PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE
ESCUELA DE INGENIERIA

CONSERVATION PLANNING MODEL FOR URBAN WETLANDS

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Thesis submitted to the Office of Research and Graduate Studies in partial fulfillment of the requirements for the Degree of Master of Science in Engineering

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Santiago de Chile, June, 2021

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To my family.

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Everyone has been through tough moments during this strange times, our characters have had to strengthen in order to continue with our personal, professional, academic, community and social duties. I am grateful for the support of my family, girlfriend, work colleagues and friends despite everything.

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RESUMEN

Los humedales son uno de los ecosistemas más amenazados, sin embargo, al mismo tiempo suelen ser los más productivos en cuanto a entrega de servicios ecosistémicos en ciudades.

La presente investigación propone el "Structured approach for urban wetland conservation planning" (SUWCP) como lineamientos estructurados para contribuir a la planificación de la conservación de humedales urbanos. La propuesta aborda las preguntas más críticas (por qué, quién, qué, dónde, cuándo y cómo) buscando mejorar el proceso de toma de decisiones directamente relacionado con los humedales insertos en las ciudades chilenas en tiempos donde se deben tomar decisiones con incertidumbre, contextos cambiantes, múltiples actores y escasez de datos. Consecuentemente, con SWUCP los practicantes de la conservación en humedales urbanos pueden contar con una aproximación directa a la planificación de la conservación que considera los marcos y herramientas seleccionados disponibles a nivel nacional e internacional -buscando responder a los desafíos críticos de la conservación de humedales urbanos.

Finalmente, una pequeña ciudad del sur con presencia seis humedales, una comunidad empoderada y practicantes de la conservación que trabajan para protegerlo se tomó como prueba de concepto para la aplicación de algunas de las sub-etapas de la metodología y directrices propuestas. Los resultados presentados esperan servir de ejemplo para desafíos más amplios para la práctica de la conservación de los países en vías desarrollo.

Palabras Claves: humedal urbano, sistemas socio-ecológicos, planificación de conservación, servicios ecosistémicos, infraestructura verde-azul

ABSTRACT

Wetlands are one of the most threatened ecosystems, yet at the same time, they are usually the most productive at the delivery of ecosystem services inside cities.

The present research proposes the "Structured approach for urban wetland conservation planning" (SUWCP) as structured guidelines to aid urban wetland conservation planning. The proposal addresses the most critical questions (Why, Who, What, Where, When and How) aiming to improve the decision-making process directly related to wetlands embedded in Chilean cities in times were complex decisions have to be made with uncertainty, changing contexts, multiple stakeholders and scarcity of information. Consequently, urban wetland conservation practitioners can count with a straight-forward approach for conservation planning that considers the selected frameworks and various tools available nationally and internationally, looking forward to responding to the urban wetlands conservation critical challenges

Finally, a small southern city with the presence of six urban wetlands, an empowered community and conservation practitioners working to protect them, was taken as a proof of concept for the application of some of the sub-steps from the proposed guidelines. The results presented expect to serve as an example for broader challenges for the practice of conservation in Chile and other urban contexts in the developing world.

Keywords: urban wetland, socio-ecological systems, conservation planning, ecosystem services, blue-green infrastructure

ACRONYMS

AM: Adaptive management

APR: Área de Protección de Recursos

BGI: Blue-green infrastructure

CS: Conservation standards

DIDECO: Dirección Desarrollo Comunal

DEM: Digital elevation model

DRC: Derecho real de conservación

DPSIR: Drives, Pressures, State, Impact, Response

EAE: Evaluación Ambiental Estratégica

EIA: Environmental Impact Assessment

ERD: Estrategia regional de desarrollo

ES: Ecosystem services

FrASH: Framework for Adaptive Socio-hydrology

GEF: Global environment facility

LBGMA: Ley de Bases Generales de Medio Ambiente

NbS: Nature based solutions

OGUC: Ordenanza General de Urbanismo y Construcción

OS: Open Standards for Wildlife Conservation

PRC: Plan Regulador Comunal

PROT: Plan regional de ordenamiento territorial

ROAM: Restoration Opportunities Assessment Methodology

RS: Remote sensing

SBAP: Servicio de Biodiversidad de Áreas Protegidas (in english: Biodiversity and protected area service)

SDG: Sustainable Development Goals

SEREMI: Secretaría Regional Ministerial

SEA: Strategic Environmental Assessment

SEIA:	Servicio de Evaluación de Impacto Ambiental
SMART:	S = Specific, M = measurable, A = achievable, R = result-driven and T = time-specific
SPI:	Spatial planning instruments
SUWCP:	Structured approach for urban wetland conservation planning
TESSA:	Toolkit for ecosystem service site-based assessment
ToC:	Theory of change
UES:	Urban ecosystem services
UN:	United Nations
UNPD:	United nations population division
UW:	Urban wetland
UWCP	Urban wetland conservation practitioner
ZOIT:	Zona de interés turístico
WWT:	Wildfowl & Wetlands Trust
MEA:	Millennium Ecosystem Assessment
LBGMA:	Ley de bases generales de medio ambiente

DEFINITIONS

Adaptive management: A formal statement detailing a desired outcome of a project, such as reducing a critical threat. A good objective meets the criteria of being specific, measurable, achievable, results-oriented, and time-limited (SMART). If the project is well-conceptualized and designed, the completion of the project objectives should lead to the fulfillment of the project goals and ultimately its vision.

Blue-green infrastructure: it has been defined as a planned network of natural and semi-natural areas that utilize natural processes to improve water quality and manage water quantity by restoring the hydrological function of the urban landscape and managing stormwater (Brears, 2018).

Conservation frameworks: "a cohesive set of tools and guidelines within which one may structure the planning and management of a conservation program or project" (Schwartz et al., 2018).

Conservation planning: The goal of conservation planning is to support actions to achieve explicitly defined objectives through documented, structured, and socially engaged processes (Groves & Game 2015).

Conservation target: An element of biodiversity (species, habitat, or ecological system) at a project site on which a project has chosen to focus. All targets should collectively represent the biodiversity of concern at the site (The Conservation Measures Partnership, 2020).

Ecosystem service: Services that intact functioning ecosystems, species, and habitats provide that can benefit people. (The Conservation Measures Partnership, 2020).

Evidence-based conservation: The explicit use and generation of relevant information in all steps of conservation practice. Specifically, practitioners make decisions and take actions informed by systematic analyses of both their own and the world's previous experiences. Practitioners also document their results and contribute their findings back to the evidence base. The conservation standards explicitly bring evidence-based

conservation principles into conservation practice. (The Conservation Measures Partnership, 2020).

Goals: A formal statement detailing a project's desired impact, such as the desired future status of a target. A good goal meets the criteria of being specific, measurable, achievable, results-oriented, and time-limited (SMART). (The Conservation Measures Partnership, 2020).

Human well-being targets: In the context of a conservation project, human well-being targets are those components of human well-being affected by the status of conservation targets. All human well-being targets at a site should collectively represent the array of human well-being needs dependent on the conservation targets. (The Conservation Measures Partnership, 2020).

Miradi: Online system that provides additional capabilities for team collaboration and cross-project and -organizational learning. (The Conservation Measures Partnership, 2020)

Objectives: A formal statement detailing a desired outcome of a project, such as reducing a critical threat. A good objective meets the criteria of being specific, measurable, achievable, results-oriented, and time- limited (SMART). If the project is well-conceptualized and -designed, the realization of a project's objectives should lead to the fulfillment of the project's goals and ultimately its vision. Compare to vision and goal. (The Conservation Measures Partnership, 2020).

Project: All conservation efforts at any scale can be either explicitly or implicitly described as "projects" – a set of actions undertaken by a defined group of practitioners – including managers, researchers, community members, or other stakeholders – to achieve defined goals and objectives. In this document, we use the term "project" to represent both projects and groups of projects (i.e., "programs") at all scales (e.g., ranging from managing a small pond to an entire ocean).

Ramsar convention: Ramsar works for the conservation of wetlands looking to preserve, value and strengthen all that these ecosystems provide for the human well-being (Ramsar Convention Secretariat, 2010b).

Stakeholders: Any individual, group, or institution that has a vested interest in or can influence the natural resources of the project area and/or that potentially will be affected by project activities and has something to gain or lose if conditions change or stay the same. Stakeholders are all those who need to be considered in achieving project goals and whose participation and support are crucial to its success. (The Conservation Measures Partnership, 2020).

Strategies: A strategy is a set of one or more activities with a common focus that work together to achieve specific goals and objectives by targeting key intervention points, integrating opportunities, and limiting constraints. Strategies should meet the following criteria: linked, focused, feasible, and appropriate (The Conservation Measures Partnership, 2020).

Theory of change: A series of causally linked assumptions about how a team thinks its actions will help achieve both intermediate results and longer- term conservation and human well-being goals. A theory of change can be expressed in text, diagrammatic (e.g., results chains), or other forms (The Conservation Measures Partnership, 2020).

Tools: "a structured set of specific activities used to accomplish one or more critical planning steps"(Schwartz et al., 2018)

1 INTRODUCTION

Population dynamics between rural and urban areas are in constant change due to different factors and trends (e.g., covid-19, wars, climate change, economic crises, health services, water scarcity, decentralizing politics) and no precise, certain or self-evident predictions can be made. For example, according to the United Nation Population Division (UNPD), approximately 54.5% of the world population lives in cities, and it is expected that by 2030 this urban / rural ratio will increase up to 60% (Ali et al., 2018) expecting a 13% increase by the year 2050 (ONU, 2018). Furthermore, based on the 2016 UN-Habitat World Cities Report, it is stated that the global urbanization process is led by developing countries in Africa, Asia and Latin America (Cohen, 2006; Joyce et al., 2017). Whether people escape or arrive to/from the cities, this process is recognized to threaten the functioning of local and global earth ecosystems, transforming land-use and land-cover, generating changes in the environments and the ecosystem in urban, peri urban and rural areas (e.g., unplanned subdivision of lands in peri-urban areas, improvised urbanization led by real-estate market, social housing projects, migrants in the peripheries) (Alberti, 2005; Merlotto, Piccolo, & Bértola, 2012).

Because of the above mentioned social processes, the relation between water and cities has been in constant transition and evolution since early days (Fletcher et al., 2015). In fact, urbanization has been, for over centuries, dramatically modifying the landscape and ecosystems lost (Davidson, 2014; Rojas et al., 2018).

Wetlands tend to be ideal places for urban settlements and they also are one of the most threatened ecosystems yet, at the same time they are usually the most productive delivery of ecosystem services (Millennium Ecosystem Assessment, 2005a; Wantzen et al., 2019). Around the world, wetlands are facing faster rates of loss during the last two centuries and it is already widely recognized that 50% of the wetlands has been lost (Davidson, 2014). One of the root causes behind this problem is related to the fact that ecosystem services are usually neglected during the planning process (Heller & Zavaleta, 2009). The fragmentation, degradation and loss of these ecosystems have caused severe damage over biodiversity and ecosystem services that wetlands provide to communities. It is estimated that this wetland degradation is equivalent to 20 billion dollars annual loss (Gardner et al., 2015).

To address threats to wetlands and other ecosystems, different global responses have emerged (e.g., Conservation Measures Partnership, Conservation Standards, Wildlife Conservation Society, World Wild Fund, The Nature Conservancy among others). Specifically, to raise awareness for wetlands, in 1970 the Ramsar Convention appeared as an intergovernmental looking to create agreements between countries to protect wetlands (Ramsar Convention Secretariat, 2010b). Ramsar works for the conservation of wetlands looking to preserve, value and strengthen all that these ecosystems provide for the human well-being.

Having said that, according to Ramsar, wetlands have been severely impacted by city growth reaching up to a 64-71% of this ecosystem disappeared since 1990, this degrading

threat has kept at an alarming pace in extension and quality (Gardner et al., 2015; Kumar et al., 2017). As a sign of interest in urban conservation, the Ramsar Convention launched the Ramsar Wetland City accreditation guidance creating incentives for wetland conservation inside cities. Also, to raise awareness, the 2018 World's Wetland Day (celebrated annually the 2nd of February) was themed as "Wetlands for a Sustainable urban future" (see Figure 1.1).

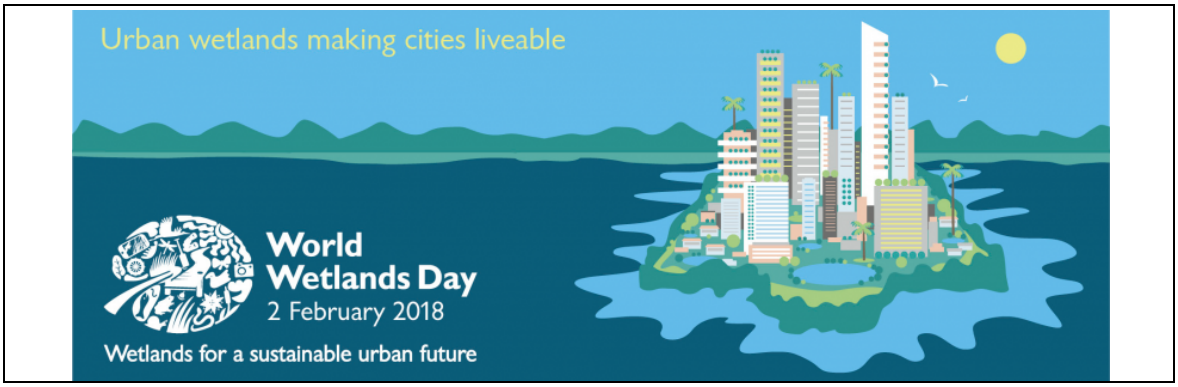

Figure 1.1 World wetlands day 2 February 2018 showing the importance that the urban wetlands in recent years

Source: "World Wetlands Day 2018: Wetlands and cities - UNESCO World Heritage Centre" (2018)

Chile has faced the same problems. In fact, it has more than 1.4 million hectares of wetlands and just 2% of this area is currently protected (Rojas, 2018). In 1981, Chile adhered to the Ramsar Convention and has already declared 16 wetlands as Ramsar sites. As a response to this crisis, in 2018 the Chilean Environmental Ministry launched the National Wetland Plan (in Chile *"Plan Nacional de Humedales"*) declaring activities, objectives and goals that needed to be done in order to diminish or stop the problem. This crisis also had reactions from academia quantifying the benefits of wetlands to prevent the 2010 tsunami (e.g., Villagra et al. (2014); Rojas et al., 2019) and the development of a

Wetland toolkit that delivers easy to follow instructions that empower citizens and urban dwellers in general to report when they see direct negligence and actions that threaten wetland conservation (e.g., Bergamini et al. (2020)). Also, for many years, a researcher and citizen-led movement was able to push the decision makers in the Chilean Congress to finally pass a bill (Law 21.202) that specifically deals with the conservation of urban wetland clearing up some of the responsibilities and policies that local governments must follow to protect wetland inside their administrative boundaries (Vicepresidencia del Senado, 2019). There are also other recent examples of conservation-led initiative related to wetlands (e.g., from research URBANCOST (Rojas, 2018), from government GEF Humedales Costeros (https://gefhumedales.mma.gob.cl/) , among others). These different efforts towards wetland conservation have been highly valuable.

In Chile, as in other developing countries, there is often scarcity of data and resources for the conservation of wetlands in cities and this implies the need to generate low-cost and low-data tools and not necessarily highly-complex to execute frameworks for wetlands conservation (Johnston et al., 2013). Examples of this can be seen in many cities ("Angachilla" wetlands in Valdivia, "Tres Puentes" wetland Punta Arenas, "Los Batros" wetlands in Concepción, "Lujan" river catchment located in Argentina, among many others).

2 RESEARCH QUESTION AND OBJECTIVES

2.1 Hypothesis

There are specific frameworks and tools available at a national reach that could potentially benefit urban wetland conservation planning in Chile.

2.2 Objectives

General objective: Propose conceptual guidelines to improve urban wetland conservation planning.

Specific objectives

1. Identify frameworks, tools and practices useful in the planning process for urban wetland conservation practitioners in Chile.
2. Develop conceptual guidelines to support the planning process for urban wetland conservation practitioners in small Chilean cities.
3. Apply the proposed guidelines in a low-resource and data-poor small Chilean city.

3 THEORETICAL BACKGROUND

3.1 Wetlands

From ancient times, humans have been building their settlements around wetlands due to their high supply and demand of ecosystem services. Nowadays, in a world with an accelerated growth of urban population, wetlands are extremely threatened and pressured. Urban wetlands are considered as wetlands located inside the administrative limits of a city according to their spatial planning instruments.

Cities around the world are facing new challenges in urban planning and wetlands, among many ecosystems, must be taken in account. Wetlands are considered one of the most productive ecosystems. The present research will consider a broad and globally recognized wetland definition proposed by the Ramsar Convention in 1971:

"(…) wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." (Ramsar Convention Secretariat, 2010b)

Following Ramsar convention, these habitats can be classified into 5 categories: marine, estuarine, riverine, lacustrine and palustrine. These categories are presented below.

3.1.1 Common wetland categories

Marine wetlands are exposed to waves and tides of the open ocean and the water regimes are mainly determined by the fluxes of the oceanic tides. Salinity exceeds 30% with almost no dilution except for the estuary inflows. The vegetation and animal distribution reflect differences in mainly four factors: 1) grade of exposure to waves; 2) Physicochemical texture and substrate nature; 3) amplitude of the tides and; 4) Latitude,

which governs water temperature, intensity and duration of solar energy, and ice presence/ absence (Cowardin et al., 2005).

Estuarine wetlands consist of deep-water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. The estuarine system includes estuaries as well as lagoons and are considered low-energy systems (Cowardin et al., 2005). The regimes and the water chemistry are affected by one or more of the following phenomena: tides, precipitation, freshwater runoff and winds.

The riverine wetlands include all wetlands and habitats from deep waters contained in a canal. A canal is understood as "open conduct created in a natural or artificial way that periodically or permanently contains flowing water" (Cowardin et al., 2005).

The lacustrine system includes wetlands and habitats of deep waters with the following characteristics: (1) located in a topographic depression or a river channel with a dam; (2) absence of trees, bushes, moss or lichens with land cover higher than 30%; and (3) the total area exceeds the 8 [ha]. The lacustrine system includes lakes and dams with permanently flooded and lakes with salinity lower than 0.5% derived from the ocean.

Palustrine wetlands include all non-tidal wetlands dominated by trees and bushes, persistent or emergent, moss and lichens. These wetlands occur in tidal areas where salinity is below 0.5%. It also includes wetlands lacking vegetation but with the following four characteristics: (1) area of less than 8 ha (20 acres); (2) the active features of the

shoreline formed by waves or bedrock are missing; (3) water depth in the deepest part of the basin less than 2 m. to little water; and (4) salinity due to ocean derived salts less than 0.5% (Cowardin et al., 2005).

3.1.2 Urban wetland

According to Ramsar Convention on Wetlands, urban wetlands are considered as follows:

"Urban and peri-urban wetlands are found in and around cities and their suburbs. They include rivers and their flood plains, lakes, swamps as well as salt marshes, mangroves and coral reefs" (Ramsar Convention Secretariat, 2018)

Internationally, as stated by Wildfowl & Wetlands Trust (WWT) Consulting and Ramsar (2018) in their good practice handbook published in 2018, urban wetlands around the world are those that have survived the historical urban development (WWT Consulting, 2018). In Chile, according to the planning instruments, the definitions starts from the same Ramsar wetland definition, adding at the end "that are totally or partially inside the urban limits". They are managed following urban planning norms and plans, usually neglecting ecosystem services and biodiversity. Furthermore, being inside the urban fabric usually implies that these fragile ecosystems are over exposed to threats such as refilling, draining, vegetation changes, water contamination and sediments excess (Rojas et al., 2015; Rojas, 2018).

3.2 Urban wetland conservation planning based on the "Open Standards for the practice of conservation (CS)"

3.2.1 CS as a framework for conservation planning

The goal of conservation planning is "*to support actions to achieve explicitly defined objectives through documented, structured, and socially engaged processes."* (Groves & Game, 2017). As mentioned in the review *Decision Support Frameworks and Tools for Conservation* by Schwartz et al. (2018), every planning must respond to the basic questions: Why, Who, What, Where, When, How. This review describes six highly recognized conservation frameworks to assist the conservation planning available trying to answer the questions mentioned above.

This research focuses on the Conservation Standards for Wildlife Conservation (CS) as one of the broader and with recognition around the world. The focal problem looks to solve is *How can we best use our limited time and funding to achieve desired outcomes and learn from our work?* (Schwartz et al., 2018). The CS is a result-oriented methodology developed for the improvement of the practice of conservation (CMP, 2013). It aims for the effective actions towards the desired goals of the conservation efforts. The CS is structured in five steps (see Figure 3.1) that will be considered along this research for the development of the conceptual model proposal.

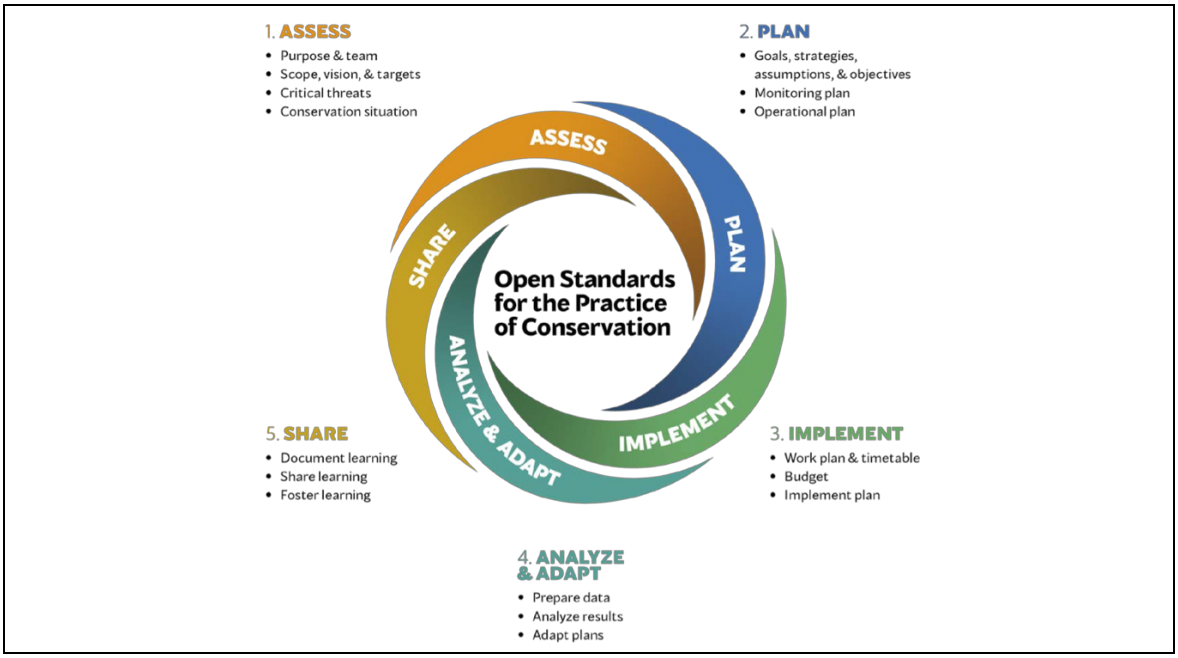

Figure 3.1 Open Standard for Wildlife Conservation workflow

Source: The Conservation Measures Partnership (2020)

Step 1. Assess: analysis stage to define the conservation objects to be addressed, understanding their problems, context, among others.

Step 2. Plan: the project objectives, goals and strategies are defined, as well as a monitoring plan to evaluate the proposed strategies and their eventual changes.

Step 3. Implement: the plans developed by the previous stage are adjusted and put into practice.

Step 4. Analyze and Adapt: the data obtained in the process are collected and analyzed to adapt the plan accordingly.

Step 5. Share: the process is documented emphasizing the acquired learning, and then transferring this knowledge.

After these five steps, the first step is returned, making the pertinent corrections derived from the first cycle analysis, and so on. (Open Standards, 2013).

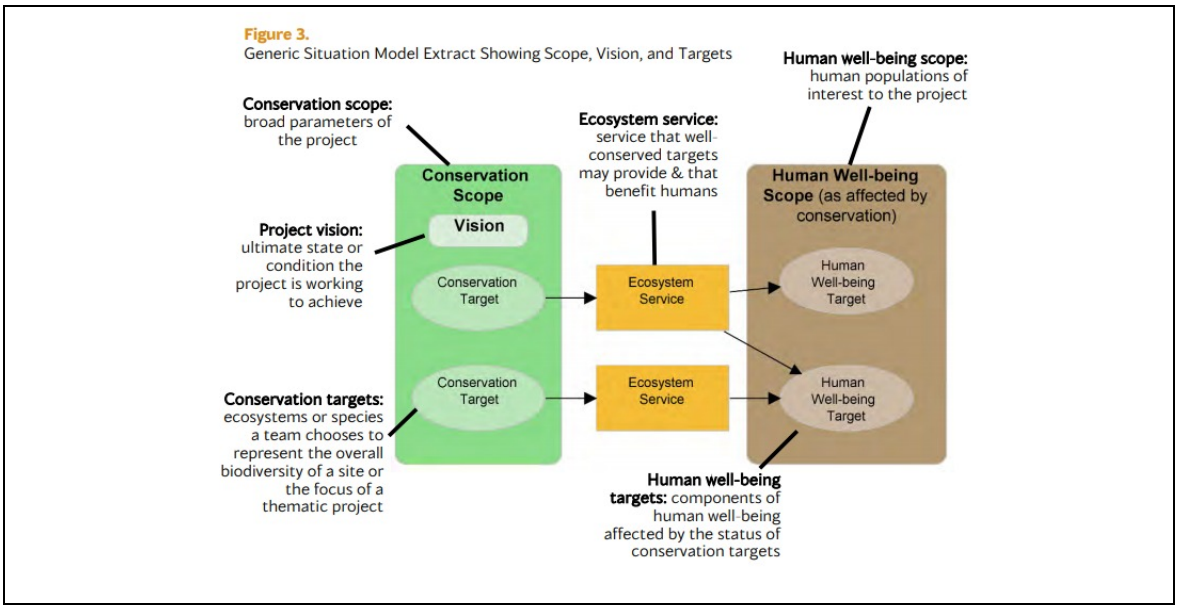

Figure 3.2 Conservation situation from Open Standards

Source: (The Conservation Measures Partnership, 2020)

3.2.2 Urban wetland ecosystem restoration

According to the Society for Ecological Restoration, the ecological restoration is understood as *"the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed"* (SER, 2004). Methodologically, in the Conservation Standards, as was previously exposed, once the *Conservation Situation* is described, the Theory of Change demands the definition of strategies to tackle the direct and indirect threats to the defined conservation targets (e.g., wetlands). One of the possible strategies is the ecosystem restoration (The Conservation Measures Partnership, 2020).

Together with the reduction of wetland loss and tackling other critical threats, restoration of degraded wetlands or even the creation of new wetlands is urgently needed (Bobbink et al., 2002). For these restoration endeavors, *"undisturbed reference wetland ecosystems are sometimes needed",* serving as a guidance to reveal environmental conditions necessary for the restoration of these wetlands in highly stressed or changed landscapes, where these conditions disappeared before quantification (Bobbink et al., 2002). Despite that fact, reference wetland ecosystems *"(...)have to be treated with care to avoid too high expectations by wetland managers. In addition, experimentation is needed in many situations to verify the correlative data from most reference studies."*

In urban contexts with many former and/or fragmented wetlands and limited resources for conservation actions (e.g., restoration, communication) it is strategic to *"(...)develop management priorities first, then prioritize the sites where each goal can best be achieved."*(Bobbink et al., 2002). Thus, "i*t may not be possible to recover exactly what was lost; in such cases, recovery of a general wetland vegetation type and recovery of ecosystem functions might be more realistic goals".* In this cases, project goals must be calibrated to *"to suit the site's potential to be restored."*. Also, since *the "understanding of the underlying processes that influence ecosystem development is poor"* restoration actions can be designed and focused on *"learning as restoration proceeds."* (Bobbink et al., 2002; Wantzen et al., 2019). This, iterative restoration process would match the need of the Adaptive Management

(e.g., CMP, (2013); Salafsky et al. (2001)).

3.2.3 Urban wetland conservation planning

According to the Ramsar Convention subscribed by the Chilean government in 1981, conservation and wise use of wetlands is understood as the *"maintenance of their ecological character, achieved through the implementation of ecosystem approaches within the context of sustainable development"* (Ramsar Convention Secretariat, 2010b).

The context of sustainable development, needs to understand that urban wetlands are embedded in a complex socio-ecological system (Li et al., 2014). This approach is useful because recognizes that urban wetlands interface is highly influenced by the three dimensions namely, social, ecological and hydrological where the hydrological processes create the conditions for nature to exist and provide ecosystem services for the human well-being (Li et al., 2014).

In order to face these challenges, cities have been increasingly considering nature as an essential asset in urban planning (e.g.: Garden City; Beautiful Cities; Water Sensitive Cities, Sponge Cities, Blue-green infrastructure, among others) (Wong et al, 2006).

As stated by Moreno (2013) "Blue-green infrastructure (BGI) serves as a strategic approach for the conservation of the landscape and its components of natural and cultural value, within the framework of the initiatives of ordering and sustainable planning of the territory, in this way it allows impact regulation generated by the urban expansion, soil substitution, ecological fragmentation and habitat destruction".

3.3 Ecosystem services

Ecosystem services (ES) have been defined as a subset of ecological functions (physical, chemical and biological processes) that are directly relevant of beneficial to human well-being (Costanza et al., 1997). ES have been clustered in 4 categories according to Millennium Ecosystem Assessment (MEA) (2005):

(1) Provisioning services (food, water, resources).

(2) Regulating services (air quality, water quality, erosion control).

(3) Cultural services (aesthetics, spiritual).

(4) Support services (soil production, oxygen production, biodiversity)

ES, as presented in MEA (2005), recognizes the fact that humans need nature and proposes a set of standardized terms and methods that enable conservationists, city planners and authorities to operationalize this balance between human well-being and nature.

There is abundant evidence that ES provide an important portion of the total contribution to human welfare on this planet (Gómez-Baggethun & Barton, 2013). In fact, it is estimated that marine and terrestrial ecosystems annually provide services valued in more than $33 trillion US (Costanza et al., 1997). This research incorporates ES as an important input to assess the interventions and to guarantee that the solutions the model provides deliver of human-based solutions. ES enables linking benefits of ecosystem to achieve human well-being targets (Millennium Ecosystem Assessment, 2005a). They represent an "(…) opportunity to guide sustainable resource management as it makes the services of nature explicit and thus allows the analysis of trade-offs and impacts of different

management options" (Grêt-Regamey et al., 2017). Furthermore, they have an "important use for project appraisal, where ecosystem services lost must be weighed against the benefits of a specific project (Costanza et al., 1997).

ES also grant a persuasion advantage in conservation pursuits because they are ‘‘easier to sell’’ to stakeholders than the intrinsic value of biodiversity (Cimon-Morin & Poulin, 2018). Thus, they provide a framework to achieve goals of safer living conditions for city dwellers unlocking new funding sources and attract new conservation stakeholders (The Conservation Measures Partnership, 2020).

Last, but not least, in cities, ES may be a "powerful incentive to promote conservation as a valid land use that contributes to the development of sustainable cities" (Cimon-Morin & Poulin, 2018). In cities, integrating ES into spatial and landscape planning contributes to the creation of alternative urban patterns that conserve the ecosystem and the provision of the services to the urban human community (Grêt-Regamey et al., 2017). Based on the four ES categories stated by MEA, Ramsar provides a list of possible ES delivered by wetlands are presented below in

Table 3.1. However, there is less evidence of ES estimation in urban wetlands, an example of the social ES estimations in Chile (e.g., O. Rojas et al., 2017; De la Barrera M. et al., 2009).

Table 3.1 Ecosystem services examples

	Ecosystem services	Example
Provisioning services	Provision of fresh water	Water used for domestic drinking supply, for irrigation, etc.
	Provision of food	Crops, fruits, fish, etc.
	Provision of natural medicines	Plants used as traditional medicines, etc.
	Provision of ornamental resources	Collection of shells, flowers, etc.
Regulating services	Air quality regulation	Removal of airborne particles from the exhaust of cars, chimneys of industry, dust from agricultural land, etc.
	Local climate regulation	Regulation of the local microclimate through evapotranspiration and the presence of water, reducing air temperature, etc.
	Water and purification regulation	Regulation of flows of surface water during high and low flows, regulation and purification of recharge of groundwater, etc.
	Flood regulation	Regulation and storage of floodwater hazard; intense rainfall events.
	Pest regulation	Control pest species such as mosquitoes, rats, flies, etc.
	Pollination	Pollination of plants and crops by bees, butterflies, wasp, etc.
	Fire regulation	Providing physical barriers to the spread of fire, etc.
	Noise buffering	Wetland vegetation absorbing and buffering the impact of noise.
Cultural Services	Cultural heritage	Importance of the wetland for historical or archaeological value, as an example of traditional practices, as a cultural landscape, etc.
	Recreation and tourism	Importance of the wetland for providing a location for recreation such as fishing, swimming, or as a tourism destination, etc.
	Aesthetic value	The wetland es overlooked by properties, is part of known area of natural beauty, is use as a subject for painters and artists, etc.
	Social, spiritual and religious value	The wetland plays a role in local religious festivals, it may be a sacred site, or forms part of a traditional belief system, etc.
	Inspiration value	Presence of local oral/written tales about the wetland, creation of different art forms associated with the wetland.
	Educational and research	Use of the wetland by local school children for education tours, site of long-term research and monitoring, etc.
Supporting services	Primary production	Presence of primary producers such as plants, algae, etc.
	Soil formation	Deposition of sediments, accumulation of organic matter, etc.
	Nutrient cycling	Source of nutrient from internal cycling of plant material, inputs from: agricultural land, floodwaters.

