

UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ  
FACULTADES DE CIENCIAS QUÍMICAS, INGENIERÍA, MEDICINA  
Y CIENCIAS SOCIALES Y HUMANIDADES  
PROGRAMA MULTIDISCIPLINARIO DE POSGRADO EN CIENCIAS AMBIENTALES  
AND  
TH KÖLN - UNIVERSITY OF APPLIED SCIENCES  
INSTITUTE FOR TECHNOLOGY AND RESOURCES MANAGEMENT IN THE TROPICS AND SUBTROPICS

**THE ROLE OF URBAN WETLANDS IN DISASTER PREVENTION: THE CASE  
OF FLOOD RISK REDUCTION IN BOGOTA, COLOMBIA**

THESIS TO OBTAIN THE DEGREE OF  
MAESTRÍA EN CIENCIAS AMBIENTALES  
DEGREE AWARDED BY UNIVERSIDAD AUTÓNOMA DE SAN LUIS POTOSÍ  
AND  
MASTER OF SCIENCE  
NATURAL RESOURCES MANAGEMENT AND DEVELOPMENT  
DEGREE AWARDED BY TH KÖLN – UNIVERSITY OF APPLIED SCIENCES

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## Abstract

Wetlands offer different ecosystem services that contribute to human well-being (Kovács *et al.*, 2015). According to the Ramsar Convention Secretariat (2018) wetland located in urban areas have been threatened by several activities such as drainage, pollution, encroachment, agriculture, among others. On the other hand, wetland degradation reduces the resilience of hazards like floods and storm surges (Kumar *et al.*, 2017). For that reason, ecosystem-based disaster risk reduction (Eco-DRR) is an important strategy which enhances the conservation and restoration of ecosystems to reduce disaster risk aiming to sustainable development and resilience (Estrella & Saalismaa, 2013). Despite international recognition of the importance of wetlands, urban wetlands have diminished their capacity to cope with flood threats (Boyer and Polasky, 2006) due to the aforementioned human impacts.

That is why this thesis aimed to identify the role of urban wetlands in Bogota, Colombia, that has an urban wetland complex that is recognised as a Ramsar site in 2018. However, wetlands in the city reduced its area from 50.000 hectares to less than 800, approximately, in less than 40 years, mainly because of urban expansion and encroachment (IDIGER, 2018). To achieve this objective, an analysis of the city's risk management framework was conducted, as well as a stakeholder analysis based on semi-structured interviews and a spatial-temporal analysis for the period 1998-2017, for which the Jaboque wetland was used as a case study. This wetland is located near the Bogotá River and is in the area threatened by flooding.

It was possible to determine that national and district policies on wetlands, biodiversity, and climate change adaptation address some ecosystem functions. Still, disaster risk reduction is not strongly linked to them. Thus, based on the case study, the wetlands in Bogota have not played a decisive role in flood risk management in the city.

**Keywords:** Ecosystem-based reduction (Eco-DRR), Flood risk reduction, Urban wetlands, Ecosystem services, stakeholder analysis.

## Resumen

Los humedales ofrecen diferentes servicios ecosistémicos que contribuyen al bienestar humano (Kovács *et al.*, 2015). De acuerdo con la Secretaría de la convención Ramsar (2018) Los humedales situados en las zonas urbanas se han visto amenazados por varias actividades como el drenaje y relleno, la contaminación, la invasión y la agricultura, entre otras. Por otra parte, la degradación de los humedales reduce la resiliencia de amenazas como las inundaciones y las mareas de tempestad (Kumar *et al.*, 2017). Por esa razón, la reducción del riesgo de desastres basada en los ecosistemas (Eco-DRR) es una estrategia importante que mejora la conservación y la preservación de los ecosistemas para reducir el riesgo de desastres con el fin de lograr un desarrollo y una resiliencia sostenibles (Estrella & Saalismaa, 2013). A pesar del reconocimiento internacional de la importancia de los humedales, los humedales urbanos han disminuido su capacidad de hacer frente a las amenazas de inundación (Boyer and Polasky, 2006) debido a los impactos humanos mencionados.

Por esta razón, esta tesis tuvo como objetivo identificar el papel de los humedales urbanos en Bogotá, Colombia, que cuenta con un complejo de humedales urbanos que será reconocido como sitio Ramsar en 2018. Sin embargo, los humedales de la ciudad redujeron su superficie de 50.000 hectáreas a menos de 800, aproximadamente, en menos de 40 años, principalmente debido a la expansión e invasión urbana (IDIGER, 2018). Para lograr este objetivo, se realizó un análisis del esquema de manejo de gestión de riesgos de la ciudad, así como un análisis de los actores interesados basado en entrevistas semi-estructuradas y un análisis espacio-temporal para el período 1998-2017, para el cual se utilizó como estudio de caso el humedal del Jaboque. Este humedal está situado cerca del río Bogotá y se encuentra en la zona amenazada por las inundaciones. Se pudo determinar que las políticas nacionales y de distrito sobre los humedales, la biodiversidad y la adaptación al cambio climático abordan algunas funciones de los ecosistemas. Sin embargo, la reducción del riesgo de desastres no está fuertemente vinculada a ellas. Así pues, sobre la base del estudio de caso, los humedales de Bogotá no han desempeñado un papel decisivo en la gestión del riesgo de inundaciones en la ciudad.

**Palabras Clave:** Reducción de riesgo de desastres (Eco-DRR), reducción de riesgo de inundación, Humedal urbano, Servicios ecosistémicos, Análisis de actores interesados.

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## Abbreviations

ADESSA: Asociación del desarrollo social y ambiental  
BISE: Biodiversity information system for Europe  
CAR: Corporación Autónoma de Cundinamarca  
CC: Climate change  
CCA: Climate change adaptation  
CICES: The Common International Classification of Ecosystem Services  
DAMA: Departamento Técnico Administrativo del Medio Ambiente  
DNP: Departamento Nacional de Planeación  
EAAB: Empresa de acueducto y alcantarillado de Bogotá  
EbA: Ecosystem-based Adaptation  
ECDBC: Estrategia Colombiana de Desarrollo Bajo en Carbono  
Eco-DRR: Ecosystem-based disaster risk reduction.  
ES: Ecosystem Services  
FBS: Fundación Banco de Semillas  
FONDIGER: Fondo Distrital para la Gestión de Riesgos y Cambio Climático de Bogotá D.C,  
GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit  
ICANH: Instituto Colombiano de Antropología e Historia  
IDEAM: Instituto de Hidrología, Meteorología y Estudios Ambientales  
IDIGER: Instituto Distrital de Gestión de Riesgos y Cambio Climático  
IDU: Instituto de Desarrollo Urbano  
IPBES: The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services  
MEA: Millenium ecosystem assessment  
NbS: Nature-based solutions  
PDGRD-CC: Plan distrital de gestión del riesgo de desastres y del cambio climático  
PEDRR: Partnership for environment and disaster risk reduction  
PNACC: Plan Nacional de adaptación al Cambio Climático  
SDA: Secretaría distrital de ambiente de Bogotá  
SDGR-CC: Sistema Distrital de Gestión de Riesgos y Cambio Climático  
SDP: Secretaría Distrital de Planeación  
SDPAE: Sistema Distrital para la Prevención y Atención de Emergencias  
SINA: Sistema Nacional Ambiental  
SIRE: Sistema de Información para la Gestión de Riesgos y Cambio Climático  
SNCC: Sistema Nacional de camcio climático  
SNGRD: Sistema Nacional de Gestión del Riesgo de Desastres  
TEEB: The Economics of Ecosystem Assessment  
TNC: The Nature Conservancy  
UNGRD: Unidad Nacional para la Gestión del Riesgo de Desastres  
WWF: World Wide Fund for Nature

## 1 Introduction

*“Wetlands in all parts of the world play an important role in disaster risk reduction if the wetlands are effectively managed and restored”* that is one of the statements that the Ramsar Convention (2015, p.1) in the 12<sup>th</sup> Meeting of the Conference of the Parties. This is also recognised by the Convention on Biological Diversity (2018), that the good quality and health of the ecosystems is fundamental to the Ecosystem-based Disaster risk reduction (Eco-DRR). This acknowledges that wetlands that are healthy and well managed can be a buffer or protective barrier from the impacts of hazards, such as floods, by storing water, which reduces peak flow during the rainy season, while in dry season maximise water storage (Ramsar Convention, 2015).

However, due to the human activities and urban expansion, services of ecosystems located in urban areas and their boundaries have been reduced, resulting in loss and fragmentation of urban ecosystems (Maes *et al.*, 2019). These same issues are associated with urban wetlands reduction, which can be related to the absence of public policies aimed for the protection of ecosystems and the non-consideration of its ecosystem services. But also because the conversion threatens most of the urban wetland to non-wetland purposes, alteration of water-quality by a discharge of sewage, urban encroachment or drainage trough landfilling; that result in loss of biodiversity of these ecosystems, among others (Ramachandra, Aithal and Kumar, 2012).

For that matter, it is worth mentioning the main and diverse benefits that wetlands and its biodiversity bring to people: first recognising that biodiversity has an important role for ecosystems, due to the link to their dynamics, that perform the offer of ecosystem services to the human well-being (The Economics of Ecosystems and Biodiversity - TEEB, 2012).

The benefits of these ecosystems are related to provisioning, regulating, supporting and cultural services, classification proposed by the Millennium Ecosystem Assessment - MEA (2005). Regulating services contemplate carbon management, water quality improvement, flood control, and the like; while wetland biodiversity provides key support and provisioning services like genetic resources and soil formation. Also, important non-material benefits such as spiritual,

aesthetic and educational values are given by wetlands (Clarkson, Ausseil and Gerbeaux, 2014). Nonetheless, this study will focus on the flood control ecosystem service of wetlands.

Understanding that resilience “*provides the capacity to absorb shocks while maintaining function*” (Folke *et al.*, 2002, p.13). The resilience of wetlands against hazards like floods, droughts and storm surges is reduced within their degradation (Kumar *et al.*, 2017). For that reason, risk reduction is paying no more attention to the ability of nature to address hazards, mainly through the Eco-DRR approach which has gained greater international recognition. Eco-DRR is defined as “*the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim of achieving sustainable and resilient development*” (Estrella and Saalismaa, 2013, p. 30); generating benefits for the environment, societies and even economies (Convention on Biological Diversity, 2018).

Eco-DRR is included in the umbrella concept of nature-based solutions (NbS), which are those actions that use ecosystems and their services to face societal challenges like climate change, food security or natural disasters, that also contemplates the Ecosystem-based Adaptation (EbA) (Cohen-Shacham *et al.*, 2016) that has a closer approach to climate change adaptation (CCA). Besides, The World Bank (2017) mentioned that for mitigation of floods, nature-based solutions (NbS) are helpful for effective flood risk management.

Furthermore, urban wetlands in Bogota, Colombia, are part of the most important wetland system in the northern Andes. However, the original area of approximately 50,000 hectares was reduced to less than 800 in less than 40 years (IDIGER, 2018). The main causes of this loss of area have been given mainly by the transformation of its vocation of use “*through dumping, filling and urban occupation, not only by neighbourhoods but also by roads, parks, bike paths, poplar groves, squares and infrastructure of public services such as electricity networks, the passage of sewage collectors, the passage of gas networks and other services*” (Calvachi *et al.*, 2013, p. 8). All of this has caused fragmentation on the structure and functioning of ecosystems affecting the biologic diversity, which is directly connected to ecosystem attributes and services (Cortés Ballén, 2018).

On the other hand, it has been identified that the city is prone to have fluvial and surfaces flooding events, mostly due to overflowing of the main tributaries of the Bogota River. In the same way, this is linked to the deforestation, waterproofing of the soil with materials such as

concrete and cement, the inadequate liquid and solid wastes that obstruct drains, wetland fillings (natural areas of flooding) and constructions on riverbanks, among others (SDA and IDIGER, 2015)

That is why this thesis aims to identify what is the role of wetlands in Bogota, in relation with flood risk reduction, considering how has it been their loss, degradation and restoration in the last years. Also, to identify the possible strategies of best practices or strategies in other places around the world that could be applied or evaluated for application considering the own dynamics of the city, to improve the risk and environmental management. To do so, as appropriate to focus this analysis in the Jaboque wetland ecological park.

To achieve that, this thesis presents ten more chapters. Chapter 2 shows the problem statement and research gap that was the primary reference to this research. Chapter 3 is the theoretical framework, where the main key concepts are explained and were put into context. Chapter 4 Describes generally urban wetlands in Bogota, Colombia, and flood risk in the city. Chapter 5 highlights the role of urban wetlands on flood as part of state of the art, which was intended to describe how international and national research have considered urban wetlands and flood risk reduction. Chapter 6 shows the main and specific objectives of the thesis. Chapter 7 describes methods that were applied, according to the necessities of each of the specific objectives. Chapter 8 presents and illustrates the results, and Chapter 9 display the discussion of the results. Chapter 10 encounters the main conclusions of the study, followed by the limitations of the study (chapter 11), references, and the annexes generated.

## 1.1 Justification

The thesis project developed aimed to contribute to the construction of the relevance of Eco-DRR from the analysis of the role of urban wetlands in flood risk reduction in Bogota, Colombia. It is considered as great importance the awareness of ecological functions of those ecosystems on the prevention of disaster risk based on its services, in this case, flood control.

The current document proposed to find in the disaster risk reduction approach based on ecosystems as one powerful tool that could be used in the management scheme of Bogota's urban wetlands. The International Strategy has also recognised this approach for Disaster Reduction (ISDR), where the integrated management of ecosystems is a key component of DRR strategies (Renaud, Sudmeier-Rieux and Estrella, 2013).

In the same way, it is intended to access and generate scientific information for the integration of disaster risk reduction based on wetland ecosystems, to give it a more significant academic and literary support that will increase the interest of the academy to learn more about the particularities of urban ecosystems, such as wetlands.

## **2 Problem statement and Research Gap**

Renaud et al. (2016) mentioned that for the paradigm of flood risk management is essential to recognise ecosystem services in attenuating flooding. To do so, it is necessary to develop a scientific analysis of the linkages between wetlands and flooding (Janssen et al. 2014; Wesenbeeck et al., 2014).

As mentioned by Boyer and Polasky (2006), Urban wetlands have ecological characteristics that allow them to withstand certain types of natural disturbances; however, these have intensified over the years, mainly due to human activities, such as urban sprawl, agriculture, livestock activities, among others. All of them and other aspects regarding wetlands are contemplated in the RAMSAR Convention of 1971. The convention has been the starting point to carry out the plans or policies in favour of the maintenance and conservation of these ecosystems. Countries that are part of it, like Colombia, who adopted it in 1997 through law 357, is an example of it.

According to with the Institute of Environmental Studies for Development [Instituto de Estudios Ambientales para el Desarrollo – IDEADE] (2015), approaches to ecosystem services of wetlands in Colombia, remain rather precarious and have not been incorporated as inputs to integrated land management processes, despite having important developments in the national context. Besides, it was identified in the Bogotá's Public Policy on Ecourbanism and Sustainable Construction (2014-2024), that the city faces a growing demand for land to be urbanised, but this land is not available. What is more, is the disarticulation between the urban and the environmental management, causing losses and functional, systemic and connectivity ruptures between the elements of the Main Ecological Structure, imposing additional challenges for the achievement of adaptation and mitigation of climate change (SDA & IDIGER, 2015). This means that despite having an environmental entity, institutions and community environmental organisations in the city, ecosystems like wetlands still are vulnerable due to the location in an urban area that in general, has low perception and knowledge of its ecosystem services.

Regarding disaster risk reduction, the management of flood risk reduction in Bogota has given to the city recognition in Latin America. Due to the improvements in climate change adaptation, water resource and risk management under the scope of interinstitutional decentralisation and local autonomy (Aragón-Durand, 2014). Though, it is important to mention

that despite the progress made by the authorities in disaster risk management in the city, it has not yet come close enough to considering ecosystems as an integral part of its management. That is mainly because structural measures continue to be relevant in mitigating the risk of flooding in already urbanised areas and in the adequacy of land to be developed in the future (IDIGER, 2018).

Therefore, the ecological functions have not been linked in a transverse way to the prevention and reduction of ecological risks. It can be considered as a key factor for the development of planning instruments and public policies that could have a key effect on the welfare of the population and environmental stability, as well as the reduction of economic losses that disasters bring. Which, according to with the Convention on Biological Diversity, (2018) selecting ecosystem solutions in disaster risk reduction, are usually more adaptive and cost-effective and easier to maintain, and most importantly, it focuses in the whole suite of services that an ecosystem or landscape provides. The reason why Eco-DRR could integrate those ecological functions to address ecosystem-based approaches in the national, regional and local level. That is why urban wetlands can be taken as part of the management of disaster risk reduction related to flooding events. Considering that these ecosystems in the city are located close to Bogota river, and are identified in areas with a high threat of flooding, according to IDIGER's flood hazard map referred in the Resolution 1060 of 2018 of Bogota Secretariat of Planning [Secretaría Distrital de Planeación- SDP]. To do so, it is important to recognise how wetlands are or not involved in the district management scheme, for it to have a closer approach to the Eco-DRR, and more important recognised how is the current state of them through previous research over them.

In this matter, over the last decades, research regarding wetlands in Bogota is becoming a topic of interest; especially in institutional and academic investigations that are available in databases and repositories of Universities and environmental institutions in Colombia. Those are who have developed great knowledge and new interest in this type of ecosystem. According to the previous consultation, it is possible to imply that biological, ecological and, even sociological aspects are recurrent in those researches in Bogota. However, it was possible to identify that in the District, topics in urban wetlands related to the prevention of disaster risk reduction is not yet frequent.

As Lara (2017) mentioned, Wetlands need to be subject to study in a differentiated way, recognising the diversity of contexts in which are strengthening the science-policy interface, where academia can help to fill those information gaps. This study has as an overall purpose to analyse the role of urban wetlands in flood risk reduction in Bogotá, Colombia, to identify from the scope of ecosystem-based disaster risk reduction, if wetlands in the city have been considered as a key aspect to this risk management.

### 3 Theoretical Framework

As an important aspect for this research, to develop a context to identify the role of Urban wetlands in disaster prevention, is to mention the principal concepts that are considered the most relevant. That is the case of the nature-based solutions (NbS), that is defined by the IUCN as “*Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits*”(Cohen-Shacham *et al.*, 2016). This NbS, include as part of its approach the concepts of ecosystem-based disaster risk reduction (Eco-DRR) and Ecosystem-based adaptation (EbA), which are further explained below.

Furthermore, it is important to understand the ecosystem services (ES) in a general way, so that after recognising the characteristics of the wetlands and their own ES, focusing on flood control.

#### 3.1 Ecosystem-based disaster risk reduction (Eco-DRR) and Ecosystem-based Adaptation (EbA)

Eco-DRR has its first definition given in 2011 by the Partnership for Environment and Disaster Risk Reduction (PEDRR), as the “sustainable management, conservation and restoration of ecosystems to provide services that reduce disaster risk by mitigating hazards and by increasing livelihood resilience”. However, Estrella & Saalimaa (2013, p. 30) defined it as “*the sustainable management, conservation, and restoration of ecosystems to reduce disaster risk, with the aim of achieving sustainable and resilient development*”. This approach later was conceived that Eco-DRR also contributes to climate change adaptation, even though climate change (CC) was not a reference (Renaud *et al.*, 2016).

Is worth mentioning that internationally, in the last years Eco-DRR has being recognised as an essential ecosystem-based approach, which aims for prevention of disasters and reduction of risk, based in the protection of ecosystems and their services. For example, in 2014, The twelfth Conference of the Parties to the Convention on Biological Diversity (CBD COP 12) encourages all Parties to adopt ecosystem-based approaches to both CC and DRR. In 2015 The Sendai Framework for Disaster Risk Reduction 2015-2030, updated the Hyogo Framework for Action 2005–2015. This was adopted as a more rigorous monitoring framework which enhanced ecosystems, biodiversity into the development and knowledge for risk management. In this same

year was recognised the role of wetlands in the Ramsar Convention Decision XXII.13 in disaster risk reduction; the UN General Assembly adopted the Sustainable Development Goals (SDGs), and 195 countries adopted the Paris Agreement (Monty, Murti and Furuta, 2016). As shown in Figure 1, Renaud et al. (2016) identified the linkages between the main international agreements, including a key aspect that corresponds to ecosystem services.

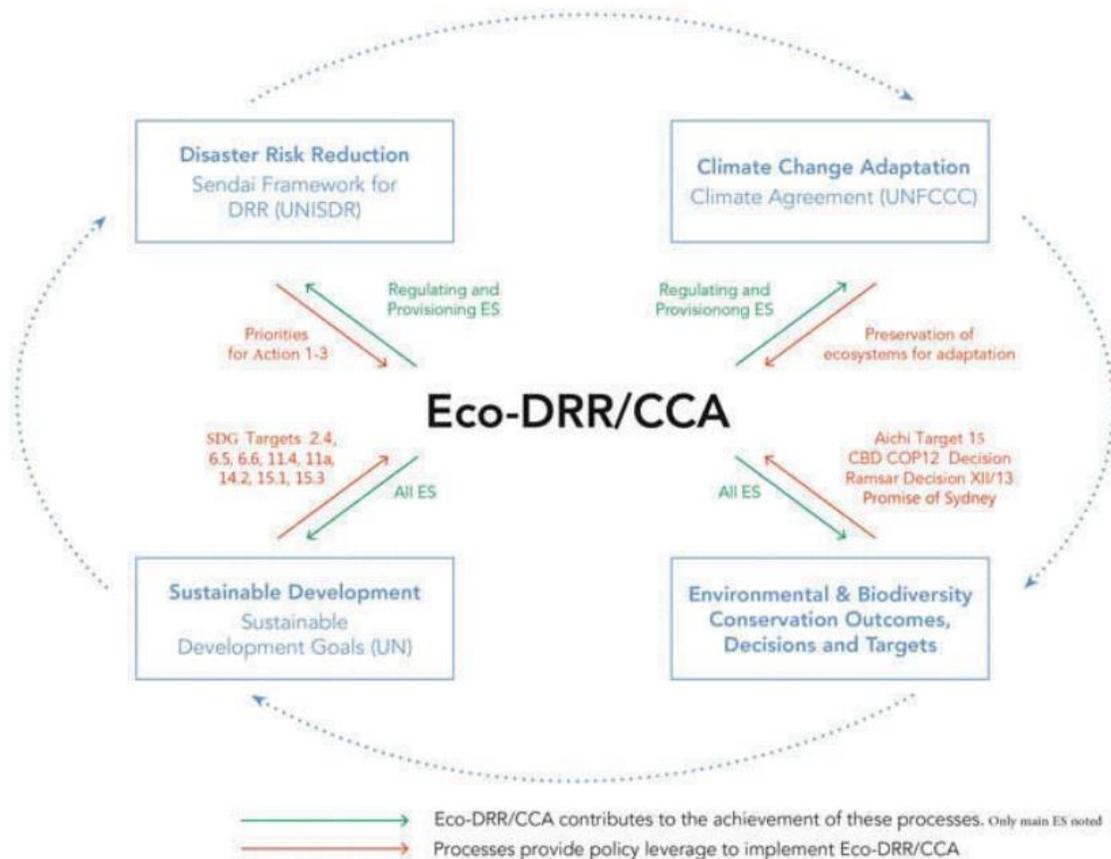


Figure 1 Linkages between main international agreements and Eco-DRR.  
Source: (Renaud *et al.*, 2016)

On the other hand, Ecosystem-based Adaptation is defined by CBD (2010) as the “sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic and cultural co-benefits for local communities”. Also, it was recognised that EbA is the most appropriate to integrate broader adaptation and development strategies. Which takes ecosystem’s sustainable management, conservation and restoration, as an opportunity for people to adapt to impacts of

CC, and increase people and ecosystem resilience of adverse effects of climate change (CBD, 2009:41).

However, it is important to note, that that traditional practices of Eco-DRR and EbA address in different ways the adaptation of people and ecosystems to climate change as an equally significant aim (CBD, 2018). Which it is possible to say that both are based in the preservation of ecosystems, its sustainable use and the restoration of ecosystem services.

### 3.2 Ecosystem Services

The study needs to know the concept of Ecosystem Services (ES) and how different authors define the term in the literature. Not before, understanding that as an important input for ES, biodiversity plays a significant role in the function of ecosystems, which are strongly linked to the different ES (Norris,2012). This relation is also recognised by The Economics of Ecosystems and Biodiversity - TEEB (2012), which highlighted that is possible to associate that changes in the biodiversity imply changes in the associated ecosystem services that benefit human well-being. Also, they mentioned, that is important to understand how variation in biodiversity affects the dynamics of ecosystems, which are what bring all different goods and services.

According to the analysis of ES conceptualisation, made by Valdez, Luna, & Corresponsal (2012); highlighted that Westman (1977) contemplated the concept of “Nature’s services”. Which states that ecosystems have different structures that can offer two kinds of benefits for humans: (i) harvest different types of natural products, such as plants, minerals, among others, including obtainment of genetic resources from diverse species; and (ii) value ecosystems for recreation, study and its aesthetical use. This concept is based on how can be identified ecosystem functions by ecology, which is considered the main study area to be contemplated due to understanding what ecosystems can offer.

On the other hand, Ecosystem Services are defined by Daily (1997, p. 3) as “*the conditions and processes through which natural ecosystems, and species that make them up, sustain and fulfil human life*”. That can be related likewise with one of the main function of ecosystems: production of “ecosystem goods”; but it also refers to the life-support functions, and intangible benefits such as aesthetic and cultural as well. In addition, two of the concepts that are highlighted by Costanza et al. (1997) are ecosystem goods (i. e. as raw materials) and

services (such as water supply). They are related directly and indirectly to the functions of ecosystems and benefits for the human population.

With a similar approach, Groot, Wilson, & Boumans (2002, p. 394), proposed a classification of certain ecosystem functions, which provide a larger number of what is called good and services. Those were defined as '*the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly*'. This definition allows those ecosystem functions to be as a subdivision of ecosystem structures and ecological processes.

However, according to Valdez et al. (2012), the millennium ecosystem assessment in 2005, promoted by The United Nations, has become the benchmark for the subject of Ecosystem Services and the analysis, since it has defined classification for the services that ecosystems can provide, but also which can be affected by human activities. This classification is shown in Figure 2, where it is possible to identify that there are four categories for the ecosystem services: Supporting, Provisioning, Regulating and Cultural.



Figure 2 Classification and linkages between Ecosystem Services and Human Well-Being  
Source: Millennium Ecosystem Assessment -MAE (2005)

It is noteworthy to mention that supporting services are considered as the base of the ES classification, due to their characteristics that are related with services, such as nutrient cycling, soil formation, primary production, among others. They can be considered as an input for the other three types of services. First, provisioning services are related to the provision of food, freshwater, wood and fibre, fuel, etc. Regulating services are associated with climate, food, disaster regulation or water purification. Finally, cultural services are the ones related with aesthetic, spiritual, educational, recreational aspects that the human population can appreciate from diverse of ecosystems.

Moreover, with an economic approach, TEEB defined ecosystem services as “*the direct and indirect contributions of ecosystems to human well-being.*”(Groot et al., 2010, p. 19). This is like the MA definition, except the fine distinction between services and benefits and the acknowledgement of how people can benefit from them in multiple and indirect ways.

In 2012, ninety-four Governments in Panama City established The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), aims to strengthen the biodiversity and ecosystem services in the science and policy interface. IPBES superseded the MA classification, considering the contribution to people that nature has. In that case, different services can fit un more than one of the categories that MA proposed (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2012).

Finally, the main definitions and especially the classification of ecosystem services were included in the Common International Classification of Ecosystem Services (CICES). There are great equivalences with the classifications made by the MA, TEEB and IPBES. This classification considers the main categories of ecosystem outputs recognised as provisioning, regulating and cultural services. However, the “supporting” services are taken as part of the structure, process and functions of ecosystems. This allowed creating a structure to facilitate their accounting, mapping and assessment. Table 1, shows the ecosystem services categories, between the MA, TEEB and CICES, and their equivalences, which was proposed by CICES. It is important to mention that CICES hierarchical system has tailored the MA global classification and the TEEB classification, which is used mainly in studies across Europe (Biodiversity information system for Europe - BISE, n.d.).

Table 1 Ecosystem services categories.

| MA categories                          | TEEB categories                      | CICES v4.3 group  |
|--|--------------------------------------|---|
| <b>Provisioning</b>                    |                                      |   |
| Food (fodder)                          | Food                                 | Biomass [Nutrition]   |
|  |                                      | Biomass (Materials from plants, algae and animals for agricultural use)                           |
| Fresh water                            | Water                                | Water (for drinking purposes) [Nutrition]   |
|  |                                      | Water (for non-drinking purposes) [Materials]   |
| Fibre, timber                          | Raw Materials                        | Biomass (fibres and other materials from plants, algae and animals for direct use and processing) |
| Genetic resources                      | Genetic resources                    | Biomass (genetic materials from all biota)  |
| Biochemicals                           | Medicinal resources                  | Biomass (fibres and other materials from plants, algae and animals for direct use and processing) |
| Ornamental resources                   | Ornamental resources                 | Biomass (fibres and other materials from plants, algae and animals for direct use and processing) |
|  |                                      | Biomass based energy sources  |
|  |                                      | Mechanical energy (animal based)  |
| <b>Regulation and Maintenance</b>      |                                      |   |
| Air quality regulation                 | Air quality regulation               | [Mediation of] gaseous/air flows  |
| Water purification and water treatment | Waste treatment (water purification) | Mediation [of waste, toxics and other nuisances] by biota   |

| MA categories   | TEEB categories   | CICES v4.3 group   |
|---|---|--|
|   |   | Mediation [of waste, toxics and other nuisances] by ecosystems   |
| Water regulation  | Regulation of water flows   | [Mediation of] liquid flows  |
|   | Moderation of extreme events  | -  |
| Erosion regulation  | Erosion prevention  | [Mediation of] mass flows  |
| Climate regulation  | Climate regulation  | Atmospheric composition and climate regulation   |
| Soil formation (supporting service)   | Maintenance of soil fertility   | Soil formation and composition   |
| Pollination   | Pollination   | Lifecycle maintenance, habitat and gene pool protection  |
| Pest regulation   | Biological control  | Pest and disease control   |
| Disease regulation  |   |  |
| Primary production<br>Nutrient cycling (supporting services)  | Maintenance of life cycles of migratory species (incl. Nursery service)   | Lifecycle maintenance, habitat and gene pool protection  |
|   |   | Soil formation and composition   |
|   | [Maintenance of] water conditions   |  |
|   | Maintenance of genetic diversity (especially in gene pool protection)   | Lifecycle maintenance, habitat and gene pool protection  |
| <b>Cultural</b>   |   |  |
| Spiritual and religious values  | Spiritual experience  | Spiritual and/or emblematic  |
| Aesthetic values  | Aesthetic information   | Intellectual and representational interactions   |
| Cultural diversity  | Inspiration for culture, art and design   | Intellectual and representational interactions   |
|   |   | Spiritual and/or emblematic  |
| Recreation and ecotourism   | Recreation and tourism  | Physical and experiential interactions   |
| Knowledge systems and educational values  | Information for cognitive development   | Intellectual and representational interactions   |
|   |   | Other cultural outputs (existence, bequest)  |
| <i>MA provides a classification that is globally recognised and used in sub global assessments.</i> | <i>TEEB provides an updated classification, based on the MA, which is used in on-going national TEEB studies across Europe.</i> | <i>CICES provides a hierarchical system, building on the MA and TEEB classifications but tailored to accounting.</i> |

Note: Adapted and Reprinted from the Biodiversity information system for Europe (BISE). Retrieved from <https://biodiversity.europa.eu/maes/ecosystem-services-categories-in-millennium-ecosystem-assessment-ma-the-economics-of-ecosystem-and-biodiversity-teeb-and-common-international-classification-of-ecosystem-services-cices>

### 3.3 What are Wetlands?

Wetlands are defined by The Ramsar Convention on Wetlands in 1971 in the Article 1.1. of the text of the Convention as "*areas of marshes, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is flowing or static, fresh, brackish or salty, including areas of marine water the depth of which at low tide does not exceed six metres*" (RAMSAR Convention, 2007). Another concept of wetland refers to a land transitional between terrestrial and aquatic systems, usually, the water is shallow, and according to Cowardin, Carter,

Golet, & Laroe, (n.d.), those ecosystems must have one or more of the three attributes: (i) the land is covered, at least periodically hydrophytes<sup>1</sup>, (ii) the predominant substrate is undrained hydric soil, and (iii) during the growing season of each year, the substrate is saturated by shallow water for a certain period.

