or social damage to an element (living being or material artefact), while the degree of exposure of an element to a hazard determines the intensity of its vulnerability. Hazards can be natural (i.e. volcanos, earthquakes), anthropogenic (i.e. floods) or technological (i.e. explosion, contamination, dam breaches), and planning is the tool for understanding these processes and interactions, issues of spatial impact, and also the most appropriate strategies for generating resilience to these events (Cardona, 2003).

Between 2003 and 2014, the cost of disasters stemming from natural phenomena in Latin America and the Caribbean was US$ 34.3 billion, representing a quarter of global losses, and affecting some 67 million people (FAO, 2017). According to the FAO, climate-related disasters, whose impact and frequency are exacerbated by climate change, are the ones that most affect the region, accounting for 70% of emergencies (FAO, 2017). The Global Climate Risk Index published in 2016, notes that three of the five countries with the highest risk are in Latin America and the Caribbean: Honduras, Haiti and Nicaragua, with Guatemala in tenth place. Bolivia was also identified as high-risk due to the torrential rain and floods in February 2014 that led to 64 deaths and 10.000 displaced families. In total, a third of the regional population lives in areas that are highly exposed to geological and, particularly, hydrometeorological hazards. It is this high degree of exposure linked to extreme poverty that increases climate risk, as Hillier and Nightingale (2013) have identified: "Disasters have a disproportionate effect on people living in poverty. Between 1975 and 2000, the population living in extreme poverty concentrated 68% of mortality due to disasters." The response to climate change there is not only one of understanding the hazard and its potential severity but also to engage fully with poverty and exposure issues. Resilience is the term that has been increasingly employed to cover this range of reponses, however it remains highly controversial in terms of its definition, its reach and the potential trade-offs involved (Chelleri et al. 2015; Meerow et al, 2016).

2. Is climate resilience the issue?

Since the 1990s, the climate change theme has been central in the international development debate. The role of the IPCC (Intergovernmental Panel on Climate Change) and the successive Assessment Reports have documented both the magnitude of the effects according to various scenarios, as well as the gravity of the impacts (IPCC, 2014). However, this agenda is not separate from many others that have been part of the development debate since the 1950s. These include the challenges of poverty and equity, basic needs and infrastructure, security and human rights, among others. Latin America, like other regions in the Global South, has to face each of these challenges and understand how they overlap and generate negative or positive synergies.

Given the data published by the IPCC, the threats from climate change are, without doubt, immediate and considerable. However, they are also linked up with other challenges that can be summarised as wider 'development' and 'risk and disaster'. The IPCC extreme impacts report of 2012 raised this issue of overlaps and synergies and the importance of not understanding climate change as a separate silo of knowledge and action (IPCC, 2012). It is here that a Latin American resilience framework has to be contextualised and constructed. For Latin American communities, both urban and rural, the impacts of climate change form part of a wider set of challenges relating to resilience (Chelleri et al., 2015). These include resilience to poverty and exploitation, and resilience to hazards relating to health and security.

The importance of making connections to a range of issues where there is vulnerability and insecurity enables the construction of a framework that is more transversal and contextualised. Furthermore, it builds the impacts of climate change into existing strategies and experiences relating to local and regional development. Latin America has a long history of strategies for engaging with development – embedded in approaches from structuralism, dependency, neostructuralism and neoliberalism (Kay, 1989; Leiva, 2008) – as well as confronting risks and disasters (Furtado, [1959] 2007; CEPAL, 2017). It is precisely this experience that can provide the basis for a Latin American framework for

resilience. This framework will have at its base this experience of successes and failures, of sectoral versus more integrated planning, and in particular the need for a holistic approach to climate change adaptation that makes strong connections with other phenomena that are also driving forces in local and regional contexts (Barton and Irrarázaval, 2016).

Despite international efforts since the 1960s (The Decade for Development), particularly investment in infrastructure and housing, poverty persists across the Global South while inequality increases across different dimensions, not only income (World Bank, 1994; CEPAL 2010, 2016). A particular feature of development during this fifty year period is that urbanization has concentrated this poverty and inequality in specific locations, with marked intra-urban differences in the urban fabric and adaptive capacities (UN Habitat 2011, 2016). In this light, the role of neoliberalism or 'savage capitalism' has also to be seen as having had a role in shaping vulnerability to climate change, particularly in the context of urbanisation in the Global South (Satterthwaite, et al, 2009).

Rather than climate change, and resilience to it, being 'the' issue for a Latin American resilience framework, climate impacts should be understood as revealing certain trends that compound existing vulnerabilities. When the layers of vulnerability are considered, for example sensitivity, exposure and adaptive capacity, these relate to factors that are generated by socio-economic, socio-ecological and cultural dimensions. Sensitivity, for example, is shaped by generational factors that are defined by the demographic profiles of particular communities. Exposure is linked to residential location, for example, and therefore to land use and access to tenure. While adaptive capacity is produced not only by access to financial capital, but also by human and social capital (Barton, 2013; Henríquez, 2018). These are all multi-dimensional considerations that lead to the conclusion that a Latin American resilience framework is one that is centred on broad-based considerations of development, within which the threats of climate change, particularly the predicted behaviour of these threats during the rest of the twenty-first century, have to be equated.

The reason for a more contextualised, regional approach to climate change adaptation is necessary in the face of the predominance of the global climate change debate and the consequent agreements - initially the Kyoto Protocol mechanisms and more recently the INDCs of COP21, for example, which outline each country´s strategy to – theoretically – contribute to a global goal of under 2oC of warming; in the Chilean case, the language is similar to many others in not clarifying any legal commitment: "Chile hopes (sic) to reduce its greenhouse gas emissions while decreasing poverty and inequality as well as continue advancing toward sustainable, competitive, inclusive and low-carbon development." (INDC, 2015, 11).

While mitigation, with the need to reduce greenhouse gas emissions and increase carbon sequestration, has dominated the agenda since the launching of the UNFCCC in 1994 and has been relatively uniform in its set of responses: 'global solutions for a global problem', adaptation requires a different approach. This approach has to be highly contextualised given the tremendous range of potential impacts and the local conditions in terms of vulnerability. To reduce vulnerability to climate change impacts requires a reduction in vulnerability to a range of other development considerations in order to reduce exposure and increase adaptive capacity.

Until the landmark special report on extreme events, climate change research and proposed responses tended to be fragmented, sectoral and rarely linked to wider development issues. The IPCC Working Group (WG) II on adaptation had considerably less protagonism than WG I on climate science and WG III on migitation (IPCC, 2014). It can also be said that this adaptation WG has the strongest links with local and regional development

concerns. Each of the adaptation chapters on regional conditions - for example, chapter 27 on Central and South America (Magrin et al, 2014)– stresses the local contexts in which the impacts are generated and to which appropriate responses are required. While there may be many commonalities in climate science and mitigation research and action agendas, in the realm of adaptation, it is context – for impacts, vulnerability and resilience – that is paramount (Magrin et al, 2014).

3. A history of risk and resilience

Rather than assuming that climate change is neutral in terms of adaptive capacities and risk, the Latin American experience leads to the need to examine vulnerability and climate hazards in terms of what Ulrich Beck terms 'the risk society' (Beck, 1992). Although Latin America has a long history of risk and disaster associated with tectonic and seismic activity – volcanic eruptions, earthquakes, and tsunamis – the role of the risk society in terms of climate change is particularly relevant. In the case of 'natural' disasters based on geological activity in the earth´s crust, the issue of anthropogenic factors is less of an issue in terms of risk. There are clearly factors that reduce these risks, such as the location of settlements in proximity to areas affected by a tsunami, lava flows, and mudslides. However, in the case of climate change, the risk society as defined by Beck is more than explicit. He refers to the term 'reflexive modernization' as the form with which society should adapt to the production or manufacture of new risks, usually new technologies and products (nuclear energy, for example, see Beck, 1992). However, governments, and society more generally, has proved to be poor in terms of engaging reflexively with the threats emanating from greenhouse gas emissions as well as planning for adaptive measures for constructing more resilient communities.

As in the urban centres of Africa and Asia, Latin America cities congregate millions of people living in precarious housing with unsanitary conditions, often in areas defined as having a high level of risk from climate impacts (IPCC, 2014; Henríquez and Romero, 2019). Since many of these settlements are informal and irregular, the conclusion can be drawn that risk is being manufactured through urban planning and management strategies, whether the inability to access land that is not classified as at risk, or in terms of the generalized adaptive capacities of low income, high vulnerability (socio-economic and socio-ecological) communities (Krellenberg et al. 2016; Krellenberg et al. 2017). The segregation that characterizes Latin American cities is also a segregation that shapes climate risk and resilience.

The more vulnerable, socially and spatially segregated population has highest exposure to hazards ('socio-natural hazard', or natural hazards that are socially induced, Lavell, 1999) and therefore has higher risk levelsin terms of the consequences of 'natural' and climate change. A Latin American resilience framework highlights that adaptation alternatives cannot be considered without addressing these structural issues first. These are issues that constitute the basis of climate risk and social resilience. Rather than climate change being understood as a 'natural' phenomena relating to climate science, it should be defined clearly as an anthropogenic risk, produced since the Industrial Revolution but with a notable acceleration in the second half of the twentieth century. When this anthropogenic process is then combined with the twentieth-century risks associated with urban development, it can be viewed as a compounded problem.

Urban development in Latin America since the 1960s has been both rapid and intensive. Urbanisation rates in most countries – Mexico and Brazil in particular – were among the highest in the world, leading to the production of the most urbanised region in

the world. Although there are differences between the highly urbanised Southern Cone countries and the less urbanised countries of Central America, the region as a whole reflects this dramatic shift from rural, subsistence societies to urban manufacturing and service economies in a short space of time. However, the rate of urbanisation and poor systems of governance led to high levels of spontaneous settlement and low service provision (United Nations, 2014). Of particular importance has been the settlement on urban fringes and in risk areas within the city, whether river banks, floodplains, gullies or steep slopes, leading to the new urban population being located primarily in risk areas. It is precisely this historical condition of Latin American cities that provides the context in which climate change impacts add to the vulnerability of the urban population. Nevertheless, climate change impacts should not be considered in isolation.

According to the IPCC, the increase in intensity and/or frequency of extreme events is related to climate change. However, most of the disasters recorded in the region over the past fifty years have occurred in or have affected urban areas (IPCC, 2012). This can be partially explained by the exponential growth of the urban population and their location, particularly in cities with recognized high levels of exposure to 'natural' hazards and climate variability events.

The impacts of climate change exacerbate the effects of disasters that were traditionally experienced in Latin American urban settlements, whether 'natural' hazards or those generated by climate variability. More recently, the IPCC has noted that there is no climate variability that is not affected by climate change – the 'new normal' - therefore many of the events since the 1950s have also had a factor of climate change related to them (IPCC, 2014). Resilience to these earlier events is highly relevant to the ways in which climate change adaptation and resilience-building are understood. Rather than new terrain, Latin American societies and their authorities have a long tradition of knowledge in relation to risk, disasters, adaptation and resilience, but economic priorities have directed investments to the fulfilment of external demands rather than longer-term protective measures for local populations.

The insertion of Latin America within the international division of labour as peripheral and disarticulated has fostered economic dependence, structural indebtedness, significant inequalities, and persisting poverty. These circumstances have affectednational capacities for developing appropriate adaptive responses, while at the same time national links to Global North countries and agencies – through economic agreements, and bilateral and multilateral technical assistance - has limited the formulation of a specific Latin American perspective on regional and local challenges, although CEPAL has attempted to define more autonomous paths, such as neostructuralism (Sunkel and Zulueta, 1990, Bielschowsky, 2009).

The search for swift economic growth to reproduce the 'development path' of Global North countries has resulted in the assumption that economic, political, academic and other categories imported from those countries, could be easily and directly incorporated by Latin American countries. However, the incorporation of such concepts without considering previous knowledge and diverse contexts, in in other regions of the Global South (Chakrabarty, 2001; Wallerstein, 2001), has helped aggravate the risk of low income economic groups, while investments in logistics for production and export have been prioritised in order to accelerate the conversion of areas according to specific productive and financial rationalities, which often lead to water stress, wholesale ecosystem modification, and increased emissions and discharge levels. In this sense, climate change discourses have often replicated development discourses that position Latin American societies as European cultural appendices - hybrid, unfinished, and following postcolonial trajectories –

and which have diminished the role of traditional knowledges. Climate change, as with other structural challenges to the sustainability of communities in the region, will depend on a decolonisation of knowledge as an important step in renegotiating power relations and reorganising priorities (Santos, 2010). In the field of risk and disaster, knowledges that have been considered as "primitive", "underdeveloped", "pre-modern", should be drawn upon to address climate change, and to position alternative strategies for resilience-building that are bottom-up, context-based and historically-informed.

4. Final Remarks: The importance of developing regional frameworks for developing resilience.

The ideas presented above were raised to highlight that neutrality or unrooted discussion is not possible in the field of climate change. Debates on resilience require reflections on historical change and knowledge as much as future threats. How much of this knowledge can be drawn upon – e.g. from experiences facing disasters not related to climate change (such as earthquakes, tsunamis or volcanoes' activities) –to integrate into regional and local strategies in the face of droughts and floods caused by human activity (change in land use, deforestation and changes in water cycles), which have been progressively aggravated by climate change.

The presence of different kinds of hazards across the continent is a superficial justification for the historical lack of effort to create a regional framework to face environmental problems and, at present, to build broad-based resilience. Targeted funding for climate change may not engage with the root structural weaknesses that exist and that are central to the vulnerability that exists and persists. This funding may also employ methodologies and instruments that are not necessarily in tune with national and local practices in situ. The requirement for complementary funding by beneficiary states may also be a limitation, as is the longer-term commitment once the disaster status period has ended. For example, in Brazil, the organisations such as UNISDR (United Nations Office for Disasters Risk Reduction) are welcomed when a disaster strikes but they rapidly lose protagonism as the disaster period shifts into reconstruction (Salim, 2012; Coffee, 2016).

Despite incipient progress in integrating the approach to risk reduction into urban development, food security, planning, budgeting, institutional mechanisms and action implementation at the local level, Latin American institutions remain focused on responding to emergencies and have struggled to engage with the key structural issues that define resilience. This orientation has evolved from responses to disasters that precede climate change discussions. However, decades of experience reveal that emergency response is not enough. Enhanced resilience means that communities and authorities must be prepared for disasters and also must engage in actions to reduce climate risk by reducing vulnerability, in terms of physical losses, economic costs, and most importantly loss to human life. In this sense, climate risk reduction is part and parcel of generating inclusive, sustainable development.

In terms of building a regional resilience framework through which climate risks can be linked to other risks and more generalised conditions of vulnerability, it is important to recognise factors of context, including history. Latin American societies have a long history of risk and disaster and there is evidence of them being intuitively resilient, with adaptation to drought, extreme heat and flooding being grounded in traditional practices of construction and design. However, much of this traditional knowledge has been colonised by otherforms of knowledge associated with modernisation during the twentieth century. The combined

processes of: a) modernisation of particular types of ‘valid’ knowledge; b) climate change, and c) urbanisation rates (with consequent demands on regional food, water, and energy systems) have led to increased vulnerability of a large numbers of Latin Americans over recent decades.

It raises the need to introduce a contextualised resilience framework, able to place climate risk alongside other structural and systemic risks associated with socio-economic development, provision of basic needs, services, and infrastructure, with a view to combined actions of land use management and planning, and an understanding of risk and of possible measures for increasing local resilience.

The willingness to integrate traditional and indigenous knowledge to scientific frameworks is a fundamental step for strengthening resilience in locations where vulnerable communities are mostly concentrated. By focusing on local knowledges that combine different experiences, methods and practices, and by focusing on context andsocio-ecological specificities, it should be possible to avoid the standardised formulas which are favoured by funding agencies and bilateral partners,but are so often disconnected from everyday experiences. Macro regional economic and planning agendas need to stress the importance of local planning demands and environmental regulations, land use norms, and the importance of addressing claims for socio-ecological justice. In Latin American cities, the evidence of the gap between those with enhanced adaptive capacities, less exposure and less sensitivity, and those who are more vulnerable, is brutally evident. It is for this reason that a regional resilience framework has to place climate change in a wider context of structural inequalities and risks, as well as recognising the long history and experience of risk and disaster that the region has faced before climate change was even a consideration on the public policy agenda.

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Section I. Climate change and resilience national institutional frameworks

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The eight countries that participate in the "CARE" project, of which 5 belonging to Latin America (Brazil, Chile, Colombia, Ecuador, Uruguay) and three to the European Union (Italy, Spain, The Netherland), have all ratified the "Paris climate agreement"and have approved at least a program, a strategy and/or even a law, see the case of The Netherlands, of adaptation to climate change at the national level. Furthermore, for the three member

countries of the European Union, the strategies and plans related to climate change derive from the European Union's Directives, Recommendations and Guidelines.

The plans, strategies or laws approved have in some cases indicated the targets for the reduction of greenhouse gas emissions compared to the year 1990, always considering that the member countries of the European Union have as a whole and individually targets to be reached defined at the continental level. These targets can only be improved by individual countries, and on the whole they progressively go from 20% in 2020 to 80% in 2050. Among the CARE project countries that have given indications, the targets range goes from the one of Colombia, which plans to reduce its emissions by 20% in 2030, to the one of The Netherlands, which plans to reduce its emissions by 49% in 2030 and 95% in 2050.

The problems resulting from climate changes that have been observed in the different countries, albeit with very different intensities, mainly concern the phenomena linked to the water cycle, such as floods, extreme rainfall, rising sea levels, melting ice, drought and water shortages, while less problematic arethe heat waves and the unstable land phenomena.

The strategies, tools and general intervention criteria indicated for adaptation to climate change tend to be similar since, with different accents, national and local adaptation plans, urban-scale resilience strategies, and achievement of climate proofing conditionsare pointed out. Furthermore, the need to achieve a strong integration of climate change adaptation strategies with mitigation ones and with the intervention tools and strategies of other sectorsis indicated, in particular those of risk management, freshwater supply, spatial planning and nature, agriculture and economic policies. The general objectives that are indicated are the vulnerability and disaster risk reduction, the resilient improvement and the ability to cope with the increasing weather extremes. The strategies generally consider the risk associated with the climate change impacts as a result of the interaction of natural hazards with the vulnerability and exposure of human and natural systems, as well as their capacity for adaptation. Latin American countries aim to implement resilient actions as part of the sustainable urbanization process, to integrate the theme of urbanization with the eradication of poverty and the conception of public land policies.

In general, there is a great difficulty in implementing the strategies in a systemic way and with the speed necessary to meet the objective of the Paris agreement not to exceed 2% increase in the average global temperature, even better if under the 1.5%, although considerable efforts are being made both by states and individual cities.

Up to now, the implementation of adaptation strategies are very limited in these countries and are generally developed above all at the project level, while there are many and widespread plans, actions and actions designed to manage territorial risks or to improve the urban comfort and the quality of life that can be considered adaptation actionsto all effects. There are also several experiences in the implementation of resilient actions designed on a local scale, including those of some cities participating in initiatives such as "C40 cities", which are taking bold climate action, and "100 Resilient Cities", sponsored by The Rockefeller Foundation, which aim to support the adaptability of urban areas to climate change.

The following chapters show the progress of experiences in implementing adaptation and resilience policies and strategies related to Brazil, Chile, Colombia, Ecuador, Uruguay, Italy, Spain and The Netherland.

Chapter 1.Advances and regressions in the risk management policy in Brazil

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1. Introduction: How the urban climate resilience frame matches the Brazilian context

The last two centuries have been marked by major social, economic, spatial and environmental transformations. An unprecedented search for wealth accumulation, through the integration of New Territories and the continuous growth of the economic product, was based on the incorporation of environmental resources into the productive process and the exploitation of work, causing a concentration of benefits and unequal distribution of socioenvironmental impacts. In Brazil, the intensification in the rhythm of assimilation of rural areas for productive uses related to an industrial matrix (mineral extractivism, agribusiness, etc.) plus population concentration in cities since the years 1950, have consolidated an unequal and unsustainable standard of land use and occupation, which promotes a dispute over access to environmental resources, such as water and occupation of appropriate sites for urbanization.

Urbanization in Brazil was associated with an unequal economic structure and with a political power differentiated among social groups throughout its history, this circumstance generated different material and symbolic expressions across Brazilian regions. However The distributive focus, concerned with access to natural resources, services and opportunities in the city, was disregarded in favor of a pragmatic approach to risk with a focus on disasters, following industrial societies, where disaster prevention methodologies have been associated with a strong planning and regulation experience of urban space-producing agents, and the recognition of nature's risk as intrinsic to the capitalist economy.

From this perspective, the disruption of the Chernobyl reactors (Aleksiévitch, 2013) and the impacts of tsunamis and tornadoes, although associated with human failure and natural environmental disasters respectively, would be processes both arising from recent capitalist strategy of appropriation of natural resources and economic growth acceleration.

The recognition of risk as something intrinsic to the contemporary society has been absorbed by the financial market, and industrial societies became stricter to pollution, fostering the displacement of polluting and risk-causing structures to peripheral countries. On the other hand, the insertion of peripheral countries into the international division of labor has been more permissive to the factors that aggravate the risk (due to insufficient regulation and/or supervision, lack of planning or ordering territorial policy, etc.), in the face of the dispute of these countries by the industrial activities, which although polluting, were seen as instruments for the expansion of internal income and consumption.

While the conditions of land use and occupation remain looser in countries such as Brazil, in the contexts of the post-industrial countries the consequences of events of geological and hydrological natures – capable of damaging either the physical, social or mental integrity of

human beings (due to death, missing, displaced, homeless, and affected in general), or public functions (transport, water and energy supply, communications, etc.) and buildings (private and public), or economic and environmental resources (soil, flora, fauna, water bodies), have led to the construction of international landmarks facing disaster risks, that came about from these events, and also the vulnerability to exposure to these risks (Cardona, 2007).

The inability to articulate environmental, productive processes and urbanization standards forwarded the Brazilian alignment to international formulations led by technical and reactive bias, with distancing of relevant social aspects for the definition of risk and vulnerability situations. Despite the increase on the importance of the environmental discussion in the 1980s, the discussion on sustainability was quickly co-opted by the search for the reduction of productive activities impacts on the territory by means of technological modernization, before that the distributive problem should be properly placed.

This question is reflected in the construction of climate policies in Brazil. The National Policy of Climate Change (Federal Law n. 12.187), approved in 2009, still under the validity of the Kyoto Protocol, focuses on "Consolidation of a low-carbon economy", and therefore its guidelines are mainly related to the productive sectors: generation and distribution of electricity, urban public transport and interstate cargo and passengers transportation, as well as the various industrial sectors, of health and livestock services, without regard to the Brazilian specificity in relation to the unequal distribution of the consequences of climate change. Under the Paris Agreement in 2015, the country laid the foundations for its Nationally Determined Contribution (NDC), built in a project supported by the Inter-American Development Bank (IDB). The document deals with mitigation actions and aims, in addition to the above-mentioned sectors, the production of biofuels, forest recovery and the reduction of deforestation.

In 2016, the National Plan for Adaptation to Climate Change (MMA, 2016) was published, broader in its objectives than earlier documents on climate change. It stands out in one of its objectives, namely the identification and proposition of measures to promote adaptation and reduction of climate risk in people and vulnerable populations. Although the idea of resilience appears superficially, in general linked to the maintenance of the activities of the productive sectors or to biodiversity and ecosystems, it is also considered in the chapter on strategies for cities, which recognizes the historical construction of the socio-environmental vulnerabilities of Brazilian cities and their increase in the face of climate change. In this context, it links resilience to the need for planning for vulnerability reduction.

In a much more consistent way, however, such topics have been treated in the institutional construction related to the identification and mitigation of geological-geotechnical, hydrological and disaster reduction risks.

The Brazilian political context of the years 2000 favored a commitment to the international agendas defined within the framework of the United Nations – through the "International Disaster Reduction Strategy" (EIRD), created as part of the system of Nations United Nations and regional organizations around the reduction of disasters and activities in socio-economic and humanitarian fields (UNISRD, 2018), and by the I, II and III world conferences on disaster risk reduction, carried out in Japanese cities with a history of Earthquakes, in the 1994s (Yokohama), 2005 (Kobe - Hyogo Agreement) and 2015 (Sendai - Sendai Agreement).

The II International Conference produced the Hyogo Framework of Action (2005-2015),

considered the most important instrument for the implementation of the 'disaster risk reduction' within the member states of the United Nations. The III World Conference on Disaster Risk reduction that generated new protocol in 2015, the Sendai landmark, more focused on planning, prevention, risk reduction and disaster. Among its various developments, this milestone based the campaign "Building resilient cities: My city is preparing", with the purpose of raising awareness of mayors, governors and national authorities for the development of actions for To establish resilient cities as part of sustainable urbanization processes, seeking to articulate the theme of urbanization with the eradication of poverty and the conception of territorial public policies. Due to the diverse circumstances of the cities in the world, a ten-step plan of action was also organized, with ten aspects considered essential for the resilience of the cities.

It should be noted that the definition of resilience as "the ability of a social or ecological system to absorb disturbances derived from climatic phenomena, maintaining the same basic structure and modes of operation, the capacity of self-organization and the ability to adapting to stress and change" (Project CARE report, adapted from the IPCC, 2007), or the ability to restore the conditions before a disaster, would have the prospect of conservation of the productive structures, which given the conditions of the cities could be translated by maintaining the unequal distribution of the impacts of economic restructuring and environmental degradation.

In the Brazilian context, the social geography of power is clearly a sort of sacrifice zone, where great material deficiencies prevail due to the precariousness and improvisation of urbanization and which houses the population exposed to adverse conditions; in these places, conflicts, risks and failure in the control of the urbanization process prevail. There is a geopolitics of risk, which is technological and environmental, but it is also socio-economic, associated with the lack of income and socio-environmental injustice (Beck, 2010; Acserald, 2009). In recent decades, it has been added to the framework of precarious socio-environmental, the increase and frequency of extreme events associated with global and regional climatic variability, causing disasters in various regions of the country. The urgency of an agenda and facts, coupled with a period of strong State acting in the development and social policies, resulted in the creation of institutional policies and structures as will be described below.

2. Background of risk and disaster prevention policy in Brazil

In Brazil it has long held the belief that, on account that the Brazilian territory has no history of occurrence of natural phenomena such as earthquakes, cyclones or volcanoes, the country would not have to worry about major natural disasters, with the exception of drought events, especially in the semi-arid northeast region, and flooding in the cities, especially after mid-20th Century, when a number of ineffective actions were carried out. During the 20th Century the developmentalist attitude of the federal government, disseminated the logic of the exploitation of nature as something dead, in principle in the conception of regional development, and subsequently in a negligent management of environmental and social issues within cities.

Since the 1950s, urbanization has been associated with roads paved with asphalt, the use of reinforced concrete in buildings, and the diffusion of motor vehicles, all was seen as synonymous with progress, while a rural restructuring was exclusively guided by economic interests, disregarding nature within urban and rural areas. Large enterprises such as hydroelectric plants and productive structures were taken as best choice to smaller and best

adapted solutions and deployed in the margin of any environmental concern. Two examples of this period are: a) the implementation of the Itaipu hydroelectric power plant and the flood and disappearance of the waterfall of Seven Falls, compromising natural and landscape heritage; and b) the high levels of water and air pollution caused by the Cubatão petrochemical complex near the coastal region in the state of São Paulo.

In the urban environment an expression of this orientation was the provision of mass housing during the 1970s, to assimilate the migration of the rural population to urban areas. The expansion of cities was improvised, assimilating peripheral land that supported rural communities and traditional extractivism even in areas such as the Amazon, and taking water courses as sewage launch channels, to be rectified and buffered. By the end of 1980s, the landscapes of the urban areas, especially of the periphery, was characterized by high density of occupation, precariousness or lack of infrastructure, especially regarding sanitation and vulnerability of the communities against the risks arising from natural threats, predominantly landslides and floods.

Another Brazilian peculiarity from this period has been the failure to comply with environmental legislation by sectors with economic and political power with the consent of the state and sometimes by the State itself, which endures today. This posture is especially due to high-income groups when refers to landscape-valued sites (mountain ranges, dunes, waterfronts, etc.) or areas valued because of infrastructure or centrality. The spatial result is the worsening of risks and sociospatial inequalities and the occurrence of geological-geotechnical and hydro-meteorological processes that can generate disaster situations.

The normative and institutional Brazilian environmental framework was consolidated from the 1980s; however, since the 1960s, Brazil has had instruments to control land use and occupation, especially in areas close to rivers and hillsides. From the Federal Constitution of 1988, the Brazilian federation system defined different environmental and territorial competences at the three levels of government: Federal, State and Municipal. In environmental matters, competences are complementary and competing, with the federal level being the general ruler, while states and municipalities regional were in charge of local issues, always respecting the principle of obedience to the most restrictive criterion, or of greater precaution as well as its constitutionality. In territorial matters, the local level (the municipalities) received greater autonomy and responsibility in the management and control of land use and occupation, with setting up Planos Diretores Municipais (Municipal Master Plans in Portuguese). Considering that the territory is the basis of natural resources, the relative municipal autonomy in its planning and management, has created a bottleneck and difficulties in the implementation of various environmental policies and instruments. The Brazilian social and spatial disparity, with 5.570 municipalities in the territory of 8,516,000 km², presents municipal contexts with extensive territories and low institutional and governance capacity, and, on the other hand, municipalities with very high population densities and high institutional capacity in already degraded or highly modified territories.

Despite the history of occupations on slopes and river banks by excluded social groups occurring since the end of the 19th Century in Brazilian cities, and the risk to which they are exposed, it was only after the occurrence of a sequence of extreme climatic events that the culture and planning system was changed. In 2008, in the Itajaí Valley in Santa Catarina State, a climatic event with no precise record of recurrence due to the volume and intensity of the precipitation - about 500 mm of rain in 48 hours, caused 135 deaths (Jacobi, Momm-Schult, Bohn, 2013). In 2010, floods occurred in Alagoas State, and in 2011 the largest event recorded in the last 50 years caused landslides and movement of big portions of land (mass

races) in several municipalities in the Serra Fluminense region in Rio de Janeiro State. Faced with this series of disasters, a new perspective was assumed, precisely by including among the victims the highest income groups, including tourists who visited the cities of Nova Friburgo, Petrópolis and Teresópolis, with 905 dead, 345 missing, 34,600 persons homeless or displaced in the region. (Busch, Amorim, 2011), a circumstance that expanded media coverage of the event and its consequences.

The magnitude and sequence of disasters clarified the need to develop effective policies and instruments for risk prevention and mitigation and disaster response, what led the subject to be included in the federal government's agenda. The occurrence of disasters in the most vulnerable areas (i.e.: housing on dumping ground, improvised landfill or on hilly areas) made more explicit that social exclusion would be the main source of vulnerability in the Brazilian context, but scholars suggest that environmental policies miss this issue (Valencio, et. all, 2009). The other hand, in areas with infrastructure and centrality, the real estate value and the political power of the owners restrained preventive measures being taken. In this case, the realization of works and interventions aggravated the problem, as is the case of flood-prone wetlands and the plumbing of water courses.

The amount of casualties and the material losses occurring in the Serra Fluminense region in Rio de Janeiro, triggered a timid dialogue between civil protection/risk management actions (military and technical staff in charge of emergency action) and spatial planning (related to land use and occupation control and preventive planning) policies, which still remained independent of the discussion on the management of urban or environmental policies, more linked to the epistemological field of environmental sciences and the earth (climatology, meteorology, geology). In practice, the emergency character of interventions became an electoral asset, due to the loosening of the rules and possibility of hiring without bids (Valêncio, 2014; Jacobi et al 2013), discouraging the implementation of measures at a preventive level. To treat the risk as something strictly "natural" and as "episodic" favors an emergency approach of the processes, which is disinterested in the search for ways to prevent and face their causes. Emergency usually gives opportunity to interventions to happen outside planned budget, providing greater political and financial return to the political and economic elites (Klein, 2015; Momm et al, 2017).

In this respect Douglas (2012) points out that the very classification of areas such as "inadequate" can be based on common sense and discriminatory character, vetoing a space to the most vulnerable social groups, that if they go through technological improvements can come to make, suitable for a shopping-center or high-income housing. However, while maintained as inadequate to occupation, such areas constitute an environmental liability. However, they are maintained in this condition while the informal occupation is instrumental for the urban productive sector, and environmental policy is primarily occupied by non-urban environments, based on the belief that some ecosystems should be protected while others could be appropriate for the urbanization and the productive sector.

In short, the fierceness of climatic variations (e.g. El Niño, La Niña), associated with a climate change scenario, and the needs of the "new vulnerable" (social groups of medium and high income), motivated the creation of a flood alert system, with incorporation of cities in the forecast scope of meteorology, until then very focused on the needs of the agricultural sector. In the cities, the emergence of disasters sustains the role of firefighters in the states, associated with Civil Defense systems of municipal scope. This shows that politics have much more a focus on emergency care than in preventive actions in terms of planning and preparedness and response. From 2011 there was the Association of Risk Analysis to the

elaboration of the Planos DIretores Municipais, but the interdisciplinarity needed to understand the limits and socio-environmental challenges of Brazilian cities was not established, nor were they attacked central issues of the Brazilian development model that produces and reproduces socio-environmental vulnerability.

The closest proximity to this debate between engineers and geologists, added to the reactive way in which public management is based on media collections, has valued works and investments, defined from an industrial hegemonic logic, which governs the conception of the public administration and make understanding and low-cost approaches illegal. In addition, the disclosure of budgets for prevention actions (for equipment acquisition, construction work, infrastructure maintenance) is seldom fulfilled, exacerbating the problems accumulated by the lack of articulation of the epistemological fields. The actions were not completed in any of the directions, and the doctrine of emergency services of disasters prevails, without discussion of solution to its causes, i.e. for an effective policy of planning and prevention.

3. The design of the Risk Management Policy, advances and regressions in the current scenario

From the mobilization, especially in the technical and scientific means associated with the visibility and the clamor that the disasters previously related caused, the Federal government in the Lula period (2003-2010/14), characterized by the state' strong performance, when the Ministry of Cities proposed a national policy for the organization of actions and a risk management system. The approval of the 12.608/12 law that established the National Policy of Protection and Civil Defense – PNPDEC (Brazil, 2012) was constituted in a period still favorable to the creation of policies considered progressive on account of instruments of social participation and sustainability-related issues (such as sanitation policy, solid waste, and climate change). PNPDEC gained special prominence in the short, faltering and fragile history of risk management in Brazil by pointing out the need to incorporate disaster risk reduction actions in territorial management, urban planning and other sectoral policies (Nogueira, 2008; Nogueira et al, 2014). From a technical point of view, it brought positive aspects: the adoption of the watershed as a unit of analysis and action for planning, the compulsory development of prevention plans by the three levels of government, the creation of a National Register of Areas susceptible to the occurrence of large-impact landslides, abrupt floods or related geological or hydrological processes, the proposed integration with other sectoral policies, with an emphasis on prevention.

Law 12.608/12 foresees in its 6th item VIII: "To institute the National Plan for protection and Civil Defense-PNGRD" (Brazil, 2012), extending its scope, to meet the country's pressing demands, for the management of risks and disasters, with the inclusion of Risk prevention effectively. Actually, this plan highlights the importance of the articulation of the various actions, programs and policies focused on identifying and reducing threats, vulnerabilities and natural and technological risks, by all levels and sectors of government, to achieve qualification, Synergy and integrated planning, reducing losses and damage to populations, infrastructure and the economy. The PNGRD points out action lines and procedures, supported in principles and guidelines, for the full implementation of strategic programs and actions, pathways for the development of a culture of risk reduction in the country and the construction of a resilient society, in more harmonious coexistence with the environment.

However, the reductions of resources envisaged for their implementation were progressive, with the changes that occurred within the framework of the legislative and the executive at

the federal level from the impeachment of President Dilma Roussef of the Workers' Party in 2016. Since then, the current period is characterized as a process of dismantling and discontinuity in the creation and implementation of public policies, within the reduction of the role of the State, especially after the validation of constitutional amendment 95 which fixes a limit for public spending, and a dismantle social and corrective policies of the unequal and unsustainable development model. Currently, Brazilian Congress holds several legislative propositions that fully reshape important instruments used in regulation and environmental management, as is the case of environmental licensing (Ciminelli, Momm, 2016).

In this context, the still fragile advances obtained by PNPDEC, can suffer setbacks further worsening the Brazilian vulnerability in the face of disasters. It is highlighted that the 6th National Conference of Cities (and its state and municipal preparatory), the Brazilian urban policy procedure that seeks to approximate urban management, territorial and local demands of the population has been cancelled by the federal government In December 2017 (Brazil, 2017), and that the National Council of Cities has been weakened since 2016. The retreat in the discussion about the structural causes of urban problems supports the maintenance of the focus on the risk as a physical problem, to be treated as an emergency. The debate continues disarticulated even within the academy; research groups and risk events do not dialogue with others dedicated to the study of the climate, or to urban studies and still very far from the population. The emergency action in turn offers administrative benefits such as the authorization of transfers of resources and of contracts in an emergency, with dispensing of bidding processes. Everything indicates that this modus operandi, established in authoritarian times of the twentieth century, still resounds valid in the 21st Century.

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Chapter 2.Climate change in Colombia

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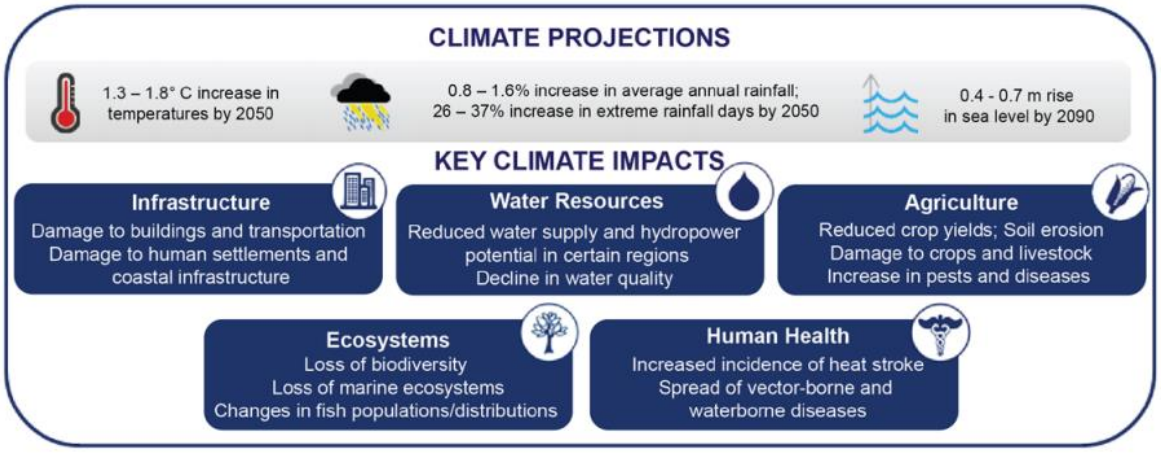
Colombia is particularly vulnerable to climate change, given that the majority of the population lives in the elevated Andes, areas prone to water shortages, flooding and unstable land, and on the coast, where increases in sea levels and floods will likely affect populated places and economic activities. In addition, the country presents a high recurrence and magnitude of disasters associated to climate conditions.The Colombia's Third National Communication on Climate Change envisages an increase in average temperature of 1.6°C by 2070 with a rainfall reduced by 10 to 40% that will affect to 30% of national territory(IDEAM, PNUD, MADS, DNP, & CANCILLERÍA, 2017).The country is responsible of 0.46% of total global emissions, according to data from 2010, and exhibit biogeographical conditions that are ideal for mitigation of climate change through greenhouse gas sequestration and emission reduction. However, the greenhouse gascontributions could have a tendency to grow. An increase in emission of 50 % by 2030 has been predicted, if no actions are taken(IDEAM et al., 2017).As shown in figure 1.

Figure 1. Climate projection and key climate impacts in Colombia



(*Source:*USAID Colombia, 2017a)

1. Background of climate change policy in Colombia

The Colombian adaptation agenda around climate change has become increasinglyimportant in recent years in light of the global negotiation process and due to greater national awareness.The country is a signatory of the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreements. Like most countries in the region, Colombia has submitted one National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2001, laying out the actions that the government has already taken, the analytical basis for its policy response to climate change and outlining its commitments to take future actions within an official international framework(Gobierno de Colombia, 2015). The Communication established the First National GHG Inventories for 1990 and 1994. It also presented the actions done for mitigating of GHG emissions in Colombia, as well as vulnerability and adaptation studies for the coastal area, water resources, agricultural sector and land management.

Colombia has been developing important norms and legal instruments to face the challenges of climate change within the framework supporting both mitigation and adaptation actions. Among the adopted national norms, Law 1523 of 2012 implements the National Policy on Disaster Risk Management and establishes the National Disaster Risk Management System. In this norm,adaptation to climate change has been conceived as part of the process of disaster risk reduction.Law 1715 of 2014promotes the development and use of non-conventional sources of energy, mainly those of a renewable nature as a necessary means for sustainable economic development, the reduction of emissions of greenhouse gases and the security of energy supply.The country has also adopted public policies by the National Council for Economic and Social Policy (CONPES), such as CONPES 3242 of 2003 that implements the institutional strategy for environmental services sale for mitigation of climate change, and CONPES 3700 of 2011 that contains the institutional strategy for shaping policies and actions on climate change in Colombia. At the same time, climate change issueshas been incorporated into several national policies, such as the National Policy for integral management of water resources, the National Policy for management of biodiversity and its ecosystem services and the National Policy for management environmental soil, among others.

Colombia submitted its Intended Nationally Determined Contribution to the Secretariat of the Convention on Climate Change in September 2015(Gobierno de Colombia, 2015).


LEGAL FRAMEWORK OF CLIMATE CHANGE IN COLOMBIA
general characterization of the legal framework in relation to climate change.
1994
Law 64
Approval of the 'United Nations Framework Convention On Climate Change'
2000
Law 629
Ratification of the Kyoto Protocol
2003
CONPES 3242
Institutional strategie for the sale of enviromental services related to CC mitigation
2011
CONPES 3700
Institutional strategie for the articulation of policies and actions related to CC
2012
National Adaptation Plan to Climate Change (PNACC)
Law 1523
National policie of disaster risk management
2014
Law 1715
Promotes the development and utilization of non-conventional sources of energy
2016
Decree 298
Established the organization and functioning of the National System of CC (SISCLIMA)
Law 1819 article 221
Creates the national Carbon Tax
2017
National Policie of Climate Change
Law 1844
Ratification of the 'Paris Climate Agreement'
CARE
empowering climate resilience

It commits the country to reduce 20% of its GHG emissions by 2030,in case of further international support, the country has enough international support, this reduction could be increased to 30%(Florian, M. Pabón, G. Pérez, 2017).Furthermore, the actions to perform the National Plan for climate change adaptation to 2030, can be prioritized as:

1. All regions will be covered by climate change plans, to be properly elaborated and implemented.
2. A national system of climate change adaptation indicators will be provided, in order to monitor and evaluate the implementation of adaptation measures.
3. Instruments of water resource management will be developed, embodying considerations on climate variability and climate change in the country's priority watersheds.
4. Climate change considerations will be included planning instruments and innovative adaptation actions will be boosted in to six priority sectors of the economy.

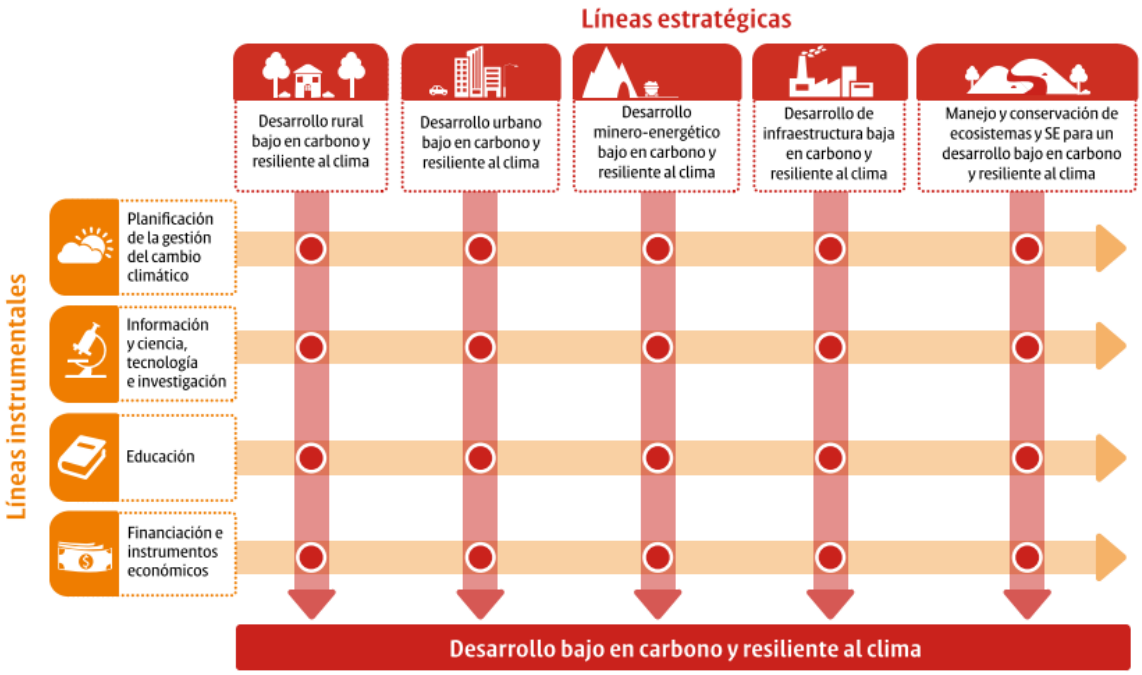
This contribution was incorporated into the Paris Agreement at end of 2015 and it entered into force on November 4, 2016.

Finally, Decree 298 of 2016 proposed the creation, organization and operation of the National Climate Change System (SISCLIMA). SISCLIMA is defined as an intersectional scheme to facilitate and promote the formulation and implementation of policies, plans, programs, methodologies, incentives and projects related to climate change, mainstreaming climate into the design and planning of development projects in the country.

2. Climate change policy in Colombia

The Government of Colombia’s 2010-2014 National Development Plan listed climate adaptation as a priority and established a National Climate Change System to improve coordination among the institutions. Since 2014, a National Climate Change Policy has focused on mitigation and adaptation actions by increasing resilience and achieving low carbon development.In 2015, the Government of Colombia’s 2010-2014 submitted its Intended Nationally Determined Contribution, which reiterates a commitment to adaptation and resilienceefforts. A year later, the Government of Colombia’s 2010-2014 established the Colombia National Climate Change Decree, which creates the Intersectional Commission on Climate Change to implement and coordinate climate change efforts at the national level and Regional Nodes for Climate Change for sharing regional efforts. In 2017, the Government of Colombia’s 2010-2014 completed a National Climate Change Adaptation Plan.

Figure 2. Strategies and instrument of National Climate Change Policy of Colombia



Source:(Florian, M. Pabón, G. Pérez, 2017)

The objective of the National Climate Change Policy is to incorporate climate change management into public and private decisions, in order to advance in developing climate resilient and low carbon economies, which reduce the risks of climate change and makes it possible to take advantage of the opportunities that climate change generates(Florian, M. Pabón, G. Pérez, 2017). This policy proposes a series of general and sectoral territorial strategies, with a high impact for adaptation and mitigation. Furthermore, it introduces guidelines for their articulation aiming to optimizing the combination of different criteria and elements in the same territory.

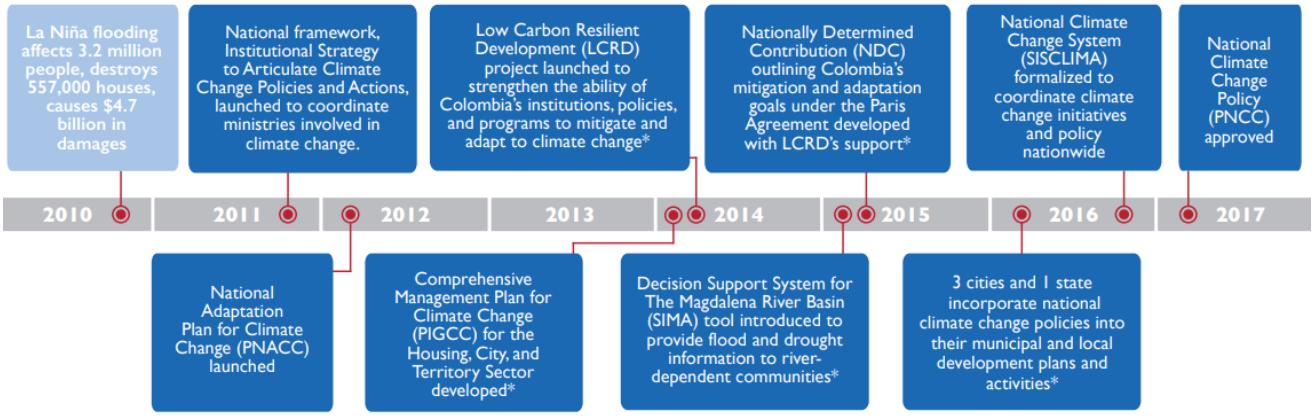
The territorial proposed strategies are:

- Climate resilient and low carbon rural development
- Climate resilient and low carbon urban development.
- Climate resilient and conservation of ecosystem and their service.

Additionally, two sectoral strategies are proposed:

- Development mining and energy sectorswith low carbon and climate resilient
- Infrastructure development with climate resilient and low carbon.

Figure 3.Evolution of climate resilience in Colombia.



(*Source:* USAID Colombia, 2017b)

To implement these five strategies, appropriate instruments are required:

- Information, science, technology and innovation
- Education, training and public awareness
- Climate change management planning
- Financing and economic instruments.

The policy has also proposed a planning cycle for the actions. The cycle has begun with the formulation of long-term national strategies:

- Colombia'slow-carbondevelopmentstrategy (ECDBC) (Estrategia colombiana de desarrollo bajo en carbon)
- Nationalclimatechangeadaptationplan (PNACC) (Plan nacional de adaptación al cambio climatico)
- National strategy for reducing emissions from deforestation and forest degradation (ENREDD+) (Estrategianacional de reducción de emisiones y deforestación)
- National disaster risk management plan (Plan nacional de manejo del riesgo y desastres)
- Financial protection strategy against disasters (Estragia de financiacion de protección contra desastres)
- National climate financing strategy; (estrategia nacional de fianciamiento del clima)

Table 1 - Action Lines of strategies in the National Climate Change Policy

Strategic line	Action lines
Rural development with climate resilient and low-carbon	▪ Promote agriculture, forestry and fisheries production to improve competitiveness and food security. ▪ Generate and disseminate strategic agro-climatic information for development climate resilient agriculture, climate insurance and early warning systems.

	▪ Promote the efficient use of soil, low-carbon livestock intensification, reduction of deforestation and technical assistance or technology transfer. ▪ In post-conflict scenarios, provide productive alternatives and access to land, in terms of productive system resilient. ▪ Promote technologies and adaptation and mitigation options in agriculture, livestock, agroindustrial and biofuel sectors. ▪ Promote a climate resilient, low-carbon, and territorial ordering in no-agricultural sectors (i.e. tourism). ▪ Promote the sustainable forest management, sustainable use of natural resources and restoration of degraded areas.
Urban development with climate resilient and low-carbon	▪ Provide urban resilient infrastructure to flooding or sea level rice (e.i. aqueduct and sewerage systems). ▪ Reduce climate risk due to water shortage, through incentives for efficient water use, losses reduction and unaccounted-for water. ▪ Provide an efficient and integrated public transport with low carbon and climate resilient. ▪ Reduce the generation of solid waste. Promote the reuse, recycling and use of waste, including energy recovery from waste and sanitary landfills. ▪ Encourage residential and non-residential energy efficient and promote green and sustainable construction. ▪ Decrease exposure to floods and emission through to cities development compact and interconnected way. ▪ Generate scientific knowledge for CO2 uptake by marine and coastal areas.
Management and conservation of ecosystem and their services for development with low-carbon and climate resilient	▪ Promote the conservation and restoration of terrestrial and marine-coastal ecosystems that favor the adaptation to climate change of socioeconomic systems. ▪ Incorporate impact of climate change scenarios in the management, conservation and restoration of the terrestrial and marine-coastal ecosystems. ▪ Incorporate in the territorial planning and sectoral development, actions of management and conservation of the ecosystems and their services. ▪ Strengthen forest governance to prevent deforestation and forest degradation. ▪ Encourage the development of urban systems that save natural resources. ▪ Promote strategies and territorial agreements to resolve conflicts for access to vulnerable environmental services between economic sectors and communities. ▪ Evaluate and strengthen the institutional capacity of environmental authorities.
Development mining and energy sectors with low carbon and climate resilient	▪ Integrate policies, instruments and regulation on expansion of electricity supply, adaptation objectives to climate events and low-carbon development measures. ▪ Evaluate biofuels use with low carbon footprint throughout their life cycle and prevent their potential impacts on water resources, food security and biodiversity. ▪ Encourage the energy diversification through instruments and technologies with benefits on GHG mitigation, air quality, climate resilience and energy security access. ▪ Promote the use of renewable energy sources complementary to non-renewable sources in order to supply electric power in non-interconnected zones (ZNI). ▪ Improve the adequate fugitive emissions management that occur during mining and hydrocarbon activities.
Infrastructure development with climate resilient and low carbon	▪ Incorporate climate change consideration in design of transport infrastructure. ▪ Evaluate the vulnerability of current transport infrastructure and implement options to reduce its climate risk. ▪ Promote share management of climate risk in public-private partnerships for construction, concession and maintenance of transport infrastructure.