	Provision of habitat	Presence of locally important habitats and species, presence of species and habitats of conservation concern, etc.

Source: Based in Ramsar Convention Secretariat (2012)

3.4 Blue-green infrastructure

Blue-Green Infrastructure (BGI) has been defined as a planned network of natural and semi-natural areas that utilize natural processes to improve water quality and manage water quantity by restoring the hydrological function of the urban landscape and managing stormwater (Brears, 2018). BGI includes natural components as green spaces, ponds, rivers, lakes and wetlands, an also man-made features as green roofs, green walls, artificial wetlands and channels (Brears, 2018; European Commission, 2013). The sum of these elements enables BGI to be *"multifunctional; specifically, its ability to perform several functions and provide several benefits in the same spatial area by harnessing the interrelationships between vegetation and the water cycle, thus improving urban living conditions in a way that enhances both sustainable development and water- and greenery-related ecosystem services"* Brears (2018). Furthermore, the three most relevant aspects of the BGI are: i) being an interconnected network; ii) in planning and management and; iii) providing ecosystem services to the community (Liquete et al., 2015; Mubareka et al., 2013).

BGI is based on a multi-scalar approach focused on the understanding of ecological and cultural processes, expressed in the units and elements that make up the landscape mosaic. Identify and analyze the set of open spaces of the territory - urban green areas, wild areas, productive areas, water corridors, brownfields, borders and risk areas, among other types

- revealing their potential connectivity and complementarity. Thus, the BGI is configured as a synergistic and articulated network allowing the provision of ecological, cultural, social and / or aesthetic services, thus contributing to the resilience of life systems and the general welfare of individuals, communities and economies (Moreno, 2013).

4 RESEARCH METHODS

The development of conceptual guidelines for urban wetland conservation planning was done by a descriptive research and therefore, a theoretical and an empirical work including qualitative and quantitative methods of analysis.

The theoretical study developed conceptual guidelines aiming to improve urban wetland conservation planning. This study was based conservation tools reviews, interviews to conservation practitioners and government documents pursuing understanding of the decision-making process of urban wetland conservation practitioners in Chile.

From this point, three macro-steps were defined together with their correspondent sub-steps. These were presented with flowcharts recognizing inputs and outputs with a description. Framing the research around urban wetland conservation practitioner (UWCP) shortens the distance between the researcher and the wetland conservation challenges, increasing the likelihood of utility and improvement of the study. Finally, helping the conceptual proposal with the empirical application of some of the conceptual guidelines in a study-case enabled the recognition of practical challenges that allowed improvement during the research period and also recognized interest for future studies. The case-study was Llanquihue (17,591 inhabitants), a small Chilean city with 6 urban wetlands located in Los Lagos Region (south of Chile).

The table below presents a general methodological design scheme to achieve the objectives proposed for the research.

Table 4.1 General methodological design scheme

Objective	**Research Methods**	**Results**
Nº1 Identify frameworks, tools and practices useful in the planning process of UWCP in Chile.	- Explore limitations and benefits of the normative and legislative Chilean frame that may influence urban wetland conservation - Characterizing the UWCP based on Salafsky et al. (2001) complemented by semi-structured interviews to Chilean UWCP based on the snow-ball method - Strengths, weakness, opportunities and threats (SWOT) analysis integrating literature review on frameworks, tools and with the context of the UWCP	- Benefits and limitation charts for each reviewed instrument. - Chart of clusters for decisions and actions from the urban wetland conservation practitioners and literature.
Nº2: Develop conceptual guidelines to support the planning process for the UWCP in Chile.	- Defining general and specific conceptual guidelines requirements. - Literature review of "Decision Support Frameworks and tools for conservation" by Schwartz et al. 2018 as a point of departure looking for published papers of frameworks, tools and methods. - Rapid systematic prototyping of the conceptual guidelines	- Written guidelines of the conceptual model for every step and sub-step. - Workflow charts of the conceptual guidelines.
Nº3: Apply the proposed guidelines of the urban wetland conservation in a low-resource and data-poor Chilean city.	Iterate the development of the conceptual guidelines aided by testing of some of sub-steps such as: - Hydro spatial analysis based on ArcGIS - Land-cover recognition by remote sensing (RS) analysis - Multi-temporal RS analysis - ES mapping based on qualitative data	-Hydro ecological mapping of the study case - ES maps - Insights and direction for the model improvements

Source: Own elaboration (2020)

The methodology and activities for objectives Nº1 to Nº3 are presented below.

4.1 Methods for Objective Nº1

Creating an informed big picture of the current wetland situation together with available frameworks and tools and understanding the decision-making process that UWCP faces.

Analytical review of the limitations and benefits of the normative and legislative Chilean frame that may influence urban wetland conservation.

4.1.1 Explore benefits and limitations of the Chilean normative and other regulations that may influence urban wetland conservation

- A review of 7 instruments a protection figure was made looking for potential influences (positively or negatively) on urban wetland conservation. The reviewed instruments are presented below in Table 4.2 and consisted of:
- 3 land-use planning instruments of normative and indicative of reginal, intercommunal and/or metropolitan and communal: PRC, PRI and ZOIT
- 1 current figure of protection in Chile of normative character: Nature Sanctuary (in spanish “Santuario de la naturaleza”)
- 1 international indicative protection figure: Ramsar
- The Urban Wetlands Law and Communal Ordinances.

Table 4.2 Existing planning instrument, tools and laws reviewed

Chilean name	**Type**	**Application scale**
Plan Regulador Comunal (PRC)	Normative	Communal
Plan Regulador Intercomunal (PRI)	Normative	Intercommunal
Zona de interés turístico (ZOIT)	Indicative	Intercommunal
Ordenanza municipal (OM)	Normative	Communal
Sitio Ramsar	Indicative	National
Santuario de la naturaleza	Indicative	Local
Ley de humedales urbanos	Normative	Site

Own elaboration (2020)

4.1.2 Characterizing the UWCP decision-making process

To characterize the UWCP decision-making process a sequence was built based on Salfsky et al. (2001) *"Adaptive Management: A tool for conservation practitioners"* collecting critical decisions, actions and conservation challenges.

Additionally, conservation practitioners involved in wildlife conservation, urban wetland management and urban design were interviewed to expand on critical points and understand their challenges in the Chilean context. For the interviewee selection the snow-ball method was applied (Flores, 2009).

Afterwards, a list of conservation frameworks and tools were reviewed based on the "*Decision Support Frameworks and Tools for Conservation"* by Schwartz et al. (2018).

4.1.3 SWOT integrating instruments and tools review with the context of the UWCP

The recognition of strengths, weakness, opportunities and threats (SWOT) helped to clear and analysis. This method was used to characterize the urban wetland conservation problem. The analysis was based in two primary sources: i) literature review and; ii) interviews presented above. It contributed to the identification, clustering and prioritization of the key challenges for the development of the urban wetland conservation model.

4.2 Methods for Objective Nº2

The proposal of the conceptual guidelines is to support the planning process for UWCP in Chile. This was framed in the first two steps of the Open Standards for Wildlife Conservation, i.e., Step 1: Assess and Step 2: Plan.

4.2.1 Defining the model requirements (general and specific) and the general functionality (scale, ecosystem type, development level, inputs and outputs type)

By the analysis of the processed data in the Objective 1, a creative process was led to define the general functionality considering: i) Scale of action, ii) Ecosystem type, iii) Development level, iv) General input data type, v) Detailed input data type, vi) General output data type and vii) Detailed output data type.

With general functional requirements, a proposal of a conceptual planning model for urban wetland systems, looking forward to create the steps and processes that once applied could answer the fundamental questions (Why, Who, What, Where, When and How) recognized by conservation researchers to address the three critical stages of the conservation project management: Project scoping, Operational planning and Learning (Schwartz et al., 2018).

4.2.2 Literature review of framework and tools for conservation

The research was on the review "*Decision Support Frameworks and Tools for Conservation"* by Schwartz et al. (2018) to understand the decision-making process considering best practices for the development of the conceptual guidelines for the UWCP

based on the most relevant conservation frameworks (presented in Table 4.3) and tools looking for insights to build a coherent proposal.

Finally, the development considered Open Standard for Wildlife Conservation as is base framework.

Table 4.3 Focal problem from five main framework

Framework	**Focal problem**
Strategic Foresight	What are the critical future possibilities and uncertainties?
Systematic Conservation Planning	Where are the critical locations for action?
Structured Decision Making	What actions are likely to most efficiently achieve competing objectives?
The Open Standards for the Practice of Conservation	How can we best use our limited time and funding to achieve desired outcomes and learn from our work?
Evidence-Based Practice	How effective are our actions (including context)?

Source: Adapted from Schwartz et al. (2020)

4.2.3 Designing workflow flowcharts and written guidelines for the model

The conceptual guidelines were split into steps and sub-steps. Additionally, they also were presented in workflow charts recognizing inputs and outputs in each step as a road map to achieving the desired goals involved in each activity of the process. The workflow recognized the structured decision-making process explicitly including: Name of every step, Input (type of inputs: data, reports), Output (type of outputs: data, reports, decisions), suggested method description and key reference form literature review. The proposal was

structured in steps following the Open Standard for Wildlife Conservation and also benefiting from the *Review of Decision Support Frameworks and Tools for Conservation* from Schwartz et al. (2018).

4.3 Methods for Objective Nº3

The methods for the empirical application conducted followed some of the suggestions from the written conceptual guidelines and helped as testing during the iteration of the written guidelines. This included methods such as: Photo interpretation of temporal changes, remote sensing techniques for satellite images (NDVI, NDWI, NDMI), hydro-spatial analysis using hydrology toolbox, ES mapping and documents review.

5 STUDY CASE: LLANQUIHUE

5.1 Geographic and demographic characteristics

The case study was developed in the city of Llanquihue. Historically this place was a Mapuche territory and received its actual name from the Mapudungún language, meaning: "a place to dive into the water". It is located in the south zone of Chile in Los Lagos Region (further regional description is presented in Annex B).

Llanquihue is la small town located at 41°15'S and 73°01'W, between the touristic communes of Frutillar up north and Puerto Varas down south, all developed by the Llanquihue Lake shore which is second largest of the country and gives birth to the Maullín River. Population rises 17,591 inhabitants covering a total administrative area of 421 [km] (INE, 2017). Their main economic activities are agriculture (46,4%), tourism (17%), and manufacturing industry (8,5%), the latter is the greatest job provider in the urban zone of the commune. The urban and industrial zones sum-up to 0.55% of the total commune surface based on the last Population and Housing Census (2017) and PLADECO (2014). The 80.8% of the population lives in urban areas. According to the Ministry of Social Development, income poverty is up to 13.69% compared to the regional 11.7% (BCN, 2020).

5.1.1 Climate and hydrology

According to the Köppen classification, the climate is "warm temperate rainy with Mediterranean influence". With an annual precipitation of 1,679 mm on average and it is focused on the Andean and coastal massifs. As it can be seen in Figure 5.1, the lowest

rains registers during summer. Given its climatic conditions, the dominant vegetation is the temperate rain forest and the Valdivian Forest. This area is characterized by being a periglacial and lacustrine region of active volcanism (Börgel, 1983).

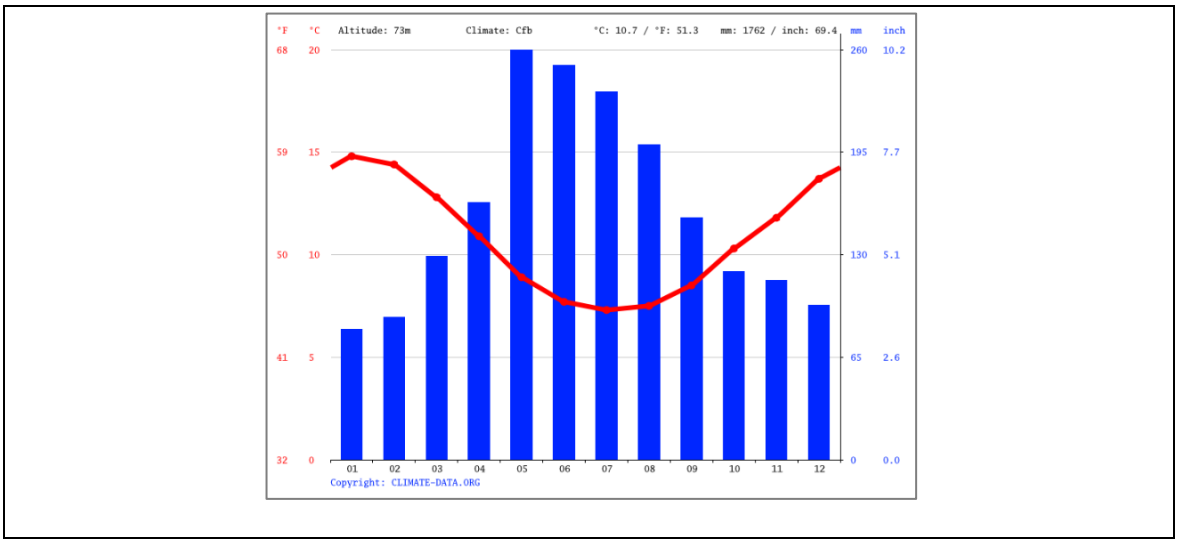

Figure 5.1 Climograph “Los Pellines”

Source: https://es.climate-data.org/

5.1.2 Conservation status of the urban wetlands

This interconnected hydrological system is composed by a river, estuary, lagoons and a lake (see Figure 5.2 and Figure 5.3). In this place, the Maullín River is born which is the drainage of the Llanquihue Lake, this has generated a smooth topography due to erosion and can be flooded more easily. The river divides the city into the north and south side and at the borders by the bank of Llanquihue Lake. The city has at least five wetlands (riverine, palustrine and lacustrine) that are surrounded by urban development and play a key role as the largest green spaces in the city. By visual inspection these wetlands within its urban limit, the Lacustrine edge of Llanquihue, the Maullín River, “El Loto” Lagoon, Baquedano wetland, “Los Helechos” wetland and “Las Ranas” wetland.

Figure 5.2 Aerial view of Llanquihue

Source: Ilustre Municipalidad de Llanquihue (2005)

Despite the important services these urban wetlands provide they are strongly threatened by illegal fishing, illegal logging, the advance of urbanization, the micro garbage dumps, liquid industrial waste. They have not yet been protected due to a low density of professionals and low budget for the management of its natural heritage and an industrial past (Ministry of the Environment, 2017).

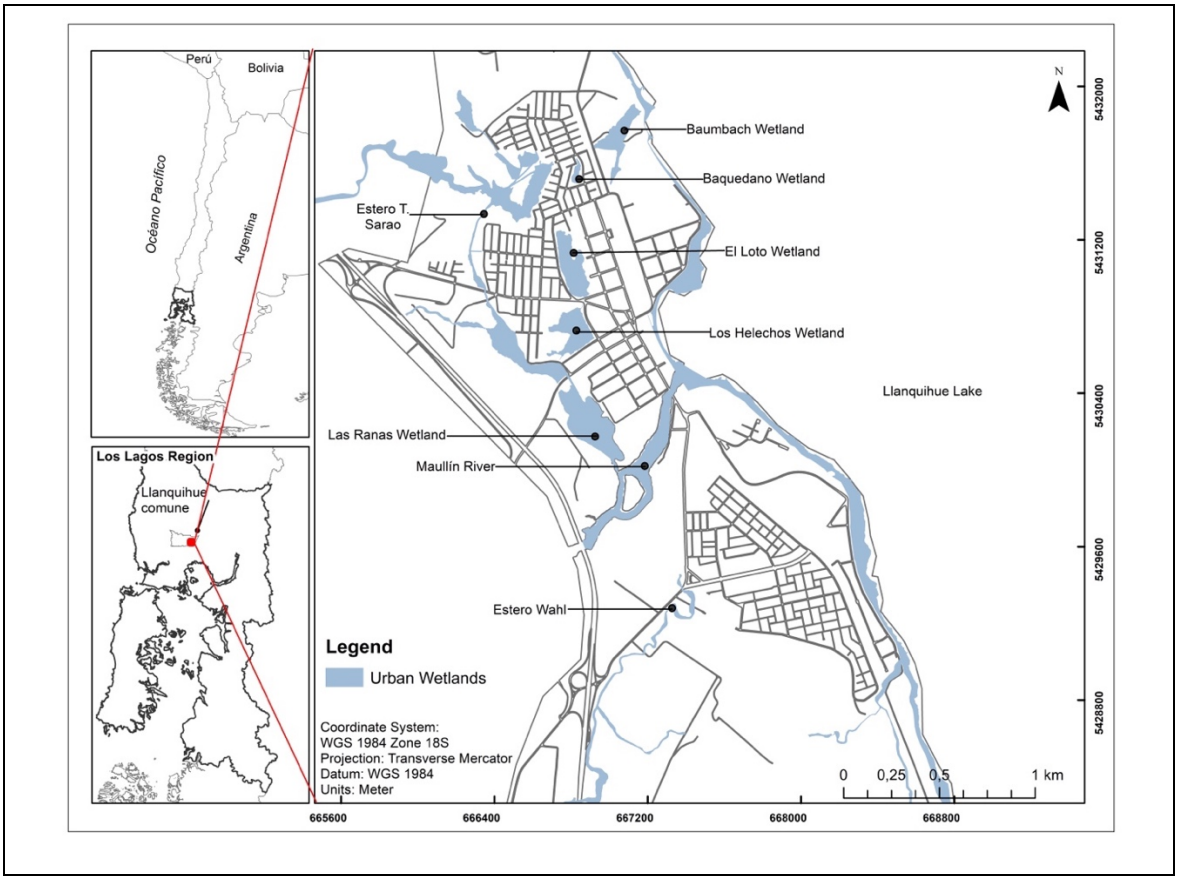

Figure 5.3 Study-case Llanquihue showing the water landscape

Source: Own elaboration (2020)

This research takes Llanquihue city as a study case because it is a Priority Conservation Site for the National Biodiversity, Important Bird Area (IBA, BirdLife) and Western Hemisphere Shorebird Reserve Network (WHSRN). Also, it is a place that "complies" with the approach proposed by this research: small and low-income commune with the presence of urban wetlands. Furthermore, it is a territory that has incipient initiatives around urban wetland conservation. Finally, it is a place that is growing a lot in tourism, which has a high pressure associated with the natural space of the city (FLC, 2018).

6 RESULTS

6.1 Objective Nº1

6.1.1 Explore benefits and limitations of the Chilean normative and other regulations that may influence urban wetland conservation

The review conducted is presented below recognizing its potential benefits and limitations.

Table 6.1 Analysis of current normative: Communal Plan Regulator

Instrument	Communal Regulator Plan
Chilean instrument name	Plan Regulador Comunal (PRC)
Type	Normative
Scale	Communal
Potentially applicable norms and tools for urban wetlands protection	- The 19,300 Chilean Law *"Ley de bases generals de medio ambiente* (LBGMA)" requires this planning instrument to be submitted to the Environmental Strategic Assessment that activates mechanism to look for the territorial sustainability and bring an opportunity for the participatory process that could act as auto-regulation to protect wetlands. - As EAE regulation establishes, the PRC must include environmental objectives and sustainability criteria that bring the possibility for urban wetland protection. - Since the ecosystem services that wetlands provide are usually demanded by the population the fact that the process for the PRC requires participatory process helps to consider the wetland as a protection area. - This land-use regulation is positive and useful spatial protection that helps to directly mitigate refilling, logging, water extraction

	that are widely recognized as one of the biggest threats. Although this protection is not enough to avoid the loss of biodiversity or ecosystem services delivery. Thus, other efforts and tools must complement this protection.
Limitations	- Wetlands are not usually considered as critical ecosystem providers of multiple services. - On one hand, completing the PRC process usually takes up to 8 years but on the other hand, the socio spatial dynamics go much faster. This implies that protection and conservation effort could arrive late and there is a need to take other tools into account in order to achieve short, mid and long-term effective conservation. - There are still Municipalities that have no current PRC working and this implies total land-use deregulation that could specially damage wetland conservation due to their highly demand ecosystem services. - The General Urbanism and Construction Ordinance is abbreviated OGUC in Chile. This ordinance just recognizes as areas of natural values those that previously have a protection element (e.g., coast border, national park, nature sanctuary, etc.), thus, as most of urban wetland are not actually recognized nor protected, they will not be recognized as nature areas.

Source: Own Elaboration (2020)

Table 6.2 Analysis of current normative: Intercommunal Land-Use Plan and Metropolitan Land-Use Plan

Instrument	Intercommunal Regulator Plan and Metropolitan Regulator Plan
Chilean instrument name	Plan Regulador Intercomunal (PRI) y Plan Regular Metropolitano (PRM)

Type	Normative
Scale	Intercommunal or Metropolitan.
Potentially applicable norms and tools for urban wetlands protection	- Parks, as land-use that OGUC defines, free space of public use, forested and eventually includes equipment for recreation, culture, sports practice, among other uses. By this land-use the supply of cultural ecosystem services could be secured. - This planning instrument must include sustainability criterion and objectives that could potentially consider the existence of urban wetland. Thus, the wetland areas could be included in the definition of protection areas for natural and cultural heritage. This zone could avoid or mitigate wetland threats. - Defines green spaces at an intercommunal level as a surface destined preferably for people movement and generally constituted by green vegetation and other complementary elements. - Defines risks zones and prohibits construction. This definition would avoid the wetland refilling securing ecosystem service provision. - Includes a risk assessment and environmental protection identifying specific restriction to urban development and protection areas establishing use conditions that could protect the supply of regulating ecosystem services.

	- Urban wetland area could be defined risk zones and/or not buildable zones according to .1.17 OGUC land-use ordinance bringing a category of protection against refilling threats. This is due to the fact that among the areas that could be defined in these categories are floodable or potentially floodable areas.
Limitations	- Potentially poor decision process due to the fact that none of the authorities responsible for the elaboration of the PRI necessarily must have internal competences in conservation nor wetland conservation. - As a normative instrument, the entity responsible for defining the protection status of an urban wetland differs from the one to be prescribed to be responsible for the management. There is no explicit coordination between both entities. The latter may imply potential problems in effective conservation. Thus, there are scenarios where lack of coordination may end-up impoverish the urban wetland conservation planning. - PRI cannot declare protection zones, at most it could recognize previously declared areas and wetland are underrepresented as resource sites despite the fact that they are one of the most productive ecosystems in the planet.

	- Although PRI could potentially contribute to wetland protection just 0,87% of Chilean communes currently have a PRI.

Source: Own Elaboration (2020)

Table 6.3 Analysis of current normative: General environment base law

Law	General environment base law
Chilean instrument name	Ley de bases generales de medio ambiente
Type	Normative
Scale	National
Potentially applicable norms and tools for urban wetlands protection	- The law provides the legal foundations to avoid and/or sanction project that could eventually damage wetlands. - Develops the notion of the environmental impact assessment that will impact several instruments and regulations including urban wetlands. - Letter b) Article 2 Environmental heritage conservation: use or repair of the components from the environment, especially the ones that are uniquely to that environment looking to guarantee its permanence and regeneration capacity. - The Letter e) defines environmental damage as significative loss or diminish of the environment.

	- There are legal resources within the law that can be used restrict projects that may potentially damage urban wetland. - Article Nº10, letter ñ) explicitly mentions that projects, programs or activities susceptible to damage urban wetlands must be submitted to the environmental impact assessment. Article Nº10, letter q) mentions the use of chemicals that could damage a wetland must be submitted to the environmental impact assessment. Article Nº10, letter s) mentions that activities that may imply a physical or chemical damage of biotic components, ecosystem fluxes that imply its refilling, drainage, drying, flow alteration among others threats to an urban or partially urban wetland must be submitted to the environmental impact assessment. This implies that every common threat that Chilean urban wetlands have been facing are included in this article. - Article Nº11, letter d) explicitly mentions that projects or activities executed in (or close to) protected wetlands submitted to the environmental impact assessment. - Article Nº70, letter i) explicitly declares that the Environment Ministry must propose policies, plans, programs and actions that favor restoring and conservation of water resources, habitats,

	landscapes, natural places and specially the most fragile and degrade contributing to the international agreements on biodiversity conservation. This may empower urban wetland conservation practitioner to ask for proactive actions when there are explicit threats to the wetlands since they could be included inside the mentioned categories and also consider the work with Ramsar sites as a way to engage conservation responsibility to the authorities.
Limitations	- There is no exact definition of what a "protected wetland" means and that may lead to confusion and lack of effective conservation. - According to Article 54), if there is environmental damage in a protected wetland, the local government could bring help to an affected individual for the legal claim. This may be a political problem when the local government is responsible for the damage. - The environmental assessment is mainly focused on assessing project by project and holistically understanding the complexities and fragilities of an ecosystem.

Source: Own Elaboration (2020)

Table 6.4 Analysis of current normative: Tourism Interest Zone

Declaration	Tourism Interest Zone

Chilean declaration name	Zona de Interés Turístico (ZOIT)
Type	Indicative
Scale	Intercommunal
Potentially applicable norms and tools for urban wetlands protection	- According to Nº20.423 Law which declares a ZOIT, the Chilean Government will promote the cooperation between the Local Government, the private sector and other relevant actors to coordinate and develop a planned and sustainable touristic activity (art.4 and 22). - The ZOIT considers conservation and integrated planning measures (Art. 13). This represent a direct benefit to urban wetland conservation. - According to the Art. 14 the ZOIT looks for synergies and enables modifying other land-use planning instruments preventing incoherences between other IPT currently working in the territory. - According to the Dº40, Art. 9 the Environment Impact Assessment Service (in Spanish *Servicio de Evaluación de Impacto Ambiental (SEIA)*) considers ZOIT's as officially protected areas, it may potentially prevent the investment projects that could be eventually harmful for the wetland health.

	- According to the Art. 17, this zone will be prioritised for the funding and execution of public programs, projects and infrastructure. This represents a comparative advantage that may enhance conservation funding.
Potential limitations	- The approval of the request is processed by the Chilean national tourism service (in Spanish "SERNATUR"), an entity that is not technically prepared for wetland conservation. (D.º30, Art. 4) - The declaring request must be done by the Regional direction of the national tourism service (D.º30, Art. 3), this creates a strong dependence on the decisions of a political entity that may (or may not) decide in favor conservation and tourism

Source: Own Elaboration (2020)

Table 6.5 Analysis of current normative: Ordinance municipal defined by Law 21.202

Local regulation tool	Municipality Ordinance
Chilean instrument name	Ordenanza municipal
Type	Normative
Scale	Communal
Potentially applicable norms	- Communes with urban wetlands must enact a Municipal Ordinance (*Ordenanza Municipal*) that explicitly settles the criteria

and tools for urban wetlands protection	for the protection, conservation and preservation of their wetlands. (Law 21.202, Art.2, Reg. Art. 15). The definition of this criteria will be aided by a technical guidance provided by the Environmental Ministry. - It has the power to prohibit private or public activities in order to protect an urban wetland if needed. - It has an immediate action in the territory because it is created, enacted and executed directly by the local government.
Limitations	- It has intrinsic volatility because it depends entirely on the major and the city council which may be influenced by political forces that can approve or revoke any *Ordenanza.* - They are created by the municipal council which may not necessarily have the technical science-based knowledge to define conservation criteria. - The Municipal Ordinance depends on the local government formally recognizing the existence of urban wetlands. And, as said by Vergara et al. (2016), in some cases, this dependency on the discretionary power of the local authorities may generate inequality among communes facing similar requirements. The latter may potentially go against wetland conservation.

Source: Own Elaboration (2020)

Table 6.6 Analysis of current normative: Ramsar site

Declaration	Ramsar site
Chilean declaration name	Sitio Ramsar
Type	Indicative
Scale	National
Potentially applicable norms and tools for urban wetlands protection	- It defines a wetland in a broad way that enables a variety of places to be recognized as wetlands and thus potentially declared Ramsar sites. - Worldwide recognition of the protection status of a Ramsar site - Facilitates national and international project funding. - 19.300 Art. 10p Law any project or activities executed in a Ramsar site must be submitted to the Environmental Impact Assessment Service and these benefits the urban wetland reducing threats to ecosystem services and biodiversity. - The Chilean adherence to the Ramsar convention compromises the direct effort on the conservation of declared Ramsar sites.
Limitations	- It does not prohibit any particular activity inside the wetland.

Source: Own Elaboration (2020)

Table 6.7 Analysis of current normative: Nature sanctuary

Local regulation tool	Nature sanctuary
Chilean regulation name	Santuario de la naturaleza
Type	Indicative
Scale	Local
Benefits	- Mainly for research purposes this instrument can declare the protection of urban, rural, marine area. This area could be either private or public.
Limitations	- It does not establish prohibition of intervention or project execution. - The Environmental Ministry cannot start the requirement process of requirement for this declaration. It must come from a non-wetland technical Council from the National Assets Ministry. - There are low standards to request a permit to execute activities inside a nature sanctuary.

Source: Own Elaboration (2020)

Table 6.8 Analysis of current normative: Urban wetland Law

Law	Urban wetland law
Chilean law name	Ley de humedales urbanos Nº 21.202
Type	Normative
Scale	National (with communal specific characteristics when implemented)
Potentially applicable norms and tools for urban wetlands protection	- It creates a new commission to promote the adequate management of the urban wetlands (R. Art. 5), thus it formally adds an additional entity that watches for the good governance and boosts the effective participation of stakeholders in the wetland conservation. - It enforces the updating of the wetland boundaries in the land-use city plan (including launching technical guidelines for wetland delimitation). It also updates the analyzed instruments and normative from indicative to normative; thus it directly tackles important current threats for urban wetland conservation (e.g. refilling; draining) (R. Art. 18). - It includes wetlands inside urban legislation that is a first step for its recognition in the city planning. - Requires wetland to be included among the natural value protection areas in the communal land-use plan.

	- Modifies 19.300 Law Art. 10 p) –which is related to the submission to the Environmental Impact Assessment Service (EIAS)- explicitly adding UW as area under official protection. Thus, the benefit is that any project which execution includes areas inside (or close to) UW must be submitted to the EIAS. - The instrument must define minimal requirements for the sustainability of urban wetlands looking forward for its protection and maintain its hydrological regime. This minimal requirement definition may be assisted by the recently developed criteria recommendation ("Propuesta de criterios mínimos para la sustentabilidad de humedales urbanos") as guidelines from the Environmental Ministry that may improve the decision-making process trigger multiple benefits with small well-thought conservation actions (e.g., blue-green infrastructure; knowing the financial value of certain threats; education). - 21.202 Law declares that the Environmental Ministry will design bring technical aid to the local governments to design the *Ordenanza.* This may potentially contribute to a good *Ordenanza* that effectively protects urban wetlands.

	- It diminishes administrative fragmentation related to urban wetlands by simultaneously updating a group of relevant laws related to ecosystem conservation and environmental issues. - 21.202 Law declares that the Environmental Ministry will bring technical aid to the local governments to design the *Ordenanza.* This may potentially contribute to a good *Ordenanza* that effectively protects UW. - *GEF Humedales* -organization from the Environmental Ministry supported by the UN- is providing financial aid to implement the law (e.g., wetland cadaster; communication campaigns). - Environmental Ministry is providing guidelines to local governments for UW delimitation and other wetland-related issues.
Limitations	- Does not assign financial resources for the conservation projects to municipalities. - The declaration process may be affected by the administrative perceptions of the local governments. - Local governments may have low-capacity for the regulatory compliance of the ordinance for the protection of urban wetlands (Vergara et al., 2016), this is being tackled by providing guidelines (as stated above in the benefits section).

Source: Own Elaboration (2020)

Table 6.9 Analysis of current normative law: Conservation easement

Law	Conservation easement
Chilean law name	Ley de Derecho Real de Conservación
Scale	National
Benefits	- It has the power to preserve the environmental heritage of a property or of certain attributes or functions of it. - It opens up the more possibilities for the private conservation. - It is simple to carry out, since it is constituted through a contract - It is flexible and adaptable to each situation, since the agreements for the specific conservation actions of the are established in the contract between both parties. - There is a high implicit trust in the guarantor conservation institution since the only requirement for the guarantor is that it must be an NGO dedicated to conservation.
Limitations	- It is not a recognized protected area, therefore, with both parties agreement conservation efforts could be revoked. - It totally depends on the will of the owner so that they give the trust of the land. - There is an extreme dependency on the good work of the guarantee organization.

Source: Own Elaboration (2020)

6.1.2 Characterizing the decision-making process of the UWCP

Actions and decisions were summarized in Table 6.10 based on the literature review of the conservation practitioner by Salafsky et al. (2001) complemented by the semi-structured interviews done to the UWCP.