Moreover, these areas also are recognised as an ecosystem with different range of ecological economic benefits (Turner, 1991). However, Wetlands are considered an endangered ecosystem due to rapid urbanisation (Bassi, Kumar, Sharma, & Pardha-Saradhi, 2014), especially those located in urban areas.

### 3.4 Ecosystem Services of Urban Wetlands

According to Bolund & Hunhammar (1999), street trees, lawns or parks, urban forest, wetlands, streams, cultivated land or lakes are considered as part of the ecosystem in a city, which in each case would have different characteristics of conditions and state of conservation. Wetlands in urban areas are part of a bigger urban ecosystem that most of the time is manipulated and managed by humans. This situation is influenced by the conversion of land to built-up this ecosystem, that contributes to the increase of its vulnerability, affecting its inherent functions (Pauchard and Barbosa, 2013).

Urban wetlands can provide several services, like improving water quality, support of a variety of plants and wildlife, and flood control (Mahan, Polasky & Adams, 2000). However, these ecosystems have not always been considered that way, especially before the middle of the 20<sup>th</sup> century, when wetlands were considered as “dismal” places (Vileisis, 1997). That is why several works are focused on demonstrating the importance and high value of these ecosystems (Turpie *et al.*, 2010). Successfully as Boyer & Polasky (2006) recognised, perception towards wetlands has become more positive principally due to the increased understanding of the wetlands ecological role in ecosystems. This role is attached to the ecosystem services that wetlands offer.

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<sup>1</sup> Hydrophytes are aquatic plants suitable to live in aquatic environments.

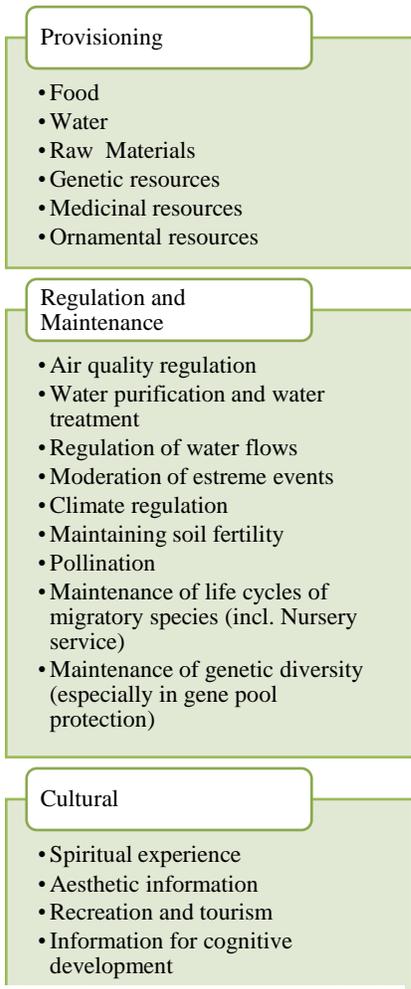


Figure 3 Wetlands ecosystem services in urban areas.

Source: own elaboration

To have a better overview of the ES of urban wetlands, and taking as a reference the classification of them, shown in Table 1, Figure 3 highlights the most recurrent services mentioned and analysed by Boyer & Polasky (2006); Clarkson, Ausseil, & Gerbeaux (2014) and Ricaurte et al. (2017).

Those ecosystem services in urban wetlands are associated principally with the type of use that human can take from, mainly if some of them represents any economic profit. Although, as Schleyer et al. (2017) mention, that the concept of Ecosystem Services suggests that its scope within parameters in wetlands is beyond the climate regulation or agricultural products, it also involves cultural services. This leads to stress the importance of include human and policy fields in the analysis of how ecosystem services can affect the regular human activities and economy. This is one of the key messages from Russi et al. (2013), they recognised that wetland loss and degradation have a great economic and social impact, for example, increased risk of floods and decreased water quality. These aspects are of great interest to

the study. Therefore, the focal point is the flood control ecosystem service of urban wetlands.

## 4 Urban Wetlands in Bogotá

The city of Bogotá is located in the central part of Colombia, in the Cundiboyacense highlands, in the eastern mountain range of the Andes, near to the paramos of Chingaza and Sumapáz (Secretaría Distrital de Ambiente, 2015). The city has a particular river system, as it is located next to the eastern hills [Cerros Orientales], in proximity to the paramos already mentioned. The city has a total area of 163.663 ha; however, its urban area covers 38.431 ha according to the current land use plan, given by the decree 190 of 2004 (Alcaldía Mayor de Bogotá, 2016).

Historically counted on wetland complexes of large tracts that with the passage of time and the expanding urban areas were reduced, from approximately 50.000 hectares to less than 800 in less than 40 years, leaving the ecosystem fractioned, as well as the water currents that interconnected them (IDIGER, 2018). Figure 4 illustrates the location of urban wetlands in Bogotá, highlighting the urban area, from the whole perimeter of the city.

The Capital District Wetlands Policy of Bogotá of 2006 adopted as definition of wetlands as *“ecosystems of great natural and cultural value, consisting of a body of permanent or seasonal shallow water, a strip around it that*

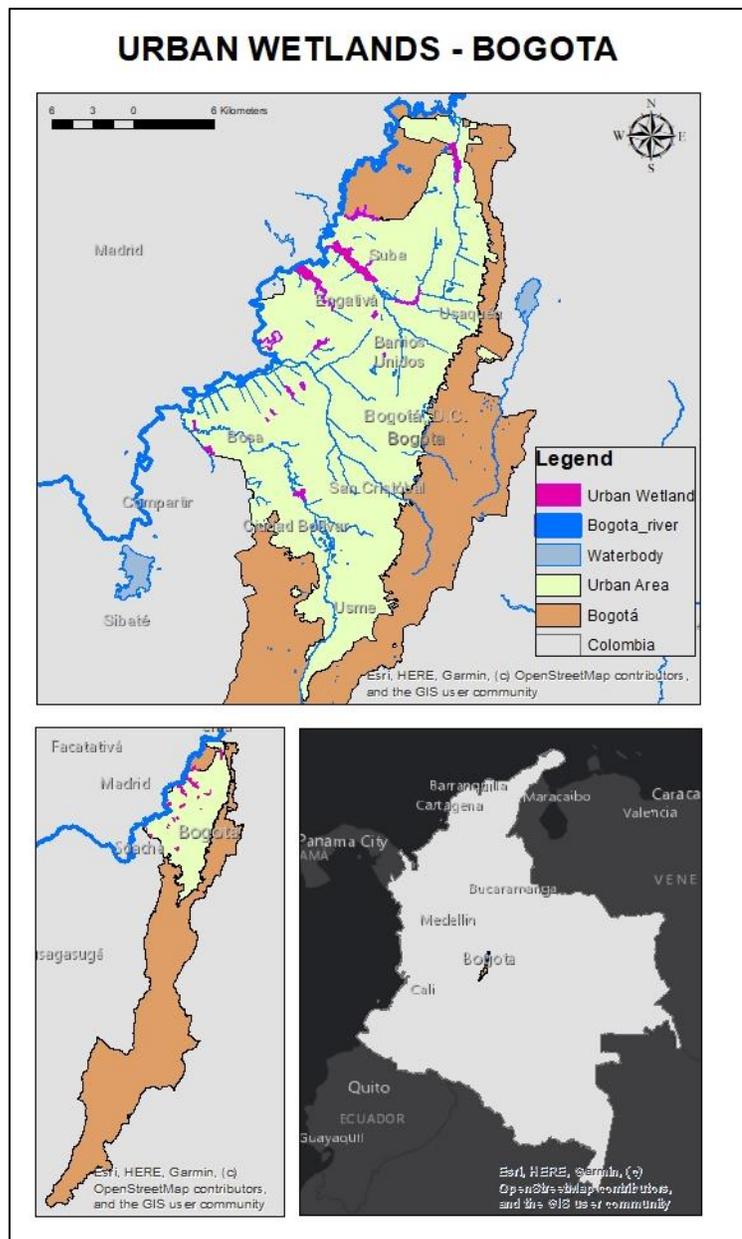


Figure 4. Location of urban wetlands in Bogotá, Colombia  
Own elaboration

*can be covered by periodic flooding (riparian buffer zone) and a strip of land that is not flooded, called the Environmental Management and Preservation Zone”* (Alcaldía Mayor de Bogotá, 2006, p. 23). As for the Cundinamarca Regional Autonomous Corporation<sup>2</sup> (Corporación Autónoma Regional de Cundinamarca – CAR), mentions that wetlands are water-saturated lands that combine the characteristics of terrestrial and aquatic ecosystems, and maintain a biological activity that adapts very well to humid environments; this is why it is common to find the presence of animals and plants closely related to the aquatic environment (CAR, 2011, p. 14).

As mentioned before, wetlands have three main zones: i) The upper zone, or terrestrial zone, is not covered by water and can be continuous or discontinuous. It may have trees, shrubs, grasses or other vegetation. ii). A riparian zone or transition zone has various extension and due to the frequent flooding, allows to connect the aquatic area and the terrestrial zone. It has abundant vegetation, mainly grasses, shrubs and some trees. And iii) the aquatic zone, which may be permanent or not, and has variable depth. Its vegetation is mainly aquatic (Pinzón, Díaz Espinosa, & Díaz Triana, 2012; CAR, 2011). These zones are shown in Figure 5.

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<sup>2</sup> The “Corporaciones Autónomas Regionales y de Desarrollo Sostenible” (CAR) are public corporate bodies, integrated by the territorial entities, in charge by law of managing - within the area of their jurisdiction - the environment and renewable natural resources, and of promoting the sustainable development of the country.

A Typical Wetland

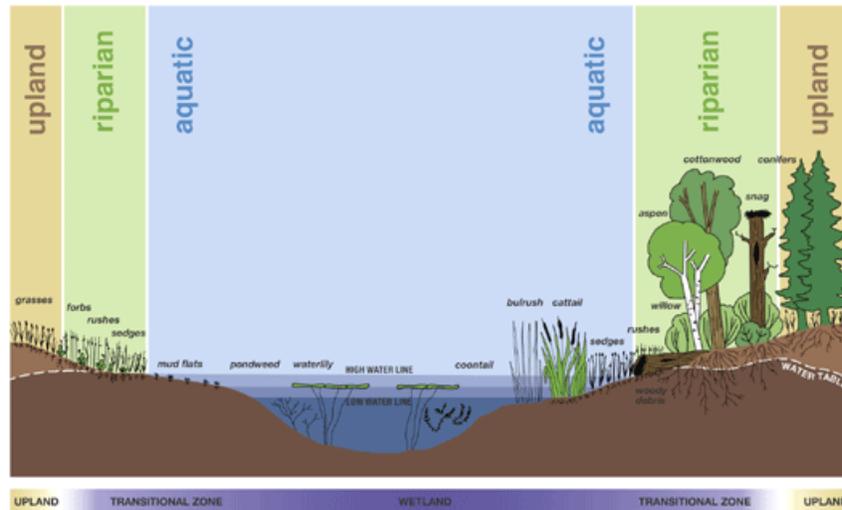


Figure 5. Profile of the areas that compose a wetland.

Retrieved from CAR (2011) from the modification of Schmidt-Mumm (1998) and the translation accessed 20 July 2020 in <https://i.pinimg.com/originals/dd/38/13/dd381343c471da7a0a1bd3983eec7af3.gif>

Given the location of Bogota in the central mountain range of the Andes, between 3,490 and 2,600 meters above sea level, this allows it to have diverse ecosystems. The city’s wetlands are classified into three types, according to origin, morphology and orographic position: moorland, slope and plain Andean wetlands, which are shown in Table 2. These plain wetlands are located mainly in the urban area of the city. It’s important to recognise that Bogotá has included a great part of those wetlands in its main ecological structure <sup>3</sup>.

Table 2 Types of wetlands in Bogotá

| Type of Wetland   | Origin                | Orographic position | Morphological aspects | Height above sea level  |                              |
|-------------------|-----------------------|---------------------|-----------------------|---|------------------------------|
| Highland Wetlands | Moorland Wetlands     | Glacial             | Highland              | Lagoon system, peat, flood areas morphometrically uneven            | Above 3200 m.a.s.l.          |
|                   | Andean slope wetlands | Glacial             | Highland              | Single water body with a well-defined circular perimeter pulse area | Between 2700 - 3200 m.a.s.l. |
|                   |                       | Built               | Highland              | Single water body with a pulse area                                 | Between 2700 - 3000 m.a.s.l. |

<sup>3</sup> The ecological main structure is defined as *the set of natural and semi-natural ecosystems that have a location, extension, connections and state of health such as to guarantee the maintenance of the integrity of biodiversity and the provision of environmental services (water, soil, biological resources and climate), as a measure to ensure the satisfaction of the basic needs of the inhabitants and the perpetuation of life* (IDEAM (T. van der Hammen & G. Andrade), 2003)

| Type of Wetland | Origin                | Orographic position | Morphological aspects   | Height above sea level |
|-----------------|-----------------------|---------------------|---|------------------------|
| Plain Wetlands  | Fluvial<br>Lacustrine | Savanna             | Single water body with multiple flood areas morphometrically uneven | Below 2700 m.a.s.l.    |
|                 | Built                 | Savanna             | Single water body, defined littoral                                 | Below 2700 m.a.s.l.    |

Note: Adapted and Reprinted from (Alcaldía Mayor de Bogotá, 2006)

Natural plain wetlands in the city were recognised as part of the main ecological structure, which is important to know the four components of it: the system of protected areas (SPA) of the Capital District, the urban parks, the ecological corridors and the particular management area of the Bogota River. Wetlands in Bogota are included in the System of protected areas of the Capital District under the name of “District ecological park” which besides has two subcategories: District Mountain Ecological Parks and District Wetland Ecological Parks (Art. 72 of Decree 190 of 2004).

However, not all wetlands have been recognised at the same time, in the first place 13 were included as a District Wetland Ecological Park in 2004 by the Art. 72 of Decree 190 of 2004 of Bogota, with a total area of 685.15 ha. In 2014, by the Agreement 577 of 26<sup>th</sup> of December, two new areas were included, leaving the city with a total area of 726 ha of urban wetlands, under the name of District wetland Ecological Parks (Cortés Ballén, 2018). All 15 wetlands under this label and the District mountain parks are shown in Table 3, including the use regimes.

Another aspect to be recognised regarding the district wetland ecological parks, is that 11 of the 15 have been declared as a Ramsar site as an urban wetland complex, first of its kind in Latin America located in the High Andean mountains, as well, has been designated as an Important Bird Area (IBA). Regarding the ecosystem services that were highlighted are emphasised the regulation of water supply of the rivers of Bogota savanna, flood control, conservation of groundwater levels, among others (Ramsar Sites Information Service, 2019)

Table 3 District ecological parks and their use regimes in Bogota

| Classification SPA               | Type                               | Name                 | Use regimes   |
|----------------------------------|------------------------------------|----------------------|---|
| System of protected areas of the | District Mountain Ecological Parks | 1. Cerro la Conejera | 1. Main uses: preservation and restoration of native flora and fauna, environmental education<br>2. Compatible use: passive |
|                                  |                                    | 2. Cerro de Torca    |   |
|                                  |                                    | 3. Entrenubes        |   |
|                                  |                                    | 4. Peña Blanca       |   |

| Classification SPA    | Type                              | Name                                    | Use regimes  |
|-----------------------|-----------------------------------|---|--|
| Capital District      | District Wetland Ecological Parks | 5. La Regadera                          | recreation.<br>3. Conditioned uses: reception centres, environmental education and information for visitors to the park, ecological, pedestrian and bicycle trails, safety facilities linked to the defence and control of the park, other infrastructure associated with the permitted uses.<br>4. Prohibited uses: agriculture and livestock, forestry production, active recreation, industrial mining of all types, residential of all types, endowments, except those mentioned as permitted. |
|                       |                                   | 1. Tibanica Wetland*                    |  |
|                       |                                   | 2. La Vaca Wetland*                     |  |
|                       |                                   | 3. Del Burro Wetland*                   |  |
|                       |                                   | 4. Techo Wetland                        |  |
|                       |                                   | 5. Capellanía or La Cofradía Wetland*   |  |
|                       |                                   | 6. Meandro del Say Wetland              |  |
|                       |                                   | 7. Santa María del Lago Wetland*        |  |
|                       |                                   | 8. Córdoba and Niza Wetland*            |  |
|                       |                                   | 9. Jaboque Wetland*                     |  |
|                       |                                   | 10. Juan Amarillo or Tibabuyes Wetland* |  |
|                       |                                   | 11. La Conejera Wetland*                |  |
|                       |                                   | 12. Torca Wetland*                      |  |
|                       |                                   | 13. Guaymaral wetland*                  |  |
|                       |                                   | 14. La Isla wetland                     |  |
| 15. El Tunjo wetland* |                                   |   |  |

Note: Adapted and modified from (Cortés Ballén, 2018). The first 13 District Wetland Ecological Parks were recognised in 2004, the last two (La Isla and El Tunjo) were declared with the same category in 2014.

Note 2: (\*) Urban Wetlands declared as a Ramsar site.

Despite these 15 wetlands recognised as a "wetland ecological park", there are other water bodies and zones that according to different actors, should also be recognised as such. This is the case of the Escobar Moreno (2016) and the research made with “Fundación Humedales de Bogotá”, who has published a collective construction of a wetlands map for Bogotá. This is of great importance to understand that the city has other water bodies that also can contribute to the flood control and the regulation of water. In total, this author mentioned all 15 “recognised” wetland (Table 3), 19 “non recognised wetlands, and other water bodies. This last two are shown in Table 4

Table 4 Other none-recognised wetlands and water bodies in Bogota

| None-recognised Wetlands   | Other Water bodies  |
|--|---|
| <ol style="list-style-type: none"> <li>1. Central reservation wetlands of Autopista Norte motorway</li> <li>2. Colegio San Viator Wetland</li> <li>3. Chorrillos Wetland</li> <li>4. Club Los Lagartos Wetland</li> <li>5. Salitre Greco Wetland</li> <li>6. Mamá Dominga Wetland</li> <li>7. El Dorado Airport Wetland</li> <li>8. La Florida Wetland</li> <li>9. El Burrito Wetland</li> <li>10. Tingua Azul Wetland</li> <li>11. Los Arrayanes (North edge) Wetland</li> <li>12. Shelter of "Tingua de Pico Verde" of the Universidad de Ciencias Aplicadas Ambientales (UDCA)</li> <li>13. Colegio San Jorge de Inglaterra Wetland (Suba)</li> <li>14. Biorefugio Zasca Colegio Los Nogales Wetland</li> <li>15. Laguna de Chinará Wetland (Usme)</li> <li>16. Chicú</li> <li>17. Humedalito del Salitre</li> <li>18. El Cortijo Wetland</li> <li>19. Nuevo Cortijo Wetland</li> </ol> | <ol style="list-style-type: none"> <li>1. Lake Simon Bolivar Park</li> <li>2. Botanical Garden Wetlands</li> <li>3. Jardines de Paz cementary lake</li> <li>4. Jardines del Recuerdo cementary lake</li> <li>5. Timiza Lake</li> <li>6. El Lago park or Los Novios park</li> <li>7. Country Club Lago</li> <li>8. Ciudad Montes park lake</li> <li>9. Club Choquenzá lake</li> <li>10. Lakes Club Campestre El Rancho</li> <li>11. Carmel Club lake</li> <li>12. Club Campestre Guaymaral lake</li> <li>13. Club Los Búhos lake</li> <li>14. Chisacá lagoon</li> <li>15. Compensar Av. 68 Lake</li> </ol> |

Note: Own elaboration with the information of (Escobar Moreno, 2016)

#### 4.1 Flood risk and urban wetlands in Bogota

The most important and recent flooding event in Colombia, including the capital in 2010 – 2011 was caused because Bogota river overflowed during the effects of “La Niña” phenomenon. In which rainfall levels exceeded the normal average, leading to flooding events that affected 711 properties and left 32,365 families affected in Bogota (SDA & IDIGER, 2015). It is mentioned that these effects respond not only to the impact of climate change but to the progressive deterioration of river basins, the draining of marshes, swamps and wetlands; and deficiencies in planning, land management and inter-institutional coordination (Defensoría del Pueblo Colombia, 2011)

Due to the proximity to Bogota river, extreme rain events presented during those years, the city and its surroundings were flooded close to the wetland areas, especially in the west and south part of the city. A situation that is linked to the housing settlement and urban encroachment in the river floodplains, that are also located in the areas for preservations and environmental management of water bodies (IDIGER, 2016).

Bogota's most flood-prone areas have been identified in the western part of the city, as it is a flat area with a low slope and low capacity to evacuate water flows (IDIGER, 2020). These areas are identified in the flood map zoning of 2018, which identifies areas in the urban

perimeter of Bogotá, with the high, low, medium risk hazard. This map was issued by the Resolution 1060 of 2018 of Bogotá Secretariat of Planning [Secretaría Distrital de Planeación - SDP]. The Figure 6 shows the hazard map and the location of urban wetlands in the city.

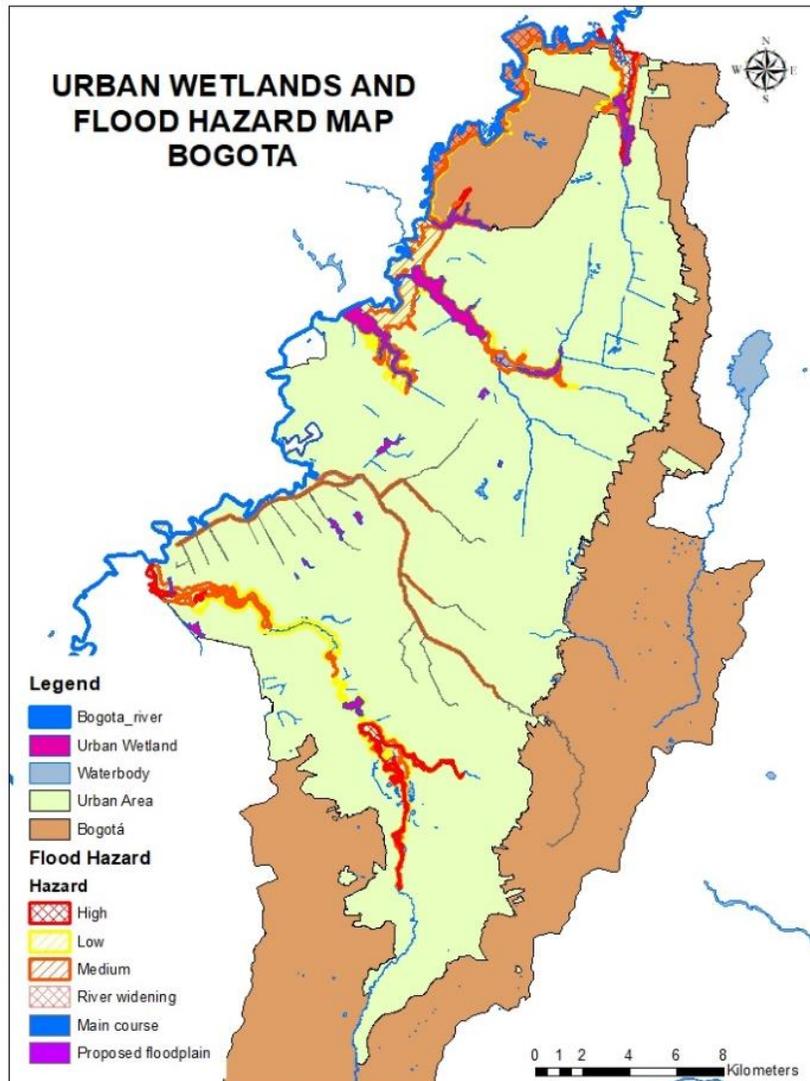


Figure 6 Urban wetlands and Flood hazard map.

Own elaboration, based on the flood hazard risk map in Bogotá and the wetland areas, "GEOPORTAL" from SIRE accessed 13 April 2020, < <https://www.arcgis.com/apps/webappviewer/index.html?id=fa4b277533584c3a95a9208b4d542e19> >

## 5 State of the art: The role of urban wetlands on floods

According to with the research made in international databases of published papers related with urban wetlands, it was possible to find several studies, with diverse approaches, such as biological and ecological description, identification of ecosystem services, among others. However, regarding this UW with DRR and Eco-DRR, results are scarce. Despite this, regarding flood management, wetlands have more participation in research from this field.

For example, Janssen *et al.* (2014) and Gunnell *et al.* (2019), mentioned in their respective studies, that “greening flood protection” (GFP) and “nature-based flood protection”, also called “nature-based flood management”, are strategies that use the natural characteristics of ecosystems. Such as wetlands to mitigate and reduce flood risk, either in inner or coastal lands. Especially this last author, carried out hydrological modelling using metrics from WaterWorld (V2) for examining flood risk reduction. Highlighting areas that have more runoff than storage capacity and those where natural infrastructures, such as canopy cover, soil and wetlands; could help in storing more water due to their maintenance and restoration, therefore alleviate flood risk. This model was developed in Bogotá, Colombia; New York, Chennai, India; Jakarta, Indonesia and Guayaquil, Ecuador. The main results regarding Bogota after modelling were in the first place that storage capacity of the natural infrastructure of the city in upstream basins comes principally from the canopy (45.7%), soil storage (31.4%). Meanwhile flood plain corresponds to 14.5 %, waterbodies 7.2% and finally wetlands with only 1.2%. Also it is mentioned that most of Bogota upstream basin has the potential to flood on an annual basis (Gunnell *et al.*, 2019).

On the other hand, research regarding flood risk reduction or flood mitigation, hydrological modelling is a tool that has been developed by some scientist that have interest in associate ecosystems services, such as flood control, into the urban contexts of planning and management. This is the case of Barbedo *et al.* (2014) that mention in their study that to reduce urban flooding, is fundamental to know and recognise the potential of water flow regulation systems of ecosystems, in this case, to preserve urban flood plains. These models allow quantifying the benefits of flood mitigation, as an essential input for wetland assessment of values for design strategies for conservation of periurban landscapes, like in their study case of the Brazilian coastal city of Paraty.

Equally, Wu *et al.* (2020) developed a hydrological model in Nenjiang river basin, in China, where they have researched the attenuation efficiency of wetlands on flood generation and magnitude, considering a large river basin. As a result of the model, they conclude that wetlands have different behaviour depending on where they are, attenuating or having an amplification effect. With this, the study demonstrated that the restoration of these ecosystems could improve hydrological resilience to flooding risk in a river basin, and also mention that this study can be applied to other large river basins, as part of the examination of management policies regarding wetlands restoration.

In the national context of Colombia, open databases, such as universities and the Alexander von Humboldt Biological Resources Research Institute [Instituto de Investigación de Recursos Biológicos Alexander von Humboldt] were consulted to identify studies regarding urban wetlands and DRR studies. It was found that since Colombia is part of the Ramsar Convention in 1998, the country has increased the research and studies about wetlands, especially since Colombia's National Policy for Inland Wetlands was established in 2002. Several studies developed by institutions aim to make a diagnosis of inland and coastal wetlands in the country, which undoubtedly generated a conceptual and knowledge base for decision making in the country regarding these ecosystems.

Likewise, Urban wetlands in Bogota have had in the last decades a greater interest from the national, regional and local perspective. Wetlands in the city are the most known, and are also the most damaged, because of the unplanned construction of the city subtracted more than 99% of their original coverage, transforming them by urban occupation, wastewater, landfills. All this caused by neighbourhoods, roads, parks, bike paths, poplar groves, squares and public service infrastructure (Calvachi *et al.*, 2013).

Several studies in Universities in Colombia, of Bachelor and postgraduate programs, have included wetlands as a research topic. However, those have been developed mainly the biological, chemical and ecological characteristics, environmental problems and social interaction with them, even if those wetlands are not natural. This is one of the facts that was analysed by Lara (2017). The author reviewed over 1070 thesis in Colombia between 1980 and 2017. As a reference, it was reviewed the list of studies (Annex A). This review was considered to identify wetland related thesis in Bogota from 1998 (year of the integration of Colombia to

the Ramsar convention) and 2017. It was found that over 100 studies had developed the theme of wetlands in the city in an explicit way. Nevertheless, only one study was recognised with the topic of urban wetlands and flooding events, which demonstrates that these matters have not been investigated to any great extent.

## 6 Objectives

### 6.1 Main objective:

*Analyse the role of urban wetlands in flood risk reduction in Bogotá, Colombia.*

### 6.2 Specific objectives:

- I. Identify the loss, degradation or restoration of urban wetlands in the study area according to its ecosystem service of flood control.
- II. Analyse the existing risk management scheme in the City of Bogotá to identify the degree of inclusion of ecosystems in general and wetlands in particular, in disaster risk reduction.
- III. Explore the potential to improve the current management scheme and health status of one wetland in Bogotá by analysing best practices around the world on wetland management in urban wetlands.

## **7 Methodology**

The development of the thesis has a qualitative approach according to with characteristics of the research. The methodology of this thesis has five methods to achieve the main and specific objectives. The first method is the literature review. This is transversal to all objectives.

For the first objective, it was necessary to consult diagnosis and research of urban wetland in Bogotá, to be able to identify the state of the ecosystem. In the same way, open cartographic data of the district entities in Bogotá were consulted for developing the time-space analysis; which is the second method, applied in the first objective.

For the second objective, a literature review was focused on consulting policies and risk management zoning in the city. Also, for this objective, was necessary to apply the review of risk management scheme, develop interview with experts, and make a stakeholder analysis and mapping. These last correspond to the methods three, four and five.

Finally, for the third specific objective, a literature review was related to best practices or study cases of urban wetlands management regarding flood control.

This overview of the methodology is shown in Figure 7. It is important to mention that the methods and activities developed during the study are described further below.

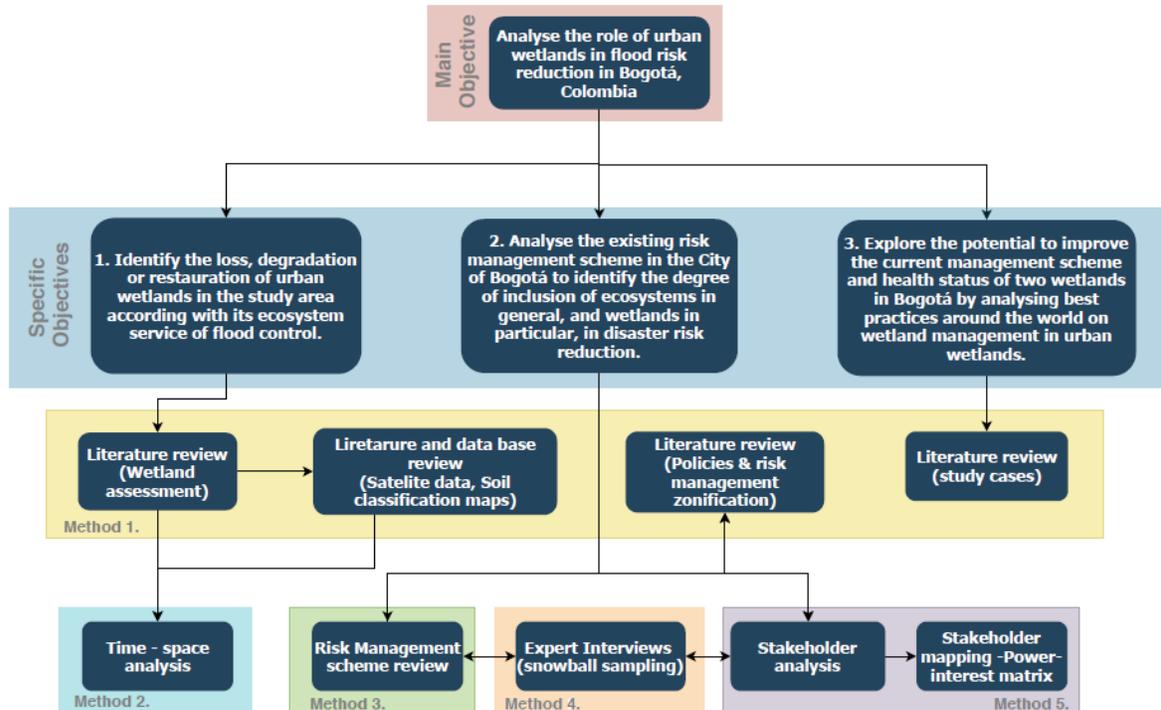


Figure 7 Overview methodology.  
Source: own elaboration

### 7.1 Identification of wetlands loss, degradation and restoration regarding flood control

To aim this objective one, in the first place, and space-time analysis was made to be able to identify the loss and main changes that urban wetland must face, principally due to the urban expansion. Literature review regarding wetland studies and research in Bogota was the main source, also the interviews with experts, in like manner to identify the restoration activities in these ecosystems.