	▪ Consider instruments to internalize the climate change costs in the transport sector (e.i. carbon and emission tax).

Source: Florian, M. Pabón, G. Pérez, 2017

3. Progress toward climate resilience in Colombia

According to the National Unit for Disasters Risk Management, from 1998 to 2012, 90% of emergencies in Colombia were related to hydro-climatological phenomenon. Therefore, it is a priority to articulate the mitigation processes and efforts to be performed, including through the identification of potential co-benefits and synergies with adaptation, in order to move towards resilient and sustainable climate scenarios. Mitigation actions reduce the risk of loss and damage as well as future adaptation costs; whileadaptation measures have co-benefits in reducing emissions(Florian, M. Pabón, G. Pérez, 2017).

Colombia assumes its Intended Nationally Determined Contribution as an opportunity to strengthen and build on the work done on sectorsand territories both in mitigation and in adaptation to climate change. This will contribute to formulateintegrated policies, plans, programs and projects, sharing with the different productive sectors,public and private entities, non-governmental organizations and civil society in general(USAID Colombia, 2017).

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Chapter 3. The resilience framework in Chile

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The increasing frequency of extreme events, such as flooding, landslides and coastal storm surges, have highlighted the fragility of urban areas in the face of climate change(IPCC, 2012, 2014; UN-Habitat, 2011). The climate change impacts projected for Chile include a generalised increase in temperatures and a reduction in rainfall over the next decades (Fuenzalida, Falvey, Rojas, Aceituno, & Garreaud, 2006), although the variations across the national territory due to its longitudinal extension and strong gradients on the east-west axis, from the Andes to the coast. Despite the threats and the diversity of conditions however, there is little evidence that cities have adopted resilience as a strategy for development to face these impacts, in spite of the high concentration of population (88%) in urban areas (INE, 2018).

Resilience can be understood as the capacity of socio-ecological systems to adjust and adapt in the face of natural and socio-economic perturbances at larger scales, and the resulting ability to return structures and functioning to a stable state, in as short a timescale as possible and better prepared for a future event. This takes into account considerations such as knowledge of the causes of the changes, the consequences of them and the preparations by individuals, communities and institutions, the capacity to absorb these impacts, the robustness of physical installations, and the strength of social networks and governance arrangements(Gallopín, 2006; UNISDR, 2009).If adaptation to climate change is understood as the processes that are associated with the required transformations, resilience is the condition that is generated; consequently, better adaptation processes lead to greater resilience.

In the Chilean case, rather than effective resilience in the face of adverse climate impacts, especially extreme hydro-meteorological events and drought, most capacity is reactive in origin (Pelling, 2010), which replicates a common historical precedent, whereby many cities have had to recover and reorganise following significant riskevents(Barton & Irarrázaval, 2016).To this can be added the fact that the most socio-economically vulnerable social groups are those most affected by these events. This reveals the fragility of urban areas and the weak or inexistent governance arrangements of formal or informal systems of social regulation, to combat these threats, or to anticipate and recover from them effectively (Henríquez, 2018).

The following chapter briefly reviews the Chilean urban system, followed by the principal instruments and urban resilience strategies at the national level. Some examples are introduced from the coastal zone before concluding with some key observations and recommendations.

1. The Chilean urban system in the face of climate change impacts

Chile is a largely urban country in a highly urbanised region. It is also highly centralized. Recent census data show that the Santiago metropolitan areas continues to be the most important hub in the Chilean urban system, concentrating not only the bulk of the population (45%, or6.220.197 people), but also the principal economic activities (or at least their headquarters and the declaration of their contribution to GDP). Following Santiago, the most important conurbations are Greater Valparaíso and Greater Concepción that have 866.268 and841.861 inhabitants respectively. Finally, there is a network of smaller cities of between 50.000 and 500.000 people that represent 29% of the national urban population, with the cities of Paine-Hospital, Mejillones andPozo Almonte registering the highest increases – over 40% - during the intercensal period2002-2017(INE, 2002, 2018). In spite of the fact that, proportionally, it is the intermediate cities that have shown the highest urbanization rates over the past two intercensal periods, it is still the traditional metropolitan areas that dominate the national urban profile.

The lack of explicit consideration of climate change effects in cities has been evident in the ways in which these cities have expanded over recent decades, with increasing use of designated risk areas and other areas where there has been a consolidation of heat island effects, loss of green space, degradation of natural areas, and a generalized increase in urban vulnerability. One explanation for this is the lack of adequate planning for climate change, also the lack of a national urban development policy from 1985until 2014 (the former having been approved under dictatorship). The new policy is not explicit regarding the importance of climate change however, preferring to outline a wide range of anthropic and natural risks facing cities and noting need to incorporate these into planning instruments (MINVU, 2014).

Generally speaking, these impacts have not been dealt with in detail in public policies, since much of the focus has been on the reduction of greenhouse emissions and other mitigation measures, with an emphasis on how mitigation can also favour – through co-benefits – the challenges of poor air quality that are faced by a large number of cities up and down the country (during the second government of Michelle Bachelet, 2015-18, 14 local air contamination reduction plans were approved and implemented). In this regard, the Ministry of Environment initiative to create an Emissions and Contaminants Register is worth noting, also the MAPS Project with its objective of pushing the country towards a low carbon development path(Henríquez, Smith, Qüense, Villarroel, & Treimun, 2018), also other proposals promoted by the UN at the regional scale (Ruiz Tagle & Jordán, 2013; Sánchez Rodríguez, 2013).

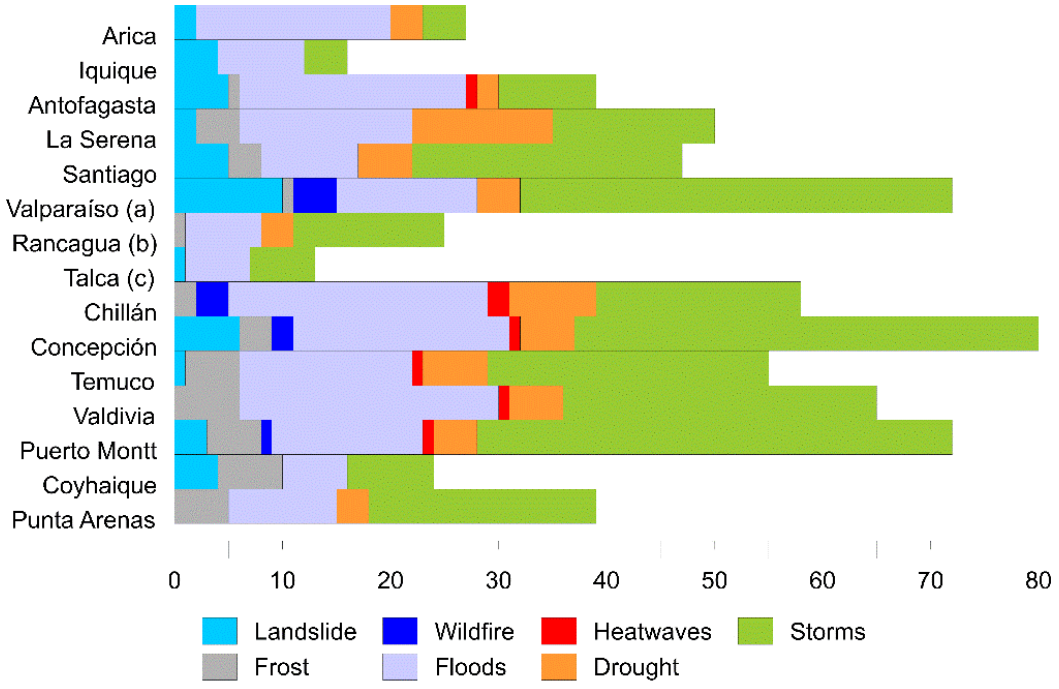
Despite these initiatives however, and given the urban predominance in the country, it is adaptation to climate change that concentrates – or should concentrate – most concern among authorities and communities. Wildfires, flooding, landslides, storm surges, among other events, are the impacts that are leading to severe damage to the stability of the urban system and put at risk the effective implementation of the national urban development policy (MMA, 2014, 2018a).

Risk management instruments in Chile tend to more reactive rather than preventative or adaptative

(IPCC, 2014; Pelling, 2010). In certain ways, disasters have defined public policy innovations in urbanisation, reconstruction and urban renovation, including the earthquakes of Talca, Chillán and Valdivia that influenced building regulations (Arenas, Lagos, & Hidalgo, 2010). This explains why the 27 February 2010 earthquake generated such little impact in terms of loss of life from damage to buildings and the urban fabric. Despite these positive responses to earthquakes however, implementation of measures to increase resilience to climate change remain weak. For example, the national report of the Chilean government to the Habitat III forum in Quito in 2016 highlighted the fact that the country has important exposure to natural and anthropogenic risks, as evident in a series of events over the previous decade. Consequently, the incorporation of specific measures in urban and regional planning insturments remains an essential step for facing the challenges of climate change. This should involve the approach based on resililence in order to reduce and mitigate impact sas well as instituting systems and processes for recovery and repair (Gobierno de Chile, 2016).Chile is not the only countries in this situation in the region, since the Declaration of Quito in October 2016 – *The New Urban Agenda* - emphasised the importance of increasing resilience through adaptation measures (UN-Habitat, 2016).The Regional Action Plan developed during 2017 – led by UN ECLAC – emphasised that climate change is now a priority for sustainable urban development (CEPAL, 2017).

For Chilean cities, these events are increasingly important, for example in the number of events that have been registered over recent decades that have led governments to declare ‘catastrophe zones’ or significant damage. According to a study by Henríquez et al (2019), in the regional capitals of the country, there have been more than 700 disaster events over the past fifty years. For example, in coastal cities, such as Concepción, flooding events and storm damage have been particular intense and damaging.

Figure 1. Climate-related disasters registered in regional capitals, 1965-2015, according to disaster zone declarations and news sources.



Source: Henríquez etal.(2019).

2. Chilean urban resilience strategies and instruments

The most important public policy on climate change at the national level relates to the National Climate Change Adaptation Plan from 2014, which was generated as a result of the National Climate Change Action Plan (2008-12). This document, produced by the Ministry of Environment, was approved by the Council of Ministers for Sustainability and Climate Change on 1 December 2014 (MMA, 2014) and is valid for the period 2015-2019. Although it does not emphasise urban resilience per se, it is centred on the concepts of efficiency and management of the risks that directly or indirectly influence it. The plan includes a conceptual framework and guidelines for adaptation in Chile, articulating the need for specific plans in the following sectors: agriculture and forestry, biodiversity, fisheries and aquaculture, health, infrastructure services, and cities (MMA, 2018b).

Also at the national level it is important to highlight the Intended Nationally Determined Contribution (INDC) of Chile towards the Climate Agreement of Paris 2015 and the Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change (2016). Both reports were developed by the Ministry of Environment(MMA, 2015, 2016)and the emphasis is principally on mitigation and proposals for certain energy-intensive sectors.Despite the urgency of adaptation, as experienced by the prevalence of catastrophic events, e.g. drought, wildfires and flooding (Centro de Ciencia del Clima y la Resiliencia (CR2), 2015; de la Barrera, Barraza, Favier, Ruiz, & Quense,

2018), both reports are weak in terms of adaptation in relation to the emphasis on mitigation; in the INDC (INDC, 2015), only 3 of over 30 pages are dedicated to adaptation measures.

From the perspective of risk management, it is also relevant to note the DIPECHO Action Plan for South America 2011-2012, which provides a general vision of current risk conditions, including threats, vulnerability and capacities present in the country (Khamis & Osorio, 2012); this report updates the *Análisis de lascondiciones de riesgoen Chile*presented in 2010.More recently, the National Policy for Disaster Risk Management (ONEMI, 2016), has the objective:"to grant the Chilean State an instrument or framework to allow it tocarry out integral disaster risk management, linking general policy with transversal policies and sectorial policies, and within which the actions of prevention, response and recovery can be carried out in the framework of sustainable development in the event of any disaster".This policy prioritises five strategic areas linked to the Hyogo Action Plan. In the area of institutional strengthening, the National Platform for Disaster Risk Reduction, coordinated by the ONEMI (National Emergency Office), and Disaster Risk Management in policies, strategies, and sectoral and spatial plans, at all levels of political administration. Although this was formerly designed in the light of the Hyogo conference, and more recently the Sendai Strategy, it is important to emphasise the synergies that exist between both agendas (risk and climate change) in terms of strengthening urban resilience. It is precisely this need to link agendas of development, disasters and climate change that forms the basis of the IPCC special report on extreme events (IPCC, 2012).

In urban areas, without doubt the most notable advance in terms of policy has been the 2018 approval of the Climate Change Adaptation Plan for Cities (2018-22). This plan is coordinated by the Ministry of Environment and has the objective of "proposing adaptation guidelines for cities in the face of climate change, strengthening, with a prospective vision, the capacity of inhabitants to respond to different impacts, with a view to improving spatial equity."(MMA, 2018a). The specific objectives are as follows:

1. To engage with climate change from a territorial perspective, through urban planning and land use.
2. To generate investments and projects that take climate change into account, improving adaptation capacity in cities.
3. To develop capacities to prevent climate change impacts and devise response mechanisms for climate change effects in urban areas.
4. To promote coordination and cooperation to confront the different effects of climate change in cities.
5. To strengthen training, and the development of research and dissemination, that are necessary for implementing actions for climate change adaptation.

There are five strategic areas and ten lines of action relating to: Urban planning and land use; Sustainable infrastructure and construction; Reduction and management of disaster risk associated with climate change; Local management and interinstitutional collaboration; and Dissemination. Various of the 35 measures and actions are based on urban resilience and sustainability. For example, measure 7 on strengthening climate change adaption through public infrastructure investment, measure 24 on strengthening intersectoral

coordination to deal with urban climate change challenges, measure 27 on actions for environmental sustainability in the context of climate change in intermediate cities (based on the IADB ICES experience), and measure 28 on promoting actions for reduce disaster risk in neighbourhoods. All these measures propose specific results, timings and responsibilities, where the local level plays a strategic role in urban and territorial resilience.

Although there are objectives associated with cities in previous plans, e.g. the integration of climate change in land use plans, and the reduction of risks in coastal settlements (from storm surges and rising sea level), both in the National Climate Change Action Plan of 2008, progress was slow and weak, as documented in the mid-term evaluation of the Plan. This new sectoral Plan, which is clearer in terms of details of responsibilities of local government and the Ministry of Housing and Urbanism, constitutes a first initiative in prioritising urban resilience to climate change in Chile.

3. Experiences and practice

In spite of the delay in generating a sectoral urban policy, there have been different initiatives set in motion in the meantime. One of the more interesting responses at the urban level in Chile is the 100 Resilient Cities project of the Rockefeller foundation, applied to Santiago through the *Resilience Strategy: Human and Resiliente Santiago*, led by the Metropolitan Region Intendent in 2017.It is a resilience strategy centred on climate change and risk areas, including adaptation and mitigation. The conceptual framework of the initiative proposes measuring the capacity of the city for maintaining its operations, adaptation and behavioural change once confronted by an event.The following impacts are noted in the strategy: (1) geophysical phenomena such as deep (subduction zones) or surface earthquakes (the San Ramón fault), also volcanic eruptions; (2) extreme climatic phenomena such as flooding and drought cycles, which affect the greater part of the Metropolitan Region;(3) landslides as a result of heavy rainfall in urban areas built in risk zones;(4) wildfires in rural areas of the region. This proposal is not a legal instrument as such, since the official strategic plan is the Regional Development Plan (to 2021) (Equipo de Resiliencia Santiago Resiliente, 2017).Another international initiative is the InterAmerican Development Bank (IADB) project *CiudadesEmergentes y Sostenibles*, that promotes local assessment, an indicator set and an emphasis on linking specific urban initiatives to a sustainability strategy. In Chile, two cities have benefited from support through this project: La Serena and Puerto Montt.Adaptation to climate change is present in both of these city strategies.

In terms of municipal government, the work of Adapt-Chile is most relevant since this NGO has coordinated activities in urban localities (Adapt-Chile, 2018).Financed by national and international multilateral organisations that include the EU, CEPAL, GIZ, FCIL, the Ministries of Energy and Environment, and the Avina Foundation,Adapt-Chile is a non-profit that was set up in January 2013 with the objective of promoting climate change integration into local government decision-making, to improve local responses. The work of this organisation is focused on local governments but it has also collaborated with other government tiers, firms and academic centres.Although focused on Chile it has carried out similar work in other countries in the region.

Its most important contribution is the organisation and coordination of the Chilean Network of Municipalities against Climate Change(www.redmunicc.cl) which currently accounts for 46 local governments in 15 regions of the country. Other projects involve: the generation of local capacities, with special emphasis on tools and methodologies for technical personnel; improving science-policy dialogue through communication and collaboration bridges between academics and decision-makers in local and regional government; critical analysis, design and formulation of public policies and governance arrangements for climate change; and the generation of spaces to make the strategic role of local governments more visible, such as the Forum for Mayors against Climate Change (Adapt-Chile, 2018).The experience of this ONG in knowledge transfer and adaptation capacity building has resulted in it becoming the most relevant actor in this field in Chile, and also an important player in the region.

In terms of research, there are different national academic centres that have engaged with climate change issues. Three of these, which have 'priority area' funding from the National Science and Technology Council, are CR2, CEDEUS and CIGIDEN. The Center for Climate and Resilience Research (CR2),based at the Universidad de Chile, works on improving knowledge on climate systems as well as increasing resilience to change in the national context.Although not a central part of its activities, the Center for Sustainable Urban Development (CEDEUS), which links researchers at the Pontificia Universidad Católica de Chile and the Universidad de Concepción, focuses on urban transformations in which climate change is increasingly relevant, whether in connection to urban energy efficiency and emissions, or expansion onto risk zones (CEDEUS, 2018).The third of these centres, CIGIDEN (Integrated Management of Natural Disasters) is focused on knowledge for responding effectively to extreme natural events, through preparation, response, recovery and mitigation (CIGIDEN, 2018); climate change impacts are an important contributor to this list of events. While CR2 generated a key policy paper relating to the 'mega-drought' in the country, CEDEUS has worked with local governments on measuring their carbon footprint, while CIGIDEN co-produced – with the National Commission for Resilience to Natural Disasters (CREDEN), the National Council for Innovation in Development (CNID) and other public and private organisations – the National Strategy for Research, Development and Innovation for a Chile resilient to natural disasters(CREDEN, 2016).

Similarly important, and operating over a longer period of time is the UC Global Change Center.This centre brought together researchers across the Pontificia Universidad Católica de Chile, who were working on biophysical and human climate change-related issues, dissemination, continuous education, and links to other stakeholders(CCG UC, 2018). It has drafted several of the government adaptation and mitigation plans at the national and sectoral levels.Other research projects that are worthy of mention, and that relate to the Santiago Metropolitan Region specifically, are Risk Habitat Megacity (RHM), Climate Adaptation Santiago(CAS) and the MAPA project (vulnerability and adaptation to climate change variability in the Maipo Basin).

RHM was financed by the German federal government in order to generate inputs for public decision-making around strategic planning of the Santiago Metropolitan Region, in particular

the Regional Development Strategy of 2010(Helmholtz-Association, 2011). The principal problem that it faced was the stability of the public sector political representatives: there were 5 Intendents during the five-year duration of the project, and there was also a transfer problem at the end of the project when the results were not incorporated into the new Development Strategy in a systematic way given the change of national government in 2010. The CAS project was linked to RHM with many of the researchers in the Helmholtz Association, the Universidad de Chile and the Pontificia Universidad Católica de Chile taking their work from RHM to concentrate on the challenge of adaptation to climate change. The objective was to devise a participatory process, informed by scientific research, to generate an adaptation plan for Santiago, focusing in the themes of vulnerability, water and energy(CAS, 2013; Krellenberg & Hansjürgens, 2014). The final plan of 14 measures was supported by a 10-session participatory process with a large number of stakeholder organisations, and it was presented to the Intendent in December 2013(Barton, Krellenberg, & Harris, 2015). Unfortunately, the following year was also an electoral year and the government changed hands once again.The plan would not be taken up by the new government. While CAS focused more on the urban area of the Metropolitan Region, the MAPA: Maipo adaptation plan (2012-2015 project developed by Centro de Cambio Global UC and financed by the Canadian Development Agency (IDRC), put more emphasis on basin-wide processes and modelling of water demand and supply across different sectors. Widespread participation was also a feature of this project, with workshops and roundtables(MAPA Maipo: Plan de Adaptación, 2017). As with the other projects, the final products were not explicitly incorporated into regional policy, however the findings have been influential in other policy documents in which these researchers have been involved, with the Ministry of Environment in particular.

Finally, it is important to note that the proposal for the protection of urban wetlands is also highly relevant for urban resilience.Coastal wetlands in particular provide critical ecosystem services for controlling flood events and, as green infrastructure, have a role in mitigating climate change impacts. Nevertheless, currently they have no official recognition on spatial planning instruments, being considered as part of urban expansion zones, leading to draining and indiscriminatein-filling. In 2018, a debate was generated on a Law for Urban Wetlands Protection in the Senate Commission on Environment and National Property. This law would require changes to the general laws on Environment, and Urbanism and Construction(Martínez, 2018). The problems associated with the loss of wetlands to urban development are documented in Section II. b) Natural resources management and resilience.

Conclusions

One of the most significant challenges that has been identified in terms of the application of adaptation mechanisms is that of governance arrangements. As can be seen in the examples of adaptation initiatives, there is a lack of continuity in public authorities and an absence of stable networks of coordination between different key actors. This in turn is one of the principal weaknesses for implementing strategies for resilience.

There are also difficulties in articulating private sector actors in adaptation and risk management proposals.This accentuates further the issue of governance and intersectoral coordination, especially in terms of the management of risk cycles: mitigation, preparation, early warning systems, recovery, and response. Privatisation has left much critical infrastructure in the hands of private firms (water supply, sewerage, electricity, etc.), which can generate problems in terms of urban sensitivity and fragility, in relation to decisions relating to short-term accumulation versus longer-term public goods(Henríquez, 2018).The influence of private firms can also be seen in the Rockefeller-financed 100 Resilient Cities strategy (2012-2021), generating tensions and confusion in terms of formal strategic planning instruments.

In summary, it is vital that urban climate diagnostics in Chile are improved, also the coordination of stakeholders through governance arrangements, especially in cities comprised of more than one municipality. This is essential for channeling and managing the necessary actions for participative adaptation measures for promoting more sustainable and resilient cities. Following a decade of partial and fragmented initiatives in the field of urban development in the country, with regards to climate adaptation and increased urban resilience, the approval of the Adaptation Plan for Cities in March 2018 marks a turning point in the incorporation of the impacts of climate change in urban area planning and management. It will also provide a context for generating synergies with the national risk reduction agenda and the urban development policy.

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Chapter 4. Institutional Framework of Climate Change in Ecuador

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Introduction

The following section presents the main frames used for the topic of climate change in the country of Ecuador. All the instruments base their strategies on the National Development Plan called “Toda una vida”. The main instruments and strategies used for adaptation, mitigation and resilience to climate change in the different regions of Ecuador are detailed as well.

1. Institutional strategic plan 2018-2021

The goal of the plan is the administration of the National Decentralized System of Participatory Planning (SNDPP) in order to contribute to the economic growth and sustainable development of the country.This plan considers that state institutions and the cycle of public policies must be consolidated.The strategic objectives are developed to be aligned with the national development plan, which are valid until 2021.

Regarding the organizational structure, the Regional Undersecretaries main task is to direct and coordinate the zonal planning within the framework of the National Competencies System and the SNDPP, and to promote social participation in the different processes that the National Secretary of Planning and Development (SENPLADES) has in charge.

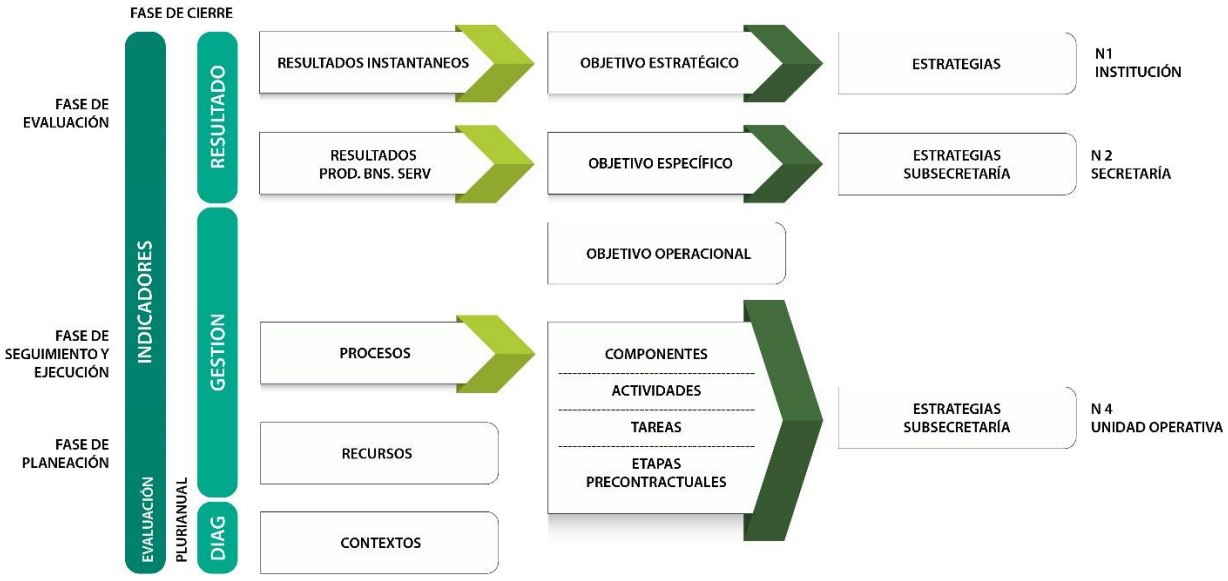

Figure 1: Methodological structure for monitoring and evaluation of the Institutional Strategic Plan
Source: Adapted from General Coordination of Planning and Institutional DevelopmentManagement: Institutional Planning and Monitoring and Social Communication

2. National development plan 2010-2021 “toda unavida”

The National Development Plan 2017-2021 which is called "*Todaunavida*" (A lifetime) is the first planning tool that addresses governance for compliance with government programs and the achievement of national goals; this instrument is structured as follows:

Figure 2: General Structure of the National Development Plan 2017-2021
Source: Adapted from National Development Plan 2017-2021 LIFETIME
Preparation: Senplades

The National Development Plan (2017-2021) was built on the Government Program of President Lenin Moreno Garcés, entitled "An Agenda for society, education, production, and decent work"(Senplades, 2017). Such project is supported by 12 revolutions which are included in this plan. These 12 revolutions stablish the major themes of the public agenda during the corresponding period and are described in the following list:

- Political and Ethic
- Economic

- Production and Labor
- Rural and Social
- Ecological
- Knowledge and Skills
- Cultural
- Justice
- Security and Coexistence
- Urban and Territories
- Sovereignty and Integration
- Youth

Similarly, the National Plan has been directed to comply with the proposals made by the government during the electoral campaign, including a set of emblematic interventions such as the “Toda unavida” Plan or “MingaAgropecuaria” Plan. These instruments were created to address critic topics and to seek for specific outcomes, which respond to the reality of the country and to improve the living conditions of people (especially those who need it most).

The SNDPP center its content in compliance processes. It specifies the institutions, the instruments and the tools for planning and management that allow the interaction of the different social and institutional actors. All of these objects are detailed to organize and coordinate development planning which is required at all levels of government.[2]

The National Spatial Strategy is complementarily defined as "the expression of national public policy in the territory and is an instrument of territorial planning at national level, including the criteria, guidelines, and action guidelines on land management, natural resources, its great infrastructure, human settlements, economic activities, great facilities, and the protection of natural and cultural heritage.This strategy is based on national objectives and policies contained in the national Development Plan. The Strategy will contain specific policy guidelines for border areas, the Amazon, the Galapagos special regime and the coastal marine territory, without detriment to its national character "[3]

The National Spatial Strategy is incorporated into the National Development Plan to enhance the capabilities of the territories, articulate the interventions to the national objectives and define specific guidelines for the deconcentrated and decentralized public action. This means, harmonious coordination between national and subnational planning through multilevel governance; and implementation of effective, participatory and permanent mechanisms for monitoring, evaluation and accountability. Therefore, the National Development Plan (2017-2021) has become the instrument that articulate and bind all elements of governance in Ecuador and enables coordination between the Central Government and the autonomous decentralized governments[4]. However, beyond their technical functions, the Plan and its National Spatial Strategy are instruments for social and

[2]Constitution of Ecuador, Art. 279, 2008

[3] Organic Law on Territorial Planning, Land Use and Management, 2016

[4]Constitution of Ecuador, Art. 280, 2008

political dialogue, through which we can identify similarities and agree on a joint work for the benefit of all.

National Development Objectives

Axis 1: Rights for All throughout life

Objective 1: To ensure a decent life with equal opportunities for all people

Objective 2: To affirm intercultural and multinational, revaluing the different identities

Objective 3: To guarantee the rights of nature for present and future generations

Axis 2: Economy in the Service of Society

Objective 4: To consolidatethe sustainability of economic and social solidarity system, and strengthen dollarization

Objective 5: To promote productivity and competitiveness for sustainable economic growth and solidarity redistributive way

Objective6: To developproductive capacities and environment to achieve food sovereignty and rural Good Living

Axis 3: More society, better State

Objective7: To encourage a participatory society, with a close to the service of citizenship State

Objective8: To promote transparency and responsibility for a new social ethic

Objective 9: To guarantee sovereignty and peace, and strategically position the country in the region and the world

3. Organic environment code (coa)

This code aims to establish the legal and institutional framework for planning, coordinating, and monitoring public policies in order to design, manage and execute local, regional and national actions on adaptation and mitigation of climate change transversely, timely, efficient, participatory, coordinated and articulated with the international instruments ratified by the State and the principle of common but differentiated responsibility.

National policies in this area will be designed to prevent and respond to the effects of climate change and contribute to global efforts against this anthropogenic phenomenon.

The articles detailed inthis code define actions to promote care and adequate responses to climate change, generating policies and procedures that help to fulfill the objectives

proposed by this code.[5] Article 248 determines the state's objectives on climate change which are:

1. To prevent and avoid the occurrence of environmental damage and thereby reduce the effects of climate change;
2. To develop education, research, innovation, development, disaggregation and technology transfer on climate change programs;
3. To reduce the vulnerability of people and ecosystems of the country against the effects of climate change;
4. To regulate and control the actions and measures for adaptation and mitigation of climate change;
5. To coordinate, implement and enforce national policies on climate change, throughstate institutions and different levels of government in the scope of its powers;
6. To promote sustainable development in territorial management models and planning at local, regional and national levels;
7. To establish mechanisms to manage risks and disasters or emergencies caused by climate change impacts;
8. To ensure on-timeaccess to necessary information to properly manage risk through adaptation and mitigation measures;
9. To promote the use and ensure access for renewable energy; and,
10. Other established for the purpose.

4. National climate change strategy 2012-2025 ecuador

The Government of Ecuador has seen the need to develop a National Strategy of Climate Change (Ministry of the Environment, 2012) of a transversal nature to the different sectors.This strategy leads to a concerted, ordered and planned action that promotes internalization of the climate issue in public and private instances throughout the country. Moreover, it considers the corresponding political, regulatory and institutional framework.

The coordination of efforts in the different levels of management is of fundamental importance to ensure the consistency required and to improve the impact of this Strategy. The strategy wants to achieve by 2025 that Ecuador could handle the challenges of climate change, ensuring good living and the rights of nature.

It operatesover9 principles that guide the implementation of the National Climate Change Strategy to achieve the vision outlined by 2025.

1. Regional and international coordination.
2. Consistency with international principles on climate change.
3. Emphasis on local implementation.
4. Environmental integrity.
5. Citizen participation.
6. Proactivity.
7. Protection of vulnerable groups and ecosystems.
8. Inter-generational responsibility.

[5]Organic Environment Code, 2017

9. Crosscutting and comprehensiveness.

For this, there are two strategic lines; The first one relates to adaptation to climate change aimed at reducing the social, economic and environmental vulnerability to the impacts of climate change. The second strategic linefocuses on mitigating climate change by reducing the gas emissions,the greenhouse effect and by increasing carbon sinks in strategic sectors.

5. National biodiversity strategy

The Ecuadorian Constitution (2008) and the National Development Plan are cornerstones of the political agenda, which is inspired by the natives ancestral knowledge and posit the regime ofGood Living or *SumakKawsay* as a new form of citizen coexistence in diversity and harmony with nature. From this historic statement, Ecuador has enshrined in its Constitution the rights of nature and recognized as fundamental duties of the State: planning national development, eradicate poverty, promote sustainable development and equitable redistribution of wealth to achieve Good Living.[6]

The 2030 development vision, aligned within the framework of the SNDPP, involves the implementation of successive stages of government and steps that society must take to materialize a new mode of accumulation, distribution and redistribution of wealth. In this scenario of changes, biodiversity is the spearhead to reach the superior objectives of transforming the productive matrix and eradicating poverty. However, moving from a primary-extractivist development model dependent on the export of raw materials to a generating economy with high added value in sustainability principles requires the responsible use of the state's strategic natural resources.(Ministry of the Environment, 2015)

Therefore, it is essential to have a specific instrument for managing biodiversity that, while recognizing the intrinsic challenges to the process of structural change that the State is going through, proposes a set of measures that guarantee the human right to live in an environment healthy, free of contamination and sustainable, as well as ensuring the rights of nature. This means deepening knowledge of available and potentially usable biological resources, protecting the intangible values associated with them, restoring ecosystems, undertaking sustained processes of research, development and technological innovation based on biodiversity; and, strategically linking local initiatives for the use of biodiversity with national and global economic dynamics.

6. Plan of land use and occupancy (puos)

The plandelimitszonesof the geographical area of the Metropolitan District of Quito (DMQ)and establishes land use and compatibility relations; occupation and buildable land through the definition of load factors; the volume and height of buildings; standards for enabling the ground; categories and dimensions of the tracks; affected areas and special protection needs.[7]

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[6]Constitution of Ecuador, Art. 3, 2008

[7]MetropolitanOrdinance No. 0172

Allocation in urban land use, urban and rural expansion, is set according to the destination of each area defined by the structure model established by the Metropolitan Land Management Plan. It is classified in:

Residential use, multiple use, industrial use, equipment, cultural heritage use, natural resource use, agricultural use, residential, commercial and service sectors.

7. Atlas of natural threats and exhibition of infrastructure of the metropolitan district of quito

The atlas contains information on the entire DMQ which determines the level of vulnerability that each sector has according to the different types of exposure to both natural and human risks. It details the exposure that exists regarding the public infrastructure. The DMQ territory is characterized by its geodynamic conditions (earthquakes and volcanic eruptions), geomorphological (landslides, subsidence, mudflows, among others), hydrometeorological (torrential rains, floods, hail, etc.) and anthropic that distinguish their natural and urban landscapes. In this scenario, the constituent elements of the Metropolitan territory (population, infrastructure, services, production, natural areas) are exposed to multiple and diverse threats that originate in the dynamics of nature and the social and economic interventions of the population.(Municipality of the Metropolitan District of Quito, 2015)

In the physical complexity of this area, the public services that serve as support for the development of the activities of the inhabitants of the DMQ present different levels of fragility depending on their location and exposure to the threats that are generated in the territory. In this situation there are infrastructures considered fundamental to guarantee the integrity of the population and the functioning of the city in case of crises, such as mobility systems (roads and airport), drinking water and sanitation, electricity, telecommunications, networks of health service, education, and public administration.

8. Metropolitan development and territorial plan (pmdot)

It is a comprehensive territorial ordering instrument of the DMQ that aims to organize the land of the entire metropolitan territory, to achieve a harmoniousand sustainable development through the best use of natural resources, the organization of space, infrastructure and activities according to their physical, environmental and social impact in order to improve the quality of life of its inhabitants and achieve good living.[8]

The principles of the strategic planningare:

a) Quality of life for all citizens.
b) Greater opportunities for all.
c) Correspondence between development, land use and planning.
d) Crosscutting and comprehensiveness.

[8]MetropolitanOrdinance No. 0172; Article ... (20), section 1.

e) Innovation towards a smart city.
f) Multiple centralitiesof Quito.
g) Responsibility.

Within the city, sustainable development is considered necessary, which is why strategic planning is generated. This strategic planning is understood as a tool to meet the challenges posed by a sustainable future. It must be consistent with a change in vision that has been carried out to date. had respect to the city. This paradigm shift implies understanding, guiding and integrating the essential factors that influence territorial development, such as the availability of natural resources, economic and social dynamics, identity and socio-cultural fabric, geophysical characteristics and the infrastructure network, just to mention some. In this light, planning is the guiding instrument that drives the dynamics and guides citizens towards a sustainable human and territorial horizon.(Metropolitan Council of the DMQ, 2015)

Although it is true that the regulations in the country are aimed at guaranteeing the quality of life for all citizens, not all of them respond in a timely manner to the impacts that have arisen and could arise in the future because of climate change. Therefore, local, regional and national environmental education must be increased at all levels and instances to guarantee a high level of knowledge about the factors that intervene in climate exposure as an external element that cannot be controlled by society, generating timely and effective reactions, so that this same society can assess their sensitivity to these external factors. It is important for this to consider their adaptive capacity to these events, assuming innovations for development, planning based on mutual non-individualistic interests, in such a way that the potential impact on the territory is seen before of its occurrence and if this occurred, that the community is resilient before any capital damage which is achieved through the application of the public policy documents mentioned and discussed above.

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Chapter 5. Framework for climate adaption and resilience in Italy

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In Italy the institutional and programmatic framework for resilience can be xxxx to three main themes:

1. Climate adaptation and resilience
2. Disaster risk reduction
3. Sustainable development

The main themes are developed through specific policy documents, described in the following paragraphs.

1. Climate adaptation and resilince

Following the international and European vision, the Italian Ministry for Environment, Land and Sea (MATTM), in charge of climate change policy, in 2015 has approved the Italian National Adaptation Strategy to Climate Change (NAS).

The Strategy is a tool for encouraging adaptation actions in planning activities at national, regional and local level. After approval by the "State-Regions Unified Conference" on the 30th of October 2014 (14/136/CU6/C5), the NAS was finally adopted on June 2015 with a Directorial Decree of the Climate Change and Energy General Director (DG-CLE) establishing specific objectives to be reached by 31th December 2016.

In order to elaborate the NAS some background documents have been published

- an analysis of European and National policy framework for adaptation;
- a state of the art on the knowledge on climate change, impacts, vulnerability and adaptation for relevant sectors
- elements for a strategy document.

The NAS implements at the national level the European Adaptation Strategy to Climate Change 2013 and provides a set of adaptation actions in order to mitigate and take advantage from climate change for the different areas and sectors. Such actions are divided into 5 categories: non-structural or soft actions; ecosystem approach based or green actions; infrastructural and technological or grey actions; brief and long term actions; transversal actions (soft, green, grey).

The main adaptation activities already implemented in Italy and collected by the NAS concern the most vulnerable sectors as agriculture, water use, forests, human health, flood risk, desertification and drought, coastal areas, biodiversity, tourism, urban settlements.

Resilience is often mentioned as the main goal and result of the application of the National Strategy (through the Adaptation Plans at the national and regional levels). It is particularly important at the community level and looking at the adaptation of production sectors. Resilience of urban settlements is directly mentioned looking at the adaptation of urban areas. It is then mentioned throughout the document when addressing the need for action to enhance climate change adaptation and reduce the damage in urban areas, where risk may produce huge damages and economic losses, which could overpass adaptation costs. With reference to urban settlements, the NAS foresees the strong need of actively engage citizens in defining urban adaption strategies, promoting “no regret interventions”, expected to solve existing problems while providing socio-economic benefits to citizens, in order to increase their adaptation capacity (Ministry of Environment, 2015).

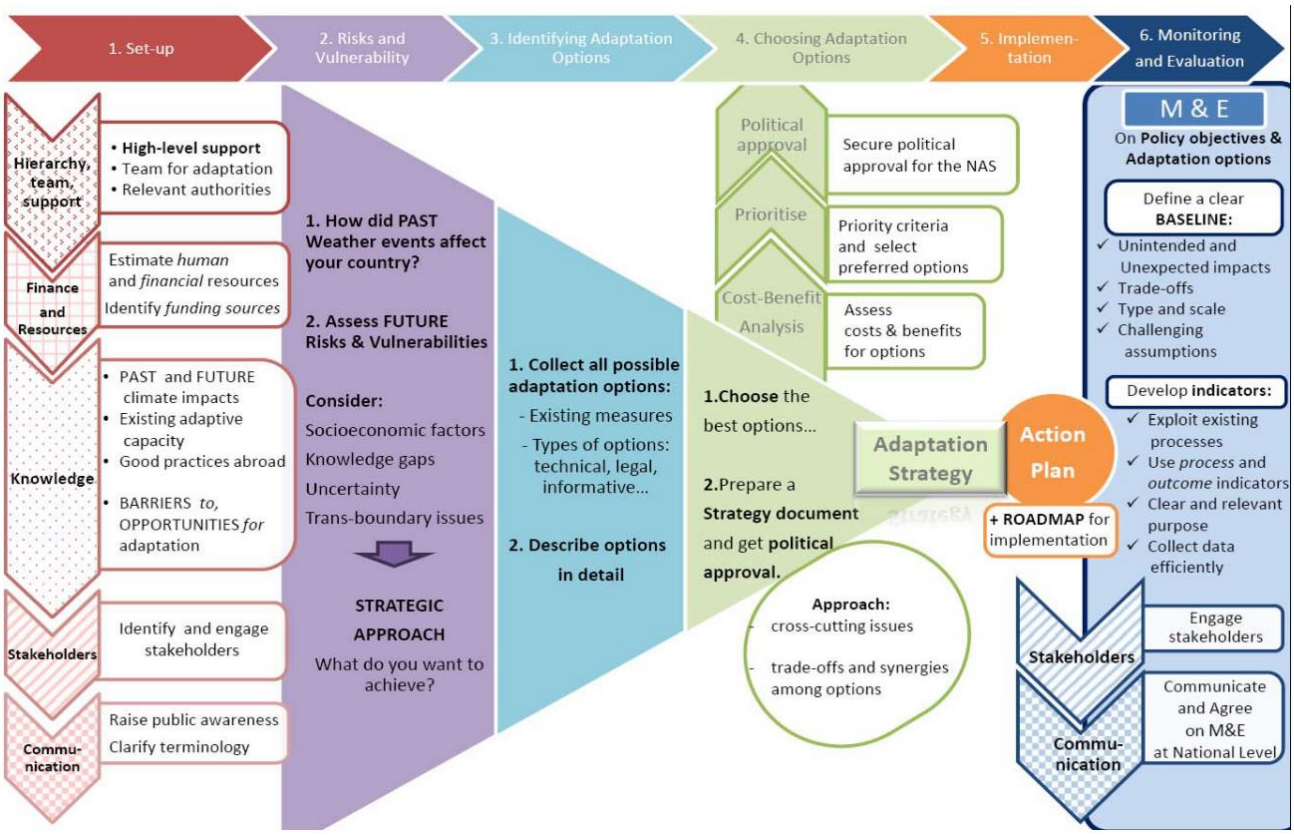
The approach adopted by Italy in elaborating the strategy includes:

- The collection, analysis and interpretation of data and scientific information about impacts, vulnerability and adaptation issues on economic sectors
- The study on adaptation governance processes and issues
- The involvement of stakeholders and national institutions in delivering priorities on climate adaptation actions

Following such an approach, the strategy delivers an overview on how to address climate impacts by focussing on 9 principles, deriving from the European Adaptation Strategy elaboration process (EC, 2013).

- Adopt a knowledge and awareness-basedapproach
- Promote partnership as well as stakeholders’ and citizens’ engagement
- Work jointly with the research and innovation sector
- Consider complementarities between mitigation and adaptation
- Adopt the precaution principle to address scientific uncertainties
- Adopt a flexibility-based approach
- Adopt a sustainability-based and intergenerational approach
- Adopt an integrated approach in the adaptation assessment
- Adopt a risk-based approach in the adaptation assessment
- Mainstreaming adaptation into existing policies

Image 1 – The five steps of the adaptation policy process, to be considered as iterative and closely interlinked phases.



Source (EC, 2013)

The Ministry of Environment, with the support of the Euro-Mediterranean Center for Climate Change (CMCC), has been working on the implementation of the NAS through the development of the Italian National Adaptation Plan for Climate Change (NAP). The NAP represents a national framework for other ministries, regions, local authorities with technical-scientific background information, for the integration of adaptation within policy processes. It delivers a detailed description of the adaptation actions focussing on the actors needed for their effective implementation and the expected role. It also contains information about available funding means. The NAP is currently being finalized taking into account the outcomes of the process of public consultation and scientific review. Regions are required to further implement their regional adaptation strategies.

2. Risk reduction

In the recent years Italy adopted some focussed instruments directly addressing the disaster risk reductions. They follow the update of European framework on the issue, as well as the raised awareness due to the intensified frequency of the events.

The Decree no. 66/2008 of the President of the Council of Ministers establishes “the National Platform for Disaster Risk Reduction”, which focusses on a few main principles:

- reducing the risk must be understood as a national responsibility and treated in an interdisciplinary way in the context of sustainable development processes;
- the participatory approach should guide the work of the Platform in order to facilitate the involvement of various sectors within the framework of different perspectives and actions;
- Platform works shall give way to positive changes through planned and coordinated efforts in the processes of decision-making;

Consequently, the objectives of the Platform aim at ensuring the full implementation of the Hyogo Declaration and of the Hyogo Framework for Action in Italy, namely to integrate Disaster Risk Reduction into decision making processes at all levels in policy, administration and in the private sector. The overall goal is to promote all activities that may enable the society to reduce human, social and economic losses caused by natural disasters (https://www.unisdr.org/partners/countries/ita).

The Platform, leaded by the National Civil Protection Department of the Presidency of the Council of Ministers, is to be intended as a governance mean. Its Main objectives directly address intergovernmental and stakeholders interaction mechanisms and can be described as follows:

- be a forum for knowledge sharing, political cooperation on DRR and the definition of sector-specific policies;
- help putting theory into practice by liaising between policymakers, scientists and DRR professionals;
- promote public-private partnerships and joint projects carried out in Italy and abroad;
- link national and international activities and initiatives.

In 2010 Italy also adopted the Legislative Decree no. 49/2010 “implementation of the EU Directive 2007/60/CE regarding the assessment and management of flood risks”. The Italian Government, Italian Ministry of Environment, Land and Sea, the Water Basin Authorities, the Regions, the Civil protection Department are jointly responsible for the implementation of the plan both at National and Regional level.

The Decree regulates the activities of assessment and management of flood risks in order to reduce the related negative impacts on human health, territories, goods, the natural environment, the cultural heritage and the economic activities. In particular, the regulation refers to the development of flood risk maps on the bases of most appropriate and advanced tools, with particular attention on limiting required economic efforts; to the development of the early warning system at the national and regional levels.

It further provides information about the plans for flooding risk management to be adopted by Regions. Following the EU flood directive, they are required to focus on four main categories of action:

Prevention – measures acting on the vulnerability and on the value of exposed elements, directly linked to planning issues (vincles on flooding areas; measures of delocalization and re-development; adaptation measures)

Protection – measures acting on the probability of flooding (measures of reduction of flows, structural measures for the regulation of outflows; measures for urban drainage; management measures)

Preparation – measures for empowering the responsiveness to extreme events addressing the population and the civil protection system as a whole (alert systems, emergency planning, awareness raising training and information measures)

Reconstructionand post-event assessment– safety and recovery measures in order to overcome critical conditions imposed by floods (preliminary risk assessment; collection of information and data on floods).

Most regional plans for flooding risk have been adopted, delivering prioritized actions.

3. Sustainable development

The link between climate adaption and resilience and sustainable development is widely recognized, particularly in urban areas(Collier et al. 2013).

The above cited National Adaption Strategy points out how the capacity of selecting and implementing climate oriented actions taking into account the need to avoid conflicts with other sustainability dimensions is increasingly important(IPCC, 2007; 2014).

It also stresses how climate change as well as the provided adaptation and mitigationmeasures have to be intended as a part of the wider sustainable development challenge.

Italy is currently engaged in gearing the 2030 Sustainable Development Goals (SDGs) to the economic, social and environmental planning, by drafting the National Sustainable Development Strategy 2017/2030 (NSDS).

The NSDS, approved at the end of 2017 by the Interministerial Committee for Economic Programming (ComitatoInterministeriale per la ProgrammazioneEconomica – CIPE) is an update of the former Environmental Action Strategy for Sustainable Development in Italy 2002/2010 and a first step towards a holistic policy framework, widened to include social and economic dimensions, in line with the 2030 Agenda.

The delivery and implementation of the NSDS interlink the existing national programming documents, namely the National Reform Programme and the Economy and Financial Document.

The NSDS is organized in five core areas: People, Planet, Prosperity, Peace and Partnership. Each area consists of a set of national strategic choices articulated in strategic national goals. The goals integrate the three dimensions of sustainable development and are the result of a synthesis and abstraction procedure of the most relevant issues emerged in the consultation process. The chosen structure represents a concise way to reflect the complexity of the 2030 Agenda – and balance the three environmental, economic and social pillars of sustainable development, focusing with particular attention on the environmental

dimension whose integration is traditionally weak. Furthermore, this arrangement allows to synthesize the information yielded from the consultation, without scattering the significant contribution provided by the institutional players, who know best about the different matters of intervention.

Within this framework, the NSDS mainstreams the adaptation, mitigation and resilience issues all along the strategic choices and objectives it defines, concerning PEOPLE (risk exposure), PLANET (sustainable management of natural resources, water and soil management, air pollution, city, territory and landscape management), PROSPERITY (sustainable consumption and production, decarbonization of the economy), PARNERSHIP.

The PLANET area also contains a strategic choice dedicated to creating resilient communities and territories, protecting landscapes and cultural heritage.

The NSDS is to be intended as a wide framework for implementing the 2030 Agenda in Italy. It is also by law (art 34 of the Decree 152/2006 and subsequent amendments) the framework for territorial planning and environmental assessments. Regions and Autonomous Provinces have to further contribute to the implementation of the NSDS by implementing their own sustainable development strategies.

The NSDS is endorsed by the Italian Council of Ministers. A Plan of Action is being developed and will include numerical and quantitative targets at 2030, as well as monitoring and review mechanisms and analytical models capable of measuring the impacts of policies on the NSDS objectives.

The Government will provide an annual review about NSDS implementation as well as an assessment of the achieved results.

To this aim, the National Statistical System is progressively releasing sets of indicators hugely based on the BES project, launched in 2011 to measure equitable and sustainable well-being (BES) besides economic conditions. It considers economic parameters alone as inadequate to evaluate the progress of societies and views them to be complemented by social and environmental information as well as by measures of inequality and sustainability. For the first time, in 2017, four BES indicators have been introduced within the Economy and Financial Document, following national legislation promoting the integration BES within economic programming (L.163/2016).

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Chapter 6. Climate Change Adaptation and Disaster Risk Reduction Strategies in Spain.

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Introduction

The main objective of any risk management strategy must be to avoid human fatalities and to minimize socioeconomic and environmental impacts. To reach this objective requires a firm commitment to influence the different aspects that make up exposure, vulnerability and the ability to adapt the different socio-territorial systems. Important efforts are being made from national and international organizations to reduce climate change effects. Although this strategies have prioritized mitigation actions, in recent years adaptation strategies have acquired a relevant role. Very recently, climate change studies have concerned about the relationship between natural hazards and climate change. The fourth IPCC Report (IPCC, 2007) and the Special IPCC Report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (IPCC, 2012) have prompted the definitive recognition of the relationship between these two processes. Due to its climatic, geographical and socioeconomic characteristics, Spain is exposed to different natural hazards related to weather events (droughts, floods, wind storms, storms, etc.). Moreover, the projections on climate change suggest that hazards linked to climate will increase and worsen, as well as that new risks will be generated for natural and human systems (IPPC, 2014, EEA, 2016).

Specially sensitive to risks are urban areas, due to their high degree of occupation, where people and resources are concentered. In Spain, urban area, which combine a variety of natural hazards -especially hydroclimatic hazard- with a high degree of human occupation, are territories of risk and it is necessary to focus on prevention, mitigation and adaptation strategies. In this regard, three key tools are highlighted for the strengthening of urban resilience in Spain, from the point of view of urban areas: urban planning, new urban agendas and city resilient networks.