Table 6.10 List of technical actions and decisions

Type of work	**Specific actions and decisions**
Defining cost-effective spatial conservation strategies	Territorial spatial analysis
	Defining conservation zones
	Zone priorities (areas, relation between them)
	Defining connectivity areas (connectors)
	Designing urban interventions
Monitoring and evaluation conservation planning and execution	Creating KPI's for the actions implemented
	Measuring the effectiveness of the conservation efforts
	Developing conservation projects
	Managing professional and non-professional teams
Managing the relation with stakeholders	Negotiating project funds
	Reporting results periodically
	Running participatory processes for critical data collection
	Obtaining approval for project execution
	Communicating to the general public
	Designing, articulating and participating in community work related to the conservation targets
Obtaining critical technical data	Estimating ecosystem services demand and provision
	Estimating biodiversity indexes
	Biophysical modelling
	Ecological assessment
	Hydrological modelling

Source: Own elaboration (2020)

6.1.3 SWOT analysis integrating instruments and tools review with the context of the UWCP

A SWOT analysis is presented below in Table 6.11. It was developed based on the reviewed instruments and tools, the semi-structured interviews to the UWCP and the conservation literature review.

Table 6.11 SWOT analysis of urban wetland situation

Strengths
1. Public awareness on the need of urban wetland conservation is rising on the civil society as well as academia and political authorities (e.g., Ramsar declared 2018 the urban wetland year; recently launched urban wetland law; new urban wetland NGO's; Wetland citizen network) *2.* There are low-cost tools available to assist decision-making of UWCP (e.g., TESSA Toolkit for in-site assessing ES; Environmental Ministry Wetland Guidelines; wetland toolkit for reporting damaging actions on wetlands (*Toolkit de humedales urbanos*) from Bergamini et al. (2019)). 3. Wetlands provide various urban ES and BD (Millennium Ecosystem Assessment, 2005a).
Weakness
1. Current valid spatial planning instruments do not consider the ecological connectivity, thus a great amount of wetlands have been refilled and fragmented representing one of the biggest current threats for urban wetlands (Rojas, 2018). 2. Useful frameworks and tools for conservation require technical skills and are usually in English representing an entry barrier for UWCP in Chile. 3. Lack of a hydrologic basin scale management focus (semi-structured interviews). 4. Plenty of conservation practitioners lack of planning frameworks for conservation (from semi-structured interviews). 5. Administrative fragmentation undermines the possibility to achieve collective future visions for urban wetland conservation (e.g., Law: 19,525; 21,202; 19,300).

Opportunities
1. Urban dwellers and other relevant stakeholders are increasingly valuing blue-green public spaces (e.g., healthy living, nature as a platform for education, covid-19). 2. Subsequently, strategies concentrated on building an institutional framework to enable sectoral integration of the multiple agencies dealing with wetland issues, mainly at the national level may (Millennium Ecosystem Assessment, 2005b). 3. Internationally, there is a variety of frameworks and tools that may help in conservation (e.g., Ramsar, Open Standards for Wildlife conservation, Adaptive Management). 4. Conservation easements and land-trust could be a way to achieve urban wetland conservation of private parks 5. The multiple ES that urban wetlands may offer to the urban and the city in general. Furthermore, ES as a concept is being increasingly known by policymakers. 6. Recent urban wetland law that could enable faster recognition of this ecosystem by the local government and incorporate them in urban planning. 7. New small public grants have appeared to aid conservation practitioners actions 8. Solid territorial planning instruments (Rojas, 2018). 9. Landscape architecture, NBS, BGI may be a useful framework to expand and continue developing city planning in Chile integrating urban wetlands.
Threats
1. Wetland refilling and drainage due to urban development (Rojas, 2018). 2. Land-use changes in adjacent lands for agriculture, forestry and livestock whose industrial processes generate diffusive contamination because of the use of pesticides, fertilizers and nitrogen compounds (Rojas et al., 2018). 3. Deforestation for domestic firewood production from riverine/estuarine, lacustrine forest creates chemical changes in the wetland water as well as soil erosion. 4. Wetland water contamination, liquid industrial waste, etc (Novoa et al., 2020). 5. Biodiversity loss and sedimentation, agriculture, illegal hunting and forest industry 6. Soil degradation and overgrazing by livestock inside wetlands. 7. Communal land-use plans usually look for urbanism regulation with special effectiveness in buildings and not in the protection and conservation of ecosystems (Rojas, 2018)

Source: Own elaboration (2020)

6.2 Objective Nº2

6.2.1 Model requirements (general and specific) and functionality (scale, ecosystem type, development level, inputs and outputs type)

The general requirements are presented in Table 6.12. They were defined based on the SWOT focusing on the urban wetland conservation practitioner (UWCP) as the future users for the conceptual development**.**

Table 6.12 General model requirements for the conceptual guidelines development

Statements	**Conceptual guidelines general requirements (GR)**
Cities in Chile are recognized to be data-poor context for conservation and urban planning	GR1. The model must include tactics to use simple qualitative and quantitative data collection and use.
Cities in Chile are recognized to have a lack of financial resources for conservation and urban planning	GR2. The model must require free or low-price tools for data collection and use.
Cities in the Chile are usually based in top-down planning process and are mostly ineffective for conservation and urban planning	GR3. The model must include participatory involvement for every step of the application.
Cities in the Chile are recognized to have low number of professionals specialized in conservation and urban planning	GR4. The model needs easy-to-learn and easy-to-use tools for every step of the application.

Source: Own elaboration (2020)

Specific requirements presented in Table 6.13 were based on the actions and decisions list combined with insights from the "Adaptive management: A tool for conservation practitioners" from Salafsky et al. (2001), semi-structured interviews and SWOT analysis.

Table 6.13 Specific model requirements for the conceptual guidelines development

Type of work	**Specific actions and decisions**	**Conceptual guidelines specific requirements (SR)**
Defining cost-effective spatial conservation strategies	Territorial spatial analysis	SR1.1 There is a need to understand the basic spatial dynamics that influence the wetland conservation
	Defining conservation zones	SR1.2 There is a need to define specific zones where conservation actions are going to be implemented
	Zone priorities (areas, relation between them)	SR1.3 There is a need to recognize action priorities in each zone and within a zone
	Defining connectivity areas (connectors)	SR1.4 There is a need to map the connectivity areas that are required to guarantee flow
	Designing urban interventions	SR1.5 There is a need to translate the actions necessary for the conservation of a zone into urban design operation and strategies.
Monitoring and evaluation conservation planning and execution	Creating KPI's for the actions implemented	SR2.1 There is a need to keep track of the management and technical results to adapt the actions and decisions that conservation practitioners take.
	Measuring the effectiveness of the conservation efforts	SR2.2 There is a need to keep track of the management and technical results to adapt the actions and decisions that conservation practitioners take.
	Developing conservation projects	SR2.3 There is a need to group the conservation actions into individual written projects.

	Managing professional and non-professional teams	SR2.4 There is a need to have competences and tools to manage diverse background teams.
Managing the relation with stakeholders	Negotiating project funds	SR3.1 There is a need to have information and abilities to negotiate with different stakeholders to secure the project funds.
	Reporting results periodically	SR3.2 There is a need to present explicit tangible and intangible results to different stakeholders to maintain trust and funds.
	Running participatory processes for critical data collection	SR3.3 There is a need to collect critical data that requires human interaction via the participation of different stakeholders.
	Obtaining approval for project execution	SR3.4 There is a need to obtain the permits, approval and agreements of the different stakeholders affected by a conservation project.
	Communicating to the general public	SR3.5 There is a need to communicate results, projects, problems to the general public.
	Designing, articulating and participating in community work related to the conservation targets	SR3.6 There is a need to execute projects that directly generate community work to familiarize the urban citizen with the conservation targets.
Obtaining critical technical data	Estimating ecosystem services demand and provision	SR4.1 There is a need to have quantitative data about the ecosystem services demand and supply.
	Estimating biodiversity indexes	SR4.2 There is a need to have quantitative date about biodiversity.

	Biophysical modelling	SR4.3 There is a need to have biophysical modelling.
	Ecological assessment	SR4.4 There is a need to have an ecological assessment.
	Hydrological modelling	SR4.5 There is a need to have quantitative understanding of the water flow under different scenarios.

Source: Own elaboration (2020)

Based on the general and specific requirements stated above in Table 6.12 and Table 6.13. These requirements were used to draft a group of steps. The general requirements are presented below in Table 6.14.

Table 6.14 General model functionality

Functionality	**Model information**
Scale of action	Local
Ecosystem type	Wetlands
Development level	Pilot conceptual model
General input data type	Qualitative and quantitative
Detailed input data type	Spatial information, expert knowledge and local community knowledge
General output data type	Qualitative and quantitative
Detailed output data type	Spatial information, ES Values, Preferences list

Source: Own elaboration (2020)

6.2.2 Building the conceptual guidelines based on the CS

The proposed conceptual guidelines are presented following the structure: i) providing a general overview of the proposed method in Figure 6.1; ii) detailing Table 6.15 to Table 6.17 presenting each step and; iii) individualized description of each sub-step (for more details see Annex C). The conceptual guidelines built during this research were named "Structured approach for urban wetland conservation planning" (SUWCP). These guidelines expand on the first two steps of the CS. This approach aims to tackle, in a straight-forward clearly defined way, the particular challenges that UWCP's face in Chile and other countries facing similar problems in the developing world. It is important to mention that the proposal of the SUWCP may be tailored and partially applied adjusted to the conservation practitioner specific requirements. The SUWCP are presented in three interconnected macro steps: Arrival, Asses and Plan. The first macro step provides general context background of the urban wetland as a socio hydro-ecological system. The second, follows the CS Assess step defining the project scope and making sense of the project context. Finally, the third, follows the CS Plan integrating a BGI view for the planning process. A detailed description of the proposed steps is presented in the following chapters.

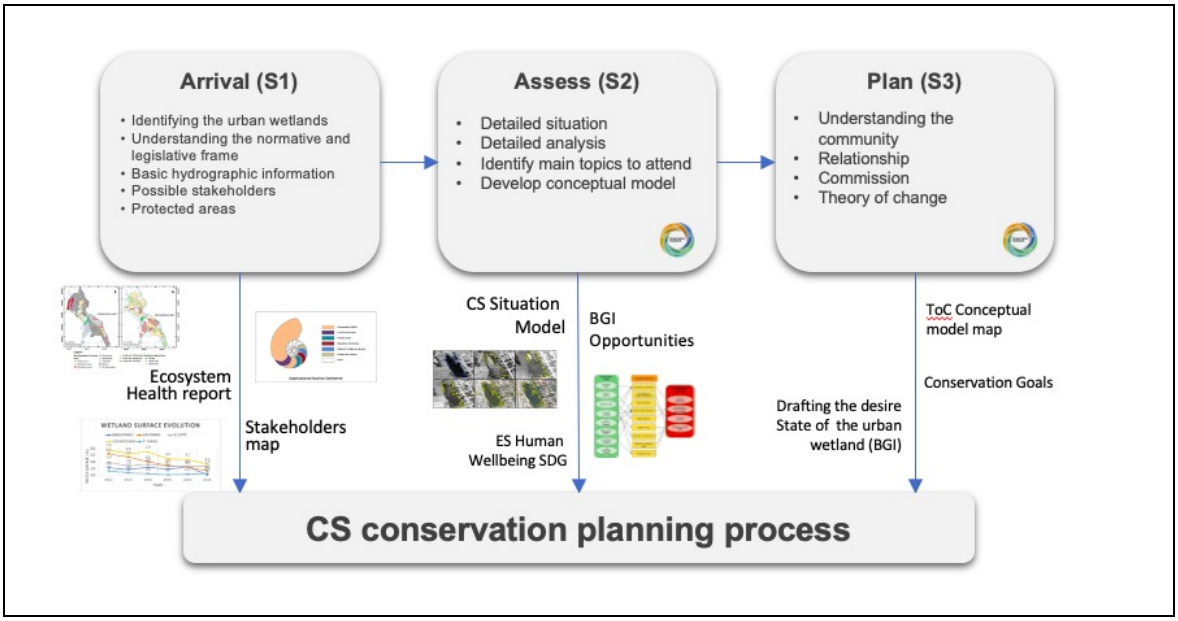

Figure 6.1 SUWCP general diagram

Source: Own elaboration (2020)

A general overview of the SUWCP ARRIVAL STEP is presented in Table 6.15.

Table 6.15 Detail SUWCP ARRIVAL STEP detailing sub-step, Key Question, core methods and key reference.

SUB-STEP	Key question	Core methods	Key references
1A Develop city-region general context	What is the general context of the study area (city-region)?	Systematic review	CMP (2020); Alvarez-Garretón et al. (2018)
1B Analyze the hydro-spatial context of the urban wetland system	What is the basic hydro-spatial conditions of the urban wetland system?	Hydro GIS tools	Zhou et al. (2008)
1C Understand the regulations affecting linked to the urban wetlands	How do the primary local regulatory policies impact my urban wetland conservation planning?	Systematic review	Bergamini et al. (2018); Vicepresidencia del senado (2009); Precht et al. (2016)
1D Understand the city-wetland relation	What and how many urban wetlands do I identify by satellite or aerial images?	Photointerpretation; threat prioritization; Systematic review	FLC (2018); Ramsar (1990) FLC (2018); CMP (2020); Bergamini et al. (2018)
1E Understand current hydro-ecological status of urban wetlands	What are the urban wetland basic hydrologic features? Which are my wetland system vegetational basic features? What is the currently identified biodiversity conservation state?	Remote sensing; Systematic review	Zhou et al. (2008)
1F Map the urban wetland stakeholders (FrASH)	Who may be the stakeholders that may have a primary and secondary interest on the urban wetlands?	FrASH model	CMP (2020); FLC (2018); Schifman et al. (2017)
1G Proximity assessment to protected area for conservation (BGI)	Are there any protected areas nearby? What are they protecting?	GIS proximity tools	-
1H Building the conservation team	What are the key professions to build a team to achieve the future conservation challenges?	Work planning	CMP (2020); FLC (2018); Schifman et al. (2017)

Source: Own elaboration (2020)

A general overview of the SUWCP ASSESS STEP is presented in Table 6.16.

Table 6.16 Detail SUWCP ASSESS STEP detailing sub-step, Key Question, core methods and key reference.

SUB-STEP	**Key question**	**Core methods**	**Key references**
2A Define geographic scope and conservation targets	What is the geographic scope for the conservation project? What will my limited conservation targets be?	Expert elicitation; Evidence synthesis;	CMP (2020); Ramsar (2010); (Moreno, 2019b)
2B Study of the city dynamics for the BGI	What is the current and planned city land-use? What opportunity for the masterplan of BGI do the city dynamics represent?	Evidence synthesis;	Moreno (2019); (Wantzen et al., 2019)
2C Rapid assessment wetland health	What is the current health of the urban wetlands?	Viability assessment	Ramsar (2010); Moreno (2019); CBD Ramsar (2006)
2D Characterize the ES from each wetland and link them to key stakeholders	What are the current ecosystem services that the wetlands are providing? Who benefits from this ES?	Data on targets	Peh et al. (2017); CMP (2020); FLC (2018)
2E Connect ES to human-wellbeing targets	What are the current human-well-being targets that the wetlands are providing?	Common lexicons	Millennium Ecosystem Assessment (2005)
2F Describing the direct and indirect threats	What are the current critical direct and indirect threats to my urban wetlands?	Expert elicitation; Data on targets; Systematic review	CMP (2020); Millennium Ecosystem Assessment (2005);
2G Execute an additional study of social urban dynamics	What complementary local social information could benefit the conservation planning?	Expert elicitation;	FLC (2018)
2H Assess the conservation situation	What does your CS conceptual model look like?	Situation analysis;	CMP (2020); FLC (2018)

Source: Own elaboration (2020)

A general overview of the SWUCP PLAN STEP is presented in Table 6.17.

Table 6.17 Detail SUWCP PLAN STEP detailing sub-step, Key Question, core methods and key reference.

SUB-STEP	Key question	Core methods	Key references
3A Understanding ES community interest	What are the most relevant ES recognized by the community? What is the link of the ES with the SDG?	Horizon scanning; multicriteria assessment	CMP (2020); Alvarez-Garretón et al. (2018)
3B Relations with stakeholders	What is the link of the ES with the SDG? What are my stakeholders expecting from me? What do they need? Do you see any organization redundancy?	Systematic review Systematic (evidence) mapping	Zhou et al. (2008); Schifman et al. (2017)
3C Creating a citizen commission	What is your stakeholder engagement strategy? How could you improve the stakeholder engagement?	Stakeholder assessment	Bergamini et al. (2018); Vicepresidencia del senado (2009); Precht et al. (2016)
3D Drafting a community desired state	What is the collective vision that the stakeholders hold as a whole? What do they see for each Conservation Object selected?	Scenario planning;	FLC (2018); Ramsar (1990) FLC (2018); CMP (2020); Bergamini et al. (2018)
3E BGI master plan	What are the objective, goals and actions lines for the BGI masterplan? What is my zonification?	Spatial prioritization; Cost assessment	Moreno, (2019b); Sciaraffia, Kumar, Nideroest, & Zander, (2019)
3F Developing the Theory of Change	What areas do I recognize as needing urgent protection and recovery? What are the viable conservation object to protect and recover? How does your CS theory of change look like?	Results chains; Backcasting; Threat prioritization	CMP (2020); FLC (2018); Schifman et al. (2017)

Source: Own elaboration (2020)

6.2.2.1 STEP 1: ARRIVAL

The ARRIVAL creates a general view of the situation and establishes the base work for the whole evaluation. It has eight sub-steps to be performed, denominated with a code as follows:

- Develop city-region general context (SUB-STEP 1A)
- Analyze the hydro-spatial context of the urban wetland system (SUB-STEP 1B)
- Understand regulations affecting linked to the urban wetlands (SUB-STEP 1C)
- Understand the city-wetland relation (SUB-STEP 1D)
- Understand current hydro-ecological status of urban wetlands (SUB-STEP 1E)
- Map the urban wetland stakeholders (FrASH) (SUB-STEP 1F)
- Proximity assessment to protected area for conservation (BGI) (SUB-STEP 1G)
- Building the interdisciplinary conservation team (SUB-STEP 1H)

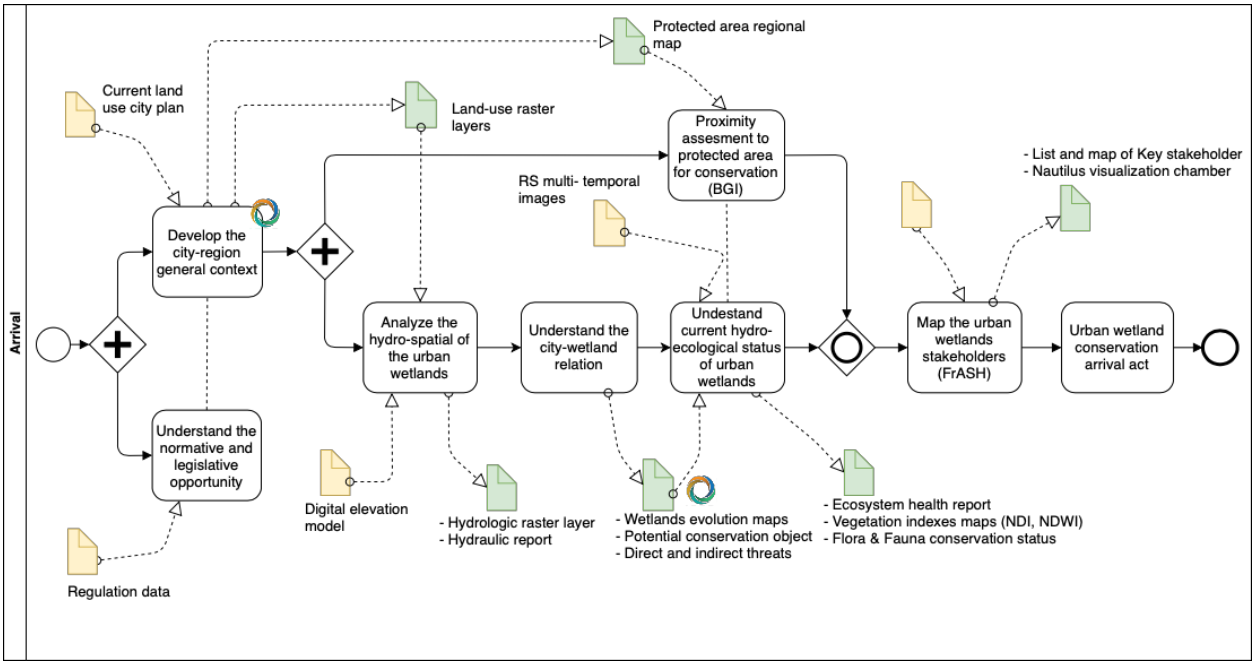

Figure 6.2 ARRIVAL STEP workflow

Source: Own elaboration (2020)

Each one of these SUB-STEPS has a certain number of questions, that should be addressed according to the base information and attending the objectives and methodological recommendations to accomplish the desired outcomes. A potential information source is depicted for each case.

Sub-step 1A: Develop city-region general context

1) **What is the general context of the study area (city-region)?**

The main objective is to create a general notion of the demographic, climatic and landscape description of the city and its relationship with the region. To accomplish this, the following information is required:

- Demographic data of the city, basin and region.
- Catchments attribute and meteorology of the city, basin and region.

Potential sources for this information could be considered: i) National Statistics Institutions (in Chile known as INE), ii) Meteochile (e.g.: http://.meteochile.gob.cl/), iii) Dirección General de Aeronáutica Civil (e.g.: https://dgac.gob.cl/), iv) CAMELS-CL (this dataset includes 516 catchments: http://camels.cr2.cl/), v) Environmental Ministry (https://gefhumedales.mma.gob.cl/)

Method description

To start the conservation planning process for the wetlands inside a city, it is useful to have background knowledge regarding: i) basic social situation, ii) climatic/hydrological, iii) economics, iv) ecological and v) political. This knowledge must come from different reliable sources. It may start by a desk research of the basic demographic, climatic and

landscape information. Achieving these outcomes, in a data-poor context, demands primary and secondary sources, such as direct interaction with urban dwellers, analysis of aerial photography and satellite imagery. Additionally, with other sources, for instance books, policies, etc. (Johnston et al., 2013). It is also useful to look for other conservation-related projects at different scales, such as city/region/basin. It is also necessary to do in-site in person visits to the prospect study area (FLC, 2018). Finally, an initial approach to defining the geographic scope is recommended following the CS (CMP, 2020).

As a result of this work the expected Outcomes should be:

- Land-use raster layer
- Protected area regional map
- Possible geographic scope

Sub-step 1B: Analyze the hydro-spatial context of the urban wetland system

1) **<u>What are the basic hydro-spatial conditions of the urban wetland system?</u>**

It is necessary to develop a hydrological overview of the urban wetland system to later assess the hydro-ecological status for the ecosystems. Additionally, a digital elevation model of the terrain is necessary, which could be obtained from Alos Palsar DEM from USGS NASA (view in: https://search.earthdata.nasa.gov/). If possible, SUWCP recommends understanding wetland inflows/outflows early on (they will be later described in a rapid assessment SUB-STEP 2C).

Method description

Once the general context is developed, the SUWCP recommends a hydro-spatial analysis which could be performed to create basic hydrological information of the area. Further on, this analysis will enable the initial understanding of potential threats to the wetland conservation. Since SUWCP is a low-data approach, it recommends using a hydrological GIS tool such as "Integrated ecological assessment of biophysical wetland habitat in water catchments: Linking hydro-ecological modelling with geo-information techniques" (Zhou, Gong, & Liu, 2008). This method uses just a Digital elevation model (DEM) to develop a digital water-system and a hydrological zonation. Some of the possible outcomes of the workflow proposed include: Water bodies, Sub-catchment surfaces, Drainage hierarchy, Basin surface, Stream network and Inflow and Outflow from the individual wetland units. Furthermore, the previously mentioned workflow may also be supported based on the use of satellite images RS analysis (e.g., NDWI) available for free (e.g., Landsat and/or Sentinel satellites). This will also be worked in the SUB-STEP 1E and 2C.

2) **Are there any other water bodies that have not recognized on the field and/or with the satellite images?**

At this stage, a complete recognition of the urban wetlands is necessary, based on the previous hydrologic analysis. This could be completed using i) Hydrologic raster layer and Hydraulic Report; ii) Wetland sub-catchment map and; iii) Stream network map obtained from previous question of this sub-step.

Method description

The SUWCP model takes into account that the conservation efforts will be done in an urban context. Thus, it is possible that some of the potential wetlands digitally modelled in the previous steps may have been severely modified.

A field recognition is recommended to compare and assess the modelled analysis. When encountered with major differences, third low-cost input sources are recommended, such as satellite images suggested in further steps. These findings, (as will be shown later in the study case of the present research) may lead to interesting findings like previously unrecognized urban wetlands in official maps, field work or other sources have not previously been shown.

3) **How and where does the geographic scope change if the sub-catchments of every wetland are added?**

With the aim to develop a more accurate geographic scope, according to the modelled sub-catchments, for each recognized wetland, this should be performed based on the information previously obtained: i) Wetland sub-catchment map and; ii) Initial geographic scope from previous question and sub-step.

Method description

Once an initial hydrology-driven analysis is done, it is suggested to compare the map of the initial geographic scope with the area that includes the sub-catchment of every urban wetland.

Since cities are dense, it may be found that the sub-catchment of the wetland may exceed the administrative boundaries of the city and or the defined geographic scope (as will be shown later in the study case of the present research).

This sub-step will deliver the following results:

- Hydrologic raster layer and Hydraulic Report (from question 1)
- Initial map of potential wetlands and sub-catchment (from question 1)
- Updated map of potential wetlands and sub-catchment (from question 2)
- Updated conservation geographic scope (from question 3)

Sub-step 1C: Understand the local/ regional regulations linked to the urban wetlands

1) **How do the primary and most relevant regulatory and planning policies impact my urban wetland conservation planning?**

In order to reach a proper conservation planning, it is needed to accomplish a good general understanding of the legal framework and regulations. It may be necessary to review different sources, the most direct one is to visit the relevant communal website were spatial plans, development plans and protection figures may be found. Also, as a secondary source, in Chile the Housing Ministry facilitates the search and download of various spatial planning instruments for each commune (e.g., http://observatorios.minvu.cl). Additionally, in 2019 a handbook was published providing key information and recommended sources for key wetland information "Guía práctica para el conocimiento

de humedales e identificación de conductas denunciables" (Bergamini et al., 2019). Some of the recommended policies to review are:

- Pladeco "Plan de Desarrollo Comunal" (Communal Development Plan)
- Municipal environmental ordinances
- Urban wetland ordinance following the requirement from the recently launched urban wetland law 21.202.
- Urban wetland cadaster of MMA.
- Zone of touristic interest (Chilean acronym: ZOIT), Regional development strategy (Chilean acronym: ERD) and the Territorial planning regional plan (Chilean acronym: PROT)
- Protection figures (e.g., Ramsar Site, Natural Sanctuary, etc)

Method description

Select, read and identify the key components of the normative figures, spatial planning instruments that may be related to the city and its wetlands. As an example, it may be considered the Urban Wetland Law and its local relevance to figure it out if there is an officially protected wetland under this law located inside the work area. The analysis, of the above-mentioned policies, should take into account: i) general and specific objectives; ii) maps; iii) restrictions and; iv) spatial planning strategies and legislative frame.

To aid this analysis, there are some suggested literature to review: *"El Ordenamiento territorial en Chile"* from Precht et al. (2016), *"Toolkit de humedales urbanos"* from Bergamini et al. (2020).

2) **Are there other relevant legal documents and publications directly or indirectly concerning urban wetlands?**

Together with the previous step, it is also recommended to look for other relevant sources that may not be easily accessible, nevertheless, it is necessary to fill the gaps of any critical piece of information that must be taken into account for the planning process.

Method description

Once the critical information is reviewed and key components are extracted, then knowledge gaps should be explicitly identified and addressed through other sources, direct interaction with local policy and regulation makers. Some potential sources for this data could be local, regional and national newspapers as well as environmental assessment service. Also, the information will serve as an input in the following SUB-STEP to prepare actions such as the promotion of declarations (e.g., Ramsar, Natural Sanctuary, etc), current or potential threats, among others.

After sub-step 1C is accomplished, deliverables like the following should have been achieved:

- List of existing protection policies and legislative frames (from question 1)

- Main regional development objectives for the commune (from question 1)
- Main communal development objectives (from question 1)
- Maps of green areas, protected areas, restricted areas and urban growth (from question 1)
- Assessment chart of benefits and limitations for each instrument (from question 1)
- Updated Assessment chart of benefits and limitations for each instrument, if applies (from question 2)

Sub-step 1D: Understand the city-wetland relation

1) **<u>What type and how many urban wetlands can be identified by satellite or aerial images?</u>**

Using satellite images as well as national and/or regional wetland census from private or government institution, quickly develops a big picture identifying the urban wetland in the initial study area.

Method description

To develop a plan for conservation, including a blue-green infrastructure (BGI) spatial plan, the relation between the city and the wetland must be clearly understood. In consequence, to attain this goal a first approach is suggested through a quick wetland recognition. This must be executed in order to identify the visible wetlands and explicitly

define them as conservation objects, based on field work, photo interpretation analysis and satellite image analysis (FLC, 2018).

Images could be obtained from the Aero Photogrammetric Service known in Chile as "Servicio Aerofotogramétrico" (SAF)[1]. For example, SAF offers historic aerial photography from urban areas of Santiago starting from 1949 to the present. For Concepción and Llanquihue (Chilean cities) the offer starts from 1978 approximately. Also, NASA and Google Earth provide suitable data for this and further steps.

2) **What type of wetlands are seen?**

After the urban wetlands were initially recognized (from previous steps and questions) they should be quickly classified in one of the Cowardin (2005) and Ramsar types (2012).

Method description

Since the conservation planning is located in a data-poor and low-resources context it is recommended to run a desk-research pre-classifying wetlands by visual inspection of satellite images and/or historic photography. This pre-classification can be done following the Ramsar classification proposed in the "Recommendation 4.7: Mechanisms for improved application of the Ramsar Convention" (Ramsar, 1990).

[1] A military institution that provides satellite images and aerial photography.

After the pre-classification is done, it can be verified by field work with a wetland visit and direct relation with stakeholders. Then, if possible, lead an expert knowledge validation of the wetland type classification.

3) **How has the city in general and the wetlands in particular evolved over time?**

At this point, to understand the main dynamics in terms of urban fabric growths and their relation to wetlands, it is required to develop an informed big picture view of the city, using historic photography and satellite images. The former may be gathered from the Aerophotogrametric Service (known in Chile as "Servicio Aerofotogramétrico" (SAF)), NASA and Google Earth could also contribute with valuable material.

Method Description

Since the wetlands (our conservation objects) are embedded in a city, it is necessary to develop a basic understanding of city growth dynamics. This must be conducted paying special attention to the past and current relation of the urban sprawl to the wetlands. For the latter, the SUWCP suggests low-cost and low-data approach to level-up the understanding of this matter. The first recommended step is to run a historic multi-temporal aerial photo interpretation analysis (from low-cost photographs sources), to identify qualitative and quantitative changes in the city, with special attention on the urban wetlands. This analysis must be assisted, which means that the process requires the visual inspection of the photographs and/or images. Then it must be complemented with

local knowledge and other sources of information from previous sub-steps to accurately profiling the wetland.

This method suggests that you draw a clear borderline for each wetland recognized from the oldest photograph (using Q-GIS or Arc-GIS) or satellite image available (using Google Earth). Then, continue to carefully repeat the same procedure for the following photograph/satellite images.

The end-result of the proposed methodology includes arrows, borderlines, colored areas where the wetland surface was lost (or recovered) through the years. This will create a basic overview that identifies critical changes in the urban fabric in its relation to wetlands (as will be shown later in the study case of the present research), hence contributing to a better understanding of current trends, threats and insight into how to avoid them. Additionally,

4) **What direct and indirect past, current or future threats do I recognize for the urban wetland conservation?**

Taking as base information land-use raster layer, protected area regional map and possible geographic scope resulted from previous sub-step a detailed review must be done to clearly identify the main threats that need to be tackled for the conservation of urban wetlands.

Method description

Once an initial understanding of the city dynamics is built, UWCP recommends that it is time to explicitly recognize the apparent (and perhaps self-evident) threats. This individualization of threats will be then incorporated into the Conservation situation model of the next step (The Conservation Measures Partnership, 2020). For this identification, it is suggested to do visual analysis of maps obtained in the previous sub-steps to discover and describe the threats. Some of the common threats for urban wetland in Chile as well as international are presented as follows: deforestation, overfishing, refilling, fragmentation, poaching, pollution, draining, among others as these are the most common threats for urban wetland in Chile (Ramsar Convention Secretariat, 2018; Rojas et al., 2018; WWT Consulting, 2018). This analysis may also include maps that reveal relevant visual ecological and infrastructural linkages between the city and the wetland (Sciaraffia et al., 2019). These direct threats must be scrutinized by clearly defined categories, as proposed in the Conservation Standards (CS) from CMP (2020) and *Plan de Acción* Ambiental (PAM) from FLC (2020), as well as prepare the Viability Assessment that will be addressed later on during the PLAN STEP of the SUWCP.. Adding three independent categories to the decision-making process to select which threats to set about first and how. Following the CS these three categories are: i) severity, ii) irreversibility and iii) urgency.