It was necessary to focus the analysis in one wetland: Jaboque ecological park of wetland, due to the extension of the city and the different characteristics and conflicts that wetlands have. Mainly, that wetlands in the north part of the city have higher rainfall rather than wetlands in the southern region, which increases the amount of water in them, improving their environmental conditions; due to the climatic conditions of the city (Rodríguez Alarcón, 2016). In the same way, the official flood hazard map for the city was considered (issued by SDP through the resolution 1060 of 2018).

The aspects that led to this selection were three: i) Wetland needed to be recognised as a “District ecological park of wetland” and have an environmental management plan; to be able to identify how this management tools have or not worked to the maintenance of the ecosystem. ii) Location in an identified flood hazard area (flood hazard map of 2018), which in this case is due to the direct connexion with Bogota River and the ecological connectivity that still have to it and the flood control ecosystem services that it even might have. This last characteristic was possible to identify due to the literature review, but also from the interviews with experts. This last has mentioned, that probably the wetlands that might still have some flood control capacity are those that have some proximity to the remaining rivers in the city. Moreover, these wetlands have had some measures of “course” maintenance to protect and restore their waterbodies, aspect that is considered in the environmental management plan. iii) Proximity to a non-recognised wetland, an element that has great interest, due to the connectivity that these two areas have. This non-recognised wetland is La Florida, which by stakeholders like Fundación Humedales de Bogotá have developed the identification of these areas as wetland ecosystems, mentioned in the publication “Urban Nature: Platform of experiences” (Naturaleza Urbana: Plataforma de experiencias) by Mejía (ed) (2016). Is important to mention that La Florida is recognised by the city as an urban park where “birding” is one of the main attractions in the city.

- Description of the study area: Jaboque wetland

The Jaboque wetland is in the locality of Engativa, northwest of the city of Bogotá, covering an area of 148 hectares. It is recognised as a Wetland District Ecological Park and is part of the Salitre River basin; which an important hydric system integrated by seven canals, three of which converge in the protected area of the wetland. It is the second largest in Bogotá after the Juan Amarillo-Tibabuyes wetland. It is bordered to the north and south by urban areas, to the west by the Bogotá River and to the east by the Bogotá Canal: Carmelo, Jaboque and Los Angeles (Cadena Valbuena, 2018). The location of Jaboque wetland is shown in Figure 8

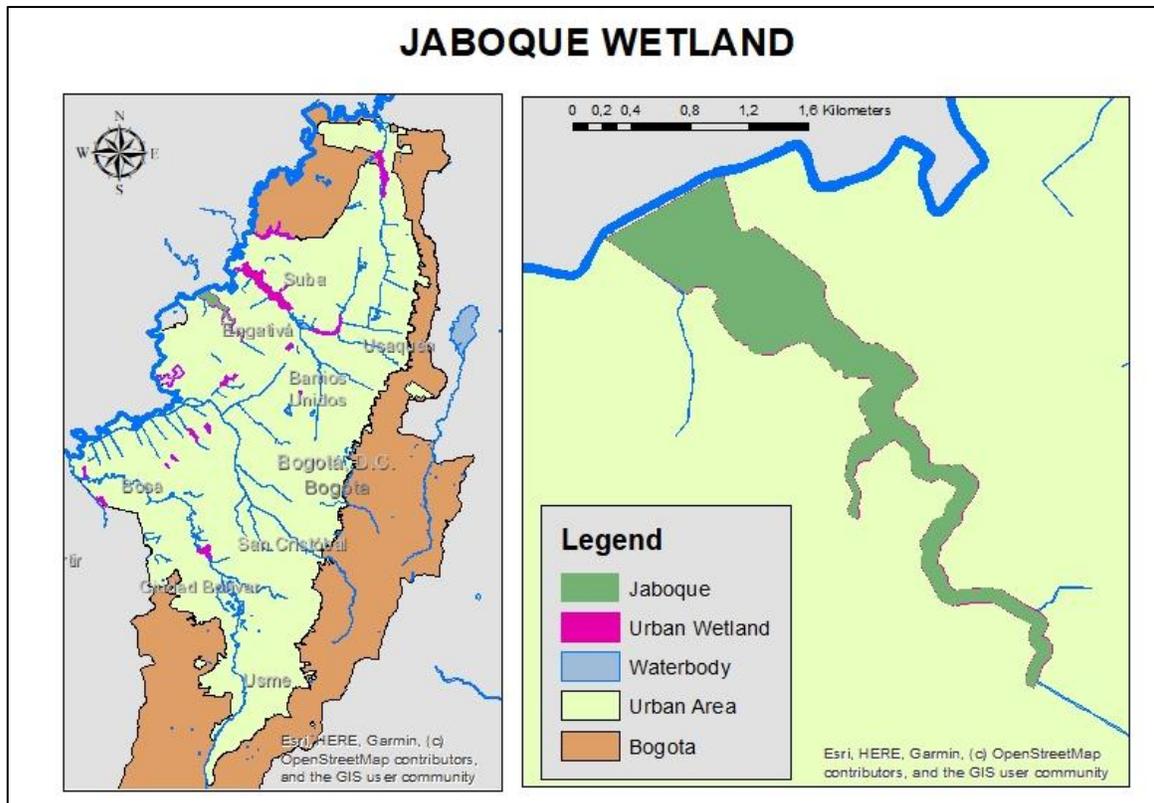


Figure 8 Location of Jaboque wetland  
Own elaboration

The fauna that can be found in this wetland includes amphibians such as the Savannah Frog (*Dendropsophus labialis*); reptiles such as the Savannah Snake (*Atractus crassicaudatus*) and mammals such as the Curi (*Cavia anolaimae*), Squirrel (*Sciurus granatensis*) and Weasel (*Mustela frenata*). On the other hand, there are records of 121 species of birds, where the families with the greatest wealth of species correspond to the families Rallidae (Tinguas and Rascones), Ardeidae (Hérons), Thraupidae (Tanagers) and Icteridae (Toches). Both native and migratory bird species subsist in this wetland, among which are the Tinguá, Turrio Duck, Canadian Duck, White Heron, Cardinal, Canary and Spectacled Parakeet (SDA, 2020).

In the terrestrial area of this wetland, native plant species are found such as The Weeping Willow (*Salix humboldtiana*), the Alder (*Alnus acuminata*), the Tree (*Smallanthus pyramidalis*), among others. Similarly, in this area, invasive species are found, such as Kikuyo grass (*Pennisetum clandestinum*), Black Acacia (*Acacia melanoxylon*) and Eucalyptus (*Eucalyptus*

*globulus*). On the other hand, within the aquatic plant species are found Buttercup (*Bidens laevis*), Reed (*Juncus effusus*), Mullein (*Persicaria punctata*), among others (Escobar, 2020).

## 7.2 Time-space analysis

A Time-Space analysis within 22 years was performed, through the ArcMap 10.6,1 software, to identify how wetlands have changed over this period taking as reference land use planning. That aimed to determine the loss, degradation or restoration of the ecosystem according to its ecosystem service of flood control. The procedure used to develop this analysis started with five steps (shown in Figure 9): orthoimages selection, image digitising, identification of areas prone to flooding events in the last 22 years, check official the flood risk zoning map and perform the final time-space analysis in Jaboque wetland.

The use of orthophoto or also called orthoimages are considered as an important tool to analyse change in territory due. Ortho images “are geometrically equivalent to planimetric maps, which show true geographic locations of terrain features” (Yoo & Lee, 2016, p,227). For that matter, this tool was used to analyse the state of the ecosystem of study. To be able to develop the Time-space – analysis in Bogota, the official images were obtained subject to availability from the Integrated Spatial Data Infrastructure for the Capital District (Infraestructura Integrada de Datos Espaciales para el Distrito Capital – [IDECA]).

The orthoimages were consulted in the online viewer of IDECA, where six images were obtained in WMS format for 1998, 2010, 2015 and 2017 in the <https://www.ideca.gov.co/>. Those images are described in Table 5. Following, it was necessary the Software ArcGis 10.6.1 – ArcCatalog/GIS server to obtain the digital image.

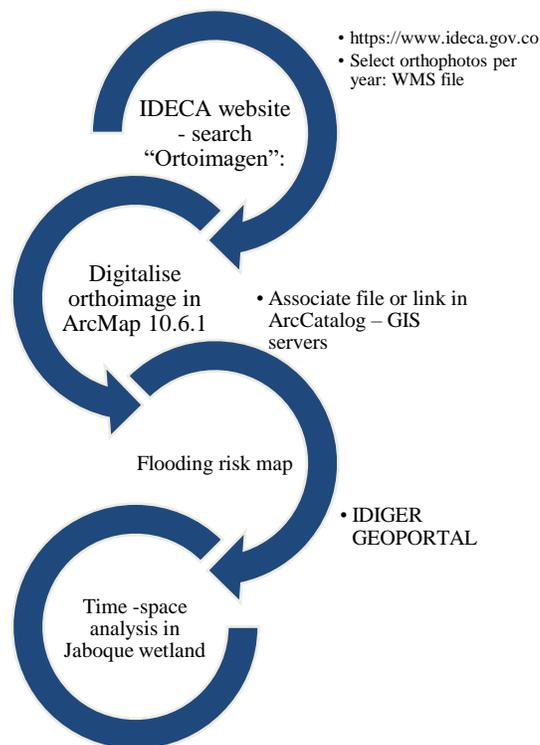


Figure 9. Procedure selection areas for the time- space analysis.  
Own elaboration

Table 5. Orthoimages.  
Source: own elaboration

| <b>ORTHOIMAGE</b>           | <b>LAST UPDATE</b> | <b>SOURCE</b>       | <b>PUBLISHED</b> | <b>DESCRIPTION</b>                               |
|-----------------------------|--------------------|---------------------|------------------|--|
| Othoimage. Bogotá D.C. 1998 | 01.01.1998         | Mapas Bogotá        | 04.07.2020       | Based on photographs from 1998.                  |
| Othoimage. Bogotá D.C. 2010 | 30.09.2010         | Mapas Bogotá        | 29.06.2020       | High resolution orthorectified WorldView-2 image |
| Othoimage. Bogotá D.C. 2014 | 08.08.2014         | Mapas Bogotá        | 08.07.2020       | Digital orthophotomosaic                         |
| Othoimage. Bogotá D.C. 2017 | 31.12.2017         | Colombian Air force | 30.06.2020       | orthorectified raster mosaic                     |

*Note: Description of images are taken from IDECA, accessed 13 April 2020 <<https://www.ideca.gov.co>>*

The official flood hazard map in Bogota was consulted in the open viewer “GEOPORTAL” from Bogota’s “*Information System for Risk Management and Climate Change*” – SIRE. This map, in its fourth version, was updated by the Resolution1060 of 2018 of SDP, and shows the areas with low, medium and high flood hazard. This information was overlapped to the location of urban wetlands, to analyse which areas are close to them and later Jaboque wetland was chosen because the flood hazard and the proximity to La Florida, as it was mentioned before.

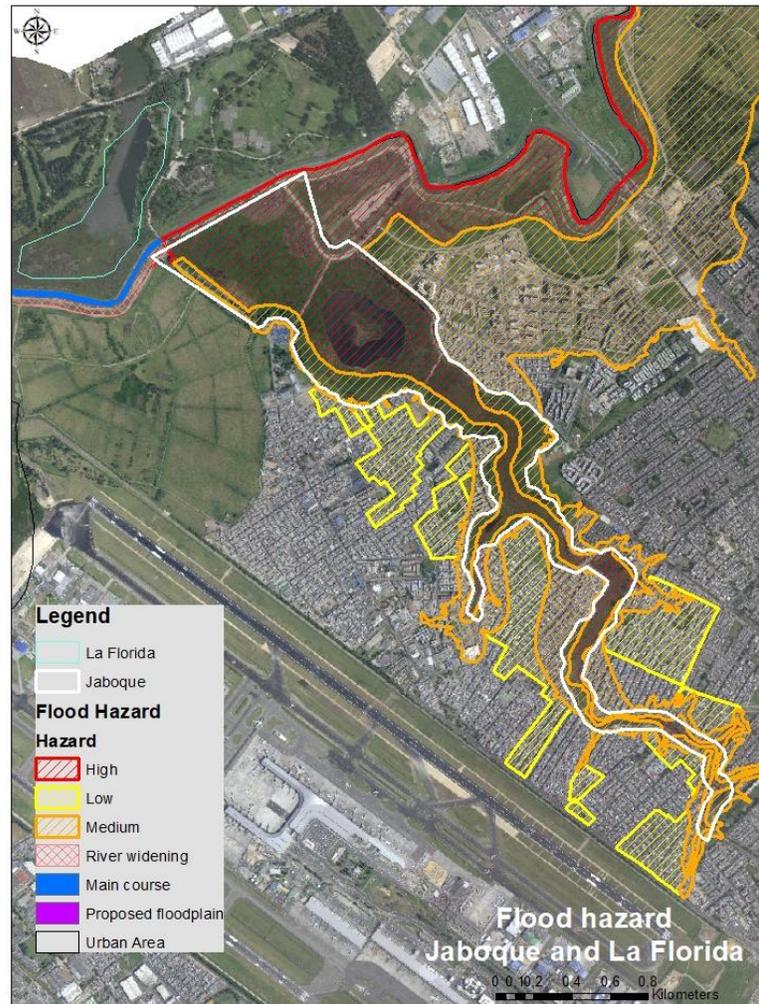


Figure 10 Flood hazard: Jaboque ecological park of wetland  
 Own elaboration based on the flood hazard risk map in Bogotá and the wetland areas, “GEOPORTAL” from SIRE, accessed 13 April 2020, < <https://www.arcgis.com/apps/webappviewer/index.html?id=fa4b277533584c3a95a9208b4d542e19> >; and the Orthoimage of 2017 from IDECA, accessed 13 April 2020 <<https://www.ideca.gov.co>>

After the selection of the wetland, orthoimages of 1998, 2010, 2014 and 2017 were overlapped with the official polygon of Jaboque wetland that was obtained in the open data access of Bogota (<https://datosabiertos.bogota.gov.co/>). However, the official polygon of the wetland, corresponding to the most recent year, was modified for the first three years of analysis. It was considered relicts of the vegetation in areas with no urban expansion or visual evidence of intentional drainage. It was considered the flood hazard limit to identify the possible flooding areas of the Bogota river that might be part of the wetland.

Simultaneously, a review of wetland assessment of previous thesis and diagnosis of different entities were consulted. This to identify the current state of the urban wetlands in the city, especially Jaboque, and to determine how healthy these ecosystems are. The principal sources, as scientific papers on academic databases, Non-Governmental Organisations (NGOs), State and District entities and institutions, foundations, among others, related to wetlands and ecosystem services were considered, focused on flood control of urban wetlands in Bogotá.

Finally, after developing the previous steps, analysing the consulted diagnosis, and considering referred information from experts and the maps generated, the loss was calculated by the difference of areas that the ecosystem has had during the period of analysis. Second, the degradation was approached also considering the results of the loss or recover of area, the literature review of the current state and previous events that affected it. And finally, restoration was identified by the management plan and actions developed in the wetland of study by the local government, other entities or the community.

### 7.3 Risk Management scheme review

To meet the objectives, it is crucial to recognise the importance and relevant role of local governance, as is highlighted by RAMSAR (2012). In Colombia, in the last decades, there has been great improves in policies that aim to maintain, preserve and restore ecosystems, nevertheless this has been made due to the international interest to maintain ecosystems, reduce risk and disasters and also, adaptation to climate change.

According to the revision and consultation of the policies that could integrate wetlands in the risk management scheme in Bogotá, was necessary first to understand the national context of risk management, as this is the reference for most of the management regulation in the city. From this point, it was also important to consider that there are three main management systems in Colombia. They are related with the topic of interest of this study, which is the National environmental system (SINA), National disaster risk management system (SNGRD) and the National climate change system (SNCC). All three are involved in some way in the management of adaptation and mitigation of climate change, and consider hydrometeorological phenomena like El Niño and La Niña as main causes of disasters in the country, being flooding the most recurrent emergency event in the period between 1998 and 2012 (DNP, 2014)

The risk management scheme in Bogotá has been developed under diverse aspects through the time. Nowadays, IDIGER has categorised legislation regarding risk in four big topics of approach: Governance, knowledge of risk and effects of climate change, risk reduction and adaptation to climate change and, emergency and disaster management. In this classification, national or local laws, resolutions, agreements, among others, can be related to one or more topics. That is the principal source of information about the management scheme. However, referred information of experts was also considered. That is why key policies regarding water management, biodiversity management and adaptation to climate change are also considered in the analysis, due to the relevance in environmental management and conservation of fragile ecosystems like wetlands, as deemed by Ramachandra, Aithal and Kumar (2012).

Moreover, for the current study, the review was done on the premise of identifying whether the ecosystem services of Bogotá's urban wetlands were or not, considered in the formulation the legislation, especially the flood control. For that matter, the review of the main wetland policies was also consulted in the national and local level.

Finally, to show the full selection of policies that were considered relevant to this study, a chart was constructed, relating wetland, risk and climate change and, disaster and emergencies management, which is shown in Annex 3. Policy scheme: wetlands/ Risk and climate change/ Disaster and emergencies management.

#### 7.4 Stakeholder analysis

There are diverse definitions of stakeholder, which result from different perceptions. The description of Freeman (1984) suggests that: *A stakeholder is any group or individual who can affect, or is affected by, the achievement of a corporation's purpose. Stakeholders include employees, customers, suppliers, stockholders, banks, environmentalists, government and other groups who can hurt or help the corporation* (Bevan and Werhane, 2011, p. 37). This definition can be associated with corporative environments; nevertheless, as mention by Reed et al. (2009) stakeholder definitions in literature are part of a debate of defining what constitutes a legitimate stake. For that matter, it is essential to recognise which are the contextual actors by performing a stakeholder analysis (SA), which is considered as a powerful tool to know and understand

system, its changes; and its performance in nature resource policy and programme development (Grimble and Wellard, 1997).

This analysis was considered, to be able to identify the main stakeholders related to urban wetlands and the risk management in Bogota, especially flood risk reduction. At the same time, this tool helps to determine behaviour, interaction, intentions and interest of actors in the natural system of study, which can be related to the decision-making process and implementation. This study considers Varvasovszky & Brugha's (2000) primary considerations to perform a SA. Those are the determination of frame, scope, and the level where the analysis takes place, which can be local, regional, national and international, which influences the collection of data and who to consider as a stakeholder.

As a first step was performed identification of key stakeholder in the different levels, starting with a literature review. To cover their perception, 20 semi-structured interviews with experts were conducted between March and August. However, 18 were performed via Online platforms due to the outbreak of COVID 19, announced by the World Health Organization as a pandemic on the 12<sup>th</sup> of March. The complete list of interviewees and function is in Annex 1. List of interviewees.

All interviews had a qualitative approach of data collection, which are identified by Patton (2002) as open-end interviews with three alternatives: (i) the informal conversational interview where the questions are generated in a spontaneous and natural interaction as a part of participatory observation fieldwork. (ii) The general interview guide approach considers a set of issues that need to be explored. For example, through a prepared checklist during the interview to cover all the topics of interest; and (iii) the standardised open-ended interview, which has a set of arranged questions, with limited flexibility, appropriate to minimise variation in questions given. This study performed mainly the first two alternatives. Therefore, key topics were selected considering the specific objectives 1 and 2, to enrich the information found in the literature. Also, this allowed for a more realistic and grounded view of the actions taken concerning environmental and risk management in the city of Bogotá. Key topics and questions are shown in Table 6.

Table 6 Key topics and questions for interviews

| Key Topic  | Key Questions   |
|--|---|
| <ul style="list-style-type: none"> <li>-Changes in wetlands over the years</li> <li>-Wetland management</li> </ul>   | <ul style="list-style-type: none"> <li>-Which are the ES of the urban wetlands in Bogota?</li> <li>-How has the wetlands health change over the years?</li> <li>-Which functions or services have been recovered or lost over the years?</li> <li>-What is the perception of the declaration of Ecological Parks concerning the conservation of wetlands in the city?</li> <li>-What is the perception of the RAMSAR declaration of Bogotá wetland complex, and could that contribute to their conservation?</li> <li>-How are the city's unrecognized wetlands taken into account?</li> <li>-Management plan contemplated risk reduction?</li> <li>-What is the potential to reduce flooding risk?</li> <li>-How have ecosystems been considered in environmental policy?</li> </ul> |
| <ul style="list-style-type: none"> <li>-Ecosystem-based Disaster risk reduction in the city: Wetlands as a tool for flooding prevention</li> <li>-Natural-based Solutions</li> </ul> | <ul style="list-style-type: none"> <li>-Have wetlands been considered as part of risk prevention, especially the risk of flooding in the city of Bogota?</li> <li>-How has been the measures/improvements in the city have had regarding flooding?</li> <li>-What actions have been developed in the city for flood control?</li> <li>-What is the potential for improved flood management and disaster risk reduction?</li> <li>-Management scheme: from ES (flooding control) or ecosystemic characteristics?</li> <li>-Flooding: is possible for the wetland to improve the capacity of flood control?</li> <li>-NbS is being promoted in the country/city?</li> </ul>   |
| <ul style="list-style-type: none"> <li>-Stakeholders in wetland management and DRR.</li> </ul>   | <ul style="list-style-type: none"> <li>-Which are the main entities that are key to maintain wetlands in the district?</li> <li>-How is the interconnection with other entities?</li> <li>-How is the interaction between the academy within the processes of wetland management in the city?</li> <li>-Which can be possible solutions to the lack of communication between entities?</li> <li>-Which can be actions to include wetlands in the city and citizens perception of them?</li> <li>-Which are the key actors for the Eco-DRR in Colombia</li> </ul>  |

Based on the first interviews conducted with the key actors, stakeholder identification was also possible. It was applied the non-probabilistic method of “snowball sampling”, that consists in a link-tracing sampling of collecting data on population members, used in hard-to-reach populations considering interpersonal environments and opinion of leader or followers (Handcock and Gile, 2011), which in this case correspond to the experts interviewed.

The second step of the Stakeholder analysis was the classification of the identified actors, according to their influence and importance. Grimble & Wellard (1997, p. 176) mentioned that “*importance refers to those whose needs and interests are the priorities of aid while influence refers to the power certain stakeholders have over the success of a project*”. Also was highlighted that the Overseas Development Administration - ODA (1995) advised for classification of stakeholders, using a matrix for assessing their importance and influence into a

graph. In the same way, Ackermann & Eden (2011) applied the power/interest grid, wherein each quadrant a category of stakeholder is defined. These authors describe the characteristics that stakeholders might have according to their location in the matrix; in the context of a firm. However, this can be related to their behaviour, interest and influence in decision making processes under the natural resource management (Reed *et al.*, 2009).

In the matrix, the upper two categories group are the most “interested” actors, with differences in their power. Those located on the top right are considered the “key players” that have more power to support or sabotage strategies; meanwhile, stakeholders situated on the left side are the “Subjects” that have less influence. The lower categories show the “Context setters”, which potentially can have more influence in the decision-making process; however, its required strategies to operate. Finally, in the last quadrant are the “Crowd”, which currently have lower power and interest to influence strategies (Ackermann and Eden, 2011). The outline of the classification of stakeholders adopted in this study is in the grid shown in Figure 11.

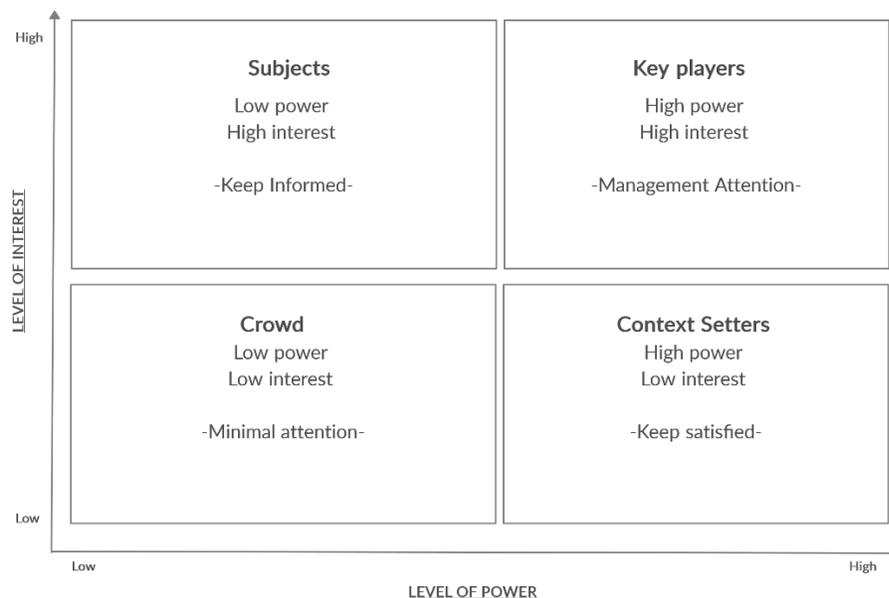


Figure 11. Outline Stakeholder grid.  
Source: own elaboration, adapted from Ackermann & Eden (2011) and Grimble & Wellard (1997)

Other aspects that are considered in a management context is that “key players” are those stakeholders that managers must face and satisfy to be successful. “Subjects” could encourage actions to increase power to have more influence in an issue, these have important in projects

or activities in the local influence of power like a woman and the poor, and managers should keep them informed. “Context setters” can influence in the future overall context, and managers should raise awareness and keep them satisfied to convert them into players possibly; however, those are not considered always as the main target. Meanwhile, Stakeholders considered as “Crowd” require minimal attention and effort from management. (Boddy, 2008; Ackermann & Eden, 2011; Grimble & Wellard, 1997)

Finally, with all stakeholders identified and classified, and the referred information from the expert’s interviews and literature review, was possible to understand better the dynamic of different actors and their role in urban wetlands in Bogota regarding flood risk reduction.

#### 7.5 Potential of improvement of urban wetlands management in the risk management scheme in Bogotá

To meet the third objective, results from the time-space analysis, the review of the management scheme in Bogota related with urban wetlands and disaster risk reduction and the stakeholder analysis, helped to recognise key aspects and challenges that Bogota has to develop Ecosystem-Based management. It was necessary to develop a review of success cases where cities that have urban wetlands have been able to improve their management and health, involving flood risk reduction. The literature review was done through international databases of scientific publications, and the primary keywords of the research were: “urban wetland”, “urban wetland management”, “flood risk reduction” and “disaster risk reduction”,

One of the aspects to select the experiences of management, was to consider places with similar characteristics as Bogota, or wetlands like Jaboque, which is located close to a river and has been affected by urban extension and low water quality. Having these cases or initiatives was intended to highlight the applicable cases in the area of study.

## 8 Results

### 8.1 Interviews with experts

Twenty interviews conducted were part of the most imperative methods for obtaining information, as was the literature review. These results of the interviews were taken into account for the fulfilment of the objectives of this thesis.

Due to the current situation of COVID -19 pandemic, 18 of them were performed online. It was possible to contact experts from different groups of stakeholders. Nine of them are part of the Academy (University teachers and researchers) or research institutes. Four local and international Non-Governmental Organizations (NGOs) were contacted; one from the consultancy (with expertise in research as well); five District and National entities and one member of a civil organization (See Table 7).

Table 7 Total of interviews per stakeholder group  
Own elaboration

| <b>Stakeholder group</b>     | <b>Num. Interviews</b> | <b>Percentage (%)</b> |
|------------------------------|------------------------|-----------------------|
| Academy/Research institutes  | 9                      | 45%                   |
| NGOs                         | 4                      | 20%                   |
| Private sector (Consultancy) | 1                      | 5%                    |
| Entities                     | 5                      | 25%                   |
| Civil organization           | 1                      | 5%                    |
| <b>Total</b>                 | <b>20</b>              | <b>100%</b>           |

Interviews were semi-structured and guided by key topics a question. The topics in every interview were developed according to the expertise of the interviewee. Is noteworthy that all proposed key topics were able to be covered by the total performed interviews, as shown in Table 8, which keep the number of each interviewee in Annex 1. List of interviewees. Moreover, the transcription of all twenty interviews can be found in Annex 2. Transcript of expert's interviews. Is important to mention, that all information given by the experts correspond to the experience they have, and it was allowed to be used into the development of this thesis.

Table 8 Topics developed in the interviews  
Own elaboration

| Topic   | Interviewee |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
|---|-------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
|   | 1           | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Changes in wetlands over the years                              | x           |   |   | x |   | x |   | x |   | x  |    | x  |    | x  |    |    |    | x  | x  | x  |
| Wetland management  | x           | x | x | x |   | x | x | x |   | x  | x  | x  | x  | x  |    |    | x  | x  | x  | x  |
| Eco-DRR in the city: Wetlands as a tool for flooding prevention |             | x | x | x | x | x | x | x | x | x  |    |    | x  |    | x  | x  |    | x  | x  | x  |
| Nature-based Solutions  |             |   |   | x |   |   |   |   | x |    |    |    | x  |    | x  | x  |    | x  | x  | x  |
| Stakeholders in wetland management and DRR.                     |             | x |   | x | x | x |   | x | x |    | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  |

Note: The name of the interviewees are mentioned in Annex 1. List of interviewees.

In consideration of the “Annex 2. Transcript of expert’s interviews” and the topic classification and the interviewees in Table 8. several answers were very similar in some aspects. It was possible to highlight and summarise the overview of the recurrent responses obtained throughout the interviews as following described.

- Changes in wetlands over the years

Most of the interviewees mentioned that wetlands in the city have been affected by human activities like urban expansion, encroachment, agriculture, among others. It was recognised that the health of urban wetlands in the city depends on the location and their dynamics and conditions of the site, social appropriation, management.

It was mentioned that wetlands have a negative perception due to the diverse conflicts that are present in these ecosystems. One of them is the insecurity given by robbers, drug dealers and homeless (Sarmiento, 2020, pers.com).

The canals and other infrastructure have carried wastewater from different areas of the city to the wetlands, reducing their water and soil quality. (Villalobos, 2020, pers.com; and Sarmiento, 2020,pers.com).During the last years, “misconnections” of sewage are being

identified to be closed, to improve water quality in wetlands, in the same way, is known that illegal connections also discharge wastewater into wetlands (Olaya, 2020, pers.com).

Specific actions have developed beneficial results for the ecosystems, mainly worked from the local level. These actions could also promote regional, national or international initiatives to protect wetlands. Activities should be performed from bottom to top (Nieto, 2020, per.com).

- Wetland management

Since the creation and design of the District Wetland Policy and the national policy for inland wetlands, these ecosystems have had more attention and management. Tools like environmental management plans allowed in some wetlands to improve their health. However, it is also known that several wetlands have management plans; their conditions have not improved due to lack of monitoring and continuity. In the same way, the definition of ecological park of wetland has given place to the conservation of the ecosystem, especially considering that thanks to it. However, the construction of a specific type of hard works is allowed (Escobar, 2020, pers.com).

Most of the environmental management plans were focused on biodiversity, biological or hydrodynamic aspects (Garzón, 2020, pers.com). Some actions that have implicit the risk reduction, like keeping the water levels, but usually does not have the approach of DRR. Also, wetlands are not managed as a system, but as an individual ecosystem (Sarmiento, 2020, pers.com).

The declaration of Ramsar site for the urban wetland complex in Bogota is an international recognition that is valuable for the city and the country. However, this does not represent a guaranty for wetland management and preservation of the ecosystem as has happened with other Ramsar sites in the country with other Ramsar sites like Ciénaga Grande de Santa Marta (Escobar, 2020, pers.com; and Ayazo and Ruiz, 2020, pers.com).