1. Natural hazards in a climate change context in Spain

Spanish's climate is characterized byan intense variability due to its complex topography and geographical situation. The spatial, seasonal and interannual climatic variability is very high, which makes the country a territory of climatic contrasts, conditioned in large, by the circulation patterns of the atmosphere in the Northern Hemisphere, in particular by the North Atlantic Oscillation (NAO) (Martín-Vide, 1996). The coincidence of a complex and difficult physical environment and a dynamic and growing population, increasingly concentrated in urban centers, with a massive occupation of the territory in some regions, especially on the coast, means that Spain is one of the most affected geographical areas for the dangers of nature. As Olcina Cantos says (2009)

"Spain is territory of risk. The variety of natural hazards, especially climatic ones, which can affect it joined to high degree of human occupation in some of his regions, turn Spanish territory in geographical space with raised natural risk in the set of Europa" (Olcina Cantos, 2009:197).

In Spain, the most significant risks capable of generating major disasters are those related to terrestrial dynamics, specially earthquakes. Earthquakes are not very frequent in time in Spain however they have reached sufficient magnitude to devastate populations. The most devastating of the last two centuries was the 1884 earthquake in Granadameasured over 6.0 on the Richter scale. This earthquake caused more than 1,000 fatalities, thousands of injuries and houses destroyed, in addition to damages on the ground (IGN, 1980). More recently, in 2011 it occurred in Lorca (Murcia) an earthquake measuredon 5.1 on the Richter scale. It caused9fatalities, several injured and numerous property damage worth more than 1,000 million euros. Also of seismic origin there is some volcanic risk in the Canary Islands, where the only Spanish region currently exposed to this type of risk is located. The most recent eruption occurred in 2011 on the island of El Hierro, where a submarine volcanic eruption took place that lasted six months forcing to evict 547 people.

However, greater recurrence and socioeconomic hazards in Spain are those related to hydroclimatic conditions: droughts and floods. The most severe drought episodes in terms of economic losses took place in 1941-1945, 1979-1983, 1990-1995, 2004-2008 and 2015-2017; These drought events affected the whole of the Spanish territory. Floods are the natural phenomenon that most often occur and produce the greatest number of economic and human losses in Spain. According to the Ministry of Ecological Transition, flood damage is estimated at an average of 800 million euros per year[9]. In addition, wind storms and heat waves, present virtually throughout the Spanish territory generate significant human and socio-economic impacts. Forest fires are another problem that seriously affects the Spanish territory, without any region being free of them. Their number tends to increase and for the most part they are provoked and, therefore, fall into the category of induced risks. However, in addition to the economic losses they cause and the danger they entail for people and human goods, fires cause important environmental impacts and, in the long term, environment degradation wich causes the appearance of other problems such as, for example, soil erosion. Vegetation degradation and soil erosion can combine and affect hydrology, triggering desertification phenomena.

In terms of fatalities due to natural disasters in Spain, in the period 1995-2014 amounted to 1,174, highlighting by its incidence, those due to floods, storms, forest fires and heat waves (Table 1) .

Table 1. Number of fatalities in Spain due to natural disasters (1995-2014).

Natural Hazard	1995-2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total

[9] http://www.mapama.gob.es/es/agua/temas/gestion-de-los-riesgos-de-inundacion/

Flood	229	8	9	11	6	5	12	9	15	5	2	17	10	339
Storm	139	8	9	4	3	11	6	2	1	7	5	3	1	200
Forest fire	53	19	8	1	1	11	9	12	10	1	4	3	1	133
Landslide	21	0	5	2	1	2	2	3	0	2	0	0	3	41
Hot waves	86	9	23	9	3	6	16	6	6	4	0	33	8	209
Snow avalanche	27	1	0	0	4	3	11	2	0	4	0	1	1	54
Cold waves	17	3	0	0	0	1	1	1	0	0	0	0	2	25
Marine storm	202	nd	nd	nd	4	2	5	2	7	9	18	2	04	248
Earthquakes	0	0	0	0	0	0	0	9	0	0	0	0	0	9
Total year	774	48	54	27	22	41	62	46	39	32	29	59	30	1268

Source: MAPAMA, 2016.

Besides this risk scenario, climate change forecasts are added on future climate scenarios and their effects in the medium and long term in Spain (IPCC, 2014). The Fifth Assessment Report of the IPCC (2014) (AR5) has worked on a set of new General Circulation Models (CGM) and new emission scenarios. Regarding the new MCGs, the AR5 has worked with both Atmosphere-Ocean coupled MCGs (MCGAO) that simulate the dynamics of the physical components of the climate system (atmosphere, ocean, earth and ice sheet), such as the Models of the MCG Earth System -ESM (from English, Earth System Models). These last ones are considered more complete when including representation of several biochemical cycles like those implied in the cycle of carbon, sulfur or ozone. Regarding the emissions scenarios used to obtain the climate projections (the AR5 of the IPCC), the new emission scenarios for climate change have been used, known as trajectories (or paths) representative of concentration (RCP of its acronym in English). These RCPs describe different projections for emissions and concentrations of greenhouse gases and aerosols and for land uses throughout the 21st century. The RCPs include scenarios of strong reduction of emissions (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and a scenario of high emissions (RCP8.5). The reference scenarios, in which emissions are not controlled, are between RCP6.0 and RCP8.5. The Spanish Meteorological Agency (AEMET) has carried out a regionalization for Spain of climate scenarios of RCP 4.5, 6.0 and 8.5 of the AR5 using the 1961-1990 period as the reference series. AR5 stands out that: in relation to temperatures;an increase in temperatures is expected, an increase in the number of warm days and a progressive increase in the annual and seasonal average value of the maximum temperature throughout the 21st century in all emission scenarios evaluated, with greater increases in the interior and lower in the north and northwest of the peninsula. An increase in the average of the anomalies of the minimum temperatures is also expected. Regarding precipitation; the report acknowledges more uncertainty than for the case of temperatures and forecasts a reduction in average rainfall in peninsular Spain and a decrease in the average number of days of annual precipitation, with longer dry periods, with a fork of important differences depending on the scenarios used and the seasons of the year. Thus, in summer, the greatest decreases are expected to be located in the southern part of the peninsula and in the extreme northwest of the Peninsula. A decrease in runoff and real evapotranspiration - both variables dependent on rainfall - is also forecast for the reference period with steeper decreases for the summer months.

Regarding the incidence of climate change on extreme weather events in Spain, the report predicts a very likely increase in the frequency and duration of heat waves and a decrease

in the annual number of days of frost. The report does not evaluate the effects of climate change on the frequency and magnitude of hydro-climatic risks (droughts and floods), which in Spain have the highest incidence, both in the number of events and in the number of people affected. In this sense, the Center for Studies and Experimentation of Public Works (CEDEX) published in the year 2017 the report "Evaluation of the impact of climate change on water resources and droughts in Spain" in which it concludes that the forecasts point in general towards a reduction in water resources as the 21st century advances and, therefore, towards an increase in water scarcity in Spain. In addition, the report predicts a change in the drought regime in which most of the climate projections show a future in which droughts would be more intense and frequent, with that effect occurring as the 21st century advances.

2. Spanish Institutional framework to cope with climate change effects and Natural Hazards

As a European Union member a large part of the strategies and plans related to climate change and natural risks in Spain are derived from documents prepared by the European Commission, either by obligation, through Directives , or through documents that, without being mandatory for member countries, establish a series of recommendations and guidelines to follow where the main priorities and opportunities in terms of climate change and natural risks are established (Strategies, reports, recommendations, etc.).

At European level, the White Paper“Adaptation to Climate Change: Towards a European Action Framework” (EC, 2009) was an important imput and currently remains as a reference for the development of policies and strategies for adapting to climate change in Europe. This document is structured around four pillars of action, (i) reinforcement of the knowledge base, (ii) integration of adaptation into all EU policies, (iii) instruments (financial and otherwise) to ensure effectiveness of adaptation and (iv) strengthening of international cooperation and the external dimension of adaptation. This first effort served as a seedbed to develop the European frame of reference in terms of adaptation to climate change, *European Strategy for Climate Change Adaptation (2013 -2020).* The overall aim of the EU Adaptation Strategy is to contribute to a more climate-resilient Europe. This means enhancing the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination. Although it is true that the reduction of disaster risk is not one of the priority lines of the EU Adaptation Strategy, this strategy recognizes the importance of the natural system-human system interaction for the generation of risk and defines the risk associated with the impacts related to climate as a result of the interaction of the interaction of natural hazards with the vulnerability and exposure of human and natural systems, as well as their capacity for adaptation. Furthermore, it considers it essential to bring the areas of adaptation to climate change and disaster risk reduction closer to the national and sectoral policies of the different EU countries.

This strategy establishes specific activities to support a better informed decision-making and promote adaptation in the most vulnerable key sectors. In this regard, the platform should be highlighted Climate-ADAPT (https://climate-adapt.eea.europa.eu) which aims to support Europe in adapting to climate change trough access and share information on: expected climate change in Europe, current and future vulnerability of regions and sectors, national

and transnational adaptation strategies, adaptation case studies and potential adaptation options and tools that support adaptation planning.

In the Spanish context, the reference tool for dealing with climate change is “The Spanish Strategy of Climate Change and Clean Energy (2007-2012-2020)”, which is part of the “Spanish Strategy for Sustainable Development (EEDS)”. The Spanish Strategy of Climate Change and Clean Energy is divided into two main blocks. On the one hand, a series of policies and measures are presented to mitigate climate change, mitigate the adverse effects of climate change, and make it possible to comply with the commitments assumed by Spain. It also a priority to facilitate public and private initiatives aimed to to combat climate change from all sectors, focusing on the achievement of the objectives that allow compliance with the Kyoto Protocol. On the other hand, measures are proposed for the achievement of energy consumption compatible with sustainable development. Disaster Risk Reduction is not considered in this instrument. This strategy is focused more on mitigation and the reduction of emissions rather than adaptation to climate change.

Regarding adaptation,the frame of reference at the National level is the “Spanish National Plan for Climate Change Adaptation (PNAAC)”. It is the frame for coordination between Public Administrations in the activities of impact assessment, vulnerability and adaptation to climate change in Spain. The main goal is to reach the effective integration of climate change measures in all sectoral and natural resource management policies that are vulnerable. For this, it relies on the best knowledge available. The PNACC is developed through different work programs, which allow prioritizing and structuring the activities contained therein. The first PNACC Work Program (2006-009): was approved in 2006, together with the Plan itself, in order to address the immediate priorities and crosscutting aspects of adaptation in Spain (Develoment of regionalized climate change scenarios in Spain, Impact assessment of climate change on water resources, coastal areas and biodiversity). The second PNACC Work Program (2009-2013) has as a main objective the integration of adaptation to climate change in different sectoral planning. The third PNACC Work Program (2014-2020): was approved in 2013 and seeks to comprehensively address adaptation to climate change.

In relation to disaster risk management, the PNACC contemplates a double approach to risk assessment. On the one hand, the risks associated with the gradual effects of climate change and on the other, the risks associated with extreme weather events —such as torrential rainfall, large floods or prolonged droughts— that can cause great effects and where adaptation to climate change can reduce the risk of disaster. On the latter, despite putting the focus in reducing exposure and vulnerability and increase resilience to the possible adverse effects of climatic extreme events,the integration between climate change and disaster risk reduction has received little attention. At least, at the institutional level until the recent publication of the IPPC Special Report Management of the risk of extreme weather events and disasters to improve adaptation to climate change in the year 2012.

In addition to the Nation Strategy PNACC, the Autonomous Communities, in the exercise of their competencies, have developed and maintain strategic frameworks, plans and / or programs in terms of adaptation to climate change, which are implemented through different initiatives and actions. The Platform for exchange and consultation of information on adaptation to climate change in Spain AdapteCCa[10]. This platform compiles a complete and homogeneous information, and provides the entry point to know in depth the frameworks and actions that are carried out in Spain.

[10]www.adaptecca.es

Different plans and strategies for adapting to climate change are increasingly introducing considerations related to necessary integration between the effects of climate change and disaster risk reduction. In these documents, adaptation to climate change is considered as a fundamental strategy for risk management. In spite of the opportuneness and convenience of this approach, which is from the point of view of the authors unquestionable, its development is ambiguous enough so that, in practice this integration between adaptation to climate change and disaster risk reduction is not operationalized. As the most notable evidence of this lack of concreteness in Spain, specific flood risk management plans and drought risk management plans have been developed and, in turn, the integration of the effects of climate change into ordinary hydrological planning has been practically null. (Vargas et al., 2018). As a result, we have increasingly better tools for managing risk situations, but at the same time, we increase exposure and vulnerability to these situations by not integrating the effects of climate change into sectoral planning. Therefore, the utility of these tools is reduced.

Regarding operational management of disaster risk, Spain has a National System of Civil Protection[11] for the management and coordination of emergency situations. The objective of the Civil Protection service is to protect people and property, offering an adequate response to different types of emergencies and catastrophes, whether natural or derived from human action. Although Civil Protection service has traditionally emphasized more in the response to emergency situations, its actions also include forecasting and prospective analysis by improving knowledge in order to reduce risk and mitigate its effects. The National Civil Protection Strategy is based on prospectively analyzing the risks that can affect people and goods, the necessary response capacities, and formulating strategic lines of action to align, integrate and prioritize efforts to optimize resources to mitigate the effects of emergencies. This strategy is developed through different tools that operate at different administrative levels and in a different degree of detail. On the one hand, the General State Plan, which develops the basic guidelines for the organization and coordination of State action procedures to provide support and assistance to other Public Administrations in cases of emergency. On the other hand, the Territorial Plans that are prepared to face the emergency risks that may arise in the territory of an Autonomous Community or municipality, where it will be mandatory to provide the local civil protection service if it exceeds 20,000[12] inhabitants, being able to request of the respective Autonomous Community the exemption of this obligation when it is impossible or very difficult to comply with the establishment and provision of such services by the City Council. Another tool is the Self-protection Plans, which establish the organic and functional framework foreseen for the centers, establishments, facilities or dependencies included in the applicable regulations, in order to prevent and control the emergency risks of civil protection on people and services. goods and give an adequate response in those situations. In addition, there is a type of Special Plans, which may be state or autonomous and whose purpose is to deal with flood risks; earthquakes; tidal waves; volcanoes; adverse weather phenomena; forest fires and technological risks. These special plans affect many of the most recurrent natural hazards in Spain, such as floods and droughts. These plans have their own regulations and are covered by sectoral policies.

[11] Ley 17/2015, de 9 de julio, del Sistema Nacional de Protección Civil

[12] Ley 7/1985, de 2 de abril, reguladora de las bases del Régimen Local (LBRL)

As a consequence of the approval of the European Floods Directive[13], the obligation to develop Flood Risk Management Plans (PGRI) in each of the Spanish river basin districts is established. These PGRI start with a preliminary assessment of the risk of flooding and an identification of the Areas with Potential Significant Flood Risk (ARPSIs) based on the preparation of hazard and risk maps. The PGRIs include a series of measures to minimize the damage caused by the floods; many of them are non-structural ones related to early warning systems and land use planning for limiting uses in flood areas. In the case of droughts, as in a pioneering way in Europe, the Hydrological National Plan establishes the obligation to develop drought plans, such as the preparation of territory-specific special drought plans, urban-supply emergency drought plans. As a result, the National Floodplain Mapping System (SNCZI) has been launched. The SNCZI is established as an instrument to support the management of fluvial space, risk prevention, territorial planning and transparency. In the case of droughts, as in a pioneering way in Europe, the Hydrological National Plan establishes the obligation to develop drought plans, such as Special action plans in situation of alert and eventual drought (PES) in the field of river basin district and Emergency Plans for urban supply systems (PEM) in the field of urban supply systems of more than 20,000 inhabitants. This drought management plans are tools that are based on the establishment of a system of indicators that allows forecasting and tracking the evolution of the period of time and then establish a series of progressive measures while the phenomenon advances to minimize environmental, economic and social.

3. Urban initiatives. Resilience strategies opportunities

If there is any scenario especially sensitive to the effects of climate change and natural hazards, this is undoubtedly urban areas. In an unprecedented process, the concentration of population in urban areas has gone from 10% in 1990 to over 50% in 2010 (UNDESA, 2010). In Spain, the percentage of the population living in urban areas reached 80% in 2016 (INE, 2017). The concentration of population and activities in urban spaces has increased the exposure to natural hazards and has turned cities into territories prone to economic damage and loss of human lives.

Urban areas are therefore territories of risk and a large part of disaster risk reduction strategies are oriented and / or integrated to reduce vulnerability and strengthen resilience in urban areas (Senday Framework for Disaster Risk Reduction 2015 -2030 (UNISDR, 2015), Urban Adaptation to climate change in Europe 2016 - transforming cities in a changing climate (EEA, 2016b), City Resilience Program of the World Bank (CRP). In Spain, three different but complementary tools stand out, which represent important opportunities for the practical application of strategies to strengthen resilience in urban areas: territorial planning, the New Urban Agenda and the participation of different cities in networks on resilience.

3.1. Territorial planning: the key to promote urban resilience

In recent years we have gradually witnessed a change in the consideration of risk reduction policies, from the emphasis on structural measures and the lack of consideration of risk in plans and regulations towars the proposal of measures based on the ordination and management of the territory (Olcina Cantos, 2009). At urban level, municipalities in Spain

[13] Directiva 2007/60 de evaluación y gestión de los riesgos de inundación

have a great capacity - and also legal responsibility - in terms of prevention, mitigation and response to natural risks. In addition to the mentioned civil protection competencies, in the case of municipalities with more than 20,000 inhabitants and the obligation also for these municipalities to develop Emergency Plans for urban supply systems (PEM), the municipalities hold the competences of land management through the General Plans of Urban Planning. In this sense, the Land Law of 2008 represents a great step forward for the integration of the consideration of risk in urban planning processes, at least at the regulatory level. This Law obliges all municipalities to develop risk cartography to delimit soils not suitable for urbanization; However, there are still not many general municipal plans that incorporate natural risk mappin. Until very recently, the problem of natural hazard and its territorial effects in the allocation processes has not been taken into account. (Pérez et al., 2016, Olcina Cantos, Morote and Hernández-Hernández, 2018).

Territorial planning competencies represent a fundamental tool for adequate risk prevention for several reasons: 1) it facilitates better knowledge about the territory and allows for more detailed diagnoses about risks (hazards and vulnerability), capacities and means to deal with these; 2) adequate planning of activities, settlements and infrastructures is a fundamental prevention tool and can have a very important influence on the greater or lesser exposure to natural hazards; 3) the municipal level facilitates the participation of diverse agents where it is possible to take into account their perception, evaluation, diversity of knowledge and political interests in order to produce vulnerability analysis and decision making in risk management (Klinke &Renn , 2013). This last point is especially relevant because it allows strengthening the institutional and population capacities to face the risks and therefore generate more resilient individuals. Cities can not be resilient if institutions and citizens are not in turn resilient

3.2. Spanish Urban Agenda

The Spanish Urban Agenda (AUE) is being developed, which is a strategic document (not normative) that aims to be an instrument at the service of all Public Administrations, within the scope of their respective competences and mainly of the Town Councils, to propitiate improvements in the areas of regulation and planning, financing, governance, knowledge, transparency and participation. The EUA is in line with other similar international initiatives that have recently been developed, such as the Urban Agenda for the EU (NP-CEU 2016) or the New Urban Agenda of the United Nations (UNU-HABITAT, 2016). These initiatives represent a common ideal to achieve a better and more sustainable future through an adequate coordination between good urbanization and development. In a context of climate change, no self-respecting strategy can be called sustainable without considering the effect of climate change and natural risks. Thus, these initiatives include climate change and resilient urban development as strategic objectives. However, all these initiatives and the good intentions derived from them have not yet crystallized into operational frameworks put into practice. And it is that, in this case, the main advantage that the urban area has to address these issues, which is precisely to be able to work on a specific territory, becomes a difficulty when trying to establish common assessment procedures and frameworks Top-to -Down precisely because of the variety of contexts and territorial realities that characterize each municipality and that hinder the application of these methodologies and common frameworks to specific contexts.mIn spite of this, the development and future maturation of these urban agendas, incorporating adequate information and public participation channels, can be a very useful frame of reference for the integration of sustainable and resilient urban development.

3.3. City resilient networks

In recent decades, several city resilient networks have emerged, such as the Global Campaign for Resilient Cities of the United Nations Office for Disaster Risk Reduction, the Resilient Cities Network, promoted by UN-HABITAT or the Red Redes 100 Ciudades Resilientes Network promoted by the Rockefeller Foundation. These strategies promote urban development by incorporating the concept of resilience as a cross-cutting element in development plans and providing support to local governments to develop capacity in resilience, adaptation and recovery, in an efficient manner, in the face of the economic or social impacts of natural disasters.The great potential of this type of network, of which several Spanish cities are part, lies in the promotion of cooperation through the exchange of good practices and experiences.

Conclusions

Spain is a territory of risk. The natural recurrence of different natural hazards is compounded by a growing population, increasingly concentrated and more exposed that determines higher levels of risk. In addition, climate change forecasts predict an increase in the frequency and intensity of extreme weather events and place Spain as one of the countries most vulnerable to the effects of climate change. In spite of the remarkable advances that have been made in Spain in recent years to face the challenges posed by climate change, especially through the National Strategy for Adaptation to Climate Change and its development through the different work programs, the The relationship between adaptation to climate change and disaster risk reduction has received little attention both in terms of regulations and in the development of operational tools. There are many strategies about climate change which talk about vulnerability and resilience and point out its importance in disaster risk reduction, however, these strategies do not develop or design specific tools, methodologies or action plans. In practice, adaptation to climate change and risk management are covered by different strategies, most of them sectoral strategies and in many cases contradictory with each other.

Especially relevant is the consideration of urban spaces as risk territories, as these concentrate more than 80% of the country's population and it is in these areas that most of the activities for generating resources are carried out. In Spain, the municipalities have the Civil Protection competencies (those with more than 20,000 inhabitants) for the prevention, mitigation and response to natural risks, and also have the competences of spatial planning through the General Plans of Urban Planning and therefore they have a very important role in the configuration of land uses. An adequate urban planning is the best tool to reduce the exposure of people and goods to natural hazards and reduce the vulnerability of the population. In this regard, the preparation of risk mapping in urban planning as required by Article 15 of the Land Law of 2018 is essential to increase knowledge about risks and incorporate this knowledge into planning. In addition, the preparation of the Spanish Urban Agenda and participation in networks of resilient cities are ideal opportunities to integrate communication and risk management, strengthen social and institutional capacities and promote the exchange of experiences.

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Chapter 7. Resilience Frameworks Netherlands

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Introduction

The Netherlands are one of the front-runner countries when it comes to acting on climate change. It is likely to soon be among the seven countries worldwide that have passed a 'climate law'.

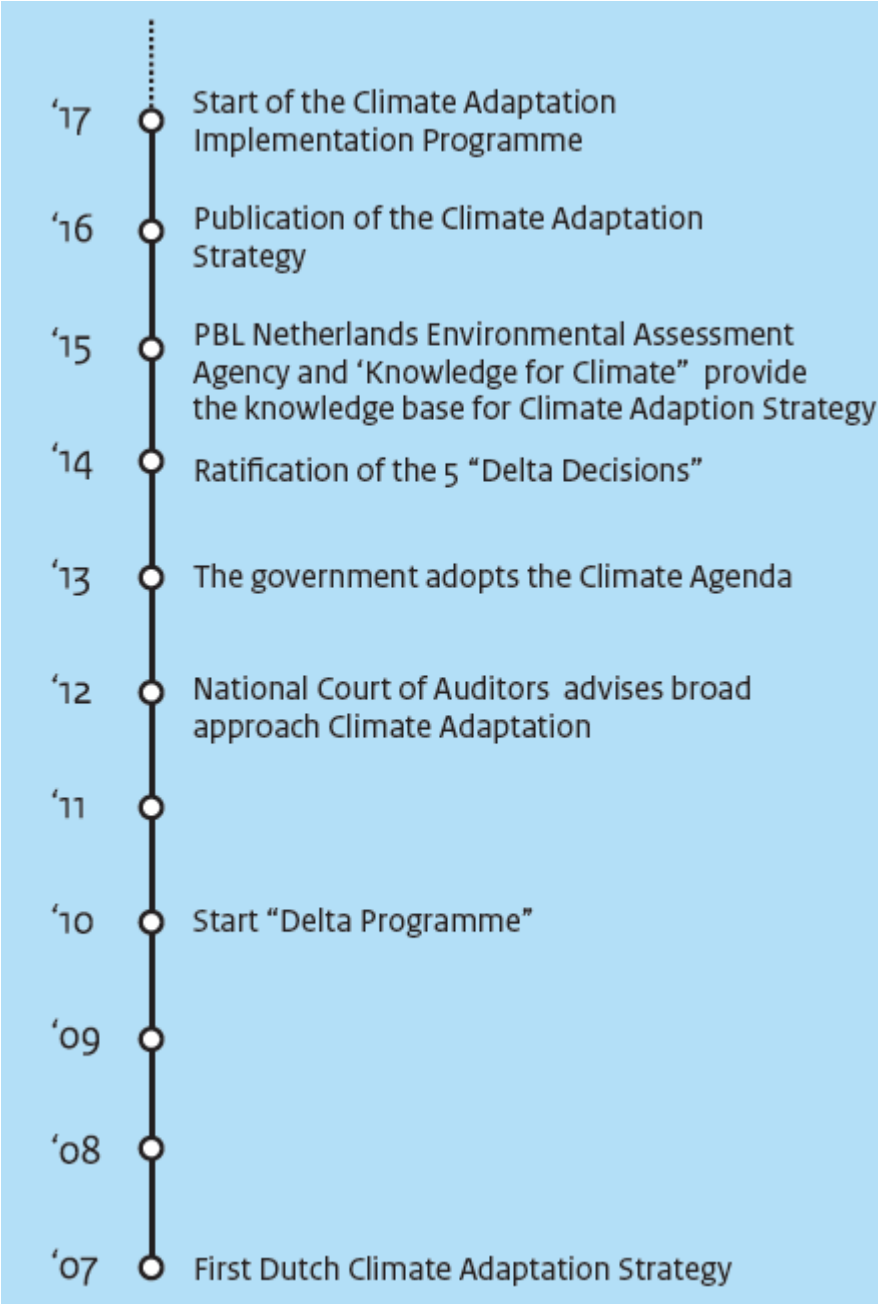
On June 28th 2018, after months of negotiations, a parliamentary fraction of seven parties have reached an agreement on a new Climate Act. The proposed law would bind the Netherlands to reduce its CO2 emissions by 49% in 2030 and 95% in 2050, as compared with emission levels in 1990. The proposed law is now with the Council of States (the Dutch Senate) for advice. Due to the broad support of the law it is expected that it will pass the Dutch Senate without delay after the summer. Should the law be adopted, the Netherlands will be the 7th country in the world with its own Climate Act after the United Kingdom, Sweden, Norway, Denmark, Finland, France and Mexico.

But the Netherlands are not only a front-runner when it comes to climate change mitigation, the country is also in the process and in need of large-scale climate adaptation. With about 26% of the Netherlands being below sea level (Schiermeier 2010), it is a low-lying country characterised by an abundance of water. The Netherlands borders the North Sea region of the North Atlantic Ocean, with several major rivers flowing through the country into the ocean forming an extensive delta region. During the course of the 19th century, the country closed off a number of previous ocean bays and river arms by large dikes making artificial lakes, such as the IJsselmeer, in order to use the water bodies for human purposes, manage flood waters, and calm the coast. In essence, the whole country is a large delta region and therefore in need of comprehensive and smart water management. This need is amplified with changing climatic conditions.

1. The National Level Framework: Dutch National Climate Adaptation Strategy (NAS) - Adapting with ambition

The Netherlands adopted its first National Adaptation Strategy in 2007. Called "Make Space for Climate", this strategy sets out the general policy for tackling the effects of a warming climate. In 2013, the national government published the "Climate Agenda", and integrated climate mitigation and adaptation approach. As regards adaptation, the report reiterated the goals of the previous adaptation strategy from 2007 and announced that a new comprehensive and integrated National Adaptation Strategy will be developed in the coming years. In December 2016 the Council of Ministers adopted the current National Climate Adaptation Strategy (EEA 2018). As a follow up to the strategy, in 2017, the Climate Adaptation Implementation Programme was started (see Fig. 1).

Imagen 1 – Temporal development of Climate Resilience Planning in the Netherlands.

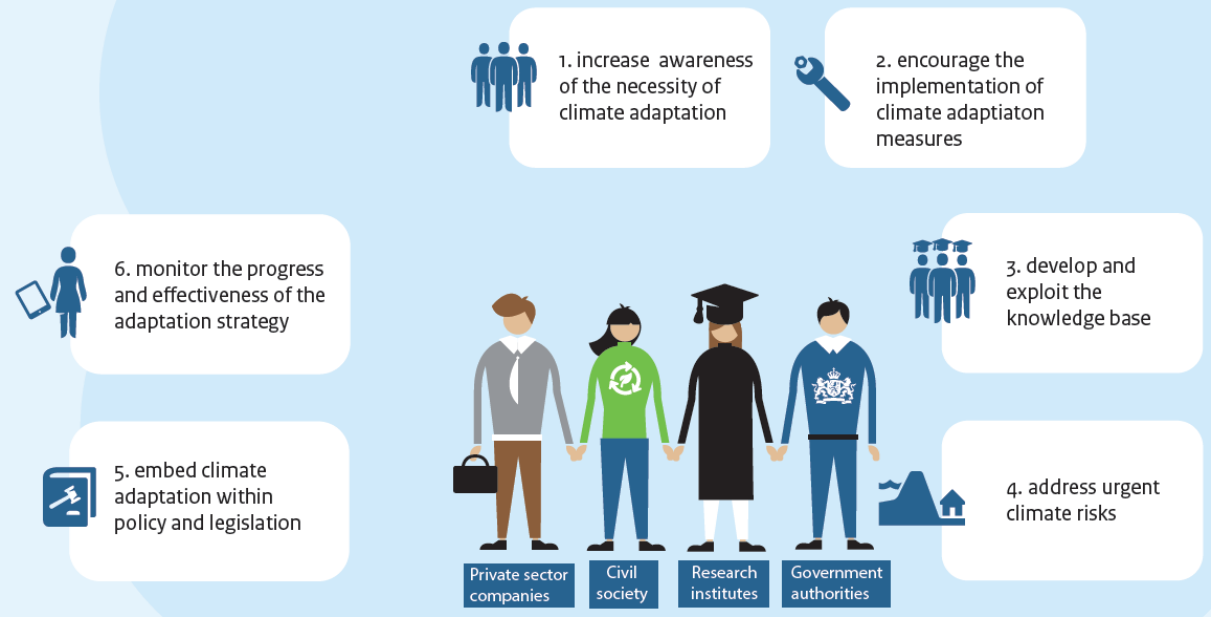


(*Fuente:* Kennisportaal Ruimtelijke Adaptatie, 2018)

Climate adaptation in the Netherlands is understood as a comprehensive process of "climate proofing". The National Climate Adaptation Strategy shows the effects of climate change in the Netherlands as well as the high impact risks that urgently need to be addressed. The approach is to launch new adaptation initiatives and to support and accelerate existing adaptation initiatives and practices. The national government wants to cooperate with local governments, industry and citizens to invest in these practices and in the development of policies and research that firmly supports them, in order that the Netherlands will soon be

adequately prepared for climate change. The NAS envisaged 6 steps of climate resilience planning (or climate adaptation, or climate proofing), as laid out in Fig. 2.

Imagen 2 – The six steps of Climate proofing as envisaged by the Dutch National Adaptation Strategy (NAS).



(*Fuente:* Kennisportaal Ruimtelijke Adaptatie, 2018)

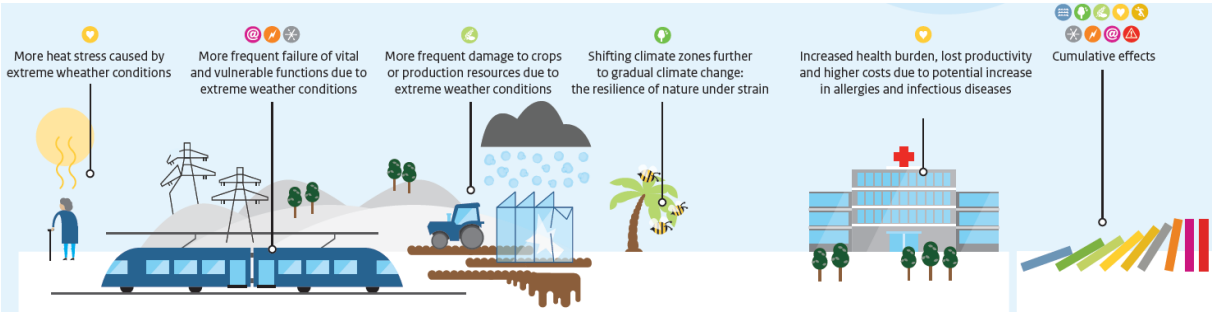
An important building block to the new adaptation strategy is an overall assessment of the risks and opportunities arising from climate change, particularly looking at nine social and economic sectors as shown in Fig. 3, namely: water/ spatial planning, agriculture/ horticulture/ fisheries, nature/ biodiversity, health, recreation/ tourism, infrastructure, energy, ICT and safety and security. These sectors are assessed for the potential impact of four climate risks, i.e. increasing temperature, increasing and decreasing rainfall, and rising sea levels.

Imagen 3 – Climate trends affect 9 economic and social sectors - Infographic of the National Adaptation Strategy (NAS).

(*Fuente:* Kennisportaal Ruimtelijke Adaptatie, 2018)

Thereby the new National Adaptation Strategy adopts a comprehensive approach, going beyond the water related focus of the previous strategy and related Delta Programme (see section 'national and regional adaptation programs'). Strikingly, cross-sectoral cascading effects (Fig. 4) are also addressed as are the effects of climate change in other countries with potential impacts on the Dutch society and economy (within and outside Europe).

Imagen 4 – Cross-sectoral cascading effects of climate change impacts as envisaged and addressed in the Dutch National Adaptation Strategy.



(*Fuente:* Kennisportaal Ruimtelijke Adaptatie, 2018)

The NAS has been developed in close cooperation with stakeholders. To this end, three national workshops were held as well as a national climate summit, all bringing together representatives from different government levels, knowledge organisations and the private sector.

Various projects have been initiated to support the implementation of the strategy, stressing an adaptation need with regard to the following aspects:

- Heat stress, in particular looking at vulnerable societal groups
- Failure of infrastructure networks, mainly as related to extreme weather conditions
- Frequent crop damage and other damages in agriculture and horticulture due to extreme weather conditions
- Shifting climate zones, related to gradual climate change
- Reduction of health, labour and others costs, following a possible increase in infections, allergies and other health-related impacts
- Cascading effects (see Fig. 4)

The National Adaptation Strategy announces the development of a Monitoring and Evaluation framework for climate change adaptation. This is currently under development with the Netherlands Environmental Assessment Agency (PBL). This system will primarily look into progress with the adaptation policies (=process), but also seeks transparency with regards to implementation (=output) and effectiveness (=outcome) of actions.

2. The National Level Implementation

Within the framework of the National Adaptation Strategy several programs for climate adaptation are set up. One of the largest programs is the Delta Programme. It started in 2010 and concurrently re-evaluates the water management strategy and spatial planning in light of long-term climatic change. The Delta Programme is a nationwide programme, in which the national authorities as well as provinces, (regional) water boards, and local authorities work together with NGO's, knowledge institutes, companies and citizens in order to innovatively and comprehensively manage the complex issue of water supply and demand, including flood waters, droughts and storm surges, in the Netherlands. The objective of the Delta Programme is to protect the Netherlands from (coastal and river) flooding, to work towards a climate resilient country, and to ensure adequate supplies of freshwater for the current and future populations (EEA 2018).

The legal framework for the implementation of the Delta Programme is the Delta Act on Flood Safety and Freshwater Supply (short Delta Act). The Delta Act came into force on 1st January 2012. It anchors the role of the Delta Commissioner, the Delta Programme, and the Delta Fund (EEA 2018).

The Delta Commissioner, a special government commissioner, is leading and directing the development and implementation of the Delta Programme. Every year the Delta Commissioner reports to the Cabinet about progress and advises on necessary steps. On

behalf of the Cabinet the Minister of Infrastructure and the Environment (politically responsible for the Programme and the Funding) presents the Delta Commissioner's annual report to the Parliament supplemented with an appropriate policy response. The provinces, municipalities, the regional water boards, as well as NGOs, are closely involved in developing this annual report (Delta Programme 2018; EEA 2018).

The Delta Programme sets out the strategic focus areas to work for climate resilience over the coming years. In the first stage, it included extensive research to identify the climate challenges and to explore potential solutions. This research has resulted in 12 recommendations to increase the protection level of the Netherlands and 5 Delta decisions. These decisions pertain to the standards for dikes and dams, the availability and distribution of freshwater, the water level of the IJsselmeer, ways to keep the river Rhine estuary and Drechtsteden area safe without losing its economic value, and ways to take account of water in the construction of neighbourhoods and districts. Solidarity between regions and between generations, sustainable development and flexibility are the three key principles of the Delta Programme (Delta Programme 2018).

The Delta Fund is used to finance the projects of the Delta Programme. The Delta Fund holds money dedicated by the national government for the implementation of measures and research needs. It has an average budget of 1.2 billion € per year up to and including 2030. Every year the Delta Commissioner will present an advice on how to target the budget on necessary measures and supporting research in the annual Delta Programme. The Delta Program Commissioner assumes that the Cabinet will continue to fund the program after 2030, due to the major tasks in the decades ahead. The fund will be highly significant for credible and timely delta-management in the coming decades (Delta Programme 2018; EEA 2018).

Interim decisions will take account of uncertainties around the future impact of climate change as well as spatial and socio-economic developments. The approach here is the so called ‘adaptive delta management', choosing the kind of necessary measures that keep options open for later adjustment. In the process all relevant material, results of research and knowledge programmes (‘Knowledge for Climate'), experience from international cooperation (e. g. ‘Netherlands Water Partnership', ‘Partners for Water', ‘Delta Alliance' and Connecting Delta Cities), and assessments by the Netherlands Environmental Assessment Agency (such as the study ‘Climate Adaptation in the Dutch Delta - Strategic options for a climate-proof development of the Netherlands') are taken into account. Adaptive delta management based on sound knowledge used in a future oriented Delta Programme is essential for cost-effective investments (Delta Programme 2018; EEA 2018).

The process of developing the Delta Act involved significant amounts of consultations and participation. Participation in legislation and planning decisions is a legal requirement, and it is embedded in Dutch culture. The so-called “polder model” of planning and decision making refers to the need to collectively manage the land and water resources of this low-lying flood prone the country. Although it is a national program many of its actions are taken at sub-national levels by public and private organizations and citizens. Engaging these actors is therefore an essential part of the program.

3. Dutch Regional Level Frameworks: Delta Plans

As part of the National Delta Programme 2018 three focal areas were established, leading to three so-called Delta Plans. The aim is that flood risk management, freshwater supply and spatial planning will make the country climate-proof and water-resilient by 2050, so that the Netherlands will be able to cope with the increasing weather extremes. For that reason the government now focuses on three areas:

1. Delta Plan on Flood Risk Management: New flood protection standards will not only be linked to the probability of flooding, but also to the impact of a flood. The scope of the impact is the decisive factor. As part of the Delta Plan on Flood Risk Management the country conducts implementation programmes/ measures, such as 'Room for the River', 'the IJsselmeer Closure Dam' project, a.o. (Deltaprogramma 2018).
2. Delta Plan on Freshwater Supply: The availability of freshwater for agriculture, industry and nature will become more predictable.
3. Delta Plan on Spatial Adaptation: It is envisaged to make the Netherlands more climate-proof and water resilient through appropriate and comprehensive spatial planning measures (Delta Programme 2018).

The Delta Plan on Spatial Adaptation, added in 2018, goes back to an agreement between the national government and the Dutch provinces signed in 2009, which explicitly calls for mainstreaming adaptation into spatial planning. Today most provinces have developed climate adaptation action programmes. Priorities are 'no regret' options and mainstreaming climate adaptation into water management, spatial planning, nature policy, agriculture and economic policy. Next to these programmes, sector (infrastructure, nature, health etc.) specific adaptation measures are in the process of being created or are already being implemented (Delta Programme 2018; EEA 2018).

4. Dutch Regional Level Implementation of Delta Plans - Example Rhine Estuary (Overijssel)

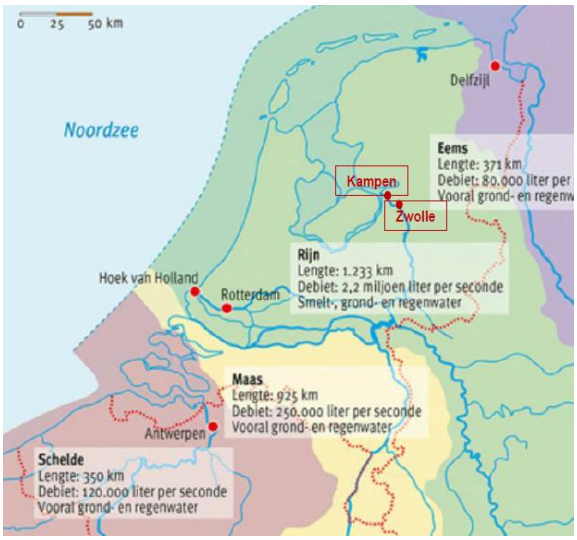
Regional level implementation of the National Level Delta Program in the Netherlands is not organised based on provinces or administrative regions, but along river catchments, delta regions and coastal areas (see Figure 5a). In the current program following eight regions are centre of attention (Fig. 5b):

1. IJsselmeer Region/freshwater supply region IJsselmeer Region
2. Rhine (Rijn) Estuary-Drechtsteden/West-Netherlands freshwater supply region
3. Rhine (Rijn)/ Area around the major rivers freshwater supply region
4. Meuse (Maas)
5. Southwest Delta/Southwest Delta freshwater supply region
6. The Coast
7. Wadden Region
8. Elevated Sandy Soils South and East

In these regions, attention and problem foci can vary, but regions need to work towards implementing the three Delta Plans (Delta Plan on Flood Risk Management, Freshwater

Supply and Spatial Adaptation). As part of implementation regions have to report on progress, on their integrated implementation approach and on the participation strategy.

Imagen 5a – River basins of the major rivers in the Netherlands.Key: Rijn = Rhine; Maas = Meuse.



(*Fuente:* Adapted from Wereldwijs-Reggesteyn, 2019)

Imagen 5b –Topography of large rivers and waters of the Netherlands against the distribution of provinces in the Netherlands.

(*Fuente:* Adapted from Topomania, 2018)

As one of the local case study areas, (see chapter 13) will introduce a practice example and highlight the experiences of implementation from two localities in the River Rhine area (Fig. 5a - Rijn area).

The next section, X.5, introduces a local resilience framework.

5. Local Level Resilience Framework: Rotterdam

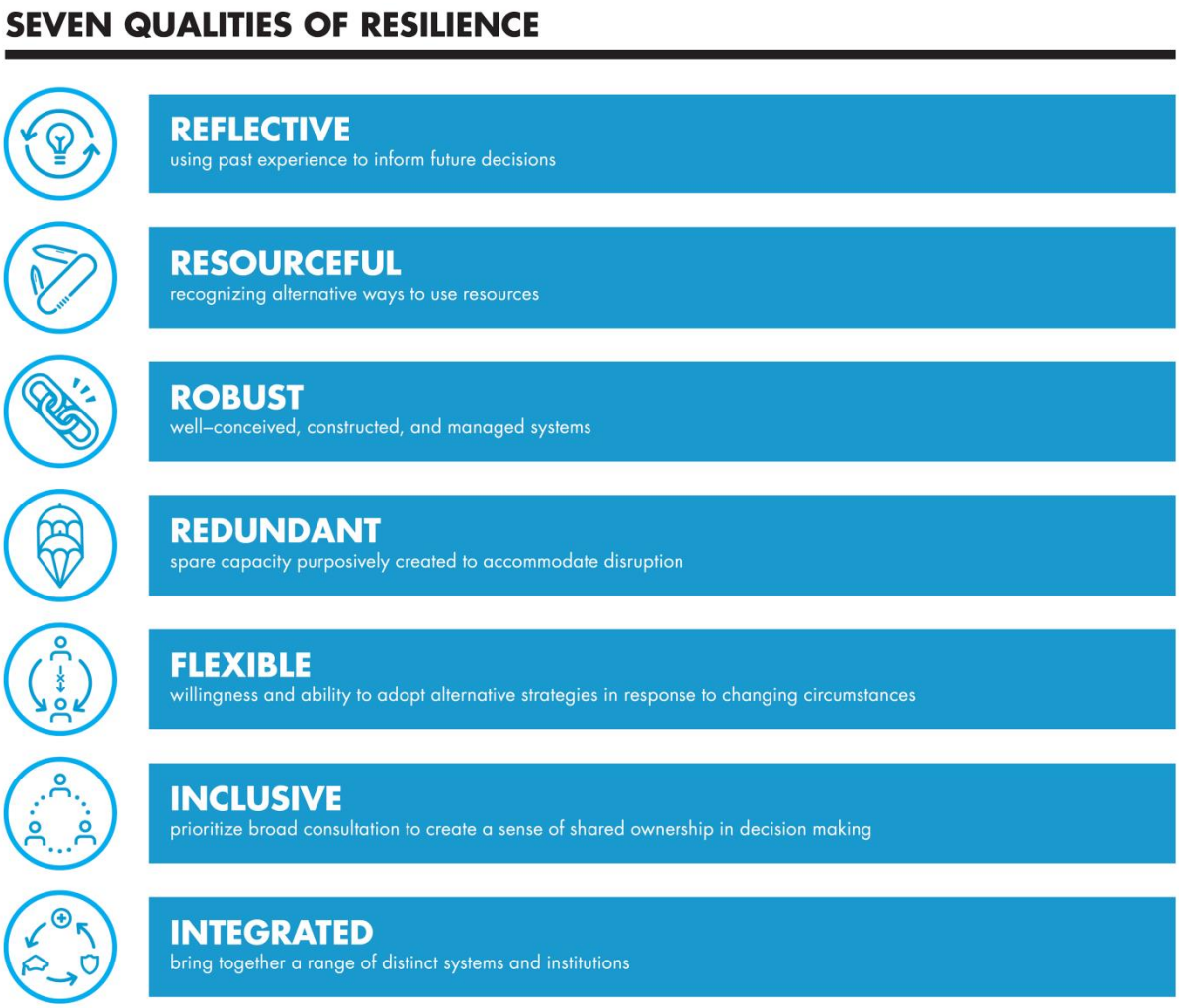
As outlined above, climate adaptation and resilience strategies in the Netherlands are strongly organised along the National Adaptation Strategy and its regional implementation. Local authorities heavily rely on these national frameworks as adaptation service, resources and guiding material allowing for a coherent approach and implementation. In fact, few cities in the Netherlands have separate local climate change adaptation or resilience frameworks in place (Reckien et al. 2018).

Rotterdam is the exception. It has both, a separate Climate Change Adaptation Strategy (City of Rotterdam 2018) and a Resilience Strategy (City of Rotterdam 2017). Possibly due to its size and location at the sea, and therefore international relevance as port city, decisive for the European trade economy, Rotterdam is highly vulnerable to projected climate change impacts. This elevated vulnerability has required and inspired Rotterdam to become a front-runnner city as regards, climate adaptation. With it came international recognition for its climate adaptation initiatives and its international accessibility (Rockefeller Foundation

2017). It is part of a world-wide resilience program “100 Resilient Cities”, funded by the Rockefeller Foundation (Rockefeller Foundation 2017). It is also--together with the Dutch City of Groningen--hosting the Global Centre of Excellence on Climate Adaptation (GCECA)(Rockefeller Foundation 2017). The GCECA is an international knowledge centre to help countries, institutions and businesses adapt to a changing climate, initiated by the country of Japan and UN Environment. The cities were chosen based on factors such as the cities’ location, expertise on the impact of climate change, and innovative office buildings. Continuing with its groundbreaking adaptation work, Rotterdam is exploring the possibility of building a new climate-neutral floating office building for the climate centre staff.

Resilience as understood and employed by the City of Rotterdam is a city when it is able “to recover quickly and to bounce back to become stronger” (The City of Rotterdam 2017, p.14). Guided by an underlying vision containing 7 objectives (see Fig. 6) and 68 action campaigns, Rotterdam aims to enhance the city’s resilience – aiming to ensure that Rotterdam will be prepared to embrace the opportunities and challenges of the 21st century.

Imagen 6 – The seven qualities of Rotterdam’s Resilience Strategy.



(*Fuente:* City of Rotterdam, 2017)

However, future challenges are not only related to climate change. Rotterdam takes a more holistic view and incorporates a number of societal and economic challenges as well. The main focus areas for Rotterdam's resilience are: 1) social cohesion and education, 2) the energy transition, 3) cyber use and security, 4) adaptation to climate change, 5) infrastructure, and 6) changing governance. These foci relate to seven objectives as outlined in Fig. 7.

Imagen 7 – Rotterdam's Resilience Objectives.

(*Fuente:* City of Rotterdam, 2017, adapted.)

With that Rotterdam "shows vision, courage, and perseverance; as a strong, assertive, and resilient city." (City of Rotterdam 2018). However, one must also acknowledge that the level of risk, projected impacts, and social and economic vulnerability, coupled with international economic relevance and financial resources puts Rotterdam in a unique position. It might therefore not necessarily be a representative example of the Dutch local situation and resilience frameworks--though, we might say 'it should be, for Dutch as well as other local authorities elsewhere'. As formulated in the Rotterdam resilient Strategy "Resilience is the new robust." (City of Rotterdam 2018).

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Chapter 8.Resilience Frameworks in National Policies and Territorial Planning in Uruguay.

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Introduction

Uruguay is known in Latin America for its strong political, social and economic stability, which is supported by a legal and robust democracy. This is essential to work on public policiesin orderto reach solid results in the long term. In this chapter we describe, on the one hand, how actions and strategies in climate change and urban resilience have grown at the National level in recent years and, on the other hand, how current territorial urban planning policies incorporate this new knowledge in order to create better and more efficient effects in prevention and mitigation to deal with this issue.

1. Development of the legal and institutional frameworks

Uruguayan government participate actively in international Summits in order to achieve the United Nations Framework Convention on Climate Change (UNFCCC) objectives. It declares the aim to build a sustainable, resilient and low-carbon country, by enduring efforts and capacities, which means incorporate these topics to public policies and actions in different sectors.

Based on the executive summary of Uruguay's Fourth National Communication to the Conference of the Parties in the UNFCCC on 2016, the main topic on Climate Change that worried the country in 2015, was the water deficit that had a strong impact on the agricultural sector, causing major economic losses. While in other Latin American countries, that counts on fossil fuel or other main natural sources for their economies, this problem could be not so much important, for Uruguay the agricultural and livestocksector is a central motor for its economy, therefore a priority to Climate Change policies (Hareau et al. 1999).

In addition to this, the regional climate scenarios show an increase in rain-fall and temperatures with a strong influence of the El Niño–Southern Oscillation (ENSO) phenomenon. That means in the same year, 2015, severe floods in the Departments of

Salto, Paysandú and Artigas, north of the country, forced until 25% of the population in these areas to evacuate their homes. This caused major losses in housing and urban infrastructure and had a psychosocial impact on the most vulnerable population.

Since 1992 several international agreements were ratified by Uruguayan Government in the area of Sustainable Development, the government follows-up international measures defined to avoid the negative effects of climate change. As long as Uruguay has not fossil fuels, or minerals, the main productive sector is the agricultural and livestockone (Achkar et al. 2016), that means government focus on create systems to protect, mitigate and adapt rural environments from extreme events, like floods and droughts, hurricanes and other periodic phenomenon that El Niño–Southern Oscillation (ENSO) phenomenon takes year after year (FAO-Project; Bidegain et al. 2013).

At the first decade of the XXI Century, the National Emergency System was created, including urban areas, helping to understand and mitigate some of the worst effects that increase with the strong winds in the costs, and floods in poor slums or deprived areas of the cities.

The Ministry of Housing, Territorial Planning and Environment (MVOTMA) became the focal point and competent national authority in charge of enforcing the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. In 2018 MVOTMA started to elaborate the National Plan on Climate Change, reinforcing the idea that this should be a central topic for the country in the next years.

If we evaluate these measures we can find that many actions were undertaken, for example, the country strengthened its domestic capacities to develop national greenhouse gas inventories, climate scenarios, and to implement pilot projects on adaptation and mitigation technologies and strategies. Between 2009 and 2014, with the creation of the National Climate Change and Variability Response System (SNRCC) and the participatory development of the National Climate Change Response Plan, the topic is brought to the forefront.

The main objective of these tools is to create an inter-institutional and cross-sectorial coordinated work, as well as to analyze the national and local impact of climate change related problems and develop strategic guidelines for the year 2050 within a model of sustainable, inclusive, low carbon and climate change resistant development.

In this period, climate change and variability has become part of national strategies and public policies, that should be applied to sectors such as energy, agriculture, tourism, health, disasters risk and water resource management.

As of 2015, the Administration strengthened its commitment to achieve sustainable and resilient development in the country. This can be seen in the support given to the SNRCC, in the creation of a political management position for all climate change affairs within the MVOTMA, and in the creation of the National Environmental System (SNA), the National Environmental Cabinet and the National Environment, Water and Climate Change Secretariat (SNAAC) under the higher authority of the country, the Executive Power.