In consequence the sub-step 1D generates these results:

- List and map of potential conservation object (from question 1)
- List and map of wetlands types (from question 2)
- General wetland description (from question 2)
- Wetland surface evolution data, char and map (from question 3)
- List and map of threats per wetland (from question 4)
- List of wetland threats (from question 4)
- Map of the conservation object temporal evolution (e.g., filling and fragmentation) (from question 4)
- City-wetland ecological and infrastructural linkages map (from question 4)

Sub-step 1E: Understand current hydro-ecological status of urban wetlands

1) **<u>What are the urban wetland basic hydrologic features?</u>**

Evaluating outcomes from previous stages and understanding the hydrological situation will enable a practical description of the urban wetlands. The main data to consider is: i) Digital elevation model, ii) List of existing urban wetlands and iii) Map of the urban wetlands, all of them from previous steps.

Method description

In the conservation planning process of urban wetland (as in other ecosystems) it is necessary to develop a preliminary conceptualization of the study area, considering that you are situated in a data-poor context. The SUWCP understands this study area as a socio hydro-ecological system.

The drainage hierarchy obtained in previous sub-steps together with the vegetation and water indexes (e.g., NDMI, NDWI) and also with the field work. Ramsar classification and visual interpretation contribute to the building of a report conceptualizing the system (e.g., https://portal.geobon.org/).

2) **Which are the wetland system vegetational basic features?**

This step is devoted to build an estimation of the quantity, quality and development of the vegetation of the zone utilizing satellite images from Zhou et al. (2008).

Method description

To contribute to the understanding of the hydro-ecological status of the urban wetland system a quantitative but low-resource approach can include a simple Remote Sensing (RS) analysis to develop normalized indexes that provide initial information. Following the previously mentioned study "Integrated ecological assessment" proposed by Zhou et al. (2008), the vegetation recognition and bodies of waters can be summarized in the normalized indexes of vegetation (NDVI). All this allows to estimate the quantity, quality

and development of the vegetation based on the measures following the proposed methodology.

3) What is the currently identified biodiversity conservation state?

Up to this stage, it is essential to collect, organize and build a list of the biodiversity potentially involved in the conservation planning. To do this, information coming from scientific research and national/regional biodiversity reports, the input data could come from: i) Scientific papers related to national, regional or local biodiversity; ii) Environmental impact assessment with biodiversity description; iii) Environmental impact studies with biodiversity description; iv) Local flora and fauna field books; v) National, regional or local biodiversity conservation status.

Method description

With all the above-mentioned sub-steps, methods, questions, inputs and outputs, it is time to give special attention into the existing flora and fauna relying on the wetland system as habitat and provider of key resources. This analysis will provide valuable information for further prioritization of conservation the actions in SUCWP PLAN STEP that the conservation practitioners must harness in order to reach the desired outcomes as declared in the Conservation Standards (CMP, 2020). A proposed step-by-step process is presented below.

1. Define a geographic scope of the conservation planning.

2. Background review of: i) scientific papers related to the study area ii) Environmental impact assessment and studies.
3. Rating the conservation state of each listed species.
4. Develop a summarized chart with at least the following columns: Order, Family, Scientific name, Common name, Environment, Conservation State.

An example of this final deliverable is exhibited in the study case results of the present research.

Expected results are:

- Basic features of the wetland: Total area, shape, Maximum and mean depth, bathymetric map, nature of sediments (from question 1)

- Hydrology: Inflows, Outflows and Water level changes" (from question 1)

- Vegetation indexes maps (NDVI, NDWI) (from question 2)

- List of species of flora and fauna with their associated conservation status (from question 3)

Sub-step 1F: Map the urban wetland stakeholders

1) **Who might be the stakeholders that have a primary and secondary interest on the urban wetlands?**

Addressing this task implies gathering the information to know, identify and understand the social complexity of the work area, looking to include stakeholders early-on in every step of the planning (and execution) process. The stakeholders will then work to co-define the objectives for the BGI master plan, get involved in the urban wetland declaration by the local government, identify cultural values of the wetlands, work in the theory of change strategies, among many others . What could be considered for this is: i) Chile national cadaster of environmental NGO and ii) Public meeting minutes from government and non-government projects related to the city. This question (and the following) may be addressed aided by the "Framework for Adaptive Socio-hydrology" (FrASH) by Schifman et al. (2017a) that recognizes the city as a socioecological system and also blue-green infrastructure (Núñez-Regueiro et al., 2020).

Method description

As stated on the fourth version of the CS manual published 2020: "You should use your stakeholder analysis to select target audiences whose behavior you want to affect" (The Conservation Measures Partnership, 2020). Based on the principles stated by (Stoll-Kleemann, 2004), a participatory management approach is needed. The WET win decision support framework Johnston et al. (2013) acknowledges that the decision processes in the planning of wetland are subjective and driven by the needs and interests of particular

groups. Hence, an early recognition and engagement needs to be done. Later on, the stakeholders are involved in the construction of the conservation situation model[2].

In a socio hydro-ecological system it must be understood that their inhabitants/ urban dwellers/ authorities/ landowners, power institutions, decision-makers among others may (and must) be part of the planning process (FLC, 2020). This process will eventually enable access to potential resources, key informants, useful contacts, adherence, etc. Actions to be taken:

1. Create a list of stakeholders based on city official and non-official sources.
2. Desk research of social media accounts and webpages related to the city.
3. Complement the list by the direct interviews with key informants.
4. Run workshops for different wetland stakeholders at different administrative levels.
5. Find opportunities for engagement defining initial strategic partners to start the development of the conservation planning.

[2] The "conservation situation model" represents a Conservation Standards concept of cause-effect sentences.

Some initial questions recommended to organize the key stakeholders are:

- What is their primary interest?
- Who can they influence?
- What are the relations between these stakeholders?
- What is their hierarchical position?
- Are there past and/or current conflicts? ES and disservices main interest?

An example list of potential stakeholders in a Chilean city are presented below, based on the "Manual PAM" from FLC (2018). The potential stakeholders presented below include the Chilean common name in parentheses:

1. Neighborhood committees (JJVV).
2. Local government employees and authorities.
3. Regional government institutions related to environment (MMA), housing (MINVU: EP, SERVIU), Agriculture (MINAGRI: CONAF, SERNAPESCA) y Public constructions (MOP: DOP[3], DGA, DOH) (MMA, SERNATUR, CONAF, SERNAPESCA, MINVU, Superintendencia de Medio Ambiente).

[3] DOP: Dirección de obras portuarias

4. Environmental responsible from private companies' sector.

5. Local environmental, social and political leaders.

6. Scientists, wildlife photographers, artists, city council members, etc.

2) <u>Which could be your i) main organization, ii) major participants, iii) minor participants?</u>

SUWCP recommends starting with a list and influence map of potential key stakeholders (obtained in previous sub-steps) as a way to obtain an ordered and clearly defined potential level of key stakeholder commitments, visualized in a friendly manner with the aim of achieving a conservation and blue-green infrastructure (BGI) spatial plan.

Method description

Once the stakeholders are listed, mapped, characterized and described it is recommended to start a continuous engagement process with them. This engagement must be explicitly functional to the planning process. Thus, the SUWCP suggests following the "Framework for adaptive socio-hydrology method (FrASH)" proposed by the EPA in the Schifman et al. (2017).

This method looks for a structured approach towards working with a network of stakeholders that can enable a better decision-making process for planning and situating

BGI infrastructure installations in the city. Consequently, improving the generation of strategies and actions aligned with the final result of urban wetland planning conservation.

Use the Chambered Nautilus Visualization Model to classify Organization types, using the list and map created in previous sub-steps. The Nautilus chambered will be an internal visualization of stakeholders that will be updated periodically.

As part of this work, you will get the following outcomes:

- List of potential key stakeholders (from question 1)
- Influence map of key stakeholders (from question 1)
- Nautilus visualization chambers (from question 2)

Sub-step 1G: Proximity assessment to protected area for conservation (BGI)

1) **Are there any protected areas nearby? What are they protecting?**

With the proximity map from previous steps of the planning unit to the closest protected areas (e.g., http://areasprotegidas.mma.gob.cl/) you must identify potential connectivity zones and create steppingstones between areas.

Method description

On the one hand, due to the lack of insufficient information for the planning process, the SUWCP proposes the collection of relevant information from indirect sources, such as other conservation project nearby the geographic scope.

On the other hand, to develop a BGI spatial plan that connects with other relevant priorities and strategic conservation projects. A simple approach to identify these projects can be to look through a national map of conservation project. The latter can be complemented with private conservation projects maps from other resources. As a third and complementary option, a proximity assessment using GIS tools is presented below:

1. Find national or international raster layers that include public and/or private conservation project areas (recommended Chilean source: National Register of protected areas from MMA).

2. Identify the private or public areas protected in the study area (in city, district or regional level) for this you can review them in the National wetland cadaster (e.g. Inventario Nacional de Humedales 2020 available in: https://humedaleschile.mma.gob.cl/inventario-humadales/).

3. Once you have acknowledged these areas you can use the tool 'near' Q-GIS/ArcGIS to identify the AP closer to the defined study area.

2) <u>What potential opportunities do I recognize from the other protected areas that could benefit my UWCP?</u>

Analyzing the protected area regional map from previous steps should look for opportunities connecting with already existing protected areas to improve the planning process.

Method description

Once you have identified the closest private or public protected areas it is time to leverage on the potential opportunities for positive synergies in the conservation efforts. Some of the possible opportunities are listed below:

1. Recognize potential priorities for the Blue Green Infrastructure, like ecological corridors or corridors that can guarantee a habitat (Schifman et al., 2017).

2. Run a comparative analysis of endangered species to identify common ground and needs to build future partnerships and collaborations.

3. Build stronger teams and relations with other key stakeholders.

4. Assess the need for corridors to guarantee connectivity between blue-green areas (Kukkala & Moilanen, 2017).

5. Matching common interest and objective to find ways to improve future fundraising endeavors for the strategies and actions prioritized in the third Step (PLAN).

6. Collaborate in scientific research among common grounds fields that generate win-win benefits for everyone involved.

7. Obtain lessons learned from previous conservation experiences achievements and defeats.

8. Finally, complementary to the previous steps, RS analysis may be done for habitat suitability (https://appliedsciences.nasa.gov/) in nearby areas.

Finishing this stage will deliver:

- List of nearby protected areas (from question 1)
- Co-relations between the identified species in previous sub-steps and the species present in the protected areas (from question 1)
- Protected areas proximity of the region (from question 2)
- Written possible strategies to address the BGI opportunities (from question 2)

Sub-step 1H: Building the interdisciplinary conservation team

1) **What are the key professions, activists and conservation practitioners to build an interdisciplinary team to achieve the future conservation challenges?**

To fulfill this question requires all the maps generated by the Chambered Nautilus Visualization Model from the SUB-STEP 1F, then define a result-driven interdisciplinary conservation team that enables the planning and implementing process.

Method description

Comprise an initial project team following the Conservation Standards 1A (CMP, 2020). This team must meet the requirements of the planning and implementing process. Since conservation in urban environments demands different knowledges, an interdisciplinary team is suggested to maximize the chances to success. SUWCP suggests considering a team and board of directors/ advisors. Key profiles from both works could include the following:

- Environmental, cultural and social activists (e.g., NGO members, grassroot organization leaders, citizen committees leaders, etc)
- Gatekeepers to expert knowledge, such as academia, conservation scientists, research centers (e.g., landscape ecologist, RS and/or GIS trained experts, conservation scientists, hydrologist, engineers, environmental and conservation easement lawyers, landscape architects)
- Professionals closely connected to media and other relevant communication forms.
- Business professional that may bring links between the conservation actions and the private sector for funding.
- Conservation standards coaches or professionals.

- Public sector senior advisors.
- Experienced conservation practitioners from other projects and fields.
- Urban planners/ Architects and/or fields related to decision-making in the city planning with experience with BGI an/or ecological infrastructure planning.

It is also suggested to create a group of ad-honorem experts and advisors that will contribute to make informed decisions, enable networks and influence the strategic decisions.

2) **How can I fulfill the climate change considerations into the conservation team?**

With all the maps generated, the Nautilus model and climate change scenarios from the project team, evaluate and define the climate change considerations to be included.

Method description

Consider including one or more climate change specialist to support the planning and implementing process by the prospect effects of climate change scenarios over the geographic scope and conservation targets (CMP, 2020).

Expected results:

- Description of the project/program team (from question 1)

6.2.2.2 STEP 2: ASSESS

Following the basic CS proposal, this step defines a project scope and makes sense of the project context from the ARRIVAL step. Thus, creating a structured view of the conservation situation that will enable the whole planning. It has nine sub-steps to be performed, denominated with a code as follows:

- Define geographic scope for the conservation planning (SUB-STEP 2A)
- Study of the dynamics for the BGI (SUB-STEP 2B)
- Rapid assessment of wetland health (SUB-STEP 2C)
- Characterize the ES from each wetland and link them to key stakeholders (SUB-STEP 2D)
- Connect ES to human well-being targets (SUB-STEP 2E)
- Describing the direct and indirect threats (SUB-STEP 2F)
- Execute an additional study of social urban dynamics (SUB-STEP 2G)
- Assess the conservation situation (SUB-STEP 2H)
- Finding opportunities for BGI (SUB-STEP 2I)

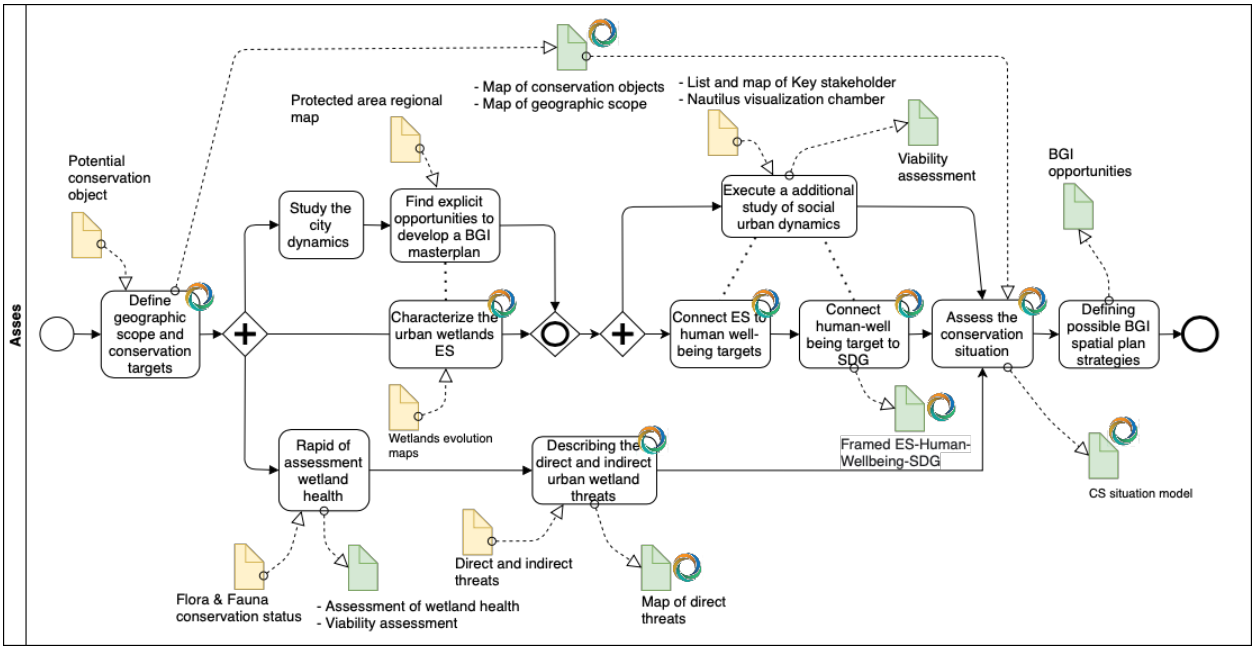

Figure 6.3 ASSESS STEP workflow
Source: Own elaboration (2020)

Sub-step 2A: Define geographic scope and conservation targets

1) **<u>What is the geographic scope for the conservation project?</u>**

After the ARRIVAL step is done, it is time to define a scope. Starting with the sub-catchment map resulted from ARRIVAL step, define a place-based scope for the conservation planning.

Method description

The SUWCP proposes a place-based scope initially defined by the administrative city limits and then potentially expanded by the hydro-spatial analysis (SUB-STEP 1B), city-region considerations (SUB-STEP 1D) and hydro-ecological assessment (SUB-STEP

1E) carried out in previous steps. This geographic scope must be represented in a clear map that should be then socialized with stakeholders and other audiences. This geographic definition should also benefit as an input for stakeholders that are interested in supporting and moving forward the application of the Urban Wetland Law 21.202. The application of the law considers that municipalities can request the Chilean Environmental Ministry to officially declare a wetland as an "Urban Wetland".

Besides, as the CS defines "climate change views must be taken into account" then would be required to figure it out if the ecosystems or species ranges are likely to shift (latitudinally or altitudinally) or the distribution of species within an ecosystem is likely to change. If this is the case, you will probably need to increase the size of your project scope. Since, climate change scenarios may be complex science-based analysis SUWCP recommends acquiring them from other relevant studies done by prestigious public or private institutions (e.g., ministries, research centers, land-use plans) also interested in the geographic scope defined. Finally, the above-mentioned considerations should specially influence the pursuit of BGI opportunities for the spatial master plan (SUB-STEP 2I) incorporating resilience planning to better confront the detected potential dynamic phenomena from the foreseen scenarios. This may be tackled activating landscape features in order to give a cost-efficient response extreme events (e.g., increasing the water harvesting volume capacity of an urban wetland to diminish residential flooding). An example of this strategy can be seen in ANNEX I.

2) **What will the limited conservation targets be?**

Having the place-based scope for the conservation planning already defined, now it is needed to define the wetlands that you are going to protect as a group of conservation objects.

Method description

As was previously defined in the ARRIVAL STEP, conservation targets must be clearly defined. For the case of the SUWCP, the suggested conservation target should be the identified urban wetlands or some of them clustered in groups, such as, the riverine wetlands, the palustrine wetlands, etc. The ARRIVAL STEP deliverables provided critical spatial information from the temporal evolution analysis (SUB-STEP 1D) as well as the current state (SUB-STEP 1E) should contribute to this definition. Before a final decision is made, the potential conservation target should be visited on site. During this field visit attention should be paid to the threats. Concluding this revision, the result would be:

- Geographic scope map (from question 1)
- Conservation target map (from question 2)

Sub-step 2B: Study of the city dynamics for the BGI

1) **What is the current and planned city land-use? What have been the LULC dynamics?**

It is interesting to note from multi-temporal images and city spatial planning instruments how the city has evolved and the impact that has generated in the conservation object defined in (SUB-STEP 2A). The required information could come from different possible sources like:

- Spatial planning instruments from the city (e.g., https://www.observatoriourbano.cl/)
- Satellite Images and aerial photography from Chilean Aerophotogrametric Service.
- Global/ national/regional and local satellite information such as NASA (USGS and Google Earth, ArcGIS online app, .

Method description

To progress in the pursuit of the understanding of the basic dynamics in which the urban wetlands -defined as the conservation targets in SUB-STEP 2A- are located, it is recommended to study land-use to find opportunities. In Chile, land-uses and urban zones are defined by Communal Land Use Plan, or Intercommunal Land Use Plan. This information must be contrasted with field work across the city.

Despite having an active spatial plan, it is necessary to empirically review what is the real situation in the city itself. For that, simple activities such as field work and/or Google Earth satellite images visual inspection from a bird's-eye view should reveal what are the

actual differences (e.g., wetland borders might be considered as a green space in the spatial plan but, once in site, it might be found to be in use for other purposes). Also, analyzing the critical temporal changes in LULC might trends that derive in current or potential threats and opportunities for the conservation of the urban wetlands (Grêt-Regamey et al., 2017). For this, a combination of false colors and supervised classification from multispectral satellite images such as the one used in Carolina Rojas et al. (2018) is recommended. This analysis of land-use trends can also be aided by the previously obtained maps of normalized indexes (Zhou et al., 2008) and city photographs. Examples of possible finding may be refilling of wetlands, unplanned threatening construction projects, wetland fragmentation, vacant lots with potential for wetland conservation ecological and/or hydrologic connectivity areas. Potential products of the above-mentioned analysis might be clear maps comparing current planned land-use compared to actual land-use and also LULC change map based on common categories (e.g., waterscapes, native forest, urban area, agriculture, wastelands, saturated/ wetland).

2) **How do these city dynamics offer opportunities for the BGI spatial plan as a strategy for urban wetland conservation?**

The intent is to find explicit opportunities to develop a BGI masterplan, grounded on: i) list of critical differences between current land-use and valid city spatial planning, and ii) Map of differences resulted from question 1.

Method description

Now that you have a big picture of the city dynamics from ARRIVAL STEP complemented with the land-use analysis from previous sub-step, then BGI opportunities can be looked for. Following some of the suggested next actions:

1. Classify the different LULC as the category of risk for the urban wetland and/or upgrades of the current wetland status.

4. Identify habitat suitability/ viability (e.g., Habitat Viability in Esri ArcGIS; https://appliedsciences.nasa.gov/)

2. List the explicit opportunities that the critical differences between the regulated plan use and the current empirical land-use offer for the development of a BGI plan (e.g., planned restricted or protected land-use in the city that have not yet been materialized in urban infrastructure and might be addressed as urban blue-green infrastructure).

3. Identify large elements (e.g., linear, non-linear) of the city that may act as nodes, corridors and/or areas for blue-green infrastructure interventions (Moreno, 2019).

4. Identify critical pressures and needs for wetland restoration based on outputs from the SUB-STEP 1D, SUB-STEP 2C and 2E. This analysis may also be assisted cross-checking the recognized pressures and restoration needs by the (Wantzen et al., 2019).

5. Split the components of the city in layers (landscape planning units). Example of spatial layers for analysis are presented below (they can be developed in a GIS software (e.g., Feng et al., 2011) or simply in an analog system):

    a. Urban fabric, urban border and wetland border polygons based in SUB-STEP 1A, 1C and 1D.

    b. Infrastructure and housing polygons.

    c. City waterscape polygons.

    d. Water inputs and outputs to each wetland recognized in SUB-STEP 1D.

    e. Ecological areas (Trees, rivers and other flora and fauna patches polygon (complemented from flora and fauna outcome from SUB-STEP 1F).

    f. Maps of soil (and soil quality) for infiltration, accumulation, presence/absence of nutrients, etc (aided by SUB-STEP 2C).

6. Generate a map that shows the potentiality of this BGI possible interventions to the enhancement of the relation between the city and its wetlands.

Concluding the city dynamic evaluation would get the following:

- List of critical differences between current land-use and valid city spatial planning (from question 1)

- Map of differences (from question 1)
- Map of the spatialized opportunities (from question 2)
- List of opportunities (from question 2)

Sub-step 2C: Rapid assessment wetland health method

What is the current health of the urban wetlands?

Having the list of existing urban wetlands and the captures from field observation, enables you to create a general overview of the urgency and irreversibility of the urban wetland ecosystems health as started in SUB-STEP 1E.

Method description

Build an ecosystem health report, such as the Rapid Assessment of Biodiversity (Ramsar Convention Secretariat, 2012) (available at: https://www.conservation.org/projects/rapid-assessment-program). As stated in the *"Guidelines for the rapid ecological assessment of biodiversity in inland water, coastal and marine areas":* This health report should involve a collection and analysis of qualitative and/or quantitative information on the occurrence of various kinds of organisms in a defined area or habitat of interest, by actual field surveys." (CBD, 2008).

This assessment can continue as one of the following types:

- Baseline assessment - Baseline inventory - prioritization; conservation; identification
- Species-specific assessment - Conservation of specific species; status of alien species
- Change assessment - Change detection
- Indicator assessment - Overall ecosystem health or condition; and
- Resource assessment - Sustainable use of biological resources

This information may contribute to the recognition of the general ecological health of the landscape related with urban wetlands.

Concluding this assessment, the following deliverables are obtained:

- Wetland Rapid Ramsar Assessment Biodiversity
- General conclusions about the NDVI, NDWI and NDMI maps produced in ARRIVAL STEP
- Health Viability Assessment (e.g., NASA ARSET Conservation)

Sub-step 2D: Characterize the ES from each wetland and link them to key stakeholders

1) **What are the current ecosystem services that the wetlands provide?**

Based on TESSA ES Assessment and ES Maps from TESSA tools[4] (available at: http://tessa.tools) qualitative and/or quantitative information of the ecosystem services could be obtained.

Method description

To develop a participatory planning process, it is important to start working from the map and basic features of the wetlands systems as recognized firstly in the ARRIVAL STEP. Now is the right moment to explicitly define (and hopefully quantify) the ES supply and demand. It is relevant to consider that in data-poor context an ES information may be precarious. Thus, SWUCP suggests that a first approach must be done by the qualitative description made in previous steps. The use of TESSA Toolkit for Ecosystem Service Site-Based Assessment could be a useful aid (available at: conservation.org/projects/rapid-assessment-program). These tools serve low-data context with a systematic approach to quantitatively or qualitatively assess ecosystem service.

Once these first two actions are accomplished it may be supported by modelling and mapping tools (e.g., InVEST modelling). To assist the selection of the specific tool for the ES mapping the ValuES Project tool (http://aboutvalues.net/) is recommended.

[4] Toolkit for Ecosystem Service Site-based Assessment (TESSA). Version 2.0 Cambridge, UK

Furthermore, ES social perceptions will later improve later improve the stakeholder engagement strategies in the action plan (e.g., O. Rojas et al., 2017; Vichuquén interviewee social).This analysis will support the definition of the BGI masterplan, prioritization, fundraising and negotiation with stakeholders.

2) **Who benefits from this ES?**

To explicit identify who benefits from the ES in order to develop good conservation strategies and actions, SUWCP suggests utilizing the Wetland maps (SUB-STEP 1A, 1B, 1F, 2A) and the List of ecosystem services (SUB-STEP 1A) together with the detailed Ramsar list of ecosystem services that wetlands provide (Ramsar Convention Secretariat, 2012). The ES can then be processed linking them to human well-being targets. SUWCP recommends "Ecosystems and human well-being: wetlands and water" MEA (2005). This report was developed by the Millennium Ecosystem Assessment in collaboration with the Ramsar Convention. This is the base data to identify the different stakeholder groups that receive human-well being benefits from the demand of ES out of the urban wetland system, then characterize the benefits that each wetland provides to neighbors and urban dwellers.

Method description

By characterization of the benefits that each wetland provides to the key stakeholders such as neighbors, local private sector and other urban dwellers. For the sake of developing a participatory conservation planning it is important to explicitly recognize who is actually

receiving the wetland ecosystem services and disservices. This could be performed following to next actions:

1. Develop an initial guess of the ES that each urban wetland is providing and who could be the beneficiary.

2. Link the ES to human-wellbeing (Millennium Ecosystem Assessment, 2005a; The Conservation Measures Partnership, 2020).

3. Spatial analysis using a GIS software such as ArcGIS or Q-GIS. Run a proximity or buffer analysis to map a walkable distance (e.g., 900 [m]).

4. Run a series of workshops or participatory cartographies with the urban dwellers of the city to clearly identify who are receiving the ES and what services are they receiving (FLC, 2018).

5. Characterize benefits of each wetland ES (e.g., (Namaalwa et al., 2013)).

6. Synthesize the results via visualizing the ES, human-wellbeing, beneficiary groups.

The outcome of this work will be:

- Raster layer for each prioritized UES (from question 1)

- Nautilus chamber visualizing ecosystem services and the groups that receive them (from question 2)

- Theory of change including the ES and human-wellbeing targets (from question 2)

- Map of proximity to wetlands (from question 2)

Sub-step 2E: Connect ES to human-wellbeing targets

1) **<u>What are the current human well-being targets that the wetlands provide?</u>**

Given the data obtained from previous activities, establish the relations and enable a direct linkage between conservation targets, ES and human well-being targets is required.

Method description

Since wetlands deliver a wide range of ES, it is recommended to explicitly link their ES to human well-being targets. These may be argued through practical purposes such as: increase the influence over the decision makers, broaden the fundraising opportunities, increase stakeholder engagement. Conservation practitioner face negotiations where the conservation effort must be judged against other funding needs. Hence, ES enable a direct transformation from nature to clear cut human benefits.

Some relevant human well-being targets are: livelihoods, social cohesion, security, health and social development (governance). SUWCP suggests the review of *"Ecosystems and*

human-wellbeing: wetlands and water" from Millennium Ecosystem Assessment (2005) to guide the linkages study between ES and human well-being.

The conservation target-ES-human well-being target linkage will provide some of the critical information needed for the fundraising via grants (e.g., "FPA Conservación de Humedales Urbanos", CORFO "Reto de innovación", CONAF "Ko-una-yaku" Monitoreo de Humedales). Other wetland grant examples are listed in Annex D. (Other funding sources: services provision, donations, local government financial aid, family philanthropy). Also, studies such as *"Gobernanza y financiamiento para la protección y conservación eectiva y sostenible de los humedales en Chile"* (Jarpa, 2016) and environmental compensations to urban wetlands as "maintenance of terrestrial patches" in the wetland borders.

2) **<u>What are the current SDG</u>[5] <u>accomplished when the human-wellbeing targets are tackled?</u>**

Having fulfilled the match between human well-being and ES, now is possible to directly link human well-being targets and Sustainable Development Goals (SDG) 2030.

Method description

[5] Sustainable Development Goals 2030

It is also recommended to connect the conservation targets, human well-being targets and ES with the SDG. This will open up opportunities with private sector and international grants. As an example, in Chile there are platforms that present industries linked to SDG (e.g., http://www.accionempresas.cl; http://www.pactoglobal.cl).

Comply these actions will provide:

- CS Situation model draft (from question 1)
- Critical information for funding pitch, presentations and applying for grants (from question 2)
- Framed ES-Human-wellbeing-SDG linkages (from question 2)

Sub-step 2F: Describing the direct and indirect threats

What are the current critical direct and indirect threats to the urban wetlands?

From the conservation threats classification, is possible to take the Framed ES-Human-wellbeing SDG linkages and Conservation situation model draft to adequately understand the direct threats and the drivers of these threats. The threats (or threatening activities), as stated in the Ramsar handbooks 4th edition: Impact Assessment, "can vary in scale, magnitude and seriousness and can be actual or perceived" (Ramsar Convention Secretariat, 2010a). In identifying the threats, focus on the components, processes, benefits and services that most strongly influence the ecological character of your wetland.

Method description

At this point, it is recommended to extensively describe and define the causes and effects of the threats. These threats, as presented in the ARRIVAL STEP, were recognized by different analysis including satellite images (SUB-STEP 1D), detecting implicit threats through the understanding of city dynamics (SUB-STEP 2B) focused on the city-wetland relation. This study must also be complemented by the Rapid Assessment produced in previous sub-steps (SUB-STEP 2C). Finally, direct engagement with stakeholders (city dwellers, local authorities, among others) and expert opinions will contribute to generate a wider and deeper understanding of the cause-effects (if-then statements). Having created these relations, a conservation situation model will be obtained.

Sub-step 2G: Execute an additional study of social urban dynamics

What complementary social information could benefit the conservation planning?

Starting with the gathered information from ARRIVAL STEP such as, interviews, focus groups, informal conversations and other interactions with potential stakeholders. The SUWCP suggests a deeper look for relevant information that could expand the social comprehension of the city and their inhabitants, thus enhancing the conservation planning.

Method description

As a complementary approach for the enhancement of the "conservation situation", a social dynamics and perceptions study is proposed. This study aims to deepen the

understanding of the social dynamics of the people that will be potentially affected by the outcomes of the conservation actions. Consequently, by improving the decision-making process related to behavior change strategies that will be later defined for the Theory of Change in the PLAN STEP. These knowledge gaps need social research and could be based on qualitative methods like interviews and focus groups. Some of the topics suggested by FLC (2018) manual for the social interactions are:

- Describe the main economic activities
- Diver past relations with the wetlands
- Social and political conflicts between stakeholders
- Local identity and territory history
- Recognition of urban environmental threats
- Natural and cultural heritage
- Beliefs and behaviors

Achieving this would contribute the conservation planning process matching deliverables such as “Complementary social report” from “PAM: Plan de Acción Medioambiental” from FLC (2018), the Social perception study from Rojas et al (2017) and Vichuquén “Strategic Perecption Diagnose” done after the algae bloom crisis in 2015 (obtained from interview).

Sub-step 2H: Assess the conservation situation

What does your CS conservation situation model looks like?

Bear in mind the data obtained in the previous activities will orientate the building of the CS situation model for the conservation of the urban wetland (CS conservation situation model). Assembling will bring a logical (cause-effect), systematized document widely recognized by conservation practitioners all around the world familiar with the Conservation Standards for the Wildlife Conservation.

Method description

Now that all the previous analysis has been done, generate a technical document to effectively create a "Conservation situation model" as proposed in the CS manual (Barlow et al., 2017; CMP, 2013) is required. The building of the Conservation situation must include:

- geographic scope (SUB-STEP 1A, 2A)
- vision (SUB-STEP 1A, 2D)
- conservation targets (SUB-STEP 1B, 1D,1F)
- direct threats (SUB-STEP 2C, 1D,1F)
- indirect threats (SUB-STEP 2C, 1D,1F)
- ecosystem services (SUB-STEP 2E)
- human-wellbeing targets (SUB-STEP 2F)

Getting to this point will bring the:

- CS Conservation situation model

Sub-step 2I: Finding opportunities BGI

1) **<u>Which are the urban landscape components of the study that may be considered for the future BGI masterplan?</u>**

As a general purpose, SUWCP strategically recommends that in order to be effective in the urban wetland conservation the actions must be embedded into a macro plan that benefits not just the wetlands in particular but the city in general. Thus, the BGI masterplan should create background information recognizing the different components of the city with which it is able plan the different nature-based solutions. To identify these landscape components some of the results needed from previous steps are:

- Wetland sub-catchment map (SUB-STEP 1B)
- Land-use analysis map (SUB-STEP 1D, 2B)
- Conservation objects map (SUB-STEP 2A)
- Wetland maps (SUB-STEP 2D)
- ES Maps (SUB-STEP 2D)

Method description

To prepare the background information for the future planning of the BGI masterplan (in the PLAN STEP) it is recommended to recognize some of the following:

- Run a visual spatial analysis of the maps generated from (SUB-STEP 1B, 1D, 2A, 2B and 2D) to identify linear (e.g., train railway, bike lanes, electrical transmission lines, urban trees in streets and avenues, among other) and non-linear (e.g., parks, plazas, wetlands) components of the urban ecological landscape (Riveros, 2018).