- Eco-DRR in the city: Wetlands as a tool for flooding prevention

Bogota has a risk management scheme that has identified the flood hazard areas, which are located principally close to the rivers and streams (Castaño, 2020, pers.com).

The city has developed diverse grey infrastructure to control and mitigate floods (Garzón, 2020, pers.com; and Sarmiento, 2020, pers.com). However, this infrastructure has reduced connectivity with other natural sites in the city. Which can be associated with the traditional engineer solutions developed in the country, that traditionally had not considered ecosystems in the designed as part of the solution. Also is related to the “hydraulic vision” of flood control (Andrade, 2020, pers.com).

Ecosystems have taken more part in the policy design for resilience and DRR actions. However, it is the political will of those in power that allows ecosystems to have a more significant presence in politics and in the projects to be implemented (Amaya, 2020, pers.com; Lacambra, 2020, pers.com and Gomez, 2020, pers.com)

Evaluation of ecosystem services of ecosystems is a challenge. Especially in flood control, because to determine store capacity, is needed to develop more research help the decision-makers to establish new and more green alternatives to manage flood risk (Lacambra, 2020, pers.com)

- Nature-based Solutions

There is a high potential to develop NbS due to the significant incidence that it might have in the city, mostly related to Eco-DRR. However, it is essential to mention that there is a lack of blue and green infrastructures in cities to cope with disasters (Rianudo, 2020, pers.com).

NbS is an emerging topic in the country, which is referenced by the international cooperation and conventions that Colombia is a member. It can be advantageous to governance (Castaño, 2020, pers.com).

Climate change is the primary input to include NbS as a complementary action for climate change adaptation. In the political aspect, Colombia has several environmental policies, where EbA is not expressed, but contribute to the conservation of biodiversity and resources, but also there are contradictions in national, regional and local policy, and the implementation of those policies (Rianudo, 2020, pers.com).

- Stakeholders in wetland management and DRR

Various community initiatives have been the main reasons why wetlands in the city are increasingly recognized. It was mentioned that the city's wetland policy took into account different stakeholders in its formulation. However, this has not been consistent over time.

The principal interaction of the community with the risk management entities is through the local community committees.

It was possible to identify the principal stakeholders that are involved with wetlands and risk management; however, this result will be further developed in the subchapter 8.4 Stakeholder analysis.

## 8.2 Wetlands loss degradation and restoration: Jaboque wetland

The results corresponding to the first objective, are shown in the first place the time-space analysis, followed by the identification of loss, degradation and restoration of the Jaboque wetland, though they complement each other.

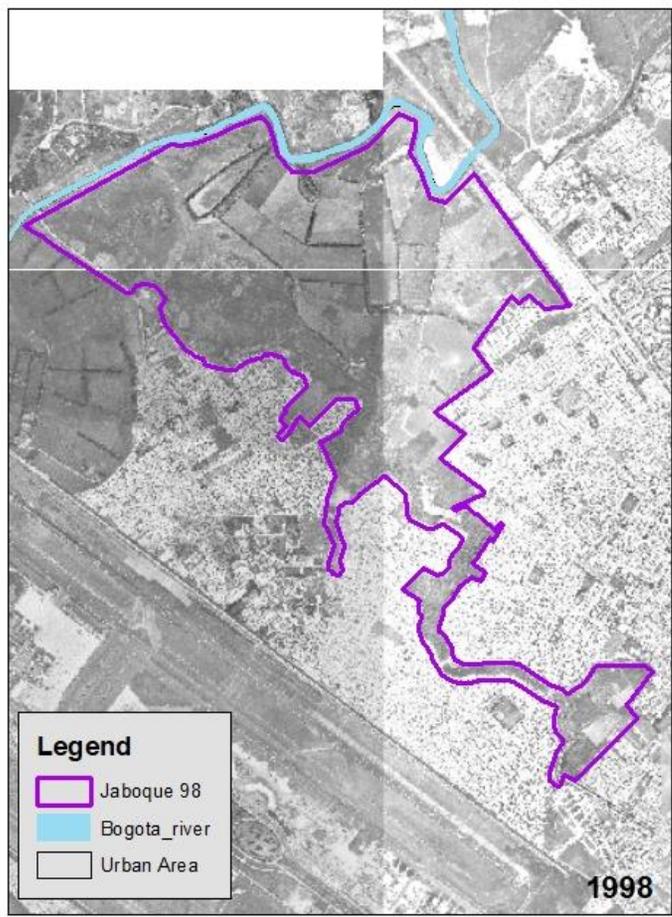
- Time-Space analysis

Is important to mention that even though the Jaboque wetland was declared as an urban ecological park of wetland and, is part of the main ecological structure in the city in 2004, this wetland has been affected by the pressure of urban expansion and intentional drainage processes. This can be identified in all four maps that were made for every year of analysis (1998, 2010, 2014 and 2017), which are illustrated in Figure 12 and Figure 13.

In the map corresponding to 1998 (Figure 12), before the wetland was declared as an urban ecological park of wetland in 2004, is evident that in the northern part of the wetland, close to the river, it has suffered land intervention. Is possible to identify private lots, delimited between them with living fences. In the same way, the southern part of the wetland is notorious a dense urban expansion and reduction of the natural area. According to Segura Castellanos (2013), several neighbourhoods in the area were initially illegal locations, which were later legalized by the city by obtaining public services, especially in the late 1980s. In the same figure, map of 2010 shows that the area in the north close to the river has urban constructions, and the soil is heavily drained and eroded. Is assumed, that the areas that were identified in 1998 free of

urban buildings, were occupied after the declaration in 2004. It is worth mentioning, that this modification of the polygon is based on the official delimitation of the wetland. It intended to show the possible terrestrial area of the wetland that was lost without detracting from the criteria of the authorities at the time of delimitation.

Meanwhile, in Figure 13, the map of 2014 has an area very similar to the polygon of 2017. In comparison with the maps of 1998 and 2010, it is evident the more massive urban construction that is in the northern part of the wetland with considerable proximity to the river. This area is identified in Figure 10, with a medium flood hazard. The main difference between these two maps of 2014 and 2017, is that the official polygon does not consider the northern not urbanised area as part of the wetland. This can infer that is part of the flood plain of the Bogotá River. Another aspect that is worth mention is that the inner part of the wetland, in 2017 is possible to identify the part of the aquatic area. This can be related to the measures that have been implemented in the district's wetlands by the EAAB to improve the quality of the water and the health of the ecosystem.



**Jaboque wetland  
1998 vs 2010**

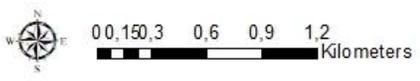
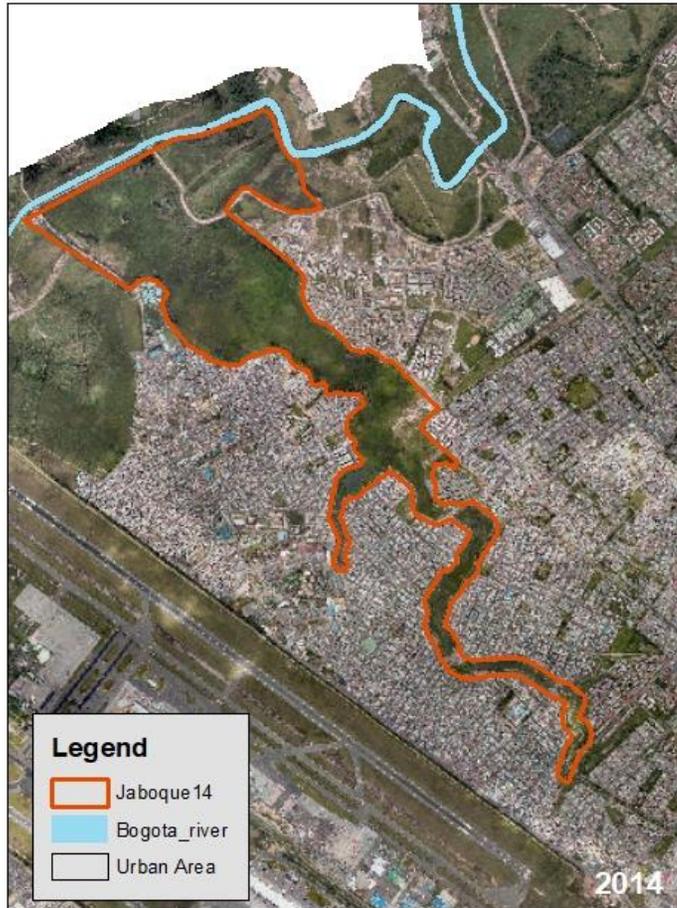


Figure 12 Jaboque Wetland 1998-2010  
Own Elaboration, based on the Orthoimage taken from IDECA, accessed 13 April 2020 <<https://www.ideca.gov.co>>



**Jaboque wetland  
2014 vs 2017**

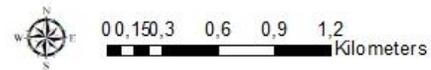


Figure 13 Jaboque Wetland 2014-2017  
Own Elaboration, based on the Orthoimage taken from IDECA, accessed 13 April 2020 <<https://www.ideca.gov.co>>

- Loss of wetland area

In Bogotá, the surface area of wetlands occupied 50,000 hectares in 1940. However, this area was dramatically reduced to only 773 hectares (Renjifo, 1992). This situation has been caused mainly by urban growth. As a result of some protected areas, such as wetlands, was formerly located in peripheral or rural areas and have been absorbed by the accelerated development of the city, resulting in the loss of their eco-logical characteristics (Sandoval 2013; Cortés Ballén, 2018).

During Bogota's population growth at the beginning of the 20th century, the Jaboque Wetland maintained mainly agricultural characteristics with potato, corn, vegetable, and fruit crops. During 1948 to 1958, large civil works were carried out around the wetland, affecting one of its extensions and causing the modification of the water flow in the area. Later, in the 1960s, with the rapid population growth in Bogota due to the arrival of people from the countryside because of violence and civil conflicts, it created scattered, illegal construction, built by self-construction (Peñuela López and Vargas Sandoval, 2018). This had no consideration of planning and control, due to the low economic value due to their high degree of flooding (Cruz-Solano, Motta-Morales and García-Ubaque, 2017). These authors also mentioned that according to the EAAB (2013), the aquatic area of the wetland in 1950 was about 128.62 ha. But with the appearance of new urban settlements, it was reduced by 1989 to 113.17 ha, losing 12.01%. Later, in the 1990s, construction processes intensified for both residential and industrial areas. It was causing the water body to be reduced to 20.02 ha by 2013, a reduction of 84.43% since the 1950s.

In contrast, polygons of Jaboque wetland in 1998, 2010, 2014, and 2017 in Figure 12 and Figure 13, was possible to calculate the different areas for each year of analysis, which are shown in Table 9. In this same table, it is possible to see that between 1998 and 2010, 41% of the wetland was lost, mainly because of the urban encroachment and soil drainage. In 2014 and 2017, the percentage of the lost area corresponds to 13 and 17% respectively. As a result, during the period 1998-2017; 71% of the original calculated area of Jaboque wetland was lost. Which is equivalent to 200 ha. Is important to note, that the polygons for the first three years, were modified from the official polygon of 2017, considering the identified areas that might have

been part of the wetland. Considering that historically, all surroundings were part of the wetland, even though the presence of crops as was mentioned by Cortés Ballén (2018).

Table 9 Loss of Area in Jaboque wetland  
(Own elaboration)

| Year                             | Area (ha) | Lost Area (ha) | Percentage lost area (%) |
|----------------------------------|-----------|----------------|--------------------------|
| 1998                             | 350       | -              | -                        |
| 2010                             | 207       | 143            | 41%                      |
| 2014                             | 181       | 26             | 13%                      |
| 2017                             | 148       | 31             | 17%                      |
| <b>Total lost area 1998-2017</b> |           | <b>200</b>     | <b>71%</b>               |

Note: These areas contemplate the whole aquatic and terrestrial part of the wetland

- Degradation

The ecosystem services provided by wetlands include flood mitigation, water quality improvement, habitat creation, biological productivity, groundwater recharge, sediment retention, nutrient retention, and microclimate stabilization, among others. However, unplanned construction and urban expansion in and around the Jaboque wetland area have affected the dynamics of the system by cutting off the physical, biological and ecological connections between them. The fragmentation generated by roads and perimeter channels, mainly in the upper part of the Jaboque, has made hydraulic and biotic connectivity between the different sectors of the wetland difficult (EAAB and ADESSA, 2006).

As some interviewees mentioned it, due to the arrival of people from the countryside because of violence and civil conflict, this not just generated loss of area of the ecosystem (Villalobos, 2020, pers.com). The perception of wetlands become extremely harmful, because of crime and insecurity by robbers, drug dealing and the presence of homeless people. That is one reason why the inhabitants have had low interest in the conservation of ecosystems in the city (Mejía, 2020, pers.com).

Is recognised by Segura Castellanos (2013) the change in the function of the Wetland from rainwater storage to a wastewater channel since the construction of canals around the wetland to conduct sewage of the close-by neighbourhoods affected the water quality of it. This has also reduced the natural vegetation and the endemic fauna, which has also been affected.

Also, according with EAAB and ADESSA (2006) in the environmental management plan of the wetland, mentioned that there are misconceptions and rainwater with some degree of contamination, due to the washing of the streets. Besides, the water coming from the Carmelo and Los Angeles canals comes with a high quantity of solid waste, which is tried to be retained by means of grids, but which in turn requires the implementation of alternative systems for its cleaning. On the other hand, when the wetland interacts with the Bogotá River at times of flooding, this causes the entry of pollutant loads brought by the Bogotá River to the wetland, with some degree of dilution. As a result, the natural habitat has been affected, producing a high degree of contamination of water bodies, favouring the growth of invasive macrophyte species and other species such as “kikuyo” or grass, which in turn has affected habitats for fauna (Cruz-Solano, Motta-Morales and García-Ubaque, 2017).

There is some community interest in wetlands and environmental leadership in the district. However, in Jaboque wetland, the last years has a considerable setback in this matter, even though it is one of the biggest wetlands in the city (Calvachi *et al.*, 2013). In the same way, some interviewed experts mentioned that the wetland board that worked closely with the Alcaldía Mayor, was suspended, which made more difficult the community participation regarding the wetland. However, the local interest of some neighbours and community organizations are still interested in the health and preservation of the ecosystem.

- Restoration

Through Decree 61 of 2003, by which the Capital District Environmental Management Plan was adopted, Article 9 of the Programme of Strategic Ecosystems and Biodiversity was established, within which the recovery of urban wetlands was discussed. The previous one was repealed by Decree 456 of 2008, which reformed the Capital District's Environmental Management Plan and issued other provisions. In the latter, water quality and hydrological regulation, including that of wetlands, are discussed. On the other hand, the Ministry of the Environment, Housing and Territorial Development (today MADS) issued Resolution 196 of 2006 adopting the technical guide for the formulation of management plans for wetlands in Colombia.

Following Decree 61 and Resolution 1960, in the same year (2006) the Environmental Management Plan for the Jaboque Wetland was formulated by the Asociación el Desarrollo

Social y Ambiental (ADESSA) and incorporates the results of research into ecological restoration carried out by the Empresa de Acueducto y Alcantarillado de Bogotá and the Universidad Nacional de Colombia in 2003. This document sets out the actions required to manage the ecosystem, such as:

- Adequate management of the wetland because it is a zone of high archaeological significance since it has spaces that were part of the Muisca culture, remaining under the parameters established by the Colombian Institute of Anthropology and History (ICANH).
- Creation of open classrooms to implement awareness processes and environmental education projects in concrete actions in the wetland, creating a harmonious nature-society relationship.
- Social appropriation of the territory mainly by actors who have an impact in multiple ways in the area of direct influence, through environmental citizen competencies that contribute to dialogue and decision making regarding these ecosystems.
- Land reclamation for hydrogeological adaptation, physical recovery, ecological rehabilitation of the surrounding area and the management zone, environmental preservation, and perimeter enclosure. This land reclamation refers to the negotiation between the environmental authority, and the habitants of those areas that are identified are necessary to recover and integration into the main ecological structure of the city.

Besides, the “Protocol for the ecological recovery and rehabilitation of wetlands in urban centres” was published by (Alcaldía Mayor de Bogotá - Bogotá Positiva, 2008). This publication has described the state of wetlands, and the measures that should follow to have a proper ecological recovery of the wetlands, considering hydric regulation, terrestrial, aquatic and semi-aquatic vegetation, control of invasive species and wildlife. This document has been of great importance in the restorations and recovery of wetlands in the city.

In summary, all actions have benefited the maintenance and care of the Jaboque wetland. However, there is still a long way to go to recover the surrounding areas that have gradually deteriorated the ecological structure of the wetland with the construction of roads and

urbanizations. It should be noted that the actions that have contributed to the wetland have been: the School Environmental Projects (PRAES), appropriation of the ecosystem by the community, efforts to remove debris and rubbish in the channels that lead to the wetland, removal of mud and water holes for the recovery of the aquatic area, recognition of the Jaboque wetland as a Ramsar wetland in 2018, recognition of land in the wetland as part of the city and not as private property, among others.

Regarding the recognition of the urban wetland complex as a Ramsar site, different perceptions were noted in the interviews. One of them is that this declaration would not be the conservation of the ecosystems in the city. Especially, recognising that in some of the Ramsar sites that Colombia has, like Ciénaga Grande de Santa Marta, which nowadays is listed in the Montreux Record, a list of Ramsar sites that threaten bay changes in their characteristics. Because of this, consulted experts highlighted that the restoration and preservation of wetlands in the city, need to have permanent work between entities, community and scientific and educative institutions.

Finally, one of the current measures that the EAAB is developing, is the identification and closure of misconnections that lead to sewage falling into the wetlands, especially in Juan Amarillo, and soon is going to take place in Jaboque as well (Barreto, 2020).

### 8.3 Management scheme involving risk reduction and urban wetlands

The review of the policies, in the first place, is referred to the IDIGER policy framework (nomogram) and is four topics of classification. From the adaptation of this classification, a chart was created, where policies regarding Urban wetlands, risk and climate change and, disaster and emergencies management were identified in the national and district level. It was necessary to include the international level in the scheme, as it has been the main reference in developing policies related to the topic of interest. However, this is not integrated into the main analysis. This chart is presented in full in Annex 3. Policy scheme: wetlands/ Risk and climate change/ Disaster and emergencies management.

After the construction of this policy scheme, the main regulations and context regarding risk management, wetland policies and others in consideration are explained bellow:

- Risk and Disaster Management scheme

The construction of the integrated risk management Policy in Bogota started in 1996, as a result of local emergency committees. This process was focused on improving the management of different hazards according to the geomorphological characteristics of the territory. In the same way, it was intended to recognise territorial particularities and the population of the city. In 2000, through the Decree 619 of 2000, it was achieved the incorporation of the “risk component” in the land use planning, where hazard studies for mass removal, flooding and seismic, were input for regulating land use from a risk management perspective. After this, it was possible to identify priority areas subject to risk analysis in the capital to define the measures needed (DPAE & FOPAE, 2008).

According to with the law 1523 de 2012 of the Colombian Congress, risk management must be incorporated in the land planning of the cities or municipalities in the country; in line with the risk that each of them has identified in their territory. Moreover, must consider watershed management, to integrate risk analysis into biophysical, economic and socio-environmental diagnosis and consider disaster risk as a condition for the use and occupation of the territory, thus trying to avoid the configuration of new risk conditions. This Law transforms the conceptualisation of disaster prevention that had been in place until then. Conceiving risk management as a social process, this law involves the participation of all actors in society as a fundamental part of the National Risk Management System (SDA & IDIGER, 2015).

The Agreement 546 of 2013 of Bogotá Council, transforms the District System of Prevention and Attention to Emergencies -SDPAE-, into the District System of Risk Management and Climate Change-SDGR-CC, its instances are updated, and the District Fund for Risk Management and Climate Change "FONDIGER" is created. In the same way, the Emergency Prevention and Care Fund -FOPAE- was transformed into what will be called "District Institute for Risk Management and Climate Change", with the acronym IDIGER, an entity that coordinated the SDGR-CC. This system aims to articulate the policies, structures, functional relationships, methods, resources, processes and procedures of public and private entities, communities and citizens within the scope of their competencies, with the common purpose of generating synergy in the strategies that integrate risk management and climate change in Bogotá D.C.

The previous Agreement is regulated in the city by the Alcaldía Mayor in 2014 tree main Decrees. First, the Decree 172 of 2014, settles coordination entities and guidance for the District System of Risk Management and Climate Change SDGR-CC. Especially stipulates the transformation of the FOPAE into the IDIGER. This Decree gives the transversal Processes for Risk Management and Adaptation to Climate Change and the Risk Management and Climate Change Instruments in Article 6 and 7, respectively, which are shown in Figure 14. The other two regulatory decrees correspond to Decree 173 of 2014 of Alcaldía Mayor de Bogotá, that establishes the provisions regarding IDIGER, its nature, functions, management and administrative bodies. While Decree 174 of 2014 regulates the operation of FONDIGER.

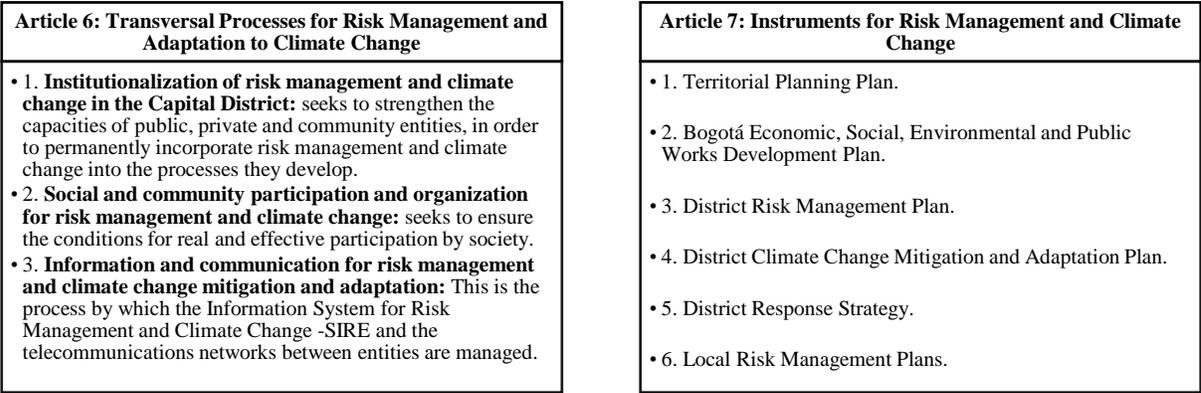


Figure 14. Processes and instruments Risk Management and Adaptation to Climate Change in Bogota. Own elaboration retrieved from Decree 172 of 2014

Climate change policies have also influenced in the risk management scheme in the national level, due to the close approach between these two concepts, that coincide that the adaptation of CC effects and the disaster risk reduction integrate Ecosystem-based strategies.

The Nacional Climate Change Adaptation Plan (Plan Nacional de adaptación al Cambio Climático – PNACC) of 2014 establishes that the principal objective of adaptation in Colombia: to achieve the risk reduction and the socioeconomic impacts associated with climate variability and climate change. In this plan, Disaster Risk reduction is mentioned as a complementary strategy, pointing out that due to the country’s inner characteristics, is prone to the CC effect. Thus, DRR is important to develop nationally. Is also recognised, the close relationship between climate, ecosystems and development, because population depends on the ecosystem services that they offer, and again, knowing that ecosystems are exploited and affected (DNP, 2014)

In 2015, was presented the District Risk Management and Climate Change Plan for Bogota D.C., 2015 – 2050. In this plan was recognised that since the long and intense rainy season in Colombia between 2010 – 2011, the perception of consequences of climate change has changed and the country has been incorporating and strengthening this issue in its development agenda (SDA & IDIGER, 2015). This document also mentions the concept of Ecosystem-based Adaptation as one of the scopes of climate change adaptation, which also includes the community-based adaptation and infrastructure adaptation. However, this approach is not integrated into the plan explicitly.

Two years after, The National Climate Change Policy in the country of 2017, articulates several strategies related with the adaptation of climate change, such as the Colombian Low Carbon Development Strategy -ECDBC-, the National Climate Change Adaptation Plan -PNACC-, and the National REDD+ Strategy, among other initiatives. In this policy, it is briefly mentioned measures of Ecosystem-based adaptation as part of the strategy of the policy: Management and conservation of ecosystem services for low-carbon and climate-resilient development. Which aims in the future to evaluate the role of ecosystems in the vulnerability and the effect of CC, to also promote the joint work of environmental authorities with the support of environmental institutions to advance in the design of adaptation measures based on ecosystems (MADS, 2018)

From the policies that are in the Annex 3. Policy scheme: wetlands/ Risk and climate change/ Disaster and emergencies management; Law 1931 of 2018 of the Congress of Colombia establishes the guidelines for the management of climate change, mainly in the actions for CCA and the mitigation of greenhouse gases. Furthermore, stipulates the inclusion of this concept in risk management plans in the national and regional level and the articulation with the National Disaster Risk Management, to harmonise the adoption and implementation with climate change policies, plans and programs. This indicates once again that the CCA is one of the clear goals and international compromises for the management and development of the country.

This is reflected in the issue of the Decree 837 of 2018 of Alcaldía Mayor de Bogotá, D.C. adopts the District Disaster Risk Management and Climate Change Plan for Bogota D.C., (PDGRD-CC) 2018-2030. This incorporates the dispositions established for the District Risk Management Plan, the District Climate Change Mitigation and Adaptation Plan and the District

Response Strategy, established in Law 1523 of 2012, Agreement 391 of 2009, Agreement 546 of 2013 and especially those defined in Article 7 of Decree 172 of 2014, and guide climate change and risk management components and programmes for future development plans, as well as the prioritization of investments by FONDIGER and the institutions that are part of the SDGR- CC.

Is worth to mention that the PDGRD-CC has a program in which involves the management of strategic ecosystems and areas of environmental interest for Bogota and the Region. This program aims to increase the district's adaptive capacity to the effects of climate change and climate variability (with emphasis on the El Niño dry phase), based on the recovery and conservation of ecosystem services. To do so, the planning, integral management and protection of the main ecological structure and areas of environmental must be integrated with the object to improve water dynamics and reconstruct the ecological functions of natural drainage. (IDIGER, 2018). The strategic lines of action are shown in Figure 15, where have highlighted the ones that involve the main ecological structure, which includes urban wetlands in the city.

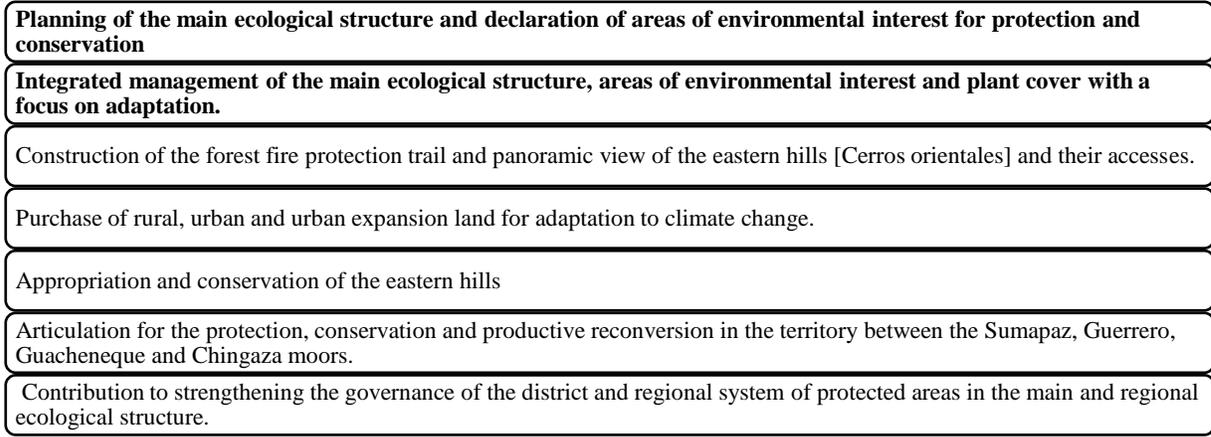


Figure 15 Strategic lines of action of the management of strategic ecosystems and areas of environmental interest for Bogota and the Region from the PDGRD-CC 2018- 2030  
Own elaboration retrieved from IDIGER (2018)

- Wetlands policies

Due to the problematic situation with wetlands, Colombia adopted the RAMSAR convention with the 357 law in 1997. After, in 2001 the Policy for Colombia's Inland Wetlands

was issued, considering the constitutional principles and the given functions by the Law 99 of 1993. This last one is one of the key laws that considered enhance formulation, agreement and adoption of policies aimed at regulating the conditions for the conservation and management of marshes, swamps, lakes, lagoons and other inland water ecosystems. (CAR, 2011)

The official, and still in force, land use plan for Bogota, established with the Decree 190 - 2004 of Bogota's Council, recognised wetlands as a "District wetland ecological park" as part of the protected areas of the district. Which gave later in 2006, to the recognised wetlands the implementation of environmental management plans with the Decree 062 of 2006 of Alcaldía Mayor de Bogotá. In this decree, the 27<sup>th</sup> Article mentions the *“acquisition of land for rainwater reservoirs. For all those wetlands where the option of supplying an ecological flow from the eastern hills [Cerros orientales] is not feasible, steps must be taken to purchase land and adapt the reservoir areas on the alluvial valley of the Bogota River adjacent to or near them, so that a system of ecological connectors can be established between most of the wetlands adjacent to the river”*. This can be related in as implicit measure to maintain and preserve the flood control ecosystem service of the wetlands, especially for those located close to the river. Nevertheless, from the 15 recognised wetlands, named as “District wetland ecological park”, twelve have an environmental approved by a resolution, tow is in the approval face and one is in formulation. The details of the resolution of each wetland is presented in Table 10.

Table 10 Environmental management plans for "District wetland ecological park"

| <b>Wetland</b>          | <b>Resolution</b>                      |
|-------------------------|--|
| Tibanica                | Res. 0334 of 2007 SDA                  |
| Córdoba                 | Res. 1504 of 2008 of SDA               |
| El Burro                | Res. 4383 of 2008 of SDA               |
| Techo                   | Res. 4573 of 2009 and 6469 2009 of SDA |
| Capellanía              | Res. 7474 of 2009 of SDA               |
| Santa María del Lago    | Res. 7773 of 2010 of SDA               |
| Juan Amarillo           | Res. 3887 of 2010 of SDA               |
| La Conejera             | Res. 0069 of de 2015 of SDA            |
| Jaboque                 | Res. 01 of 2015 of CAR and SDA         |
| Torca - Guaymaral       | Res. 02 of 2015 of CAR and SDA         |
| Humedal Meandro del Say | Res. 03 of 2015 of CAR and SDA         |
| Tunjo                   | In the Approval Phase                  |
| El Salitre              | In the Approval Phase                  |

| Wetland | Resolution     |
|---------|----------------|
| La Isla | In Formulation |

Note: Torca and Guaymaral share the same environmental plan, due to the close location between them.  
Own elaboration. Retrieved from the Decree 450 of 2017. Mayor of Bogota:

In 2006, the Technical Administrative Department of the Environment (Departamento Técnico Administrativo del Medio Ambiente – DAMA, today SDA) issued the Capital District Wetland Policy for Bogota. This was based on the recommendations of the Ramsar Convention concerning management planning in wetlands and the proclamation of the national inland wetlands’ policy (Alcaldía Mayor de Bogotá, 2006). This policy in the city enhances the protection and restoration of these ecosystems in the city. It is keeping the identification of wetlands as “District wetland ecological park”. Even though the policy does mention other places included in the main ecological structure of the city. One aspect that this policy has received good feedback is due to the enhancement of community participation. Which has led to the creation of The District Wetland Committee with the Resolution 2618 of 2006 SDA as an advisory body for the implementation, monitoring, evaluation and updating of the different instruments of environmental policy and management of wetlands of the Capital District

Despite the stipulated in the district wetland policy in Bogota, in 2017, the Decree 565 of 2017 of Alcaldía Mayor de Bogotá was issued. This aimed to modify the district wetland policy concerning the definition of passive recreation and uses in wetlands. However, this Decree was suspended in 2018 by the Council of State. Through a lawsuit filed against the district, for not respecting the participation guidelines of the district wetlands policy; and the violation of the operation and conservation of the wetlands in Bogota. Later in June of 2020 was declared revoked; therefore, the policy guidelines are still in force.