2. Academic and civil society support

Following this strategy, a particular support was given to the research on climate change and variability that the country starts to produce, which has helped to promote and consolidate knowledge creation and research teams at different institutions, in order to start collaborative and supplementary lines of work. For example, the Interdisciplinary Network of the Universidad de la República (UdelaR), a horizontal grid integrated by: a) Urban Waters Planning & Management; b) Interdisciplinary Response Center to Climate Change and Variability (CIRCVC); c) Interdisciplinary Center for the Integrated Coastal Management of the Southern Cone (MCISur); d) South American Institute for Resilience and Sustainability Studies (SARAS). The National Climate Change Response System put together a Task Force on Indicators of Variability and Social Vulnerability to Climate Change, which has demanded thorough interdisciplinary and cross-sectional work to draw input for further assessment on the social vulnerability of our country.The coordination happened also with other sectors of applied research, government agencies and regional research centers.

Since climate change studies take on a strong territorial component, several research/action lines have been developed to validate adaptation and mitigation strategies in different sectors, thus, allowing for multidisciplinary and cross-sectorial efforts, engaging national and local governments, NGOs, farmers and urban local communities.

That means several institutions in the country have been engaged in meteorological and climate information generation and climate services, providing essential inputs for the different sectors in the Uruguayan economy to plan their undertakings and to protect the population.

However, there are still shortcomings both in the quality of the information produced and its utilization as long as the efforts have mainly been focused on: the development of a Flood Early Warning System to forecast and manage floods in the priority cities of Durazno and Artigas (middle and north of the country); the development of a Climate Index Insurance in Uruguay for different sectors in farming production; the development of instruments to monitor water excess and droughts in the country; and the rollout of the National Climate Database.

The information before shows thatsome progress has been made towards the development of additional information systems, in order to supplement efforts to manage the impacts of climate changealthough many of them are currently under development: the Environmental Information System (SINIA), National Environmental Observatory (OAN), National Agricultural Information System (SNIA), Information and Support System for Decision Making (SISTD) for climate risk management in agriculture, the GIS viewer of the National Emergency System, and the National GHG Inventory System. There is still a great need to discuss how to deal with the vulnerability that Uruguay confronts, by thinking how different actors could create capacities to act a coordinated resilience strategy.

As Borrego states:

> “The concept of vulnerability includes a complex and dynamic reality. Besides referring to the possibility that a system is negatively affected by something (a stressor), it is also a relative property defining both the sensitivity and the capacity to deal with that stress. Therefore, vulnerability cannot be defined by the stressor alone, nor can it be represented strictly by internal properties of the system being stressed. Instead, it must be considered as an interaction of these factors, expressed by the sum of several dimensions: exposure, sensitivity, and capacity to adapt” (Borrego et al 2015, p. 381).

3. Climate Change in territorial and urban planning

From the territorial and urban planning point of view, the creation of The Territorial Planning and Sustainable Development Law (Ley de Ordenamiento Territorial y Desarrollo Sostenible LOTDS N.18308, 2008), gives a framework for streamlining actions and management of great importance. The law allows, and has progressively enabled to, deploy several tools of planning at different levels, for example, National and Regional Guidelines for Territorial Planning and Sustainable Development, Strategic Environmental Assessment Protocol,

Local Plans, Special Plans, among others. Thanks to the law new planning initiatives in the country are applied with a gradualrecognition of their importance, including social participation and environmental awareness of the impact on territorial development.

Uruguay is divided in nineteen regions, called epartments, the Departamental and city governments had been including the climate change and variability in local plans for emergency situations, technology replacement and infrastructure arrangements among other initiatives. Specific inter-institutional areas were created, and progress has been made regarding knowledge creation and the implementation of adaptation and mitigation measures.

One of the most important challenges about Climate Change and Urban Policies in Uruguay,is the need to know exactly which type of phenomena are affecting Uruguay's cities. In order to study the problem properly, information and management tools were incorporated at all levels to address for example, droughts and floods, which were previously absent in the government management of urban effects.

On the second hand, particular attention was given to coastal ecosystems, as long as coastal areas are central to urban development and tourism in Uruguay and are at the same time a natural barrier against sea level increase and high wind storms (Gadino et al, 2012). This last topic was identified by academic research and social movements, but not by the touristic and real estate sector that continue making unsustainable urban development in coastal areas, in some cases with the acceptance of local governments, which don't create economic alternatives to such environments (De Álava, 2008).

Finally, another important topic for urban policies is the effects of climate change for the most vulnerable sectors in urban contexts, especially the flood affected population. Uruguay is a country with a high level of rain falls, but in the last years the extreme situations between heavy rains and drought periods have considerablyincreasesed. The Program for Mapping of Flood-Prone Areas has started recently; it was proposed that cities with more than 10,000 inhabitants should have a map of their flood risk areas in the short term. This mapping will be part of the Water Information System within the framework of the Environmental Information System. The delimitation of these areas is a priority for the definition of territorial policies, in particular for Urban Plans.

In this sense, the Law on Territorial Planning and Sustainable Development, LOTDS, in article 49 states that "territorial planning instruments should guide future developments towards non-flood prone areas identified by the competent water resources state body" (LOTDS: 2008).

In order to support planning instruments, The National Relocation Plan was launched. As Piperno and Sierra stated, it has required the coordination of decentralized policies and programs together with the efforts of departmental governments, in order toapply a new interdisciplinary approach to the topic. It is early to determine the results, because the first experiences are being developed currently, however the prevention aspects are clear and sign a path to near solutions (Piperno and Sierra 2015).

From the innovation in local administrations, it is important to underline how the elaboration of local plans for territorial planning, responsible of the departmental level, incorporate risks maps in a shared work among the first and the second level of government. Furthermore, systematization of existing information on floods has been carried out under the Program for Mapping of Flood-Prone Areas (DINAGUA-MVOTMA). The information implies a set of data processed with order and hierarchy so that they can be understood by the users. Hence, quality criteria need to be defined in terms of accuracy, consistency, timeliness, comparability, accessibility to data, metadata with information about the quality of the curves, presentation of the curves in user friendly and usable formats, and compatibility with the mapping Spatial Data Infrastructure.

Within this framework, DINAGUA (National Direction of Water at the MVOTMA), performed a compilation and processing of riparian flood curves, i.e. the area occupied by water during floods. This compilation comprises the analysis of past flood events and curves resulting from hydrodynamic studies of watercourses, which estimate the flood curves. The generation of new information on river flooding implies the articulation of different actors at various levels. During the Flood Area Mapping Project, protocols were also developed to generate new information.

According Agrawala,“Analyses of current climatic trends reveal a warming trend in recent decades with country averaged mean temperature increases of 1.1 °C and 1.9 °C projected by 2050 and 2100. Climate models also project increased precipitation both in summer and winter, although there is considerably less agreement across climate models on such projections. The most significant impacts of climate change are projected to be on Uruguay’s

coastal zones, both because of the higher certainty of sea level rise and the high exposure of critical economic and natural resources on the coastline. On the other hand, many other sectors dependent on natural resources – including forestry, agriculture and livestock – offer considerable potential for mitigating climate change through carbon sequestration. Natural resource management therefore is a critical link in Uruguay's efforts to both adapt to and help mitigate climate change". (Agrawala et al. 2004).

From the urban planning point of view, the Department of Urban Planning (ITU) at the Faculty of Architecture, Design and Urban Studies, UDELAR has made significant contributions for flood management in the country, in particular in the characterization of the vulnerability of the exposed areas and started to work on how to incorporate Climate Change issues to Urban and Territorial Planning.

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SECTION II. Climate resilience experiences and practices

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In recent years, society has become more aware of the enormous risks that climate change poses for cities; the increase in temperature and sea level, more intense storms, droughts and heat waves, are a reflection of the eventual and increasingly frequent threats to which they are exposed. In fact, the recent IPPC report shows that the climate risk is increasing with critical consequences to humanity that could be catastrophic. The target to stabilize the temperature under 1.5 C° is getting difficult, and we are on the way to reach 3 C°. In this sense, there are still a number of opportunities, but they come with a cost. It certainly implies that we must adapt for the changes that are upon us.

Climate change brings new risk. In order to reduce the risk and impact of these threats, cities must work to increase their resilience by incorporating it as a priority in urban planning, involving a wide range of stakeholders including civil society, local and national governments, the private sector and the academy. There should be taking into account that the strategies adopted at the local level will have a significant impact on a global level, taking these strategies from strategy to action.

The adaptation always has to do with the local territories, where it is practically impossible to have a solution or universal recipes. The case studies have been an important tool to evaluate the pros and cons of the alternatives. This chapter presents a series of experiences and initiatives on urban resilience in Europe and Latin America cities. Although, thanks to geographic and social differences, each city needs to create its own unique resilience plan, cross-cutting elements are highlighted for the development of strategies that help increase urban resilience.

Some elements that we observe in common from the cases,it highlights the fact that, despite the wide spread knowledge, it is still required to increase *awareness* of climate change and the *individual actions* we could take. There is also a need for an *integral view* of the problem, and not a collection of individual pieces. Finally, we have to consider to strongly move from speech and plans to actions and

implementation. The message to be conveyed is that resilience and risk reduction should be part of urban design and strategies to achieve sustainable development.

Chapter 9. What resilience to aim for in Brazil? Readings on São Paulo's and Belém's local practices.

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1. Presentation of the formation processes of São Paulo and Belém

The continental dimensions of Brazil (8.515.767,049 km²) and the diversity of circumstance of its 5.570 municipalities and regions hinder any effort of comparing municipalities in such different regional contexts. To compare São Paulo and Belém, it is necessary to introduce elements of the formation of Brazil, a country that had its territory appropriated defined by colonial economic cycles and the conditions of communication with Europe.

The occupation of the Brazilian territory developed from the Atlantic coast in the portion that today corresponds to the Northeast region and unfolded in two vectors. A vector followed towards the gold mines of Minas Gerais and the port of Rio de Janeiro. Only in the 18th century the small village, which was the place of a Jesuit college since 1554, was raised to the condition of the city of São Paulo, at that time, the connection of the interior to the port of Santos, by railway, was a starting point for a larger logistics structure consisting of ports, roads, railways, hydroelectric dams, etc., made possible by the prosperous and long cycle of coffee occurring between the years 1800 and 1930 (PradoJr, 1989). These elements in addition to the high European migration and the support of the federal governments in both coffee farming and the industrialization process allowed the city to take a position of political and economic leadership in the country at the beginning of the twentieth century, and reached the 21st century as the seventh largest agglomeration on the planet. São Paulo is the core of a metropolitan area with 20 million inhabitants and of a mega metropolis with about 33 million, which still concentrates the largest part of Brazilian industrial production and is articulated by means of a dense urban network, to the research and production centres of high technology industry of Brazil (Emplasa, 2017).

The second vector of occupation of the territory went towards the north, where Belém was founded in 1616, to defend the territory from French, Dutch and English occupations, towards the Amazon. This region was a "frontier Mundi", disputed by five nations until the 18th century (Becker, 2013), and the privileged location of Belém sustained it as a port of outflow from all Pan-Amazonia towards the Atlantic, and a privileged connection point with Europe. The forest product cycles and the pombaline expectation of making Belém the capital of northern Brazil (Rio de Janeiro was already capital of the colony and would be the capital of south Brazil according to these plans), sustained the condition of main metropolis of the region until the 1960s (Correa, 1987), when the national highways and all the military government's colonization policy for the Amazon, significantly altered the population and environmental conditions in the region. The insertion into the international division of work of both cities is very distinctive, although in the two cases the urbanization has been accelerated and generates many environmental liabilities. São Paulo has reproduced the trajectory of European industrial cities, such as the epicentre of industrialization and urbanization, without achieving, however, the same socioeconomic conditions as those cities, while Belém assimilated the impacts of the productive system restructuring in an area that covers more than 50% of the Brazilian territory - the Amazon, assumed as a provider of natural resources, taken as infinite, and that has been converted to cerrado since the implantation of the federal highways. The imposition of industrial logic in the Amazon was due to the implantation of logistical networks and land uses changes, over an ancient pattern of well articulated with the biome and dispersed occupation. Resistances to the transformations of the Amazon are still visible, despite the fact that the region already has its population urbanized since the 1980s, and they can be taken as inspiration for new platforms of more Biocentric than Anthropocentric urbanization character - like the one that prevailed in the twentieth century.

Given these considerations, it becomes easier to understand that São Paulo and Belém have absolutely different socioeconomic, institutional, cultural and environmental conditions, but that they share the common characteristic of being governed by the peripheral capitalism, and now liberal, Brazilian government. In this article it is expected to explore to what extent the realities expressed by these two cities (from the national and global metropolis of São Paulo and the peripheral metropolis of Belém) were considered in the formation of the National Civil Defence policy and how the Issues of civil defence and urban governance could be articulated in each of them.

2. The National Civil Defence Protection Policy (PNPDEC)

The occurrence of disasters in areas with susceptibility to gravitational movements of mass - notably landslides in the southeast region where the states of São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo, as well as in the South region, especially in the State of Santa Catarina and in the northeast region, mainly in the states of Pernambuco and Bahia, in addition to severe floods and inundations that have been occurring in different regions of the country -, promoted national mobilization for the need of advances in the coverage of Civil Defence bodies. The scenario of disasters, in the progressist political context, has delivered the National Civil Defence Protection Policy (PNPDEC) as the response (Brasil, 2012). To a large extent the Brazilian progressist political context, between 2003 and 2014, during the Governments of Presidents Lula and Dilma, was favourable to the construction of an institutional and technical apparatus to support the PNPDEC. The same can be said with respect to municipal policies, which have found an institutional environment in which the risk-affecting issues could move forward. However, the current scenario has already changed completely.

The PNPDEC was established by Law No. 12.608 of 10 April 2012 (Brasil, 2012) as the main Brazilian instrument for the management of the disaster risk, aiming to ensure adequate social, economic and environmental conditions to foster the dignity of and the promotion of sustainable development. Its determinations include the Union, the States, the Federal district and the municipalities, which have the duty to take the necessary measures to reduce the risk of disaster.

The policy dictates which are the responsibilities of the Union, of the States and of the municipalities: the development of a national disaster prevention culture, to increase the awareness of the disaster risks in the country, provide the stimulus to prevention behaviours capable to avoid or minimise the occurrence of disasters; to stimulate the reorganization of the productive sector and the economic restructuring of disaster-affected areas; to establish preventive safety measures against disasters in schools and hospitals located in risky areas; to provide human resources training for civil protection and defence actions; and to supply data and information to the national system of information and disaster monitoring.

However, the main objective would be the integration of territorial planning policies, urban development, health, environment, climate change, water resource management, geology, infrastructure, education, science and technology and other sectorial policies, with a view to promoting sustainable development. It also goes back to the elaboration

and implementation of Defence and Civil Protection Plans at the three levels of government, setting short, medium and long-term goals; National disaster information and monitoring system; National Register of municipalities with areas susceptible to the occurrence of high impact slides and associated geological processes, floods and hydrological processes.

Some instruments provided for in law 12.608/12 as the responsibility of municipalities are being drawn up with the resources and support of federal agencies, such as the identification of risk areas, maps of susceptibility to the processes of landslides and floods and geotechnical maps of suitability for urbanization. The creation of the National Centre for Natural Disaster Monitoring and alerts, which responds to the Ministry of Science, Technology, Innovation and Communication, performs the monitoring of natural threats in areas of risk in Brazilian municipalities susceptible to Occurrence of natural disasters. Even so, the States also play the role of supporting municipalities in monitoring meteorological, geological and hydrological risks.

The subject of disaster risk reduction has entered the administrative agenda as the need for relief and assistance to disaster-affected populations has been highlighted, since then articulation of sectorial policies of risk and disaster reduction and Civil Defence actions to the instruments of planning and territorial management was demanded, that is, it was a proposal more focused on prevention actions than simply to emergency services. It is also in the scope of disaster risk reduction the promotion, identification of threat assessment, susceptibility and vulnerability to disaster, in order to avoid or reduce its occurrence. Their actions can also extend to the monitoring of meteorological, hydrological, geological events, aiming to produce early alerts on the possibility of natural disasters; and to the stimulus to the planning of the occupation of urban and rural land, with a view to its conservation and protection of native vegetation, water resources, and human life; as well as combating the occupation of environmentally vulnerable and risky areas and promoting the relocation of the resident population in these areas.

The starting point for the involvement of municipalities with the theme was the realization of mappings with the support of the National Geological Service and the CPRM. In recent years these bodies have developed and made available mappings of risk areas (sectorization) and maps of susceptibility to gravitational movements of mass and floods, within the framework of the Risk Management Program and Natural Disaster Response, foreseen in the Multiannual Plan 2012-2015 of the Ministry of Planning,

Budget and Management, which counted on the allocation of resources of the Ministries of Cities for the elaboration of geotechnical maps of aptitude to urbanization.

The Maps of Susceptibility to Gravitational Movements of Mass and Floods elaborated on scale 1:25.000 indicate the degree of susceptibility (high, medium and low) for the occurrence of a given process, (mass movements and floods). Despite the progress that its elaboration represents, its objective is only to indicate in general the distribution of processes and the degrees of susceptibility in the territory (Bitar, 2014).

At a higher level of detail (scale 1:10.000), with a look at defining guidelines for the occupation, it is foreseen in PNPDEC, the elaboration of Geotechnical Maps of Aptitude to Urbanization in the Face of Natural Disasters. This Map has a caption with the geotechnical units defining the terrain aptitude classes, according to the limitations and potential for the occupation, and providing guidance for urban expansion. The results should be incorporated into the elaboration and discussion of the Municipal Directors Plans (Planos Diretores Municipais in Portuguese) (Nogueira, Canil, 2017).

Under the new guidelines for the elaboration of the geotechnical maps of aptitude for urbanization, the number of municipalities that have this instrument is still incipient. This reduced number is due to budget cuts in the federal bodies after the political coup of 2016 and also by the reduced teams of the teaching and research institutions that hold the knowledge and experience in the implementation of these products.

Belém and São Paulo rely on the mapping of susceptibility elaborated by CPRM according to the new legal framework. Belém does not have the geotechnical maps of fitness for urbanization in the face of disasters Natural and São Paulo has that precedes the new policy.

In south-eastern Brazil (where São Paulo is inserted), in addition to the legal determinations, there would be an influence of the type of correlation between the amount of public investment and the value of the land, in attention to the demands of the land market. While in the north (where Belém is inserted) the situation is reversed, there would be the influence of events listed as associated with climate change capable of generating great losses.

In both contexts, there is a disarticulation of risk surveys with the policy of urban and regional planning, possibly because the PNPDEC is not yet regulated. The prospectuses posed by the current political context are of reduction in the role of the State, the reduction of spaces and approaches that allow the direct participation of society and the option for non-structural measures, which can jeopardize the whole institutional apparatus ever conquered so far, or even the response capacity of Civil Defence in the

cases of disasters that have intensified since 2012. In the municipal sphere, the creation of the instruments and policies and their developments in the production of technical instruments, demonstrate that there is a lack of dialogue between technicians who act in the prevention of risk, planning and management of the territory, and in the face of the impacts of climate change.

3. The Case Studies

Despite the expectation of the national risk and disaster management policy to be articulated with other federal laws, such as the City Statute, and the recognition of the importance of integrating the various instruments related to the territorial planning, there is a great diversity of situations in the country as to the effective manifestation of this articulation. In this sense the construction of a parallel between Belém, located in a region assumed since the decade of 1950 as of extraction and agrarian vocation, and São Paulo, assumed as an industrial region and motor of the national economy (Loeb, 1987) can be very illustrative of how these differences influence compliance with the premises of PNPDEC in the country.

The exploitation of natural resources in the Brazilian Amazon by public and private initiative has caused major environmental and social impacts, which have made the management of risks and disasters to which urban populations are subjected a challenge for formulators of Public policy. For decades the extractivism of wood, iron ore and livestock production reduce the rainforest, destructured traditional populations, and caused large population displacements to cities. In São Paulo the policies of industrialization and the attraction of European and Japanese migration made the population of the city grow in the decade of 1940 from 100.000 to 1 million inhabitants (Rolnik, 1997). The concentration of the Brazilian industrial park at MRSP in the mid-twentieth century made it the main attractor pole of manpower in the country.

In Belém the flow of unqualified migrants to enter the urban market occupied, and gradually consolidated from landfill, areas originally flooded when they were not interested in the market. Cycles of occupation, consolidation, and absorption of land by the real state market configured the metropolitan periphery, modifying ecosystems and urban metabolism while expelling the poorest population to farther peripheries (Cardoso, 2002; Lima, 2000).

In São Paulo the urban expansion process was clearly accelerated from the beginning of the years 1950, associated with the growth of the industrialization process, especially at ABC Region, within the metropolitan area. The increase of the population, especially

from other Brazilian states, in an exponential way, was not accompanied by planning actions. In parallel, the implementation of protection legislation, as the example of the Law of Sources Protection, which restricted both the infrastructure implementation and the occupation in the dams watersheds, already in the process of peripheral growth, worsened the precariousness of informal occupations by the low-income population that could not access urbanized areas with infrastructure (Maricato, 2003). A similar process occurred in the floodplains of the streams, also protected by law. From then on, such areas considered to be despised by the formal real estate market and for being environmentally fragile from the standpoint of the physical environment (areas of hills, with geological-geotechnical problems, susceptible to landslides, streams and plains Rivers subject to flooding and erosion of margins), of the biotic medium (areas with significant portions of plant cover that meet the maintenance of ecosystem services), and of the socio-economic environment, which present high vulnerability, have undergone a process of densification and precariousness, which began to challenge the government in the search for solutions.

In that respect, Maricato (2003, 158) clarifies:

“What happens most frequently, however, is the consolidation of illegal occupations in areas of environmental protection due to the unfeasible cost of its removal. The numbers of illegality in the use and occupation of the soil in the Guarapiranga dam in São Paulo (which serves the need for water of one-third of the population of the municipality) are definitive proof of that statement [...]. The maps that present the use and the occupation of the soil in the basin, evidence the massive illegality (UGP/Sema, 1999)”.

Box 1 presents relevant variables to the understanding of the nature of the risk existing in both cities (demographic growth, physiography, precariousness). It is observed that in the proposed structure for Civil Defence operation, risk events are treated as a state of exceptionality, when in fact they happen cyclically. It is necessary to consider the risk in a different approach to that of the expert's discourse, capable of recognizing the social construction of inequality as a source of vulnerabilities.

The risk used to be seen as something probabilistic, associated with natural events, and therefore immutable. Alternatively, the prospect of the social construction of the risk has as its agenda to deconstruct this probabilistic characteristic and to consider the historical formation of the occupation of the places. The speech merely probabilistic favours the belief that the elaboration of parameters and models of predictability can solve the problem. Part of the prohibition of the occupation of certain areas, without considering the reasons that led to such occupations. In both cities it is necessary to

make a more complex analysis, involving the technicians (scientific as narrative taking into consideration the balance of the built environment), the scholars and the demands of the population.

Table. 1. Parallels between São Paulo and Belém: the site and conditions of informal production of the cities. Sources: cited in the text.

São Paulo is the largest Brazilian city, with a population estimated in 12 million inhabitants, which polarizes a metropolitan region with 21 million inhabitants (IBGE, 2017; EMPLASA, 2017). The city extends to a site consisting of valleys, hills, and plateaus, where there has been suppression of smaller rivers, in the areas of older urbanization and, therefore, with greater infrastructure, and rectification of the largest, especially the Tietê and Pinheiro rivers. The urban rivers were historically the objects of major interventions, in a first moment by reasons for sanitation and power generation and subsequently for the attempt to reduce floods and also to support the city's main road system.

The Tietê and Pinheiros Rivers limit the region known as the expanded Centre and, with its large alluvial plains, also limit the region more favourable to urbanization, although susceptible to

Belém has an estimated population of 1,450,000 inhabitants, although it is no longer the city with the largest population in the Brazilian Amazon region, it makes up the largest Metropolitan Region in Brazilian Amazon, with 2.4 million inhabitants. The location of Belém on an estuarine site of Amazonian lowland is very relevant to the urban planning process, due to the determinations of the daily tides water regime to the old meadows, which constituted the central popular districts after occupation and landfill, and the way the land market is operated by the real estate sector.

Belém is surrounded by rivers and crossed by diverse types of watercourses forming 14 typical lowland drainage micro basins, it has a predominance of sites with altimetry up to 14 meters, extending up to 30 meters in the conurbation area with the municipality of Ananindeua. The

flooding. As urbanization moves away from it, it reaches progressively more altitude differences, reaching 1100m and greater declivities in the granite massifs that delimit the upper Tietê basin, especially north and south, where the biggest susceptibilities to mass movements are observed (Ab'Saber, [1956] 2007).

The urban area has high indexes of infrastructure coverage and greater management capacity installed when compared to other Brazilian capitals, yet the coverage of environmental sanitation services still presents many failures in periphery and, in relation to the sewage system, although part of the infrastructure is installed, much of the sewers produced still have as main destination the water bodies, resulting in great environmental degradation.

In demographic terms, although São Paulo has presented a cooling in its average population growth, it continues to present significant changes in the intramunicipal territory, with significant urban expansion in regions of high susceptibility to landslides, as in the far east and north regions, as well as in the environmental commitment is greater in the surroundings of the water bodies that functioned as natural drainage, on sites with altimetry of up to 4 meters, to the extent that they were mostly modified to serve as infrastructure to receive domestic and industrial sewage, in addition to garbage, and suffered silting and landings of streams. Thus, the significant presence of areas of lowland and igapós in the urbanized basins highlights the vulnerability of several areas to events such as flooding.

According to the IBGE, approximately 55% of the population of Belém lives in subnormal agglomerations (IBGE, 2010), which are characterized and located as follows: 2.,784 households are in the margin of streams, rivers or lakes, of which 331 are stilts, according to the demographic census of 2010 (IBGE, 2010). Studies of the years 1960 (Penteado, 1968), record that the quota of flooding in Belém varied between 4 and 4.5 meters. Recent studies indicate flooding in areas of quotas up to 6 meters depending on factors such as soil proofing, precarious maintenance of drainage networks, presence of garbage in the city streams, narrowing of water

southern region (São Paulo, 2018). A result of this process is the existence of, in 2010, 407 areas of geological risk, configuring almost 106,000 endangered dwellings, located mainly in precarious settlements, with situations of land, urbanity, and building irregularity (São Paulo and IPT, 2010; São Paulo, 2018). Among these, 54.5% of the buildings do not even have information in the real estate register. However, the vulnerability may be even greater, with regard to the risk of flooding, of the 386.000 domiciles located in precarious settlements, in the municipality, 274.000 are wholly or partially located in valley funds, with varying degrees of susceptibility (Travassos et al, 2017).

The population that lives in the 407 areas of risk mapped is mainly composed of families with less income than a minimum wage (70%) and 4 times more sewage and open-air waste disposal. In these areas, also live on average almost one third more of children than in the rest of the municipality (São PAULO, 2018).

courses due to the landfill and water flow modification (Pinheiro, 2015).

The area of flooding in Belém, considering the quota up to 6 meters, has 27.05 km2, representing approximately 10% of the municipal urban area and 45.39% of subnormal settlements universe concentrated in the area that corresponds to the metropolitan center and its immediate surroundings, placed in low areas that were occupied between 1930 and 1980. State-funded drainage projects have brought profound modifications to the water operation with the commitment of natural drainage and the worsening of flooding points; 77.10% of the population of the subnormal settlements is in a situation of vulnerability in relation to the risk of flooding and possible inundation. However, the Amazon Protection System (SIPAM in Portuguese) in Study for the Civil Defence of the State of Pará identifies floods outside the "risk area", associated with the convergence of rainfall and low slope, which function as valleys in relation to the built-up mass (Pinheiro, 2015).

The prosperity of São Paulo (it concentrates a range of 34% of the São Paulo State GDP, which represents itself near one third of Brazilian GDP (SEADE, 2018) and its great concentration of technical competence were decisive for the implementation of the most complete management apparatus in the country. The city has a Susceptibility Map, finalized in 2015 (Bitar, 2014) and a mapping of geological risk areas produced in 2010 (São Paulo, 2010), which gathers and updates previous mappings. These were the instruments that could be used as a diagnosis when the municipality elaborated its Strategic Director Plan (São Paulo,2014) prepared and approved between 2013 and 2014, which adopter the Map of Risk Areas as one of the maps of the law (Map 10, Risk Areas). The PDE 2014 established priority actions in areas of risk, within the housing policy of Social interest, focusing on the prevention of occupation of susceptibility areas, implementation of infrastructure to minimize risks in areas already occupied, in addition to the participatory development of actions and prevention and relief programs. Many of these actions have been consolidated in a Municipal Risk-Reduction Plan, not yet concluded.

However, the issue of disaster prevention and risk was no longer considered in the planning instruments that regulated the PDE. The debate on the Land Use and Occupation Settlement Act (Municipal Law n. 16.402, 2016) carried out after the elaboration of the Strategic Director Plan, did not consider the mappings of this document to define the rules of occupation, and did not establish forms of Specific control to curb occupation in high-risk areas. Similar situation occurs in the regional plans completed in 2016, in which the flood risks appear indirectly, associated with the idea of recovering water bodies and their margins, but without pointing out the question of geological risk clearly. Doubts prevail over the possibilities of regulation and specific action in the reduction of risks in the municipality, through the existing planning tools.

Regarding the institutional framework, the risk management structure in the municipality of São Paulo was established in 2006, therefore, six years before the PNPDEC. Since 2013 there is a bill aimed at the creation of a Municipal Civil Defence Secretariat and its instruments of action in the municipality (PL 664/2013), but its structuring remained institutionalisedthrough Municipal Decree N. 47.534/2006, leaving it more likely to extinction by the administration by means of a simple act of repealing his decree of creation. The decree reorganizes the Municipal System of Civil Defence, in convergence with the National System of Civil Defence (structured in the country in 2005), aiming at the integration of municipal actions to the state and federal, through

the Municipal Civil Defence Coordinator (COMDEC), subordinate to the municipal Department of Urban Security. The COMDEC consists of representatives of all the bodies of the municipal administration and has the commitment to create policies and guidelines for Civil Defence: prevention, alert, relief, and recovery.

Among its functions, the implementation of decentralized Civil Defence actions, in particular the creation of District Civil Defence - CODDECs, and the Nucleus of Civil Defence- NUDECs. The CODDECSs have the task of adapting the general guidelines of the policies and programs to the reality of the risk incidence of each of the 31 regional prefectures of the municipality. The NUDECs are formed by community representatives of risk areas, who act in a decentralised and voluntary manner under the coordination of CODDECs.

Despite the importance given to risk management in the municipality of São Paulo, and the historical association of susceptibility and vulnerability to extreme risk in the occupation of the city, the information necessary to accomplish it and the consolidation of the structuring of its institutional framework walk in a slow and limping way. Although technical efforts have been made around the mitigation of risks, political disinterest persists in prevention, manifested in the disarticulation of actions related to prevention and territorial planning, and in maintaining the reactive posture of emergency and post recovery actions.

In Belém, there is a clear disarticulation between disaster risk prevention and urban planning policy. The regulation of the use and occupation of the soil in Belém is highly committed to the real estate interests, to the extent that there are no indicators that incorporate risk management and response to natural disaster policy developments. The status quo is maintained in the low-income areas, subjected to constant flooding, which are treated as ordinary by the local government and receive punctual actions in the event of disasters. On the other hand, in the areas of interest of the real estate capital, the rule of use and occupation of the soil suffers interferences from the market and allows the indiscriminate increase of the impermeability of the soil intensifying the flooding in the course of the last years. In general, CPRM's susceptibility maps indicate the possibility of problems, but they are not incorporated into the urban control instruments.

The management and operational centre of the Amazon Protection System (CENSIPAM), linked to the Ministry of Defence is today the main provider of information for the Civil Defence structures installed in the Amazon. It operates in the prediction of floods and inundations caused by tidal waves, and flooding and inundation caused by heavy rainfall. In urban basins, it also monitors the formation of clouds and storms,

including short-term forecasts. The Civil Defence structure existing in the state of Pará is a joint responsibility of the Fire Department and the State and Municipal Civil Defence. The actions of state and municipal structures are aimed at actions of prevention, mitigation, preparedness, response, and recovery, to minimizing disasters. Threats are defined from a radius of action within which may occur damage and disorders. A representative of the Fire Department in the event promoted by the CARE group of UFPA on May 2018 (UFPA, 2018) conceptualized the vulnerability as exposure, fragility, and low responsiveness. The disaster is measured by the intensity of environmental, material and financial human damage, while the disaster exists only when there are elements exposed to vulnerability, notably in the northern region: fires, droughts, floods. Meanwhile, the Emergency situation is seen as an abnormal situation caused by disasters, which implies the loss of the official responsiveness capacity, and ultimately the situation of public calamity: loss of substantial capacity. At this point, the State is called to provide support to the Municipality.

The Municipal Civil Defence created in 1984, works in a coordinating of the Municipal City Hall of Belém and has goals that coincide with the vision of the Fire Department as to prevention, mitigation, preparedness, response and reconstruction (UFPA, 2018), namely: conducting threat studies, establishing vulnerabilities, classifying and prioritising risks, keeping residents of the areas on alert to maintain support for State Civil Defence - CEDEC. The response focus is the immediate reconstruction of losses in the case of up to 30 affected families, which depends on the assessment of the occurrence and realization of the First Care procedures, survey of families and affected homes, of food needs and personal hygiene, and the activation of the organs involved in the process. In larger events, the state administrative structure is triggered. According to its records, the most recurring causes of disasters are the soil waterproofing, trees removal, occupation of river margins, excessive deforestation and increased concentration of rainfall.

There are no considerations in the planning and urban Legislation and Belém (Belém, 1999 and 2008) about risks and disasters caused by occupations in areas identified as subnormal agglomerations or in association with changes caused by drainage engineering works modifications. The way to see the lowland and the practice of converting this type of ecosystem by landfill and plumbing since the 17th century have transformed this risk-building factor into a blind spot for official planning, which accepts as "natural" the transformation of these spaces, at first by the action of families and communities in small agglomerations, but more recently, by action of the great capital

in cities, notably by the real estate sector, and in the rural environment, where major transformations are promoted by agribusiness, livestock and mining activities.

In Belém, it is also clear that the inadequacy of occupation in lowland area already anthropic impacted is selective; the risk is emphasized always that it refers to low-income population, which only initiates the processes of conversion of areas, that are subsequently absorbed by the market and offered to other population social extracts, after large public and private investments and significant changes in their relative location within the metropolitan area. Thus occupying vulnerable areas, deforestation, and waterproofing are very lucrative businesses that are kept out of the reach of limiting regulations. Not by chance during the years 1980, Belém was known in the country as the capital of the invasions and is currently the only capital that has more than 50% of its occupied territory improvised or informal (Trindade JR, 1998; CEM, 2007).

4. Deficiencies and challenges in São Paulo and Belém

Despite the institutional and legal apparatus available in São Paulo, there is still little public policy effectiveness in the implementation of the instruments envisaged in the policies. The situation is marked by the structural problems caused by the Brazilian peripheral development model manifested in the urban infrastructure deficit and in social inequalities that result in the production of risk. The lack of participation of civil society and the population in the production and management of public policies aggravates the distancing between policy formulation and real demands of society. It also highlights the scale of the challenge of promoting mechanisms of interest and participation to mobilize society. It is pointed out that given the magnitude of the problem both the technical structure and the investments are insufficient, which is a major challenge, considering the recessive period and the liberal orientation of the current Brazilian government, which advocates the reduction of State action (Brazil, 2016). In addition, there is no link to prevention and risk actions with climate change policies (Brasil, 2012), this is the reason underneath the inadequacy of many regulations devised in Brazil since they disregard the need of structural inequalities reduction, which is essential to achieving resilience.

On the other hand, it is observed the weak institutional performance in the face of the impacts of climate change in Belém, the lack of consistent connection between urban and environmental policies on specific issues related to resilience, notably in the need of drainage projects consistent with the precipitation intensity and natural behaviour of abundant water bodies in the region. The challenges posed are related to the need for

greater integration between sectorial policies and deeper relationship between land use planning, land policies, environmental project and territorial planning policies.

Specifically in the recognition of living conditions in the peripheral areas, the lack of policies for slum urbanization, for example, the fact that there is a majority of the households (inadequate and improvised) in the region Metropolitan of Belém, despite the socio-environmental context, indicates the importance of the planning for land use and occupation. In Belém, unlike São Paulo, there are problems in the management of water resources in the institutional frameworks, linked to the fact, for example, that regional committees of basins rarely meet and do not deliberate in the environmental policy of the state of Pará. Associating technical territories with political jurisdictions would be a major step towards the democratization of water problems, regionally. In this respect, it should also be noted that the Planos Diretores Municipais, basic instruments and sometimes, the only ones available in municipalities, do not deal adequately with the modelling of the built environment, and do not seek to improve the environmental performance. There is a need for revision and detailing of urbanistic instruments to achieve better urban project results, both in physical and socioeconomic aspects.

In the Amazon, traditional territorial strategies begin to be recognized as low impact, but institutionalized planning instruments have not assimilated this. So there is a need to recognize, encode and apply traditional knowledge in planning instruments, which will certainly generate nuisance for the social agents accustomed to benefiting by the concentration of land, established as part of the modus operandi of elites, despite the agendas of urban reform and agrarian reform claimed by Brazilian social movements, but still to be restructured for better adherence to hybrid conditions and socio-environmental diversity, generated by superimposing logics, of the Amazon.

In both cases, there are challenges related to the application of agendas to encourage resilience, starting from the question: what is the point one wants to establish as the reference to return after events that create system disturbances?

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Chapter 10. Planning for Climate Change Adaptation in Italy. Two Innovative Case Studies

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1. Introduction

The paper describe the characteristics of the municipality adaptation plans of Ancona and Bologna, that are considered among the most innovative ones in Italy (Figure 1). These plans are developed from the Sustainable Energy and Climate Action Plans (SECAP - see Climate ADAPT https://climate-adapt.eea.europa.eu/about) and have three mainly aims: to reduce polluting emissions and energy consumption, to increase the production and use of renewable energy, to implement adaptation strategies to reduce the exposure and vulnerability to climate change of the territory and to increase its resilience. The description focuses on some of the factors that characterize the urban resilience to climate change.

Figure 1: The geographical location of Ancona and Bologna

(*Source:* Authors)

The Plan of Ancona is one of the pilot application of a common methodology about climate adaptation planning, shared through the LIFE Project ACT -Adapting to Climate Change within European cities in the Mediterranean basin (see http://www.actlife.eu). It represents a concrete implementation of an action plan oriented toward the integrated risk management and the vulnerabilities reduction, acting on contingency and on prevention of environmental, social and economic impacts of hydrogeological risk and climate change.

The Plan of Bologna is the result of the European Commission funded project LIFE+ ""BLUE UP Bologna Local Urban Environment Adaptation Plan for a Resilient City" (see http://www.blueap.eu/site/en/). It focuses on the vulnerabilities of the urban area of Bologna and the close surroundings, mainly related to droughts, heat waves, floods and hydrogeological

instability. The Plan offers a gallery of tools and possible solutions, especially selecting those based on a more stable and effective public-private partnership. This is why the participation of stakeholders and target communities to the Plan design process has been emphasized and considered one of the main focuses of the Plan development itself.

The comparative analysis factors considered are:

1. *Planning Approach*
2. *Exposure and Vulnerability*
3. *Solutions*
4. *Raising Awareness*
5. *Monitoring*

The *Planning Approach* of the climate adaptation strategies is characterized by three factors. The first one concerns the adoption of a systemic vision, that is distinguished by the integration of the strategies/actions of the different plans at different scales that affect the area of intervention and the integration of the main dimensions (socio-economic, environmental, institutional, etc.) of the problems to face up. The second is linked to the consideration and representation of a multilevel governance, in which all the main actors are contemplated, while the third is linked to the involvement of the personnel of all public authority sectors in the elaboration and implementation of actions.

Exposure and Vulnerability are strictly connected. Exposure focuses on the elements of a territorial area that may potentially be damaged by the impacts of events caused by climate change on a certain territorial area (heavy rains may cause floods and hydrogeological hazards, high temperatures may cause droughts, hit waves may cause diseases). It can be defined as “the degree to which natural or socio-economic community or territorial systems are exposed to the potential impacts of climate change” (Ensure Final Report, 2011). Vulnerability can be broadly defined as “the degree of fragility of a natural and/or socio-economic community or territorial system towards the impacts of climate change” (Ensure Final Report, 2011). Vulnerability can therefore refer to the physical fragility of buildings and infrastructures, to the physical and psychological fragility of communities and individuals, to the fragility of the economic sectors and the production models facing the impacts of climate change. Attention has to be paid also to systemic vulnerability, deriving from the interconnections and interrelated dynamics of the different territorial sectors, subjects and elements with the related characteristics.

The *Solutions* are the adaptation actions and measures (soft, grey, green) that a Plan sets in order to reduce the climate change hazard, the exposure of people, activities and territorial contexts to these hazards and the vulnerability of exposed resources, increasing robustness and/or improving adaptive capacity to resist, react and rebuild.

The *Raising Awareness* is supported by the Information, Knowledge, Awareness interrelated factors that individually and in their synergistic relationship contribute to strengthening the adaptive and resilient capacities of individuals and communities. We consider the relevance that Adaptation Plan gives to those factors, in term of promotion, implementation and improvement of: information about the context (among the others, characters, problems, resources, opportunities) and the Plan (among the others, vision, objectives, strategies, action options, decisions, results, impacts); knowledge as comprehension of the phenomena, the problems and the solution options consistent

with the Plan; individual and community awareness of own vulnerabilities, of the effects of own behaviours and actions, of the way the Plan to react and act proactively to solve the problems.
The *Monitoring* is the control activity of the effects of a plan as a consequence of the implementation of the planned actions. It is a process that must be set since the elaboration of the plan and must be closely integrated with the planning analysis, evaluations and choices. Its application requires a systematic verification of what is being implemented through the plan and the level of achievement of the related objectives and to carry out a possible modification of the plan in case there are significant deviations with its objectives. The main difficulty in monitoring climate change adaptation arises when measuring the effects of a given plan action, since it is necessary to measure the specific contribution of that action to the increase in the resilience level of the intervention area. To do this assessment it is necessary to have an adequate cognitive framework. The analysis of the monitoring is then carried out taking into account which of the steps indicated above are contemplated or/and carried out and if all steps are carried out, the much greater effectiveness would be obtained.

2. The Climate Change Adaptacion Plan of Ancona

2.1. The description of the Plan

Ancona is a port city of about 100.000 inhabitants with an international dimension characterised by a controversial relation between its urban structure and its historical position, its socio-economic dynamics and its complex and dangerous geomorphology. This coastal, dynamic and vulnerable, city has historically been affected by calamitous events such as the epoch-making landslide in 1982, become part of the historical memory of the local population as "la Grande Frana" (the Great Landslide), and nowadays is affected by climate change effects the make risks and vulnerabilities more severe (Figure 2).

Figure 2 - Urban structure and hydrogeological risk in Ancona

(Source: Authors)

The Adaptation Plan of Ancona, carried out between 2010 and 2012 (see http://www.actlife.eu/medias/260-actpianoadattamentoancona.pdf), is conceived as a local planning tool able to integrate the hydrogeological risks management with the wider promotion of an urban development able to strengthen sustainable conditions and to raise resilience to climate change, working on "the self-organization capacity of a social/economic system to maintain its structures and functions in the presence of multiple risk factors" (*Finley*, 1994).

2.2. The comparative analysis

Planning Approach

The Adaptation Plan is strongly integrated to the Urban Plan and takes into account its systemic visions to specify its strategic axes for adaptation.

The Plan declines visions and strategic axes in adaptation strategies and actions in all local policies and sectors (climate change, environmental and urban regeneration, risk management, among the others), according to the mainstreaming logic, in order to guarantee the transversal consideration of the theme, multiply the synergistic interaction among policies and reinforce the results. At the territorial scale, the Adaptation Plan recognizes and assumes the planning and legislative indications of regional and sub-regional institutions that have influence on local adaptation planning, highlighting the territorial adaptation policies (even "unaware") already in place (Table 1).

Table 1 - Urban Plan Systemic Visions and Adaptation Plan Strategic Axes

Urban Plan Systemic Visions	1.	*Polycentric, liveable and accessible city*	Combine the new housing demands with the forms assumed by its polycentrism which is one of the peculiar characteristics of the regional "functional urban areas"
	2.	*Joint, interconnected and competitive city*	Enhance the strengths of the infrastructure system by transforming it into a strategic resource and a growth multiplier
	3.	*Ecological city*	Integrate urban planning and planning of scarce and renewable resources, through the strengthening of ecological connections, the bioclimatic and energetic renewal of settlements and buildings and the development of rail and cycle system
	4.	*Landscape, beautiful and identity city*	Protect and enhance the physical and cultural resources as networks of places and systems of landscape of the sea, of the city and of the rural territory
Adaptation Strategic Axes	1.	*Territorial safety / prevision and protection*	Ensure the safety of citizens exposed to landslide risks but also of infrastructures, cultural heritage and economic activities, such as tourism
	2.	*Management and prevention*	Combine protection with development of the city's natural and cultural heritage, which implies awareness of negative externalities related to planning choices
	3.	*Change management / recovery and innovation*	Raise awareness about the inevitability of some climate change consequences and translate this constraint into opportunities, reorienting development policies

(Source: Authors)

The governance of the Adaptation Plan is based on a top-down direction open to the stakeholders' involvement. The process governance is hinged on a Local Adaptation Board (LAB), a multidisciplinary and inter-sectoral working group that include representatives of sectors involved, from environmental and civil protection to land and water management, from tourism and infrastructures to business and communication. Within the LAB a manager (member of the Municipality of Ancona) of the adaptation process is identified, with the dual role of coordinator of the internal resources of the local authority and facilitator of relations with the stakeholders to promote dialogue and participation.

The participation is activated through a multi-level process: starting from actors mapping, the Plan selects the selection criteria of key stakeholder based on their capacity to influence the decision-making process and on the level of competence on the topic at hand; the first stage consists in enhancing stakeholders involvement, asking their contribute into the analysis, evaluation of impacts and planning; during the second phase, they discuss and define a sharing vision and action options sets, raising consensus and strengthening governance capacity on climate change; the last stage is the launch of initiatives or actions of Adaptation Plan by the local authority, even in collaboration with stakeholders (business and civil society) which have an active role within the community.

Exposure and Vulnerability

The city of Ancona is characterized by a heterogeneous historical urban texture, where local and supra-local functions and services are concentrated, due to the role of regional capital, to international importance of the port and to tourist appeal, and generate and attract significant flows of goods and people. At the same time, the city is strongly diffused in a territory with a complex orography, that has influenced the development of the infrastructural network and the organization of the collective transport system, and has led to both

congestion situations on the main roads and isolation or access difficulties. even in parts of the city that are contiguous to each other.
The context of Ancona is, by location and orography, exposed to landslides and erosion and to meteorological and climatic phenomena in some cases linked to them, in particular:

- the great deep landslide of Ancona (1982), produced by persistent and long lasting rains;
- the localized floods, as a result of extemporaneous and short but intense rain concentrations;
- the coastal erosion, accentuated by intense rainfall and prolonged periods of summer dryness;
- the summer heat waves.

In addition, the territorial and urban vulnerability of Ancona with respect to these risks have been accentuated by anthropic factors: the high urbanization, mainly due to tourism and industrial dynamics, in hydrogeological instability zones, the improper consumption of natural resources, for example connected to the extraction of fluids from the subsoil near the sea and to the reduction of the dune system, with effects of increase of subsidence and coastal erosion, the improvised and unorganized management of the emergency and the lack of coordination between the responsible subjects involved.
The Plan identifies the most relevant climate phenomena that may exacerbate the context vulnerability, starting from future climate scenarios based on the probability of occurrence during the 21stcentury: raising of the sea level, increase in intense precipitation events, increase in the number of very hot days and heat waves, and increase in storm intensity.
According to the climate scenarios, it is expected that the increase in temperature, the uneven distribution of rainfall and the sea level rise will have consequences on soil and subsoil. There will be increased coastal erosion and landslides on the road and railway infrastructures, which run behind the coastline, and physical deterioration of cultural and artistic heritage. Finally, health risks due to the increase in heat waves are expected.
Consequently, the Plan identified soil and subsoil (landslides), coastal erosion, infrastructure connectivity and mobility, cultural heritage as priority action sectors.

Solutions

The Adaptation Plan sets actions and measures referred to the 4 priority action sectors, aimed at reducing natural hazards, exposure of people, activities and territorial contexts to natural and climate risks and its vulnerability, increasing robustness and improving capacity to forecast risk and properly react to it.
The Plan distinguishes four categories of actions: political decisions and behavioural measures, both considered *soft* solutions, and management actions and technological and infrastructure actions, both considered *not soft-grey/green* solutions. *Grey/green* solutions refer to the priority action sectors (landslides, coastal erosion, infrastructure connectivity and mobility, cultural heritage) and for each sectors a symbolic action in identified (Table 2).
Table 2 - Categories, priority sectors and example of solutions

Categories	*Priority Action Sectors*	*Symbolic solutions (◆) and other examples*
Political decisions		- Improvement of the governance process (LAB, …) - Introduction of a financial budget for adaptation on the

		budget of the Municipality of Ancona
Behavioural measures		- Information campaigns for the population - Enhancement of public awareness - Training for the creation of specific professionals for assessment, monitoring and analysis of the historical and cultural heritage
Management actions	Landslides	- Map of landslides speed
	Coastal erosion	- Improvement of knowledge on erosion and monitoring - Study of the coastal sea currents between Ancona and Senigallia
	Cultural Heritage	- Map of cultural heritage risk
Technological and infrastructure actions	Landslides	◆Enhancement and optimization of the system of early warning of Ancona's landslide, coupled with extension of monitoring landslides that are ranked as very dangerous ones in the whole municipal territory of Ancona
	Coastal erosion	- Drainage and naturalistic engineering interventions ◆Defence of Portonovo's coast obtained by moving back from the coastline bathing establishments and restaurants - Improvement and extension of technologies for coastal monitoring
	Infrastructure connectivity and mobility	- Improvement of the urban green network ◆Restoration of landslide damages of the railway and the Via Flaminia

(Source: Authors)

Raising awareness

The Adaptation Plan identify the awareness of citizens, communities and institutions as a key factor of resilience, as the adaptive (resilient) capacity of a system is strictly connected to the awareness about existing and expected risk and the effects of climate change and about the rules and the ways for dealing with it.

There are several actions, both soft and not soft, that promote and/or support raising awareness through:

- the deepening of knowledge, based on a step-by-step knowledge construction process: data collection and definition of basic scenarios on climate variables (temperature, precipitation and sea level); evaluation of existing and expected socio-economic dynamics; identification of key systems (coasts, landslides, infrastructures, cultural heritage) on which to conduct risk and vulnerability analysis; definition of future climatic scenarios and the consequent potential impacts (taking into account frequency, intensity, vulnerability, sensitivity, uncertainty); estimation of the risk exposure of each of the key systems with respect to the scenarios identified; assigning intervention priorities to reduce risk (danger, exposure and vulnerability) and improve resilience;
- the diffusion of information, because the knowledge heritage must be transmitted to all relevant stakeholders in the most appropriate ways, to create a basic level of awareness from which to compare visions, objectives, options of intervention. The diffusion of reliable information is also considered useful to debunk false myths and fake news spread by the

press and social media;
- acceptance and management of uncertainty: an "adaptive" approach is proposed in the construction of climate and socio-economic scenarios, based on regular monitoring and consequent revision of the actions undertaken on the basis of the results and of any new information that may be available;
- the knowledge sharing and awareness processing: the Local Adaptation Board (LAB), activated by the Adaptation Plan, is conceived as a "place" in which all the stakeholders of the adaptation process have the opportunity to discuss and share a common vision of the problems and a common strategy and the consequent actions to face them.

Monitoring

Monitoring of the Adaptation Plan is carried out on two levels:
- Process Monitoring: it is conducted with respect to the "Ten essentials" principles defined by the "Make my city resilient" campaign (Table 3). The campaign provides an online tool for participating cities, which allows for a self-assessment of the success of the process.
- Action Plan Monitoring: it is the monitoring of indicators developed for each measure adopted by the Plan, that allow periodically checking the progress and effectiveness of the intervention, in order to assess the possibility of a reorientation if the results they are not satisfactory.

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Table3 - Ten essentials of "Make my city resilient" campaign

1. PUT IN PLACE ORGANISATION AND COORDINATION to understand and reduce disaster risk, based on participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role in disaster risk reduction and preparedness.
2. ASSIGN A BUDGET FOR DISASTER RISK REDUCTION and provide incentives for homeowners, low income families, communities, businesses and the public sector to invest in reducing the risks they face.
3. MAINTAIN UP TO DATE DATA ON HAZARDS AND VULNERABILITIES. Prepare risk assessments and use these as the basis for urban development plans and decisions, ensure that this information and the plans for your city's resilience are readily available to the public and fully discussed with them
4. INVEST IN AND MAINTAIN CRITICAL INFRASTRUCTURE THAT REDUCES RISK, such as flood drainage, adjusted where needed to cope with climate change.
5. ASSESS THE SAFETY of all schools and health facilities and upgrade these as necessary.
6. APPLY AND ENFORCE REALISTIC, RISK COMPLIANT BUILDING REGULATIONS AND LAND USE PLANNING PRINCIPLES. Identify safe land for low income citizens and upgrade informal settlements, wherever feasible.
7. ENSURE THAT EDUCATION PROGRAMMES AND TRAINING on disaster risk reduction are in place in schools and local communities.
8. PROTECT ECOSYSTEMS AND NATURAL BUFFERS to mitigate floods, storm surges and other hazards to which your city may be vulnerable. Adapt to climate change by building on good risk reduction practices.