- Identify, understand and describe the current urban-ecological gradient, limits the elements previously recognized, edge effect occurring in the wetland-city relation, etc (Picon et al., 2007).

- Analyze the connectivity and fragmentation of the conservation objects and other components of the urban ecological landscape to better understand the spatial patterns and challenges ahead. For this analysis, SUWCP suggest some tools such as Conefor and Corridor Designer (GIS open-source software extension for connectivity analysis). Also there are plenty of published articles addressing landscape and urban areas connectivity (e.g., Kukkala & Moilanen (2017); Nor et al., (2017); Zhou et al. (2008)).

2) **<u>What are the main opportunities for a BGI spatial plan development based on this urban landscape components?</u>**

Since SUWCP is based on the Conservation Standards, the recognition of the main opportunities must be tackled and guided by the direct and indirect threats to the urban wetlands obtained in SUB-STEP 2F, 2G and 2H. Also, it must be coherent with the ES and human well-being targets from SUB-STEP 2D and 2E.

Method description

Once the landscape components have been identified, the SUWCP suggests it is time to assess, select and prioritize the BGI opportunities to start building the masterplan that at the same time achieves a better city and achieves the most important conservation outcomes. To address the exploration of these main opportunities at a city-landscape level, there are methods such as "Restoration Opportunities Assessment Methodology" (ROAM) published IUCN (Maginnis et al., 2014), Integrated ecological assessment of biophysical wetland habitat in water catchments: linking hydro-ecological modelling with geo-information techniques by Zhou et al. (2008), "Green corridors potential assessing linear landscape components" (Riveros, 2018), Ecological mosaic (Picon et al., 2007). These, among other, offer a combination of quantitative and / or qualitative way to assess opportunities that identify the key ecological and hydrological functions (e.g., water depuration, storing, groundwater recharge) together with the ES that this components may offer. This methods may include visual inspection of current and old maps, expert knowledge, monte carlo simulation with ES and BD cost-benefit embedded analysis, structured spatial conservation analysis (e.g., landscape ecological metrics for

interconnectivity, fragmentation, among other) based on free or low-cost opensource GIS tools (e.g., Zonation, Marxan, InVEST).

In the above-mentioned analysis, is important to consider that probably the linear urban landscape components may serve as corridors for connectivity improvements and the non-linear components -that will serve as nodes in the blue-green network- should include the conservation objects defined in SUB-STEP 1B, 1D,1F are structured in the "CS Conservation situation model" obtained in SUB-STEP 2H. Also, based on question 1 from the SUB-STEP 2I (current sub-step), it is necessary to understand which of the recognized components are not actually serving ecological functions and what would they need to become active components of an ecological plan that serves urban wetland conservation. Just as an example, if one of the main threat of a Conservation object (constructed in SUB-STEP 2H) is the rapid illegal refilling from the ecological borders inwards disconnecting critical areas for the mammal (e.g., Myocastor coypus) movement, a possible BGI opportunity BGI could be the creation of multiple green corridors connecting the fragmented areas that secure water flow and at the same time enables the animal movement.

In view of the fact the SUWCP focuses on spatial conservation, there is a direct need to convert the conservation actions and requirements into a future master plan that the urban dwellers, city council and urban planners understand and support socially, technically, politically and financially. Ergo, it is suggested to identify the most important

opportunities for later development the plan during the STEP PLAN, addressing at the scale of city, neighborhood and house. These opportunities should holistically include hydrologic functions that could also enhance ES. This enhancement of ES should guarantee the conservation of biodiversity. At the same time, these opportunities should be recognized and addressed towards social concerns and behaviors described in previous steps. An example of these opportunities is presented in the study case developed for Llanquihue city.

Outcomes:

- Urban ecological landscape components
- Enhanced/improved spatial opportunities for the BGI plan

6.2.2.3 STEP 3: PLAN

Finally, the third step of the conservation planning follows the CS Plan building a "(…)series of if-then statements hypothesis about the impacts of each conservation action" (Schwartz et al., 2018) to tackle the CS conservation situation model produced in the ASSESS STEP. This model integrates a BGI view for the planning process. It has six sub-steps to be performed, denominated with a code as follows:

- Understanding ES community (SUB-STEP 3A)
- Relation with stakeholders (SUB-STEP 3B)
- Creating a citizen commission (SUB-STEP 3C)

- Drafting a community desired state (SUB-STEP 3D)
- BGI master plan (SUB-STEP 3E)
- Developing the Theory of Change (SUB-STEP 3F)

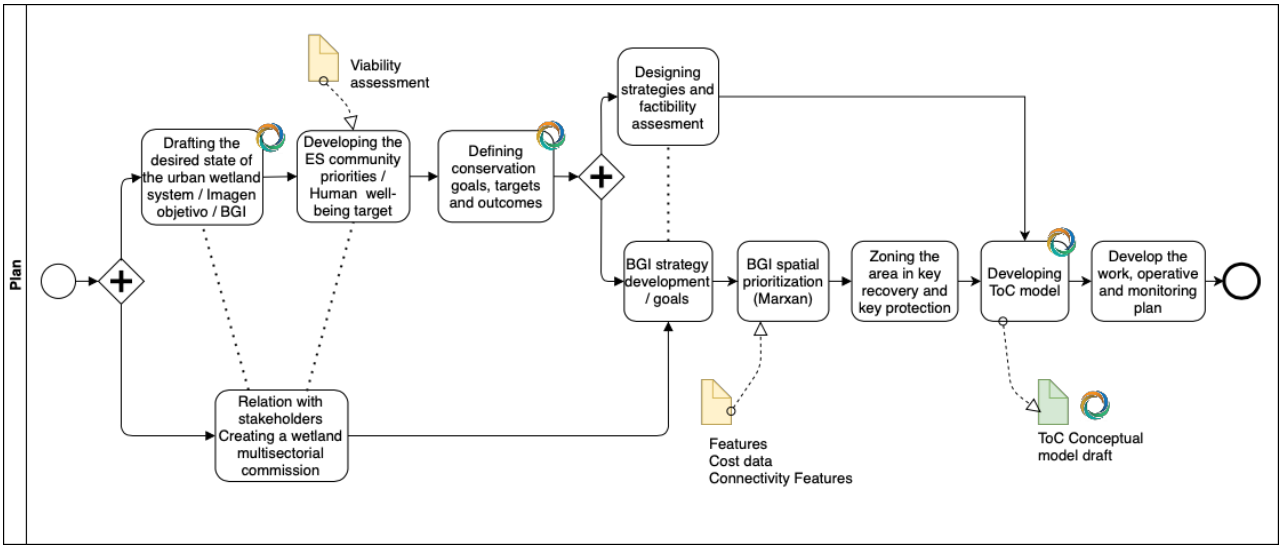

Figure 6.4 PLAN STEP workflow

Source: Own elaboration (2020)

Sub-step 3A: Understanding ES community interests

1) **<u>What are the most relevant ES recognized by the community?</u>**

Having understood the ES and stakeholder's association, is now necessary to recognize what are the community most urgent and relevant needs for the prioritization of the different ES provided by the different wetlands. To accomplish this information from previous steps would be necessary:

- Stakeholder lists (SUB-STEP 1F, 2G)

- Nautilus chambered visualization of stakeholders (SUB-STEP 2D)
- Stakeholder maps and ES mapping (SUB-STEP 1A, 1G, 2D)
- CS Conservation situation model (SUB-STEP 2H)

Method description

Since the city is understood as a socio-ecological system, there is a need to include a social dimension of the conservation planning process. Therefore, the ES priorities must be settled recognizing the diverse community priorities. Since stakeholders may differ in interests, locations, cultural background, religion, worldviews, among others it is suggested to:

1. Run a series of stakeholder activities about envisioning the city future and their relation to the wetlands to ensure every voice is considered and pondered. These outcomes can be met by methods such as a workshop, participatory cartographies, surveys, focus groups, etc. Part of these results must be complementary to the ones obtained in previous steps.
2. Visually display the community priorities to show different stakeholder perspectives.
3. Run a trade-off analysis (quantitatively or qualitatively depending on the available data and resources) to explicitly tackle the differences among groups of stakeholders. This trade-off analysis may be approached via multi-criteria analysis, biophysical modelling that connects with social value, economic value,

among others. These recommendations are mentioned in the WETwin research paper *"A structured approach to evaluating wetland management options"* by Johnston et al. (2012).

4. Prepare a report of the community interests in the protection of the urban wetland in order to prepare a public requirement to the local government to initiate a "urban wetland" declaration process with the Environmental Ministry and prepare a social road map to consider: i) The mapping and other relevant information for the declaration process; ii) Get actively involved in the elaboration of the urban wetland conservation municipal ordinance; iii) Safeguard the correct implementation of the stated point in the ordinance (e.g., getting involved in the monitoring, restoration actions, education projects, updating of the CS ToC as an iterative, looking for funding for small BGI interventions, etc)

2) <u>What is the link of the ES with the SDG?</u>

Using SDG list, ES list and ES maps from previous steps, review and find the matches to enable a direct link between ES and SDG for practical purposes.

Method description

Urban conservation is a social endeavor that necessarily involves changes in human behaviors, community-based socio-ecological restoration and monitoring, scientific research, political agreements, landscape management, environmental education, among others. As such, fundraising to achieve the desired conservation goals will benefit by

recognizing that the implementation of the conservation planning addresses human-wellbeing targets. Nationally and internationally the SDG from the 2030 Agenda[6] has been widely recognized, thus the planning of programs and projects for the urban wetland conservation should directly inform what of the SDG aims to contribute. Including:

- Direct link between the ES, human well-being and the SDG (SUB-STEP 2E, 2D)
- In subsequent steps (SUB-STEP 3F), when the Theory of Change (ToC) is drafted, the work packages should be tagged with the most relevant SDG being directly tackled.

As a result of this understanding, the products would be:

- List of ES prioritized by the communities (from question 1)
- Biophysical modelling analysis (from question 1)
- Scenarios (from question 1)
- List of prioritized ES linked with SDG (from question 2)
- SDG derived from the prioritized ES (from question 2)
- Potential grants connected to the SDG objectives (from question 2)

[6] UN initiative for Sustainable Development

Sub-step 3B: Building stakeholder engagement for the BGI spatial plan

What are the stakeholders expecting from the urban wetland practitioner? What do they need? Is there any organization redundancy?

During the first two STEPS of the SUWCP, relevant social data has been collected. This data has come from interview notes in field visits, meetings with local people participatory cartography, prioritizing ES. It is now time to continue structuring the stakeholders roles and responsibilities. There is an opportunity to start the building of relations with the local government, organized civil society, companies, academia and the urban inhabitants.

Method description

Communicate the UWCP interests publicly and specifically to each of the relations stated above and taking specific actions like the followings:

- Empower the community with information related to conservation, urban ecosystem services, environmental problems inside the city, participatory activities, etc (e.g., there are tools such as the Chilean Wetland Toolkit developed by Bergamini et al. (2020) *"Guía práctica para el conocimiento de humedales e identificación de conductas denunciables"* that explicitly empowers people with basic information such as wetland definitions, who to call to report contamination, etc).

- Meet and persuade authorities on the values of ecosystem services and the BGI strategies.
- Lead up stakeholder partnerships for grant applying to national and international funding.
- Start creating exploratory meetings to start potential agreements with companies and other stakeholders that can threat wetlands.
- Communicate and coordinate the academia to collaborate in the collection and analyze of the critical information that could directly contribute to the decision-making process of the UWCP in a data-poor context.
- Review, understand and include objectives from national and regional institutions as key stakeholders for the planning process.
- Inform, present and discuss relevant information and results to local, regional and national institutions as stakeholders. As an example, some institutions are presented below:

    - Local government: City major, City council, Planning secretary (Chilean name: SECPLAN), Communal Development Department (Chilean name: DIDECO), Environmental Department.

    - Regional Government: Environmental and Housing ministry (Chilean name: SEREMI Medio Ambiente, MINVU).

Succeeding in this relation task, the following deliverables should be issued:

- Advanced stakeholder characterization, map and list.

- Chambered Nautilus Visualization of different stakeholder groups.

- Successful stakeholder meetings related to BGI planning and ES.

Sub-step 3C: Creating a citizen commission

1) **<u>What is the stakeholder engagement strategy to build the conservation planning? How could you improve the stakeholder engagement?</u>**

There is a need to find ways to develop and/or improve stakeholder engagement and also positive relations between different groups of interest. Taking advantage of information generated from previous steps like the list of potential stakeholders (from SUB-STEP 1F), the influence map of stakeholders (from SUB-STEP 1F) and the list of ES linked with human-wellbeing and SDG targets (from SUB-STEP 2E).

Method description

Stakeholder engagement plays a key role in the conservation planning process. Thus, specific and conscious efforts must be made to foster engagement among every step of the conservation planning process. Actions should contemplate:

1. Develop an audience that wants to be informed about the conservation planning process.

2. Visualize the positive relations that each stakeholder has with the urban wetlands.

3. Involve the stakeholders in the decision-making process through consultations (e.g., workshops, focus groups, participatory cartography, individual discussion, etc.).

These recommendations are mentioned in the WETwin: A structured approach to evaluating wetland management options by Johnston et al. (2012).

2) <u>What common interest do all the previously recognized stakeholders share?</u>

To address this question, it is relevant to identify the common ground of the multiple stakeholders in order to promote present and future collaboration and agreements. To attend this, use all the material gathered from former interviews, talks, deliverables, etc.:

- Notes from previous participatory activities
- Conservation situation model
- CS Theory of change
- Nautilus chambered visualization groups

Method description

To develop an articulated spatial plan for BGI along with other conservation strategies, common ground must be built among the subjective interests of the stakeholder groups.

1. Evaluate common interests among the urban wetland declared and non-declared ES and human-wellbeing targets.
2. Hold individual discussion with representatives of different stakeholder groups themed around the established conservation priorities.
3. Identify key elements in the declared vision of the city.
4. Prioritize projects related to industries in which the benefits of the outcomes will be perceived by multiple stakeholder groups.

These recommendations are mentioned in the WETwin by Johnston et al. (2012).

3) **What is your initial proposal to present to them?**

Taking into consideration the CS conservation situation model (obtained as an important outcome from SUB-STEP 2H) it would be required to clearly define an initial message and dream to open up the dialogue.

Method description

The approach to the stakeholders must be with a simple and clear message and desire.

The final outcomes for this SUB-STEP would be:

- Multisectoral commission created (from question 1 and 2)

Sub-step 3D: Drafting a community desired state

1) **<u>What is the collective vision that the stakeholders hold as a whole?</u>**

Achieve a draft of a written vision of the desired state of the urban wetland system of the city that will be accomplished through the conservation planning and implementation. The base information to consider are the conservation objects map and the conservation situation (from SUB-STEP 2H).

Method description

Following the CS Manual CMP (2020) and the working paper "Planning and management of conservation projects in urban ecosystems" by FLC (2018), a vision must be collectively drafted. This by the multi-sectorial commission. Then, recognize the Lone Rangers, Situated GI, The Collective, Specialized (Schifman et al., 2017).

2) **<u>What do they see for each Conservation Object selected?</u>**

With the understanding up to this point develop a clear collective vision of the Conservation Objects desired future state.

Method description

Detail the collective vision drafted in previous step to be specific about the conservation object. This vision must include presence of species, area, SMART objectives, coverage and urban design.

Final result would be:

- Written desired state of the urban wetland of the city (from question 1 and 2).

Sub-step 3E: BGI master plan

What are the objective, goals and actions lines for the BGI masterplan? What is my zonification?

Finally, the SUWCP proposes the development of the BGI masterplan. This plan is the call-to-action for the conservation team and the community. This will enable the key stakeholders (identified in SUB-STEP 1F and 2E) to be involved in the mapping and executing of BGI elements at different scales (property, streetscape, neighbourhood and city).

Method description

Starting from the BGI opportunities defined in SUB-STEP 2I**,** the development of the plan will look forward to the creation of a masterplan following the SUB-STEP 3C and 3D responding to the community desired state. The development of the BGI master plan looks for the creation the network through a blue-green urban matrix recognizing nodes (nucleus) for key ecological values, ecological corridors (lineal corridors, stepping stones and landscape or territorial corridors), buffer zones among other multifunctional elements (e.g., The Spanish local Government "Infrastructure for green municipality" (Rull et al., 2020)*)*.

Also, since the conservation of urban wetland is in direct relation with the flow regimes and quality of water, SUWCP proposes that the BGI master plan should holistically

respond to the main current threats (identified in SUB-STEP 2F) to the urban wetlands - that may be tackled through urban planning and design. One of the sources for this water pollution is the "first flush" of the street contaminates related to the urban runoff. SUWCP recommends that the BGI planning manages the stormwater runoff events in a way that benefits urban wetland conservation and enhances the wetland ES. For this purpose, conservation practitioner may plan BGI strategies at different scales (e.g., individual houses, neighbourhood, city). Due to the Chilean administrative fragmentation for stormwater management, diversifying the funding sources and key stakeholders involved in the planning process is recommended. A helpful example of a handbook, to specifically assist BGI planning and designing to manage stormwater in tempered climate from southern Chilean cities, are the "Guidelines for the Sustainable Urban Drainage" (original name "Guía Drenaje Urbano Sostenible") developed by Patagua firm (https://www.patagua.cl/) in collaboration with academic partners[7]. These guidelines answer the question "What is the better use of the runoff stormwater?" and were developed to empower planners, modellers, decision and policy makers to design stormwater plans that incorporate BGI strategies. Another useful example may be the *"Strategic Planning*

[7] These recently launched guidelines were accomplished through collaboration with "Pontificia Uninversidad Católica de Chile", specifically with the Hydraulic and Environmental Engineering Department and the Landscape Master Program from the Architecture Faculty.

cycle of spatial allocation of LID-BMP-GI practices" from Zhang & Chui (2018) that suggests some of the following steps:

1. Targeted areas identification
2. Objectives determination
3. Pre-assessment (Type selection, Design & sizing of individual practice and Local determination)
4. Post-evaluation
5. Optimal strategy defined

The results of this evaluation are:

- Strategic zonification plan for the BGI
- Specific BGI strategies for stormwater runoff management
- Stakeholder responsibilities and roles in the BGI implementation plan
- Funding strategies for the plan

Sub-step 3F: Developing the Theory of Change (ToC)

1) **<u>What areas do I recognize as needing urgent protection and recovery?</u>**

Employing a spatial prioritization analysis, it is recommended to define different zones addressing the variety of needs for the city. This zoning may include: Developing zones, key recovery zones, key protection zones, among others.

Method description

After the spatial prioritization has been developed the zoning, the areas for recovery spatial analysis must divide the key areas for urban design protection projects and restoration (Li et al., 2014). This division indicates different action plans for each area. While the first look to preserve a zone mainly as it is, the second demands direct actions to improve ecological process in order to have a better ecosystem health.

2) **<u>What are the viable conservation objects to protect and recover?</u>**

Having detected the areas with urgent needs, then is necessary to prioritize the conservation targets and actions objects to work with. Use all the relevant information that could help, particularly those issued during previous stages:

- CS conservation situation model (SUB-STEP 2H)
- CS Theory of change
- Conservation object map (SUB-STEP 2A, 2E, 3A)
- Green areas map (SUB-STEP 1E)

Method description

Strategic planning requires a viability assessment of the defined conservation objects in the CS conceptual model. As it is mentioned in CS manual CMP (2020) and *"Manual*

PAM" published by FLC (2018). This process determines the current and desired ecological condition of the conservation objects. To achieve this, perform the following:

1. Define the key ecological attributes that would define a conservation object as healthy.

2. Select indicator(s) that could serve as measurements in order to monitor the conservation objects.

3. Describe the current state of the conservation object.

4. Define a desired state for the conservation object.

3) <u>How does your CS Theory of Change look like?</u>

Build an explicit strategy of the conservation planning that layouts the work packages for each direct and indirect threat to the conservation objects. Consider information and outcomes from earlier stages of the process:

- CS conservation situation model (SUB-STEP 2H)

- Nautilus stakeholder visualization (SUB-STEP 1F, 2D and 3B)

- Common vision (SUB-STEP 2A)

- Conservation objects maps (SUB-STEP 2A, 2E, 3A)

Method description

Participatory develop of the Theory of Change implementing workshops, surveys and phone calls. Include commitments of the formal institutions is recommended porting to the city council.

Final results for Theory of Change will be:

- Raster layers for protection and recovery areas (from question 1).
- BGI masterplan

6.3 Objectives Nº3

6.3.1 Developing Step 1: Pre-assess: Hydro socioecological analysis: Characterizing the urban wetland system and defining the problem

6.3.1.1 Developing Sub-step 1A General context

The photo-interpretation analysis of satellite images helped to recognize natural and human threats for the conservation objects. The analysis focused on the visible wetlands. For example, it is identified that between the year 2003 and 2010 Baquedano wetland suffered a reduction of 90,2% and Las Ranas wetland suffered a 45% reduction on the same period. In the first case the reduction is due to the advance of the urban fabric.

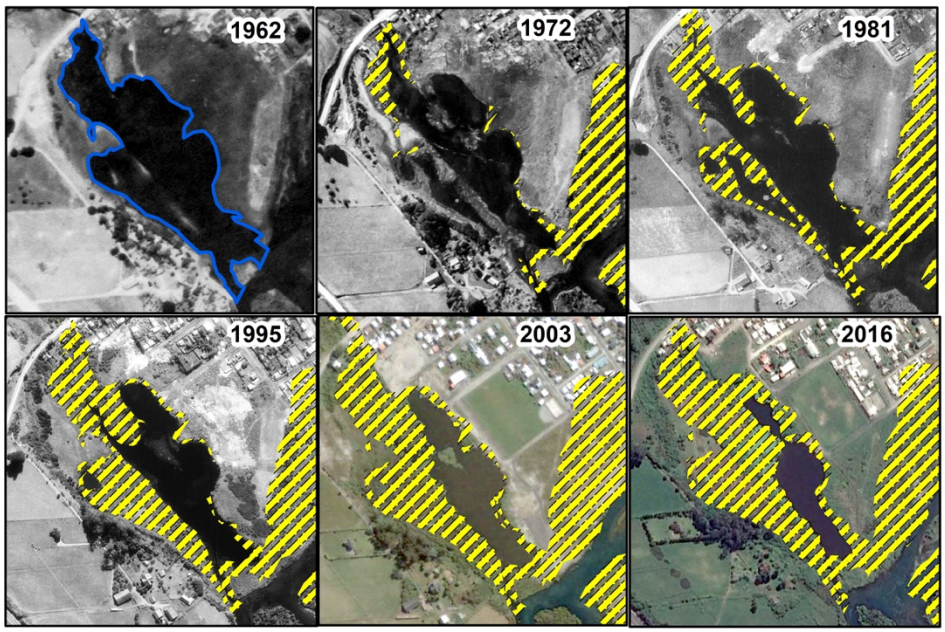

Figure 6.5 Temporal evolution “Baquedano” 1962-2016. Own Elaboration (2020)

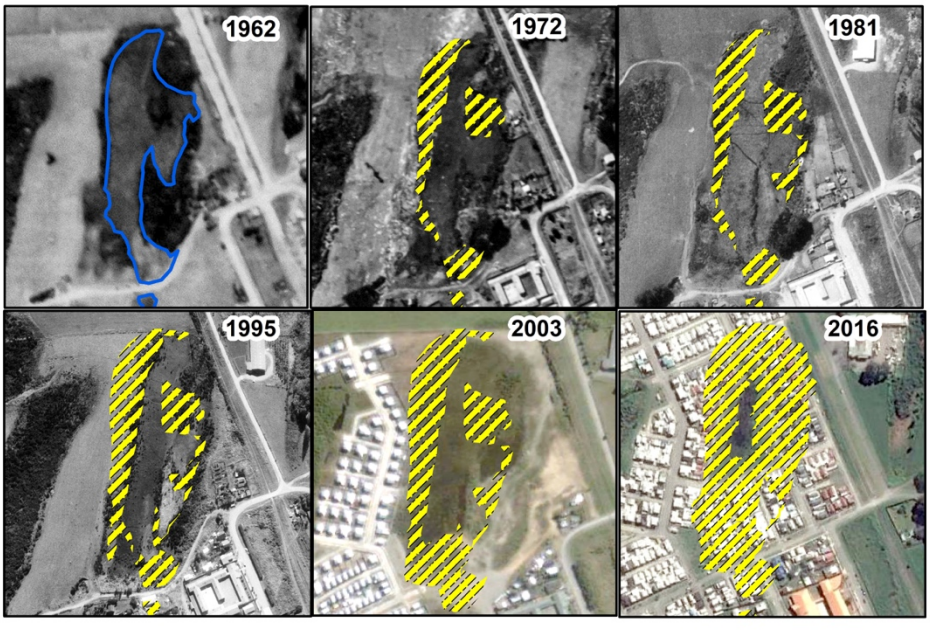

Figure 6.6 Temporal evolution “Las Ranas” wetland 1962-2016. Source: Own elaboration (2020)

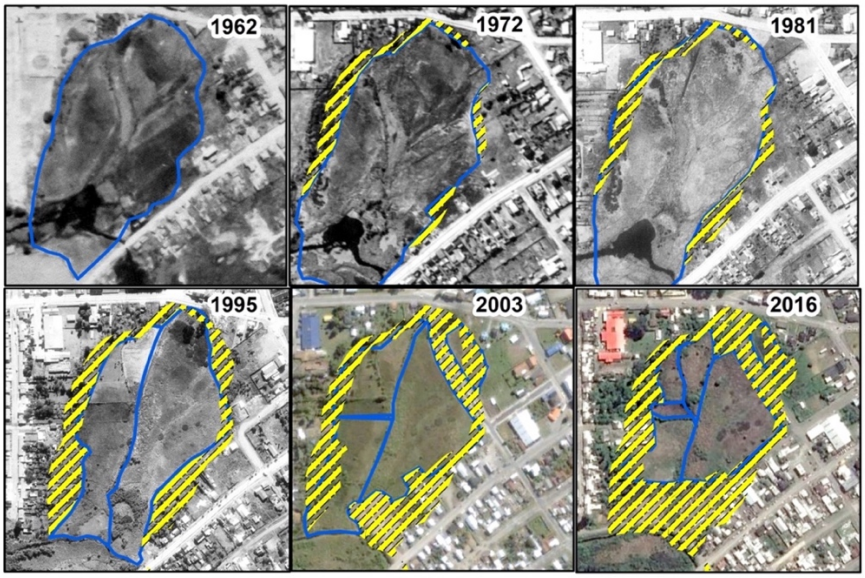

Figure 6.7 Temporal evolution “Los Helechos” wetland 1962-2016. Own Elaboration (2020)

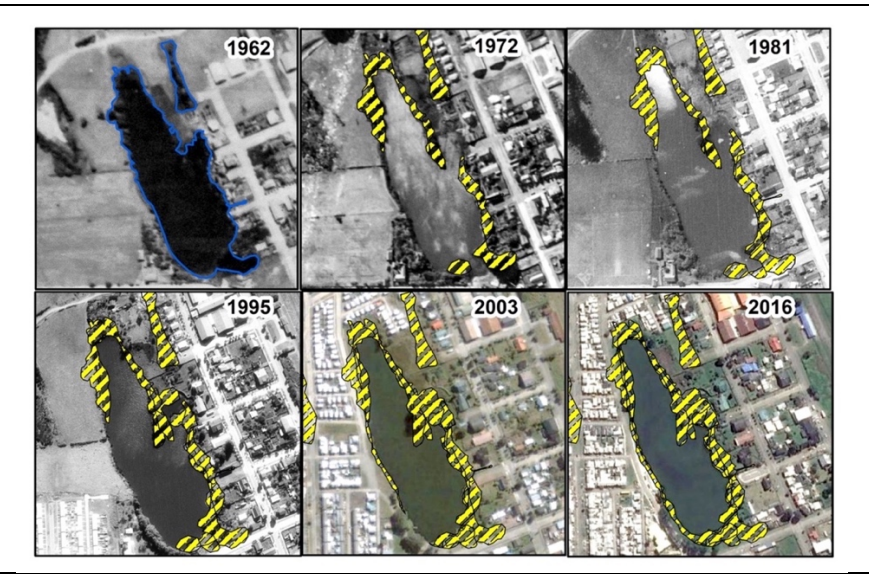

Figure 6.8 Temporal evolution “El Loto” wetland 1962-2016

Source: Own elaboration (2020)

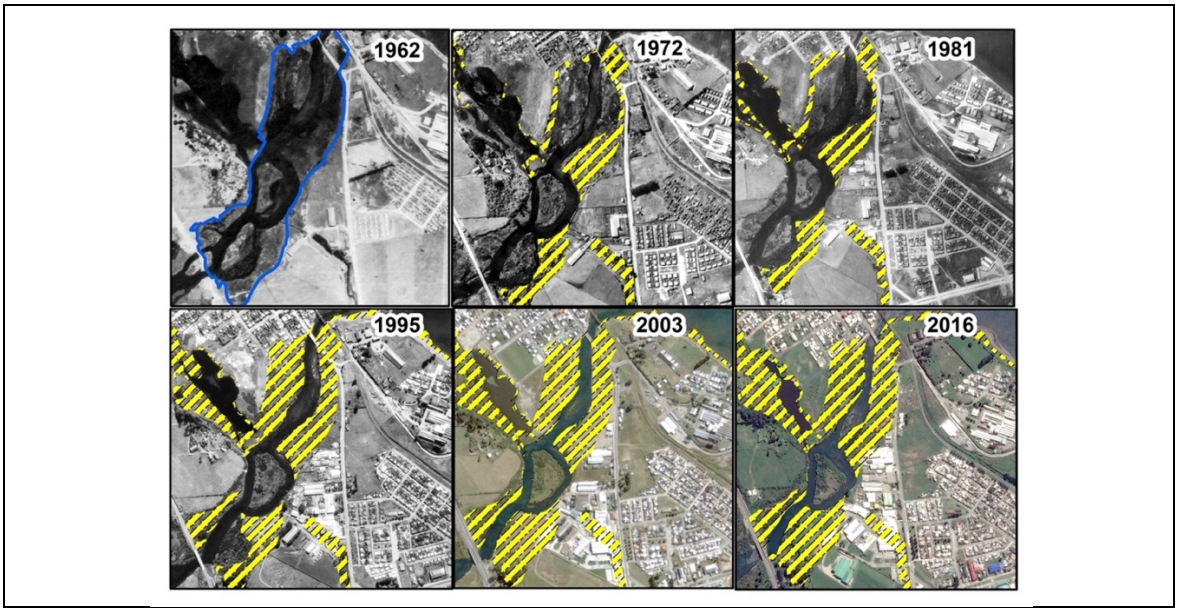

Figure 6.9 Temporal evolution “Maullín river” wetland 1962-2016

Source: Own elaboration (2020)

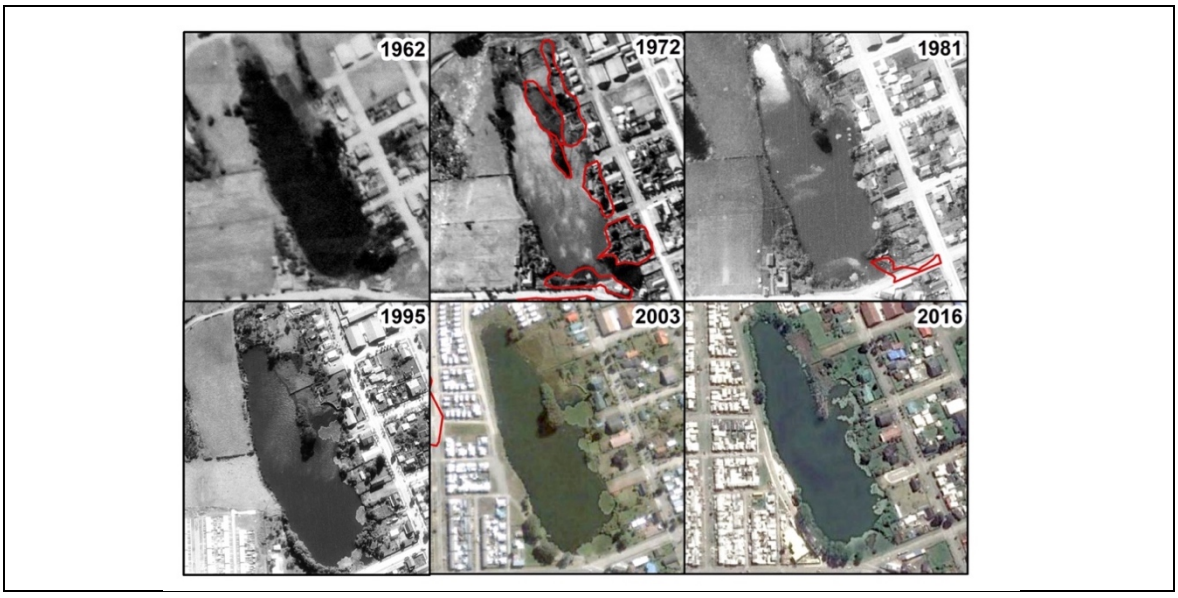

Figure 6.10 Refilling temporal evolution “El Loto” wetland 1962-2016

Source: Own elaboration (2020)

The initial SUB-STEP 1A analysis recognized the 6 Conservation objects. “Baquedano” wetland (CO1), “Las Ranas” wetland (CO2), “El Loto” wetland (CO3), “Los Helechos” wetland (CO4), “Estero Teodosio Sarao” wetland (CO5) and “Río Maullín” wetland (CO6).