- Other policies considered

From the consultation made regarding the inclusion or not of ecosystems in the risk management scheme in the city, and the interviews with experts; some other key policies in the country and Bogota were mentioned regarding the biodiversity management.

In the first place, The national policy for integrated water resource management was issued in 2010, which has the aim of guaranteeing, through efficient and effective management, the sustainability of water resources, linked to the planning and use of the territory and the

conservation of the ecosystems that regulate water supply. This policy, wetlands are considered as a key ecosystem for water management. About risks, this policy highlights the risk associated with water resources, which generate problems of water availability, shortage and rationing. It also mentions floods as one of the disasters related to water resources and the actions that are planned for their reduction. Such as the elaboration of methodological guides for the Regional Autonomous Corporations (CAR) and the municipalities to identify the most vulnerable basins, thus evaluating, zoning and reducing the risk.

On the other hand, also in 2010 was issued The Policy for Biodiversity Conservation Management in the Capital District. Which proposes measures to guarantee adequate and efficient management of the conservation of the biodiversity of the Capital District. In the document is the characterization and identification of the ecosystems in the city, the land cover and the fauna and potentially invasive species identification of the District. Also, formulates five strategies to for the implementation of the conservation of biodiversity in the city: the effective articulation of institutional initiatives; conservation of biodiversity in the territory; restoration of degraded ecosystems in the territory knowledge and information management for conservation and, sustainable use of the elements of biodiversity in the territory. All of them have in this same policy the action plan for implementation.

Two years later, National Policy for the Integrated Management of Biodiversity and its Ecosystem Services of 2012 was issued; due to a participatory work of revision and update of the Nacional biodiversity policy was formulated. This policy aims to maintain and improve the resilience of socio-ecological systems, at national, regional, local and cross-border levels. One aspect that is important to mention is that one of the six thematic axes contemplates risk management and provision of ecosystem services and biodiversity. This highlights the need for anticipating actions to address threats related to environmental change by promoting the management capacity between entities. To identify, prevent and mitigate risks associated with environmental change; increase socio-ecological adaptive capacity. Also to maintain the provision of ecosystem services at all levels of the territory; strengthen and implement risk

assessment schemes and early warning systems, and finally to the development of risk transfer mechanisms<sup>4</sup> to events related to environmental change. (MADS, 2012).

#### 8.4 Stakeholder analysis

- Identification and classification of stakeholders

As a result of the policy review and mainly the conducted semi-structured and qualitative interviews with experts, it was possible to identify 44 stakeholders. Those actors were identified due to the responsibilities in management, governance, planning, and conservation of the ecosystems, especially wetlands and the risk reduction in Bogota.

To facilitate the analysis, stakeholders were condensed into five big groups, which some of them have subgroups. That is the case for the Governmental stakeholders, which were regrouped in four levels: National, Regional, District and Locality. Also, the Non-Governmental Organizations were identified in two groups: District and International, considering that these international organizations are the most representatives according to with the referred information taken from the interviews, which mainly work in projects at the national level but also in the district. Figure 16 shows all the identified and, groups of stakeholders, which after the regrouping, only 37 stakeholders were considered to carry out the stakeholder mapping; without leaving out the other seven. Table 11 presents all description and function of each identified stakeholder.

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<sup>4</sup> “Risk transfer refers to situations where risks are difficult to manage and/or are unlikely to occur and are of high severity, which, due to their characteristics, can cause serious impacts to a community, city or nation” (Ministerio de Ambiente y Desarrollo Sostenible - MADS, 2012).

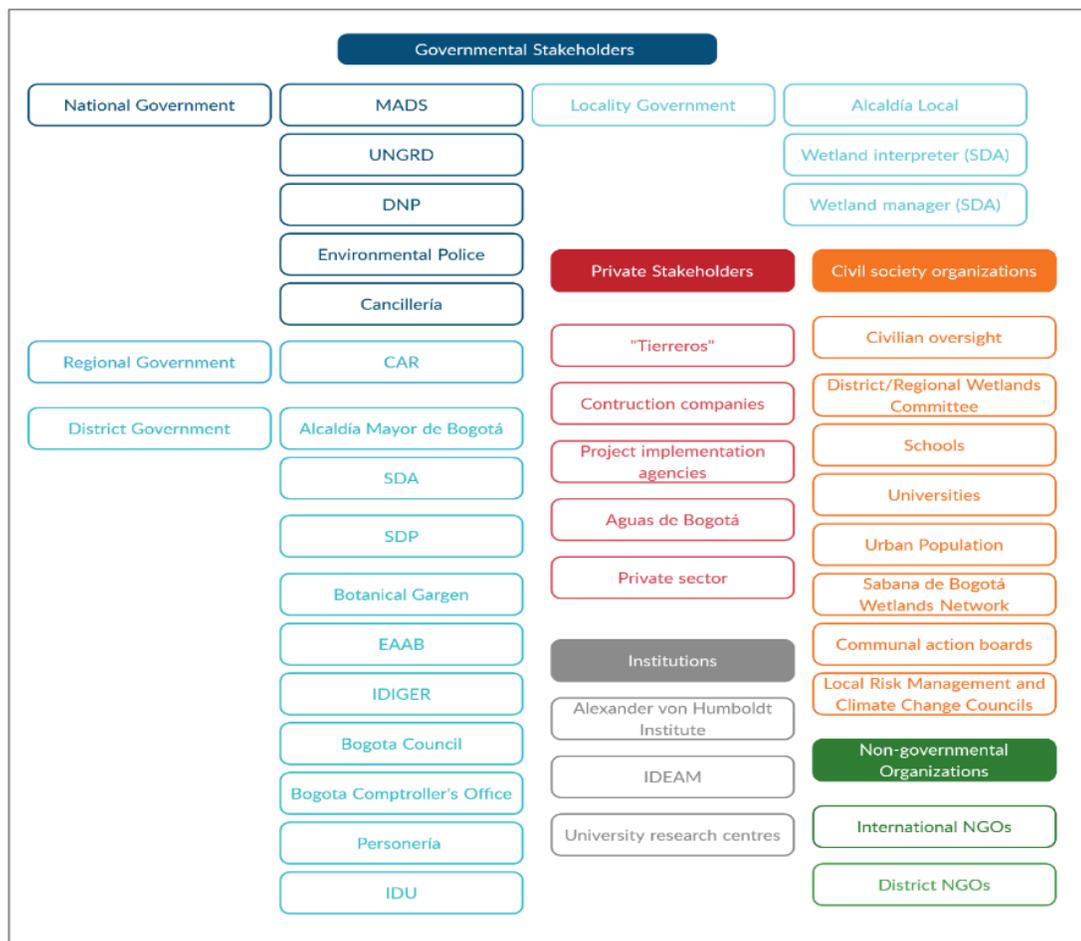


Figure 16 Identification and grouping stakeholders related to Wetlands and risk reduction in Bogota (Own elaboration based on the interviews)

Table 11 Stakeholder Identification

| Nr.                              | Stakeholder   | Function   |
|----------------------------------|---|--|
| <b>Governmental Stakeholders</b> |   |  |
| <b>National Government</b>       |   |  |
| 1                                | Ministerio de Medio Ambiente y Desarrollo Sostenible - MADS (Ministry of Environment and Sustainable Development) | Responsible for managing the environment and renewable natural resources, guiding and regulating the environmental planning of the territory and defining the policies and regulations of the country's natural resources.   |
| 2                                | Unidad Nacional para la Gestión del Riesgo de Desastres - UNGRD (National Unit for Disaster Management)           | A unit that directs, guides and coordinates disaster risk management in Colombia   |
| 3                                | Departamento Nacional de Planeación - DNP (National Planning Department)  | Administrative Department that belongs to the Executive Branch of the public power and depends directly on the Presidency of the Republic. It promotes the implementation of a strategic vision of the country in the social, economic and environmental fields, through the design, guidance and evaluation of public policies. |

| Nr.                        | Stakeholder   | Function  |
|----------------------------|---|---|
| 4                          | Policía Nacional: Área de Protección Ambiental y Ecológica de la Policía Nacional (National Police: Environmental and Ecological Protection Area) | Specialized body of the National Police, responsible for supporting environmental authorities, territorial entities and the community in general in the defence and protection of the environment and natural resources.  |
| 5                          | Cancillería - Ministerio de Relaciones Exteriores (Chancellery - Ministry of Foreign Affairs)   | Entity in charge of directing and coordinating Colombia's foreign policy and diplomatic relations   |
| <b>Regional Government</b> |   |   |
| 6                          | Corporación autónoma Regional de Cundinamarca - CAR (Cundinamarca Regional Autonomous Corporation)  | Are the first environmental authority at the regional level. Their purpose is to implement policies, plans, programmes and projects on the environment and renewable natural resources. CAR is the environmental authority for wetlands within the rural perimeter of Bogota.   |
| <b>District Government</b> |   |   |
| 7                          | Alcaldía Mayor de Bogotá (Main City Hall of Bogota)   | It is the most important political-administrative authority of the city. Its purpose is to administer municipal affairs and provide public services as determined by law. Plan the economic, social and environmental development of its territory, by the law.   |
| 8                          | Secretaría Distrital de Ambiente - SDA (District Secretary of Environment)  | The authority that promotes, guides and regulates the environmental sustainability of Bogota. Formulate the ecological policy of the Capital District and exercise authority. Also, to formulate, adjust and periodically review the Capital District's Environmental Management Plan and coordinate its execution. It is the environmental authority for wetlands within the urban perimeter.<br>District Wetlands Committee Member.                               |
| 9                          | Secretaría distrital de Planeación - SDP (District Planning Secretary)  | Articulate the city's public policies in their dimensions: territorial (physical and urban growth), sectoral (social, economic and environmental) and expenditure (investment).<br>District Wetlands Committee Member   |
| 10                         | Jardín Botánico de Bogotá José Celestino Mutis (Botanical Garden of Bogota)   | Responsible for the integral management of green coverage in the city, the development of environmental education programs.<br>District Wetlands Committee Member   |
| 11                         | Empresa de Acueducto y Alcantarillado de Bogotá - EAAB (Water and Sewage Company of Bogota)   | It is a public company that provides water, sewage and rainwater services. It is in charge of collecting, conducting, regulating and managing rain and surface water that make up the rain drainage and water system within its area of activity. It is in charge of formulating the Environmental Management Plans of the wetlands, carrying out the studies for the maintenance, recovery and conservation of the wetlands.<br>District Wetlands Committee Member |
| 12                         | Instituto Distrital de Gestión de Riesgos y Cambio Climático - IDIGER (District Institute for Risk Management and Climate Change)                 | Responsible for Implementing, guiding and coordinating actions for disaster risk reduction, emergency management and climate change adaptation. Member of the District System of Risk Management and Climate Change -SDGR-CC  |
| 13                         | Concejo de Bogotá (Bogota Council)  | It is the supreme authority of the District, has functions of a regulatory role, and is also responsible for controlling the management of local authorities  |
| 14                         | Contraloría de Bogotá (Bogota Comptroller's Office)   | It is in charge of the supervision of the fiscal management of the Capital District, including individuals that also handle funds or goods of the city.   |

| <b>Nr.</b>                                   | <b>Stakeholder</b>  | <b>Function</b>   |
|--|---|---|
| 15   | Personería de Bogotá  | A control body of the Capital District that, with a social focus, intervenes and acts as a guarantor of respect for the judicial system by the public authorities of the Capital District and monitors the conduct of public servants.  |
| 16   | Instituto de Desarrollo Urbano - IDU  | It is in charge of executing road and public space construction such as bridges and road interchanges. It is also in charge of its maintenance and rehabilitation of the city's real estate.  |
| <b>Locality Government</b>                   |   |   |
| 17   | Alcaldía Local (Locality City Hall)   | Coordinates the execution in the territory of the plans, programmes and projects of the District entities and bodies that intervene in the locality, as a complement to the Local Development Plan  |
| 18   | Wetland Interpreter (SDA)   | Member of the SDA, is in charge of supporting the research and security of the wetland in responsibility. Usually a member of the community.  |
| 19   | Wetland manager (SDA)   | Member of the SDA in charge of managing the activities, carried out in the wetland in responsibility.   |
| <b>Private Stakeholders</b>                  |   |   |
| 20   | "Tierreros"   | An actor who appropriates land and sells or commercializes it illegally   |
| 21   | Construction companies  | Companies in charge of building construction  |
| 22   | Project implementation agencies   | Contracted companies for the implementation of activities, projects or programs of different entities.  |
| 23   | Aguas de Bogotá   | In charge of the essential maintenance of the aquatic and terrestrial strips in the Bogota Wetlands. It also collects and removes solid waste from the riverbed, removes invasive species from the waterways, removes debris from the surrounding area and the management area, and ensures environmental preservation. |
| 24   | Private sector/Industries/Productive sector   | All companies providing goods and services of a private nature, which are located within the territory near the wetlands or the Bogota river, or benefit from it  |
| <b>Civil society organizations</b>           |   |   |
| 25   | Civilian oversight  | Reviewing government activities as Community participation  |
| 26   | District/Regional Wetlands Committee  | An institutional body in which a representative of the community participates for each location in the city that has wetlands and two members of the Bogota and Sabana Wetlands Network.  |
| 27   | Schools   | Educational entity for minors participating in wetland education and awareness programmes.  |
| 28   | Universities  | Educational body for youth and adults involved in wetland education and awareness programmes  |
| 29   | Urban Population  | City inhabitants who live near the wetlands or who have some perception of them.  |
| 30   | Red de Humedales de la Sabana de Bogota (Sabana de Bogotá Wetlands Network)                                   | District Wetlands Committee Member  |
| 31   | Juntas de acción Comunal (Communal action boards)   | Social groups, representatives of neighbourhood residents in the city, interested in caring for the territory   |
| 32   | Consejos Locales de Gestión de Riesgos y Cambio Climático (Local Risk Management and Climate Change Councils) | Representatives of the localities in the city. Members of the District System of Risk Management and Climate Change -SDGR-CC  |
| <b>Non-governmental Organizations - NGOs</b> |   |   |
| <b>International</b>                         |   |   |

| <b>Nr.</b>          | <b>Stakeholder</b>   | <b>Function</b>  |
|---------------------|--|--|
| 33                  | The Nature Conservancy (TNC)   | The Nature Conservancy (TNC) is a global environmental organization dedicated to the conservation of the lands and waters on which life depends. It has participated in and promoted projects involving water resources and wetlands.  |
| 34                  | World Wide Fund for Nature - WWF - Colombia  | It carries out actions on different scales, from the local to the international. It is currently developing environmental diagnosis projects in the city   |
| 35                  | International Union for Conservation of Nature- UICN   | Development and promotion of projects related to climate change adaptation and ecosystem-based adaptation; it has served as a conceptual basis for entities associated with the conservation of ecosystems   |
| 36                  | United Nations Development Programme – UNDP (Programa de las Naciones Unidas para el Desarrollo -PNUD)                               | Has worked on issues of risk reduction and vulnerability to climate change in wetlands in the country.   |
| 37                  | The Deutsche Gesellschaft für Internationale Zusammenarbeit GIZ – Colombia   | He has worked on and promoted work related to ecosystem-based adaptation for flood risk management.  |
| <b>District</b>     |  |  |
| 38                  | Fundación Humedales de Bogotá  | A non-profit organization dedicated to rescuing the wealth and importance of Bogota's wetlands and highlighting their constant threats. In 2015 we were the winners of the "Ramsar Convention's Award for Young Wetland Defenders". They have conducted an inventory of the city's wetlands. |
| 39                  | Fundación Cerros de Bogotá   | A non-profit organization that has the interest of strengthening, from the civil society; the appropriation, knowledge and recovery of the Cerros de la Sabana (Easter mountains). Those are part of the ecological connectivity between the water flows and wetlands of the city.           |
| 40                  | Fundación Banco de Semillas (FBS)  | A non-profit organization that works for the management and awareness of wetland protection in the locality of Kennedy. Mainly in the La Vaca Norte and La Vaca Sur wetlands   |
| 41                  | Fundación para el Desarrollo Social y Ambiental- ADESSA  | Non-Governmental Organization, that since its foundation has been dedicated to working around the care and protection of life and in coherence with this principle has advanced environmental, social, cultural and gender projects. It has worked in Bogota's wetlands such as Jaboque      |
| <b>Institutions</b> |  |  |
| 42                  | Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (Alexander von Humboldt Institute)                          | Scientific and technical support entities for national environmental management. Their function is environmental research for the conservation and sustainable use of resources.   |
| 43                  | Instituto de Hidrología, Meteorología y Estudios Ambientales - IDEAM (Institute of Hydrology, Meteorology and Environmental Studies) | It is in charge of managing scientific, hydrological and meteorological information and environmental issues; such as climate change and environmental quality in the country.   |
| 44                  | University research centres*   | Academic university research entities, which carry out studies involving natural resource issues. Sometimes, they provide technical support for environmental management by the government.  |

Note: \*Universities research centres are presented as a separate stakeholder, due to its specific scope in research, even though are part of “universities”. Which in this case are considered as an educational institution, like schools, that have participated in other academic activities or projects with ONGs, entities or civil society organizations.

After the identification of stakeholders, it was possible to classify them in the Ackermann & Eden (2011) power/interest grid. It was considered the natural resources management context and the information collected in the interviews of experts, related with the entities, institutions or civil organizations that take part or have an interest in wetlands in Bogota. All stakeholders in Figure 16 were located in each of the quadrants of the grid, which represents one of the four categories: “Key players”, “Subjects”, “Context setters” and “Crowd”, as shown in Figure 17.

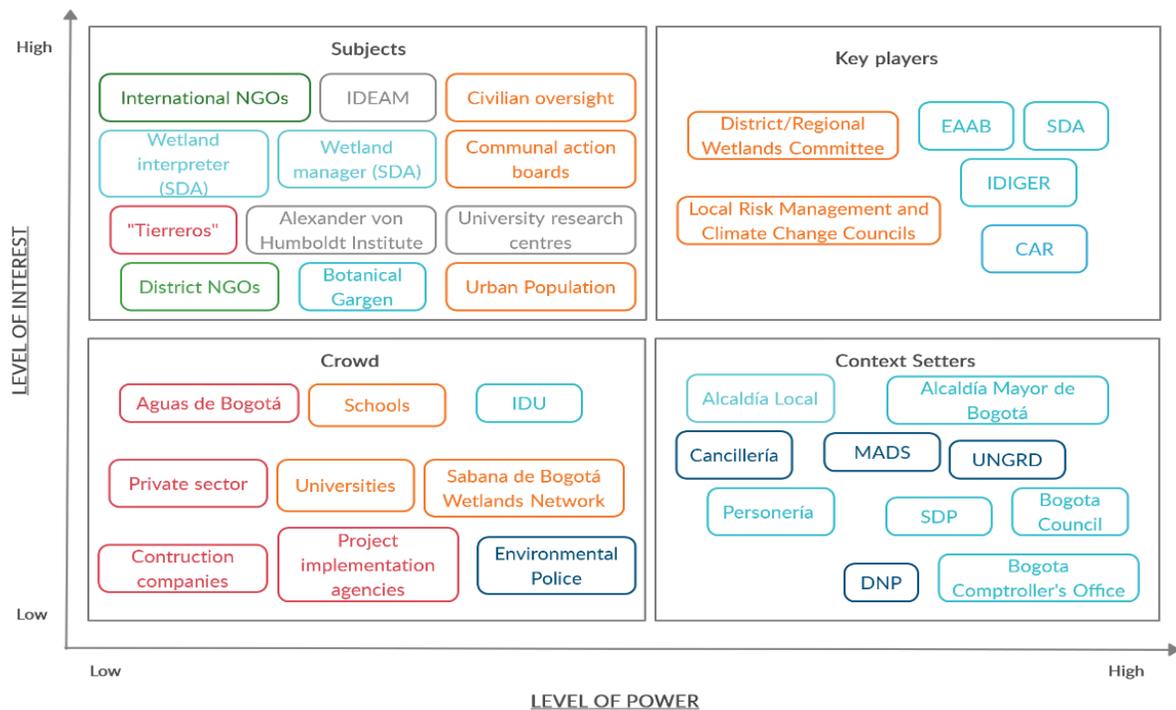


Figure 17 Stakeholder mapping of stakeholders related to Wetlands and risk reduction in Bogota (Own elaboration)

In the high power/high-interest quadrant, corresponding to the “key players”, six of the stakeholders were located there, considering that have an important role in the decision making in the territory. Regarding in this case, urban wetlands or risk reduction management. At the same time, these actors have a high interest in law enforcement through the participatory tools and/or the control of the territory to accomplish wetland protection and DRR.

The “subjects” stakeholders, located in the high interest/low power quadrant, are twelve. Mainly, those who have a great interest in research, support and knowledge development related with ecosystems conservation (wetlands), climate change adaptation, nature-based solutions and Eco-DRR were identified there, that is the case of the institutions and NGOs. In the same way, the district governmental stakeholders in this quadrant correspond to those who depend on a more powerful entity or their task relate to the maintenance of wetlands. The civil society organizations here, are the ones that play an essential role in the community participatory spaces, which regulates and controls in some way the policies execution. Even though they have no decision power, they can influence them according to the current necessities of the community. Finally, the “Terreros” were identified in this category due to the interest in the land, often where wetlands are. This actor, as mentioned by some experts in the interviews, is a group of people that illegally take over land that looked like a wasteland, but in the case of Bogota, frequently corresponded to wetland soils. These areas are covered with garbage or rubble, to drain the water body and later sell it as lots for construction.

For the quadrant of the “Context setters”, ten stakeholders were identified. All of them are part of the government category, which response to the high power to develop, promote, and execute policies in the territory, regardless of the level of governability. That is the case of the Environmental Ministry, the City Hall and their local dependencies, for environmental topics and disaster risk reduction, which correspond to the Environmental secretary (SDA) the IDIGER, correspondingly. Also, city planning and control bodies fall into this category, as they have a role in decision-making by the authorities.

The last category in this map has nine stakeholders, which are called “Crowd” because they have low interest in wetlands or disaster risk reduction, even though were identified with some activity or strategy regarding these topics. This happens with the environmental police, Aguas de Bogotá, UDU and project implementation agencies, which are only interested because of a services o product that they can offer. Also, they depend on the district or national regulations. Schools and Universities were identified in this quadrant because they are included in some of the strategies or participatory spaces. Notwithstanding, this is not the main object of them. Regarding the Sabana de Bogotá wetland network, is important to mention that although they have a greater interest in wetlands, they focus in those located in the savanna of the city,

which is not included in the territorial context of this study. Lastly, the construction companies were considered because historically, they have developed urban projects in areas where there used to be wetlands, although to do so, they have received a license to build. All justification of each stakeholder location in the stakeholder mapping power/interest grid is in Table 12.

Table 12 Stakeholder justification of power/interest

| Nr.                              | Stakeholder  | Power         | Interest      | Justification  |
|----------------------------------|--|---------------|---------------|--|
|                                  |  | (High or Low) | (High or Low) |  |
| <b>Governmental Stakeholders</b> |  |               |               |  |
| <b>National Government</b>       |  |               |               |  |
| 1                                | Ministerio de Medio Ambiente y Desarrollo Sostenible - MADS (Ministry of Environment and Sustainable Development)                                  | High          | Low           | High power is the central environmental entity. Low interest because has a delegate in the district (City hall - SDA)                |
| 2                                | Unidad Nacional para la Gestión del Riesgo de Desastres - UNGRD (National Unit for Disaster Management)  | High          | Low           | High power is the central risk management entity. Low interest because has a delegate in the district (IDIGER)                       |
| 3                                | Departamento Nacional de Planeación - DNP (National Planning Department)   | High          | Low           | High power as is the influence the national planning in the territory. Low interest because the district has its own (SDP)           |
| 4                                | Policía Nacional: Área de Protección Ambiental y Ecológica de la Policía Nacional (National Police: Environmental and Ecological Protection Area ) | Low           | Low           | Low power, as is the influence, is the security in the territory. Low interest because it is present only when it is needed.         |
| 5                                | Cancillería - Ministerio de Relaciones Exteriores (Chancellery - Ministry of Foreign Affairs)  | High          | Low           | High power is the connection with the international community. Low interest because of the focus on the national level.              |
| <b>Regional Government</b>       |  |               |               |  |
| 6                                | Corporación autónoma Regional de Cundinamarca - CAR (Cundinamarca Regional Autonomous Corporation)   | High          | High          | High interest and power because it has jurisdiction in the wetlands in the region and some in the district.                          |
| <b>District Government</b>       |  |               |               |  |
| 7                                | Alcaldía Mayor de Bogotá (Main City Hall of Bogota)  | High          | Low           | High because it is the foremost authority in the district, but low interest due to the delegates in SDA and IDIGER.                  |
| 8                                | Secretaría Distrital de Ambiente - SDA (District Secretary of Environment)   | High          | High          | High interest and power because it has jurisdiction in the wetlands.   |
| 9                                | Secretaría distrital de Planeación - SDP (District Planning Secretary)   | High          | Low           | High power as is the influence the district planning in the territory. Low interest as it only provides guidelines.                  |
| 10                               | Jardín Botánico de Bogotá José Celestino Mutis (Botanical Garden of Bogota)  | Low           | High          | Low power because it depends on the SDA regulations and high interest in maintaining the green cover in wetlands and the city.       |
| 11                               | Empresa de Acueducto y Alcantarillado de Bogotá - EAAB (Water and Sewage Company of Bogota)  | High          | High          | High power because it has jurisdiction in the wetlands in the region and some in the district. Also have interest in maintaining the |

| Nr.                                | Stakeholder   | Power         | Interest | Justification  |
|------------------------------------|---|---------------|----------|--|
|                                    |   | (High or Low) |          |  |
|                                    |   |               |          | drainage of the city and aquatic area of wetlands.   |
| 12                                 | Instituto Distrital de Gestión de Riesgos y Cambio Climático - IDIGER (District Institute for Risk Management and Climate Change) | High          | High     | High interest and power because it has jurisdiction of risk management in the district.  |
| 13                                 | Concejo de Bogotá (Bogota Council)  | High          | Low      | High power as is the influence the district planning in the territory. Low interest as it only provides guidelines.                                |
| 14                                 | Contraloría de Bogotá (Bogota Comptroller's Office)   | High          | Low      | High power as is the influence the district planning in the territory. Low interest as it only provides guidelines.                                |
| 15                                 | Personería de Bogotá  | High          | Low      | High power as is the influence the district policies in the city. Low interest as it only provides guidelines.                                     |
| 16                                 | Instituto de Desarrollo Urbano - IDU  | Low           | Low      | Low power and interest, because it is only needed for hard infrastructure.   |
| <b>Locality Government</b>         |   |               |          |  |
| 17                                 | Alcaldía Local (Locality City Hall)   | High          | Low      | High power because is the authority in the localities, with low interest because relying on the wetland and risk management in the SDA and IDIGER. |
| 18                                 | Wetland Interpreter (SDA)   | Low           | High     | Low because is an employee of the SDA, but with high interest in wetlands maintenance  |
| 19                                 | Wetland manager (SDA)   | Low           | High     | Low because is an employee of the SDA, but with high interest in wetlands maintenance  |
| <b>Private Stakeholders</b>        |   |               |          |  |
| 20                                 | "Tierreros"   | Low           | High     | Low power because it has no authority in the territory, and high interest in the appropriation of the land, even of the wetland                    |
| 21                                 | Construction companies  | Low           | Low      | Low power because it has no authority in the territory and high interest in built-in any district territory.                                       |
| 22                                 | Project implementation agencies   | Low           | Low      | Low power and Low interest because are companies that work depending on the projects to be executed.   |
| 23                                 | Aguas de Bogotá   | Low           | Low      | Low power and Low interest because it is dependent on the EAAB necessities.  |
| 24                                 | Private sector/Industries/Productive sector   | Low           | Low      | Low power and Low interest because they have no control in the territory and have minimal relation with actions regarding wetlands or DRR.         |
| <b>Civil society organizations</b> |   |               |          |  |
| 25                                 | Civilian oversight  | Low           | High     | Has low power, however, is a crucial participatory figure in community participation, which gives it high interest.                                |
| 26                                 | District/Regional Wetlands Committee  | High          | High     | High power and interest as part of the management actors for wetlands  |
| 27                                 | Schools   | Low           | Low      | Low power and Low interest because they have no control in the territory and have  |

| Nr.  | Stakeholder   | Power         | Interest | Justification  |
|--|---|---------------|----------|--|
|  |   | (High or Low) |          |  |
|  |   |               |          | minimal relation with actions regarding wetlands or DRR.   |
| 28   | Universities  | Low           | Low      | Low power and Low interest because they have no power in the territory and have minimal relation with actions regarding wetlands or DRR.                     |
| 29   | Urban Population  | Low           | High     | Have low power of decision but have high interest as an inhabitant of the city, no matter the perception of wetlands or DRR they have.                       |
| 30   | Red de Humedales de la Sabana de Bogota (Sabana de Bogotá Wetland Network)                                    | Low           | Low      | Low power and low interest because they represent mainly wetlands located outside the district. However, they are part of the wetland committee              |
| 31   | Juntas de acción Comunal (Communal action boards)   | Low           | High     | Have low power of decision but have a high interest as representatives of the inhabitant of the city, no matter the perception of wetlands or DRR they have. |
| 32   | Consejos Locales de Gestión de Riesgos y Cambio Climático (Local Risk Management and Climate Change Councils) | High          | High     | High power and interest as part of the management actors for DRR.  |
| <b>Non-governmental Organizations - NGOs</b> |   |               |          |  |
| <b>International</b>                         |   |               |          |  |
| 33   | The Nature Conservancy (TNC)  | Low           | High     | Low power as they have no decision power in the territory, but with high interest in developing projects for the conservation of ecosystems and DRR.         |
| 34   | World Wide Fund for Nature - WWF - Colombia   |               |          |  |
| 35   | International Union for Conservation of Nature- UICN  |               |          |  |
| 36   | United Nations Development Programme – UNDP (Programa de las Naciones Unidas para el Desarrollo -PNUD)        |               |          |  |
| 37   | The Deutsche Gesellschaft für Internationale Zusammenarbeit GIZ – Colombia                                    |               |          |  |
| <b>District</b>                              |   |               |          |  |
| 38   | Fundación Humedales de Bogotá   | Low           | High     | Low power as they have no decision power in the territory, but with high interest in developing projects for the conservation of ecosystems and DRR.         |
| 39   | Fundación Cerros de Bogotá  |               |          |  |
| 40   | Fundación Banco de Semillas (FBS)   |               |          |  |
| 41   | Fundación para el Desarrollo Social y Ambiental- ADESSA   |               |          |  |
| <b>Institutions</b>                          |   |               |          |  |
| 42   | Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (Alexander von Humboldt Institute)   | Low           | High     | Low power because they are just scientific assessor for the national government, but high interest in developing research regarding ecosystems and ES.       |
| 43   | Instituto de Hidrología, Meteorología y Estudios Ambientales - IDEAM (Institute                               | Low           | High     | Low power because they are just scientific assessor for the national government, but high interest in developing research regarding                          |

| Nr. | Stakeholder  | Power         | Interest | Justification  |
|-----|--|---------------|----------|--|
|     |  | (High or Low) |          |  |
|     | of Hydrology, Meteorology and Environmental Studies) |               |          | hydrology, meteorology and environmental Studies.  |
| 44  | University research centres                          | Low           | High     | Low power because they have no-decision in the territory, but high interest in developing research regarding ecosystems and ES, ecosystem conservation, CC adaptation and DRR. |

- Relation/dynamic between stakeholders

After consulting the stakeholders that have incidence in wetland management and disaster risk management in Bogota and relying on the information given by the interviewees and the policies consulted, it was possible to identify the main relations between them.

The map of relations was built from the organizational structure of two key players (SDA and IDIGER), involving all stakeholder from Figure 16, keeping its colours to maintain the group identification of them. Four types of relations were identified: i). Strong relationship or having Alliance, usually between stakeholders that always work together or are part of another stakeholder, such as the “Alcaldía Mayor de Bogotá” and the Alcaldía Local. This relation is identified with a thick line. ii). Formal relationship or linked is shown with a thin line: This represents those stakeholders that also work together, but their relationship is not that strong because they might be independent one from another, but still are linked. iii). Informal or intermittent. This relationship exists mainly because of specific project or action requires to be executed from one stakeholder to another, just when it is needed; correspond to a dashed line. iv). Discord relationship of conflict: it was identified due to the illegality of the activity of one of the stakeholders, which create conflict with others, such as “tierreros” which is illustrated with a line with an “x”.