9. INSTALL EARLY WARNING SYSTEMS AND EMERGENCY MANAGEMENT CAPACITIES in your city and hold regular public preparedness drills.

10. AFTER ANY DISASTER, ENSURE THAT THE NEEDS OF THE AFFECTED POPULATION ARE PLACED AT THE CENTRE OF RECONSTRUCTION, with support for them and their community organisations to design and help implement responses, including rebuilding homes and livelihoods.

(Source: Authors)

The Adaptation Plan introduces a specific financial budget for adaptation within the municipal budget, partially dedicated to support the annual measurement of the resources allocated to multi-level risk management, the monitoring of the achievement of adaptation targets and the mainstreaming process, ensuring a timely planning of the areas of competence coherent and integrated with the political and institutional level.

3. The Climate Change Adaptation

3.1. The description of the Plan. Plan of Bolonia

Bologna is one of the most important Italian cities. Capital city of Emilia Romagna Region, with 389.261 inhabitants (January 2018) is the seventh largest city in the country. The city, thanks to its central location in the Italian territory, is a central hub for the national transportation infrastructures, with particular reference to highways and railways (Figure 3). Because of its geographical position, the high rate of urbanized territorial areas and the presence of water-intensive agriculture, the city has severely felt the impacts of climate change in the last two decades. Climate driven impacts mainly refer to floods and droughts and one of the most important problems the city had to face in recent years have been heat waves. The highest temperature ever recorded in historical era is +40.1 °C in August 2017 but particularly hot summers have been recorded in 2003, 2013 and 2015, with long drought periods.
The growing frequency and intensity of these phenomena lead the local administration to begin working on adaptation strategies to climate change at the starting of years 2010 and in year 2012 a European Commission LIFE+ funded project has been stated in order to develop “BLUE AP - Bologna Local Urban Environment Adaptation Plan for a Resilient City”.

Figure 3 - Urban structure of Bologna (Source: property of the author)

(Source: Authors)

Two key factors can be identified in the Plan's development: a very accurate analysis of the major territorial vulnerabilities from the one hand and the centrality of the participation of local communities to the decision making processes from the other hand.

The Adaptation Plan concentrates the attention on three main issues: drought and water shortages, heat waves in the urban area and rain and hydrogeological risk extreme events. For each of the considered issues, long-term goals have been identified, in a way to make them measurable and the monitoring of the project more stable and feasible. Then operational actions have been selected, through which, at different territorial levels, local administration and other public and private bodies involved will be able to implement the Plan. Actually, one of the goals of the selection of the actions is also to experiment the effectiveness of public-private collaboration models, in order to repeat them, improve their capability to obtain good and stable results over time and to involve an increasing number of territorial stakeholders. The actions have also been the reference for the design of the intervention strategies. The main interventions can be summarised as follows: (i) reduction of the water withdrawals through the reduction of civil and agriculture water consumption profiles and the reduction of water losses; (ii) reduction of discomforts and sanitary risks for the population facing long periods with high temperatures through the setting of the alert system and the increase of green surfaces and trees in all available urban spaces; (iii) mitigation of floods through the increase of the soil capability to absorb rain waters, the improvement of the quality of the hydric and hydrographic networks and the securing of the hydrogeological instability in the hills area.

3.2. The comparative analysis

Planning Approach

The Adaptation Plan has been developed in two main steps. The first is related to the design of the “Local Adaptation Strategy”,aiming at improving the response of the Bologna territory to climate changes, identifying the main issues and solutions to be tackled under a long term perspective (2025). This includes the climate profile, the territorial vulnerability assessment and a system of goals to enhance the territorial resilience, detailed according to three main issues: drought and water scarcity, heat waves in the urban areas and extreme rainfall events and hydrogeological risk. The “Local Adaptation Strategy” integrates municipal policies and tools with other instruments available at over-municipal levels, this particularly focusing on water supply systems and services and hydrogeological instability, where problems are interconnected at the over local level and need solutions able to go beyond the administrative boundaries of the city. The second phase resulted in the operative “Adaptation Action Plan”, implementing and better specifying the strategy itself through a system of operational actions, part of which to be initially implemented as pilot actions (Table 4).

The transition from the Strategy to the Adaptation Plan passed through a long and rich participatory process, involving more than 150 participants in two main plenary (Initial and Final) meetings, 3 thematic sessions, 5 special issues meetings and many technical focus groups and discussion tables. As the result of the territorial vulnerability assessments and of the citizens and stakeholders involvement, the Adaptation Plan defines six main pilot actions aiming at building resilient communities and at raising awareness about the climate change driven territorial risks.

Exposure and Vulnerability

The Bologna area is considered particularly crucial in the Italian territorial framework, as it represents a central logistics and transportation hub because of its central geographical position.

Table 4 - Six Pilot Actions for Bologna Adaptation Plan

1. *Include adaptation measures in the city’s building code*	To design incentives for adaptation and develop more efficient management models to reduce climate change effects, while making them more explicitly foreseen
2. *Define guidelines for infrastructures at risk*	To improve coordination and system-level reactions during extreme meteorological events involving lifelines and territorial infrastructures
3. *Launch a green roofs campaign*	To sustain the Bologna Municipality, together with the other project partners and stakeholders, in promoting the spreading of green roofs through info points and other communication tools
4. *Improve the rainwater harvesting capacity of waterproof areas*	To transform paved surfaces, for example a parking place, using less waterproof materials able to increase draining rainwaters, limiting and slowing them down into the drainage system and thereby diminishing flooding risks

5. *Collect rainwaters*	To make rainwaters, when collected, become a resource: filtered and conserved, they may be reused in different ways, from WC drainage to the irrigation of green areas
6. *Promote insurance schemes*	To sustain the diffusion of insurances by informing companies and citizens about possible solutions to reduce risks, by public/private partnerships and by promoting the diffusion of knowledge about extreme climate events

(Source: Authors)

Moreover, it is the capital city of Emilia Romagna, one of the leading regions in Italy from an economic perspective (data from Banca d'Italia 2017) and in recent public surveys the Bologna metropolitan area revealed to be one of the most alive and liveable in Italy. Such territorial capital faces important vulnerabilities, which have been deeply analysed in the Vulnerability Assessment of the Plan. The climate changes are clearly visible in temperature trends. In Bologna, the recorded temperature increase is about +0.3°C per decade starting from 1980s. About rainfall, during winter, spring and summer, a decrease has been observed, while a slight increase has been recorded during autumn. The number of consecutive days without rain shows an increase during summer, when there is also an increase in the frequency of the number of intense rainfall events. Forecasts also underline that summers such as those of 2003 or 2012, which are currently in the upper part of the distribution of summer temperatures, could become recurrent, leading to a consequent increase in heat waves, while for rainfall estimates indicate a potential decrease.
These, together with an increase in the hydrogeological instability, will lead to the following main vulnerabilities (Table 5).

Solutions

The Bologna Adaptation Plan outlines a system of strategies able to positively tackle the critical situations highlighted in the Local Climate Profile and in the Vulnerability Assessment. It identifies a series of actions which refer to good practices identified at the national and international level and adapted to the specific needs, characteristics and communities of the Bologna urban environment. A special focus is made on the management of urban green spaces, existing or to be developed, able to mitigate the climate driven risks (both heavy rains and heat waves) and, more generally, on the management of the water systems and services, in order to reduce water consumptions and better managing intense weather events(Table 6).

Table 5 - The Vulnerabilities to Climate Change of the Bologna Territorial Area

1. *Drought and Water shortages*	Climate change will accentuate the intensity and duration of summer drought periods, aggravating the already present problems of water availability. The aqueduct, the historical canals crossing the city center and the network of drains are essentially fed only by the Reno river, whose natural flow decreases a lot during the summer period.
2. *Heat waves in urban areas*	The climate trends increase the frequency of the phenomenon of the urban heat waves, increasing the bioclimatic disadvantage of the population and the vulnerability of the most sensitive parts of local communities, according to age,

	family characteristics and census conditions.
3. *Natural disasters and Hydrogeological risks*	Given the geographical and topographical conditions of the urban area of Bologna, the climate change driven events will increase the vulnerability of the hills area around the urban environment and the urban water systems, intensifying the present risk of floods and landslides. This situation is worsen by the inadequate hydrogeological performance of more than 50% of the territory, particularly in areas where urbanized surfaces prevail or where there are many waterproof surfaces, which prevent rain from penetrating the soil. On the other hand, the historical structure of the city's drainage network offers good protection against the risk of floods in a large part of the urbanized area.

(Source: Authors)

Table 6 - Vulnerabilities, Strategies and Pilot Actions

Vulnerability	*Strategy*	*Pilot actions*
Drought and water shortages	· Reduce use of natural water resources · Eliminate parasitic waters and the mixing of black and white waters · Regulate the flow of Reno river · Protect and promote the local agricultural production while reducing and increasing the effectiveness of irrigation	· New goals for water saving in the Urban Building Regulations · Reduction of water use in F.I.Co Project (Fabbrica Italiana Contadina – Agriculture Italian Factory) · Irrigation with non-potable water in the Margherita Gardens · Implementation of solutions to collect rainwater at the University of Bologna Agriculture Institute · Recovery of the Aposa stream and Ficcacollo canal
Heat waves in urban areas	· Increase urban greening · Protect and enhance extensive tree-lined green areas and urban agriculture · Increase insulation and greening in public and private buildings · Reduce the vulnerability of the population exposed to health risks linked to temperature increase	· New regulation for the green areas · New municipal urban vegetable gardens · GreenUP information campaign
Extreme rain events and hydrogeological risk	· Improve the city's hydrogeological response · Make the territory more "resistant" to intense rain · Reduce water pollution carried by rain · Increase the resilience of the population	· New guidelines for sustainable urban drainage · Sustainable rain management in a new commercial establishment (via Larga) · Sustainable management of rain in a new POC urbanisation of state-owned areas · Insurance packages

(Source: Authors)

The Plan offers both strategies (what to do according to the expected results) and solutions (how to implement the strategies) paying particular attention to the interactions between administrative bodies at different territorial levels and to public-private cooperation models to enhance the Plan implementation. Moreover, the implementation of the strategies and

actions outlined in the Adaptation Plan will be enhanced by the upgrading of the over-local and regional territorial regulation and planning tools.

Raising awareness

Even if a great work has been done over the past 20 years at many institutional levels, still the territorial impacts and risks driven by climate change seem not fully understood by local communities and stakeholders. This is why the Adaptation Plan pays a special attention to the communication and the raising of awareness about the concept of Resilience.

Within the BLUE AP project, a communication strategy has been developed to enhance the perception of systemic risk. During the participatory design of the Adaptation Plan, it was noted that individuals have very diverse knowledge and beliefs about climate change. Communication was then carried out concentrating on the climate problems of Bologna.

This has been done by designing and developing “simple and clear” messages, which would elicit adaptive responses from individuals, enhancing citizen awareness about the consequences of global warming into everyday life in order to overcome the perception of climate change as something far away from individuals and their environments.

For this reason, the communication strategy has been designed to be easily developed also through the project website and the social networks, Facebook pages of the project partners and Twitter, which supported training and fact-finding activities targeting citizens and schools in order to create a collective awareness regarding the impacts and risks of climate change.

A web application, BLUE APP, has also been designed, where citizens will be able to familiarize, in a virtual way, with actions promoting the environmental health of the city. The main goal is the raising of awareness around the fact that climate change can largely be faced with already existing practices, feasible at the individual and everyday life levels and not only with huge works on infrastructures or highly innovative technology.

For the private economic sectors, a questionnaire has been distributed, in order to understand the needs and current perception regarding the performances and management of the industrial production and manufacturing plants and of the distribution and logistic systems.

Monitoring

The development of the Plan, together with the involvement of stakeholders in the urban area, is mainly based on the operational implementation of a set of actions to be carried out by public and private stakeholders in a variety of territorial sectors. The monitoring system is based on such actions, for each of which a specific set of monitoring indicators has been selected.

The indicators related to adaptation topics mainly refer to climate, air quality, potable water, ground water and green areas. The values for this set of indicators are already constantly monitored by the Municipality of Bologna and other public bodies in charge for the stable monitoring of territorial and environmental indicators (for instance the ARPAE, the Regional Agency for the Protection of the Natural Environment) through different monitoring systems and thematic reports. The indicators related to the Adaptation Plan mainly refer to temperatures, rainfall, ozone and PM10 concentrations, water resources availability, uses and services, public and private green surfaces and trees plantations.

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Chapter 11. Resilience and Urban Local Planning in Uruguay. Montevideo case study.

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1. Introduction

From colonial times Uruguay was organized mainly in little towns, that gradually became small, medium and great cities, some industrial or ports, others cattle breeding centres or transit cities. Nowadays more than 90% of the Uruguayan population lives in urban environments, which means from the point of view of territorial balance and sustainable development a historical weakness. The reasons can be found in the division of land and extensive cattle breeding, which resulted in a very scarce demand for rural working population for many years.

In the last decades these phenomena have been changing as long as productive sector was modified by introducing intensive cattle breeding as well as soya and eucalyptus production. The novel industries such as cellulose processing factories, and large coastal construction sites are creating a new urban geography, while the intra and inter-urban population flow is changing and growing, the capital Montevideo is loosing population(Altman and Martinez 2016). Other important territorial transformation is the urbanization of the south cost of Uruguay. As long as life at Montevideo become more expensive and difficult, by high rents, traffic, long distances without appropiate public transport, loose of quality in life from the natural and social point of view and security issues, a great sprawl has been consolidating in the last fiteen years. In particular creating one of the most important urban corridors of the country between Montevideo and Punta del Este in the coast. These quickly movements of population affect urban environments, making them more vulnerable to climate change. On one hand by consolidating practises of settling in informal and flood-prone areas of the cities. This is a typical survival strategy that continue growing as long as social housing solutions could not be so fast. On the other hand coastal ocupation of high class housing, which although the many laws in territorial planning, continue using special exceptions to the rules for real estate buisness that have a great impact over the coastal ecosystms.

Climate Change challenges deal with territorial and demographic great changes in the country. If we analyze the first issue, although informal settlements and urban poverty in Uruguay is different to other countries in Latin America, as long as the cities growth for a great deal with urban plans, that doesn't means illegal occupation of land is absent. However as soon as informal settlements became bigger, the State start public policies of relocation or legalization of the already existing neighborhoods (Lombardo 2015).

In Uruguay, climate vulnerability from flood risks is one of the most important climate related impacts in the country. During the last decade, more than 67,000 people were evacuated from their homes in 60 cities across the country because of flooding.

In order to deal with this problem, many departament governments adopt the country's National Resettlement Plan, which has been relocating thousands of families out of flood-prone and polluted areas and into secure housing on secure land to help them adapt to the effects of climate change. The National Resettlement Plan focuses on resettling families that live in extreme poverty and do not have the necessary resources to find housing alternatives or secure land on their own. The investment of USD 42 million resettlement plan also includes job training for family members and the reuse of former flood-risk residential land into other flood-compatible uses.

Uruguay is divided in ninteen regions call departments. The Department governments prioritize the areas where population should be relocated and provide the land and infrastructures for the construction of new homes. The financing for the works and the technical equipment involved are the responsibility of the Ministry of Housing, Planning and Environment (MVOTMA). The National Housing Agency (DINAVI) worked together with the National Water Agency (DINAGUA) helping in the intervention and the study of particular cases flooding. The Neighborhood Improvement Plan, co- financed by the Interamerican Bank of Development, situated at the DINAVI (Direction of Social Housing) developed an operating program regulation approved in 2011.

2. Policies and actions in Urban Planning and Resilience to adapt to climate change at Montevideo

The great population concentration at Montevideo, almost 60% of the Uruguayan population is the result of the concentration of economic activities and opportunities. The Capital City concentrates the Government offices, most of the industries, the main international port and airport, as well as the financial, services and commercial institutions.

Following the data of the National Institute of Statistics in the report of Poverty at the National Level, Montevideo, is the department with higher levels of poverty. In 2016 it registered 8,3% of households in poverty, that means each 1.000 households 83 are under the poverty line.

According to Carmona and Gómez (1999), the Department of Montevideo has an important planning tradition, starting in the early decades of the 20 Century, with significant examples as the Regulator Plan Pre-Project of 1930, the Director Plan of 1956, and the Plan Montevideo of 1998. This last plan is a milestone in the territorial legislation in the country, initiating a process of re- appraisal of urban territorial planning in public policies, that would afterward reach national scope with the passing of the LOTDS (Territorial Planning and Sustainable Development Law N 18308, 2008).

In the Plan Montevideo the sustainability is expressly included as an objective of territorial development, and although climate change is not explicit as a driving force, the recently introduction of adaptive strategies point in that direction, demonstrate the interest of the city.

The recognition of rurality as a value to preserve and the restoration of banks of structuring urban streams are relevant to this goal. The Plan Montevideo is the background of a derivative planning system in time and space that contribute to significant urban adaptation strategies.

The Department Guidelines were reviewed afterward the LOTDS approval and in the context of the Revision of Plan Montevideo, the environmental dimension is identified as essential for this approach and to the relevant adaptive strategies for designing projects and interventions.

The proposal is based on six items, one of them is environmental sustainability; the document emphasizes on

“preservation of environmental values, responsible use of natural resources, climate change and variability response, and comprehensive risk management. The processes that contradict environmental sustainability principles such as urban land extension, socio-territorial segregation, and lowering of life quality in consolidated city areas are critically approached" (Guidelines Document, Directrices Departamentales 2012, p. 39).

In this sense the water streams take relevance, in particular because of the high level of housing and socio vulnerability, that take place in their margins, putting them under risk in extreme events situations. Next plans are examples of this phenomena.

2.1. Special plans for urban streams and basins

Montevideo as we said is the main scenario of the country for incorporate new topics on urban planning. The water streams have a great importance for urban policies on climate change, in particular in the cases they have informal housing, under risk for floods.

The land categorization defines the banks of the main water streams as natural rural land and establishes restrictions for alteration of their natural condition. The "green wedges" (of the main urban streams Arroyo Pantanoso and Arroyo Miguelete) are recognized as extended territorial frameworks, considered "strategic territories" that materialize the link between the natural background of the territory and the urbanization processes (Plan Montevideo, 1998).

Therefore, we can see the main efforts in include resilience instruments and climate change measures in plans for urban streams and basins (Table 14.1). We are going to analyze deeper here the Miguelete Stream Plan already approved that starts its implementation recently. In the next table we are going to shortly describe some examples Casavalle Plan, Chacarita Plan and Pantanoso Basins Plan (currently in elaboration).

Table 1- Urban Planning Instruments that incorporate the resilience and adaptability to Climate Change as relevant strategies together with other social and environmental policies. Source: Self Elaboration

	Main problems related to climate change and urban issues	*Socio ecologicalActions*	*Ecosystem services and Green Infrastructure*	*Government Level of Impact and Participation*

Plan Miguelete River (PEAM)	Great Contamination of water on the river and to the Montevideo Bay. Environmental degradation of the watercourse. Housing precarious situation. Risks on population health.	Relocation of informal settlements on the river. Green Eco Place to cooperatives of waste pickers	Actions of sanitation infrastructure to avoid contamination. Linear Park. Rehabilitation of the public spaces. Vehicular, cycle, and pedestrian paths.	District, Municipality, Regional
Plan Pantanoso River (in process of elaboration)	Great Contamination of water due to domestic, industrial disposals and solid waste. Informal settlements occupied the banks. Loose of ecosystem services of the watercourse. Landscape potential loss. Non-dwelling large fields and wetland areas under high pressure. Formal housing areas next to the stream.	Main Strategies: Relocation of informal settlements on the river. Involves an interdisciplinary team. Create a hydrological model that describes the dynamics of flood pulse return that includes the climate change scenario in the design.	Main Strategies Consider the area a “green wedge" where the natural framework organizes and determines the urban development along the 16 km area length of the stream. Create Flood areas restrictions. Linear parks, Preservation areas, Ecosystem restoration areas.	Multiple institutional actors’ competence, need to coordinate
Plan Casavalle. Cañada Matilde Pacheco	Environmental degradation of the watercourse. Housing precarious situation. Extreme poverty. High Criminality	Strength inter-institutional collaboration. Create technical solutions with specific focus in create a social resilient environment.	Regenerate small streams areas which can build transversal connectivity. Build quality public space. Amelioration of sanitation.	Creation of a participatory planning and management figure, the Council of the CasavalleNeighbourhood

	rates. Flood risk situations.			
Plan La Chacarita (in process of elaboration)	Northeast area of Montevideo presents the highest vulnerability index of the city. Urban- rural borders degradation. Informal settlements. Lack of urban planning. Environmental degradation of the watercourse. Contamination of the water. Irregular settlement located on the culvert itself Santa Teresa Settlement.	Main Strategies: Relocation of informal settlements on the river. Involves an interdisciplinary team. Create a hydrological model that describes the dynamics of flood pulse return that includes the climate change scenario in the design. Working on memories about the importance of the story of Neighbourhood “Los Milagros”, the social housing plans Juana de America Cooperative, as well as the river that was culverted as rainfall sewer pipe, making that the stream "disappeared" from the local culture.	Main Strategies: Regenerate the lower course of the stream, located at the rural-urban inter-phase remains open-air with irregular occupation of the floodplains and the consequent impact of the flood events (Chacarita de los Padres Settlement). Coordination and control of the existing interventions, and elaboration of the Plan of La Chacarita basin with the Departmental Government, inside the context of a comprehensive plan of social connection and land-use planning.	Creation of a participatory planning and management figure, the Council of the ChacaritaBassin. It was created in 2014 as an inter-institutional council with members of City Council Government, local neighbors' council, Environmental Ministry, Social Ministry, National Education Authority, among other institutions.

2.2. A participatory Metropolitan Plan for Montevideo on Climate Change

The Metropolitan Plan on Climate Change for Montevideo was done in 2012 with the purpose of, on one hand, focus on the specific topic of measures to be undertaken in order to deal with this issue and, on the other hand, make an institutional coordination among different actors and programs that in the last years deals in a fragmentary way with the climate change challenges.

From the urban planning perspective, the area has had a relevant quantity of planning instruments as Departmental plans of land characterization, Departmental guidelines, and regional strategies, however the Metropolitan Area of Montevideo implies a new level of governance and coordination, which is having many problems to be implemented.

Following the current international changes in the definition of urban planning units, the Metropolitan Area of Montevideo must be conceived together with the adjacent areas of the Departments of Canelones and San Jose regarding integrated regulation and planning, which nowadays is very weak and secondary in public policies priorities.

The Metropolitan Area does not have a specific institutional organization for coordination of the three Departmental Governments, Montevideo, San Jose, and Canelones, and the 42 Municipalities(municipal councils, administrative units corresponding to the third level of Government inside each Department territory) defined by Decentralization and Political Participation Law of 2010.

The coexisting of national, departmental and municipal competences determines the absence of specific instruments of coordination, however some instruments of territorial planning as Regional Strategies for the Metropolitan Area was already approved as well as the Inter-Departmental Plans, that has to be implemented.

This coordination was not new, as long as to address this administration weakness of the faster growth of the capital of the country, at the end of 2005, the Presidency of the Republic with the Departments governments created the Metropolitan Agenda Program for solve some particular operative issues.

The Metropolitan Plan on Climate Change meet this administrative problem of coordination, that almost all new metropolitan areas encounter. Therefore, the methodological approach of the Plan is based on institutional coordination and participatory planning: the main targets groups of the Plan are ministries, and other high authorities of regional governments (from Montevideo, San Jose and Canelones), which deal with climate change issues. In addition to this, municipalities, citizens, entrepreneurs, environmental civil society associations and others are involved in the different steps of the Plan.

For the elaboration of the Plan a participatory methodology was designed. The steps design for the process were:

1) Actors Map and working groups for a preliminary diagnosis; 2) Definition of risks and opportunities for the development related to climate change; 3) Definition of priorities with multi-criteria analysis; 4) Build of a General Strategy for adaptation and mitigation of Climate Change; 5) Working Groups in order to define particular guidelines for specific topics: Transports, Coastal Management, Biodiversity, Extreme Events, Intensive and Extensive agricultural activities, Energy, Solid Waste, Build Environment and Health; 6) Participatory Mapping of Climate Change Impacts in all the metropolitan area.

Considering the Forester theory on deliberative practice, the current plan assumes more than a participatory approach, a well-done consultation (Forester 1999). That means an active involvement of the different actors, without letting yet a way in which these actors can take mandatory decisions, which Lussault states is the real difference between a consultation and a real process (Lussault 2011).

However, the plan was a success in the sense of sensitizationof the metropolitan area governments. It identifies as well the main vulnerabilities of the area which are:

a) the consumption of land by the informal settlements, as well as by the gated communities, and the free trade zones,

b) the great extension of coastal area exposed to sea-level rise and storms,

c) the increase of temperatures with the consequence of an increase in the rain level as well as in extreme events as flows,

d) the contamination of potable water.

We consider that all of these topics need not only a consultation process, but mainly a collaborative way of thinking the planning of resilience solutions, as Patsey Healey stated (Healey 1997). As well as permanet groups of citizens and local governments for monitoring and contribute to the implementation and management of actions (Goni Mazzitelli et alt., 2013).

2.3. Actions of the Metropolitan Plan of Montevideo on Climate Change

After identified the main vulnerabilities the participatory groups identified specific objectives in order to protect: 1) water resources, 2) agriculture and food production, 3) vulnerable and under risk population, and 4) coastal zone.

The program envisages some actions that need to be regulated as well as financed by the government: Sustainable management of urban water cycle, control in the increasing presence of vectors, reduction of risks to human health associated to the variability of temperatures.

The plan has many elements of innovation, although by now they are just good declarations, we can mention some of them here, underlined that the most interesting work of the group was to think in different levels, with different disciplines and involving also knowledge from civil society and local governments.

Some of the focal points were the conviction of the need of strengthening of local capabilities in the attention of human health; the development of a new management model for the governance of natural resources and biodiversity, as well as water resources in the basin; the need to better access for insurance and climate information on the rural production.

On the other hand, some modifications need to be done to the transport system inorder to stop the current impact of carbon emissions. The proposals vary from reduce carbon emissions in the urban transport, to increase the use of clean technologies and increase the efficiency in urban mobility, as well as promote of active transport.

As mentioned before the Plan think about great systems for prevention and reduce of impact measures, like support the National Policy on Sustainable Energy that is changing the matrix for low emission in Greenhouse Gases, or reduce organizational weaknesses for improve a cross strategy in adaptation and mitigation of climate change.

In order to work also in a participatory way in the monitoring of the implementation, the Plan develops a platform for associate different policies, and government directions that are related to climate change, as long as monitoring resources and investments do in the topic. In particular, trying to reinforce the National System on Protected Areas (SNAP), by creating a Corridor of protected natural areas in each region, like an Ecological Network Corridor in the metropolitan area.

The same platform should work with local level by making an Agreement of Environment Management with local governments, and supporting regional working groups with all the municipalities involved. This is a very innovative proposal as long as local actors can exchange good practices or make synergy in asking coordination of central funds in related policies. In fact, this last point is related to financial resources, as the instrument is part of a Pilot Program of the United Nations; therefore, it counts with international funds to be formulated as well as tries to work as a coordination tool for funds in the phase of implementation of it.

In addition to this the main aim of the participatory networking work is to create Innovative Management figures as the Basin Commission or Urban Local Plans with particular attention to resilience aspects.

Finally, the Plan promotes what is called prompt intervention measures, in order to avoid serious damage to the current situation. For example, protection and recuperation of coastal morphology, dune restoration, capturing fences of sand in critical places, and building of ten low impact access to beaches in coastal region of Canelones. The first measures are giving excellent results, and some of the erosion that were created in beaches and dunes by Climate Change are going back restoring natural environments.

3. Discussion and Conclusions

The main challenge that Uruguay is trying to solve, is the need of a gradual involvement of climate change and variability approach in the Territorial Planning agenda. In recent years Uruguay has progressed in making the environmental issues explicit. From different conceptual and methodological backgrounds (risk management, environmental policies, water resources management, climate change) the specific institutional framework has been created with the purpose of work crossing policies and actions in the territory and not more in a sectorial way. The challenge is that the current coordination of these diverse initiatives

transforms in a potent platform of governance on this subject, both at the national, metropolitan and local levels (Ostrom, 1990) (Ostrom, 2005).

In the case of Montevideo, the creation of the Climate Change Work Group (GTCC) in 2010, of inter-disciplinary and inter-institutional characteristics is a relevant milestone. This group contributed to the elaboration of the aforementioned Metropolitan Climate Plan of Montevideo. Other recent achievement has been the denomination of the former Planning Department of the Montevideo Government in "Planning and Resilience Department", as well as the consolidation of GTCC as a section of this Department.

The urban dimension has taken relevance, and adaptation has taken place as a significant strategy for make positive synergies with urban development in our country, where the climate variability is a main determinant of adverse event occurrence.

Also, the flood-prone urban areas have taken priority in risk management and relocation policies, consider communities that have been actively involved both in preparation processes for early warnings, recognition of their local capacities to face extreme events, development of solidarity in the implementation of adaptation measures, and design of local adaptation and risk management policies within the framework of promoting a culture of prevention and enhancement of adaptive capacity (Beebeejaun 2012).

As in all the processes some problems arise between the elaboration of these new approaches and the real incorporation of them to the institutional traditional systems that govern urban areas. For example, from the DINAVI (Direction of Social Housing) data, it is possible to evaluate that the relocation projects of the last five years have been formulated from this integral vision, but their implementation was focused on the housing response. The multi-dimensional family problems of a high percentage of the cases were addressed by contracted technical teams with scarce institutional resources or by resorting to proximity social programs when the families fulfilled the required profile.

Something similar happened with the Metropolitan Plan on Climate Change, although the platforms for map the risks, and the coordination figures were decided and design by the Plan, there are not yet evidence they have been implemented, or that they are in a process of implementation.

Therefore the future challenges are, on one hand continue producing further knowledge and responses on the climate change and variability impact in urban contexts, although the focus

on floods and extreme vulnerable population is one of the main problems. We need to explore more about other urban issues, like the city urban heat islands, or make further investigation related to the adaptation of the materials and constructive systems in coastal zones to potential resilience in front of variation in storm forces as the greatest winds that arrives to Atlantic and Rio de la Plata coasts. On the other hand, the improvements in regulations, the creation of norms and laws, that modify the traditional adaptation practices requires more time to consolidate, perhaps by supporting more practices and have examples of proceedings in different urban areas of the country, university can improve the methodology to deal with climate change phenomenon.

Anyway, we can say that the first steps were made, and that the efforts are well distributed and should be done among a great variety of actors, trying to promote collaborative scenarios to continue dealing with the climate change and urban resilience issues in the future.

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Chapter 12: Variability and climate change urban resilience index.Case study Medellín

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Introduction

Cities, understood as ecological and complex systems, with the interaction of nature and human life, are directly impacting on the world in which we live in. The activities that are considered as the sources of the effects that are altering the processes. natural climatic conditions of the earth.In turn, cities are the main focus of the impacts generated by these climate alterations that constitute one of the main risk factors for urban systems. As mentioned by Pigeon (2007) and Reghezza et al. (2012) cited by Metzger & Robert, (2013, p.27) the large cities are considered risk centers and first victims of major disasters. At the same time, cities are the main source of solutions to these risks.

Research interest in the phenomenon of urbanization in cities has been evidenced. This phenomenon is characterized by an increase in the urban population. According to the Department of Economic and Social Affairs of the United Nations, the urban population has gone from 46.5% to 54.3% of the total population and it is expected to continue increasing, which in the long run will make urban systems more vulnerable, mainly in the face of the impacts of climate variability and change.With the recognition of the vulnerability of cities and the challenges posed by the impacts of climate variability and change on urban socio-ecological systems, there is a need for cities to overcome the numerous pressures that challenge their stability; resilience appears as a means to achieve it.

Thus, as urban populations grow and exposure to climate increases, increasing their vulnerability, building resilience has become an essential component for climate adaptation, environmental management, regional economic development and strategic planning (Davoudi, Brooks, & Mehmood, 2013), the objective is to reduce the impacts, prepare in the best way possible against environmental risks and develop the capacity for adaptation.

2. Context

For the confirmation of the urban resilience index against the variability and climate change applied to the city of Medellin, the present chapter poses the following questions: How to measure urban resilience in the face of climate variability and change? Moreover, what indicators can measure the urban resilience of Medellin against the effects associated with variability and climate change?

Authors such as Leichenko (2011), mention that one of the gaps in the field of urban resilience research, is related to its measurement and evaluation, and although there are several measurement techniques for some of the components of urban resilience, a

systemic approach must be prioritized for the measurement of all the components (Jabareen, 2013).
Research has been published with proposed indexes to estimate urban resilience in the contexts of variability and climate change (Cutter, 2015, D'Lima & Medda, 2015, Engle, by Bremond, Malone, & Moss, 2014; Kotzee & Reyers, 2016; R. Shaw, 2015; Tyler et al., 2016; Xu & Xue, 2017), these tools help to understand and measure the resilience of cities, serve as inputs for planning and monitoring (Sharma, Singh, &Singh , 2014; Tyler et al., 2016), in addition, they allow directing efforts towards adaptation and mitigation policies that limit the negative impacts of the increasingly frequent extreme phenomena.

Although urban resilience indices have already been developed in the context of climate change, applied to different cities, there is not one, or a set of indicators, that measures resilience universally (Suárez, Gómez-Baggethun, Benayas, & Tilbury, 2016), since this depends to a large extent on the characteristics associated with vulnerability (Brenkert & Malone, 2005). Analyzing this variable requires a multidimensional perspective of each territory. Vulnerability differs according to geographical regions, political boundaries, climate scenarios and socio-economic conditions of the population (Harley, M., Horrocks, L., Hodgson, N., & Van Minnen, 2008).In this regard, Cutter (2015, p. 3) states that:

> There is no one size tool to measure resilience due to the variety of actors, environments, purposes, and disciplines involved. The landscape of resilience indicators is as diverse as the systems, communities or disasters being studied.

The vulnerability is a specific characteristic of each city, and Medellin has not developed a tool to measure its urban resilience in the context of climate variability and change. Thus, It is necessary to formulate an index that allows this measurement and that considers the variables that correspond to its particularities and the climatic risks that it faces.

Thus, the need was identified to develop an index that allows a better understanding of the characteristics and variables that affect the city's lower or higher resilience in the face of climate variability and change. This tool will offer a potential way to address the multivariate and complex nature of socio-ecological systems. At the same time, it will contribute to making more accurate decisions regarding the strategies that are being implemented to deal with climate impacts, and it can be used to assign priorities of institutional support, identify priority areas regarding technological projects and resource management. (Adger, Brooks, Bentham, &Agnew, 2004).

1.1. Urban Resilience

Resilience, from the Latin of the verb resilio, resilire meaning "to jump back, to bounce," is the ability to "resist" or "resurface from" a shock. (Klein, Nicholls, & Thomalla, 2003) (Davoudi et al., 2012). The concept of resilience was initially defined from the ecological perspective by (Holling, 1973), as the persistence of relationships within a system and its ability to absorb changes and persist. Since then, the concept has been refined in the context of ecological sciences to describe the tendency of an ecosystem to recover after being

disturbed through changes in ecological variables, due to natural causes (hurricanes, earthquakes, etc.).) or anthropic (introduction of exotic species, deforestation, etc.) and reorganize to fully recover their previous state (Holling, 1973).

Recently, the concept has also been applied in other areas such as human social systems (Adger, 2004, Leichenko, 2011, Pelling, 2011); urban ecological resilience (Folke, 2006); the economy (Simmie & Martin, 2010), disaster management (Alexander, 2013), and urban security and resilience against terrorism after September 11 Jabareen (2013, p.221).

In recent years, the concept of resilience associated with cities has begun to be used because they are complex socio-ecological systems. In this case, it is called urban resilience. Resilience in the urban context is understood as the way in which socio-ecological systems deal with the tensions and disturbances caused by external factors (Walker, Holling, Carpenter, & Kinzig, 2004). Likewise: "the ability of a system to absorb disturbances and reorganize itself while changing to preserve essentially the same function, structure, identity and feedback" (Leichenko, 2011). Resilience requires three main properties: (1) the amount of change that a system can suffer while maintaining the same structure and function controls; (2) the ability of the system to self-organize; and (3) the degree to which the system is capable of learning and adapting (Carpenter, Walker, Anderies, & Abel, 2001).

In the most recent studies, urban resilience has been studied from three perspectives: ecological, engineering and evolutionary or socio-ecological (Dhar & Khirfan, 2017).

From the perspective of ecology, resilience is the environmental and ecological capacity of a structure to absorb a temporary disturbance and then reorganize to recover its previous state (Holling, 1973) fully, this approach highlights the potential of self-organizing systems , learn and adapt, while absorbing disturbances and undergoing changes, in addition to maintaining the same function, structure and identity (Walker et al., 2004); it reflects a process of "bounce forward" (Davoudi et al., 2012; Davoudi, Brooks, & Mehmood, 2013) (Shaw, 2012) that points towards changes.

Resilience, from engineering, focuses on resistance to disturbance and the property of a system bouncing back to the state before external stress, this takes a "bounce back" approach that refers to the capacity of a system to return to the point of equilibrium or initial state (Holling, 1973).

On the other hand, evolutionary or socio-ecological resilience (Davoudi et al., 2012; Gunderson, 2000; Simmie & Martin, 2010) challenges all ideas of balance and admits that the nature of a system can change over time, with or without external disturbance. It focuses on the evolutionary perspective of Folke (2006) of a socio-ecological system, and in multiple and ever-changing processes rather than in a single state; therefore, they call it "transform forward." Although this approach takes into account achieving balance, it is mainly aimed at developing the ability to adapt, learn and transform systems when they are subject to disturbances.

It is from these three approaches, that the IPCC in its fifth report gives its concept on resilience, defining it as "*the ability of social, economic and environmental systems to cope with a dangerous event or trend, respond or reorganize in a manner that maintain their essential function, identity and structure, while maintaining the capacity for adaptation, learning and transformation. "(IPCC, 2014, p.5)*

2. Urban Resilience in the context of climate change and variability.

Urban resilience has been associated with the discussion about climate variability and change, the effects of these natural phenomena are considered as disturbances that endanger the continuous advancement of cities (Kim & Lim, 2016). Extreme weather events and gradual climatic changes are considered as shocks or stressors that affect urban networks (Leichenko, 2011). It is in the face of these disturbances that cities must face and develop their capacity to respond and reorganize, preserving their essential function and maintaining their capacity for adaptation, learning, and transformation since they represent risks for human and natural systems.

The concept of urban resilience has been useful in addressing climate risk, unexpected events and improving efforts to survive and thrive in the context of climate variability and change (The Rockefeller Foundation, 2012). Urban resilience has gained importance due to the direct relationship with the sustainable development of cities (Kim & Lim, 2016). since resilience is considered to be a process that consists of making appropriate changes to face climate uncertainties and reduce the adverse effects of climatic phenomena (Surjan, Sharma, & Shaw, 2008), which contributes to urban planning (Cartalis, 2014) and promotes the sustainable development of urban systems (Kim & Lim, 2016).

2.1. Urban resilience, risk, vulnerability, and adaptation.

For the context of climate variability and change, the risk is understood as: "The potential for consequences in which something of value is in danger with an uncertain outcome, recognizing the diversity of values. It is represented as the probability of occurrence of dangerous events or trends multiplied by the impacts in case such events or trends occur. Risks result from the interaction of vulnerability, exposure, and danger "(IPCC, 2014 p.5).

Likewise, vulnerability is defined according to the IPCC as "the degree of susceptibility or inability of a system to face the adverse effects of climate change and, in particular, the variability of climate and extreme events, will depend on the nature, magnitude and speed of climate change to which a system is exposed, and of its sensitivity and adaptability. That is, it is the propensity or predisposition to be negatively affected by the presence of weather or climate phenomena "(IPCC, 2014 p.5).

For the specific case of Medellín, vulnerability to variability and climate change is directly related to the impacts of extreme weather events such as increased rainfall and droughts, greater recurrence of mass movements and floods and urban runoff. , damage to infrastructure, sometimes associated with loss of life or affecting the water supply for the

population and public transport with increased congestion and travel times (Alcaldía de Medellín, 2014).

With the recognition of the vulnerability of cities and the challenges posed by the impacts of climate variability and change on urban socio-ecological systems, resilience is presented as a measure to address these risks; it has been considered as the "opposite" of vulnerability, the more resilient a system, the less vulnerable (Pelling, 2011).

On the other hand, resilience has been related to adaptation (FUNFGELD, 2013; Kim & Lim, 2016; Wong-Parodi, Fischhoff, & Strauss, 2015), understanding the latter as a means to create resilience and make adjustments based on the impacts of climate change (IPCC, 2014); In this sense, improving the adaptive capacity of a system can reduce its exposure to climate variability, thus reducing the vulnerability of this system and improving its resilience (Adger, Brooks, Bentham, & Agnew, 2004, Leichenko, 2011).

In other words, when the adaptive capacity is low, there is a vulnerability; therefore there will be a risk; whereas if the capacity for adaptation is high, there will be resilience.

Thus, the concept of resilience intersects with the notions of vulnerability, risk, and adaptation. (Bulkeley & Tuts, 2013; Leichenko, 2011). The increasingly common objectives of activities that address climate issues are to increase resilience, decrease vulnerability and improve adaptive capacity. These three concepts are not interchangeable, but all of them refer to factors that allow people or systems to anticipate, avoid, plan, assume and overcome, recover and adapt to climatic shocks related to climate variability (Jabareen, 2013).

Building resilience has become an essential component for climate adaptation (Davoudi, Brooks, & Mehmood, 2013), the objective is to reduce impacts, prepare in the best way possible against environmental risks and develop adaptive capacity.

3. Urban Resilience Measurement

The indices to measure urban resilience offer a potential way to address the multivariate and complex nature of socio-ecological systems. Such indices are a composite of indicators that summarize many aspects that can be interrelated in one value (Krishnamurthy, Lewis, &Choularton, 2014). Thus, an indicator is defined as a variable that quantifies and characterizes attributes of the object of study (Schuschny& Soto, 2009). These tools are considered useful for measuring urban resilience, so various indices have been constructed to estimate it in the contexts of variability and climate change (Cutter, 2015, D'Lima & Medda, 2015, Engle, by Bremond, Malone, & Moss, 2014; Kotzee & Reyers, 2016; R. Shaw, 2015; Tyler et al., 2016; Xu & Xue, 2017).

The urban resilience indexes are helping cities to understand and measure their capacity to support, adapt and transform (Engle et al., 2014), also, by starting from a conceptual framework that integrates all the dimensions, allows identifying how they should move cities towards a more resilient state.

For the construction of the Urban Resilience Index applied to the city of Medellín, the phases presented in Figure 1 were followed, based on methodologies applied by other authors.

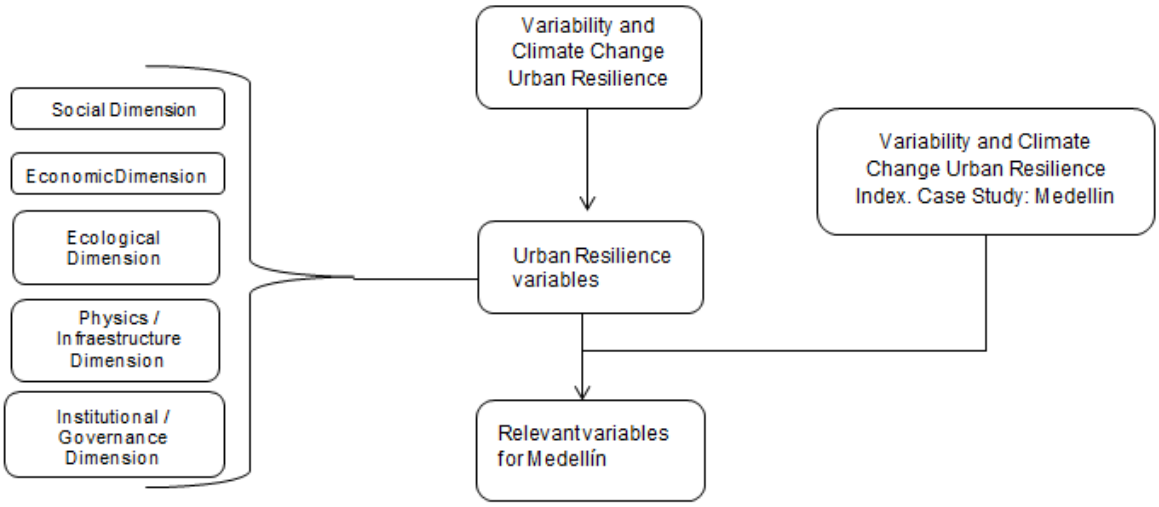

Figure 1: Methodology for the construction of the Urban Resilience Index in the face of Variability and Climate Change.

Source: self-made

Initially, a review of the literature on the conceptual framework of resilience and case studies was carried out, mainly in the context of climate change and variability, as well as a bibliographic review on the construction of composite indices (Saisana & Tarantola, 2002; Schuschny& Soto, 2009).

Next, the dimensions and variables for the urban resilience index were determined, the identification was made from two moments: Bibliography review and selection of dimensions and variables, and validation by experts in order to determine the importance and contribution of each of the variables in the construction of the index. In addition, taking into account (Schuschny & Soto, 2009), variables were selected based on relevance, quality, the frequency of sampling and the availability of information. Based on this, the following dimensions and variables were proposed for each of them that allow measuring urban resilience in the face of variability and climate change. Table 1.

Dimensions	Variables

Social	Demographic conditions: • Quality of life • Population density • Education • Social equity • Poverty / Unsatisfied Basic Needs
Ecological	Environmental quality and use of natural resources: • Ecosystem services • Water quality • Air quality • Ecological connectivity • Deforestation
Economic	• Unemployment • Level of income per capita • Economic growth • Economic diversity
Physics / Infrastructure	• Buildings Quality. • Climate-adapted Buildings • Population in areas of high threat • Areas of threat and risk • Green Infrastructure
Institutional / Governance	• Disaster prevention and response programs. • CommunityEmpowerment • The degree of integration of climate change in planning • Population aware of variability and climate change • Social cohesion • Climate changePolicies

Table 1: Dimensions and Variables to measure urban resilience.

Source: Own elaboration, based on the following references**:** (Abdrabo & Hassaan, 2015; Engle et al., 2014; Suárez et al., 2016; Xu & Xue, 2017), Sharif (2016) Tyler y Moench, 2012, Alshehri et al., 2014; Cutter, 2016). (Prashar, Shaw, & Takeuchi, 2012), (Brown, Shaker, & Das, 2016) (Thathsarani & Gunaratne, 2018) (Angeon & Bates, 2015) (The Rockefeller Foundation & ARUP, 2015) (Cimellaro, Renschler, Reinhorn, & Arendt, 2016) cox 2014, Cutter et al. (2014), Burton 2015, Abdrabo & Hassaan, 2015; Engle, de Bremond, Malone, & Moss, 2014; Suárez, Gómez-Baggethun, Benayas, & Tilbury, 2016; Xu & Xue, 2017.

From this approach, the importance of understanding urban resilience as a multifaceted concept that includes social, economic, institutional, infrastructural, and ecological elements is highlighted (Cumming et al., 2005, Cutter, 2015, Tyler & Moench, 2012) , (Figure 2), most of the indices developed address each of these dimensions (Engle, de Bremond, Malone, & Moss, 2014; Nguyen, Bonetti, Rogers, & Woodroffe, 2016; Tyler et al., 2016; Xu & Xue, 2017). Likewise, it has been identified that the dimensions (and the variables within the dimensions) may need to be modified in specific cases, some may not be necessary or may be joined if the variables encompass two or more dimensions (Engle, de Bremond, Malone, & Moss, 2014).

Likewise, although there are already several measurement techniques for some of these components, future research should prioritize a systemic approach for the measurement of all components.

Figure 2: Dimensions of Urban Resilience.

Source: self-made

In the case of Medellín, in future work the index will be applied to the city in order to obtain the measurement and, therefore, its resilience profile; If possible, a historical index will be developed to observe progress and setbacks regarding urban resilience.

Finally, it is clear that we have an instrument to identify the resilience profile of cities, correlating social, economic, institutional, environmental and infrastructure variables, with their capacity to recover from the impact of a disturbing phenomenon, in this case, climate change, is the first step to increase the resilience of cities.

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Chapter 13. Use of Geographic Information System (GIS) tools in the climate change evaluation in rural sector of Tolima

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1. Introduction

Human influence on the climate system is clear, and currently the increase of anthropogenic emissions of greenhouse gases is evident. Recent climate changes have had widespread impacts on human and natural systems (IPCC, 2014). This situation will modify the spatial distributions in physic-biotic and socio-economic components, and will produce conflicts in the society-nature relationship. Indeed, climate change seen as the modification of average temperature, annual precipitation, relative humidity and runoff, it will directly affect ecosystems, human health and water availability for different purposes (Asmus et al., 2017; Barrett et al., 2015; Barnett et al., 2005).

Given that there is a close relation between climate-vegetation-ecosystems-biomes, this environmental relation has an important incidence in the biotic processes of the planet, and particularly in the biomes spatial distribution and the existence of a certain biodiversity (Mantyka-Pringle et al., 2015). Climate change will affect biodiversity from the ecosystem to the species level. However, it will not affect all species and communities in the same way, some tend more to extinction than others, it due to direct or indirect effects of the change. The most obvious impact is on ecosystem boundaries as a result of sea level rise and changes in temperature; this will cause some ecosystems to expand into new areas and others to decrease in size (IPCC, 2014). According to Buytaert et al. (2011), climate change will displace ecosystem boundaries and strongly reduce the total area of tropical alpine regions in Colombian territories.

An approach to assess the climate change impact on ecosystems is based on the modeling of possible impacts on the spatial distribution of vegetation cover. In fact, vegetation cover is defined as the percentage of soil which is covered by green vegetation. In the planet, vegetation and forest act as natural water filters, removing many pollutants before the water reaches streams, lakes and reservoirs. Indeed, vegetation activity is regarded as one of the most important indicators for evaluating interactions between climate and terrestrial ecosystems. Vegetation dynamics are highly sensitive to climate change, especially in arid

scale (city and regional scale) are conducted based on the remote sensing techniques like Normalized Difference Vegetation Index (NDVI).

1.1. Tools for the analysis of land use

Currently, the Geographic Information Systems (GIS) is the tools used to study changes in vegetation cover and land use. The maps was transformed into a digital format for its electronic analysis, it that include updated georeferenced data ant integrate multiple sets and information processes, quickly and efficiently. A GIS is a manual or computerized set of procedures used to store and manipulate georeferenced data. The evaluation and monitoring of resources for territorial ordering of a community can be possible for the implementation of GIS, remote sensing and cartography.

Remote sensing (aerial photographs and satellite images) increases the observation capacity for obtaining data on a phenomenon with a spatial dimension; cartographic systems symbolize geographical data through maps (paper or digital), and GIS analyze and generate information from these data. The information that is generated through remote sensing systems, such as satellite images, has been applied to the assessment of natural resources and risks, through GIS. The spectral classification has been used, for example, in the detection and quantification of eroded lands, with the assumption that these constitute an identifiable spectral class. However, there is inconsistency in the identification of the classes, since different objects can have a very similar response, this also happens with water bodies, due to the large amount of sediments they can contain. Therefore, the experience and knowledge of the interpreter on the area is very important.

1.2. Image processin

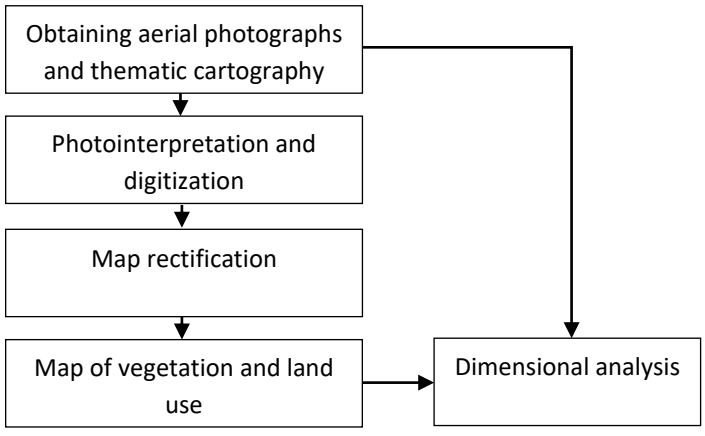
The analysis of NDVI requires the use of topographic map of the study area. A topographic map represents the main elements that make up the earth surface. These maps show natural or artificial objects of a territory, such as hills, rivers, forests, villages, roads, bridges, etc. These allow identifying the planimetry and altimetry according to the scale of work. In addition, geomatics or georeference data is defined as an approach to the measurement, analysis, management, storage and visualization of terrestrial data descriptions and location. The sources of these data included satellite, aerial and terrestrial instruments platforms. In fact, the image interpretation requires to perform adequate techniques of combination like use the remote sensing. It is based on the electromagnetic radiation registration using remote sensors that are not in physical contact the object that energy emits. The remote sensors can carried by air navigation vehicles in the atmosphere (balloons, airplanes, helicopters) or outside it (satellites, orbital stations, spacecraft).
In general, for this type of studies, the satellite images are obtained from Landsat sensor (NASA). Landsat program was created in the United State and provide essential information to help land managers and policy makers make wise decisions about our resources and our environment (Landsat Science). Seven Landsat satellites have been launched by NASA to obtain Earth images in a global way since 1972. The most modern sensor is the Enhanced Thematic Mapper Plus (ETM+). The Table 1 presents information about satellite of the Landsat program and the general characteristics of the sensor.