Table 6.18 Temporal variation of area and perimeter for each wetland “Baquedano”, “Las Ranas” y “El Loto”

Wetland	**Baquedano (CO1)**		**Las Ranas (CO2)**		**El Loto (CO3)**	
Year	**Area [ha]**	**Perimeter [m]**	**Area [ha]**	**Perimeter [m]**	**Area [ha]**	**Perimeter [m]**
1962	2,3	1002,0	6,3	1809,1	3,9	1570,0
1972	1,7	809,8	5,4	1578,4	2,8	1098,0
1981	2,4	892,1	4,1	2077,0	3,2	915,0
1995	1,8	924,0	3,0	1553,0	2,7	1095,0
2003	2,6	748,0	2,5	1239,0	2,7	928,8
2016	0,2	309,0	1,3	955,0	2,6	1040,0

Source: Own elaboration (2020)

Table 6.19 Temporal variation of area and perimeter for each wetland “Helechos”, “T.Sarao” y “Maullín”

CO:	**Los Helechos (CO4)**		**T. Sarao (CO5)**		**Maullín (CO6)**	
Year	**Area [ha]**	**Perimeter [m]**	**Area [ha]**	**Perimeter [m]**	**Area [ha]**	**Perimeter [m]**
1962	7,6	1130,2	1,3	3023,3	22,4	22771,0
1972	6,5	1113,6	0,8	1980,4	15,2	2965,8
1981	6,9	1122,3	0,5	1631,0	15,7	2644,0
1995	4,9	1691,0	0,2	1574,0	10,3	2607,0
2003	4,7	2016,0	0,3	1978,0	8,7	2427,0
2016	3,4	1817,0	0,5	3155,0	8,1	2341,0

Source: Own elaboration (2020)

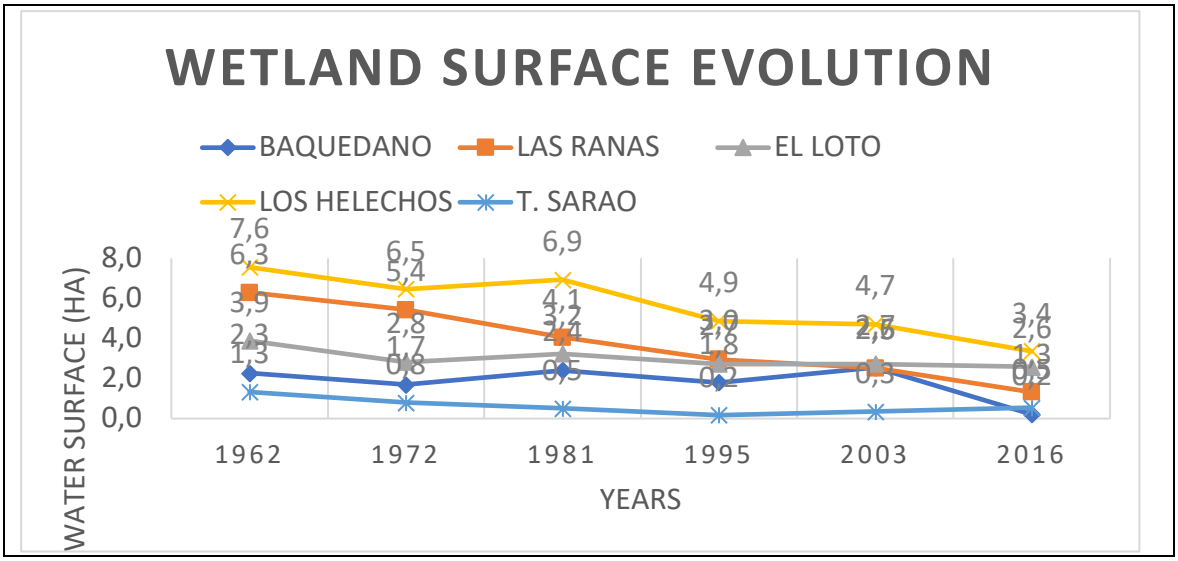

Figure 6.11 Wetland surface evolution

Source: Own elaboration (2020)

6.3.1.2 Developing SUB-STEP 1B Hydro-spatial analysis

Taking into consideration the previous step, Figure 6.12 was achieved following the proposed Zhou et al. (2008) method. Then the tributaries computed over the lake were modified and then the process was repeated. Sub-catchments from each conservation object were identified. These sub-catchments correspond to three wetlands: "El Loto" wetland, "Las Industrias" wetland and "Los Helechos" wetland. The sub-catchment generated are presented in Figure 6.13.

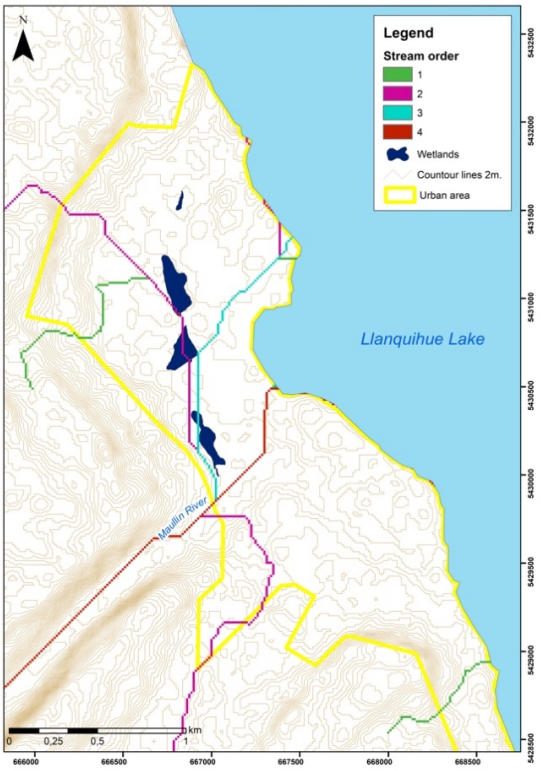

Figure 6.12 Stream order map
Source: Own elaboration (2020)

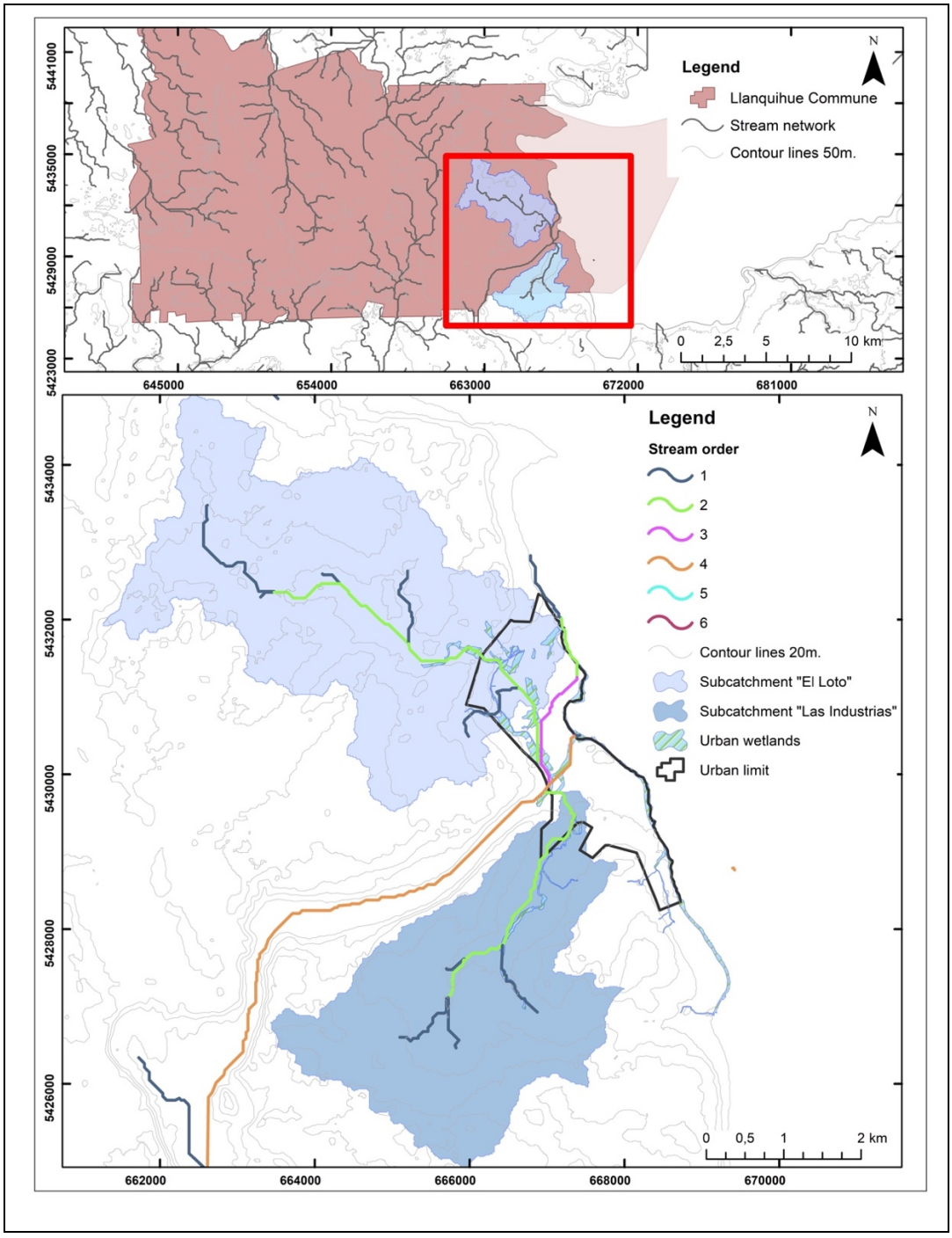

Figure 6.13 “El Loto” sub-catchment, “Baquedano” sub-catchment and “Las Industrias” catchment

Source: Own elaboration (2020)

As it can be seen in Figure 6.13 “El Loto” sub-catchment, “Baquedano” sub-catchment and “Las Industrias” catchment, “Los Helechos” wetland and “El Loto” wetland share the share sub-catchment area. The “Los Helechos” sub-catchment is completely contained by the “El Loto” sub-catchment. This implies that conservation effort for each wetland must be coordinated and be considered as part of a system to achieve the desired results. Recognizing a watershed for each wetland. The area value of each sub-catchment is presented in Table 6.20. The sub-catchment of “El Loto” wetland and “Los helechos” wetland share almost the same contributing area. “Las ranas” wetland is pending work because it considers Maulln River and Llanquihue Lake as a contributing factor.

Table 6.20 Sub-catchment area

Sub-catchment	**Stormwater catchment**
Sub-catchment “El Loto wetland”	14,3292 [km^2]
Sub-catchment “Los Helechos wetland”	14,4337 [km^2]
Sub-catchment “Las Industrias”	10,2908 [km^2]

Source: Own elaboration (2020)

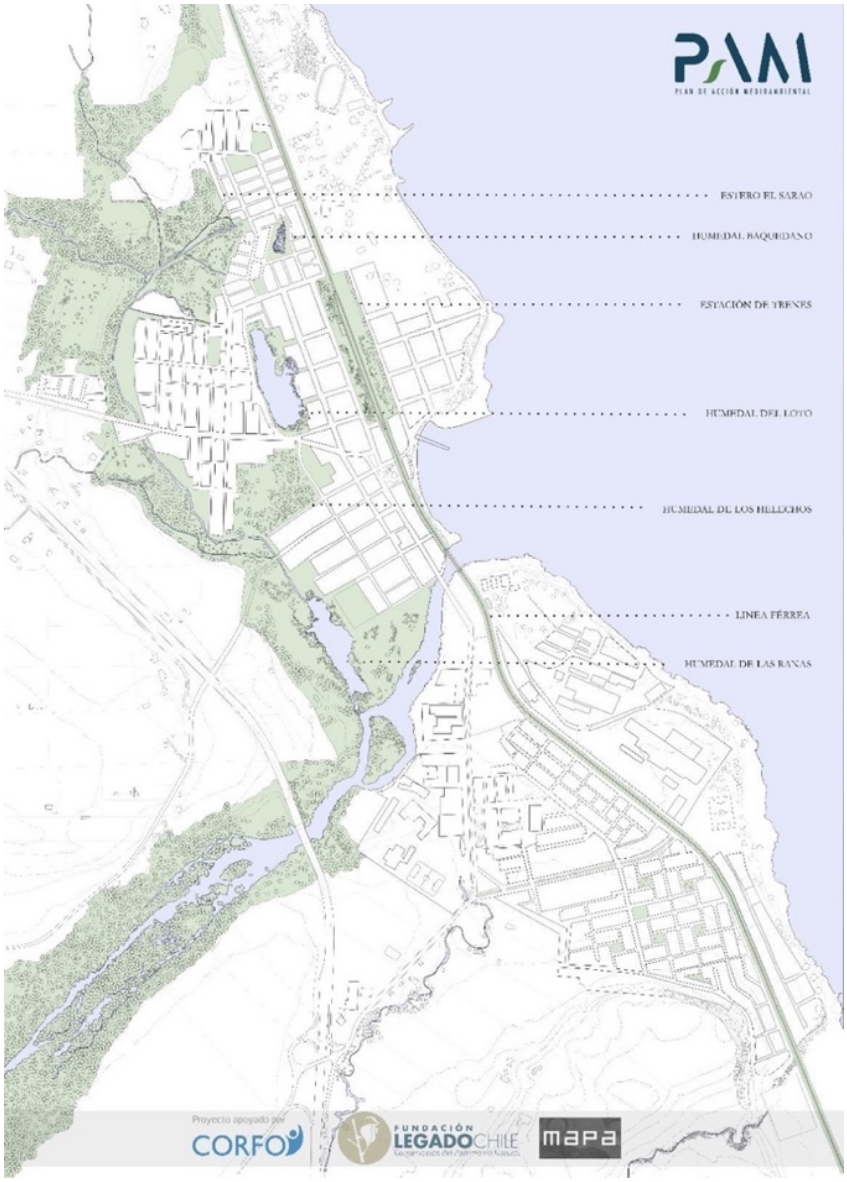

Figure 6.14 Old conservation map recognizing th urban wetlands
Source: Fundación Legado Chile (2018)

With the spatial analysis, a final work area was defined that includes the sub-catchment as the contributing area for each planning unit. It can be observed that for the proper

conservation of the “Las Industrias” wetland an area outside the administrative boundaries of Llanquihue must be included. The hydro spatial analysis produced results that enabled the recognition of “Las Industrias” wetland in south side of the city that is not currently declared by the maps and plans that the conservation NGO implementing CS in Llanquihue work.

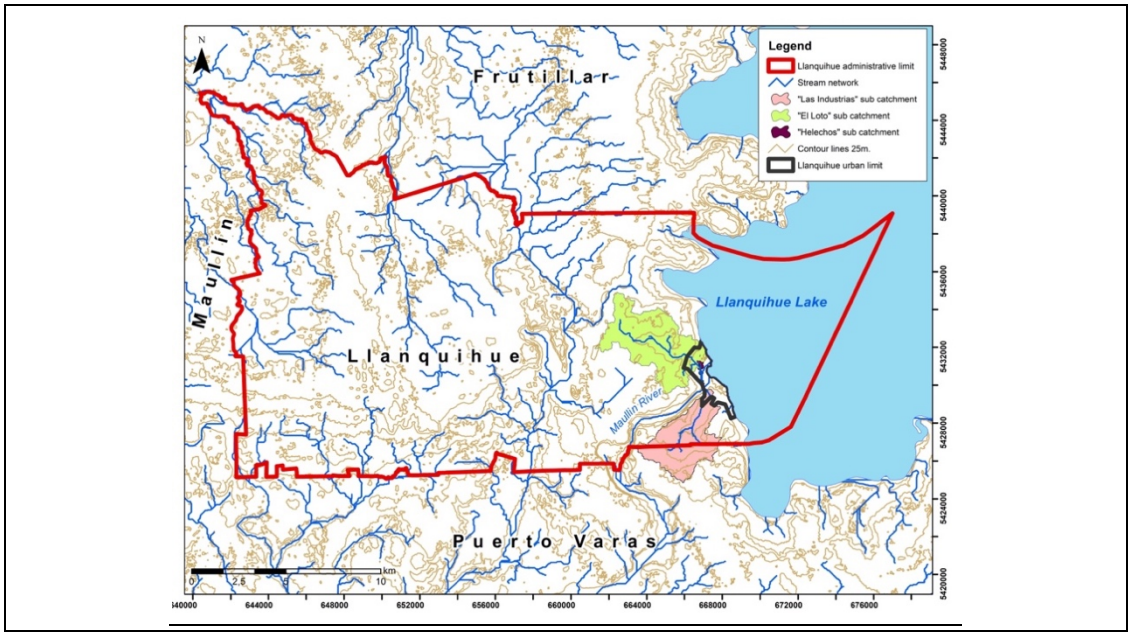

Figure 6.15 Municipality limits, sub-catchment limits and urban limits
Source: Own elaboration (2020)

6.3.1.3 Developing SUB-STEP 1E Understand current hydro-ecological status of urban wetlands

Following the recommendation of strategically using available information from other sources to build a biodiversity baseline such as previous Environmental Impact Assessment, the data collection process led to Table 6.21 as list potential amphibians from Llanquihue based on previous reports. Spanish local denomination were kept for species

common names, conservation status were kept on purpose. Order for every species is *Anura*.

Table 6.21 Potential amphibian species from Llanquihue zone and its review of nearby EIA. Conservation status declared by the Nº19.473 Hunting Law.

Family	**Scientific name**	**Common name**	**EIA**	**Environment**	**C. status**
Bufonidae	*Nannophryne variegata*	Sapo variegado		Scrubs, meadow	S/C
	Rhinella rubropunctata	Sapo de manchas rojas	X	Forest	P
Leiuperidae	*Alsodes australis*	Rana de pecho espinoso austral	X	Scrubs, meadow	S/C
	Alsodes verrucosus	Rana verrugosa de pecho espinoso		Scrubs, meadow	I
	Batrachyla antartandica	Rana jaspeada	X	Forest	F
	Batrachyla leptopus	Rana moteada	X	Forest	F
	Eupsophus calcaratus	Rana de hojarasca austral	X	Forest	F
	Eupsophus emiliopugini	Rana de hojarasca de párpados verdes	X	Forest, meadow	F
	Hylorina sylvatica	Rana esmeralda		Scrubs, meadow	I
	Pleurodema thaul	Sapito de cuatro ojos	X	Scrubs	F
	Calyptocephalella gayi	Rana grande chilena	X	Meadow	V
	Batrachyla taeniata	Rana de antifaz	X	Forest	I

Rhinodermatidae	*Rhinoderma darwinii*	Ranita de Darwin		Scrubs, meadow, Forest	I

Source: Adapted from Fundación Legado Chile (2017)

6.3.1.4 Developing SUB-STEP 1F: Stakeholders analysis

Following the Framework for Adaptive Socio-Hydrology (FrASH) (Schifman et al., 2017b) stakeholders were recognized, listed and labeled one-by-one according to their type of power and interest. Then, organization types were arranged by their decreasing contribution and then visualized using the Chambered Nautilus as follows:

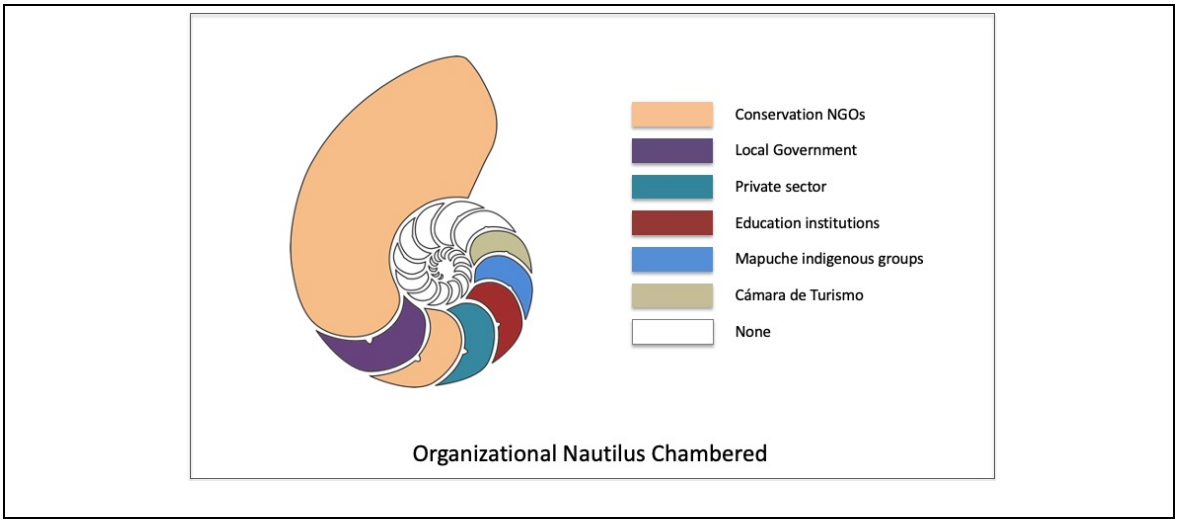

Figure 6.16 Organizational Nautilus Chambered

Source: Own elaboration (2020)

Table 6.22 Stakeholder analysis

Type	Relevant Actor	Interest / Need	Type of power and /or influence			
			Economic	Social	Legal	Technical
Primary	Local Government	Improve tourism	**x**		**x**	**x**
	ONG La Rueda Llanquihue	Conservation and protect tourism in Llanquihue		**x**		
	Education institutions	Tech children		**x**	**x**	
	Industries	Commercial benefit	**x**	**x**		
	Cámara de Turismo	Tourism		**x**		x
Secundary	Leufu Lafken	Indigenous and cultural conservation		**x**		
	Unión Comunal de Llanquihue	City socio-economic progress	**x**	**x**		
	Fundación Legado Chile	Wetland conservation		**x**		**x**

Source: Own elaboration (2020)

6.3.1.5 Developing Step 1G: Proximity assessment to protected areas

Maullín River wetland is the only protected area next to the study area (and also inside the geographic scope). This conservation object was declared a Priority Site for conservation on 2005 by CONAMA. Also, in , it was declared a natural sanctuary. This gives a small advantage in the look for funding.

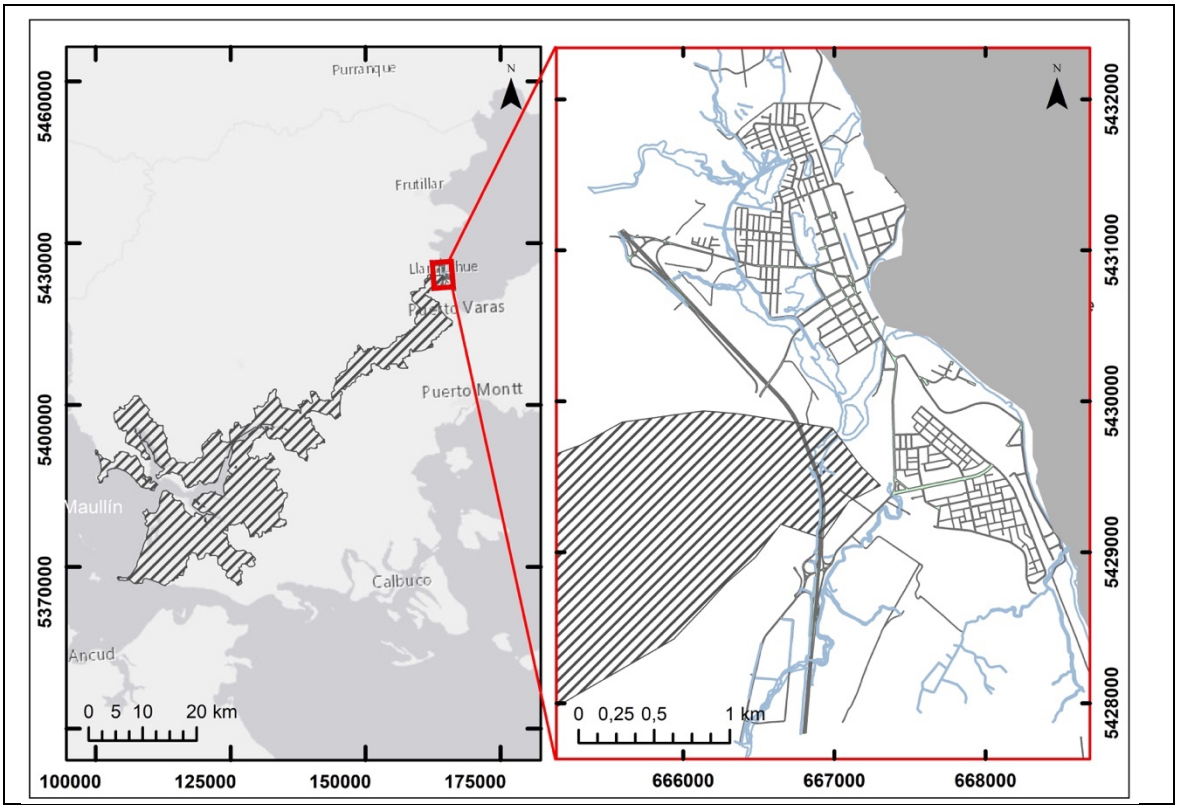

Figure 6.17 Maullín river wetland is a Natural Sanctuary declared by the Environmental Ministry since 2020 and biodiversity priority site declared by CONAMA in 2005

Source: Own elaboration (2020)

6.3.2 Developing Step 2: Assess: Hydro socioecological analysis: Defining geographic scope, threats and conservation objects

6.3.2.1 Developing SUB-STEP 2B: Land-use analysis

From the recognition of actual land-use compared with planned Llanquihue PRC Figure 6.18 is presented.

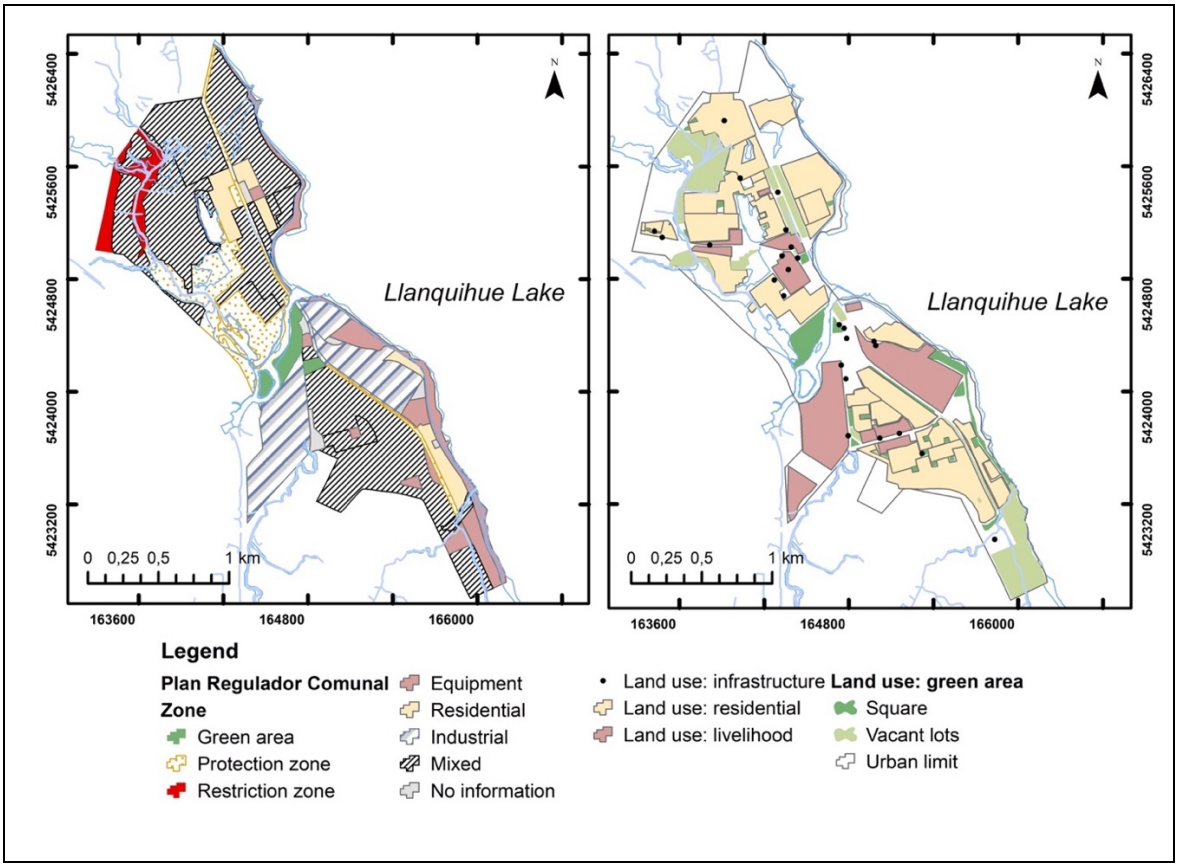

Figure 6.18 Current and planned city land-use
Source: Own elaboration (2020) adapted from Fundación Legado Chile (2018)

The following observations were made:

- Most of the PRC defined green spaces are actually vacant lots. This implies that they are not being used for the defined purpose and have been transformed into residual places. These places represent opportunities to be incorporated in the green infrastructure plan of the city benefiting the community and the conservation of nature that can positively impact urban wetlands.
- The first kilometer of the Sarao Estuary is a vacant lot that is zoned as restricted zone representing an opportunity to incorporate urban design aligned with

urban wetland conservation strategies. The PRC strategies for the restricted zones declares:

  - Hydraulic works to protect banks and riverbeds, green areas and reforestation
  - Restriction zones for natural gorges, hillsides and adjacent zones.
  - Restricted zone of streams and natural ponds.

- The second kilometer of the Sarao Estuary is a vacant lot but is zoned as protection zone representing an opportunity to incorporate urban design aligned with urban wetland conservation strategies.
- According to the PRC there is still a potential industrial zone next to 2 of the conservation objects (Maullin River and Llanquihue Lake Lacustrine shore) and historically the industrial activities have represented threats for this urban wetland conservation.
- The whole Llanquihue lacustrine shore is recognized as protection zones for the lake beaches.

6.3.2.2 Developing Sub-step 2C: Analyzing the current ecological situation

The multi-temporal analysis resulted in the NDMI, NWI and NDWI presented in Figure 6.19.

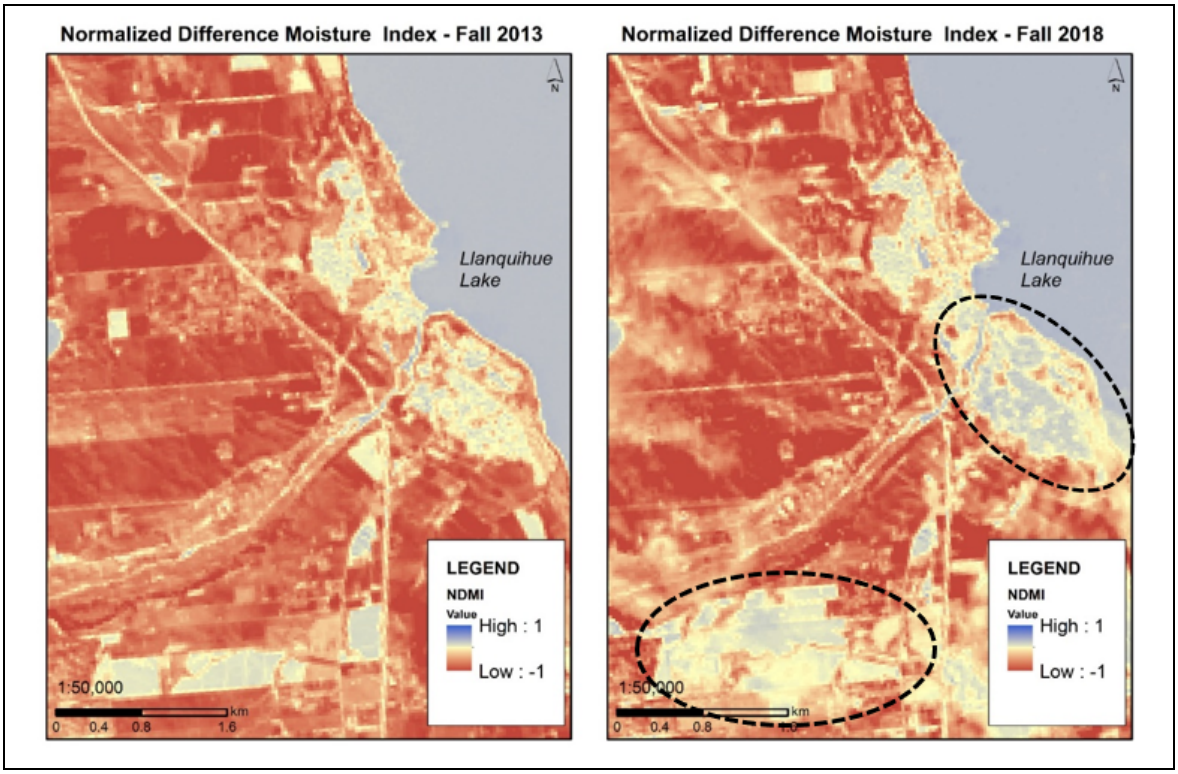

Figure 6.19 Normalized Difference Moisture Index
Source: Own Elaboration (2020)

Figure 6.19 shows the index of the normalized difference of humidity (NDMI). It shows the presence/absence of the humidity and the water content in the vegetation, in falls of 2013 and 2018. The values closer to blue represent the water content in in the vegetation or soil. The values closer to 0 are shown in yellow and correspond to pavement and middle canopy. The negative values represented with red tones show territories with deteriorated soils.