Besides, was also essential to illustrate though colours the main topic of interest in this study between actors, which are also four: wetlands (green), disaster risk reduction (purple), both wetlands and DEE and other (brown). This last was identified that does not have a direct interest in those topics, but its activity affects them in some way, this is the case of the construction companies. The complete map of the relationship is shown in Figure 18.

As mention by Aragón-Durand (2014), IDIGER and the EAAB do not share the same vision of risk management, because EAAB has a traditional engineering solution view, also, is important to mention that this is based on the current management plan for wetlands in Bogotá. However, the author highlighted that it is a challenge for IDIGER to show that environmental strategies can be a complementary solution for the hydraulic engineering task to manage flood events. This was also mentioned in some of the interviews, that historically, Colombia, has adapted mainly hard engineering solutions for most risk reduction, in this case, to mention flooding events. However, the current Environmental Ministry is working in the diagnostic of Nature-based solutions to be implemented as a key aspect for flood risk prevention.

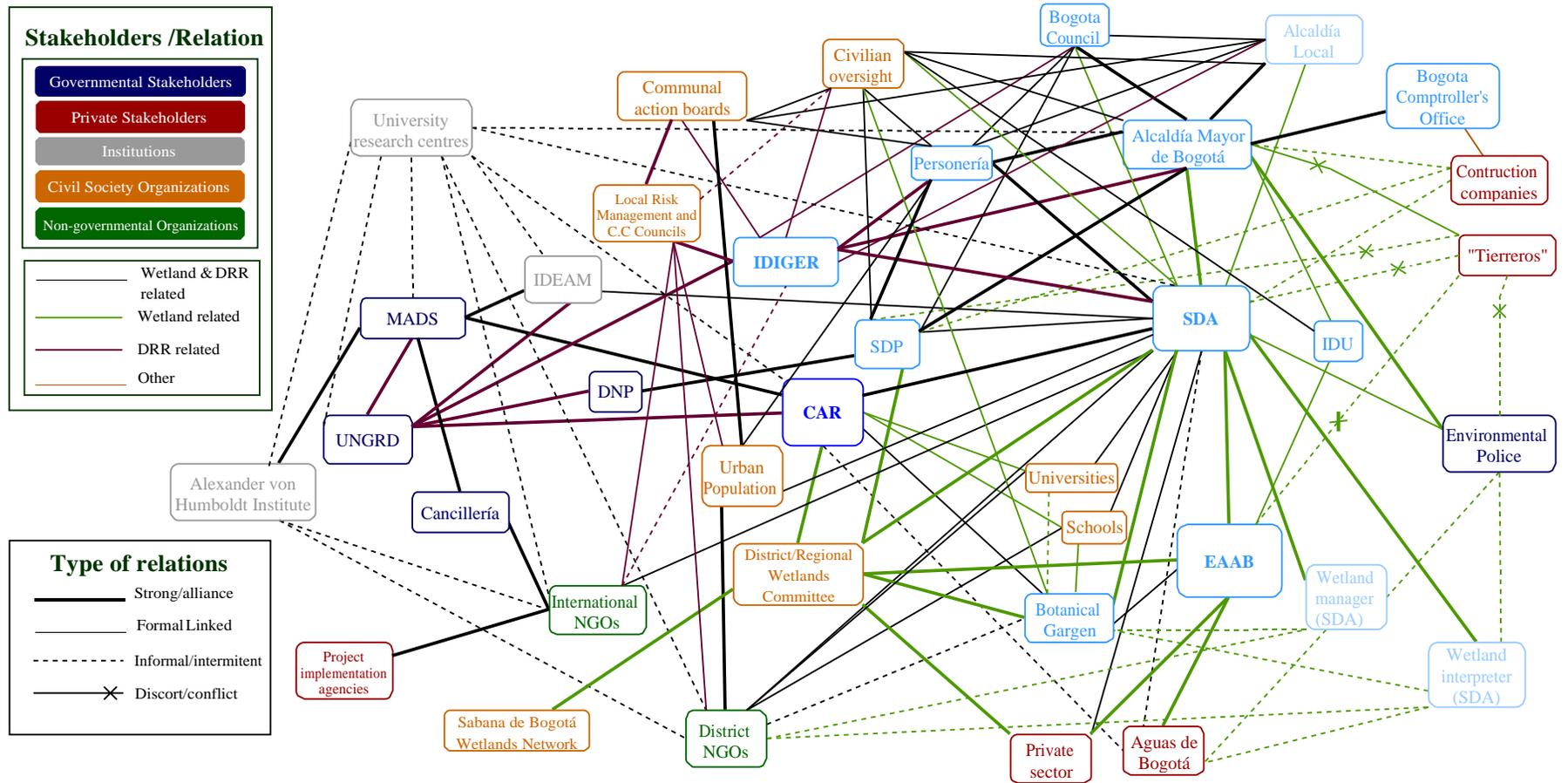


Figure 18 Relations between actors related wetlands and disaster risk reduction in Bogotá.

### 8.5 Best management practices in urban wetlands

As a result of the literature review related with best practices that have been developed around the world to compare the risk management scheme in Bogota and its wetland conditions, it was found that these two topics together have not developed much or explicitly. Also, several studies related to urban wetlands management are in coastal areas, which is a limitation in the research of information, knowing the characteristics of wetlands in Bogota. Hence, studies or institution publications of urban wetlands that developed flood risk reduction in coastal areas were considered; only considered when the ecosystem was connected to a river and no to the see, which allowed to have a better approach of the possible action that could be considered in Bogota.

On the other hand, “urban wetlands” is not a common topic of research. Most of the results regarding wetlands are located at basins scale, in inner areas with low urban development or with agricultural purposes of land use.

It was found that some papers that have developed research in wetland management, commonly develop hydrological models to estimate how wetlands bring flood resilience in river basins. That is the case of the study of Wu *et al.* (2020). In the same way, modelling is used in wetlands research to estimate its changes over time, which can be used in land used planning, like in the study of Peng *et al.* (2020). They generated a simulation considering scenarios like the increase of natural areas, economic development and wetland scenario in the Wuhan Urban Agglomeration, China. Unfortunately, this can be taken only as a reference for projects or urban land use planning.

Despite the above mentioned, the obtained results in the scientific databases, papers and institutional publications were selected and classified by the main topic: Governance and Wetland management, Wetland management and risk reduction, and Nature-based solutions, which are shown below. Is important to mention that these experiences and proposes of management should have an assessment of adoption under the context of the city.

- Governance and wetland management

Urban wetlands must be integrated into the local and national environmental planning, considering community-based environmental monitoring; this is one of the solutions to handle

the disjointed vision of environmental management and disaster prevention in many regions. This is mentioned by Hettiarachchi *et al.* (2014) in their study in Colombo, Sri Lanka, where the wetland complex in the city is affected by the change of their natural use, which represents that this ecosystem has reduced the water holding capacity and its biodiversity. The study has the perspective of disaster resilience from the analysis of water and soil quality, flora and fauna diversity and socioeconomic drivers of wetland degradation. One aspect that was highlighted is the three main components of urban wetland management: 1.) Sustainable utilization of the ecosystem services in urban development; 2) disaster mitigation or adaptation; and 3) protection of the natural ecosystem. Those components are covered by the policies in the statutory powers in the city. Nevertheless, they are disintegrated, which might be an obstacle for proper flood management. The study enhances that these components must be integrated between then to achieve flood protection to the city, especially considering that the failure of flood control services of wetlands leads to disasters in its urban river basins.

With a similar approach, Gupta and Nair (2011) analysed the challenges and lessons for the urban ecology from the events or urban floods in Bangalore and Chennai, to understand the problems in urban areas related with the increase of flooding incidences in cities that have similar contexts of development and ecological issues. The authors mention the leading causes of wetland's loss and degradation, which is mainly because of urban encroachment. This situation causes obstruction and loss of flood storage, that is evident with the increase in the flooding events in the cities. As lessons that they recognised in the cities of study, is that to manage flood risk, is essential to develop flood risk assessment, which must include criteria related with the inner economic, social and ecologic characteristics of the urban areas. They conclude in the first place, not only reduction of flooding events can be achieved by considering the ecological and ecosystem service of flood control of wetlands; but also, the removal of costly engineering structures for flood control. And finally, land use planning and watershed management should be combined with engineering measures, development planning, flood preparedness and emergency measures, at the same time involving social and economic needs for communities in the highland source areas and the lowland flood-prone areas.

For instance, according to Santos *et al.* (2019) conservation of aquatic ecosystems, such as wetlands, is key for the adaptation and resilience. They can be used to reduce disasters and

improve water availability, mainly knowing that if they have a good condition, tend to be resilient to flood and drought. Besides, they mentioned that in Latin America, there has been developing individual efforts to have sustainable management of ecosystems, which demonstrate that integrating communities, networking and develop local and scientific knowledge, delivers positive and significant results. One of the cases is the “Blue Corridor Conservation Programme” along with the Paraná-Paraguayan Wetland System, where the aim is to preserve the ecosystem to maintain the social, economic and environmental good through local interventions (Mupan, 2019). This project is related to the approached of socioecological system<sup>5</sup>

- Wetland management and risk reduction

In the study of Belle, Collins and Jordaan (2017), they propose an integrated management framework to build wetlands resilience to extreme weather events and disaster risk, caused by the effects of climate change in the eastern Free State of South Africa. It was performed questionnaires and interviews, which allowed to identify that wetlands are vulnerable due to the ignorance of the functions that they offer. With this and the consideration of international frameworks, was recognised that DRR and CCA are part of resilience measures. In Figure 19, the proposed framework is shown. According to the authors, the framework has a holistic management approach, either proactive or reactive, including an evaluation component. It can be adopted in other parts of the world and ecosystems, with adjustments according to the local conditions.

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<sup>5</sup> “An ecosystem, the management of this ecosystem by actors and organizations, and the rules, social norms, and conventions underlying this management” ((The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services - IPBES, no date).

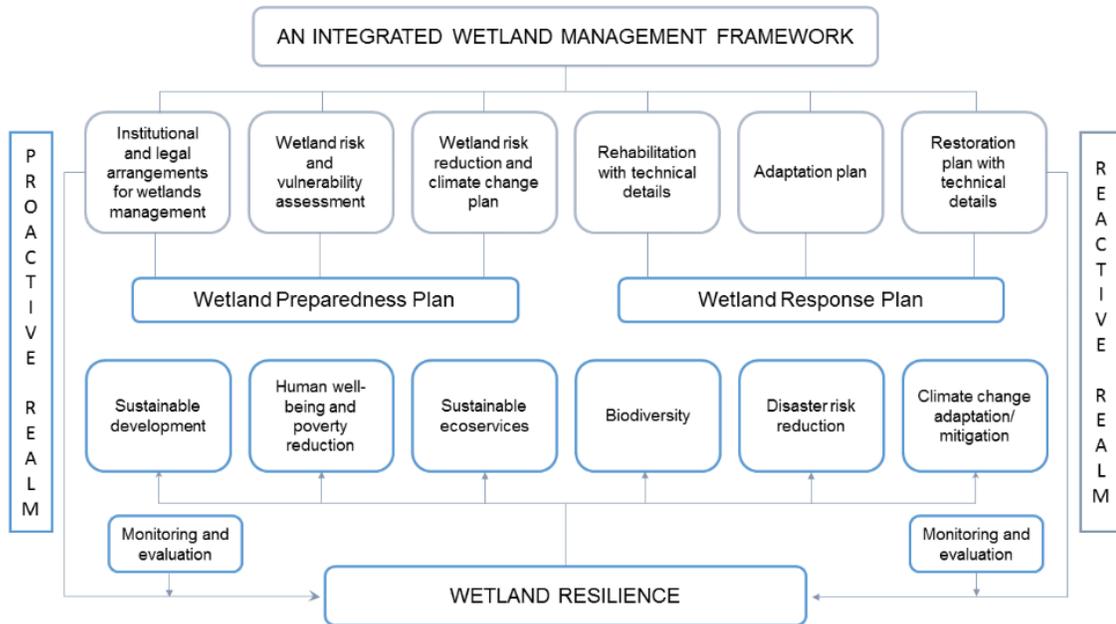


Figure 19 Proposed framework for integrated wetland management for the eastern Free State province, South Africa  
 Source: Retrieved from (Belle, Collins and Jordaan, 2017)

- Nature-based Solutions (NbS)

As a start, a clear guide for the main aspects that are intended to be considered by local ecosystem managers respecting flood protection. World Bank (2017) published the principles and implementation guidance to adopt nature-based solutions for climate change adaptation and disaster risk reduction, particularly to mitigate flood. In the Table 13 the five principles are described. In this same publication, best practices are shown, however from the interest of this study, the urban area of Beira in Mozambique is the example that has more similar context respecting the study case of Jaboque wetland. Beira city seeks to increase the resilience of the city towards floods by maintaining the natural drainage capacity of the Chivene river through the creation of urban parks in the city. To do so, was necessary the rehabilitation of the riverbed and planting active flood mitigation vegetation, which in this case are mangroves. Later, the city has implemented a multipurpose green infrastructure along the river, that includes landscape planning to increase the positive perception of citizens.

Table 13 World Bank principles for Implementing nature-based flood protection  
Own elaboration, retrieved from World Bank (2017)

| <b>Principle</b>   | <b>Description</b>   |
|--|--|
| 1. System-scale perspective                                  | Analysis of the local socio-economic, environmental and institutional conditions. This should be made with the proper spatial and time scale to explore which nature-based solutions can be considered. Thus, every territory and ecosystem have a different dynamic and conflicts, and affectations. Also, the local socio-economic and institutional context has to be integrated, especially because nature-based solutions are still not standard measures for flood risk. This represents a challenge for implementation due to the lack of information related to the cost-benefits for all stakeholders involved. |
| 2. Risk and benefit assessment of a full range of solutions. | Propper implementation of risk assessment must be developed, conducted in nature-based projects, especially to understand the capabilities of risk reduction. At the same time, it should consider a full range of measures that can be used in flood risk reduction. Finally, these assessments should quantify ecosystem and socio-economic benefits and project of future changes of ecosystem services over time.  |
| 3. Standardized performance evaluation                       | Nature-based solutions need to be tested, designed and standardised, to be incorporated in the guidelines for construction. This is still to be done, including evaluation of the measures, especially regarding the nature-based interventions for flood risk management. All knowledge gaps should be covered with an interdisciplinary view of natural systems and engineer specialist, which will increase the awareness of the role of ecosystems in risk reduction.  |
| 4. Integration with ecosystem conservation and restoration   | Understanding the ecosystem characteristics, dynamics, species is key for the Nature-based solution for flood risk. Is of great importance to NbS implementation the restoration, conservation and management of ecosystems, especially knowing that ecosystems in that are in good condition are more resilient to disturbances. Also, is important to mention, that these solutions consider the current and future state of the ecosystem, for which is worth to recognise if this has still the capacity to recover to avoid failures in projects implementations.   |
| 5. Adaptive management                                       | NbS need adaptive management based on long-term monitoring to have a long-lasting benefit. This adaptive management plan is a systematic approach that facilitates flexible decision making based on the knowledge of the ecosystem dynamic. In the same way, this should be contemplated during all stages of the project to incorporate also lessons learned for future implementation.  |

## 9 Discussion

### 9.1 Urban wetlands and flood risk reduction in Bogota:

After the extreme flood events in 2010- 2011 in Colombia, Wetlands in Bogota have recognised better their importance for hydrological regulation, especially in flood abatement, reduction of erosion (Ricaurte *et al.*, 2017). However, wetlands are also one of the most degraded urban ecosystems because of the unplanned construction of the city. That has subtracted more than 99% of their original coverage, transforming them by urban occupation, wastewater, and landfills; all this caused by uncontrolled urban expansion, roads, parks, bike paths, poplar groves, squares and public service infrastructure (Calvachi *et al.*, 2013). Today the most deteriorated and reduced plain wetlands are those of Capellanía, Tibanica, Techo, El Burro and La Vaca. The last four are strategic because of their location, as they are in one of the driest sectors of the city. Therefore their function as environmental, water and relative humidity regulators is fundamental. (Alcaldía Mayor de Bogotá, 2006)

Indeed, is possible to identify that most of those causes of deterioration and loss the wetlands in Bogota, and this case Jaboque wetland, are strongly related with that lack of local regulation and land use planning, and low ownership of the ecosystem. It was identified through the literature review and the interviews with experts. This last cause is strongly linked with the internal violent conflict that Colombia has had since the second half of the 20<sup>th</sup> century, that generated a phenomenon of forced displacement (Peñuela López and Vargas Sandoval, 2018). Forcing people to seek new opportunities in capital cities, especially in Bogota. Therefore, wetlands were invaded and slowly drained with debris, rubbish, and later lots were sold illegally, as it was told by (Villalobos, 2020, pers.com), who lived this situation, approximately since the 80's decade. From the study case of Jaboque, it is possible to identify that, after the declaration as a District Wetland Ecological Park, the reduction of the area has decreased and measures for its restoration have improved. Nevertheless, from the analysis made with the orthoimages, is to be considered that some areas could still be part of the ecosystem, having as a reference the location in the floodplain of the Bogota river and the nearby wetland of La Florida. However, this wetland is a non-recognised wetland by the district but is included as one by “Fundación Humedales Bogotá”.

Another of the conflicts identified was that the perception of those areas is highly negative, because wetlands are places which are associated with crime and insecurity, because presence of robbers, drug dealers, waste pickers and homeless people (Peñuela López and Vargas Sandoval, 2018). All of this demonstrates that social conflicts in the country have a direct impact on the health of ecosystems. For this reason, understanding the historical process and changes in wetlands is a crucial element in their recovery and conservation (Alcaldía Mayor de Bogotá, 2006).

It is worth mention that wetlands that were recognised as part of the main ecological structure of the city, and the creation of the district wetland policy, affectations in those ecosystems have been reduced. These ecosystems started to recover their natural land cover and water bodies, increasing the presence of endemic and migratory birds. For example, loss of the area has decreased and the degradation of the ecosystem due to the measures of the environmental management plan (EAAB, 2010, cited by Cruz-Solano, Motta-Morales and García-Ubaque, 2017).

However, according to with Cortés Ballén, (2018, p. 120), although there is a specific regulation for urban wetlands, their categorization “*does not conceptually involve the establishment of the connectivity of these strategic ecosystems for the regulation of the hydrological cycle of the city, nor does it functionally articulate the structural characteristics of the landscape in the main ecological structure*”. This aspect is important for the offer of its ecosystem services. Is important to note, that according to Andrade (2020, pers.com) part of those measures in the environmental management plan of wetlands to recover hydraulic functions, are heavily criticised by some stakeholders, because it involves rigid structures. Other experts consider that it is important to adopt ecosystem-based solutions and include wetlands as a complementary strategy for wetland and risk management (Garay, 2020, pers.com). However, there is still some resistance to have NbS as a complement to the traditional management measures that involve grey infrastructure (Nieto, 2020, pers.com).

Regarding the wetland policy in the city, their environmental management plans were mentioned by most of the interviewees. One of the aspects that were highlighted was the superficiality of the instruments and measures to develop actions aimed for the conservation and integration of ecosystems as a strategy in the reduction of flood risks (Escobar, 2020, pers.com).

This can be associated with the fact that some of the plans are based on the protection of some ecological benefits of wetlands or to improve the hydrological system in the city. Which evidences the low holistic approach of maintaining wetlands and, at the same time, reduce flood risk in the city; especially in wetlands that are closed to the Bogota River. Those are also recognised in the flood hazard map of the city, such as Jaboque wetland.

In contrast, some of the instruments for the risk management in the city, mentioned that, is necessary to complement the work derived from the District Policy on Wetlands in terms of how it addresses risk. Highlighting the importance of wetlands, especially those connected to the Bogota River, for flood mitigation and hazard management (FOPAE, 2008). Which is possible to infer that wetland and risk reduction management are still not integrated, knowing that the city has not modified the wetland policy in this matter.

Also, it is mentioned by the municipality of Bogota (2006) that the District policy of wetlands was made from the interaction between social organizations and institutions. According to the reviewed literature, stakeholder analysis and the performed interviews, this aspect is no longer a priority in the city, which was evidenced in the previous government of Bogota. It was mentioned in one of the interviews that it is essential to re-enhance the important role of communities manage and preserve the urban wetlands of Bogota, especially in the construction of local and national policies (Andrade, 2020, pers.com).

In relation to the mentioned above, key players (identified in the stakeholder mapping), are dependent on the national regulations and policies. However, those entities in this category have their jurisdiction in wetlands and risk reduction in Bogota, without leaving aside the participatory figures, which are stipulated within the wetlands and DRR management regulations. These are key to the management and control of the actions established in the city. Is of great importance, that the interrelation between entities, community and the rest of the stakeholders, to work not just for the maintenance of wetlands in Bogota, but to adopt them as part of the risk management for flood prevention.

## 9.2 Which are the key aspects of integrating urban wetlands and flood risk management?

Santos *et al.* (2019) mentioned that is needed to involve more the Sustainable Development Goals (SDGs) and the Aichi Biodiversity Targets, without further neglecting the risk factors in the face of climate change. Considering the national commitment to climate change adaptation, which is a concept that is strongly linked with the Eco-DRR. It is imperative to find a strategy that could integrate all policies of wetlands, biodiversity, climate change and risk reduction under one context, for them to have a holistic execution and proper application. Especially, considering the ES of wetlands and other ecosystems in the scheme of disaster risk reduction.

Finally, from the review of the best practices regarding urban wetland management, clearly, there is a lack of research made about the role of these ecosystems in flood risk reduction. However, from those that were mentioned, The integrated wetland management framework of Belle, Collins and Jordaan (2017), could be a great opportunity to integrate all different instruments that already exist in the national and district scheme for wetland and risk management. Considering increasing the initiatives that involved the community, by reinforcing the network between them and the “Alcaldía Mayor de Bogotá”.

In the same way, Hettiarachchi *et al.* (2014) study in Colombo, Sri Lanka, could be a useful reference, because they considered some of their previously published works into the research but giving them the perspective of how to improve urban wetland management. This is of great interest, because in the case of Bogota, several studies regarding the biological, ecological, water quality, and other conditions of wetlands, is valuable information to consider to be analysed with the approach of disaster resilience and flood risk reduction in the city.

## 10 Conclusion

Based on the location of the urban wetlands in Bogota, only those located near the Bogota River are identified by the city's risk authorities as being at risk of flooding.

Urban wetlands in Bogota have had diverse conflicts that have affected their health and offer of ecosystem services, including flood control. As it was identified, social dynamics have a direct impact on the ecosystems. Encroachment of wetland and further drainage and construction, and sewage disposal, reduce the area and the health of wetlands and in the same way have minimized the offer of ES. As is was identified in the study case of Jaboque wetland.

The adoption of policies aiming preservation, control and restoration of ecosystems in urban areas, are essential to maintain its ecological structure. Nevertheless, these policies should be integrated by and with other policies that can be complementary to the conservation and preservation of ecosystems, such as biodiversity, watershed management, climate change adaptation and of course disaster risk reduction. That can be the next challenge for the authorities, to identify according to the necessities and scope of local governments, to integrate and improve communication and efforts between entities, especially now that Bogota has just started a new district governmental period.

Finally, the role of wetlands in disaster prevention in the city is not recognised explicitly. It is because the interaction and articulation between entities in charge of the wetlands and risk reduction have different management scheme. However, is important to mention, that after the flooding events in 2010 and 2011, because of “La Niña” phenomenon, risk management scheme in Colombia and Bogota has improved in the integration of ecosystems as part of the strategies for climate change adaptation. Is important that the initiatives develop more nature-based solutions in Bogota, and the country, grow more towards the study of the proper application of those solutions, considering the local environmental, political and social dynamics. Which in this case, is an opportunity to promote new research in the city and country, to contextualize the different measures and actions of nature-based solutions, so that holistic actions for risk reduction and adaptation to climate change are created equally, based on ecosystem services and biodiversity of ecosystems.

## **11 Limitations**

The most important limitation of this thesis was that the context in what great part of it was developed, which was the outbreak of COVID-19 pandemic. Disease that was first identified in China in December 2019, but it was declared a pandemic in March 2020 by the World Health Organization (WHO).

Under this situation, it was not possible to perform the interviews in person, and all the process of the application and interview performance was carried out remotely, via e-mail and using digital platforms. This resulted in a more extended response and execution times. At the same time, it was not possible to hold a workshop with the key actors to properly characterize and identify the perception of wetlands in relation to disaster risk reduction in Bogota, which would have made it possible to have an even more consolidated and updated primary source. However, it is now a new opportunity to develop this aspect in another study.

By the same reason, fieldtrip to the site of the study was not possible during the times that the author was there. Thus, the time-space analysis was based on the orthoimages and literature review made. It is expected that in further research, visit the site and confirm the locations to bring more accuracy of the current state of the ecosystem and recover actions that are or not been done in the urban wetlands of the city.

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## 13 Annexes

### 13.1 Annex 1. List of interviewees.

| #  | Interviewee                              | Institution  | Function   | Date and time | Time     | Via             |
|----|--|--|--|---------------|----------|-----------------|
| 1  | Gina Paola González Angarita             | Universidad Libre de Colombia  | Faculty of Environmental Engineering. Expert in wetlands.  | 10.03.2020    | 15'      | Personal        |
| 2  | Emmanuele Escobar                        | Fundación Humedales Bogotá   | Founder and director of Fundación Humedales Bogotá   | 02.04.2020    | 26'      | Phone call      |
| 3  | Juan Manuel Castaño                      | IDIGER - Instituto Distrital de Riesgos y Cambio Climático               | Specialized professional of the functional group of risk scenarios.  | 15.04.2020    | 29'      | Phone call      |
| 4  | Angy Olaya, Carolina Alfaro, Mónica Díaz | CAR – Corporación Autónoma Regional                                      | Water culture department - in charge of water culture and socio-environmental strategies in wetlands.  | 21.04.2020    | 48'      | Hangouts        |
| 5  | María Mejía                              | Fundación Cerros de Bogotá   | Volunteer from Fundación Humedales de Bogotá, an expert in urban ecology.  | 30.04.2020    | 55'      | Google Meets    |
| 6  | Leidy Quintero y Hector                  | EAAB - Empresa de Acueducto de Bogotá                                    | Team from the corporate environmental management team of the Salitre Basin.  | 11.05.2020    | 43'      | Hangouts        |
| 7  | Nicolás Urbina                           | Pontificia Universidad Javeriana   | Expert in disturbance, ecological succession and connectivity, edge effects and ecosystem services. Part of the team that formulated the district 's biodiversity policy | 28.05.2020    | 45'      | Skype           |
| 8  | Andrés Garzón                            | Secretaría Distrital de Ambiente - SDA                                   | Environmental professional. Part of the team of SDA.   | 05.06.2020    | 1hr      | Skype           |
| 9  | Juan David Amaya                         | Pontificia Universidad Javeriana - Instituto Javeriano del Agua          | Expert in urban ecology and ecosystem services   | 08.06.2020    | 37'      | Skype           |
| 10 | Armando Sarmiento                        | Pontificia Universidad Javeriana - Instituto Javeriano del Agua          | Expert in hydraulic recovery and co-author of the Restorations guideline for wetlands.   | 10.06.2020    | 50'      | Microsoft Teams |
| 11 | Nelson Obregón                           | Pontificia Universidad Javeriana - Instituto Javeriano del Agua          | Director of Instituto Javeriano del Agua   | 11.06.2020    | 54'      | Microsoft Teams |
| 12 | Dora Villalobos                          | Fundación Banco de semillas - Humedal La Vaca                            | Foundation founder and participant of the mesa territoriales de humedales.   | 26.06.2020    | 1hr29'   | WhatsApp        |
| 13 | Ronald Ayazo and Diana Ruiz              | Instituto de Investigación de Recursos Biológicos Alexander von Humboldt | Experts in urban biodiversity and biodiversity. Territorial management for biodiversity in the wetlands line program.  | 01.07.2020    | 1hr      | Google meets    |
| 14 | Germán Andrade                           | Universidad de los Andes   | Expert in ecosystem services, wetlands and sustainability  | 17.07.2020    | 35'      | Google meets    |
| 15 | Carmen Lacambra                          | Grupo Lacambra.  | Expert in Ecosystem based adaptation   | 23.07.2020    | 1hr 30'  | Skype           |
| 16 | Cesar Garay                              | Pontificia Universidad Javeriana - Instituto Javeriano del Agua          | Expert in inland wetlands from the Biodiversity, focus in water and EbS  | 28.07.2020    | 1 hr 09' | Microsoft Teams |
| 17 | Paula Rodríguez                          | WWF - Colombia   | Expert in urban areas, in CC, air quality, and adaptation.   | 29.07.2020    | 29'      | Google meets    |
| 18 | Olga Nieto                               | Ministerio de Ambiente y Desarrollo Sostenible - MADS                    | Expert in wetlands Ecosystem based adaptation. Team of the DRR department - and flooding events.   | 30.07.2020    | 1hr      | Google meets    |

| #  | Interviewee           | Institution           | Function  | Date and time | Time | Via             |
|----|-----------------------|-----------------------|---|---------------|------|-----------------|
| 19 | Felipe Gómez          | NDC partnership - GIZ | Expert in Climate Change. Adaptation and flooding management. | 11.08.2020    | 41"  | Microsoft Teams |
| 20 | María Eugenia Rinaudo | Universidad EAN       | Expert in sustainability, climate change and biodiversity.    | 12.08.2020    | 39'  | Microsoft Teams |

## 13.2 Annex 2. Transcript of expert's interviews

### **1. Gina González. Universidad Libre de Colombia. 10.09.2020**

#### **Characteristics and ecosystem services of wetlands**

Wetlands have hydromorphic soils, which allow them to have a high capacity to control flooding. At the same time, the vegetation they have is hydromorphic, and this helps to prevent flooding in advance. Such as “sauces llorones”, “arbolocos”, which are located in the environmental management and preservation zone. These surround the hydraulic buffer (which is supposed to have 30m). However, this is not always like this. What happens in Colombia is that the hydraulic round and the management zone are mixed. Even the water body.

La Vaca wetland has a particular characteristic that has a biofilter (made with diverse plants like “junco”, “enea”, among others), which filters contaminated water from a wetland area. It is possible to see in the satellite picture the removal of total suspended solids and biological oxygen demand.

The waterbodies of wetlands have their dynamic and is an excellent way to analyse how changes have been in them. Also, I have my PhD Thesis, where I made this type of analysis. This dynamic or pulse is also shown by the von Humboldt Institute, regarding wetlands studies in Colombia.

In Bogota, after the district wetland policy, most of the wetlands were very beneficial. One of the great examples of this is La Vaca wetland, which an urban development. In my thesis, I show cartography and projection of how the city in the past was.

Now, where La Vaca, El Burro y Techo was a lake before, which was affected by the development of the airport, Kennedy area, since 1951. and this has affected the natural space.

### **2. Emmanuel Escobar. Fundación Humedales de Bogotá. 02.04.2020**

#### **Have wetlands been considered as part of risk prevention, especially the risk of flooding in the city of Bogota?**

If it has been tried, it has not been easy. However, since the creation of the IDIGER in Bogota, the organisation has been working on flood prevention. The connection with the District Secretary of the Environment of Bogota has been very superficial.

One of the events that have occurred this year was one of the largest fires that have occurred in Bogota's wetlands, approximately one month ago. No fire hydrant was found within five blocks or so. It was the neighbours of the wetland that contributed to the control of the fire.

It is mentioned that issues related to Climate Change have not been included.

The previous Mayor did not have the environmental issue as a priority, so there were “obstacles” to the inclusion of specific projects related to wetlands or risk management.

#### **What actions have been developed in the city for flood control?**

Previous projects have focused on the recovery of streams, especially in the Chapinero and Ciudad Bolivar localities. These were concentrated in reducing flooding and improving ecological connectivity; however, the budget for these projects was removed.

The priorities for the previous administration were safety, mobility and construction.

#### **How do you perceive the declaration of Ecological Parks concerning the conservation of wetlands in the city?**

Definitely, the declaration if it has given place to the conservation of the ecosystem, especially considering that thanks to it, although the construction of a specific type of hard works is allowed (this declaration was given in the first administration of the ex-Mayor Peñalosa). However, it is intended that the wetlands be considered as areas of protection and sanctuary for fauna and flora.