Landsat sensors record reflected and emitted energy from Earth in various wavelengths of the electromagnetic spectrum. The electromagnetic spectrum includes all forms of radiated energy from tiny gamma rays and x-rays all the way to huge radio waves. The human eye is sensitive to the visible wavelengths of this spectrum; we can see color, or reflected light, ranging from violet to red (Landsat Science).

Table 1 - Satellite of the Landsat program and the general characteristics of the sensor

Satellite	launch date	End of operation	Band feature
ERTS1	23/July/72	5/January/78	Band 4: blue Band 5: green Band 6: red Band 7: Infrared
LANDSAT 3	5/March/78	7/September/93	
LANDSAT 4	16/June/82	1983	Band 4: blue Band 5: green Band 6: red Band 7: Near infrared 1
LANDSAT 5	1/March/84	In operation	Band 1: blue Band 2: green Band 3: red Band 4: Near infrared 1 Band 5: Near infrared 2 Band 7: Medium infrared Band 6: Thermal infrared
LANDSAT 7	1998	In operation	Band 1: blue Band 2: green Band 3: red Band 4: Near infrared 1 Band 5: Near infrared 2 Band 6: Medium infrared Band 8: Panchromatic

In the flow chart presented below, the activities that can be develop for a study of vegetation cover.



1.3. Local. regional and globe climate

Climate is the result of environmental factors and conditions and it operate at different scales, in such a way that it is possible to speak of local climate, regional climate and global climate (Rodríguez et al., 2010). Global climate is a concept that considers the dominant atmospheric conditions during a long period (months, years, centuries). They are generated by a heterogeneous distribution of solar energy that enters to planet and produces an atmospheric and oceanic circulation. This circulation redistributes the energy (heat), humidity of air, cloudiness and rainfall. Regional climate refers to the predominant atmospheric conditions in a region, which are a consequence of the modulation of global conditions due to the physic-geographical factors that characterize it. Local climate refers to the prevalent atmospheric conditions in a place. Here the soil cover characteristics (forest, crops, water mirror, cement-asphalt) play a significant role in the modification of the underlying conditions, generated by the global and regional climate.

1.4. Global and regional impacts of climate change

Global environmental changes related to climate alteration, biogeochemical cycles, land use and mobility of organisms and species have changed the local and global diversity of the planet, with important ecological and social systems consequences (Chapin et al., 2000). According to Sala et al. (2000), for terrestrial ecosystems, land use change probably will have the largest effects in biological diversity, followed by climate change by the year 2100.

Climate change effect combined with the effects of habitat loss and landscapes fragmentation will make it possible to modify the composition of ecosystems and displace the habitats of many species. In fact, it will increase the rate of species loss and create opportunities for the establishment of other one (IPCC, 2014). Changes in the communities, composition and ecosystems distribution can produce reactions that affect the global and regional climate. In addition, changes in the intensity and spatial patterns of land use can lead to the loss of important ecosystem services and the provision of future demands of our society (Quétier et al., 2009).

2. Case study: Analysis of the Normalised Difference Vegetation Index (NDVI) in the department of Tolima, Colombia

Vegetation cover refers to the type of cover (natural or human product) that is on the land surface (grass, crop, forest, etc.). One of the most important characteristics currently used as an indicator of the status and condition of the forest ecosystem is vegetation cover. Vegetation cover estimates are developed and used to characterize forest vegetation and

enable the assignment of attributes or descriptive information regarding species type, composition, and even stand structure (Stumpf, 1993).

Vegetation is the most abundant biotic element of the biosphere and it is described for the plant life of a place. Vegetation aids several critical functions in the biosphere:

(i) Vegetation regulates the flow of biogeochemical cycles: water, carbon, nitrogen.

(ii) Vegetation strongly affects soil characteristics, that including soil volume, chemistry and texture. It also affects productivity and structure.

(iii) Vegetation serves as wildlife habitat and energy source for an extensive variety of animal species on the planet.

(iv) Vegetation is important to the word economy and in the production of food, wood, fuel, shelter, medicines and other materials.

(v) Vegetation is a source of oxygen in the atmosphere, and favors that anaerobic metabolism systems evolve and persist.

(vi) Vegetation is psychologically important to human.

2.1. Normalized Difference Vegetation Index (NDVI)

The normalized difference vegetation index (NDVI) has been widely used for remote sensing of vegetation for many years as the major indicator of urban climate (Yuan & Bauer, 2007). NDVI is related of biomass of the plants and it can estimate the ecosystem productivity. Strong chlorophyll absorption is located in two absorption peaks of visible spectrum, one is the blue light (400-500 nm) and other one is the red (600-700 nm). However, plant cells have evolved to disperse solar radiation in the near-infrared spectral region. The reflection in the red region is low due to the absorption of chlorophyll. On the other hand, infrared region shows a high reflection due to the diffusion by the structures of the leaves cells. Therefore, the vegetation appears relatively dark in the region of active photosynthetic radiation and relatively bright in the near infrared.

Normalized difference vegetation index maps are derived for images as follows:

Where NIR and R are the spectral reflectances percentage in near-infrared and red bands, respectively. NDVI equation produces values in the range from −1 to 1. Positive values indicate vegetated areas and negative values signify non-vegetated surface features such as water, barren, clouds, and snow. The classification of the NDVI can be seen in the Table 2.

Table 2 - The classification of the NDVI

Classification	Values
Clouds and water (NA)	< 0,01
Soil without vegetation (SV)	0,01 – 0,1
Light vegetation (VL)	0,1 – 0,2
Medium vegetation (VM)	0,2 – 0,4

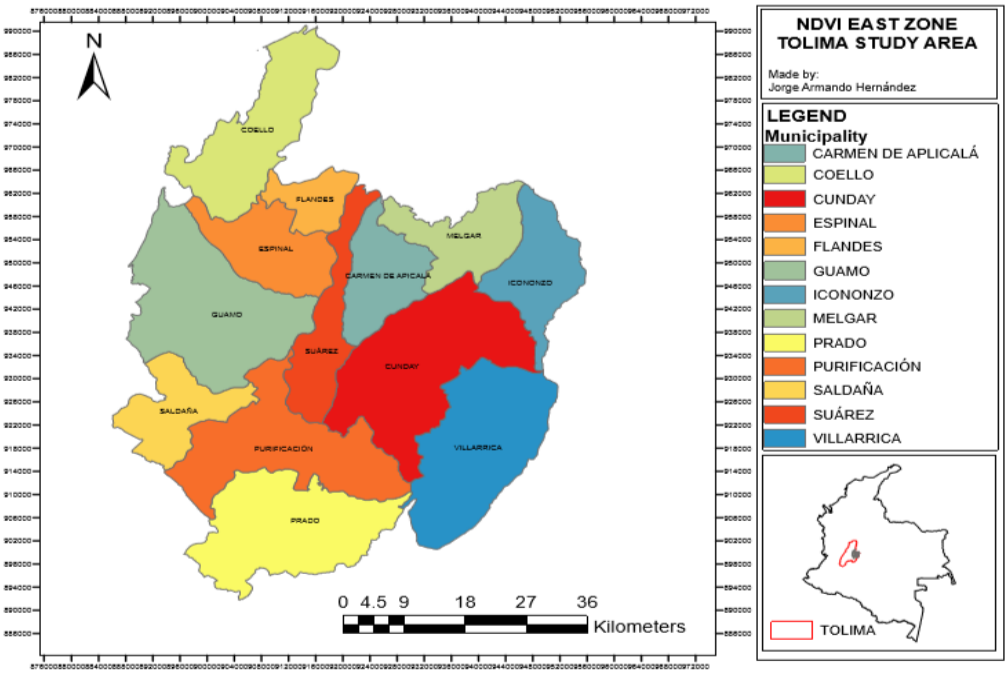
High vegetation (VA)	>0,4

2.2. Study area

The area is the eastern region of the department of Tolima (Colombia) with a surface 4115 km2 (Figure 1). The study area includes 13 municipalities with an elevation between 285 and 1300 meters above sea level. In addition, this region is characterized by an intense agricultural activity associated with the fact that most of the territory is rural. Also, some municipalities depend on a regional tourism as main economic activity. Most of the municipalities have agricultural vocation, although the latest reports indicate the change in recent years of land use. Currently, land use for the livestock and fish farming sector is increased. These activities have changed the structure of the landscape.

This region is characterized by having a tropical dry forest, it is an ecosystem used in Tolima as a supply of tree species for anthropic use. The climate of the area is characterized by the contrast in the values of the precipitation in dry areas with around 700 mm year. In general, the precipitation regime is bimodal, with two wet periods and two dry periods. In this area cross the Magdalena River, the principal river of Colombia, it is navigable and flows through the Magdalena River Valley. Another important aspect in this region is the existence of the Prado Reservoir with a store capacity of 966.22 million cubic meters of water, extension of 42 km2 and 51 MW of electrical generation capacity.

Figure 1 – Study area for vegetation cover



Source: authors

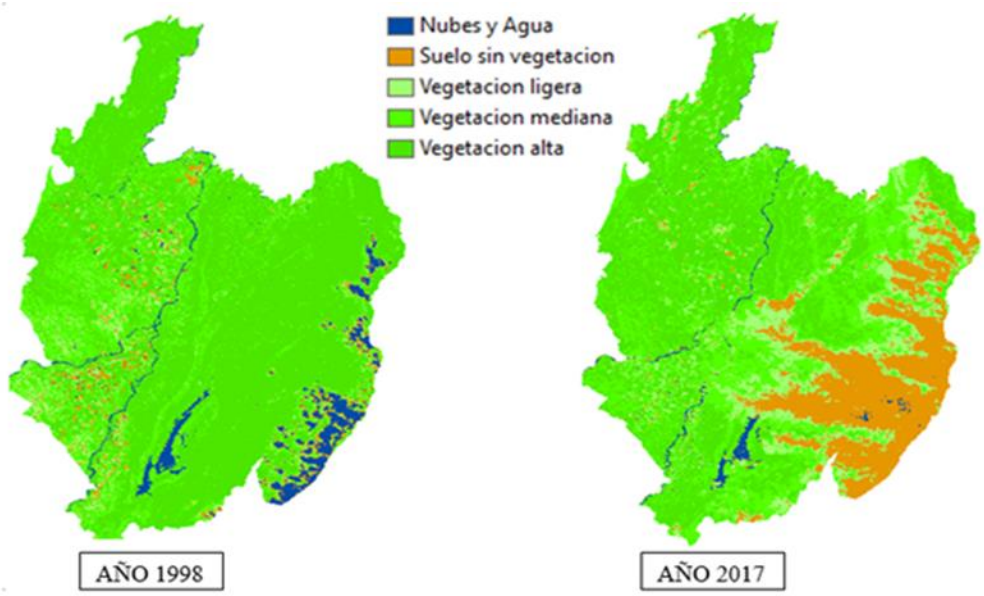
2.3. Results

The NDVI method was used for monitoring temporal changes in vegetation of the eastern region of the department of Tolima. The changes were register for two year: 1998 and 2017. It has been used to prepare spectral vegetation indices which separate green vegetation using Landsat data. This method depends on the different interactions between electromagnetic spectrum of near-infrared and red wavelengths. Red wavelength (about 600–700 nm) shows low reflectance because chlorophyll of leaf pigment absorbs more red wavelengths and infrared wavelength (about 800–900 nm) is of high reflectance because cell structure of the leaves scatters more infrared wavelength. NDVI can easily determine with the comparison of infrared wavelength band to that of red wavelength band.

NDVI values were calculated using ArcGIS raster calculator and maps of the region were prepared. In this study, forest cover area, agriculture area, grassland and shrubland are taken into consideration for vegetation class category. Classified maps for each year are presented as shown in Figure 2.

The results obtained from NDVI analysis show the loss of vegetation cover in the region on a period of 19 years. In this case, Villarica, Cunday and Icononzo, the municipalities with the highest degree of loss of vegetation cover.

Figure 2 – Classification maps for eastern region of the department of Tolima

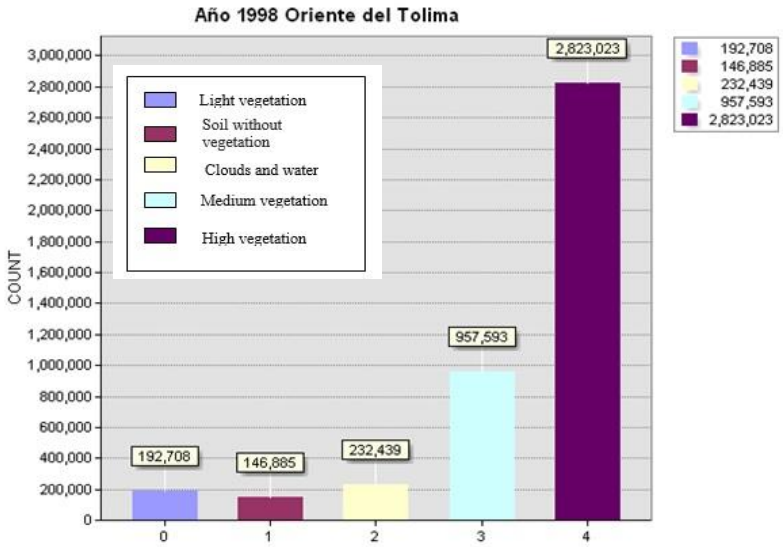


Source: authors

Figure 3 clearly shows a very good vegetation layer in 1998, we can also appreciate the Magdalena river and how it divides with the Saldaña River, and the area occupied by the hydro-Prado dam. More than 60% is high vegetative layer, and more than 86% is medium-high vegetation, little more than 4% are water and clouds although it seems very low it really is not, since we are analyzing in function of area and not volume.

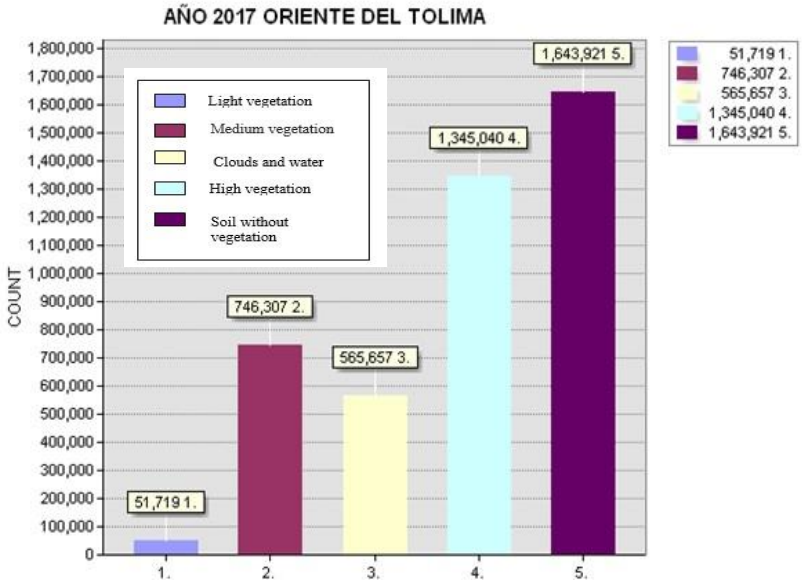
For the year 2017 (Figure 4) is a more drastic change, it is evident in the image as in the graph and numbers, since the soil without vegetation occupies just over 17% of the area and the upper vegetative layer has a percentage of 35.5%, which shows the impact of climate change on the vegetative layer of this area.

Figure 3 – State of vegetation in the area for 1998



Source: authors

Figure 4 – State of vegetation in the area for 2007



Source: authors

3. Case study: Fluvial dynamics of the Magdalena River in the municipalities of Puerto Salgar and La Dorada in Colombia

Rivers are of great importance for the economy of any society, they give us the resources such as water, energy, food and recreation. Rivers not only transport water, they transport salts, sediments and organisms, and the complex chemical and biological reactions that occur in the river channels are partly responsible for the chemical characteristics of the water retained in the large reservoirs, like lakes and oceans (Elosegi, Sabater 2009).

Rivers are dynamic entities that evolve by themselves due to hydrological, meteorological and geomorphological factors (Segura-Serrano, 2013); but the change in the structure of the rivers is also due to the anthropic intervention of natural resources, such as the changes in the land uses, construction of reservoirs, irrigation districts, agricultural activities, deforestation, among others. All these activities directly affect the river dynamics and the water resource planning (Lopez et al. 2014).

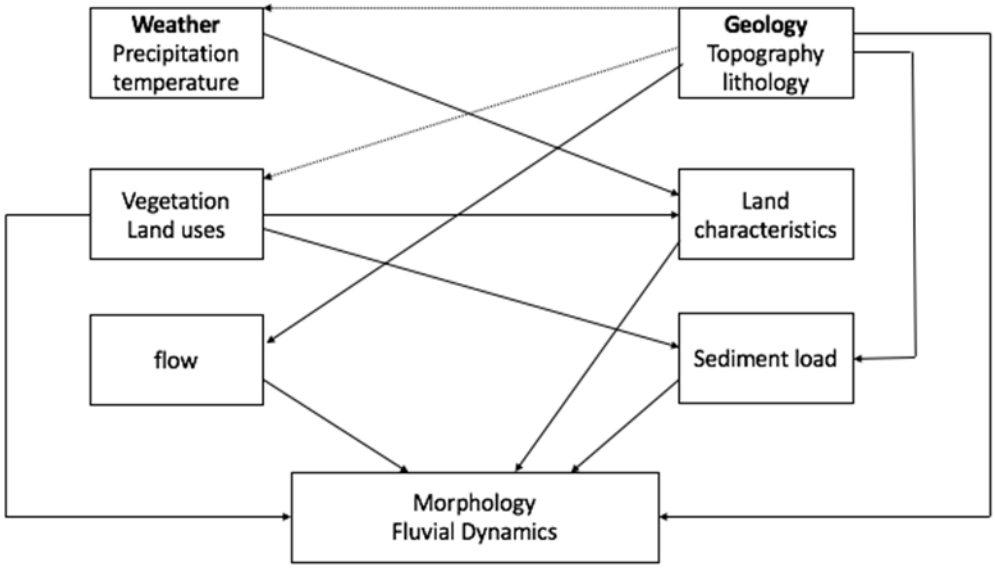
3.1. Fluvial Dynamics

Potamology, the science of rivers, focuses on issues of fluvial erosion, transport and sedimentation; and river metamorphosis or change through time. Fluvial dynamics as a branch of potamology, studies the action of forces on riverbed materials and water flow in watercourses (AMS, 2012). The understanding and identification of the way a river flows through time is really necessary to mitigate flood and erosion threats, also to design civil works and navigability (Vargas, 2012). As cited in Robert (2003, p. 9) the morphology of rivers is determined by the following four factors:

1. Volume and time distribution of water supplied from upstream
2. Volume, time distribution and character of sediment delivered to the channel
3. Nature of the material through which the river flows
4. Topographic gradient down which the river flows.

According to Elosegi and Sabater (2009) geological characteristics and climate are the key factors that explain the differences between rivers of different latitudes and biomass. Density and type of vegetation, weathering and development of soils, slope of the basin and circulating flow are descriptive parameters of the basin that depend on geology and climate as shown in figure 5.

Figure 5 – Factors that determine the morphology and dynamics of the fluvial system

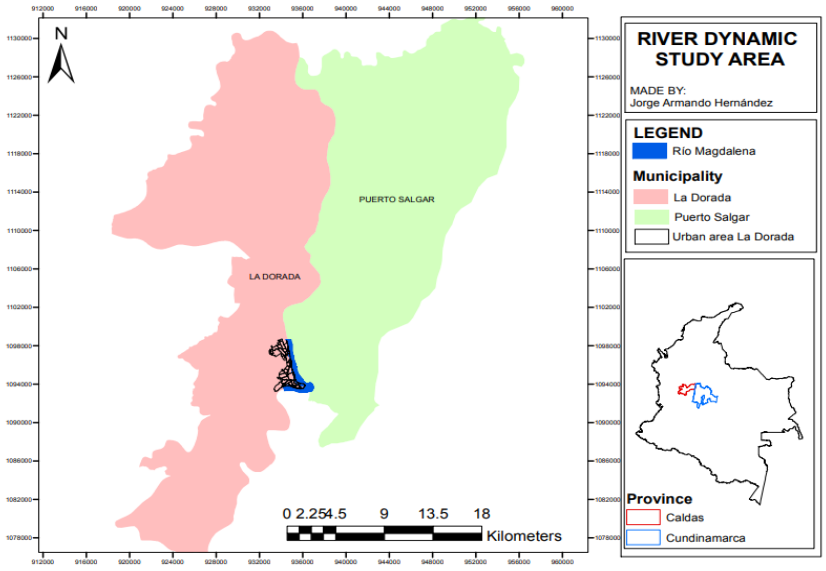


Source: Elosegi, Sabater (2009)

3.2. Study area for fluvial dynamics

For this case two municipalities of Colombia were studied: Puerto Salgar - Cundinamarca and La Dorada - Caldas (Figure 6). These two municipalities are part of the 128 bathed by the main fluvial artery of the country: the Magdalena River. This river has a length between 1528 and 1628 kilometers, which 866 km are navigable. Its basin is more than 257000 square kilometers in length which represents 34% of the national territory (Semana, 2016). In the Magdalena River basin, 70 percent of the Colombian population is settled and 85 percent of the nation's gross domestic product (GDP) is generated. 184 million tons of sedimentation are thrown every year into the river by deforestation, causing the rise of the level by 5 meters during the rain period (El Tiempo, 1996).

Figure 6 – Location of Puerto Salgar and La Dorada in the national territory and their closeness to the Magdalena River



Source: authors

The municipalities of Puerto Salgar and La Dorada are highly vulnerable to flood risks due to their proximity to the Magdalena River as shown in figure 7, which presents a flood threat, especially during the winter season and when the floodgates of the Betania Dam in the department of Huila are opened, affecting the buildings located near its channel (PBOT, 2002).

Figure 7 – Closeness of both municipalities Puerto Salgar (1) and La Dorada (3) to the Magdalena River (2).

Source: Google earth, 2018.

The bodies of water of the national territory (rivers, lagoons, lakes, swamps, etc.) cover 1.7% of the surface. The periodically flooded areas reach 12% of the national territory and extend to 28% in times with excess rainfall. 28% of the population is exposed to a high flood potential and 31% to a high and medium threat by mass movements. In 2012, floods under the phenomenon of La Niña affected both departments under study (Caldas and Cundinamarca), flooding 1203 ha and 45846 ha respectively (IDEAM, 2013).

Methodology to determine the fluvial dynamics

For determine the fluvial dynamics of the Magdalena river at Puerto Salgar and la Dorada, three phases were developed.

First phase: Image selection.

Images from the USGS portal were analyzed for years 1985 and 2015, separating the good quality images from the ones with nubosity, color and band alterations. At the end of this phase, the mosaic with the optimal images for the study area in both years 1985 and 2015 was obtained.

Second phase: Geometrical correction

It consists in the use of the gvSIG software as a tool to integrate the information stored and codified; in this program the geometric corrections of the image are made, including changes in the position occupied by the pixels that make it up; it is about changing its position, its coordinates and the geometric error is modeled.

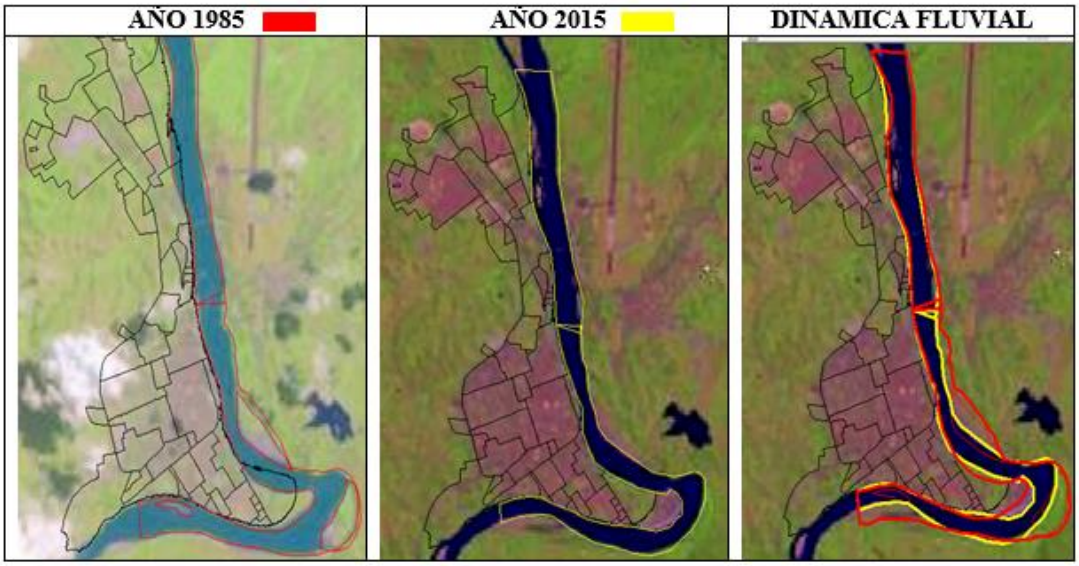
Third phase: Visual interpretation of satellite images

Once the other two phases were completed, the images were interpreted taking into consideration scientific documents (such as IDEAM maps) and papers.

3.3. Results

The forms that the rivers adopt adjust to the volumes of water and sediments they transport, and the material conditions of the lands they register. Defining fluvial dynamics for the municipalities of Puerto Salgar and La Dorada was an important factor in the planning of the territory in the departments of Cundinamarca and Caldas. Undoubtedly, reduce the exposure of the population to natural hazards through the implementation of techniques that enable the analysis of dynamic phenomena in space and time, contributing to the prevention of risks and disasters.

Figure 8 – Fluvial dynamics of the Magdalena River in Puerto Salgar and La Dorada



Source: authors

In figure 8 it can be seen that in 1985 the Magdalena River has three islands and by the year 2015 it has not; it is also observed that the dynamics of the river presents changes in the urban area of the municipality of La Dorada.

When performing the ARCGIS procedures (image corrections, composition, trimming, intersection, union), we proceed to obtain the results of the study, calculate the total area affected in each of the municipalities as shown below.

Final result of the affected areas by the real width of the river

Municipalitie	**affected area (m2) by the Magdalena River**
La Dorada	2033925.65
Puerto Salgar	65613.65
Total	2099539.3

Figure 8 – Affected areas by the Magdalena River in Puerto Salgar and La Dorada

Source: authors

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Chapter 14 .Planning for Resilience in the IJssel River Valley and Delta

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University of Twente

1. Introduction

This section describes some examples of climate change adaptation and resilience programmes that are ongoing along the IJssel River Valley and in the IJssel Delta area in the Netherlands. The description of resilience frameworks, laws and regulations related to climate change adaptation in the Netherlands in section 1 of this report, therefore provides a useful context for understanding and positioning the descriptions of specific project activities which are provided here. In this section we will focus on some of the key projects and actions which have been initiated in the region of the Netherlands around the city of Kampen, which is situated on the banks of the IJssel River. The IJssel River is a tributary of the River Rhine; regulated by a weir located at Driel (see Figure x.1), it transports some of the Rhine's water to the IJsselmeer area, which is the largest freshwater basin of Western Europe . The IJsselmeer area is a source of freshwater for agriculture in Friesland and Groningen and for drinking water in various cities around it. Water levels in the lakes, rivers and canals are all regulated to ensure a fair distribution of water resources across the various uses, and to reduce the probability of flooding disasters occurring.

Given the many large rivers that transect the Netherlands, the potential for storm surges from the North Sea and the low-lying topography of much of the country (about 40% of the land, including much of the most urbanized areas, is below sea-level), disaster risk reduction is a prominent element of the Netherlands' water management programme. Major flood events which occurred in 1993 and 1995 were the trigger to rethink water management and flood protection practices across the country. At that time it was realised that the traditional approach of building higher and higher dikes to manage flood waters was unrealistic – too expensive and impossible to implement in some areas due to space restrictions (higher dikes become broader at their base) and soil conditions. The 'Room for the River' programme was devised as a new and more cost-effective way to manage river discharges. Although Room for the River is focussed on river water discharges, it has become a key element of the broader set of instruments that make up the Dutch National Adaptation Strategy and the Delta Plan on Spatial Adaptation.

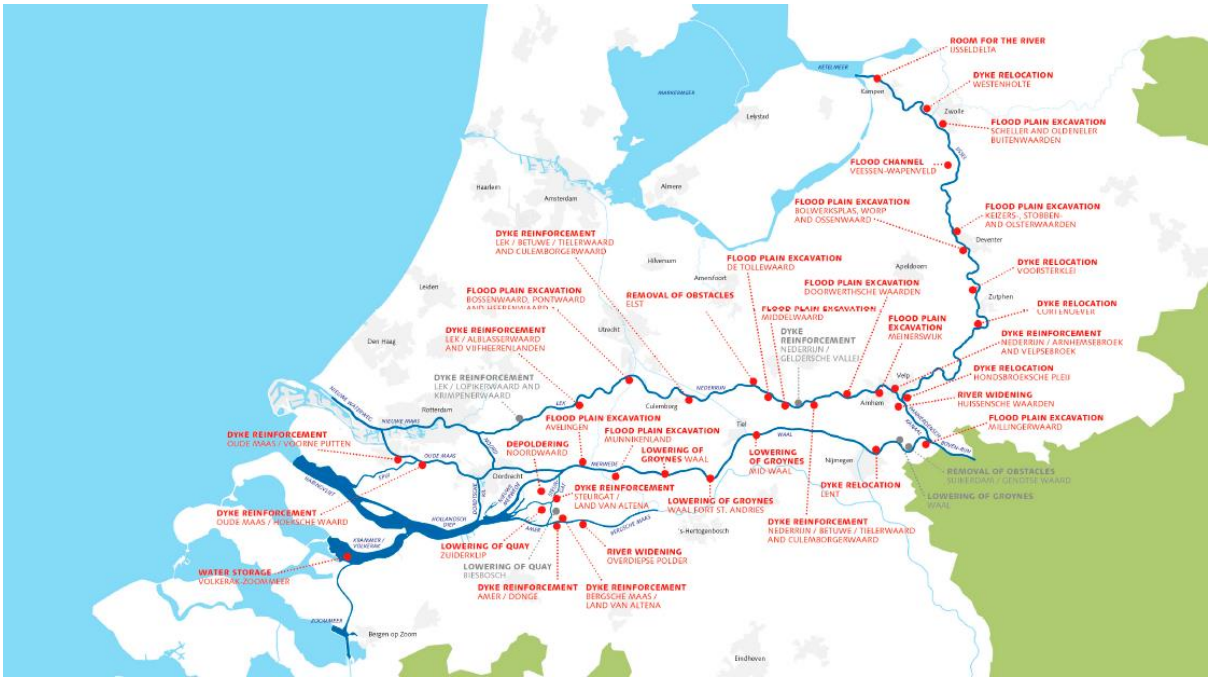
Figure x.1 The water networks of the Netherlands, showing the IJssel River connecting the Rhine to the IJsselmeer area and the cities of Deventer, Zwolle and Kampen.

(*Source:*Rijkswaterstaat, 2018)

As was shown in section 1, the Netherlands has various frameworks for climate adaptation actions at different administrative levels: at national, provincial and local levels. The local level includes both municipalities as well as water boards, both of which have elected representatives who are politically responsible for decision making. A key aspect of the Dutch approach is vertical and horizontal integration of actions across these levels. A national programme, such as 'Room for the River' under the Delta Plan

on Flood Risk Management (see Figure x.2), requires coordination with provincial and local levels to be fully realised. All levels must be party to the planning and implementation process as the measures to be undertaken under the programme have many implications for spatial planning, private and institutional landowners and all sectors of society. In other words, there needs to be a mutual adjustment and alignment between Room for the River and spatial and sectoral plans. Reaching agreement on the required alignment of planning goals, is often a difficult and time-consuming process, but it is an essential part of a successful programme.

Figure x.2 Map of projects undertaken under the Room for the River programme.



(*Source:* Room for the River, 2016)

2. Principles for climate adaptation: Multi-Layer Safety Approach

A key element of the overall strategy for water safety, which is an important component of the Dutch National Adaptation Strategy (NAS), is what is known as the Multi-Layer Safety approach (see figure x.3), which consists of three levels, prevention, spatial planning and disaster management.

As one may well imagine, realization of such a Multi-Layer Safety strategy requires a massive effort to achieve agreements between stakeholders at different levels. In the

case of the Room for the River project, it was decided that the programme would not be pursued forcefully through a special procedure for major national infrastructure projects, but rather follow the PKB procedure (Spatial Planning Key Decision) which allows for broad multi-stakeholder participation and negotiation, and the assessment of environmental and social impacts (Warner, 2011). As a consequence of this choice, about 15 years were required to go through the entire stakeholder negotiation and plan preparation stages, as stakeholders negotiated solutions to problems and conflicts, and even sometimes ended up in court to have dispute settled. Such disputes have also arisen in the IJssel Delta project presented below).

Figure x.3 The Multi-Layer Safety approach.

Level 3: Disaster Management - crisis management systems including early warning systems and evacuation, response and recovery.

Level 2: Sustainable spatial planning - aligning water safety issues with planning for spatial quality.

Level 1: Prevention - building and maintaining dykes and other infrastructures, awareness raising and

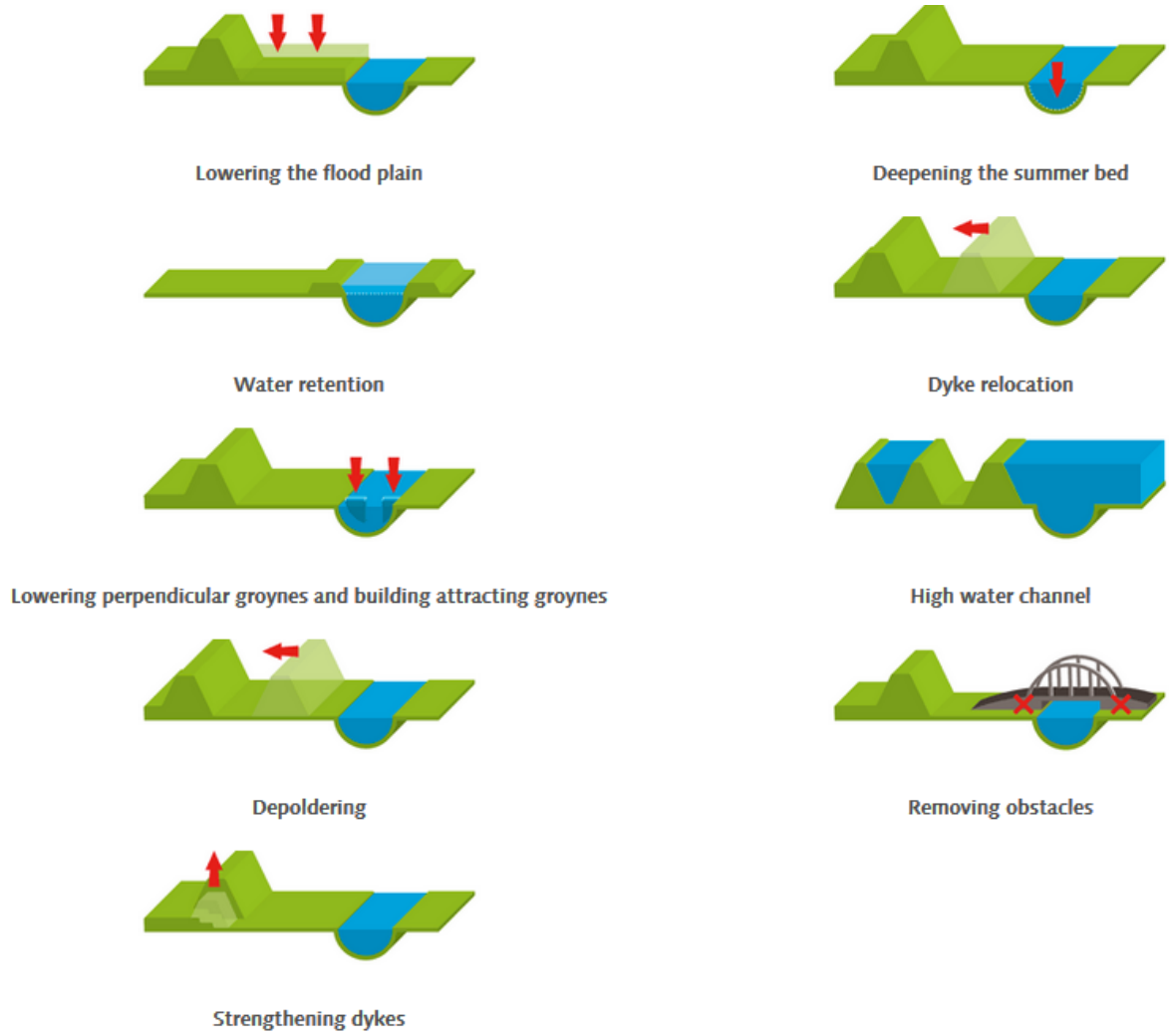
(*Source:* National Water Plan, 2009)

The first level, prevention, is generally realised through a suite of nine measures which can be applied for the purpose of flood prevention (Figure x.4). Typically, Room for the River projects, such as the IJssel Delta project, will make use of a selection of these instruments, in an integrated manner and in combination with level 2 spatial planning measures. Ultimately, all flood prone municipalities also have developed local disaster management plans in the event that level 1 and 2 measures prove to be insufficient to protect their population and their economic activities.

3. Key features of the Ijssel Delta area

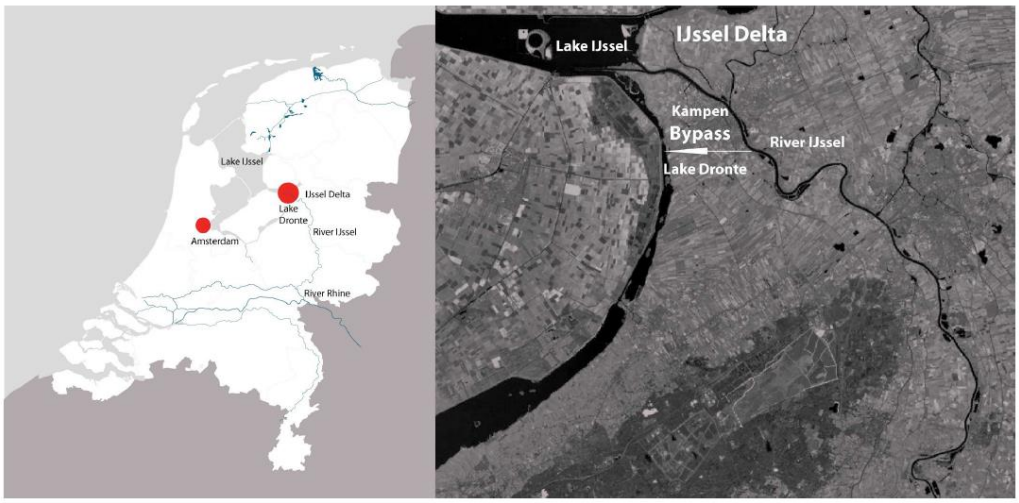
As explained above, the IJssel River is a branch of the River Rhine , which provides a means to discharge water from the Rhine to the IJssel Lake. The IJssel Delta area (Fig. x.5), therefore functions as a transition zone between Lake IJssel and the River IJssel. Its location is such that it is exposed to fluvial floods from the River IJssel and to storm-induced floods from Lake IJssel. Both sources of floods, also the combination of both as a storm surge may occur when river levels are high, have to be considered in climate change adaptation plans.

Figure x.4 Major measures for flood prevention applied in Room for the River projects.



(*Source*: https://www.ruimtevoorderivier.nl/english/)

Figure x.5 Location map of the IJssel Delta, IJssel River and IJssel Lake.



(*Source:* Sokolewicz, et al., 2011)

3.1. Ijssel Delta: challengues of water management

Following the 1993 and 1995 flood events, the design discharge in the River Rhine was increased from 15,000 m3/s to 16,000 m3/s and sea levels were anticipated to be 50 cm higher. However, as a result of climate change, water levels in the IJssel Delta area are expected to rise by between 0.20 and 0.60 metres. This rise needs to be accommodated by further adaptation of the IJssel Delta project, including an anticipated increase in discharge in the Rhine to 18,000 m3/s and a sea level rise of 0.60 metres by 2100, as well as the construction of a so-called climate-proof dyke. More details of the final adaptation measures are provided below.

4. The Multi-Layer Safety Approach in Practivce in th Ijssel Delta Project

4.1. Key features of the Ijseel Delta Project

The IJSSEL Delta project is the last in a chain of projects in Room for River programme (Fig. x.2). It is unique and complex undertaking with multiple, interlinked components. Key challenges for the project are the balancing of development goals with public safety in changing climate and hazard scenarios (rainfall, peak river flows and storm surges).

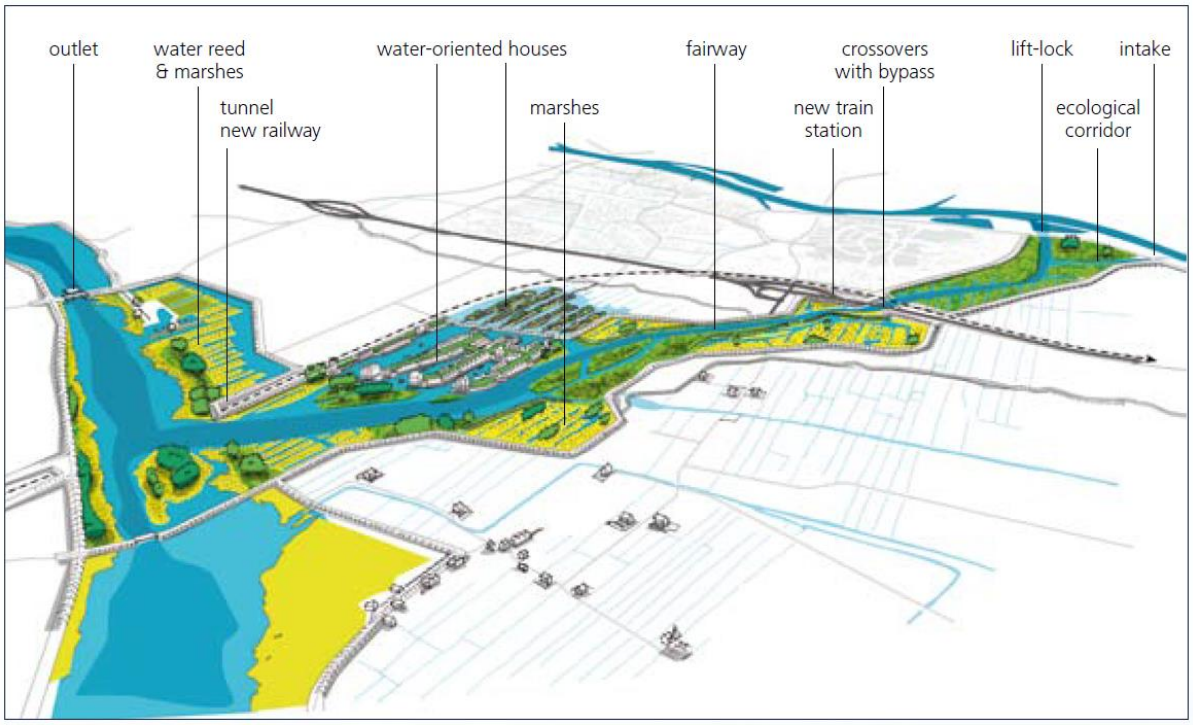
The major flood protection activities to be undertaken over the period 2015-2022 are:

- Deepening of the IJssel River summer-bed over a distance of 7,5 km
- Construction of 20 km of dykes in the Reevediep area to create a bypass around Kampen for excess water
- Creation of the Reevediep bypass, with an area of 570 ha (including more than 350 ha wetland nature reserve)
- Flood protection works encompassing a total of 6 separate flood plain areas involving a massive 6 million m3 of ground work (incl. 2 million m3 river sand)

These activities are designed to have the following effects:

- A 41 cm high water level reduction (near the city of Zwolle)
- A maximum discharge capacity via the Reevediep of 730 m3/s (approximately 25 % of the total discharge of river IJssel
- A 72 cm high water level reduction near the Reevediep inlet just upstream from Kampen (30cm near Zwolle))
- Significant flood protected areas in the municipalities of Zwolle, Hattem, Elburg, Kampen, Zwartwaterland

Figure 6. Bird's eye perspective of the plan IJssel Delta for the Reevediep bypass area



(*Source:* Province of Overijssel)

The entire planning and implementation process is summarized below.

Period	*Activity*
2001-2006	Initialization of the national programme Room for the River
2005-2007	Interactive, informal phase National pilot "spatial planning" Master plan + gentlemen's agreement between key stakeholders
2007-2015	Formal phase Review of land-use plans, SEA + EIA Purchase of land and real estate (voluntarily) 2nd gentlemen's agreement (2010) Decision to combine bypass with enlarging of summerbed (2012) Licenses, permits, blueprints / legal procedures Detailed design and tender documents / contract with developer (Isala Delta - a combination of two firms, Boskalis and van Hattum and Blankevoort which was formed for the project implementation)
2014/2015-2030	Implementation Phase 0: 2014: reed marsh development (8 ha.) Phase 1: 2015-2019: dykes bypass, nature development, inlet, dam, sluice, bypass partly operational, enlargement of summerbed Phase 2: 2018-2022: construction of 2 big sluices,

Reconstruction of 3 km. dikes, bypass fully operational
2018-2030: housing development?

The period 2001-2007 was essential a test phase, in which ideas for the new paradigm of allowing more space in the landscape to manage surplus water rather than building bigger dykes, was developed and tested through pilot projects. The formal process commenced from 2007 and is still ongoing. By 2022 all of the major construction works for water management, including the complete Reevediep project area should have been completed.

4.2. The Reevediep project

Figure 7 shows a more detailed overview of the Reevediep project area (the full map and details of projects can be downloaded here: http://www.ruimtevoorderivierijsseldelta.nl/). It indicates the locations of the various sub-projects which it entails, all of which are interconnected .

This interconnectivity is something which can exploited to the benefit of the overall project management and cost control. However, it is not conflict free. The goal of the Reevediep bypass is essentially to dramatically reduce flood risk in the city of Kampen. Figure x.8 provides an indication of how the extent of water in the Reevediep will change under a range of expected conditions. However, even after its completion, some additional flood risk management measures requiring active engagement with citizens will still be required in the city centre area during times of extreme water level. Some details of this will be provided later.

Figure x.7 Overview of projects in progress (red) and completed projects (blue) as of July 2018.

(Source: www.ruimtevoorderivierijsseldelta.nl)

Projects in progress:

1. Dyke construction including climate-proof dyke
2. Reeve dam and sluice gate
3. Landscaping of flow path at inlet
4. Navigation channel
5. Nieuwendijk bridge
6. OnderdijkseWaard - reconstruction of the IJssel floodplain near inlet
7. Navigation lock
8. Inlet Reevediep
9. Phase 2 projects Reevediep

Completed projects

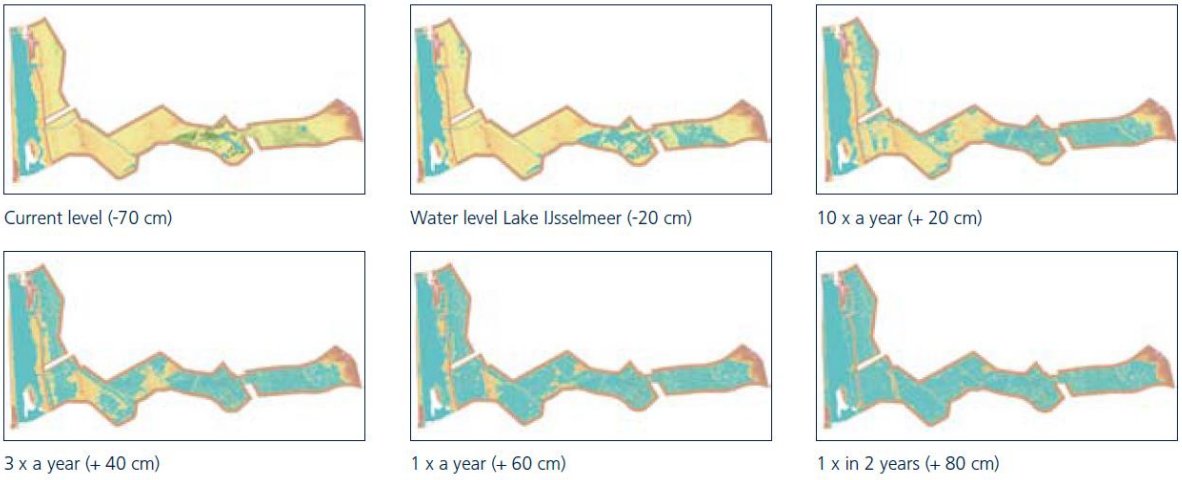
10. Deepening summer bed
11. Strengthening city bridge
12. Salvaging of historic boat (IJssel cog) from river bed

13. Restoration of Zalkerbosch floodplain

14. Restoration of Scherenwelle floodplain

15. Development of 43 ha of reed marsh (partly funded by the EU LIFE programme.

Figure x.8 Sketches of inundation extents in the Reevediep/Jssel bypass under different water levels



(Source: Province of Overijssel)

Figure x.9 Aerial photographs of the Reevediep

(TL: navigation sluice; TR: Inlet Reevediep; BL: View of Onderdijksewaard toward sluice and inlet; BR: view of reed marsh area and location of new housing near climate-proof dyke. (Source: http://www.ruimtevoorderivierijsseldelta.nl)

Figure10. Photographs of the Reevediep

(TL: Inlet Reevediep; TR: Navigation channel; BL: Climate proof dyke construction; BR: Existing farm along Zwartendijk (Source: Sliuzas, 2018)

4.3. Connections and conflicts in the Reevediep project

The Reevediep is a good example of a multi-purpose water management measure. It provides the following functions: flood protection by diverting excess water in the IJssel away from Kampen, it creates a direct channel for small recreational boat traffic between the IJssel Lakes and the IJssel River, it creates additional natural wetland conservation areas, it offers extra protection to lands from river and storm surge floods from the so-called climate -proof dyke (Fig x.7, #1) which will create opportunities for new housing development with a high spatial quality. Figures 9 and 10 show some aerial and terrestrial photographs of some locations and construction activities in the project area.

Although the primary goal is risk reduction in Kampen and Zwolle, its design as an integrated package is such that sand extracted from the deepening of the river bed and the navigation channel has been used in the construction of nearby dykes, thereby reducing the need for long-distance transport of construction materials. The design also generates new spatial qualities in the area and enables new recreational, economic and environmental functions to be realised in certain locations. Such connections are

useful in terms of the project's viability and they have helped to generate support from many stakeholders but not all.

In such complex projects involving large scale infrastructural elements, there is always a potential for conflict. Though the IJssel Delta project is generally framed as being successful (Warner, 2011), opposition has regularly been expressed to certain aspects of the project. For instance, in the preparatory stages of the project (2007-2015), much land had to be acquired from several land owners, mostly farmers, within the area. Long delays occurred around the issue of financial compensation due to acquisition. Waner (2011, see Table x.1) shows how in the end three main frames have been used by various parties with a stake in the IJssel Delta area and this project. In particular, the so-called "conservation coalition" has played a substantial role in raising frequent challenges and substantial resistance to many aspects of this project, using the full scope of possibilities for legal objections at their disposal. In this sense, the decision not to make this a special infrastructure project with a fast track procedure provides many opportunities for parties with conflicting interests to delay such a project. However, many of the current design features and qualities of the project can be directly attributed to adjustments in plans as a result of resistance form the conservation coalition.

Table 1. Coalitions and narratives in the IJssel Delta

Actor coalition with their own narrative	Members	Dominant objective	Discursive strategies
'development coalition'	National government (Ministry of Transport, Ministry of Housing); regional government; local government	To realize an integral development perspective for the IJsseldelta in which various spatial ambitions are entwined and simultaneously implemented	To connect the project to dominant and fashionable discourses within the domain of spatial planning such as 'developmental planning', 'area development', 'example project'
'safety coalition'	Water Board 'Groot Salland'; farmers' organization LTO	To prevent affecting the safety against floods and other water-related problems within the IJsseldelta area; to prevent urban encroachment and curbing agrarian development.	To interpret the bypass as a contradiction: it presupposes safety but poses a serious risk to the inhabitants of the bypass area
'conservation coalition'	Citizen group Zwartendijk; nature association IJsseldelta, several political parties	To safeguard the unique historical and spatial qualities of the IJsseldelta area	To frame the planning process as megalomaniac and a fundamental misfit with the fairytale area as it is

(*Source:* Warner, 2011)

For example, the extent of reed marsh has been increased due to opposition from the conservation coalition. Currently, the stakeholders are awaiting court decisions on whether the navigation channel will indeed be open for recreational boating or not, which is seen by some to be in contradiction with the environmental goals of the project. Also, the construction of the climate-proof dyke ostensibly makes it safe to construct housing in an area with very high spatial quality (i.e. close to environmental zones and water bodies, in the vicinity of the historic Zwaterndijk area). This is also an issue of considerable conflict, which is pitting conservationists against developmentists and is likely to require considerable time before it is resolved.