- The blue tonalities in the city are directly related with the waterbody that in this case represent the riverine, palustrine and lacustrine wetlands that were defined as the conservation objects.

- The wastelands at the south zones are more irrigated for the next crops.
- The south zone its recognized as more humid, coinciding with the hydrologic study.

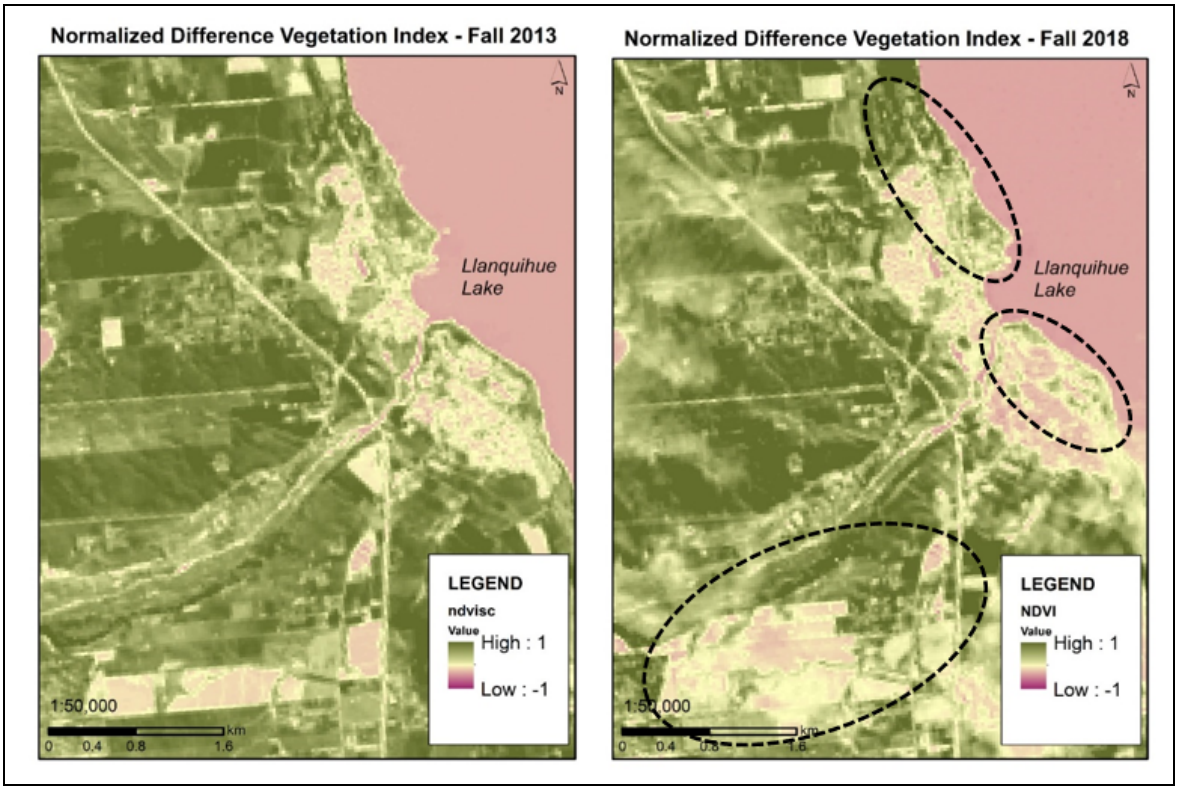

Figure 6.20 Normalized Difference Vegetation Index Fall 2023 and Fall 2018
Source: Own Elaboration (2020)

Figure 6.20 shows the normalized different index (NDVI). This index was obtained using open sources satellite images (from http://earthdata.nasa.gov) and shows the presence/absence and state of the vegetation. Values closer to 1 are represented in green and show the presence of vegetation, if the color is darker (values closer to 1) they have higher reflectance in the near infrared, this means that is correspond to a denser and

healthier vegetation. The negative values represented in purple tones are those areas of the territory that do not have vegetation.

- The fall of 2018 exhibits a lower presence of vegetation along the entire lacustrine border of the Llanquihue Lake, which could be related to the increase in tourism development in recent years recognizing the wetlands as one of the most important city attractions.
- Fall 2018 recognizes less presence of vegetation in the southern are of the image due to the growth of the city (urban development) and wasteland.
- Fall 2018, lower presence of vegetation is recognized in “Maullín” River.
- It is appreciated that a low-intensity green color for the riparian forest of the “Maullín” river in both fall.
- The “Sarao” estuary is identified by the most vigorous vegetation contour.

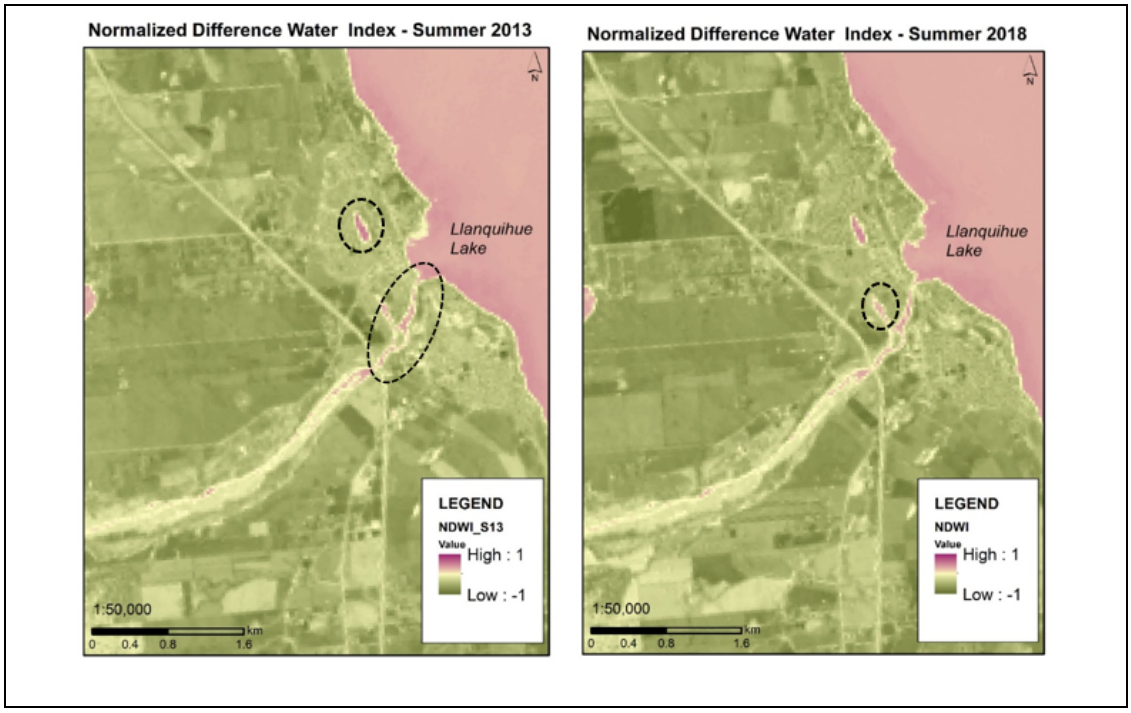

Figure 6.21 Normalized Difference Water Index
Source: Own Elaboration (2020)

Figure 6.21 shows the normalized water difference index (NDWI). It accounts the presence/absence of water bodies. It should be noted that NDWI is sensitive to vegetation and water accumulation of the land, so the conservation objects with vegetation inside could be altered. Values closer to 1 are a consequence of a higher reflectance of the NIR band, are represented in purple tones and show the presence of water content. The negative values represented in green color are related to dry vegetation or bare soil.

- Beginning of "Maullín, "Las Ranas" "El Loto" Wetland are clearly recognized
- Train line is recognized as a wet area that could potentially be included in urban planning to contribute to wetland conservation.

The Figure 6.22 that are presented below show the land-cover from the satellite images from 2013 y 2018, they reflect the changes in 6 types of covers: waterscape, native forest, urban area, agriculture, wasteland and saturated.

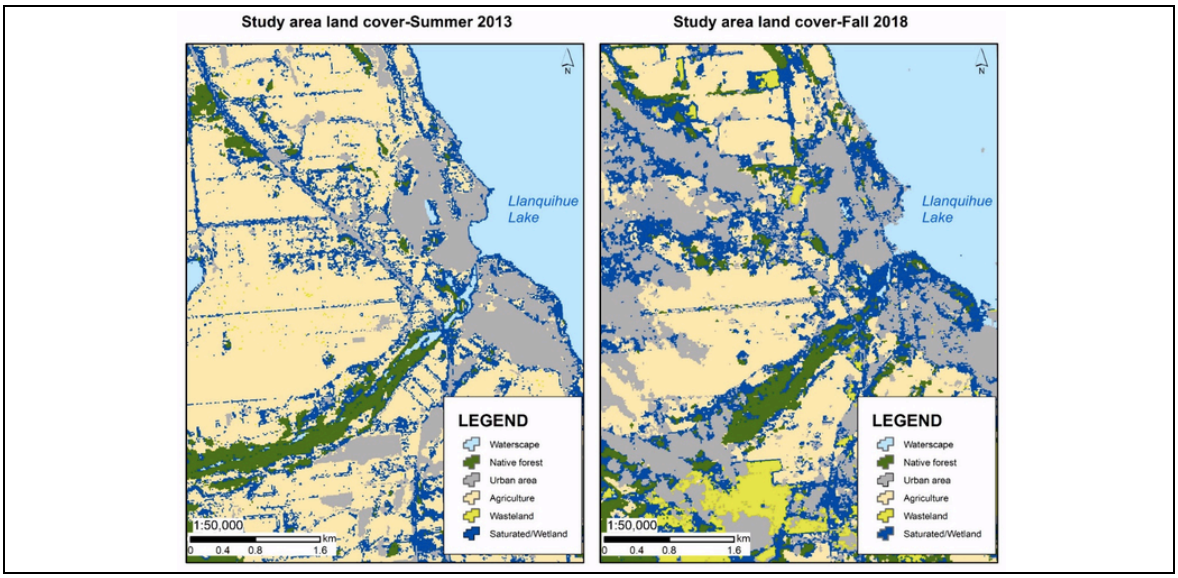

Figure 6.22 Land cover Summer 2013 and Land cover Fall 2018

Source: Own Elaboration (2020)

Table 6.23 presents the change in coverage between each studied year. It is illustrated follows that the waterscape (which contains the "Maullín" river, Llanquihue Lake and other wetlands) has decreased by around 500 ha. over a period of five years, this is consistent with the photointerpretation made in SUB-STEP 1A where a decrease in water bodies was recognized. However, an increase in saturated spaces is recognized, which could be a response of the wetland system as a result of their waterproofing.

On the other hand, the native forest is another cover that has decreased by almost a thousand ha. in this period, this is probably related to the overuse of the ES: firewood and urban growth which makes sense since the urban area has increased significantly.

Table 6.23 Land-cover comparing Fall 2013 and Fall 2018

Land cover	Area [ha]		
	Fall 2013	**Fall 2018**	**Difference**
Waterscape	1628.4	1110.4	-518.0
Native forest	1569.1	606.3	-962.7
Urban area	473.6	3059.9	+2586.3
Agriculture	3530.4	2175.0	-1355.4
Wasteland	139.2	278.5	+139.3
Saturated/Wetlands	1342.3	1452.8	+110.5

Source: Own Elaboration (2020)

Together with the previously presented results a temporal review from 1999, 2004, 2009, 2013 and 2019 from the Landsat 7 and Landsat 8 enabled the calculation of NDWI is shown in Figure 6.23 and NDVI and NDMI (see Annex E and F). This type of results will later enable vegetation analysis for conservation actions and BGI master plan.

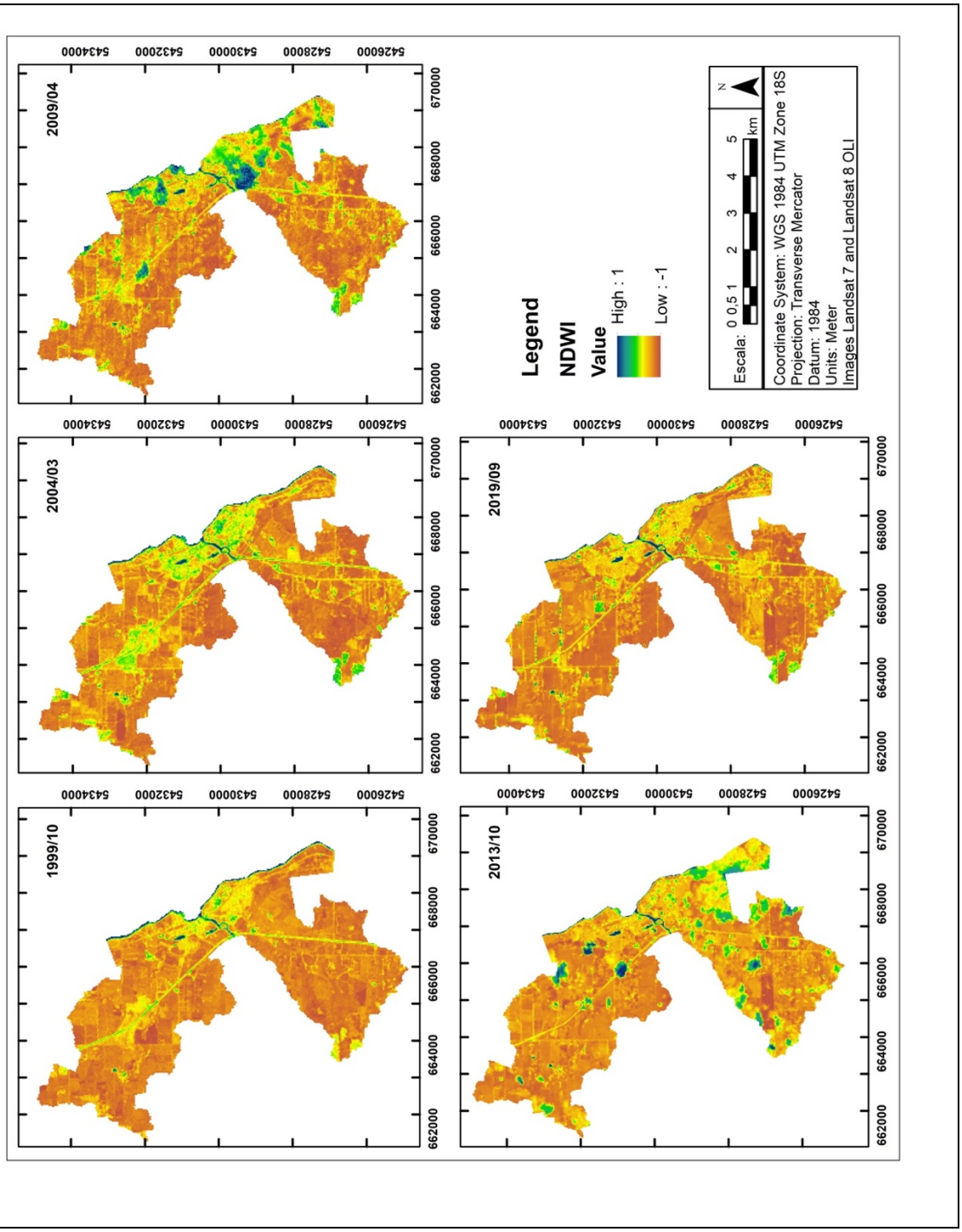

Figure 6.23 Temporal evolution of NDWI from 1999, 2004, 2009, 2013 and 2019 from the Landsat 7 and Landsat 8. The satellite images from 2009 and 2013 had presence of clouds.

Source: Own elaboration (2020)

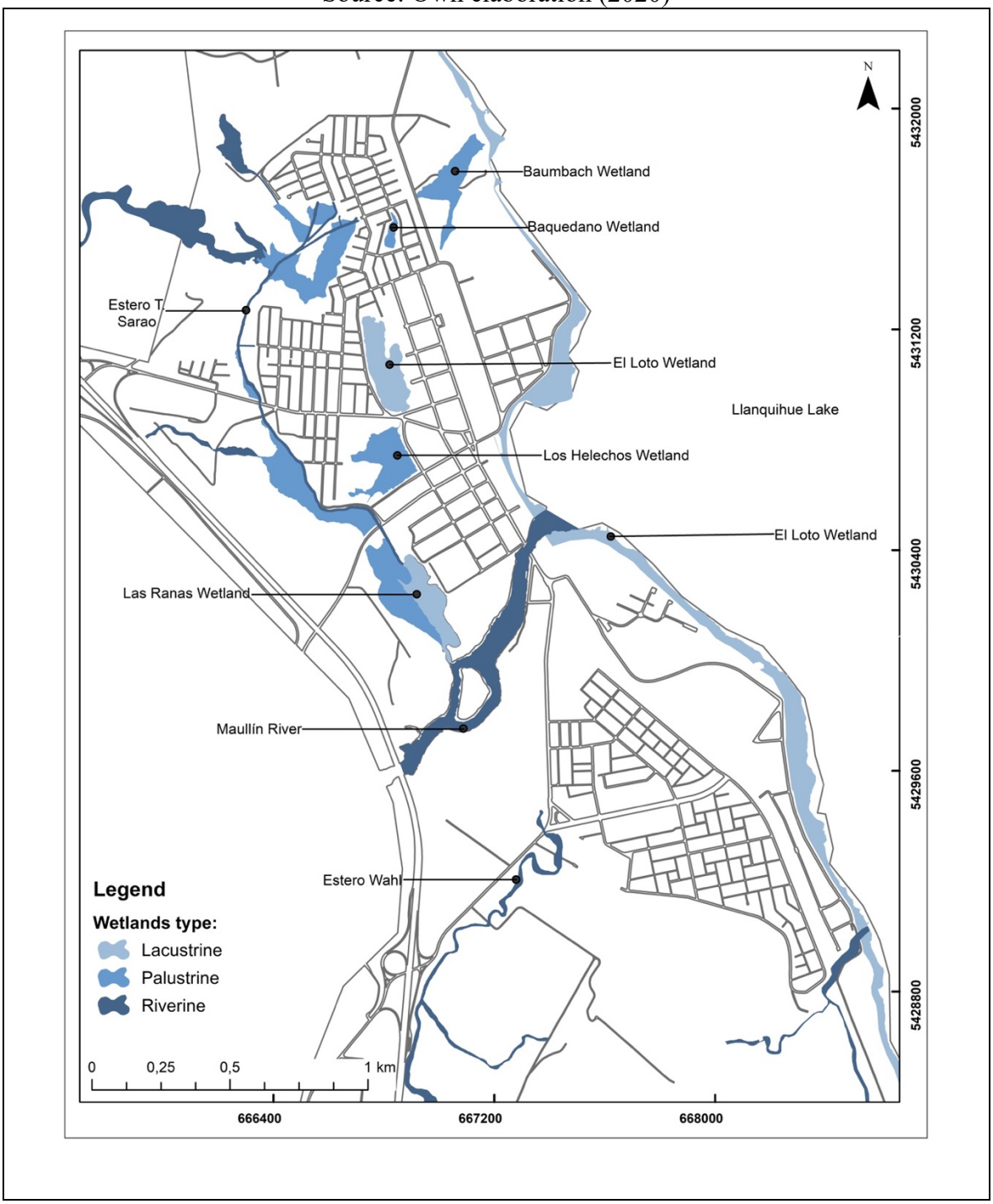

Figure 6.24 Classification of wetland types. Lacustrine: “El Loto”, “Las Ranas”; Palustrine: “Los Helechos”, “Baquedano” and “Baumbach”; Riverine: “Maullín”, “Wahl”

Source: Own elaboration (2020)

6.3.2.3 Developing Sub-step 2D: Characterizing the ES Analyzing the current ecological situation

The assessment considers the supply and demand of the ES.

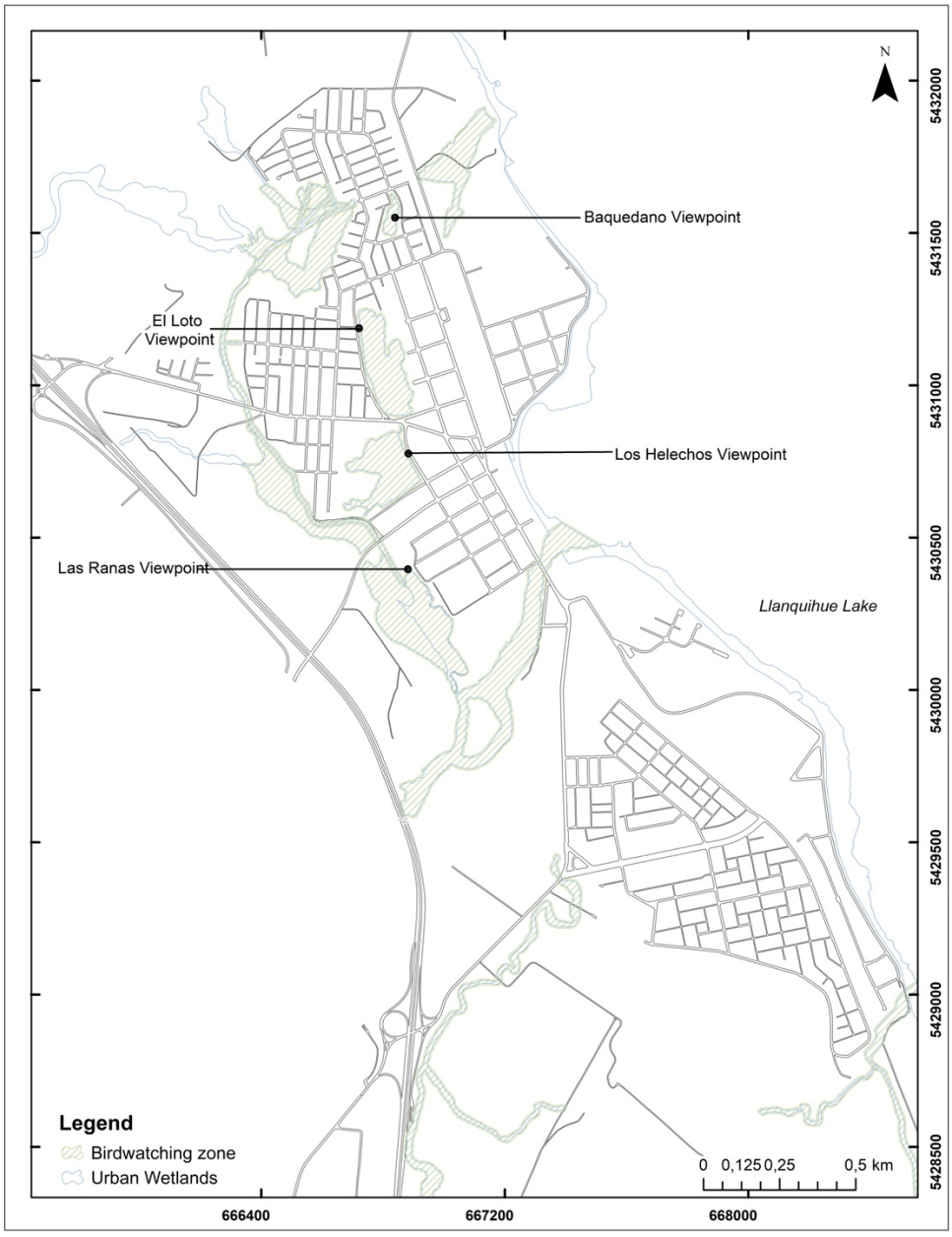

Figure 6.25 Birdwatching ES supply area
Source: Own elaboration (2020)

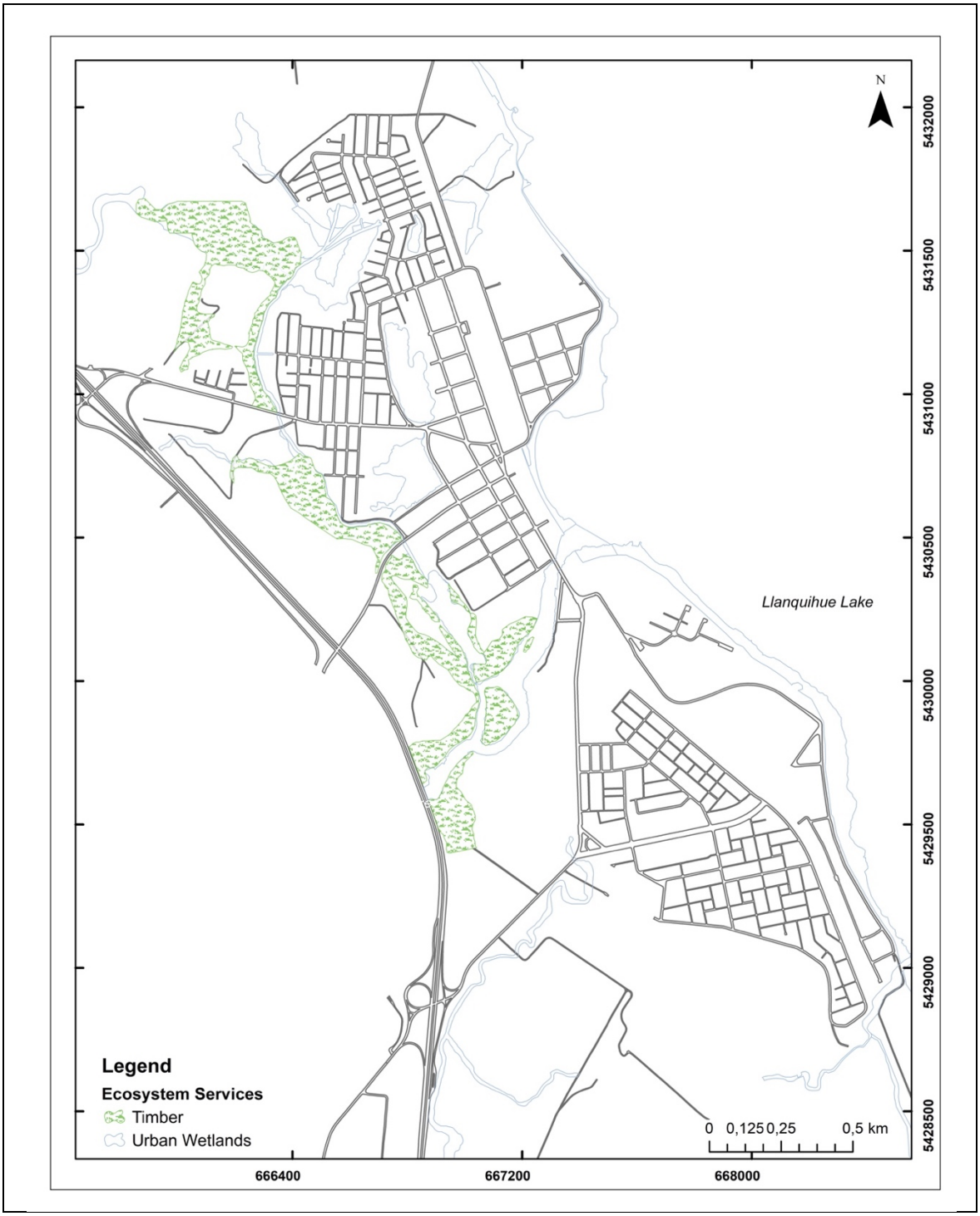

Figure 6.26 Sites where Timber ES is supplied

Source: Own elaboration (2020)

6.3.2.4 Developing Step 1G: Current ecosystem services mapping

Figure 6.27 ES Provision and Regulation

Source: German Guzmán photographs (2018)

Figure 6.28 ES Cultural and Support

Source: German Guzmán photographs (2018)

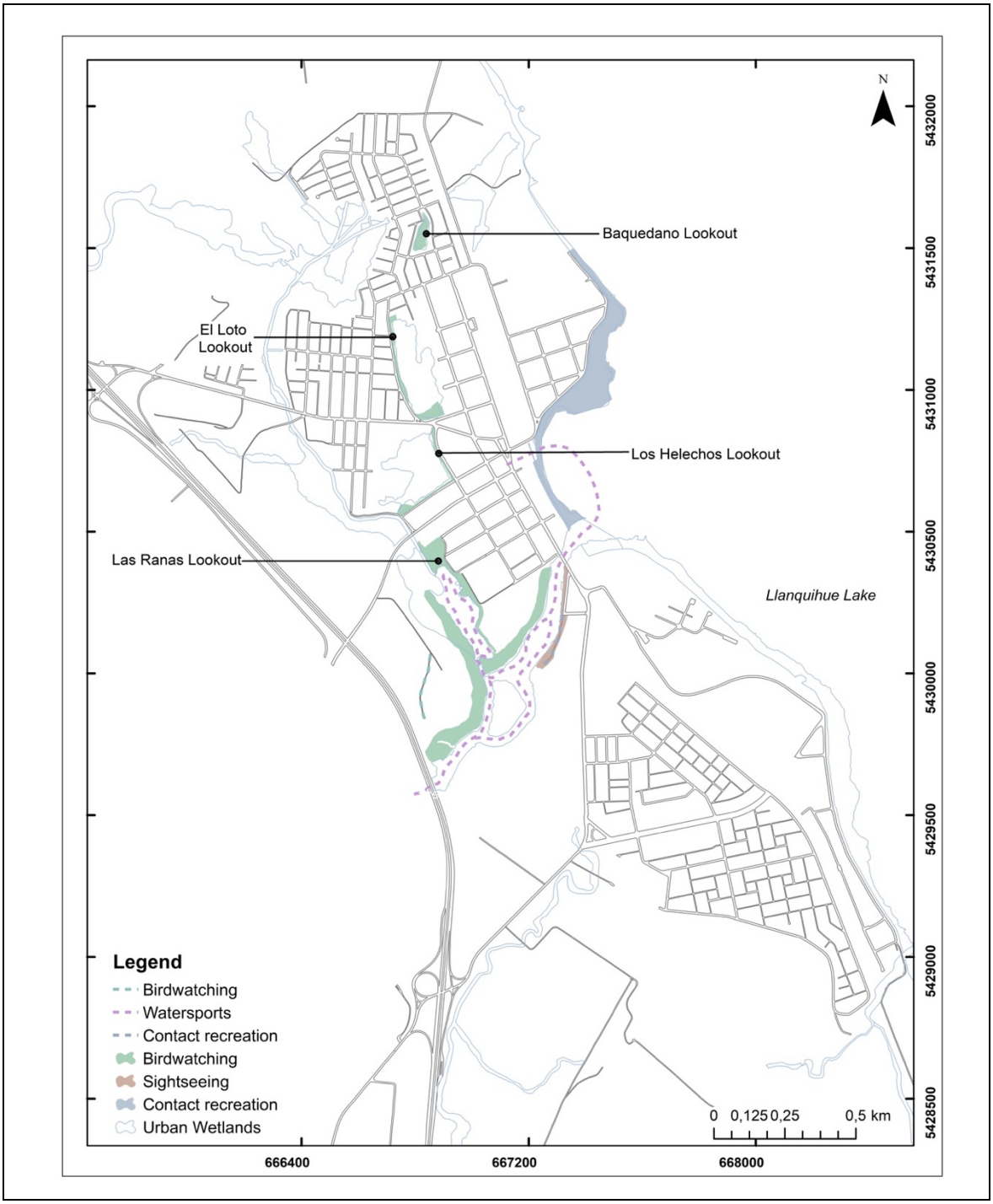

Figure 6.29 Sites where various tourism activities are done

Source: Own elaboration (2020)

ES qualitative description of the urban wetlands are presented below:

Table 6.24 Qualitative description of the ES

ES classification	**ES identified in the case study**	**Conservation object supplying ES**	**Observed conservation status**
Provision	Firewood extraction	Maullín River, Llanquihue Lake and Las Ranas Wetland	- Over exploitation of resources - First two kilometers of the riverine forest has suffered severe deforestation
	Fishing	Maullín River and Llanquihue Lake	Fishing during closed period
	Drinkable water		
Regulation	Stormwater flooding prevention	"Baquedano" Wetland, "El Loto" Wetland, "Los Helechos" Wetland, "Las Ranas" Wetland, "Maullín River" and Llanquihue Lake	Increased soil impermeability due to public and private infrastructure to urban development
Cultural	Birdwatching	"El Loto" Wetland, "Las Ranas" Wetland, "Maullín" River	Precarious in-site information. Active birdwatching activities by tourism companies
	Environmental education	"Baquedano" Wetland, "El Loto" Wetland, "Los Helechos" Wetland, "Las Ranas" Wetland, "Maullín River" and Llanquihue Lake	This ES it is in an initial state SS.EE.
Support	Habitat provision	Baquedano Wetland, El Loto Wetland, Los Helechos Wetland, Las Ranas Wetland, Maullín River and Llanquihue Lake	Loss of native species that lived in the urban wetlands (E.g.: Black swan and flamencos)

Source: Own elaboration (2020)

6.3.2.5 Developing Sub-step 2E: Human well-being analysis

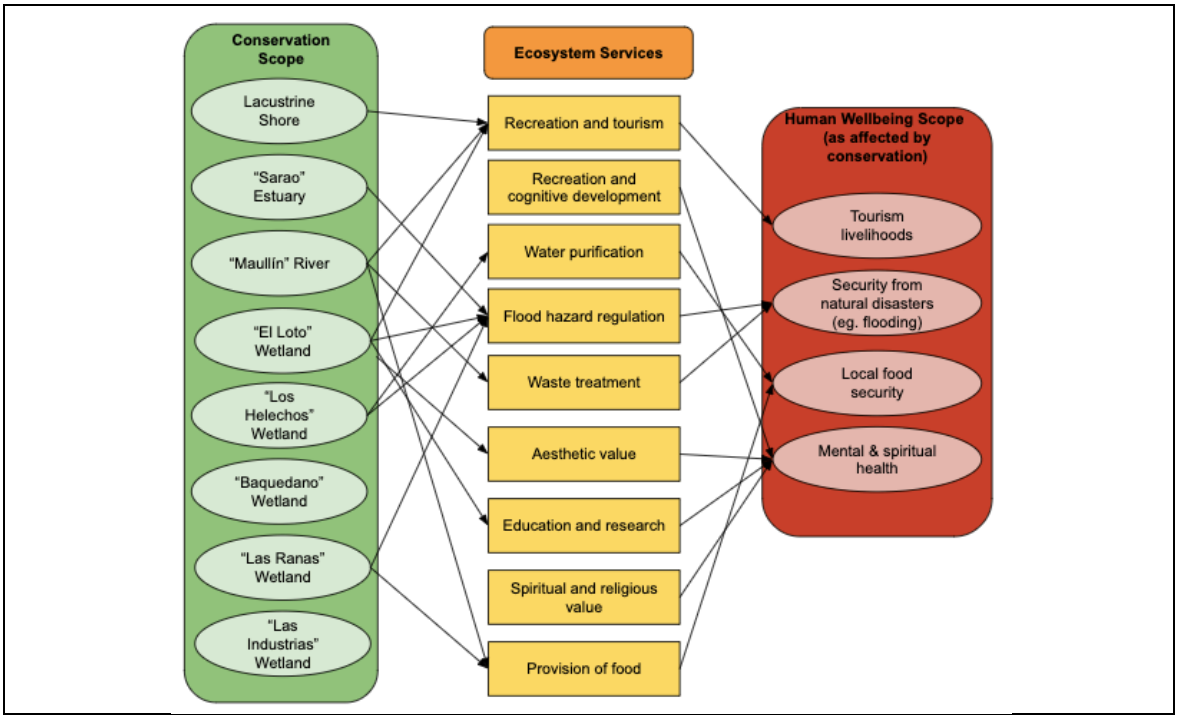

Figure 6.30 ES Cultural and Support

Source: Own elaboration (2020)

6.3.3 Developing Step 3: Plan: Urban planning of the hydro socioecological system: Defining the strategies for urban wetland conservation

6.3.3.1 Developing Sub-step 3A: Understanding the ES community priorities

Table 6.25. presents the declared priorities from a group of volunteer general public citizens that assisted to a participatory workshop developed by Fundación Legado Chile (a national conservation NGO working in Llanquihue). The 18 assistants were divided in two aleatory groups and were asked to collectively declare their interest for the wetlands.