This categorisation is being evaluated so that they can be included within the protected areas system. This issue has been mentioned with the current Secretary of the Environment of Bogota. Also, this could happen if there is political commitment.

#### **Which are the main entities that are key to maintain wetlands in the district?**

Mainly IDIGER, SDA, EAAB, the last two are in charge of the management of wetlands in the city.

Other interested actors are the members of the District Wetlands Board, which has representatives from different locations in the city. They are aware of the importance of the wetlands as part of the city's immune system, taking into account events such as the la niña phenomenon in 2010 and 2011, where areas that were not usually flooded and which are recognised as having wetland areas previously.

#### **Do you think that the RAMSAR declaration of the Bogota wetland complex could contribute to their conservation?**

The declaration is more certification of these ecosystems. It is an agreement of wills that are part of the reserves. However, this is not guaranteed for the execution of concrete actions and/or allocation of budget for them to be protected. They are not a direct requirement for the management and recovery of these ecosystems.

**How do you see the involvement of the Academy within the processes of wetland management in the city?**

The Academy has been part of the recovery of the wetlands and the formulation of Environmental Management Plans, however, it has not been constant.

The actions that the Academy has had have been more from the particular initiatives of students, more not from directives. There is no direct support from the universities. In the past, universities such as the Pontificia Universidad Javeriana worked actively with the Conejera wetland, where students developed different projects in this place.

On the other hand, the Bogota Wetlands Foundation as part of the study of the middle watershed of the Bogota River, for the publication of the Alexander von Humboldt Institute “Colombia Anfibia”, where it is estimated that approximately 3% of the national territory is part of the Wetland ecosystem. In this publication, the middle basin of the Bogota river was studied, an area that is considered to be the most studied at the wetland level.

### **3. Juan Manuel Castaño. IDIGER. 15.04.2020**

**How do you see the management of wetlands among the entities of the district?**

Management is very bureaucratic between the entities, which have to follow the corresponding regulations.

**What is the role of the entity in dealing with wetlands and flood risk in the city?**

The entity recognises wetlands as an essential part of the city’s drainage system. In particular, the role of IDIGER at the district level concerning these ecosystems and the risk of flooding is to generate flood hazard zoning. In this zoning, wetlands are taken into account. Work has been done with 8 of the city’s wetlands and those bordering the Bogota River

This zoning is reflected in the regulatory map for the district, where these ecosystems are catalogued as highly threatened, thus generating restrictions for certain activities, such as construction.

As for the city’s regulations, it is clarified that the year 2000 land use plan is in vigour, giving the District Secretary of the Environment and the Bogota Water and EAAB jurisdiction over the city’s wetlands and the maintenance of the city’s drainage system. Additionally, the importance of the sentence of the Council of State of the Nation is highlighted, regarding the protection of the Bogota River. This sentence stipulates that the River watershed Management Plans (POMCA) for the Bogota river must be framed within the framework of the current land-use plan.

As a reference, it is mentioned that Decree 528 of 2014, establishing the Sustainable Rainwater Drainage System of the capital district, which included IDIGER as part of the management of channels. Work was carried out in wetlands such as Cordoba, Juan Amarillo, recovered the water body and the canal. However, this decree is no longer in force because it is considered to be against the 2000 land use plan, so in 2018, the jurisdiction for these management works is again delegated only to the SDA and EAAB (water system’s environmental management direction).

The SDA is responsible for the Environmental Management Plans of the wetlands. In particular, this entity issued the city’s Wetland Policy.

The flood hazard map has been ineffective since 2000 and is at a scale of 1:5000, a scale that has been used primarily for city decision-making. The last updated map is from 2018, issued by resolution 1631. However, this is suspended, so in the network is in force resolution 1060 of 2018.

This map is located in the SIRE, the geoportal of the entity. Here the entity has identified eight risk scenarios for the city, where the one related to climate change is highlighted, which includes mass removal and flood risk.

Bogota’s warning system (included on the SIRE website) has rain stations for the city, information that can be downloaded.

**In terms of difficulties in obtaining information or consideration of wetlands, what would you highlight?**

For the generation of risk maps, some wetlands do not have the necessary information, such as soil type, geology, as is the case of the Capellanía Wetland. This wetland has not been recognised as such and therefore, is not included in the risk management plan.

Another aspect that makes it difficult to obtain information is the articulation between entities, which does not allow for the rapid generation of data.

**How do you recognise the risk of flooding in the city?**

The city has two types of floods, the overflow type, which is related to the natural course and drainage of the water, and the ponding type, which is associated with the city's drainage network. This drainage network is in charge of the EAAB.

One of the problems of this network corresponds to the age of some of them, sediments and debris that are thrown into them.

**What do you think of the recognition of urban wetland complexes in the city as RAMSAR sites, do you think they contribute to the conservation of these?**

Definitely, if it is a recognition of wetlands to be conserved, however, it is the SDA that defines how they are conserved or should be managed.

It is recommended that you contact the entities mentioned above for more information on this subject.

**How are the city's unrecognised wetlands taken into account?**

Within the risk map, these are considered as water bodies; however, the physical limitations of these areas are not the competence of IDIGER. These are given by the EAAB and the SDA, which define the city's drainage system and its components.

#### **4. Angy Olaya, Carolina Alfaro, Mónica Díaz. CAR – Corporación Autónoma Regional. 21.04.2020**

Monica:

The department of "water culture", is in charge of water culture and socio-environmental strategies in wetlands for their protection. To analyse the link between wetlands in the Bogota Savanna is essential to recognise the watershed of Bogota river, where most of the wetlands are located.

With an overlook in the regional level, several ecosystems are flooding areas of the Bogota River, as the Florida Park. La Conejera wetland too, however, this wetland has a dyke, but still is a connexion with the river. Guaymaral, Jaboque, Meandro del say are wetlands in the district that the CAR also has jurisdiction. This is a shared work between GOAT - Dirección de Gestión y ordenamiento ambiental territorial de la CAR, and we work with the seer, communities, children, youth, the network of friends of the wetlands, among other social actors.

The national inland wetland policy is the principal the guide to our work with wetlands.as an entity we work for the public policy enforcement.

There is "mesas interinstitucionales de Humedales" under the name of "comites locales y regionales" (local and regional committees) which aim to develop environmental actions. Another project is the "programa padrino del humedal" an initiative between public and private sectors that take care of a wetland.

The work that the CAR has been developed so far is to have a process of environmental education to enhance the ownership of the ecosystem from the communities, recognising its ES.

Angy and Carolina:

The education and participation component work with local municipalities and committees to implement the necessary measures with respect to the management plan for the ecosystem.

That happens when there's a management plan. For those wetlands that don't have a management plan, the CAR makes a technical concept and give the input of what to do in this ecosystem.

In Bogota there's a regional committee in Guaymaral, Jaboque, Meandro del say, and work together with the SDA.

To enhance the ownership in kids of the wetlands and other ecosystems through environmental education with:

Kids: "eco escuelas" "niños defensores del agua", y jóvenes pregoneros ambientales. Adults: "amigos de humedales".

Private sector: "Redes car", involves them to preserve the ES, making them aware of the environmental benefits of working with ecosystems. Tito Pabón, Flores Yasa, for example, to preserve the Florida park, creating ecological trails and a biological corridor.

"padrino de humedal" wetlands as a better neighbour.

Working this the private sector benefits the triple alliance between the state (CAR), the private sector, and NGOs or organised communities interested in environmental issues.

**Management with none recognised wetland as La Florida? How has it been the changes and improvements?**

As a reference, the Neuta wetland, one of the problems is the lack of knowledge about ecosystems, the lack of environmental land management

The private company evaluates how much a hectare of conservation land represents economically versus a hectare of industrial land. But CAR has been aware of the value of the ecosystem, especially since the flooding events of 2010-2011.

**What sort of actions has been developed in the city/area for flood control?**

Since the heavy rain season of 2010 and 2011, CAR has developed different actions, has dredged to recover flooding areas. Apart from this, in the flooding areas are invaders in water protection areas, such as La Florida, Neuta, Tierra Blanca wetlands. On the other hand, “Terrereros” get in the area to sell the land illegally. All of this enhances the vulnerability of flooding events.

In la Florida there has been a recurring problem of disposal of debris for the purpose of drying out the wetland. However, with the support of the community, Los “padrinos”, and “Red de amigos” it was possible to remove 750 dump trucks from the wetland, which were then disposed of in a tip.

They are considering that fragmentation and reduction of a wetland, in this case, begins because of construction roads. Like Jaboque, la Florida (left side of the road belongs to Bogota and the right site to CAR (Funza - Cota). Another problem is the lack of signage in the wetlands, insecurity, drug dealing.

#### **Which can be possible solutions to the lack of communication between entities?**

One way is like the one that has been developed with the Florida Park, involving different stakeholders. At the same time, is essential to economically quantifying environmental services, this to enhance the knowledge of how in the long run might get affected in case of a flooding event instead of reducing the natural area, which will protect them from it, which means that the investment on education, dredging, the donation of a piece of land to increase the natural space, or the implementation of an ecological corridor with another wetland nearby. In this case, Andes university in the “redes CAR” program, has developed a study in La Florida, where it was found that is very little the investment vs the reduction of impacts and management in risk reduction that is generated by taking no action. Is essential to understand that is the responsibility of everybody and not just from one entity or institution or municipality. It easier when organisations are involved.

Universities have developed assessments. These help to involve them as a consultancy but through the students, which generate knowledge and environmental education, having a better perception of the ES. Also, the Academy provides confidence through scientific rigour.

### **5. María Mejía. Fundación Cerros de Bogotá. 30.04.2020**

The foundation finds in the restoration of the native biodiversity of the mountains (Cerros) a tool to construct community. Aims for the transformation of the civic culture regarding nature spaces.

They try that the ecological restoration as participatory, especially with voluntaries.

Is essential the knowledge network between universities, which nowadays are not that active. The same way with schools that are located in the mountain.

This foundation plays the role or perception articulator through networks. They try to establish critical stakeholders related to the mountains. To know who is present in there to develop networking of the ecological corridor that is supposed to exist in the city mountains.

#### **What kind of an environmental conflict has identified the foundation?**

First, the failure to comply with the court’s sentence. This leads to an increase in the vulnerability of landslides in the city because of the constructions and license of infrastructure in the mountains. The zoning is not favourable to the ecosystem; this leads to other conflicts, like insecurity, innovations or illegal inhabitants.

#### **How is the perception of the foundation respect urban actions linked to urban restoration?**

One aspect is to stimulate the perception that it is possible to restore ecosystems, even though they are located in private areas. Knowing that, in this case, the mountains belong to all the people of Bogota. And the management plans usually have a measure buying these areas to the municipality to later being restored, which is considered not viable.

Is challenging to create a community in the high-class people. Sometimes, their perception is that they will have exclusivity of these areas after they donate, regardless this is a public area.

In the last three years, companies have planted 500 native trees in public in the “private reserve of the civil society” in the eastern mountains of Bogota.

#### **Perception of the mountains regarding water drainage:**

Contemplate the territory as a watershed, where the mountains are the recharging areas. By reducing the drainage influence flooding because of the increase in the speed of it.

Is important to separate the path of people and water in the trails.

#### **How is it the risk management, and the communication with these entities?**

There’s been communication with entities, especially when the district makes some type of communication. However, there are some changes in the risk zoning; which may be due to political decisions, as it was mentioned by some expert that participated in previous workshops or talks.

It was intended to create a buffer zone in an urban wetland, but with a more flexible and adaptive purpose, considering other aspects. 2015 with the “mesa de humedales”

One experience in the 15.000 in the northern area of Bogota that recover a wetland to re-establish the ecological connexion between the Thomas van der Hammen reserve and la Conejera wetland. - Fundación Humedales Torca. This evidences that no matter how and who has the jurisdiction, involving schools make a significant impact in recovering areas. This case can be seen since 2002 with satellite images till 2013, recovering Los Laguitos wetland, reconnecting the old water body with the remaining one. Raul from Fundación Torca Guaymaral wrote this experience, in the book: “Transiciones naturales” by Mauricio Calderon, from the Foundation Colombia Ambiental Jorge Samudio, that is in charge of the Capellanía wetland. To make a conservation policy figure which has not been applied in local and regional protected areas, including urban areas.

## **6. EAAB - Empresa de Acueducto y Alcantarillado de Bogotá. Leidy Quintero. 11.05.2020**

The company has a management group that works in 4 watersheds, (4 principal drains). Those are (from bigger to smaller) Tunjuelo, Fucha, Salitre y Torca y Guaymaral.

The principal ES that is recognised in Bogota related to wetlands is water regulation. One of the problematics with the drainage is urban growth and their illegal connection to the hydraulic system, which carries rainwater, sewage, and a mixed-system. Plan of intervention and correction of closed interventions are taking place (Plan de intervención y corrección de intervenciones cerradas). PICCE-

Wetlands are included in the stormwater system. When it rains, it is important to control this water, and wetlands buffer and regulate the city’s rainwater.

Juan Amarillo has 222 ha and is the more significant and the one that receives the sewage from different areas.

Is important to mention for the wetland that is important to take as a reference, how many families or population benefit from this ES of flooding control.

### **How is the interconnection with other entities?**

EAAB works with IDIGER. For example, in one area of the Juan Amarillo canal. Where there are flooding events because of the water coming upstream forks, and there’s not enough capacity. They can make all type of infrastructure to expand the hydraulic system. In this case, IDIGER did particular works that didn’t work. After comptroller checked, EAAB was designated to do the consultancy and the construction. Also, IDU (Urban Development Institution) made other works (bridge) expanding the capacity of the water flow

EAAB is not an environmental authority; that’s why it has to work with SDA. What is indeed done is a solution proposal, that has to be assessed by assessment committees, with communities, and authorities (composed by The comptroller’s office, “personería” (mostly when problematic situations are encountered), “veeduría” and the community are also involved). The company is an executing entity and service provider of sewage of the city, and to manage all water bodies in Bogota.

SDA issues environmental concepts and also ask specific requirements and license.

Depending on the necessity of work with any waterbody, is involves certain other entities.

### **How the city’s drainage system is managed?**

Depends on the industrial development of the city., considering that urban expansion and the increase of the inhabitants.

EAAB has recognised all water bodies in the city. But according to the necessity, they make works of infrastructure to ensure the flow of the water body.

There’s a program of re-naturalise some waterbodies but in the long term.

### **How is risk identification?**

It also depends on the identification of the problematic situation, like the problem of outbreaks of fire in the wetlands in the south of the city, due to the water deficit, and climate change and human action.

There is a problematic situation with homeless people in Cordoba wetland, drug dealing, insecurity; however, this risk is not handled by them; these are referred to the police department.

There is a risk matrix, and from it, all solutions are purposed.

### **What is the perception of the Ramsar site inclusion of wetlands in Bogota? How can this influence in wetland management?**

“Personally, I don’t think Ramsar is useful, maybe the object of it is not clear for me” Is important to recognise that the local reality sometimes goes against international law, and vice versa. There are mismatches between what conversion requires and the reality of wetlands and their conflicts. This declaration does not affect the current management. The management is given by the current government and the budget that can have projects.

## **7. Nicolás Urbina. Pontificia Universidad Javeriana. 28.05.2020**

He has worked in disturbance, ecological succession and connectivity, edge effects and ecosystem services. He is part of the team that formulated the district's biodiversity policy. Also participated in International cooperation.

**How, from the approach of connectivity, can be explicit in the environmental policy and the DRR in Bogota?**

In the first place is the lack of articulation between entities. Even inside the entities and the local stakeholders usually are the most affected; Also, the categorisation of areas and land use.

The traditional main ecological structure was involving a new concept, where the small parks, that can help the connectivity.

The biodiversity policy in Bogota was issued with the action plan in 2010 approx. Different from the national biodiversity policy in 1995. this was not articulated with the district policy.

National Policy for The Integrated Management of Biodiversity and its Ecosystem Services (PNGIBSE) that was issued two years later. |

Is essential to have articulated the knowledge.

SDA tried to connect the eastern mountains and the urban area of Bogota. Since this initiative is evident that there is a connectivity between the mountains and the city from east to west, and, most important the SDA realised that also there's an opportunity to connect north and south too, through wetlands and other connectivity guidelines.

Sandra Díaz "nature benefits to people" is a new concept, to consider in a better way the "negative" services, in under the IPBES.

## **8. Andrés Garzón. Secretaría distrital de Ambiente de Bogotá - SDA. 05.06.2020**

In 2004 were recognised 12 wetlands, in 2014 or 2015, 3 more were included. Bogota's current development plan is for 2004. (Dec. 190 of 2004). This helped to clarify the management of them.

**How is the management of wetlands?**

The intervention has two edges; first, a Manager (someone technician) and an interpreter (someone from the community), who are the ones who look out for the wetlands in the area (investigation, security) this is something related with governability.

The community have communication with them.

Actions in Wetlands takes part in the Management plan.

The management works between EAAB and CAR (when it's shared)

Other actors are Police, local mayors, other entities, according to the necessities and condition of the wetland.

**Management scheme: from ES (flooding control) or ecosystemic characteristics:**

No doubt is well known all ES that they have; also, they are part of the risk reduction.

Wetlands are a monthly monitoring point whether its bird watching or plants. This is related to biodiversity.

From the hydric part, all have a delimitation. In some of the wetlands, there's a hydraulic model; however, there are political guides that rule the hydraulic round boundary. In one way or another, the issue of risk is implicit.

Approx. 80% of the pluvial current get to this ecosystem through the pluvial channels, and this is very well characterised, from this point, they can know if a canal has to be widened. They also consider the return period (100 yrs.). That is an input to know which structures need to be constructed, and in this way is risk managed. Some of the wetlands have these models: Juan Amarillo, Jaboque, Tibanica, Cordoba (not published yet), Conejera (in the process)

The district does not manage the risk directly, but by determining the water spaces as the main ecological structure, risk management is done.

**Are all structures hard? Or also takes into account the recovery of natural spaces:**

First, there is an assessment of the wetland to consider the conditions of the waterbody to the purpose of the action.

One crucial aspect is the sediments that also get in the wetland through the canals. Some solutions are dredging depending on the modelling and the amount of water that might receive the canal and the wetland.

**Flooding events like 1998, 2010, are considered in the modelling too?**

Yes but, is more related to the return period and the rise levels of Bogota river.

Modelling is not public and is made by EAAB.

SDA validate the criteria of the design of the structures and include other measures.

**Perception of loss, degradation or restoration:**

Definitely, this has got better over the years, especially in those that have management plans. However, is still having problems with illegal invasion, drug dealing, essential to know the charge capacity.

Access control is a measure that helps to maintain the ecosystems, avoiding people to get in.

Sometimes there are fires, and this regeneration is slow, like in Tibanica.

The area of wetlands tends to maintain or increase in most wetlands. Regarding the waterbody, if this one reduces there's a strategy to hold, however sometimes if this is reduced, is because of the dry season. In the management include plantation and restoration.

**Which wetlands have had to improve the most:**

This depends very much on the will of the leaders of the period. One success case is La Vaca wetland. Techo has construction inside the wetland, and this management is complex by the relocation of the people and later restoration of the ecosystem, and also is expensive.

The articulation between entities is better. For example, a license for construction has to be checked by the SDA. In Juan Amarillo and Jaboque, Tibanica, there is a bioremediation project in the wetland to manage the water quality, which is a critical aspect to consider.

The communication has improved where certain entities are beginning to understand that the responsibility of environmental management is from everyone.

EAAB has excellent communication.

Individual professionals are the ones that lead to excellent communication between entities; those who commit because there is no participation figure between entities.

**IDIGER and SDA task:** the articulation is different and distant. Because they are doing, manage these spaces and focus on risk assessment and mitigate where is needed; otherwise, they just tell the entities what should do. IDIGER Is a technical support entity for the risk assessment. To delimit waterbodies IDIGER check for considering risk aspects.

**None-recognised wetlands and their risk:**

It is a complicated topic and also depends on the will of leaders. Management is done, and SDA check and visit areas to contemplate if the condition of wetlands exists and if the technical area confirm. Because sometimes to avoid projects "create" wetlands, or confuse hydrological structures that attract fauna and flora, and request that they be declared wetlands when they are not. Most of the currently recognised as a wetland is wetlands.

Other water bodies can be declared as a protection zone, but not as a wetland.

**Ramsar declaration: how management is affected:**

"I did the cartographic work for this declaration". Nowadays, this declaration in the management scheme of wetlands is not incorporated yet. But this is in progress because a new development plan is under construction.

Some of the declare sites don't meet all requirements, but the idea is that they achieve those according to the Ramsar conditions.; for example, water quality.

One aspect of being recognised is that our wetlands are not upstream but near the river.

Also, for the region city concept that the district wants to achieve, is essential to unify the terminology of the ecosystems, which generally in Bogota is different from the others, that's the case of the principal Ecological structure

**Communication between actors:**

Citizenship work in a different way. There are actors like "mesa de humedales", mesa territoriales, local mayor (which are the ones that have environmental programs to manage the area). One improvement is that people are more involved with the management, but also many thinks that via social media is the way of supporting the management of the ecosystem. Still, they no use the participatory figure even though it is important that those need to evolve with these new technologies.

**Academy:**

The problem with this is that they don't contemplate the management aspect, but this participatory figure they participate. However, they think that the entities always will ask for their knowledge, and vice versa, even though they sometimes happen. Nevertheless, there are inter-administrative agreements between regional entities and the Academy. One way to link them is the internships, but still is a complex to incorporate them. Academy gives up fast in the management. Because monetary resources usually don't include Academy and many of their projects.

**9. Juan David Amaya. Pontificia Universidad Javeriana - Instituto Javeriano del Agua. 08.06.2020**

Regarding wetlands, community ownership has grown, and the story is very particular based on the cultural ES. Several groups were formed from the community to conserve the wetlands; also, professionals worked in wetlands from the bird interest and had evolved to identify the conditions of them.

In 2005 Academy, citizens and EAAB start working together to recover hydraulic areas of wetlands, even though the concept of ES was not used.

A guide/protocol for the restorations of wetlands was written. Some wetland like Conejera, Jaboque, were affected by actions that canalised part of wetlands, in Peñalosa's first term.

Cordoba wetland have had more participation between Academy and "Fundación Humedales de Bogotá".

In the second term of Peñalosa, the "mesa de humedales" has lost strength.

After Ramsar declaration is not explicit, how is the management and the role of the communities' respect wetlands. One project of restoration in the city is to recover the connectivity of the Las Mercedes forest (the only relict of forest left in the town) with Conejera wetland. However, it is not clear what's going to happen, because a road is contemplated to cross in that place.

Wetlands in the southern part of the city have not been very mentioned over the last years; however, there are some in that area that has to improve their conditions

There's a thesis in a multitemporal analysis from Diana Arias, which assessed the biotic component in La Vaca wetland. Problem tree was critical and participatory actions to identify what have been the impacts of the activity made there.

Nowadays, it is essential to know what are the conditions and the issues that every wetland has because all are different. From this point, it is possible to define local management through governance. Is not possible to manage all with the same tool. Is necessary to involve the community to identify the variables to have better results.

#### **Entities and community:**

Bogota is an example to protect natural spaces from the interest in of the people. Through Fundación Humedales de Bogota, Fundación Cerros de Bogota, which promoted management in the government. These civil associations keep the memory of the work done.

Also, that is possible because of people in the district had the interest to do so.

#### **Flooding control ES perception:**

From the Academy, this perception is clear in flooding risk reduction.

Political: Bogota has improved slowly this perception, however in the second government of Peñalosa has lost this perception, but now is getting stronger again, with the ecosystem Based solutions, ecosystem-based adaptation and ecosystem disaster reduction. This will improve more if the governmental plan for the current project promote rehabilitation of wetlands, not just for landscape.

#### **A key aspect to consider involving more the Academy into decision making:**

in countries like ours where the science is not that important is very difficult, because the language is difficult for the decision-makers to adopt this in the actions that they promote. And there's nothing in between. Also, times in the demand and offer of information between government and Academy is an issue. Usually, the Academy takes more time that governors need the information. One example of the importance of this relationship is the current pandemic, where decision making also depends on scientific work.

Is important to create alliances between Academy and government, which depends on the political will. This to have better arguments for decision making.

#### **Actions to include wetlands in the city perception of them:**

There is already an approximation from the citizens, but the capacity of the decision making is problematic from the community. Ins essential to be more creative to create spaces to find better results, like ecosystem-based Solutions.

Urban sustainable drainage systems demonstrate to the society the value of them, for that is critical the assessment and valorisation of the ES of wetlands, as an evidence of the benefits for the people.

#### **From the institute:**

They were created in 2019 to work between science and politics. Approximation to real problems in the country using the knowledge of diverse professors from different faculties and place the University in the decision making and a conflict mediator of the water resources; bring consultancy to efficient work.

### **10. Armando Sarmiento. Pontificia Universidad Javeriana - Instituto Javeriano del Agua. 10.06.2020**

It is important to address wetlands, understand them from the perspective of fluid mechanics is key. There are two ways to address the role of wetlands: 1. from the occurrence of an event (like flooding) to know how much water and the conditions. 2. more static analysis to see the storage capacity vs the average water that drains, mass balance. This to infer if wetlands have this capacity still.

In a wetland the buffer is given by the water storage capacity it can retain.

One problem in the continuity in wetlands improvements is that entities have changed the team drastically and this has affected the management of wetlands.

The principal issue of wetlands is that sewage reaches wetlands, which decrease water quality, affecting the hydraulic capacity.

Back then, wetlands in Bogota were lagoon. But the excess of nutrients helped to clog them and nowadays, mechanical actions keep the remaining wetlands.

Some wetlands plans contemplate this type of interventions. That created controversy, because of the perception of particular environmentalist don't share this type of measures, which is not logical because then wetlands will disappear very fast by clogging.

So, flooding regulation is inferior in the city. However, wetlands in the western part of the river might have better conditions for it.

In 2011, the river had a dyke that was broken to flood the surrounding land in Funsá as a measure to control flooding in the city. In this case, it would be good to identify the hydraulic capacity to manage to flood, making hydrological studies from the soil conditions, slope, watershed.

Hydrological models are challenging to implement. They require software. Wetlands can be seen in this case as a canal to simulate events, to check their capacity of storage.

**Wetland Jurisdiction:** Petro designated the aquatic management of wetlands to the EAAB and the terrestrial to José Celestino Mutis Botanic Garden, which is an error, considering this ecosystem of wetland.

One of the biggest problems in environmental management is to divide measures from side to side of the river just because it belongs to another municipality, which is the case of Bogota and the savanna.

From the hydraulic point of view, a wetland in Bogota cannot handle external events, because the storage has changed since the canalisation of the pluvial streams. Just in those wetlands that do not receive sewage are in better conditions. Those will have a better capacity.

The EAAB has a plan to manage the "wrong connections" of sewage to avoid the combination of the pluvial system and the sewage. However, it has not been very successful due to the organoleptic water conditions that you can recognise.

Jaboque and Juan Amarillo have kept the waterbody due to mechanical actions, which is linked to the management plan.

#### **Management plan contemplated risk reduction?**

Management plans were focused on biodiversity. Either biological or hydrodynamic. Some actions have implicit the risk reduction, like keeping the water levels; however, it was not the primary aspect for them. Also, wetlands are not managed as a system, but as an individual ecosystem.

### **11. Nelson Obregón. Pontificia Universidad Javeriana - Instituto Javeriano del Agua. 11.06.2020**

Management tools work best when supported by strong tools that allow thoughtful evaluation of any decisions made.

Is important to use the modelling, but not just as tools, is better to work for the execution of the results and link them in management measures.

Historical context in the country is important to understand the risk and vulnerability of flooding, mainly when most of the municipalities are located close to the rivers.

**Tools to have a holistic thought:** Tools are just part of the process, but the problem is how to handle. Sometimes guides are only seen as the minimum to do.

**Entities and categories of ecosystems:** This helps the management of the ecosystems, to restore and conserve. The important thing is to monitor the efficiency of them, to check really how this has impacted the condition of the ecosystem.

**Stakeholder participation:** Local population is key. In Colombia, participatory is not well defined and sometimes stays in just socialisation, which is not correct. Is essential to generate tools that allow all types to knowledge, not only the scientific one, but the empiric that has a person in a rural area have, for example.

The water problem is not scientific and technological; it is psychosocial and cultural.

Is important to recognise the context and the relationship that a person has with the environment, that is key to analyse in any project, especially with ecosystems.

Perceptions of wetland in Colombia are very sectorial and particular. That is why it has been affected by a particular interest, having an approach that understands then as a big ecosystem, hopefully with a sociological scope to be able to understand global ES, because some of them can conflict with them.

### **12. Dora Villalobos. Fundación Banco de Semillas - Humedal La Vaca. 26.06.2020**

### **Ecosystem services:**

ES of wetlands that we recognised, like flood control, focused on the current management, including wastes, flooding events. Wetlands store pluvial water. Another function help with water quality. This canals with sewage also reach wetlands, not just rainwater. However, this ecosystem improves water quality. Another service is biodiversity reservoir, birds, amphibians, plants, insects. CCA, as in control of the greenhouse effect. Hydric regulation, nutrient retention, migratory fauna.

Also, ancestral importance, related to the location of the municipality, which is commonly are located close to water bodies, which is also the case of Bogota. Indigenous reservations had their traditions related to lakes (chucas) which today are wetlands. For example, women had their children in the water. Also, their economic activities were in there, like fishing and agriculture.

### **Case of La Vaca wetland recovery**

La Vaca wetland had severely reduced, and in 1993 was reduced from 25 ha to 9. Entities, “tierreros” “Corabastos” at the time did not believe that this wetland was possible to recover. However, community leaders, mainly woman, were convinced of the contrary (but not all) and they involved the district entity.

To save the wetland was essential to making pressure to the entity and the decision-makers like the mayor, council and other actors to relocate the people that were illegally there due to the purchase of land in wetland areas sold by tierreros (people who illegally sell land). In 1999, it was possible to change the land use of the site. It was declared by the Council, 9ha wetlands that were recovered. However, the condition of the area as very bad, 160 families who arrived in the city, needed to be relocated. This was a very long communitarian process, ensuring the human conditions of these people and the conditions of the ecosystem. That was a concern of the community leaders because the conditions as they were being located were not good. Community work was required, sensitising the officials in charge of this relocation and prepare people to improve the conditions of negotiations. This process was until 2005, assumed by the EAAB and the mayor office, and the national government.

After the relocation was made other conflicts for the land appeared, the wetland was abandoned, and some other families came back. But the authorities did not pay attention until the “vendors” demanded the work done in the area until the authorities managed to get the municipality to evacuate the area again and have a management plan generated. Debris and garbage were removed.

The community leaders, mainly woman, empirically created a nursery to restore the vegetation in the area. And they had help from some experts to do it in 2007 - 2008. That has made ownership.

Nowadays, this is also used in environmental education. It involves kids of the area.

After this experience, the southern part of the wetland was also recovered, even though, the beginning it was difficult because of threats.

However, awareness of people has been difficult, because of the negative perception that wetlands have, though in the last years it has changed in a great part of the people.

Also, Corabastos, who was one of the principal opponents to the recovery of the ecosystem; now is the sponsor of it since 2012, understanding that the ecosystem was necessary for their surroundings.

### **Can these actions be replicable to other wetlands?**

Totally but is necessary for the commitment of the leaders and the community. No matter the political party.

How can these actions be encouraged by the authorities so that this recovery of ecosystems is long-lasting?

Involving community, but not just socialisation but an exchange of knowledge. Also, authorities have to know the social conditions an prepare the community to be part of the process

## **13. Ronald Ayazo and Diana Ruiz. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt. 01.07.2020**

The institute has worked mainly in a national context. Related with wetlands in Bogota there's not yet a study; however, there are other studies that involve protected areas, and ES. Other works had included a workshop to face challenges of the perception that sometimes is negative. The institute has worked with WWF, to check how a mapping of waterbodies related to the hydric regulation, that can be managed flooding.

The Institute is the scientific advisor to the Ministry of the Environment and is part of the SINA.

All projects go hand in hand with a financier. These bring results like publications like “Colombia Anfibia” and the national map of wetlands; therefore, these inputs are given to the entities. Because of the scale is to provide information, not decision making. One of the most significant projects is in “la Mojana” that is related to the ES of flood control in rural space. In Bogota has been more like a scientific assessor but has not developed a publication or project.