5. Examples of other initiatives at local level

Before completing this section it is useful to point out that not all innovations and actions require such massive funding. Many actions can be undertaken by private citizens or groups of citizens as well. Typical actions of interest here relate to investments in private property related to water runoff such as green roofs, water retention tanks and infiltration areas (Figure x.11). Municipalities and water boards are increasingly requiring property owners and developers to look for ways to reduce surface water runoff from their properties as a contribution to reducing drainage and river discharges. Emergency water retention is now often included in the design of public parks and squares to reduce the pressure on water drainage systems and prevent pluvial flood damage.

Figure 11. Examples of measures for water protection in Zwolle.

L - A barrier to restrict ground water flows: R - green roofs and water retention tanks integrated into the fence with small gardens and porous paving for runoff infiltration (Source: Sliuzas, 2018).

In Kampen, a community flood brigade consisting of 200 citizen volunteers was created in 2003 to assist in protecting the historic city centre area from extreme flood events. The volunteers are trained to operate and install a set of automatic and manual flood barriers in the city centre area (see https://www.oecd.org/governance/observatory-public-sector-innovation/innovations/page/kampenfloodbrigade.htm#tab_lessons). The brigade practices the installation and dismantling of the flood barriers twice per year and it forms an important component of the cities flood defences (Figure x.12). Such citizen initiatives are an important component of Kampen's flood defences. They are part of a soft infrastructure that goes beyond awareness raising and education

alone. The engagement of Kampen's citizens in its flood defences is increasing resilience in Kampen, and can contribute to cost savings in physical infrastructure elsewhere in the IJssel Delta.

Figure 12. Flood barriers operated by the Kampen Flood Brigade to protect the city centre.

(Source: John Curtin)

6. Conclusions

The realisation of climate resilience adaptations in the Netherlands is a complex, multi-level process. Many of climate adaptation issues are related to water management and flooding, issues that have long been central to the identify and culture of Dutch society. Water issues are almost always transboundary issues, so too in the Netherlands. Its major rivers have their origins far away in neighbouring European countries and large parts of the country can be considered to be deltas. As deltas are also areas which have long been favoured for human habitation and city development, it is hardly surprising that in confronting and preventing flooding from rivers and storm surges along the coast has a high priority. The multi-layer approach to water management includes spatial planning and development concerns alongside those of flood safety and disaster prevention. The example of the IJssel Delta project illustrates how such a process works. How vertical and horizontal coordination is required and how an integrated set of actions can be designed and implemented to climate proof the city of Kampen. However, it has also shown that such plans also entail conflicts of interest which need to be addressed, ultimately leading to

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Websites containing information on the projects discussed in this section:

Room for the River https://www.ruimtevoorderivier.nl/english/

IJssel Delta project http://www.ruimtevoorderivierijsseldelta.nl/en/

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15. Development of 43 ha of reed marsh (partly funded by the EU LIFE programme.

Chapter 15. Wetlands at risk. Climate change and environmental imbalance in the Metropolitan Area of Concepción

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1. Introduction

The Metropolitan Area of Concepción (MAC) is located in the geographical centre of Chile, along the coastline of the Biobío Region. It is a fragile territory of important morphological heterogeneity and rich biological diversity, characterized by the presence of a series of bodies of water of different nature (rivers, lagoons, wetlands), which constitute an interdependent system, where the urban sprawl is distributed amongst its lands. These wetlands appear as one of the most threatened natural ecosystems on the planet, despite their importance, as noted in the international bibliography. This is mainly because of human intervention, linked to the urban expansion that progressively reduces their dimensions, transforming them into simple channels or pools that receive garbage temporarily (Rojas et al, 2015, Boavida, 1999). Also, they are threatened by the effects of climate change that alter their size, structure, hydrology and biological communities (Moreno 2005, Finlayson 1999). In parallel, the aforementioned literature concurs that the wetlands represent ecosystems that are difficult to address, given their wide diversity and complexity.

Wetlands are still undervalued by urban planning in Chile (Figueroa et al, 2009). In fact, in an institutional context in which there is no consistent territorial planning, wetlands are not yet defined within the available planning instruments which leaves them in a state of extreme vulnerability. Geographer Carolina Rojas[14] points out that, "in Chile (...) there are only construction standards, and if the urban development plan establishes that a wetland is an area of urban expansion, there is no problem in filling it […] since they are considered as simple vacant lots and swamps, the legislation only protects those that are located outside the cities "[15].

At present, the main economic activities of the MAC are tertiary and commercial, linked to higher education[16], logistics and transport derived from the exportation of raw materials, and

14 Geographer and PhD in Cartography, is one of the leading researchers on wetlands at the MAC.

15 Interview by Gabriel Espinosa of *Periodismo UdeC* - online press - *(11/08/2017),* "Grave daño Ambiental en humedales de Concepción", http://www.periodismoudec.cl/tiemporeal/2017/08/11/grave-dano-ambiental-humedales-concepcion/

16 MAC hosts four universities of the Chilean Council of Rectors: one public (U. del Bio-Bío) and three private traditional (U. de Concepción, U. Católica de la Santísima Concepción and Federico Santa María Technical University); besides 8 non-traditional private universities (U. del Desarrollo, U. San Sebastián, U. Nacional Andrés Bello, U. de las Américas, Technological University of Chile INACAP, U. Santo Tomás, U. Bolivariana and U. La República; and several professional institutes and vocational training centres.

construction. In this scenario the vulnerability of the wetlands translates into concrete risks both for the survival of these ecosystems and their biodiversity, as well as for the well-being of the population living in their vicinity, These risks are due to the fact that these territories have historically been submitted to the pressures imposed by urban expansion, industrialization processes and industrial decline. The result of this has seen wetlands, bodies of water and river beds and estuaries, used as spaces for urban expansion and places to dump industrial waste, garbage and debris. All of the aforementioned has significantly impacted the territory, causing large environmental imbalances.

2. The Metropolitan Area of Concepción (MAC) territory

With a population of around one million inhabitants, the MAC is considered the third most populated metropolitan area in Chile, and, despite being one of the main industrial development poles of the country throughout history, it has experienced important processes of deindustrialization in recent decades.

The territory where the MAC is located constitutes a kind of border area between two distinct traditional cultural zones, where the Bío-Bío river, nearly 2 km wide, acts as a natural, historical and symbolic boundary. To the north of the river lies the central Chile, peasant, born of miscegenation and the cultural matrix of the "Central Valley *hacienda*", imposed by Spanish colonization. Meanwhile, to the south of the Bio-Bío is the *Wallmapu*, the country of the Mapuche people. Specifically the Lafkenche territory – sea border Mapuche –, with its own approach to meaning, appropriation and relationship with the different elements of the territory. After centuries of independence, the Lafkenche territory was incorporated under the effective control of the Chilean State, in the mid-nineteenth century.

Administratively, the MAC is composed by 11 municipalities that extend along the coastline, and go upstream through the Bío-Bío[17]. It is a complex zone, with an abundant diversity of territories, and very different origins, historical development, demographic dynamics, and social identities. With populations ranging from 230,000 inhabitants in Concepcion to 25,000 in Hualqui, several of these municipalities have had to face the demographic, economic, and social consequences derived from the processes of gradual de-industrialization, that the area has been experiencing since the mid-70s. As a product of the implementation of neoliberal policies during the dictatorship of Pinochet, which has been continued by successive governments. Some of these consequences are: a) a decrease in the rate of population growth in several municipalities, well below the national average - even in Lota, a slight demographic contraction is observed; b) unemployment rates and poverty levels above the national average; and c) an impoverishment of the local production model.

17 Tomé, Penco, Talcahuano, Hualpén, Concepción, Chiguayante, Hualqui, San Pedro de La Paz, Santa Juana, Coronel and Lota.

Table 1. Variation of population and number of houses in the municipalities of the MAC (2002-2015)

	Var. population	Var. houses		Var. population	Var. houses
Concepción	6,0%	48,4%	Penco	12,1%	34,8%
Talcahuano-Hualpén	14,3%	30,9%	Tomé	6,3%	67,5%
San Pedro de la Paz	62,5%	128,8%	Coronel	20,5%	67,0%
Chiguayante	21,8%	39,4%	Lota	-2,6%	23,3%
Hualqui	34,6%	81,3%	MAC TOTAL*	16,8%	51,7%

Source: Author's elaboration; using data from the Population and Housing Censuses of 2002 and 2015.
* Excluding Santa Juana.

However, this scenario coexists with the effects of the liberalization of urban land market and the sustained increase in housing construction. As shown in table 1, between 2002 and 2015, the MAC recorded a 51.7% increase in the number of houses, where less than a third corresponds to high-rise housing (30.2%), which is mainly concentrated in the commune of Concepción (54.1%). In relation to this phenomenon, it is worth noting that in the same period of time the population of the MAC increased by only 16.8% which is below the national average of 19%. In terms of space, this deregulated behaviour is reflected in an accelerated growth of the urban sprawl in all directions without further planning. This goes hand in hand with real estate speculation depending on the law of supply and demand, which results in increasing pressure on the bodies of water, lagoons, wetlands and the riverbeds that characterize its territory.

The MAC territory is morphologically determined by the diversity of natural accidents as a consequence of its location being next to the ocean, in an area of fluvio-marine plain dotted by hills, hillocks, and mounds, delimited by the Coastal Range. This territory is located on the boundary between two climate zones, the Mediterranean of the north and the temperate rainy climate of the south, with humid and cold winters and dry and temperate summers. Here converge two watersheds (Bio-Bío[18] and Andalién[19]) that drain into the Pacific Ocean, forming a complex network of: bodies of water; rivers; estuaries; lagoons[20]; marshes and

18 With 24,264 km2, it is one of the greatest basins in the country. Its origin is at Galletué Lagoon, deep into the Andes Range, 1,160 m.a.s.l.; it drains on the north shore of the Arauco Gulf, after running for 380 km (Dirección Nacional de Aguas, 2004).

19 It is a 130 km long coastal hidrologic system, created from rainwater, without snow accumulation, and a higher water flow in winter, which drains on the western side of the Coastal Range into the Talcahuano Bay (Espinosa, 2018).

20 The MAC has a number of urban lagoons; Redonda, Lo Galindo, Tres Pascualas, Lo Méndez, Lo Custodio, Verde and Pineda on the north; plus Grande and Chica of San Pedro, La Posada and Quinenco on

wetlands. Al of the above contribute to a fragile and historically mistreated system.

3. The metropolisation of Concepción

At the beginning of the 20th century Concepcion was one of the first cities in Chile where urbanism principles were applied for its development; even before the first Urbanism Law of the country was enacted in 1929. In 1912 Law No. 2,658 was passed, which regulated the construction and urban limits of Concepción (Fernández, 2012), expanding the urban area to the limits of the Paicaví wetland on the northwest and incorporating the Tres Pascualas lagoon and the wet areas of Agua Negra in the plan. Progressively, the city expanded, taking space away from what was then called '*pajonales*' (place where herbs and weeds abound). With the passing of years, the 1936 the Decree with Force of Law n ° 345 of the Ministry of Public Works dated 1931 came into force. The decree would establish the instrument of the regulatory plan, becoming mandatory for all cities with more than 20,000 inhabitants. That same year, the State created the Popular Housing Fund to address the housing deficit problem. At that time Concepción already exceeded 80,000 inhabitants, and the territory that currently comprises the MAC reached 200,000.

The urban sprawl of Concepción, which for centuries was limited well beyond the limits of the foundational plot over the La Mocha valley and the coastal plains of Penco and Talcahuano, experienced an accelerated growth after the earthquake of 1939. On the one hand, the government of president Pedro Aguirre Cerda created the Reconstruction and Assistance Corporation to address the emergencies arising from the reconstruction, since 60% of the buildings of the city were destroyed or rendered uninhabitable. It is interesting to remember that most of the rubble was used to fill wet areas and riverside and lacustrine borders.

On the other hand, the government created the Corporation for the Promotion of Production (CORFO) which aimed to promote and plan the modernization and industrialization of the country. One of its first projects was to put into operation the Compañía de Aceros del Pacífico (CAP) in 1945, with the mission of building a modern steel mill in the San Vicente Bay, partly on the surface of the Lenga wetland. The inauguration of the stell mill "Huachipato" in 1950 would be followed by several other industries in the area: Carburo y Metalurgia (1953), Chilean Wire Industry - Inchalam (1954), Cementos Bio-Bío (1957), Electroquímicas Unidas S.A. (1959), ENAP Refinery (1966) and Petroquímica (1970). This consolidated a central hub for the industrial development of steel, oil, chemical and metalworking, between the city of Concepción and the port of Talcahuano, which notoriously attracted more inhabitants, and became fundamental for the conurbation of both districts (Santa Cruz, 2018).

The territory between both cities, historically known as the Vegas of Talcahuano and Hualpén, was mainly formed by wetlands, grasslands and lagoons that surrounded a handful of low hills and hillocks. However, the process of conurbation that began to become evident in the 60s, would fill and bury land that could be flooded; progressively reducing the area of wetlands. At the end of the decade, in 1968, in the Rocuant-Andalién wetland, the Carriel Sur of Concepción Airport was inaugurated, replacing the Hualpencillo aerodrome that was

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the south. numerosas lagunas urbanas, ql norte del río Bío-Bío se encuentran las lagunas Redonda, Lo Galindo, Tres Pascualas, Lo Méndez, Lo Custodio, Verde y Pineda; mientras que al sur las lagunas Grande y Chica de San Pedro, La Posada y Quinenco.

located on a sandbank between the Lenga, Green Lagoon and Price Lagoon wetlands, and the Bío-Bío river. This area would be rapidly urbanized by numerous sets of working class and social housing, giving rise to the commune of Hualpén (Santa Cruz, 2018).

Towards the middle of the century, Chile was dragging an endemic lack of housing, which would be exacerbated by the increase in rural migrants in search of new opportunities, attracted by the expansion of the industrial sector. In the decade of 1950, Chile began to introduce significant changes in the Law of Urbanism and Constructions, adding concepts like metropolis, intercommunal, and region, as an attempt to face the current processes of urban expansion, and with a special emphasis on the problem of the housing deficit. In 1953, the Popular Housing Fund and the Reconstruction and Assistance Corporation were merged, giving rise to the Housing Corporation (CORVI), which then in 1965 was taken over by the newly formed Ministry of Housing and Urban Development.

After the *coup d'état* of September 11, 1973, an extreme version of the theory of the subsidiary role of the State began to be applied in Chile, where the deregulated market was seen as the best optimizer in the allocation of resources. All of this would result in severe consequences both for the water system of the MAC and for the Chilean society as a whole. During General Pinochet's civic and military dictatorship in Chile, the Parliament was closed, a systematic policy of State terrorism was carried out against the opposition, political parties were illegal and there was no freedom of the press. In this context, the State of Chile was completely reformed according to the vision of a small group of economists, disciples of Milton Friedman, who were known as the "Chicago Boys" (Harvey, 2007). In 1976, Supreme Decree (DS) 458 of the Ministry of Housing and Urban Planning of 1975, would be passed to become a Law, known as the General Law of Urbanism and Constructions (LGUC) which, with its 28 modifications, remains in force today. Among other things, it established the liberalization of land and urban transport according to supply and demand, and stated that the "excessive" regulation of land for development was the cause for the shortage of land to develop real estate projects, reducing the functions of the public sector to those of mere recorders and generators of information for private investors.

In practice, urban and territorial planning was pushed to the background, being almost paralyzed, leading to the worsening of the uncontrolled urban expansion that was already happening in Chilean cities since the mid-twentieth century. As a consequence, in the last forty years, urban expansion has dramatically altered the coverage and uses of the territory of MAC, increasing vulnerability levels due to risks of mass removal and flooding (Espinosa, 2018).

4. Wetlands in the Metropolitan Area of Concepción

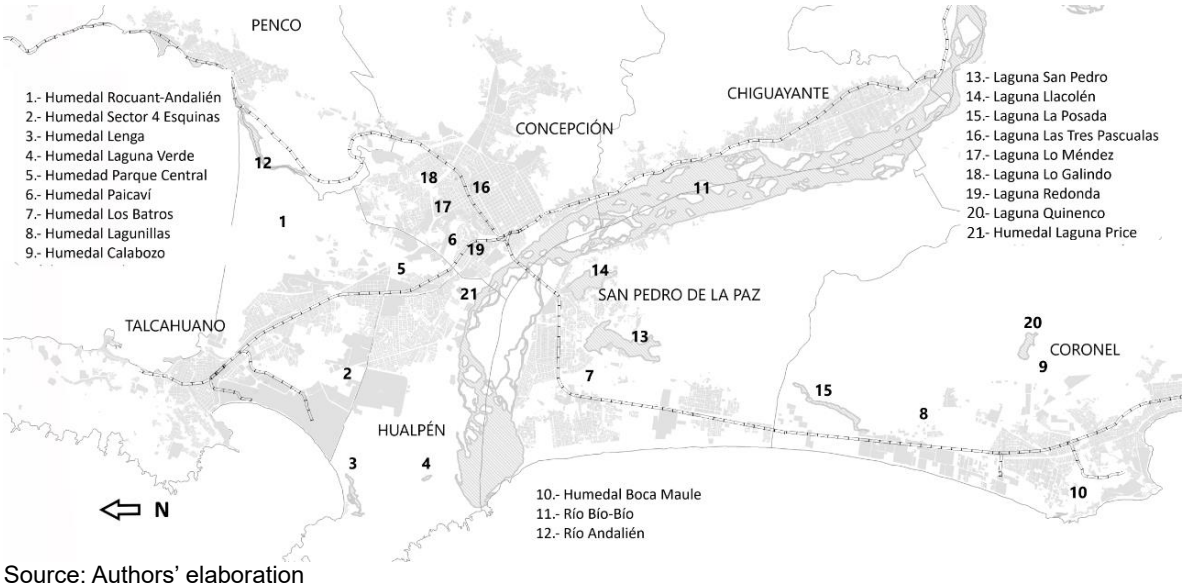
Chile is characterized by its abundant biodiversity; almost 4,400 km long, it has a wide variety of climates and landscapes in which it is possible to find thousands of wetlands or wet areas of different types. However, it has only thirteen wetlands recognized as Ramsar Sites, most of which correspond to highland wetlands (bofedales) and salt flats located in the altiplano of the Atacama Desert. None of the 13 belong to the Bio-Bío Region, despite being some of the most threatened.

As can be deduced from the name, the fundamental element that characterizes wetlands is the abundant presence of water, which determines their structure and the ecological function

they fulfil (Beltrán, 2012). In the *Penquista*[21] case, this presence is closely related to the characteristics of the hydrographic basins that converge in the Metropolitan Area and the rainfall regime of the area, with a marked rainy season between April and September and a brief dry season in summer. Although, in recent decades there has been a considerable decrease in rainfall and a lengthening of the dry season.

According to the available bibliography (since these are not yet defined in Chilean regulation), the identification of wetlands tends to respond to a variety of criteria and methodologies, which combine the use of satellite images and observations in the field, through which both their perimeters and their areas of influence are defined (Rojas et al, 2015). For the *Penquista* case, these definitions have a certain complexity, as shown in Image 1, it is a highly interconnected water system, in which 2 watersheds converge and drain into the ocean.

Figure 1: Main bodies of water, wetlands, rivers and lagoons of MAC



Source: Authors' elaboration

In this complex territory, wetlands stand out due to their great ecological importance, the biodiversity they harbour, and the environmental services they provide. The total number of wetlands distributed in different sectors of the MAC is estimated at 61, covering an area of 106 km2. Some of the areas with the greatest occurence of wetlands are: Rocuant-Andalién in Talcahuano; the Green Lagoon sector and the Lenga wetland in Hualpén; the Cuatro Esquinas sector, between Hualpén and Talcahuano; the San Andrés sector - Parque Central, between Talcahuano and Concepción; the Paicaví wetland, in Concepción (Rojas et al, 2015); the Los Batros wetland in San Pedro de la Paz; and the Boca Maule wetland, in Coronel.

This same complexity is evident in the existing variety of wetlands. In this sense, it is possible

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Demonym given to the inhabitants of Concepción and others events related to the city, because of the its original foundation in Penco area in 1550. The city was moved to its present location in the valley between Bío-Bío and Andalién rivers after a devastating earthquake and tsunami in 1751.

to subdivide the wetlands found in the Penquista territory into two large types according to their water regime: a) swampy freshwater wetlands, such as the wetlands of Laguna Verde, Paicaví, San Andrés (Parque Central), Cuatro Esquinas, Los Batros, Calabozo, and Lagunillas; and b) marsh-type wetlands, which are affected by tidal changes, such as the Rocuant-Andalién, Lenga, and Boca Maule wetlands. An interesting element is that several of these wetlands are interconnected. For example, the Rocuant-Andalién wetland - the most important and greatest in extension, which also harbours the largest number of birds - is connected to the Paicaví and San Andrés wetlands.

It is also possible to find differences in their biodiversity and, above all, in their state of conservation. For these purposes, indicators of biodiversity and wildlife of wetlands are used both to establish their delimitations and their state of health. In this sense, among other factors, the richness of species of plants, birds, crustaceans, insects, or lepidoptera that they harbour are analysed; the latter "constitute one of the groups most commonly used as an indicator of the conservation status of wetland biodiversity" (Rojas et al, 2015).

In relation to plant diversity, the bibliography emphasizes the need to study the composition and structure of the vegetation communities of each wetland in order to determine their conservation status and the course of action to be followed in their restoration or conservation processes (Gallo and Rodríguez, 2010). In this sense, a first superficial observation of the state of the wetlands in the MAC reveals a worrisome result: most of them are not protected and several are highly anthropized and have seen their dimensions dramatically reduced in the last decades. Furthermore, some are being constructed on or they have become illegal garbage and rubble dumps. Among the most endangered are the Paicaví, San Andrés, and Los Batros wetlands.

However, in order to analyse the wetlands within the Penquista territorial system, it is essential to take into account their role, in relation to the different environmental services they provide – the most remarkable being their role as reservoirs of biological diversity, their role in water purification, and their ability to control floods and mitigate the effects of tsunamis.

4.1. Biological diversity

The wetlands, especially the Rocuant-Andalién, that currently covers an area of ha 1,500, are fundamental ecosystems for the migration of avifauna in the area of Concepción (EULA Centre, 2011). Among the species with the highest number of individuals in this wetland are: the Dominican gull, the tern, the coscoroba swan, the Franklin gull, the curlew, the American skimmer, the Magellanic oystercatcher, and the marsh crow, among many other species of birds. The estimation is that in the wetland it is possible to find 25% of the waterfowl species existing in Chilean territory. In this sense, despite not having any kind of guardianship or preservation plan, this wetland would comply with at least 2 criteria to be considered of global importance. It has a population of more than 20,000 waterfowl (a figure that far exceeds), and it regularly harbours at least 1% of the individuals of a waterbird species (Beltrán, 2012). Many of these species are also found in the rest of the MAC wetlands.

These ecosystems are also home to numerous species of freshwater fish, some of them endemic and endangered, such as the catfish (*nematogenys inermis*), the “bagrecito” (*bullockia maldonadoi*) – a small fish that does not exceed 7 cm –, the “pocha de los Lagos” (*cheoirodon palusdae*) or “Carmelita de Concepción” (*percilia irwini*), the latter exclusive of the Andalién and Bio-Bío river basins, among many others; in marsh-type wetlands, they

also harbor several species of freshwater fish, such as: Patagonian bass (*eleginops maclovinus*), silverside (*basilichthys australis*) or sole (*paralichthys adspersus*), (Pauchard et al, 2006).

There are also numerous species of mammals, amphibians, reptiles, and crustaceans. Among the latter, one of the most abundant - at least until before the 2010 tsunami - was the Estuarine crab (*hemigrapsus crenulatus*), and one of the most threatened, the tiger crab (*Aegla concepcionensis*), whose habitat is currently reduced to a few estuaries and streams in the Andalién basin. These are two endemic species of this area that were considered extinct until 2004. At the same time, these wetlands harbour a wide variety of insects, which tends to vary depending on the characteristics of each wetland, and the degree of conservation it presents. In this sense, it is interesting to consider that those wetlands in a better state of conservation tend to evidence a greater wealth of macrolepidoptera, mainly due to the scarce presence of introduced flora (Rojas et al, 2015), which is a good indicator of the degree of conservation of the wetland.

In the same way, wetlands are characterized by the diversity of plant species that they harbor, although some of them evidence greater vegetational heterogeneity than others, where hygrophilous species are the most characteristic, for example: Chilean junquillo (*juncus procerus*), canutillo (*equisetum giganteum*), or totora (*typha domingensis*); and, as we get closer to the sea, the halophyte species, such as: sosa weed (*sarcocornia fruticosa*), llinto (*spartina densiflora*), and golden button (*cotula coronopifolia*), among others.

4.2. Control floods and tsunamis

Perhaps, one of the most obvious environmental services provided by wetlands, are those related to flood control, whether these events are caused by intense rain events, flooding of rivers, or tsunamis. These services could disappear or be reduced by the construction of urbanization projects, for residential, productive and general service purposes. In this regard, it is important to remember that in the last 50 years flood events have been recurrent in the MAC. In fact, between 1960 and 2010 there were 21 river floods – 5 of which were of great magnitude (Rojas et al, 2015). In 2006, the MAC suffered the effects of a historic flood caused by 36 hours of heavy rain, leaving thousands of people affected and entire neighbourhoods under water due to the replacement of natural coverings by urban landscapes - especially in the basin of the Andalién river - among other reasons (Espinosa, 2018).

Table 2: Mega earthquakes and tsunamis, in the Metropolitan Area of Concepción

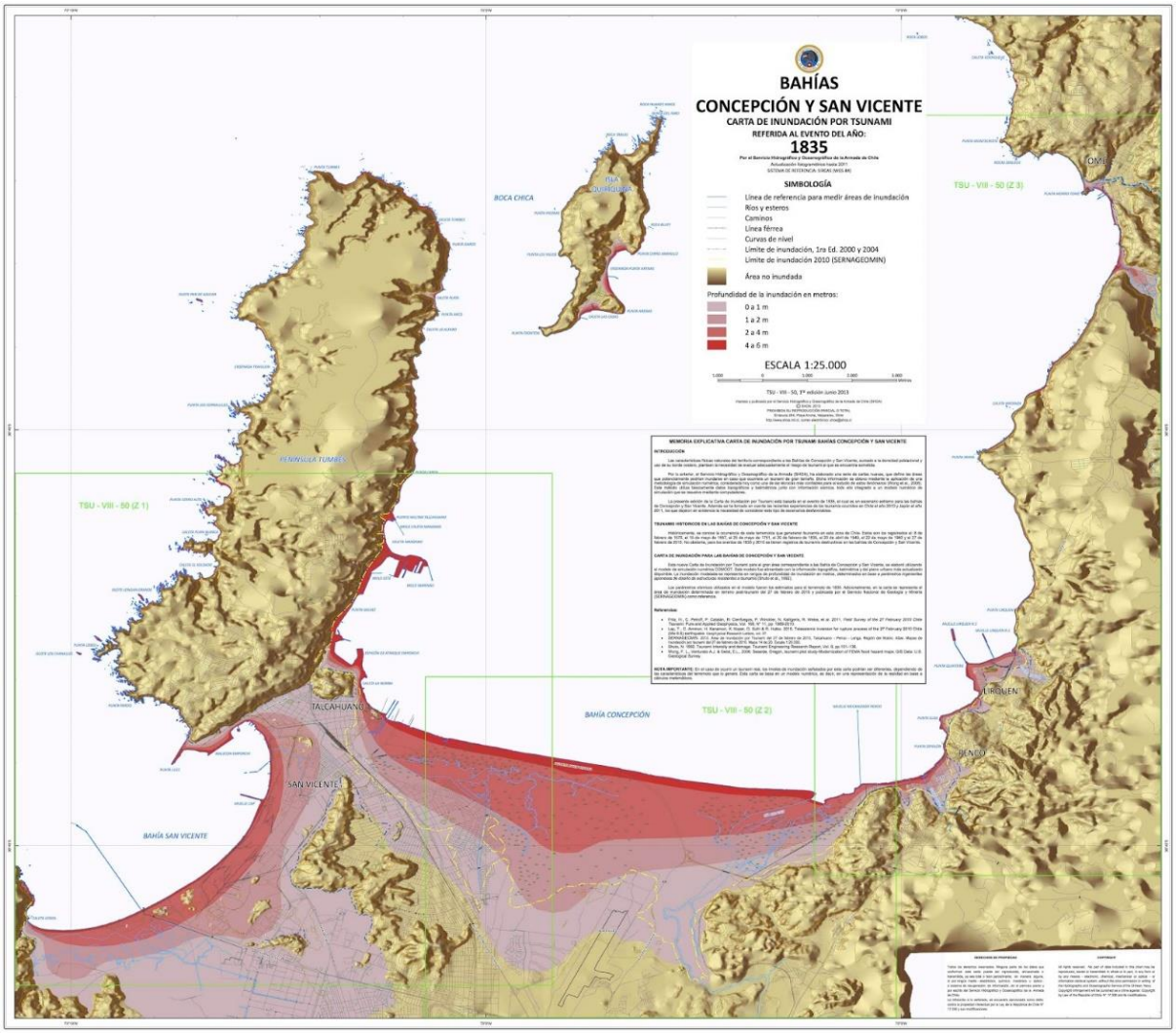
Earthquake	1730	1751	1835	1939	1960	2010
Epicentre	Valparaíso	Concepción	Concepción	Chillán	Valdivia**	Cobquecura
Richter magnitude*	8.7	8.5	8.5	8.3	9.5	8.8
Casualties	3.000	70	120	5.690	2.000	545
Tsunami	Yes	Yes	Yes	No	Yes	Yes

* The magnitudes of the pre-1960 earthquakes are estimated. // ** Strictly corresponds to two consecutive earthquakes, one on May 21 of magnitude 8.0 with an epicentre in Concepción and another in Valdivia the next

day of 9.5 lasting 8 minutes, the strongest worldwide earthquake ever recorded.
Source: Authors' elaboration; with data from the National Seismological Centre (Universidad de Chile) and the National Oceanographic Committee.

However, along with the floods of rivers and the events of intense rains, the territory in which the MAC is located has witnessed numerous tsunamis in its history. In fact, these wetlands, particularly the Rocuant-Andalién area, have historically provided protection against these events, as evidenced by the tsunami deposits of 1835 and 2010 (Beltrán, 2012; Valdivia and Lagos, 2014). It is important to consider that far from representing exceptional events, mega earthquakes and tsunamis are phenomena which have historically coexisted with the Penquista territory, with five of them occurring in the last 300 years; this means an average of one every 60 years, of which those of 1835 and 2010 are particularly significant, since great masses of water advanced deep inland, where the Rocuant-Andalién wetland absorbed much of the effect of the wave train.

Figure 2: Concepción and San Vicente bays, Tsunami flood chart, 1835



Source: SHOA, Hydrographic and Oceanographic Service of the Chilean Navy, 2011.

5. Impact on urbanisation

The aforementioned accounts for a series of demographic, social and productive processes, which take a place in a fragile and very complex territory. The urban growth of the Great Concepción has historically taken place with disregard to the effects that urbanization could generate for environmental balances. In fact, the conurbation process that would give rise to the "Concepción-Talcahuano inter-commune" and later to the Metropolitan Area of Concepción (MAC), far from stopping, has instead accelerated, generating a series of territorial imbalances, which in extreme circumstances have had severe impacts on the territorial system. This scenario was worsened after the liberalization of the land according to the law of supply and demand, during the dictatorship of Augusto Pinochet. This allowed the expansion of the city beyond any planning, consuming more and more agricultural and rural land, filling wetlands and lake edges, urbanizing hills, and canalising rivers and estuaries.

According to the available bibliography, when studying the difficult relationship between urban expansion and the ecological balances of water systems - which are part of and nourish the wetlands that coexist in the same territory - there are a series of dimensions and indicators that can shed some light not only on the state of conservation of each one of them (as explained above) but also, on the threats that hover over these areas. Some of these threats include: the proximity of these environments to productive, industrial, and seaport activities, as well as the pollutants that they emit, the form of disposal, and the places to which they expel industrial toxic waste which, in this area, were spilled directly into channels, rivers, wetlands, and the sea.

In the same vein, it is important to consider the distance from roads and highways, through which thousands of cars, buses, trucks and vehicles of all kinds pass by, emitting different types of polluting gases and acoustic pollution; these also benefit the arisal of irregular garbage and debris dumps. In the case studied, for example, the wet network of the MAC is abruptly crossed by a network of highways, roads, railways and other infrastructure.

Another dimension to be taken into consideration is the behaviour of the amount of urbanized surface and surface area considered appropriate for development over time, and to what extent they begin to put pressure on the living space of wetlands and bodies of water. Along with the dispersion of the urban sprawl, it is essential to consider other indicators, such as population density and housing density, as well as land uses allowed by the Development Plan, especially in areas like the MAC, in which the wetlands are not considered in the planning of the city and are seen only as available or vacant sites, since they are not recognized as such by the current planning instruments. For example, as a result of this, an important part of the urban expansion areas identified in the Concepción Communal Development Plan are located within the wetlands, and it is projected to fill them almost completely. This scenario is particularly worrisome, because in the last 3 decades, almost one quarter of the surface of wetlands of the MAC has disappeared as a result of urban expansion – of which environmental impact is still difficult to estimate.

In fact, it is widely documented in specialized literature that the urban expansion of the Gran Concepción has advanced to the detriment of lagoons, wetlands, and native vegetation (Rojas et al, 2019; Vidal & Romero, 2010); in doing so, significant amounts of high environmental quality areas of the wetlands of Lenga, Rocuant-Andalién, and Los Batros in San Pedro de La Paz, have been replaced by residential areas, scattered vegetation, and

areas without vegetation (Smith & Romero, 2009). Moreover, in both cases, wetlands are threatened by large infrastructure projects, which, like the Paicaví wetland landfill, only consider some small "green corridors", designated as ecological protection areas.

In the case of the Rocuant-Andalién wetland, the construction of the Logistics Platform of the Bio Bío Region is planned entirely on the area of the wetland, to serve mainly the ports of Talcahuano and San Vicente in storing containers, materials, warehouses of different types, and industrial facilities. It will be located on an area of 795 ha between the coastal border and the airport, and it is projected to cover a total area of 1,869,085 m2; this would, in fact, destroy the core of the main wetland in the whole area, reserving just a corridor of 84 ha between the two small areas that will remain, which euphemistically receives the name of "ecological protection zone". The environmental damage caused by this would be irreparable and would have consequences that we are not yet able to foresee.

Figure 3: Logistics platform of the Bío-Bío Region

A Logistics Services Center
B Logistics Activities Zone, Storage
C Logistics Support and Distribution Center
D Interport Services Center
E Storage and Transfer Center
F Industrial Productive Park
G Technological Park
H Storage and Port Support Center
I Business center
J Shopping center
K Tourist Park - Recreationa
L Ecological Protection Zone
M Airport “Carriel Sur”

Source: Baeriswyl, 2005: Logistics Platform of the Bío-Bío Region, Master Plan.

On the other hand, the Los Batros wetland from the 1990s onwards, was rapidly refilled in its upper part, at the mouth of the San Pedro lagoon, for the construction of residential buildings (Laguna Grande Residential Park), educational infrastructure, and supermarkets. It is currently facing the threat of construction of a highway and an industrial bridge on the wetland terrain. The creation of the Los Batros Wetland Park was adopted as a palliative measure, following the urban landscape of the late twentieth century, for aesthetic and recreational purposes, rather than from the logic of river and water systems restoration.

These patterns of urbanization and use of land inevitably result in serious environmental imbalances, demonstrating that, to a large extent, environmental degradation in Chile is linked to the absence of a regulatory framework, which would be capable of planning, regulating and managing the evolution of cities and urban growth, assuring the minimum conditions that would allow the survival of water systems and other elements of the landscape. In this sense, the MAC - far from being alien to this reality - is a paradigmatic example of it; this is how the urban population exposed to the flood risk has been increasing

rapidly. For the last 2 decades, along with the works of canalisation of estuaries and protection of fluvial and lacustrine banks, the real estate projects constructed on landfills, in wetlands and on the terraces against flooding of the Andalién river have multiplied, as for example, in the Brisas del Sol (165 ha), Valle Noble (50 ha) or Valle Escondido sectors.

One of the biggest problems in this regard is that - although the effects generated by the destruction of wetlands throughout the 20th century are evident - their preservation, restoration, and recovery are not a priority for the organisms entrusted by the Law of urban planning. In fact, in the municipality of Concepción, a good part of the urban expansion areas defined in the Communal Regulatory Plan are located in the wetlands, in the bed of the Andalién River, or in areas at risk of mass removal or flooding. This increases the risk of suffering large floods in the face of possible anomalous rainfall events, such as the one that occurred in 2006. The scenario is not very different from that observed in the communes of Talcahuano, Coronel or San Pedro de La Paz, where a decrease in the potential storage capacity of rain water in the Penquista water system, increases the possibility of flood and water logging events of greater intensity in the near future.

This dramatic reduction and neglecting of wetlands occurs in a global context of great uncertainty regarding the effects that climate change can generate in our territory. That is to say, a key element for the environmental equilibrium of the Penquista territorial system is being eliminated, just when important climate changes are foreseen in the near future.

6. Towards effective protection of urban wetlands

In summary, the scenario described so far reveals, on the one hand, the characteristics of the MAC wetlands, the main ecological functions that they fulfil, and their urban, cultural and scientific relevance. On the other hand, it shows us a worrying reality, of which territorial management and planning have not been effectively executed.

Even if, nominally, Chile signed the Convention on Wetlands in 1981, enacting it as Law through Supreme Decree No. 771 of the Ministry of Foreign Affairs, very little has been done about it in urban areas. The Ramsar Convention obliged its signatories to implement measures aimed at "the conservation and wise use of wetlands through local and national actions and through international cooperation, as a contribution to the achievement of sustainable development throughout the entire world" (RAMSAR, 2017). Until 2005, the responsibility for this fell on the National Forestry Corporation (CONAF), an autonomous institution of the Chilean State, which did not have the skills, nor the necessary human, technical, or material resources to effectively deal with this responsibility imposed by the conservation of wetlands. This is because the very logic of the Chilean regulatory framework sways towards deregulation, encouraging private investors to undertake projects and carry out actions which end up progressively destroying the wetlands located in the vicinity of urban and productive areas.

An aspect that complicates the situation most in the Chilean context is that the situation described above coexists with a slow but progressive development and updating of environmental legislation in the country. This, on the one hand, has increased issues and tension points for real estate, productive and infrastructure projects that are deemed as necessary and inevitable, in order to achieve the long-awaited development, generate jobs and modernise the country. On the other hand, a greater environmental awareness - striving to advance on the improvement of environmental legislation - is rivalled by the fear of investors who rush to sell or buy land, fill wetlands and obtain building permits for their

projects. Moreover, there are conflicts which may arise within the State itself, between those who want to preserve and those who do not care, as far as economic growth is at the centre, and all the intermediate nuances that may exist.

Despite the fact that Article 19 of the 1980 Constitution acknowledges "the right of every citizen to enjoy a pollution-free environment", according to the subsidiary role of the State that the same constitution establishes, the State cannot intervene in those sectors which are "regulated" by the market because it would be violating the principle of free competition. For this reason, one of the main threats facing wetlands is the liberalization of urban land which transforms urban land into a commodity, tradable in the market.

In Chile, it was not until 1994 that Law 19.300 on the Bases of the Environment was promulgated, which came to regulate the right to live in a pollution-free environment that the Constitution guaranteed, advancing towards "the protection of the environment, the preservation of nature and conservation of environmental heritage" (BCN, 1994). With this, management instruments, emission standards and the first environmental remediation plans were set, and the National Environment Commission (CONAMA) was created as a proactive organism responsible for consultation and inspection on environmental issues before the Presidency of the Republic. Over time, awareness of the urgency of a consistent and comprehensive environmental policy was gaining ground in broad sectors of society, which clearly saw the inadequacy and insufficiency of current national regulations. This motivated the first government of Michelle Bachelet to update environmental regulations, transforming Conama into the Ministry of the Environment (MMA) in 2010 (Santa Cruz, 2018). In that same vein, previously, in 2005 the National Committee of Wetlands had been created, which is currently led by the Ministry of the Environment.

This inconsistency between decisions, commitments, announcements aimed at one direction, and a regulatory framework whose logic points in the opposite direction, could explain why the implementation of the initiatives that respond to these decisions and commitments does not seem effective to ensure the preservation of fragile environments on an urban scale. For example, "in 2017 the Chilean State ratified the agreement of the XXI Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change that was held in Paris in 2015" (Santa Cruz, 2018b), accepting the obligation to reduce its intensity of emissions per unit of GDP by 30% by 2030 - and up to 45% in the case of receiving international support - including the afforestation of 100,000 ha, mainly of native forest. Nevertheless, at the same time the State does not take responsibility for the environmental sacrifice zones in Mejillones, Tocopilla, Quintero-Puchuncaví, Til-Til and Coronel - in which some 230,000 people live. Not only are there a lack of tangible environmental alleviation plans and in-depth research papers on the concrete effects that industrial poles found in the territory have had on the health of the population; but the decisionmakers have continued to pass productive and industrial projects in these places.

The above can be explained from two different perspectives. On the one hand, "territorial planning" in Chile, is not properly planned and is only limited to define the zoning and to specify the requirements and procedures necessary to obtain the construction and operation permits. Plus, its activity is reactive in general; that is to say, unlike in the academy, this planning does not foresee scenarios, but operates on the go, according to the circumstances. On the other hand, the update of the environmental legislation in force, only rules on future projects, not on those that are already being executed; this means compensation or sanctions are not foreseen for the pollution of past decades, but at most the current emissions that exceed the norm are fined; in other words, there can be an oil

refinery, a thermoelectric plant, or a steel mill polluting the adjacent wetlands or poisoning the population, and there is very little that the health inspection authority can do about it if those industries have valid permits and their emissions are within defined standards - which are quite flexible, by the way.

Notwithstanding the above, recently in 2018 the Chilean Senate took the first step towards new legislation that recognizes these spaces and protects them as urban wetlands, in an effort to resolve the legal vacuum that exists in their regulation - specifically in relation to urban wetlands, which are also those that are currently under greater threat. In fact, for the first time an official definition is included, according to which: urban wetlands would be those extensions of marshes, swamps, and peat bogs, or areas covered with water - whether natural or artificial, permanent or temporary, stagnant or current, sweet, brackish or salty, including extensions of sea water, whose depth at a low tide do not exceed 6 meters, and which are within the urban radius.

The proposal also obliges the Municipalities to establish the minimum criteria for the rational use of existing urban wetlands within the limits of each commune, through ordinances; this is one of the most urgent aspects, since the main threat is the uncontrolled urban expansion that the country has experienced in the last 40 years. At the same time, it incorporates the obligation for all projects or activities likely to cause some environmental impact to undergo the environmental impact assessment system - in any of its phases - including the execution of works, programs, or activities that may bring physical alteration to wetlands that are within the area of an urban radius and which imply their eventual destruction, filling, drainage, or drying.

As a summary, more than 100 years after the first urban planning instrument for Concepción was issued, after having destroyed, dried, and filled an important part of the area of wetlands of the Metropolitan Area to build industries, residential districts, highways, airports, supermarkets, malls, schools, and universities - among other activities - a step is finally taken in the right direction for the preservation of these environments. This is a first step which must be followed by many others in order for the State to assume its responsibility in ensuring the sustainability of the Penquista territorial system over time, and so, being able to improve the intrinsic capacities of the territory and to contribute to its resilience, as the fore coming scenario is uncertain.

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Chapter 16. "Water and population" and "food sovereignty is also resilient farming". Two resilience cases frim Ecuador.

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1. Water and population

Another important resource to consider is water. Its use allows to generate transformation. Water is the counterfoil of culture and the basic support for human life; water is the key liquid for the material and cultural well-being of societies all over the world, its existence is a sign of abundance and prosperity, and its absence has originated poverty, destruction and death. This resource is under threatening due to increasing pollution. The paradox is that, even when two third parts of our planet are made up of water, nowadays we face a serious shortage of this resource.

According to the Word State report, 2002 from all the water existing in the planet only the 2.5% is not salty, and from this only a 0.3% is available in rivers and lakes. Evidently water resources in the planet are limited what together with the high levels of consumption and usage in production activities constitutes one of the indicators of the current ecological crisis: water resource depletion. Of all the crises human beings have to face, be them social or relative to natural resources, the crisis of water is the one defining our survival and that of our planet

All over the world, water consumption by humans is divided, as a tendency, as follows: 70 % for agricultural irrigation, 22 % for the remaining industry, and 8 % for domestic use. With the growth of population, industrialization, and with the use of water at a worldwide scale grows also the demand on the part of the industry and the individuals, and given the current level of consumption, the problems of water shortage will be become problems of food supply.

Traditionally water has been considered a limited resource, but the diverse problems of the water crisis found in different parts of the world have made us aware of the depletion of this resource, due to its exploitation to much bigger index than that of its natural renovation. In the specific case of the underground water, the volume that is extracted implies a pressure for the aquifers. Water is a natural unique resource, it is indispensable not only for the man, but it is also an essential resource for diverse forms of animal and plant life in our planet. Water constitutes an essential part of any ecosystem, in qualitative and quantitative terms.

1.1. The parameters in water quality

To determine the quality of consumption water in the urban and rural areas of Quevedo canton, methodologies adjusting to our way of doing similar researches have been

compiled, based on the accuracy of sample selection and on the analysis made in laboratories approved according to quality norms. Three categories of physical analyses were made. The first consisted in analyzing the temperature, dissolved solids and suspended total; second, chemical analyses consisted in determining the pH, chlorides, nitrates and total phosphates, finally, microbiological analyses considered the total and fecal coliforms. Water simple analysis was carried out at Chemical Laboratory "Marcos", following as reference methodology the Standard Methods 2012, 22nd edition. Temperature parameters (source INHAMI-INIAP) were measured in situ; pH for analysis was obtained using calorimetry

Depending on the values obtained in the analysis of water, each evaluated parameter is contrasted with the permissible ranges established in the National Regulation of Ecuador, published by Ministry of the Environment, 2015). The Ministerial Agreement No. 061, dated on May 04, 2015, reforms the Book VI of the Secondary Environmental Legislation Unified Test (TULAS). Annexes are issued through the Ministerial Agreement No. 097-A, dated on November 04, 2015. The regulations of the 1994 Mexican Norm for human consumption water by the Secretariat of Health 1994 and the WHO Guide 2008 have also been considered. They are detailed in Table 1.

Table 1. National and international environmental norms

Classification	Parameters	Measurement unit	Annex 1, Book VI Environmental Quality – Agreement 097 TULAS					Mexico 1994. Water for human consumption	OMS, 2008
			Human and domestic	Wild aquatic life in sweet waters	Agriculture irrigation	Use in animal husbandry	Recreational purposes		
PHYSICAL	Temperature	°C	---	---	---	---	---	---	---
	Total suspended solids	mg/L	---	---	---	---	---	---	---
	pH	pH units	6-9	6,5-9	6-9	---	6,5-8,3	6,5-8,5	---
CHEMICAL	Chloride	mg/L	---	---	---	---	---	250	200-300
	Nitrates	mg/L	50	13	---	50	---	10	50
	Phosphates	mg/L		---	---	---	---	---	---
MICROBIOLOGICAL	Fecal coliforms	NMP/ 100ml	1000	---	1000	1000	200	Absence	Absence
	Total coliforms	NMP/ 100ml	---	---	---	---	2000	Absence	Absence

Source: The authors

The determination of water quality is based on the analysis of the physical, chemical, and microbiological parameters, according to Brown's methodology, developed by the National Health Foundation of the USA (NSF) and the North American index, Dinius (1987) quoted in Baque (2016), by means of the geometrically weighted average equation (Equation 1) and the weighted weight (Table 2).

$$\text{ICA (NSF, Dinius)} = \left(\prod_{i=1}^{n} Q_i\right)^{W_i} \qquad \text{Equation (1)}$$

Where:

n : Number of parameters

Q_i: *Scale of quality, it is the parameter i sub-index*

W_i: Relative weight assigned to parameter i depending on the influence of water quality

Temperature: NSF and Dinius 1987 use the difference between room temperature and water temperature ((ΔT=T_room-T_Water) expressed in °C

Table 2. Weights weighted for physical, chemical, and microbiological parameters for ICA Dinius and N

Parameter	Water Quality Indexes (Weighted weights)	
	NSF	**Dinius (1987)**
Nitrates	0,10	0.090
Temperature)	0,10	0,077
DBO	0,10	0,097
pH	0,12	0,077
Fecal coliforms	0,15	0.116
Dissolved oxygen (%)	0,17	0,109
Turbidity	0,08	-----
Total dissolved solids	0,08	-----
Phosphates	0,10	-----
Total coliforms	----	0.090
Chlorides	----	0,074
Color	----	0,063
Electrical conductivity	----	0,079
Alkalinity	----	0,063
Hardness	----	0,065

Source: (González, Caicedo, & Aguirre, 2013)

The indexes of water quality were related to the qualifications proposed for every index NSF and Dinius. Once the ICA averages are obtained, it is possible to do a statistical correlation with the "t" test of Student, whose statistical significance is p = 0,05, to see how the data correlate (Equation 2).

$$t = \frac{\bar{d}-\mu_0}{s_d/(\sqrt{n})} \qquad \textit{Ecuación (1)}$$

Where:

$\mu_0 =$ Hypothetical population and difference average

$\bar{d}$ = The averages of the groups of date to be compared)

$s_d =$ Standard deviation of the differences of the compared samples)

s_d = Samples number

The ICA values obtained are verified against the ranges of quality classification of water to be considered a source of supply for human consumption and thus the quality of the water at every monitored stage is established. Tables 3 and 4 detail the values for water state classification once the analyses have been done.

Table 3. ICA-NSF Values and classification

ICA NSF VALUE	Classification of water quality
90-100	Excellent quality
70-90	Good quality
50-70	Medium quality
25-50	Bad quality
0-25	Very bad quality

Table 4. Classification ranges of Multiapplicative ICA depending on water use according to Dinius (1987)

Human Consumption		**Agriculture**		**Fishing and aquatic life**		**Industrial**		**Recreation**	
Range	**Description**	**Range**	**Description**	**Range**	**Description**	**Range**	**Description**	**Range**	**Description**
90-100	Treatment for consumption is not required	90-100	Purification for irrigation is not required	70-100	Abundant fishing and aquatic life	90-100	Purification is not required	70-100	Any type og water sport
80-90	Minor treatment required	70-90	Minor purification for cultures requiring high quality water	60-70	Limit for very sensitive fish	70-90	Minor purification for industries requiring high quality water	50-70	Immersion sports to be restricted
70-80	Doubtful consumption	50-70	Treatment not required for the majority of cultures	50-60	Doubtful fishing without risks for health	50-70	Treatment not required for the majority of operation industries	40-50	Doubtful for contact with water
50-70	Treatment to make water potable needed	30-50	Treatment required for the majority of cultures	40-50	Aquatic life limited to very resistant species	30-50	Treatment required for most uses	30-40	Contact only with boats
40-50	Doubtful consumption	20-30	Use only in very resistant species	30-40	Unacceptable For fishing	20-30	Use restricted only to Coarse activities	20-30	Visible contamination, avoid nearness
0-40	Unacceptable for consumption	0-20	Unacceptable for irrigation	0-30	Unacceptable for aquatic life	0-20	Unacceptable for any industry	0-20	Unacceptable for recreation

Source: Adapted from León (as quoted in Corporacion Autonoma Regional Valle del Cauca 2004)

1.2. Water Quality in Quevedo Canton

The average concentrations of the parameters (water temperature total suspended solids, pH, chlorides, nitrates, phosphates, fecal and total coliforms), suspended solids and chlorides, at a temperature of 27,42 ºC are in the permissible ranges.

The pH remains at 6,92 a normal value for water according to the pH scale. As Jiménez mentioned in (Perez Lopez, 2016) states, the pH is an important operative parameter of water quality. Very acid waters dissolve the metals used in conductions (lead, copper, zinc), which, when consumed, negatively affect health. According to Galvin mentioned in (Perez Lopez, 2016), for human consumption waters, the extreme values can cause irritation in the mucous membranes, irritation in internal organs and even ulceration processes.

The content of chlorides in the water is in a range of 2,58 mg/l, that is why these waters are classified as normal chlorinated waters by (Rivera, Encina, Muñoz, and Mejias, 2004) in their study Quality of the Waters, the values of chloride are under the permissible limit, (table 5).