In the urban context, there's a concept of "sponge civic" how the restoration of wetland to absorb water and avoid flooding.

In Bogota, for the Ramsar site declaration, it was proposed at the beginning the regional complex, however by the end was not like it, and ended only the 11 wetlands in the city. The title of Ecological park of wetlands excludes other wetland ecosystems. Fundación Humedales de Bogotá has identified more than 20 places that also are considered as wetlands. However, this to be included in the district as wetland brings challenges because it will require management, communitarian participation and economic demand. The management plan is not appropriate to the wetlands because it is very superficial and does not focus on the real issues.

EbS is a concept that can be very useful to governance. Also, more people have recognised wetlands as an essential ecosystem. Likewise, universities have worked, and other actors but is also needed that politic involves it with wetlands or flooding waterbodies.

One issue that affects management is that economic resources are not always enough, which leads to include the private sector, universities, local municipalities and the communities. All of this from their vision work in some way to develop the management. This corresponds to the "Padrino del agua" program of the EAAB.

**Ramsar declaration:**

The argument that was used in the first place was the bird watching and the biodiversity aspect of the ecosystem. Politically can help to may commitments, however, as reference cases in the country, the first Ramsar site (Ciénaga Grande de Santa Marta) nowadays has not even a management plan, which confirm that the Ramsar designation is not a guaranty of management. That's why this has been included in the list of Montreaux.

In the urban context, there are other the use conflict of the territory.

**Perceptions:** Social appropriation is key to ecosystem restoration, especially if the communities are migrants, who have no attachment to the territory and wetlands, and have a negative perception. However, little by little, this perception has changed. In Bogota is part of the icons and cultural reference for mainly Bogotanians and inhabitants, even though is not generalised perception. Because of the lack of knowledge

Entities relations: The context of work is mainly national. So, the communication is with the entity that is involved with a particular project. Sometimes is involved Academy, local entities, private sector, and others. The institute is the "hinge" between the public sector and academia.

#### **14. German Andrade. Universidad de los Andes. 17.07.2020**

In the '90s, Colombia was not in the Ramsar convention, and wetlands were not defined. Sometimes it was just recognised as water or soil.

In 2004 Peñalosa promoted the construction of specific structures in the wetlands. From this point, it was the strengthening of the community in the face of the defence of the wetlands. This interest then led to the formulation of national and district wetland policies.

In the second government of Peñalosa, tried to invalidate this aspect of the district's wetland policy, but the court last week ratified it. This type of intentions is a repetition of past mistakes in wetland management.

**Hydric regulation**

In urban wetlands, in 2010 and 2011 demonstrated that they don't have the capacity of this regulation in these extreme events.

Is important to consider that, as the hypothesis of designating a total function of hydric regulation can threaten other ecosystem services. EAAB has a hydraulic vision of canals maintenance. This might bring conflict with different roles, like the natural dynamic of wetlands.

Nowadays, there's a better perception of the social-ecological characteristic, as mentioned in the Ramsar convention and the wetland policies, to ensure the health of the ecosystems.

The hydrological function of wetlands has not been adequately checked, because this can threat another benefit of wetlands.

The socioecological function of wetlands is from the entire wetland complex, not just one as an individual, due to the size of it.

Seen them as a complex can make a balance in the ES that this ecosystem has in the city. There are some nor urbanised areas in the city, that can help with the global function of the wetland complex, sadly, some of these areas are prone to be occupied by urban constructions, in the last government.

Flooding areas in the city can be integrated as helpers in the hydric function of regulations.

**Ramsar:**

Ramsar convention does not give management categories of protected areas; however, internationally is recognise the ecosystem management. The primary reference is the biological character.

Personally, this designation was a rigged action. Because of the false information given by SDA that the wetlands would have this certification, which does not correspond to what the Ramsar site declaration is. And also, was launched at the same time that social participation has decreased, by changing the politics, ending the “comité distrital de humedales “. Which this is no logical with the Ramsar parameters. The current environmental ministry has not done the task of defending these international agreements in favour of wetlands.

Is essential to improve social participation in wetlands issues.

Hopefully, the current government in the city recover the concepts and legitimacy of the Ramsar management criteria.

The idea of declaring as Ramsar site the urban wetlands of Bogota has existed for over 20 years.

In the history of Bogota, there are two periods. 1. The impact of Ramsar convention was very positive, influencing the judicial channels. 2. The district twists the original interpretation of the Convention; thus, it did not affect positively.

#### **Main ecological structure**

This does not have a clear definition of handling. It has not been approved with the protected areas system, but it does not correspond to a management standard.

#### **Is good to have an inclusion in the protected areas?**

is a necessity to identify them as a possible protected area with a previous homologation with the current system and classification.

#### **Key stakeholders.**

Historically, first were the scientist actors, later this became a social issue in governance in Bogota. It is crucial to take back. And social capital needs to be re-legitimised, through the “mesa distrital de humedales” of the wetland politic.

#### **Perception of wetland:**

In some areas, people just recognise the wetland in no more than five blocks, however the collective acknowledgement of the importance of these spaces.

#### **Flooding: is possible for the wetland to improve the capacity of flood control?**

Of course, this is recognised in an article by Thomas van der Hammen, where he said that these ecosystems are no natural, the human transforms them. And the management of balanced ES management is what needs to be done. Bogota wetlands are resilient even though the lousy management that they have.

## **15. Carmen Lacambra. Grupo Lacambra. 23.07.2020**

Colombia needs to adapt the investigations with the reality in disaster risk reduction. Not all solutions can be applicable and successful, taking into account the conditions of the ground.

In Colombia, ecosystem research is often focused on taxonomy, physiology and classification of the ecosystems. It is necessary to see them as a system.

Wetlands management can be very similar, like mangrove management, is not usually investigated as a whole.

Historically the environmental management has been present somehow without the conceptualisation, through the inner interest of education of people or even entities, new ways of living, however, have been very beneficial.

The community ownership is vital for the success of a project related to ecosystems.

Is very impressive to see the flooding areas in the Bogota savanna that were covered by water in the rain season in 2010-2011, and now there's construction in them, which most of them have a licence to build. This happens mainly when private companies make deals for construction projects, and the decision making is a private one, it is straightforward to become corruptible because there is no real control. And ecosystems are affected.

The area of the Universidad de la Sabana de Bogotá was flooded entirely in 2010. However, the solution that was adopted to mitigate was to construct a dyke. This situation will represent that probably this flooded area is not going to receive water, but other regions will receive them, affecting them. This is an example of the lack of control of land use.

One of the challenges is to evaluate the ecosystem services of ecosystems. For the case of flood control is difficult because is needed to know the actual store capacity, to be able to the decision-maker that this conservation of the ecosystem will represent more beneficial that the construction of a dyke. But this is not happening in Colombia because of the lack of research in this aspect.

Another aspect to consider is that even though wetlands are in excellent condition, the Bogota river has been modified, or many dikes were constructed. Probably in the next heavy rain season, this will be flooded because there is no place for water to be stored and the flow to be regulated.

Restoration of the wetland is possible; however, it needs to have the political will and capital. Clubs in Bogota that have lakes, they can offer in their services to enhance the ecosystem services. Mainly because these green areas in some way already bring environmental benefits to the city. One problem in Colombia is also the institutional capacity, sometimes they have to focus on other requirements more urgent, and the long-term activities cannot longer have the full attention. Sometimes concepts are mixed up, for example, ecosystem-based adaptation with natural-based Solutions, which is an important topic to have clear to apply proper measures between actors. Sometimes the concepts related to DRR are learning lessons, that have to be included in the land management. There no region-based management of wetlands is given because of a different jurisdiction, and they're not the conception of the basins. Is important to consider that concepts need to be taken into practice. International cooperation is critical in the restoration of ecosystems because they finance many projects in Colombia.

## **16. Cesar Garay. Pontificia Universidad Javeriana - Instituto Javeriano del Agua. 28.07.2020**

Wetlands are recognised as an ecosystem that must be conserved due to the politic, for example, in the Magdalena river flooding areas.

### **EbS is being promoted in the country?**

The country has a classical approach, especially in universities. Many of the people who make consultancy or studies, they did usually apply this type of concepts, even though, nowadays is growing. There are some cases like in Cartagena in Cienega de la Virgen, of flood mitigation measures of the rising water levels. In Manizales also DRR is strong because of the natural conditions of the city and past experiences.

There are some perceptions that natural areas that can affect people in cases of disasters, like in the case of Mocoa. The change of vision must also be made from the state so that the Academy can adopt it adequately, and the new professionals apply it, so as not to continue with the same model of doing things.

Also, the recovery of a community's knowledge is helpful to create local improvements and have successful projects; all of this effect to the application of the Eco DRR. This can be seen in a better way as a complementary measure in risk management.

### **EbS In Bogota:**

Wetlands were not recognised. Which changed when the wetlands politic was issued, and later was shown its benefits slowly.

For 2027, there's a plan for recovering the conditions of the hydric conditions in the Bogota Savanna, having 14 water treatment plants. Having this and the right conditions of wetlands will be very beneficial to recover this hydric flow.

In the last period of Peñalosa, the perception of the allowed activities in wetlands chained to have more active actions, including other types of structures permitted in the ecosystem, as a more recreational space. However, this is against the conservation of them, though the court revoked it. In China: In some cities, wetlands in urban areas without rigid structures in the margins allowed to have a recreational facility to the citizens.

In Colombia, green structures are not well known.

### **Potential to reduce flooding risk:**

Considering the Magdalena river, wetland does not mitigate flooding; they help to regulate the flow levels. This is because of their natural characteristic, which, in the case of an event of a flash flood, they will flood quickly due to the saturation of the soil. This regulation helps to the maintenance of ecosystems in dry seasons because they retain water and slowly release it.

One measure in flooding is to generate empty volumes that can be filled in case of heavy rain, preventing the flood from taking place. Such as underground reservoirs

In Japan the recreational infrastructure (like stadiums) helps to control flash floods, allowing to control the amount of water. They receive part of the volume of the water. This is not a function of wetlands.

At the flood peak, the wetlands cannot provide any service but bring benefits in the times of low rate of rain, and the infiltration and aquifer recharge. This ecosystem helps in the previous stages of flash flooding.

One measure could also be that in case of flash floods, water can be directed to the wetlands areas, so if this area gets flooded, then won't represent a hazard for the people, knowing that this ecosystem will be able to cope with this event. This maintaining all areas of the wetlands with soft infrastructures.

Forested areas cannot retain water, that's why drivers must not just have trees, because they won't have the capacity to maintain that much water and reduce the speed of the flooding.

#### **Stakeholders**

Intentions are there, however policing and management most of the time, do not accomplish and also, the environmental ministry is seen as a sector, instead of being a cross-sectional actor.

In the regional level: there is a deficit to implement projects formulated for the management of resources. This level is the most affected

Local: there is more support from the entities and community.

In the political aspect, Colombia has useful tools; the problem is at the moment of the execution of these.

In the private sector, many actions have been taken to improve ecosystems as part of their social and environmental responsibility, thinking in their benefit.

The approach to economic resources must be changed so that in the long term, they also generate benefits when considering ecosystems.

Community work must also have a budget if it is to be sustainable over time. It's not enough just training and goodwill.

Perception: Wetlands are potential; however, they need to have recognition and management.

### **17. Paula Rodríguez. WWF - Colombia. 29.07.2020**

WWF is working in a diagnosis of strategic identification ecosystems in Bogota and Cali in 4 aspects: Water supply, connectivity (transport), flooding control, landscape. However, this is in progress after will be possible to purpose strategies.

WWF is an assessor and develops environmental projects in the national, regional o local level, according to the requirements of the organisation of the entity.

The relation between the organisation and the entities is according to the necessities that they both have. The objective of the organisation is currently to strengthen the urban-rural relationship since it has worked mainly in rural areas.

Urban projects are relatively new.

Aspects to take into account for the management of ecosystems is the knowledge that cities depend on areas that are not their own, the example in Bogota is the water that comes from the paramos of other municipalities. And this is important to strengthen this regional approach. Also, citizens need to know the ecosystem for them to be aware of then and also allow better conservation. That's important the environmental education.

In Cordoba wetland and the close by neighbours are more sensitive to these ecosystems.

Environmental education and the economic factor can help the conservation of ecosystems by raising awareness. For example, people should be charging a small amount to at least know where the water comes from, for example.

### **18. Olga Nieto. Ministerio de Ambiente y Desarrollo Sostenible - MADS. 30.07.2020**

After the 2010-2011 flooding events, it was developed a delimitation of the main wetlands in the country. From this type of projects have been set another in a regional base.

#### **How have ecosystems been taken into account in environmental policy?**

So far, the ecosystems are being recognised. From the events of 2010 and 2011, much has been learned from that event. But it is still lots of things missing. Mainly because entities have been more concerned about improving waterways and not restoring the ecosystem as such. Still, there are much engineering solutions, traditionally in the country.

#### **How can MADS change this perception?**

The current ministry has pushed for ecosystem-based solutions. Also, Putting the ECO - DRR into context to bring it to the CAR to every region. At the same time, it is essential that the traditional way of management, needs to have a new approach, having a more ecosystem scope in the solutions of the necessities that the regions have.

#### **Environment as a sector?**

This is one of the problems; the environment should not be seen as a sector, should be a transversal aspect.

#### **How things can change, political will or professional initiative?**

It's one thing from part and part. But it's the international community that has put pressure on the country to adopt new concepts. because research in the country is slow and is not taken in to practice most of the time

#### **How to apply studies in practice?**

Many times, things have been applied in practice without knowing the concepts, but results have been obtained. It is essential to publicise this type of action to replicate it in other regions. There is also a lack of accurate data to corroborate whether the studies are useful in practice to identify possible adjustments.

One of the problems in the ecosystem-based approaches is that it requires time for certain governments that is not good because the fast results are needed.

#### **Wetlands: recover or restoration**

Individual actions have developed beneficial results for the ecosystems, mainly worked from the local level even if they are regional, national or international initiatives. Activities should be performed from bottom to top. Bogota is challenging to develop these activities because is in the middle of the urban area. However, in certain wetlands, there has been the appropriation of wetlands.

**Regional management of wetlands** is important to understand the area from as a watershed, and the CAR needs to have a more powerful strategy to deal with it.

#### **Why wetlands in Bogota are not seen as a regional complex of wetland.**

It doesn't have a logic regional jurisdiction from the CAR. It should have a better delimitation for these ecosystems and the ECO DRR, which should be by watershed.

**Risk and EbS:** Information from the POMCAs and based on the ordinance plan is taken into account. But the ecosystems are still considered as a management item., yet it is not developed. There's a lot of the resistance and therefore, there a lot of work to do in Colombia.

**Ramsar:** This is just recognition; it needs to have better work done to the actual restoration. Needs to implement the action plan of management plans.

**Potential of wetland in flood control:** It's possible, however, is very difficult knowing that all drainage network is canalised

## **19. Felipe Gómez. GIZ. 11.08.2020**

In 2011 an adaptation plan was created in conjunction with DNP, UNGRD, IDEAM, MINAMBIENTE and then projects were carried out through project implementing agencies.

Some study cases regarding flooding management are in Cartagena and sites near Sinu. These are projects that have worked with flood management, mainly working with communities, to increase the resilience of the areas.

In Colombia, there is a water fund, which aims to have funds for the development of water-related projects. Bogota also has a financial resource, and with the support of the private sector.

#### **Evolution and integration CCA and EbS?**

This topic is more known now and relevant, and one thing is that the "Plan Nacional de Adaptación de Colombia" mentions different adaptation approaches as complementary and not exclusive. And the idea was that this approach should be addressed with all the opportunities offered by the other methods. This is also taken up in climate change policy, which is very good in Colombia to work. This helps to have financial partners like GIZ, PNUD, etc.

#### **How does international cooperation get to develop projects in the country?**

It depends on how the guidelines of each organisation and cooperation are. This is prioritised yearly to check which hangs from the necessities or priorities.

In Bogota works differently, because this is a city which has good financial sources. Other smaller towns will have more opportunities to access to this cooperation.

#### **ECO DRR considers ecosystems:**

In a policy that has and is coming out in recent years, they have started to mention ecosystems for resilience and DRR actions. However, it is the political will of those in power that allows ecosystems to have a more significant presence in politics and in the projects to be implemented. In the regions, the budget is spent on the development plan, but this is often not fully implemented. Sometimes because the lack of technical knowledge, which difficult that the plan gets to the territory.

One of the positive aspects in Bogota is that EAAB has the good financial muscle to develop actions considering more the ecosystems.

#### **Potential actions to give better health in wetlands in Bogota, for example, those none-recognised**

Work between the public and private alliances, identification of the key stakeholders, and recognised the work that each stake has developed regarding the wetlands, which can be huge. Important to enhance communication between all of them, especially the community.

## **20. María Eugenia Rinaudo. Universidad EAN. 12.08.2020**

At first, when it was Climate change and biodiversity topics, the ecosystem was seen as the affected ones, but later with new approaches, ecosystems are part of the solution. From this point, EbS was my interest with an IUCN scope.

This scope is international; however, there is a gap in the local level, due to the inner characteristics of countries like Colombia.

In Colombia, decision making is not about nature-based solutions, but adaptation based on ecosystems. However, it is a complementary scope; those are not the same.

Important to recognise that ES can be beneficial or not, which also call “di-services”. Under the IPBES framework. Even though the conceptual framework of EbS from the UICN is more known, in the national context, there’s no regional or local approach. There can be another type of purposed solutions that are not contemplated internationally, and that needs to be considered.

### **Studies related to EbS will be more active in the country?**

That is an emerging topic in the country; for example, MADS still speaks about EbA (which are complementary actions from the EbS), meaning that are catalytic effects on the territory. EbS can be an Umbrella topic for several aspects to consider. Nowadays MADS is updating “la contribución nacionalmente determinada de Cambio climática”, and they are including EbS notion, which will permeate the national public policy. However, it is a long-run path.

There’s a project from the EAN and other companies, MADS, DNP, are designing an interdisciplinary and interinstitutional EbS network in Colombia.

UN has promoted EbS, especially towards CC.

The link between EbS and CC is important for the ECO-DRR.

### **Which are the key topics that should be developed more in studies?**

2. 1. Governance/Governability: promoting participatory scenarios with the community to design and implement actions for EbS, also integrating entities as support. 2. synergy policies: in Colombia, there are several environmental policies, where EbS are not expressed, but contribute to the conservation of biodiversity and resources, but also there are contradictions in national, regional and local policy, and the implementation of those policies.

### **Eco DRR In Urban Context:**

the potentiality is high, mainly because EbS should be implemented in an urban context, because of the greater human incidence, which is not the same in rural contexts. Also, considering the lack of blue and green infrastructures in cities to cope with disasters associated with CC. Especially in Colombia, where most of the towns were located close or even in water bodies like wetlands should have a more significant analysis. That is the case of Cartagena. Is important not to ignore the urban-regional spaces, which ate the transitional space between the urban and the rural area, like Bogota and Chia.

EsB must be taken as particular in each context.

Wetlands in Bogota: they are a symbol, whether the perception is good or bad.

### **ECO-DRR have been coherent with reality?**

Not quite like coherent, but has not been enough, there is a lack of certain approximations, as the notion of EsB or ECO-RR and one of the gaps is that this topic has not been deeply researched.

### **Potential in Colombia with EbS:**

First, at the national level, I am strengthening the concept of EbS and thinking more systemically than just thinking about EbA. Include the topic within the NDS.

**Key actors for the ECO DRR in Colombia:** Public actors, private sector, Academy, SINA institutes, ONG and communities.

**Academy studies in the public sector:** Should have political science interface is to involve public policy within research, so that it is a connection for decision making.

13.3 Annex 3. Policy scheme: wetlands/ Risk and climate change/ Disaster and emergencies management

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |  |   |   |   |  |  |                           |
|--|--|---|---|---|--|--|---------------------------|
| Year   | International  | National level  |   |   | District level   |  |                           |
|  |  | Wetlands  | Risk and CC   | Disasters and emergencies   | Wetlands   | Risk and CC  | Disasters and emergencies |
| 1971   | <b>RAMSAR Convention</b>                                       |   |   |   |  |  |                           |
| 1974   |  | Decree Law 2811 of 1974<br>Congress of Colombia:<br>Code of renewable natural resources and environmental protection  |   |   |  |  |                           |
| 1984   |  | Decree 1594 -1984<br>Agricultural Ministry:<br><b>Water uses in wetland</b>   |   |   |  |  |                           |
| 1990   |  |   |   |   |  |  |                           |
| 1991   |  | National constitution   |   |   |  |  |                           |
| 1992   | Convention on Biological Diversity (CBD)                       |   |   |   |  |  |                           |
|  | United Nations Framework Convention on Climate Change (UNFCCC) |   |   |   |  |  |                           |
| 1993   |  |   |   |   | Agreement 02 - 1993<br>Bogota's Council:<br>Prohibits the draining or filling in of existing ponds and wetlands                    |  |                           |
| 1994   |  | Law 165 of 1994<br>Congress of Colombia:<br>approval of the "Convention on Biological Diversity", Rio de Janeiro 1992 | Law 164 - 1994<br>Colombian Congress:<br>adopts the "United Nations Framework Convention on Climate Change", made in New York on 9th May 1992 | Resolution 7550 - 1994<br>Education Ministry.<br>Actions of the national educational system in the prevention of emergencies and disasters. | Agreement 19 - 1994<br>Bogota's Council:<br><b>Wetlands of the Capital District are declared as natural environmental reserves</b> | Decree 657 - 1994.<br>prohibition of the provision of domiciliary public services and the construction of real estate in high-risk areas |                           |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |               |  |  |                           |  |   |   |
|--|---------------|--|--|---------------------------|--|---|---|
| Year   | International | National level   |  |                           | District level   |   |   |
|  |               | Wetlands   | Risk and CC  | Disasters and emergencies | Wetlands   | Risk and CC   | Disasters and emergencies   |
|  |               |  |  |                           |  | of the Capital District of Santa Fe de Bogotá                                       |   |
| 1995   |               |  | Law 388 - 1997<br>Colombian Congress:<br>Development plan regulation   |                           |  | Agreement 20 1995 by Bogota Council Building Code of the Capital District of Bogota |   |
| 1996   |               |  |  |                           | Agreement 19 of 1996, of the Council of Bogota: by which the "general statute of the environmental protection of the Capital District" |   |   |
| 1997   |               | Law 357 - 1997<br>Colombian Congress:<br><b>Approval of the Convention on Wetlands of International Importance Especially as Waterfowl Habitat - RAMSAR 1971</b> |  |                           |  |   |   |
| 2000   |               |  | Law 629 - 2000<br>Colombian Congress: adopts the "Kyoto Protocol to the United Nations Framework Convention on Climate Change", which took place in Kyoto on 11th December 1997. |                           |  |   | Agreement 30 - 2001 Bogota's council: implementation and execution of the Disaster Prevention and Emergency Day in the Capital District is established. |
| 2003   |               | Resolution 839- 2003:<br>Terms of reference for the elaboration of the Study on the Current State of the Moorland and the  |  |                           | Agreement 079 of 2003 of the Council of Bogota: Modified by District Agreement 735 of 2019 By which the                                |   |   |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |  |  |             |                           |  |             |                           |
|--|--|--|-------------|---------------------------|--|-------------|---------------------------|
| Year   | International  | National level   |             |                           | District level   |             |                           |
|  |  | Wetlands   | Risk and CC | Disasters and emergencies | Wetlands   | Risk and CC | Disasters and emergencies |
|  |  | Environmental Management Plan of the Moorland.   |             |                           | Police Code of Bogota, D.C. is issued. Reaffirms the care and conservation of wetlands by citizens and entities.   |             |                           |
| 2004   |  | Resolution 157 - 2004 MAVDT: regulates the sustainable use, conservation and management of wetlands - Ramsar convention application                    |             |                           | Decree 190 - 2004 Bogota's Council: approval of Land Use Plan - <b>Recognition of wetlands as a "District wetland ecological park"</b> as part of the protected areas of the district. Mentions who is responsible for the development of the management plan. |             |                           |
| 2005   | Hyogo Framework for Action (2005-2015) guideline to reduce vulnerabilities to natural hazards. |  |             |                           |  |             |                           |
| 2006   |  | Resolution 196 - 2006 MAVDT: Technical guide for the formulation of management plans for wetlands in Colombia is adopted                               |             |                           | Decree 062 of 2006 Mayor: guidelines and directives for the implementation of <b>environmental management plans</b>  |             |                           |
|  |  | Resolution 1128 - 2006: modification of the Article 10 from the Resolution 839 - 2003 and Article 12 of the Resolution 157 - 2004: modification on the |             |                           | Resolution 2618 of 2006 SDA: <b>The District Wetland Committee</b> is established, and arrangements are made for its operation.  |             |                           |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |               |  |             |                           |  |  |                           |
|--|---------------|--|-------------|---------------------------|--|--|---------------------------|
| Year   | International | National level   |             |                           | District level   |  |                           |
|  |               | Wetlands   | Risk and CC | Disasters and emergencies | Wetlands   | Risk and CC  | Disasters and emergencies |
|  |               | jurisdiction of the environmental management plan of wetlands. |             |                           |  |  |                           |
| 2007   |               |  |             |                           | Decree 624 of 2007 Mayor: Vision, objectives and principles of the <b>district policy on Wetlands</b> are adopted                              |  |                           |
| 2008   |               |  |             |                           | Decree 386 of 2008 23/12/2008 Mayor: measures are taken to <b>recover and protection of wetlands</b> , as well as their hydraulic round areas. |  |                           |
|  |               |  |             |                           | Decree 462 of 2008 Alcaldía Mayor de Bogotá, D.C.: Soil Protection Policy  |  |                           |
| 2009   |               |  |             |                           |  | Agreement 391 of 2009 of the Council of Bogota: dictates the guidelines for the formulation of the District Plan for Mitigation and Adaptation to Climate Change, as a strategy of management, planning and control, which allows the city to evaluate current vulnerability, future climate risks |                           |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |   |   |   |                           |   |  |  |
|--|---|---|---|---------------------------|---|--|--|
| Year   | International                             | National level  |   |                           | District level  |  |  |
|  |   | Wetlands  | Risk and CC   | Disasters and emergencies | Wetlands  | Risk and CC  | Disasters and emergencies  |
| 2010   |   |   |   |                           |   | Decree 511 of 2011 Alcaldía mayor. Acquisition of properties located in high-risk areas  |  |
| 2012   |   |   | <b>Law 1523 of 2012: National System of disaster risk management.</b>   |                           |   |  |  |
| 2013   |   |   | Decree 1974 of 2013: procedure to update the issuing and updating of the Risk Management Plan   |                           |   | <b>Agreement 546 of 2013 of Bogota Council: District climate change and risk management system</b>   |  |
| 2014   |   |   | Decree 1807 OF 2014 by the President of the Republic: this regulates Article 189 of Decree-Law 019 of 2012 with regard to the incorporation of risk management into land-use plans. |                           | Agreement 577 of 2014: Two new district ecological parks are created and incorporated | Decree 172 of 2014 of Alcaldía mayor de Bogota: regulates the Agreement 546 of 2013, and the coordination and guidance entities of the District System of Risk Management and Climate Change SDGR-CC are organized |  |
|  |   |   | National Climate Change Policy - PNCC – 2014:   |                           |   | Decree 173 of 2014 Mayor's Office of Bogota, D.C. establishes the provisions regarding IDIGER,   |  |
|  |   |   |   |                           |   | Decree 174 of 2014 regulates the operation of FONDIGER   |  |
| 2015   | COP 21. Paris Agreement under the UNFCCC. | Decree 1076 of 2015 of the President of the Republic: By means of which the Single Regulatory Decree of the Environment and Sustainable Development Sector is issued, to include risk identification and management in the formulation of projects plans, and activities. |   |                           |   | Agreement 617 of 2015 of the Bogota Council: The Science and Climate Change Research Programme is  | Resolution 603 of 2015 of IDIGER. The Institutional Strategy of Response IDIGER to emergency situations in |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |   |   |             |                           |                |   |   |
|--|---|---|-------------|---------------------------|----------------|---|---|
| Year   | International   | National level  |             |                           | District level |   |   |
|  |   | Wetlands  | Risk and CC | Disasters and emergencies | Wetlands       | Risk and CC   | Disasters and emergencies   |
|  |   |   |             |                           |                | established in Bogota D.C.  | the city of Bogota is adopted   |
|  | Sendai Framework for Disaster Risk Reduction 2015-2030. Includes the ecosystem-based approach to build resilience and DRR. Replace the Hyogo Framework for Action | Decree 1077 of 2015 of the President of the Republic. By means of which the Single Regulatory Decree of the Housing, City and Territory Sector is issued, where the management of natural risks must be known and included. |             |                           |                | Decree 579 of 2015 from the Alcaldía Mayor de Bogota, the <b>District Risk Management and Climate Change Plan for Bogota D.C. 2015-2050</b> was adopted, approved as a planning and management instrument for the District Risk Management and Climate Change System. |   |
|  |   |   |             |                           |                | Resolution 592 of 2015 of IDIGER: guidelines are adopted for the elaboration, registration and verification of School Plans for Risk Management and Climate Change (PEGR-CC) in educational institutions and Education for Work and Human Development.                | Agreement 633 of 2015 Council of Bogota D.C.: <b>strengthens the District Risk Management System, in promotion and prevention of emergencies and disasters</b> with the participation of the community and District officials |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |  |                |  |  |   |             |                           |
|--|--|----------------|--|--|---|-------------|---------------------------|
| Year   | International  | National level |  |  | District level  |             |                           |
|  |  | Wetlands       | Risk and CC  | Disasters and emergencies  | Wetlands  | Risk and CC | Disasters and emergencies |
| 2016   |  |                | Decree 298 of 2016 of the Ministry of the Environment Establishes the organization and operation of the National Climate Change System (SISCLIMA) to coordinate, articulate and formulate programs and projects involving adaptation to climate change and mitigation of greenhouse gases. |  |   |             |                           |
|  |  |                | Decree 308 of 2016 of the President of the Republic. The National Plan for Disaster Risk Management "A Development Strategy" for the period 2015-2025 is adopted   |  |   |             |                           |
| 2017   | The Cancun High-Level Communiqué adopted at the fifth session of the Global Platform for Disaster Risk Reduction |                | Law 1844 of 2017 of the Congress of the Republic. Adoption of the Paris agreement of 2015  | Decree 2157 of 2017 of the President of the Republic: general guidelines are adopted for the elaboration of the disaster management plan of public and private entities within the framework of Article 42 of Law 1523 of 2012 | Decree 565 of 2017 of Alcaldía Mayor de Bogotá: modifies the district wetland policy in relation to the definition of passive recreation and uses in wetlands         |             |                           |
|  |  |                |  |  | Decree 450 of 2017. Mayor of Bogota: The Environmental Management Plans – (PMA) of the Wetland District Ecological Parks – (PEDH) of the Capital District are adopted |             |                           |

| Policy scheme wetlands/ Risk and climate change/ Disaster and emergencies management |               |                |   |                           |  |  |                           |
|--|---------------|----------------|---|---------------------------|--|--|---------------------------|
| Year   | International | National level |   |                           | District level   |  |                           |
|  |               | Wetlands       | Risk and CC   | Disasters and emergencies | Wetlands   | Risk and CC  | Disasters and emergencies |
| 2018   |               |                | Law 1931 of 2018 of the Congress of Colombia establishes the guidelines for the management of climate change, mainly in the actions of adaptation to the CC and the mitigation of greenhouse gases. And the inclusion in risk management plans. |                           | Judgment 00363 of 2018 Council of State Declares the provisional suspension of the effects of Decree 565 of 2017 "By means of which the Policy of Wetlands of the Capital District contained in the District Decree No. 624 of 2007 is modified, in relation to the definition of passive recreation and uses in the Wetlands" | Decree 837 of 2018 of Alcaldía Mayor de Bogotá, D.C. adopts the District Disaster Risk Management and Climate Change Plan for Bogota D.C., 2018-2030 |                           |
|  |               |                |   |                           |  | Resolution 1060 of 2018 of SDP. Flood hazard map is updated.   |                           |
| 2020   |               |                |   |                           | The Fourth Administrative Judge ruled on the merits and decreed the nullity of Decree 565 of 2017.   |  |                           |