Table 5. Physical, chemical and microbiological parameter concentrations

Classification	Parameters	Measurement unit	Average consumption in rural area
Physical	Temperature	° C	27,42
	T. Suspended solids	mg/L	27,665
Chemical	pH	pH units	6,915
	Chloride	mg/L	2,58
	Nitrates	mg/L	2,36
	Phosphates	mg/L	1,155
Microbiological	Fecal coliforms	N.M.P./100ml	6423,335
	Total coliforms	N.M.P./100ml	58370

The indexes of water quality (ICA) have been promoted in order to contribute to the reports on water condition to the society (Espinal Carreon, Cedeño Diaz, and Lopez Lopez, 2013). Water contamination has a great impact both on health and environment Morel and Hernandez quoted by (Perez Lopez 2016). The valuable concentration of undesirable components (e. g. chlorides, nitrates, and heavy metals) limits the viability of the liquid and increases its toxicity, what makes the study of pollution, the measurement its effects and the control of its evolution important aspects for quality considerations. The application of the ICA Dinius and NSF is very important in determining the quality of surface water, since they consider accurately chosen parameters demonstrating the environmental condition of water on the basis of ranges and criteria, The ICA in the north zone demonstrates that in the sector 3 according to Dinius (1987) methodology and NSF the water is slightly contaminated

(75,40) and of bad quality (41,15). The ICA in the south zone presents acceptable indicators and is considered of medium quality (Table 6).

Table 6. Water quality in the rural area in Quevedo canton.

Water quality in the rural area in Quevedo canton								
North Zone					South Zone			
Sector	ICA Dinius (1987)		ICA NSF		ICA Dinius (1987)		ICA NSF	
1	86,71	Acceptable	58,00	Medium Quality	78,55	Acceptable	49,52	Medium Quality
2	85,30	Acceptable	63,11	Medium Quality	91,76	Excellent	56,60	Medium Quality
3	75,40	Slightly Polluted	41,15	Bad Quality	92,15	Excellent	64,88	Medium Quality
Total	247,41	Total	162,25	Total	262,46	Total	171,01	
Average	82,47	Average	54,08	Average	87,49	Average	57,00	

As we observe in table 7, the excess of iron and manganese is obvious in the four zones. They adhere to the pipelines and reach 2 cm thickness. Probably, this is due to lack of systematical treatment to the well.

Table 7: Parameters for the quasi-microbiological applications of the consumer, 2018

Parameters		Zonas Zones				Norms			
		North	South	East	West	Ministerial agreement 028	OMS	EPA	INEN 1108:2014
PHYSICAL	Temperature ºC	27,9	26,8	27,8	27.7				
	Apparent color UCIPt	46	< 10	48	10	75,0		15	15
	NTU Turbidity	6.81	1.15	6.40	1.21	100	5		5
	Total dissolved solids mg/l	128	188	130	182		1000		
CHEMICAL	Dissolved oxygen mgO2/l	0,80	0.82	1.09	3.49	1.03	1		
	pH	7.10	7.10	7.12	7.20	6-9	7.1	6,5-8,5	
	Hardness mgCO3Ca/l		108.8	107.4	86.2				
	Manganese mg/l		0.4088	0.4383	0.2753				
	Iron mg/l	0.7380	0.1680	0.7380	0.2990				
	Residual chlorine mg/l	2.02	5.88	2.78	6.82			250	0,3-1,5
MICROBIOLOGICA	Total coliforms NMP/100ml		54.80	> 2419,6	224.70	20000			
	Fecal coliforms NMP/100ml	< 1,0	< 1,0	1.0	< 1,0	2000			<1,1

After the analysis of grouping between physical and microbiological parameters, we observe three groups of cluster. The first one is considered to be the point of minor pollution, the second one with average pollution, and the third, moving away from the rest, is that of major pollution. With less distance among themselves, parameters iron and apparent color, move away from other groups and are considered to be the parameters most influencing water quality (Figure 1)

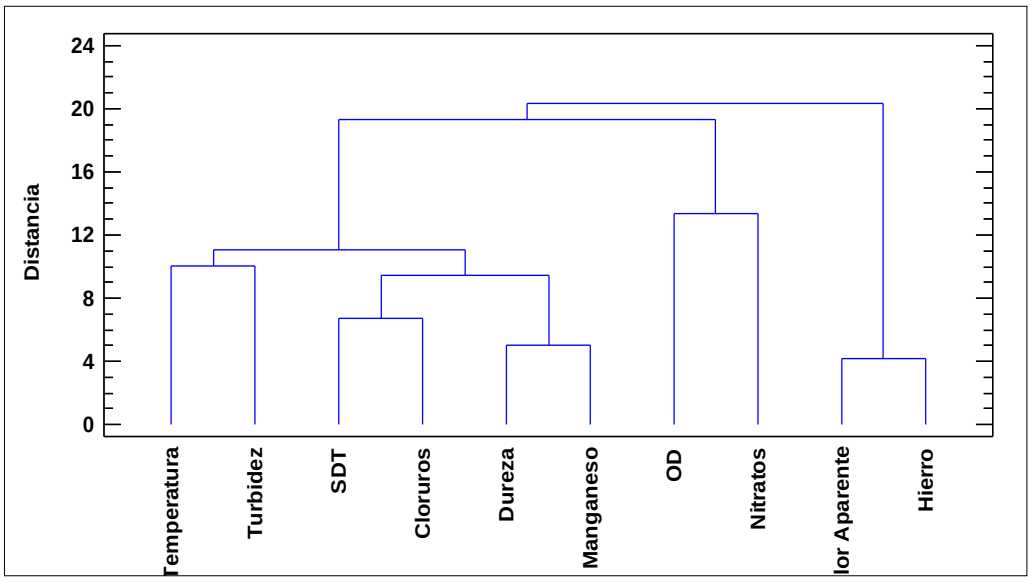

Figure 1. Dendogram of PHYSYCAL, chemical, and microbiological parameters

1.3. Conclusions

The water consumed by the people in Quevedo, according to the quality indexes established by Dinius (1987) to the north zone presents criteria of " acceptable and slightly contaminated " and according to the ICA NSF for four zones the criteria are of " medium quality ", what can be observed with the application of the GWQI. The low concentration of fluoride directly influences water due to the high relative weight that it possesses as compared to other indicators, therefore the quality standards of the water do not comply with the regulations established for the parameters apparent color, turbidity and iron. It becomes necessary to apply governmental management that would guarantee water of excellent quality for the city of Quevedo.

2. Food sovereignty is also resilient farming. The corporate food regime, and is relation with climate change

Within the ambitious agenda 2030, SDG2 target established to end hunger, through the promotion of sustainable, bio-diverse and resilient small-scale farming systems, that is, a conversion of production systems towards a more sustainable agricultural model. Among the targets set to achieve SDG2, a more conventional challenge is listed, to increase productivity, within the classic paradigm of agricultural modernization, as pushed by the green revolution, and based on industrial farming models. At the same time, SDG13 aims at facing climate change, by setting measures to reduce the risk of disasters, mitigation and adaptation plans, and strengthening education, as well as capacity building.

However, serious doubts arise from the association between resilience and industrial farming, if we consider the impacts produced by the latest in terms of food insecurity and environmental degradation at global level. Genetic loss, water pollution, soil fertility reduction, deforestation, GHG emissions, massive energy consumption, are just a few examples of the impacts of the industrial farming model, which has been imposed as universal remedy against hunger and poverty, and widely spread over the agricultural lands of Northern Countries, as well as in the Global South.

The Green Revolution was first introduced in the 60s, and then updated by many innovation waves, till the most recent “new green revolution” relying on biotechnology. Since its origin, the attempt was made to impose the Green Revolution as the only possible “modern” agricultural model, despite its impacts, not only on food contamination and environmental degradation, but also on poverty of both, rural farmers, whose production systems became non-viable, and urban citizens, affected by the increase of food prices.

The current food system has been defined as “corporate food regime” (Friedmann, 1987, 2005; Friedman y McMichael, 1989; McMichael, 2009, 2014, 2015), in order to put emphasis on its most important feature, which is the fact of being controlled by large corporations. Initially, the regime was ruled by international Institutions, such as WTO (World Trade Organization), while most recently the free trade agreements (both multi- and bi-lateral ones) took control. States are no longer the most important actors of the global food systems, which are mostly led by corporations that control the food value chains, ruling trade and imposing continent-scale distances between producers and consumers.

The corporate food regime is characterized by extremely high mechanization levels, as well as by the large use of robotics, which causes an increasing cut of manpower (“farming without farmers”). The intensive systems bring GM seeds along, as well as relevant processes of resource concentration (land and water grabbing) and the financialization of rural areas, which in turn, triggers indebtment processes.

In this framework, rather than a right, food becomes another option for business and profits, and for accumulation and guarantee system, whose approach aims at generating the highest profits in the shortest time. Since maximising productivity is the only target, there is no regard for the cost of the impact it may cause. In this kind of systems, production costs spike, and to become competitive, the scale of production must be constantly enlarged too. As a consequence, all over the world –and despite their traditional key role to ensure food security- peasants farming systems undergo increasingly aggressive factors of displacement.

Marginalized and impoverished peoples turn out to be more exposed, and more severely hit by the impact of climate-change related events.

In particular, the productive model of agricultural modernization is based on specialization, implemented by single-crop farms and a strong dependence on market-provided inputs, such as seeds, fertilizers, machinery, energy sources and manpower. In this model, natural resources are not regarded as an asset to be preserved and renewed, but to be exploited for merely productive and short-term purposes.

One such situation explains why the agricultural sector turns out to be a major driver of climate change, and therefore, a priority to be addressed when it comes to mitigation

measures, such as the reduction of GHG and CO2 emissions, change in soil use, deforestation. Its role for adaptation is recognized as well, because the negative effects of climate change, such as droughts and floods, have a direct impact on the food production capacity, and therefore, on the food security of both urban and rural population.
To address the recurring ecological and food crises, and with the declared purpose to highlight the importance of the peasant approach on thinking and making agriculture, over 20 years ago, movements like La Via Campesina introduced the principle of Food Sovereignty. This proposal was based on the claim that peasantry had resisted and replicated itself all over the world, despite the global expansion of aggressively imposed "modernizer" agricultural policies, accompanied by a discourse based on the oppositions between modern vs. traditional, and urban vs. rural
As a matter of fact, still nowadays peasant farming systems are estimated to be more widely practiced than industrial ones, and to produce the majority of the food consumed by the world population.
The principle of Food Sovereignty became popular, while in the same years, all over the world people gained awareness of the ecological issues, as well as of food quality, and of the need to shift to responsible consumption models. As a result, the so-called alternative agro-food-networks gained strength, which are nowadays well rooted over countless territories worldwide. Some examples include agro-ecology, permaculture, organic farming, short chains, solidarity economy, farmers' markets, and territorial food pacts, among others. The majority of these alternatives fairly refer to Food Sovereignty, as a guiding principle, showing the way to escape from unsustainable agricultural models.

2.1. The proposal of food sovereignty: the concept, and its consequences on agriculture and the right to food

2014 has been declared as the International Year of Family Farming, so to promote the visibility of family farming, and positioning it again "at the centre of agricultural, environmental and social policies in the national agendas by identifying gaps and opportunities to promote a shift towards a more equal and balanced development".

More than 500 million family farming units exist in the world. They include a huge variety of small- and medium-scale actors, encompassing peasants, indigenous peoples, pastoralists, artisanal fisherfolks and groups of gatherers. In many regions of the world, family farming is responsible of most of the food produced and made available. Family farming systems not only offer a balanced diet, it also contribute to the conservation of the food habits, and the agrobiodiversity within the regions concerned.

In particular, in Latin America and the Caribbean region, family farms account for 80% of the total farm land, involving more than 60 million people. Family farming is the main source of rural employment in the whole region, and produces most of the food for domestic consumption.

The principle of Food Sovereignty as launched by "La Vía Campesina" international movement in 1996 - on the occasion of the FAO World Food Summit – recognizes and highlights the role of the food systems based on family, peasant, indigenous and fisher folk producers. It sets the goal to defend and strengthen them, as suppliers of local systems, providing healthy and culturally appropriate, food, while preserving the natural environment.

The difference between the concept of food security and food sovereignty, basically lays in the possibility to decide on food production models. It does not claim only for the right to have access to food, but also to the food production resources, within local systems that

respect the peculiar ecological, social and cultural conditions of peoples, and of the territories they inhabit.

At the International Forum on Food Sovereignty held in Nyeleni, Mali, in 2007, Food Sovereignty was defined as "the right of all peoples, nations and states to determine their own food producing systems and policies, that provide every one of us with good quality, adequate, affordable, healthy and culturally appropriate food"

A few elements can be told, as key-features of agriculture, within the framework of food sovereignty:

1) a peasant and small-scale centered approach;

2) diversification, agroecology, respect and renewal of the natural resource base that nourishes the production cycles (land, seeds, water, etc.), preservation and enhancement of local agrobiodiversity and local knowledge;

3) re-territorialization: that is, the food chain is short, and it is shaped based on the territories, considering the potential and the identity of each local system;

4) promotion of virtuous economic circuits, reducing intermediaries between producer and consumer groups, and fuelling rural-urban alliances.

The proposal of food sovereignty is opposed to agro-industrial monocultures and to the massive use of pesticides. It aims at reducing the distance between producers and consumers, and at guaranteeing equitable access to productive resources (land, water, seeds, capital, technical assistance, etc.). It defines the quality of food on the basis of its nutritional properties, as well as of the social and environmental impacts caused by its production. The capacity to adjust to the food identity of each territory is another key feature.

2.2. Food sovereignty and resilient agriculture

Many types of production systems could be found matching the frame of food sovereignty. They all have common features, such as the capacity to adapt to different ecosystems, so as to preserve and reproduce their biological and cultural diversity, and to diversify productive strategies. It is possible, therefore, to propose them as a solution for both, reducing the causes and impacts of climate change.
In 2014, with the aim of contributing to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), FAO launched a new alarm claiming that emissions coming from agriculture, forestry and fishing had almost doubled in the last fifty years and that "they could increase by an additional 30% by 2050, unless a major effort to reduce them was agreed".

The main sources were listed, including the emissions generated by enteric fermentation (CH4 produced by livestock), the use of synthetic fertilizers, methane emissions generated by biological processes in rice fields, wild fires burning savannahs and the use of fossil fuels (including electricity and fossil fuels for agricultural machinery, irrigation pumps and fishing vessels).

The International panel of experts on Climate Change (IPCC) estimates that agriculture is responsible for about 14% of total GHG emissions, however, this percentage does not include "indirect emissions from agriculture", that is, for example, the energy spent to produce fertilizers, agricultural machinery or transport (of both inputs and harvests). Likewise, the emissions resulting from the change in land use generated by agriculture are not accounted for. Considering all those factors the percentage of GHG produced by the agricultural sector could very well double.

These facts explain the need for a transition to those agri-food systems living in harmony with nature, addressing the causes of CC and, at the same time, allowing to strengthen the adaptation capacities.

Food Sovereignty leads to the resilience of the agri-food systems, with positive effects on the food security of rural and urban populations. However, it is not only a matter of raw materials, but of food, going beyond production, so to address transformation and consumption as well.

In fact, the climate impact of food is not generated only at the production level. High energy costs and contamination rates are associated to transformation by hyper - industrialized farms, and to trade over extremely long distances. This is why according to various authors, if we want to counter climate change, while strengthening mitigation and adaptation capacities, "changing the industrial model of production and distribution is of utmost priority" (Various authors, 2010: s/n).

If we agree to define resilience as the "ability of an individual, family, group or system to be prepared for, absorb and recover from the effects of an adverse event, without compromising (and possibly improving) their future prospects", the agro-food issue becomes undoubtedly an enabling factor for world population to tackle this challenge, being food vital for the reproduction of every single human being, in all ecosystems.

In this regard, peasant and indigenous family farmers - as acknowledged by the food sovereignty approach - undoubtedly represent a virtuous model, inspiring an agro-ecological transition able of mitigating global warming, as well as our adaptation capacity.

These farm models are characterized by limited access to resources (such as land, water and capital). As a consequence, they must search for high levels of self-sufficiency, in order to make sure that inputs, tools, work force and technical knowledge are maintained. An extreme care for the sustainable use of the available resources becomes essential, not so much because of a natural environmental responsibility, as because of the scarcity of the available resource base. In similar conditions, the ability of safeguarding the resources necessary for the on-going productive cycle, while preserving them for the future ones becomes vital.

For example, the maintenance of soil fertility becomes strategic, as well as the ability to breed and improve seeds at farm level. According to the “peasant” small producer approach, not all the production is sent to the market: one part is left for family-consumption, and another part is set aside to start future production cycles (e.g. selection, reproduction of seeds).

For the international movement Vía Campesina (s / f), the original promoter of the food sovereignty proposal, small-scale sustainable agriculture is characterized by the fact of generating intensive work and low energy consumption, therefore contributing to cooling the planet through: (1) a greater capture of organic Carbon and Carbon dioxide in the soil, obtained through sustainable production, and also through mixed crop-livestock farming, an alternative to industrial livestock farming; (2) agro-ecological practices for soil management and soil fertility, an alternative to industrial fertilizers; (3) the production of biogas from animal and vegetable waste, maintaining sufficient organic matter in the soil; (4) the production of solar energy and other renewable sources. (5) preservation and recovery of agricultural biodiversity, at the same time counteracting genetic erosion driven by global warming, and providing species and varieties more adapted or resistant to adverse events; (6) integrated forests management; (7) diversified, small-scale and agroecological production, and fostering local markets.

Diversifying productions, recovering and preserving agricultural biodiversity and fostering the right to access agro-biodiversity by indigenous and peasant communities, provides opportunities for the production systems to both mitigate and adapt to climate change.

In other words, in order to assess the efficiency and productivity of certain agri-food systems, it is necessary to take into account not only the harvest amount, but also the vulnerability to adverse events. It will increasingly be needed to diversify risks, and to adapt to the climatic changes affecting the productive systems.

In this framework, it is possible and even urgent to strengthen the resilience and resistance capacities of peasant and fisherfolks, as well as of the entire consumers community: as Wendell Berry affirms, "eating is an agricultural act". Our choice as consumers is the key, in determining what kind of food is produced, and how.

This kind of increased resilience in agriculture could be achieved through supporting small scale agriculture. It requires more workforce and absorbs less energy, being based on production diversification, agroecological practices for the production and processing of healthy food, within food systems strongly rooted in the territories.

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Chapter 17. Drought Management Plans in urban supply systems in Spain. A resilience tool for drought management

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Introduction

Drought is defined as a transitory anomaly characterised by below-average rainfall in a given area for a long period of time (Pita 1989). These events may (or may not) lead to shortages in water supply which largely depends on demand and the characteristics of current water management and exploitation systems. Drought may have an immense impact when below-average rainfall leads to a decrease in annual pluviometric levels and shortcomings in the necessary volume of water for irrigation, human consumption, and ecosystem preservation (Morales et al. 2000). In Spain, drought is a recurrent phenomenon. A drought or quasi drought takes place approximately every ten years. Moreover, forecasts related to climate change indicate that in the future, the frequency and intensity of droughts in Southern Europe will increase (IPPC 2014) and Spain is highlighted as one of the most vulnerable countries in terms of water scarcity (EEA 11 2012).

In recent years, the European Commission and the European Environment Agency have published a series of reports on the consequences of climate change in regards to its effect on water scarcity and drought. These reports confirm that this issue is one of the main challenges posed by climate change in the short and long term (EC 2007, EEA 2/2009, EEA 11/2012, EEA 2/2015, EEA 1/2017, and EEA 15/2017). These consequences are especially concerning for cities, as they greatly affect urban water supply. This is corroborated formally by numerous basin organizations and public entities responsible for urban supply through of the “Paris Pact on Water and Adaptation to Climate Change in the Basins of Rivers, Lakes, and Aquifers” promoted in the framework of the COP21 held in Paris in December 2015.

Traditionally drought management strategies have considered these phenomena as natural events for which little or nothing can be done. This viewpoint regards droughts as unavoidable natural disasters, thus risk management strategies are typically reactive

in nature after the impact has already been felt (Wilhite 2000; UNISDR 2005; WMO and GWP 2014). Repetitive droughts have led to substantial improvements in infrastructure, such as water reservoirs, interbasin transfers, desalination plants, and underground water surveys. It has influenced the normative and especially the development of drought-oriented strategies and tools. In this sense, the approval of the National Hydrological Plan Law (PHN) in 2001 was an important breakthrough, at least in the normative corpus. The PHN establishes the obligation to develop drought plans, such as the preparation of territory-specific special drought plans and urban-supply emergency drought plans. Despite the important advances in drought risk planning on river basin districts and in large urban-supply systems, there are still large remaining problems in small and medium-sized municipalities, which are also the most vulnerable to drought.

Climate change and droughts in a context of severe water stress

Precipitation is the most important climatic element in Spain, both from a climatic point of view and in its consideration as a resource, given its limited levels in a majority of the territory and its high temporal and spatial variability (De Castro et al. 2005). Although, average annual precipitation is 650 mm (series 1981-2010), rainfall in Spain presents a great inter-annual, seasonal and spatial variability (Martín-Vide 1996). The inter-annual variability reaches up to 20% difference in the Mediterranean regions and the Canarian archipelago. On the east coast, the variation in annual precipitation reaches 40%. This inter-annual variability is caused by diverse patterns of the general circulation of the atmosphere in the northern hemisphere, among which the so-called North Atlantic Oscillation (NAO index) stands out (De Castro et al. 2005). Besides, precipitation tends to be concentrated in spring and winter and is close to non-existent during the summer months (www.aemet.es). Regarding variability, the highest amounts of precipitation are concentrated in mountainous areas and areas exposed to humid Atlantic flows, with a gradual decrease towards the south, which increases as we get closer to the southeast (Olcina 2006). This distribution of rainfall has led to the traditional regional distinction between "wet Spain", where the annual rainfall exceeds 800 mm/year and “dry Spain”, where the average rainfall is between 300 and 800 mm/year. The transition from "wet Spain" to "dry Spain" takes place through a transition zone in which rainfall decreases from north to south and from west to east, staying around 600-800 mm/year. Finally, the "Arid Spain" corresponds to those places that receive less than 300 mm/year and are located mainly in the southeast of the peninsula.

Additionally, the appearance of drought is a recurrent phenomenon in Spain which has already increased since the 1970s (Vicente 2006). The most severe episodes in terms of economic losses took place in 1941-1945, 1979-1983, 1990-1995, 2004-2008 and 2015-2017; these drought events affected virtually the entire Spanish territory. In addition to the natural variability of rainfall in Spain and the recurrent appearance of drought episodes, predictions related to climate change indicate that the frequency and intensity of droughts may increase in Southern Europe in the future (IPCC 2014). In Spain's specific case, regional climate change models indicate a reduction of water resources throughout the peninsula, somewhat more intense towards the South and in the archipelagos and a lesser impact in some areas of the peninsular East. This decrease in the availability of resources will result in an increase in the scarcity of water resources to meet water demands. In addition, a change in the drought regime is predicted. Most of the climate projections show a future in which droughts would be more frequent and intense, magnifying along the 21st century and thus increasing the exposure to drought in the future (CEDEX 2017b).

Although in Spain it rains enough to satisfy water demands (Olcina 2008), the variability of rainfall is combined with an increasing water demand for different uses (Quiroga et al. 2011). The level of pressure to which water resources are subjected in the ordinary hydrological planning determines the hydrological response of the system when a drought occurs and therefore, the sensitivity of the system suffers effects. The greater the pressure on water resources, the more difficulties there will be in meeting demands when the availability of resources decreases because of drought. The Water Exploitation Index (WEI) is a widely recognized indicator to characterize the level of pressure on water resources of specific territory or river basin (EEA 2012). This indicator relates the total use of resources (consumptive and non-consumptive) with respect to total renewable resources, expressed as a percentage. According to Eurostat, WEI values below 10% imply that the analysed system is not subject to water stress, if the value of the indicator is between 10-20% it implies a low level of water stress, if the indicator exceeds 20% it is considered that the system has reached the alarm level due to water stress, while if it exceeds 40% the system is considered as having severe stress. Another very similar indicator is WEI+ (which can be considered an evolution of the first) in which the total of resources consumed (consumption minus returns) is related to total renewable resources. According to CEDEX (2017) all Spanish river basin districts exceed WEI+ values of 31%. This value places the whole country on alert for water stress.

1. Drought management in Spain. Towards drought risk planning strategies.

Due to the intensity and frequency of drought events, Spain has a lot of experience in dealing with these risks. This experience can be framed in two different approaches. On one hand, traditional drought-management strategies have considered these phenomena as exceptional events and causality has been associated with nature. From this point of view, drought responses have been largely reactive: constructing infrastructures to increase the availability of water and distributing monetary compensation for losses and damages incurred. This is the *crisis management approach* (Wilhite 2000; UNISDR 2005; WMO and GWP 2014). As the Spanish Ministry for the Environment itself recognises (http://www.magrama.gob.es/), drought management in Spain has been dominated by a crisis-management approach. Perceptions about drought as an extraordinary event and insufficient rainfall are key to gaining a good understanding of drought management and hydraulic policy in general, in Spain from the mid-19th century onwards. The traditional division between "Humid Spain" and "Dry Spain" has often been used in hydraulic policies which aim to redress territorial and seasonal unbalance in water supply through the construction of major infrastructures, such as reservoirs and interbasin transfers (Arrojo 2003; Arrojo and Naredo 1997; López Ontiveros 1998; Naredo 1997a, 1997b; Ortega Cantero 1992). However, although the correction of territorial unbalance was the flagship of 'regenerationist' policies on water management, on which abundant literature, both national and international, exists (Gómez and Ortega 1987; Orteg 1992; Arrojo 2003; Naredo 1997a, 1997b; López 1998; Saurí and Del Moral 2001; Swyngedouw 1999, 2000). These ideas sprang up in the first place due to the recurrence of drought; furthermore, drought needs to be alleviated in order not to imperil progress and development, which was the paradigm's declared objective. In this sense, the construction of reservoirs and interbasin transfers can be argued not only to redress territorial differences, but to reduce the vulnerability of the system by making it flexible and adaptable by the 'common pooling' of resources.

However, as pointed out by Naredo (1997), what was originally conceived as a method to redress territorial unbalance in terms of water supply, ended up turning major infrastructures into the solution during conditions of scarcity that were, and increasingly became, a social construction. Within this paradigm —which is characterised by poor control over the use of the resource and little responsibility for costs— the resource is conceived as a heavily subsidised productive input which, along with other social and

political aspects, served to legitimise traditional hydraulic policies (Del Moral 1996). This forms a sort of vicious circle between low-cost supply (guaranteed by the state-sponsored construction of new supply infrastructures) and the emergence of new conditions of scarcity caused by bad management and the disproportionate use of the resource, which again legitimises the construction of further infrastructures as the only way to deal with the new situation of scarcity. In this regard, what we often call drought is nothing but the end result of policies aimed at constantly increasing the availability of water (Estevan 2003).

From crisis management approach, the institutional response to drought in Spain is materialized through reactive and emergency measures through the approval of Royal Decrees (RDL). These RDD's are justified in the alarm situation and covered by the declaration of "general interest". They establish reactive measures once the impacts have appeared: subsidies for losses, mainly in agriculture and livestock, restrictions on uses and the construction of new infrastructures to increase water supply (Del Moral and Hernández-Mora 2017). In a situation characterized by productivism and intervention in hydrological systems, for years not only the reactive approach of drought management has been consolidated in Spain, but the appearance of each dry period has been used to justify, legitimize and strengthen the consolidation of water supply policies and the construction of infrastructures, as the only viable solution to address water scarcity (Paneque 2015).

Due to the increase in losses due to drought, and despite the efforts made to mitigate its impacts, in the last decades of the last century, the effectiveness of reactive approaches to deal with droughts began to be questioned (Knutson et al. 1998; Wilhite et al. 2000). The main critiques of this approach are: (i) the ineffectiveness of the reactive approach to reduce the losses associated with droughts; (ii) the limitation of solutions to technical aspects in whose design there is no evaluation of alternatives or participation of interest groups; (iii) lack of capacity for reaction and adaptation through application of emergency measures once the event has been presented; and (iv) the emphasis on impacts rather than the underlying causes that determine them (Knutson et al. 1998; Wilhite et al. 2000; Iglesias et al. 2007; Kallis 2008). In this sense, at the turn of the 21st century, a new approach to deal with drought emerges. This approach is called the *risk management approach* (Wilhite et al. 2000) and is oriented towards the preparation, prevention and mitigation of impacts, which focuses on adaptation to drought and not so much on emergency response (Knutson et al. 1998). While crisis

management only addresses the symptoms of drought as they manifest themselves in the impacts, risk management focuses on identifying where the vulnerabilities are (sectors, regions, communities or population groups) and systematically implements mitigation and adaptation measures that reduce the risk associated with future droughts. The risk management approach has been the central element of the main strategies and guidelines developed by international organizations for risk drought adaptation: *Drought Risk Reduction. Framework and Practices* (UNISDR 2009), *Guidelines for a national drought management policy* (WMO and GWP, 2014), or *Water resources in Europe: how to cope with water scarcity and drought* (EEA 2010). The main tools presented by this approach are drought management plans, which are based on monitoring and early warning systems, which make it possible to predict, detect, and monitor the drought and thus implement different measures to be taken as the drought progresses. In addition, this approach requires the integration of these types of events within the hydrological planning, accepting the normality of the occurrence of droughts, the questioning of water supply policies and the integration of communication and environmental education. In Spain the institutions recognized, albeit with some reluctance in practice, the need to adopt new approaches based on risk management (Paneque 2015).

Considering the infectiveness of reactive approach to deal with drought as well as the assumption about the normality of drought in the Spanish climate and the projections provided by climate change models on the increase in the frequency and intensity of droughts, it can no longer be regarded as an extraordinary event. Coinciding with the arrival of the new century, the need to reorient the management of droughts towards risk management strategies is recognized in the institutional sphere, although with certain reticence still in practice (Paneque 2015). Three milestones represent the paradigm shift in Spain: 1) the experience of the 1990s drought with more than 25% of the population of the country affected by supply restrictions; 2) the entry into force of the Water Framework Directive (WFD) in 2000, as well as its transposition to the Spanish legal system through Law 63/2003 of November 30th. WFD introduces important changes in the objectives of water resources management, moving from quantitative aspects, towards qualitative role of get good condition of all the water bodies. Despite extreme weather events (as drought) is not one of the priority objectives of the WFD (nor does it incorporate any article specifically addressing the relative aspects to its management), establishes that one of the objectives of hydrological planning must be prevent the

effects of floods and droughts (article 1), which is an opportunity to incorporate drought management into planning and carry out preventive, short-term and recovery management (La Calle 2007); 3) the approval of the PHN where referring to droughts and as a novelty in the European context, its article 27 includes the requirement to draw up Special Plans for Action in Situation of Alert and Eventual Drought (PES) and Emergency Plans for urban supply systems of more than 20,000 inhabitants (PEM). This milestone is recognized by the Ministry itself as the turning point that marks the change of paradigm towards the management of droughts as risks and not as crisis (Paneque 2015).

2. Drought risk planning in Spain.

Planning means anticipating the problem before this problem becomes unmanageable, by identifying strengths and weaknesses and avoiding, as much as possible, crisis-driven contingency measures. However, the notion that these plans may be capable of confronting the problem single-handed, without a serious review of the prevailing water-exploitation model can lead us to a false sense of security. In a country such as Spain, where we cannot predict when the next drought will come, or how severe it will be, but where we are certain that it will come, the only valid strategy for confronting drought is to tackle vulnerability and improve . In order to achieve this, we must: 1) reduce the sensitivity of systems by reducing consumption and adapting planning strategies to the predicted effects of climate change; 2) presume that drought is a normal occurrence, and that the frequency of episodes of drought will increase with climate change; and 3) increase our ability to adapt and respond to this sort of event, that is, increase our resilience.

Drought management plans can be defined as management tools that are based on the establishment of a system of indicators that allows forecasting and tracking of the evolution of a period of drought and thus establish a series of progressive measures while the phenomenon advances. The objective is minimizing environmental, economic and social impacts. As has already been done, according to article 27 of the PHN, drought risk planning and management is articulated through the special action plans in situation of alert and eventual drought (PES) in the field of river basin district and Emergency Plans for urban supply systems (PEM) in the field of urban supply systems of more than 20,000 inhabitants.

Spain, as a member of the European Union and since WFD is in force (2000), the territorial and administrative organization of water management is carried out on the basis of river basin districts, which includes “the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under article 3(1) as the main unit for management of river basins” (definition 15, WFD). In peninsular Spain there are 15 river basin districts, ten of them managed by the Spanish Government, is the case of river basin district that include more than one Autonomous Community (inter-community river basin district) and five of them are managed by regional governments when the area of a given river basin district includes just one Autonomous Community (intra-community river basin district).

PES are prepared by basin authorities in the field of river basin district and must incorporate the main indicators and thresholds that flag each stage of drought (normal, pre-alert, alert and emergency), as well as exploitation rules and the measures to be implemented concerning public ownership of water at each stage (art 27.2 LPHN). PES are an important step forward in conceptual and operational terms, as they aim to evaluate drought objectively and to implement progressive measures with which to prevent droughts from becoming more severe (Estrela et al. 2016). In any case, the first steps of this new policy have suffered from several teething problems:

1) PES were meant to be approved for 2005, but most of them were published in 2007, while first-cycle hydrological plans (2009-2015) were published even later (some of them as much as six years late). These hydrological plans must be incorporated into the drought plans, but there is no guarantee that the targets and measures contemplated in both will be compatible. The late publication and inadequate updating of PES makes integrating current (but out-of-date) PES (2007) and second cycle hydrological planning (2015-2021), published in late 2015, with up-to-date information concerning resource inventories, demand, and especially ecological flows, very difficult.

2) Drought indicators in use are, in fact, indicators of scarcity. While indicators of scarcity may be useful in assessing and comparing supply and demand, they fall short of discriminating between ‘meteorological drought’ (caused by below-average rainfall) and water scarcity related to reservoir and aquifer levels, which depend to a large extent on the management model in place and the usage of water before and after rainfall declined. As such, these plans are little more than contingency plans to address

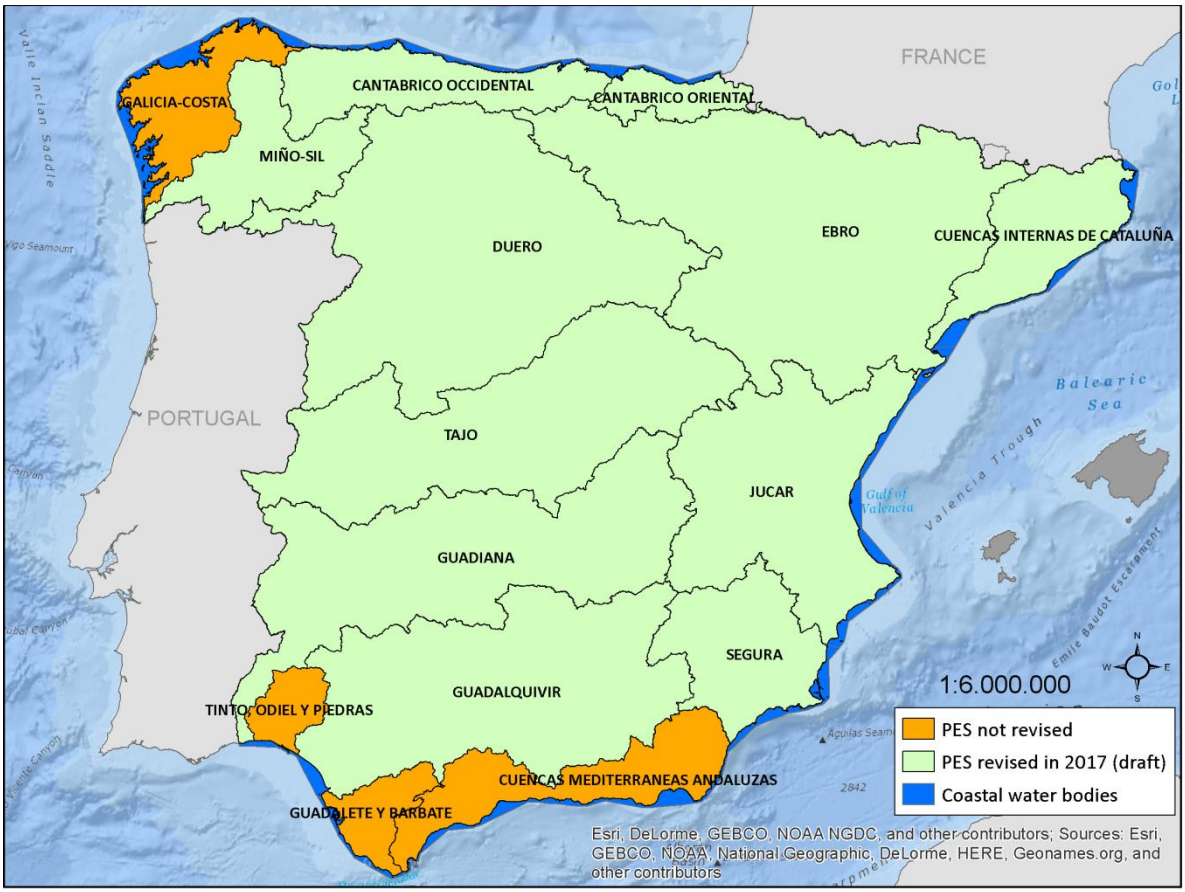
shortcomings in supply, and are largely unrelated to meteorological drought. The WFD permits the temporary deterioration of water bodies, but only in unforeseeable and exceptional circumstances (article 4.6. WFD). Adjusting the indicators to ensure that the reasons behind the deterioration of bodies of water are adequately accounted for is essential for the correct implementation of the WFD.

3) In spite of the important advances introduced by PES, they contradict the fundamental idea of integrating the risk in the management of resources, even during normal phases. As Brufao (2012: 222) states, "they are basically contingency plans with measures to apply when a drought situation has manifested, and therefore with limited to integrate the necessary preventive measures to minimize the negative impacts of droughts in the more general framework of the 'normality scenario', of hydrological planning, that is, within the framework of the studies and drafting of the new River Basin Management Plan in accordance with the FWD".

In 2017, the Agricultural, Food and Environment Ministry (MAGRAMA) published a technical guideline[22] concerning special drought plans and prolonged drought and scarcity indicators (IT), which establish a number of rules for the updating of PES. Certain basin authorities have already published drafts of updated PES (Imagen 1).

Imagen 1 – Administrative status of the PES of the Spanish peninsular river basin districts

[22] Proyecto de Orden AAA/XXX/2017, de XX de XXXX, por la que se aprueba la instrucción técnica para la elaboración de los planes especiales de sequía y la definición del sistema global de indicadores de sequía prolongada y escasez.



(*Fuente: Author´s own*)

The main change proposed by the IT and moving to the revision of the PES is the differentiation between situations of "prolonged drought" with two possible scenarios (prolonged drought or not) and situations of "temporary scarcity" with four possible scenarios (normality, pre-alert, alert and emergency). A prolonged drought represents situations of rainfall decrease that have repercussion in the natural hydric contributions. Temporary scarcity represents a situation where, independently of the cause (climatic or due to a bad management of the resource), a situation of temporary impossibility to attend the demands is identified. The type of actions and the type of measures that are activated in each of the two situations are also different (Table 1). Based on this differentiation, new territorial management units are established, new indicators capable of identifying, evaluating and monitoring the states of prolonged drought and temporary scarcity of time and the establishment of different types of measures for each of the situations or scenarios.

Tabla 1 – Objectives, actions and measures linked to each diagnostic system.

Diagnostic system	Definition	Index's objective	Typology of actions and measures that activate
Prolonged drought	Drought produced by exceptional circumstances or that could not reasonably have been foreseen. The identification of these circumstances is made by using indicators related to the lack of precipitation during a period of time taking into account aspects such as intensity and duration (definition 63. IPH).	Detecting a persistent and intense situation of rainfall reduction reflected in water contributions.	Admission of temporary deterioration of water bodies state due to natural causes. Reducing ecological flow regime.
Temporary scarcity	Temporary scarcity that even allowing the fulfilment of the criteria of guarantee in the attention of the demands recognized in the corresponding hydrological plan, temporarily limits the supply in a significant way.	Detecting the difficulties to attend water demands	Awareness and savings. Supplies restrictions and mobilization of resources. Enabling short-term systems of rights exchange. Increased environmental vigilance. Other management measures or exceptional and extraordinary that may result from application.

(*Fuente: Translated from IT, 2017*)

Moreover, new PES based on article 16 of the IT, allow declaring "exceptional situation due to extraordinary drought". The president of the river basin district may declare the exceptional situation due to extraordinary drought when in one or more territorial units one of the following situations is found: a) warning scenarios that coincide temporarily with the prolonged drought or; b) emergency scenarios that coincide temporarily with the prolonged drought or, without coinciding, are clearly affected after a passage through it.

Finally, the publication of the IT drives the promotion for the development of PEM and requires a diagnosis of the status of the PEM be included in the review of the PES. Drafts of PES published in December 2017 identify 213 supply systems for urban areas with over 20,000 inhabitants, which are required to provide a PEM. Although the deadline for the publication of PES was 2005, only a few have been published and their impact has therefore been very limited. No doubt it is one of the main pending challenges for drought risk management in Spain.

3. Drought management plans in urban supply systems. The pending matter.

The publication of the new PES draft in December 2017 meant that progress could be assessed, regarding PEM. The aim of PEM is to prevent drought from affecting urban supply and thus are only concerned with urban areas. In Spain, municipalities have control of the supply of drinking water to households and on the evacuation and

treatment of wastewater[23]. Where appropriate, consortiums of several municipalities can wield this control and manage urban water supply jointly. Thus, municipalities (or consortiums) in excess of 20,000 inhabitants are responsible for developing the plan of emergency for urban supplies (PEM). This PEM must be coherent and coordinated with the PES of the corresponding demarcation river basin district and must be approved by the corresponding river basin authority.

In Spain there are 8,124 municipalities, but only 2,566 (28%) of them have more than 20,000 inhabitants. However, if we look at the population, that 28% of the municipalities with more than 20,000 inhabitants represent 94.1% of the total population of the country (43,9 million people of 46,7) (National Statistical Institute, INE, 2017). Furthermore, some municipalities that have less than 20,000 inhabitants are taking part in some consortiums which in sum exceeds 20,000 inhabitants and therefore the consortium must develop a PEM which covers their municipalities. In sum, the majority of the population in Spain must be protected against drought in any PEM.

PES ´s drafts published in December 2017 identify 213 supply systems for urban areas with over 20,000 inhabitants, which are thus required to provide a PEM. According to PHN this PEM had to have been drafted and in force by 2005, however due to the delay in the preparation of these plans, in 2007 the Spanish Association of Water Supply and Sanitation systems (AEAS) jointly with Ministry of Environment (MMA) published the "Guide for the preparation of drought plans in urban supply systems" (AEAS-MMA 2007). It was an important resource to advance the risk management approach in urban supply systems. This guide is a technical document especially useful for systems of supply of large urban agglomerations that have sufficient economic, technical and human resources to carry out the recommendations that it is exposed. However, currently, more than ten years after the publication of this guide (and fourteen years after PEM must be in force) only an 8.5 % of these have been approved (Vargas et al. 2018).

Tabla 2 – Administrative status of PEM

River Basin District	Water supply systems that should present a PEM, according to PES	No data	In progress	There is a plan in place, but it does not fit with PES	In place
Cantábrico Oriental	5	5	0	0	0
Cantábrico Occidental	14	12	0	2	0
Galicia Costa	No data available	No data available	No data available	No data available	No data available

[23] Ley7/1985, de 1 de abril, reguladora de las bases de Régimen Local.

Miño-Sil	5	5	0	0	0
Duero	15	9	6	0	0
Tajo	16	15	1	0	0
Guadiana	25	17	8	0	0
Tinto-Odiel-Piedras	No data available	No data available	0	No data available	No data available
Guadalquivir	21	12	9	0	0
Guadalete-Barbate	No data available	No data available	0	No data available	No data available
C. M. Andaluzas	No data available	No data available	0	No data available	No data available
Segura	24	5	0	10	9
Júcar	69	54	0	9	6
Ebro	19	16	0	0	3
Cuencas internas de Cataluña	No data available	No data available	0	No data available	No data available
Total	213,0	150,0	24,0	21,0	18,0
%	100,0	70,4	11,3	9,9	8,5

(*Fuente: Vargas, et al, 2018*)

As mentioned above, only 8.5% of the 213 systems identified have approved their PEM according to current PES (2007); 11.3% of systems have already delivered their PEM, and this is currently being evaluated by the relevant river basin authorities; 9.9 % have a PEM in place, but the plans need to be revised and fitted to adapt the relevant PES, either because it was published before the PES and, in consequence, does not follow the PES guidelines, or because, despite the PEM being published after PES, the indicators used do not fit those used in the relevant PES. Most systems (70.4%) have not yet submitted their PEM to the river basin authority.

The development of these has encountered greater difficulties in small and medium municipalities (less than 50.000 inhabitants), which are usually more vulnerable to drought for several reasons: 1) they usually depend on more fragile water sources, whether for reasons of quality or due to low diversity of sources, and this causes that water sources respond worse to a period of drought; and 2) low performance and efficiency of supply system infrastructures, due to poor infrastructure and low rates of replacement, is a relevant factor especially to deal with drought.

Difficulties of these small and medium municipalities to alter the PEM can be the result of several factors. On one hand, despite the important changes about risks perception, drought is still viewed as an extraordinary event and the attitude of apathy returns once the drought has passed. This attitude causes a lack of thought about drought until the

next one and therefore we do not work on drought planning when we should, which is during normal meteorological situation. On the other hand, the elaboration of these PEM requires minimum requirements (economic, technical and human) that for some municipalities is difficult to deal with. In this sense, PHN has the same requirements for a system such as the "Isabel II Chanel", which supplies almost the entire autonomous community of Madrid with a population of more than 6 million people, and the Puente Genil municipality (Córdoba, Andalusia) that has 30,124 inhabitants (INE 2017). Moreover, there is a great variety of water management models of the integral water cycle in terms of administrative competences, sources of supply, or demographic and socioeconomic characteristics. That makes it difficult to apply a common methodology for the establishment of thresholds, indicators and measures for the preparation of drought risk management plans.

Alternatively, a new Methodological Guide has recently been published: "Guide for the participatory development of risk management plans for drought in small and medium-sized municipalities" (Hernández-Mora and Vargas 2018). The objective of this Guide is to strengthen the social and institutional capacities of small and medium-sized municipalities (up to 50,000 inhabitants) and to manage droughts in a way that minimizes their socio-economic and environmental impacts. For this, emphasis is placed on risk management and not so much on emergency response, prioritizing the reduction of vulnerability and applying a series of progressive measures as the phenomenon progresses. To reduce the vulnerability to drought, the system must be improved in periods of climatic normality so that when a drought appears the municipality is less sensitive to suffering effects. In addition, for the development of drought plans, this guide promotes an effective participatory process. Through a participatory methodology, the social and institutional capacities are increased and therefore the resilience is strengthened so that once a drought appears, the municipality will be able to better resist its effects by applying the gradual measures presented by the PEM.

Conclusions

According to traditional water-management models, droughts are perceived as extraordinary events. From this point of view reactive and contingency measures after the effects of the event have developed have dominated drought risk strategies. This interpretation has not dealt with drought effectively, but has legitimised expansionist water policies which are based on constructing major infrastructures in order to increase water supply and thus palliate water scarcity. However, given the normality of drought

in Spain and the climate change forecasts predicting the increase of frequency and intensity of droughts in the near future, drought can no longer be perceived as an extraordinary phenomenon. In contrast, droughts have to be regarded as a normal event in Spain and thus drought management strategies must shift from crisis management approaches to risk management.

The WFD represents an important advance in the way water resources management and hydric risks are approached. On one hand, the directive promotes a change from quantity-centered management to managing and maintaining the quality of water bodies and associated ecosystems. On the other hand, it establishes the objective of ordinary water planning, to mitigate the effects of droughts and floods. At the same time, as in a pioneering way in Europe, the impulse received by *Article 27. Drought management* of the PHN represents an important step forward for the establishment of the risk management approach in Spain. Since this PHN, drought risk plans are the main tool to cope with drought both at the river basin district level (PES) and at municipality level (PEM). There have been important advances at river basin district level and on large municipalities, however, there is still much to be done in small and medium-sized population municipalities which are usually more vulnerable to drought.

Perception of droughts as exceptional events limits actions to simply applying emergency measures, the diversity of management models of the integral water cycle and the requirements of technical, economic and human resources are the main reasons for explaining the low compliance with the obligation to develop PEM in systems of more than 20,000 inhabitants. However, given the forecasts of climate change and the vulnerability of small and medium-size municipalities, it is important that this issue be updated. Only through an adequate elaboration of these plans based on prevention, the anticipation, and the progressive application of measures, can we considerably reduce the vulnerability of the municipalities to the effects of the drought and reinforce the resilience of the municipality to cope with a drought and reduce the socio-economic and environmental impacts can be increased.

Despite urban supply systems, drought plans are still an ongoing challenge in terms of drought risk management in Spain, but some important recent changes represent an opportunity to address it. On one hand, the recognition of relevant authorities about the need to advance in the development of urban supply system through plans. This recognition is evident both in the IT and in the revision of the river basin district drought

plans. On the other hand, the publication of the Guide for the participatory development of risk management plans for drought in small and medium-sized municipalities. This Guide facilitates the necessary tools and procedures so that municipalities with more technical, economic and difficulties, which are at the same time the most vulnerable to drought, are able to elaborate their own drought management plans.

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Conclusions

Challenges and opportunities identified in each of the CARE + Project countries present several differences.These differences are due mainly to the different territorial, social, economic, physical, cultural and technological realities among different countries, which are also exposed to hazards of very different natures. Throughout the chapters of this book local frameworks and some resilient experiences that allow analyzing specific challenges and

opportunities are described. However, despite these differences, some common challenges and opportunities can be pointed out. In order to have a main idea, a short summary of that has been made according to different categories: political and governance and operational challenges and opportunities.

Regarding political issues, a common outstanding challenge is the weakness of territorial planning to deal with the impacts of climate change. Short-term strategies and sectoral planning, which domain planning strategies hinder the adequate integration of the effects of climate change. This common procedure not only makes difficult to address the challenges arising by climate change but also this lack of comprehensive approach and sectoral actions oftenstrengthen them.In all the countries of the CARE+ project, emphasis is placed on the need to improve co-ordination among the different sectoral policies and on the effective integration of climate change and its effects in a transversal way in territorial planning to build climate resilience.This is linked to other common need identified, the strengthening of governance. It is essential in all areas of public policies but especially in those linked to uncertainty, as is the case of climate change and risk. In all countries has been identified a lack on economic and decision making transparency, poor stakeholder engagement and little effectiveness in public policies, especially related to climate change and disaster risk reduction. Common challenges to ensure economic and political transparency have been pointed out:1) guaranteeing transparency in decision-making on climate change and disaster risks reduction.Improving transparency will also improve institutional trust and therefore the institutions responsible for decision-making will be more robust; 2) promoting participatory processes that involve citizens and stakeholders. In this regard, it is important to improve current participatory processes, through the creation of easy materials and procedures to reach as many people as possible and provide effective participation processes; 3) addressing information deficiencies.Information deficiencies are one of the essential challenges for the adequate construction of climate resilience. Information and knowledge should be the basis on which to build resilience. A common challenge as well in LA countries as in European countries is to address the uncertainty inherent to climate change and its effects in urban areas, linking the gap in the available data, make information accessible for citizens and developing and maintaining adequate financial and structural mechanism to ensure information is available.A better information and communication about climate change and its associated risks would also lead to an improvement in citizens' perception of these issues. Low perception of risk has been pointed out as a weakness that must be overcome in all the countries. As a matter of that, there is still an underestimated perception of the effects of climate change at local level. Long-term effects still dominate the perception of citizenship and institutions about climate change. This perception causes that climate changeis not a priority in the political agendas or in the concerns of the citizenship.The way of perceiving the problem guides the way of address it, so it is difficult to develop and strength climate resilience strategies if authorities and citizens have an little awareness of climate change and risks. Addressing these challenges related to Governance - transparency, public participation and information- would generate citizenship and institutions that are better trained and prepared and therefore more resilient.

In addition to these issues, a series of operational challenges have also been identified: 1) limited capabilities to cope with climate change effects, especially at local level. In this sense, there are many differences between some countries and others and also within the countries themselves. Local level does not always have the economic, technical and human resources to face the challenges posed by climate change as the development of climate resilience strategies; 2) In spite of important theoretical improvements about climate resilience, a lack of operational frameworks to analyze and strength resilience has been pointed out. However, developing common operational frameworks is difficult if not impossible due to the different territorial realities of application of each of the countries. In this regard, developing local strategies and exchanging experiences to develop common tools has agreed as a good way to address it.Greater financial resources to resilient infrastructures investment and the training of experts in the field is one of the common challenges identified. 3)The is a weak, trough growing experiences adopting urban resilience strategies. The debate on resilience is still an incipient debate, which although it has already been established in the maininternational organizations in charge of dealing with climate change and disaster risk reduction (UNISDR, World Bank, UNASUR, European Environmental Agency, etc..), is still landing at the local level.In this sense, more and more cities are takingpart on different resiliencecities in networks (Resilient Cities World Campaign, UNISDR, Resilient Cities Network, ONU-HABITAT or100 Resilient CitiesNetwork, Rockefeler Foundation). Taking part in these networks is an important input both economically, as some of these networks have funding aids, as in the learning generated by the experience exchange.