Table 6.25 Community declared interest workshop results

Wetland	**Group 1**	**Group 2**
Baquedano	·Protect fauna from attacking dogs ·Provision of "Lahuen" medicine ·Create a community space for recreation	·Create a space for the recreation of the community ·Replace exotic vegetation for native ·Improve the flux or water regime ·Protect fauna from attacking dogs
El Loto	·Decontaminate waters ·Protect fauna from attacking dogs ·Create a community space for recreation	·Decontaminate waters ·Protect fauna from attacking dogs ·Improve the flux or water regime ·Water depuration and wetland as a biofilter
Sarao estuary north	·Recover the swampy forest ·Create a cultural or spiritual space ·Protect the city from floods ·Extract wetland refilling	·Provision of "Lahuen" medicine ·Replace exotic vegetation for native ·Water depuration and wetland as a biofilter ·Recover the swampy forest
Sarao estuary south	·Provision of "Lahuen" medicine ·Extract refilling ·Improve habitat for wildlife fauna	·Replace exotic vegetation for native ·Increase the landscape beauty of the city ·Improve the flux or water regime
Los Helechos	·Protect the city from floods ·Increase the beauty of the city ·Create a community space for recreation	·Create cultural and spiritual space ·Provision of "Lahuen" medicine ·Replace exotic vegetation for native
Las Ranas	·Provision of "Lahuen" medicine ·Recover the swampy forest ·Extract refilling ·Replace exotic vegetation for native	·Clean-up and removal of litter and constructions residues ·Decontaminate waters ·Create cultural and spiritual space
Río Maullín	· Provision of "Lahuen" medicine · Increase the beauty of the city	·Improve habitat for wildlife fauna ·Create a city recreation space ·Decontaminate water ·Recover the swampy forest
Llanquihue Lake shore	Not included	·Increase the beauty of the urban landscape

Source: Adapted from Fundación Legado Chile (2019)

The declared interest were linked to function and components and finally to ES following the classification proposed by Gómez-Baggethun & Barton (2013).

Table 6.26 Linking the community-declared interest with ecosystem services

Declared interest	**Ecosystem functions and components**	**ES**
Provision of "Lahuen" medicine	Mental and physical health	Recreation and cognitive development
Create a community space for recreation	Ecosystem with recreational and educational values	Recreation and cognitive development
Protect fauna from attacking dogs	Habitat provision species	Animal sighting
Recover swampy forest	Habitat provision species	Recreation and cognitive development
Increase the beauty of the city	Ecosystem with recreational and educational values	Recreation and cognitive development
Decontaminate waters	Removal or breakdown of nutrients	Waste treatment
Backfilling wetland	Physical barrier and absorption on kinetic energy	Moderation of environmental extremes
Create a cultural or spiritual space	Ecosystem with recreational and educational values	Recreation and cognitive development
Protect the city from floods	Physical barrier and absorption on kinetic energy	Moderation of environmental extremes
Improve habitat for wildlife fauna	Habitat provision species	Animal sighting
Clean-up and removal of litter and constructions residues	Not applicable	Not applicable

Source: Own elaboration adapted from Fundación Legado Chile (2020)

The result may be used -in a data-poor context- as initial guidance to understand the community priorities for the urban ecosystems.

Table 6.27 Ecosystem services, SDG objective and Human well-being targets

ES	SDG objectives	Human well-being
Provision of fresh water	Nº6: Guarantee water availability and its sustainable management	Human health
Provision of food	Nº2: End hunger, achieve food security, improved nutrition and sustainable agriculture	Local food security Human health Fisheries dependent livelihoods
Air quality regulation	Nº11: Make cities and human settlements inclusive, safe, resilient and sustainable	Human health
Local climate regulation	Nº13: Take urgent action to combat climate change and its impacts	Security from natural disasters
Flood hazard regulation	Nº9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation Nº11: Make cities and human settlements inclusive, safe, resilient and sustainable	Security from natural disasters
Storm hazard regulation	Nº9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation Nº11: Make cities and human settlements inclusive, safe, resilient and sustainable	Security from natural disasters
Water purification	Nº6: Ensure availability and sustainable management of water and sanitation for all	Human health
Recreation and tourism	Nº3: Ensure healthy lives and promote well-being for all at all ages	Tourism livelihoods Cultural identity
Aesthetic value	Nº3: Ensure healthy lives and promote well-being for all at all ages	Cultural identity
Spiritual and religious value	Nº3: Ensure healthy lives and promote well-being for all at all ages	Mental & spiritual health
Social relation	Nº3: Ensure healthy lives and promote well-being for all at all ages	Cultural identity Mental & spiritual health
Educational and research	N4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Mental & spiritual health
Provision of habitat	Nº15: Protect, restore and promote wise use of terrestrial ecosystems and stop biodiversity loss	Cultural identity

Source: Own elaboration (2020)

6.3.3.2 Developing Sub-step 3E: Planning BGI for wetland conservation

The different steps developed during the empirical approach gave inputs to build a master plan of BGI.

Table 6.28 Ecosystem services, SDG objective and Human well-being targets

Planning units	**English Name**	**Type**
PU1	Baquedano wetland	Palustrine wetland
PO2	El Loto wetland	Lacustrine wetland
PO3	Los Helechos wetland	Palustrine wetland
PO4	Las Ranas wetland	Lacustrine wetland
PO5	Teodosio Sarao estuary	Riverine wetland
PO6	Maullín river	Riverine wetland
PO7	Llanquihue lacustrine shore	Lacustrine wetland
PO8	Train line	Grass
PO9	Small square	Built environment

Source: Own elaboration (2020)

As an academic work, a rapid draft of a long-term vision city was proposed in Table 6.29.

Table 6.29 Rapid draft of a long-term vision of Llanquihue in terms of BGI

Long-term vision	Urban Llanquihue is transformed into a blue-green sponge city, houses are re-built to recover the floodable areas recovering some navigable spaces. Wetlands thrive surrounded by wetland forests. The parks and squares are resilient to stormwater and there are public boats for people to move around when the water is too high. The green and blue path are fully working and the city is being taken care by the urban dwellers.
Justification	The elevation of Llanquihue from a topographic study showed that all the urban area of Llanquihue is built over a floodable area varying between 51 - 52 [m] of elevation. This elevation es the same as the one from the lake upstream showing that the entire city is built over a floodable area. The city could set-up a long-term goal to transform itself

	into a sponge city it is possible city together with the historic photo-interpretation levels me to the conclusion that Llanquihue must be understood as a floodable city that I once was. Before being a human settlement, it was a delta for the outflow of the Lago Llanquihue. On early times, people use to get by boat to their homes. To achieve the human well-being targets and at the same time achieving the conservation targets stated at the Theory of Change it becomes necessary.

Source: Own elaboration (2020)

Table 6.30 General BGI strategies

General BCI strategy	**Description**
1. Protect wetland border	Protect the borders looks a way to stop contamination from streets, illegal domestic sewage. According to photointerpretation the wetland system has faced a constant refilling and fragmentation and needs.
2. Connect wetland waters	According to the photointerpretation the hydro-spatial analysis. Before the rapid urbanization process the wetland use to be connected. The lack of the water connectivity between some of the wetland may explain the eutrophication.
3. Restore wetland habitats	Recover a healthy state of the wetland

Source: Own elaboration combined with adapted PAM 2018

Table 6.31 Specific BGI strategies

Specific BGI strategy	**Type**	**Justification**
1. Enhance hydrologic connectivity within the wetland system.	Blue infrastructure	According to the photointerpretation from 1962 the wetland system was connected
2. Build green path between the close wetlands	Urban and green infrastructure	Enable mammals and birds to move from one wetland to another out-of-risk
3. Build swales, infiltration beds and water garden following the wetland perimeters exposed to the streets	Green infrastructure	Since the urban wetland are surrounded by the cities. There is a need to protect borders from the entrance of contaminated waters (industries, cars, domestic sewage).
4. Integrated constructed wetland using the abandoned train line into an artificial wetland and park for recreation and sightseeing	Blue, green and urban infrastructure	The train line, according to the NDMI index from different years shows a high index of water and according to the interviews is a frequent flooding place.
5. Convert the Sarao and Maullin restrictive zones into parks	Green infrastructure	According to the analysis of the planned and actual land-use various opportunities raised using restricted and protected zones.
6. Re-open and restore “Las Industrias” wetland	Blue, green and urban infrastructure	Based on the hydro-spatial analysis there should be a wetland at the south side of Maullín River.
7. Restore deforested riverine forest	Green infrastructure	Community-led restoration of lost forest coverage.
8. Define landscape basins in frequently flooded areas	Green infrastructure	Identify the most flooded zones in Llanquihue.

Source: Own elaboration (2020)

Developing a masterplan of BGI would connect with 9 of the 17 goals so they would help SDG’s. An example of a BGI urban design intervention in a palustrine wetland (“Baquedano” wetland) from the study case is presented in Annex G.

7 DISCUSSION

The understanding of the urban socio-ecological context as a complex system led to the development of an approach that responded to the general requirements established in Objective Nº2 proposing three-macro steps assembled in the SUWCP based on the Conservation Standards for wildlife conservation. During the development of the conceptual guidelines, the application of some of them with the study case usually demanded subtracting methods and tools to the most relevant for simplicity and effectiveness matters. Also, since the SUWCP was conceptualized as a collective interdisciplinary longer planning process, it exceeds the resources from the research timings. Thus, just a small portion of the SUB-STEPS were empirically executed.

7.1 SUWCP in a data-poor context

The first structural solution for this challenge was that the SUWCP recommends tools and methods specifically designed for data poor context. For example, the SUWCP hydro-spatial analysis recommended and described in SUB-STEP 1B based on Zhou et al. (2008) uses only a digital elevation model (DEM) as an input. It processes the information using a hydrology toolbox and delivers critical information such as, potential flood zones that could be translated to wetlands, sub-catchment area of each wetland, drainage hierarchy, stream orders. Despite the results, future development should consider toolbox specifically built for hydrological analysis in urban context to produce more accurate and useful data for areas where there is none or very low hydro spatial information. Another example is SUB-STEP 2D in which the SUWCP recommends the use of TESSA (a toolkit

for ES site-based assessment) to obtain critical ES information to later prioritize and make decisions in PLAN STEP. This tool was suggested because it was explicitly developed to aid conservation practitioners from the developing countries where usually there is no pre-existent information for the conservation projects in hand.

A second structural solution for the proposal of the SUWCP to tackle the data-poor challenge, was leaning into spatial conservation and tackling the problem diversifying the input data types. The combination of qualitative and quantitative input data from various sources and the recommendation of more than one action for every sub-step aims to offer resilience and adaptability to counterbalance the scarcity of data. The consideration of multiple sources of analysis was useful to complement the data-poor context enabling the UWCP to confirm and build a robust information. An example of the success of the method applied to the study case was obtained by the recognition of a new urban wetland (see "Las Industrias" wetland in Figure 6.3) as a conservation object that was not initially declared by the early maps and plans from a local conservation NGO. This was obtained by the first sub-steps of the ARRIVAL STEP using the hydro spatial analysis (e.g., Q-GIS, ArcGIS) revealing that the UWCP[8] can benefit from easy-to-use tools. The hydro-spatial analysis effectively showed the presence of a drainage system on the western side of the city that visual inspection and field observation did not sufficiently showed. Only

[8] UWCP: Urban wetland conservation practitioner

by the photointerpretation from the STEP 1A revealed that the first 4 photos (from 1962, 1972, 1981 and 1995) showed a possible urban wetland.

Although the empirical application of some of the sub-steps in the study case was successful, the application encountered some difficulties specially in quantitative analysis. For example, the difference between the 12,5 [m] by 12,5 [m] pixel of the satellite image against the smallest urban wetland from the study case. Nevertheless, this issue was tackled incorporating cheap old aerial photography from SAF (a Chilean military institution involved in aerial photography). The use of RS for the calculation of normalized indexes (e.g., NDVI, NDMI and NDWI) may be useful for the decision-making process but in the study case they were not so useful, since various images had clouds that not even atmospheric and radiometric corrections allowed to transform in sufficiently useful information. Therefore, it is recommended to obtain them from different years from same season to get more plausible and comparable results. Additionally, considering spending time in downloading images from different satellites (e.g., Landsat 4,5,7 and 8 and Sentinel 1 and 2). Nevertheless, the index enables the possibility to contrast the field work for the vegetation health with the vigorousness that the RS normalized indexes deliver and also see the evolution over time. The 30 [m] by 30 [m] that the Landsat 7 provided from 1999 and 15 [m] by 15 [m] Landsat 8 from 2013.

A third structural solution for the proposal of the SUWCP is the several recommendations of alternatives input sources that meet the common needs of the conservation practitioners.

And also suggests alliances with different stakeholders broadening the spectrum of data sources.

7.2 SUWCP in low-resources context

This second requirement was addressed mainly via four strategies. The fist, proposing free or low-cost tools (when paid tools were used by the researcher, free tools were also suggested in the SUWCP method descriptions). CS in low resources may benefit from easy-to-use spatial tools that may strongly improve information for the UWCP.

A second strategy is that the SUWCP explicitly recommends milestones that proposes the synergies and collaboration (e.g., sub-step 1A, 1F and 2D). This looks forward to share risks, resources and find common ground for the achievement of conservation goals with other stakeholders and partnerships.

A third strategy was the fundraising. It was initially not a problem when the conservation practitioner was characterized based on the book *"Adaptative Management: A tool for conservation practitioners"* by Salafsky et al. (2001). the interviews showed the need and urgency to address the funding challenges (e.g., SUB-STEP 1H and 3B). Together with designing sub-steps that contribute to the fundraising challenges that conservation practitioners face. The latter is achieved through SUB-STEPS 2E to 2 G that offer a direct method, literature sources and a proposal of direct linkages between biological conservation targets, ES, human well-being and SDG that serve as key information for funding purposes.

The fourth and last strategy incorporated into the SUWCP building, was the decision to bond the definition of the conservation actions with the development of a participatory BGI master plan. This enables new funding possibilities that are not directly related to conservation such as, stormwater management, urban planning and design and a group of other ministries that would not invest if it were not directly related. Conservation must translate the impact and generated value into a tangible results. Also, its understanding of the city as a socio hydro-ecological system offers a direct link between different disciplinary approaches to a complex problem broadening the action angles with which the conservation planning can be addressed in an urban context (Li et al., 2014). Since it offers direct ways for the conservation practitioner to face fundraising challenges offering explicit linkages between conservation targets, ES, human well-being targets and SDG, SUWCP facilitates securing conservation funds. Additionally, several interviewees pointed out that the fundraising must be faced diversifying the funding resources bearing in mind that the multiple stakeholders enable different networks, technical capacity and financial resources.

7.3 SUWCP in a low-technical professional context

SUWCP addressed this third requirement by three strategies. The first one was selecting CS from CMP (2020) and Ramsar Convention (1971). Both of them are widely spread and implemented worldwide. The latter, lowers the entry barriers for conservation practitioners.

It also tackles the challenge by specific deliverables that should be addressed with the aid of expert knowledge. As mentioned in the previous sub-section, the inclusion of Rapid Health Ecosystem Assessments, ES assessment based on TESSA, restoration prioritization following ROAM guidelines, among others in SUB-STEP 2D of the SUWCP are tools specifically designed and offered for less specialized professionals. Furthermore, the automatization of a big part of the methodologies supported by the web-based GIS tools (e.g., using the Model Builder tool) could potentially enable less experienced professionals to rely in this previously designed tools (e.g., Feng et al. (2011)).

7.4 SUWCP in a participatory planning context

Finally, the SUWCP solves the participatory engagement requirement conceptually based on the Framework Adaptive Socio-Hydrology from Schifman et al. (2017b) offering explicit participatory mechanisms. This enables different stakeholders to be integrated into the planning process accomplishing even better results, for example, in the BGI analysis (e.g., sub-step 1C, 1E, 2C to 2E, 2G, 2H, 3A to 3D). Participatory approaches were also suggested in SUWCP in the form of workshops, interviews, focus groups for the ES and BD mapping and description and other data requirements. Additionally, several interviewees pointed out that some of the lessons learned in their conservation efforts were that, in order to be successful in the planning and implementation process all the relevant stakeholders should be listened, considered and included.

7.5 Lessons learnt based on the SUWCP development and the study case

In the hydrologic and ecologic analysis (SUB-STEP 1A, 1B, 1C, 2A, 2H) steps from the application of the SUWCP, it can be noticed that the initial work area to achieve effective urban conservation results can change and must be periodically revised. In this case the local NGO was working with urban dwellers and was explicitly limited inside the urban limit borders, but the sub-catchment shows that at least one of the wetlands is directly affected by hundreds of hectares of rural areas that are mainly dedicated to livestock and crop production. Expanding this acknowledgment implies considering peri-urban/ rural as part of the conservation geographic scope from SUB-STEP 2A and also consider the inclusion of other key stakeholders from this areas. Thus, stakeholder engagement could contribute to more effective urban conservation and should be taken into account. This does not necessarily imply a scale change, but at least the work area for the conservation efforts.

Describing, modelling and mapping ES can be a robust approach to operationalize ES in urban planning to positively impact urban wetland conservation enabling decision-makers to acquire other funds not directly related to wetland conservation but mainly focusing on BGI. Due to research limitations some disciplines were left out from the first iteration of the SUWCP, examples of this disciplines are: education (e.g., nature as a platform for education), conservation easements (e.g., Conservation Easement Law) as a way to find agreements between private landowners and organized civil society looking forward to

having lievable greener cities, artistic and cultural interventions that improve wetland social visibility and valuation, among others.

Based on the review of spatial instruments, most of them showed to be rigid, non-holistic, and lacking explicit conservations of ecosystem services and/or wetlands ecosystems. Despite that fact, the recently launched Urban Wetland Law (Law 21.202) opens up broad opportunities for Chilean conservation. Urban wetland limits and borders are mainly what connect the urban fabric and the natural world thus, in order for urban dwellers to get the ES they desire they must rapidly prioritize urban design conservation strategies to protect their borders by the creation of public-private alliances that can facilitate resources. For this, the recently minimal sustainability criteria (Rodríguez-Jorquera et al., 2020) delivered to the Environmental Ministry provide criteria that match, complement and guide the SUWCP.

Is important to highlight that -except for the nº9 and nº13- most of the proposed criteria were addressed or at least mentioned in the SUWCP written guidelines.

Since urban wetlands are usually a nucleus of a bigger network of blue-green connected areas, conservation efforts for each wetland must be coordinated and be considered as part of an integral system to achieve the desired results. To achieve effective conservation UWCP should analysis and develop conservation strategies at urban, administrative, sub-catchment and basin scales. Finally, for further work, it is important to note that conservation practitioner interviews and literature review revealed key information related to methods for the rapid generation of data, strategies for defining conservation actions in

urban context, great benefits of working with stakeholders when working with wetlands, great need to tackle urban wetland conservation merged with urban planning among others. Also, as stated by Sciaraffia et al. (2019) and confirmed by the recognized urban wetland threats, the lack of an explicit landscape masterplan might be a contributing factor to the landscape fragmentation (e.g., loss of landscape corridors) and should be revised and included during the planning process. Each of the above-mentioned topics will continue to provide possibilities for improvement of the SUWCP.

The implementation of a standardized method such as the Conservation Standards and specifically the SUWCP might contribute to share experiences among countries, cities, regions and wetlands. This shared experiences may take part of the "social learning" approach from the Adaptive Management benefiting from the existing and new knowledge informing wetland conservation actions (e.g., perspective mentioned in Salafsky et al. (2001) *Adaptive Managemen;* Wantzen et al. (2019) *Urban stream and wetland restoration in the global south-a DPSIR analysis; Minimal criteria* (Rodríguez-Jorquera et al., 2020))

8 CONCLUSION

There is no need to reinvent the wheel to provide urban wetland conservation planning solutions. Urban wetland conservation practitioners with different level of technical expertise, low-resources and in low-data context can still execute a plausible conservation planning to finally improve effectiveness in urban wetlands conservation. The SUWCP proposes to tackle the urban wetland conservation structured in three clearly defined and easy-to-follow macro-steps. The macro-steps are divided in specific 26 sub-steps based on 52 key questions with each of their corresponding objectives, methods and their key references and input resources suggested. The positive attribute of the SUWCP comes from providing a planning framework for conservation that can easily be approached to suggest strategic and operation improvements facilitating the application of the Conservation Standards in cities from Chile and others in the developing world.

The SUWCP has three main strengths, the first is that tackles the scarcity of information with the integration of spatial data. This strategy to face the data-poor context aligns with the recent announcement that the CS are developing spatial applications in their guidance and tools for best practices for the conservation standards. This team is working on the future Spatial CS working group developing protocols and example for incorporating spatial data into Open Standards work.

The second strength is the explicit proposal of operationalizing the notion of BGI into the conservation planning process to tackle the new challenges that the conservation of wetland in an urban context brings. Contributing to the possibility of converging wetland

conservation with the need to design better cities goes aligned with the SDG 2030 (e.g., SDG 3, 11, 14 and 15) and also the recently Chilean Urban Wetland Law. This encourages and empowers conservation practitioners to better achieve results that can enable a transformation wetlands from being urban residual spaces to an opportunity for multiple ES delivery by designing for multifunctionality (Moreno, 2019a; Rojas, 2018). This notion that incorporates a view from landscape architecture enables the blending of scientific arguments from conservation with a graphical/ visual expression from architecture. The application in the study case demonstrated that influence of this material in the key stakeholders such as the major and the communities.

A third strength is the incorporation of scattered methods coming from the Ramsar Convention handbooks, scientific research of specific problems, local demands of Chilean conservation practitioners. The threats for urban wetlands around the world have similarities in the Chilean context and strategically can be attacked in a similar way. The compendium of steps and methodologies proposed during this research could easily be tailored and replicated in other small cities of the developing world with presence of wetlands or even adapted to other urban ecosystems. Despite the latter, the main research goal has been to draft a structured a process and not to do an exhaustive specific reference recommendations.

Despite the fact that urban wetland conservation in Chile is facing a rapid increase in attention coming from citizens, academia and politicians (e.g., during the realization of this research a law for urban wetland protection was passed; a wetland toolkit to inform

and facilitate citizen-driven allegations when a wetland is being threaten, among many others), there is a critical effort yet to be done to condense complexity into simple steps. Wetland conservation in urban areas in Chile must continue to be assisted and supported by academic research to keep updated and specific frameworks, methods and tools that conservation practitioners will require to achieve complex and interconnected conservation goals. Therefore, to continue improving this conceptual model there are three main future challenges recommended by the researcher are presented below.

The first challenge in urban wetlands is to deepen the integration of transdisciplinary to achieve new research goals and further develop the SUWCP since urban wetlands hold multiple stakeholders with clashing interests and even more complex city systems. As an example, facing urban wetland conservation understanding the city as a complex socio ecological system were uncertainty, insufficient data (e.g., BD, flora, fauna, water quality) and changing scenarios (e.g., climate change, administration changes, city planning changes) demand multi-discipline teams and collaborations may enable deeper and stronger understanding of the problems, solutions and considerations to be effective in conservation.

The second challenge is to continue exploring the explicit and implicit links that can be done between blue-green infrastructure and conservation. This may include representation from landscape architecture, urban planning, groundwater considerations, among other related fields. This combined with a more precise detection of the severity and urgency of the threats to the conservation targets may dramatically improve the conservation planning

process selecting the key intervention points for the development and execution of strategies considered in the respective plans and programs for urban wetland conservation. The third challenge is to explore the new challenges that bigger cities may bring to the SWUCP. In particular, the researcher suggests the exploration of scaling-up the participatory methodologies of the key stakeholders where there are simultaneously multiple local governments involved, and the decision-making process gains complexity and uncertainty for the conservation planning. Since the information collected by the stakeholders has a radical impact in the final decisions made applying this conceptual mode a second future challenge could be to test diverse participatory methodologies to improve the selection and representation of stakeholders. This consideration has one of the highest impacts in the prioritized ecosystem services, thus in the modelling, mapping and defined strategies to achieve conservation results.

Finally, the SUWCP due to the combination of the CS, BGI and Ramsar Guidelines provide a series of tools that may be used to achieve coherent and useful results despite the different challenges that Chile and other countries in the developing world face. In fact, it offers complementary steps and considerations that may contribute to the operationalization of the criteria from the recently launched Urban Wetland Law -that recognizes the existence and protection of urban wetlands. This law opens up opportunities for a new era in wetland conservation planning. And also, offers an explicit bridge between conservation and BGI for future master planning that could aim to renature and rewilding cities considering the urban wetlands embedded inside them. Furthermore,

SUWCP matches the demands of the 8 criteria included in the new Ramsar City Wetland Accreditation and the goals stated National Wetland Plan 2018-2022, thus, potentially empowering Chilean conservation practitioners to begin working the accreditation process in the cities they work.

The incorporation of BGI planning solutions should always consider specific in-site solutions, typologies and strategies. They were not extensively included in this research and might represent an opportunity for future research (e.g., NBS design guidelines for urban wetlands, online conservation planning assistance, ES and BD online tools, BGI guidelines).

Also, the understanding of cities as socio ecological system demands urban wetland conservation planning to deeply comprehend a social, cultural and economic perspectives (e.g., shift of natural areas from recreational open spaces to ecological infrastructure; from green small areas of grass to landscape activation). Urban wetlands hold an important potential and should transit from mostly residual urban areas to healthy and well-planned renatured places (e.g., combination of floodable parks, urban natural parks, Ramsar sites, restoration sites, natural reserves, nature sanctuaries) serving as nodes, corridors and/or nucleus of an interconnected network of natural areas. The latter, aiming to create more resilient, renatured and harmonious cities for the future challenges ahead (e.g., pandemic, extreme meteorological events, over population, fast urbanization).

Finally, since there are plenty of options, experiences and scientific methods, and it is known that the UWCP are usually limited in time and funding, their learning curve and

effectiveness should be accelerated as much as possible. Structuring the planning process SUWCP is an attempt to offer a resilience and potentially useful inputs for future development of guidelines, frameworks and tools designed to assist conservation practitioner aiming to increase their effectiveness. Due to the current urban wetland threats, the social dimension of the problem should be considered as extremely important for future development of CS guidelines/frameworks and tools diversifying the tactics to achieve effective conservation.

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APPENDIX

A. INTERVIEWEES

Andrés Riveros (ariveros@gmail.com)
Architect and Master in Wild Areas and Nature Conservation, Universidad de Chile. More than 10 years of professional experience in the private and public sphere in the generation, management, design and implementation of urban projects, architecture, nature conservation and education. He develops his work from a participatory and socio-ecological perspective in search of sustainability. Currently, dedicated to territorial planning and intervention, urban and architecture design, consultancies in conservation and landscape ecology through the Fundación Legado Chile, Latitud 41 Sur and Andrés Riveros Arquitectos.

Camila Teutsch Barros (camila@patagua.cl)
Natural Resources Engineer, University of Chile, MSc. Integrated Water Management, University of Queensland, Diploma in Austral Landscape Design, Austral University of Chile. Co-founder and executive director of Patagua consulting B Corp. She worked in the General Water Directorate in charge of the implementation of the National Strategy for Integrated Management of Hydrographic Basins in the Baker River basin. She has worked as a consultant for UNICEF's Water and Sanitation Program for Latin America and the Caribbean and was an ambassador for Latin America for the International Water Center.

Fernanda Flores (nandi.flores@gmail.com)
Wildlife tourism guide and ornithologist. Birdwatching tourist guide at "Humedal Culebrón". Thesis research *"Propuesta de circuito de observación de aves, para la valoración del humedal costero urbano El Culebrón, Región de Coquimbo".* Tagua-Tagua natural park wildlife tourist guide. Bird monitor at "Humedal Limarí" together with the local community "Peral Ojo de Agua".

Francisco Jaime Paredes (francisco.jaime.p@gmail.com)
Wetland conservation activist. Co-founder of a citizen wetland conservation network "Red ciudadana por los humedales de Valdivia". Since 2005 in charge of the Project Office of the Ecological Committee of the Angachilla Wetland. Project manager of the "Consulta ciudadana Humedal Angachilla". Active member of the board "Angachilla" Community Park. Responsible for the territorial engagement in the consultancy for the Angachilla Wetland Nature Reserve declaration by the Environmental Ministry. Anthropologist, Universidad Austral de Chile.

German Guzman Gunderman (gguzman@uc.cl)
Architect and master's in landscape architecture, Pontificia Universidad Católica de Chile. Nature photographer, conservationist. Teaching assistant in the School of Architecture UC and currently working as a research assistant of the Fondecyt project: *Desmontando el*

plano de Ernesto Ansart y el plan de transformación de Benjamín Vicuña Mackenna. Landscape architect at the "Parque Humedal Baquedano".

Jens Benöhr (jens.benohr@gmail.com)
Anthropologist, kayaker and National Geographic Explorer. Master's degree student in Ecology and Evolution at Universität München (c). Dedicated to river conservation, environmental education and science communication. Leader of the worldwide project Home River Bio Blitz, aiming to collectively generate critical data from rivers all around the world by volunteer citizens. Co-founder of *"Bestias del Sur Salvaje"*, organization linking sports and conservation. Member of the "The River Collective: Connecting Scientists and Conservationists".

Liliana Iturriaga (cursohumedales@gmail.com)
Professor of Natural Sciences, Biology, Botany. Landscape diploma Pontificia Universidad de Católica. Environmental activist. Extensive experience in wetland restoration and conservation projects, scientific advisor to NGOs such as the Kennedy Foundation and the formation of conservation groups and corporations. Director and teacher of "Biodiversity and Wetlands Conservation" course at the Santo Tomás University. She has worked in the following wetland natural sanctuary declarations: *"Humedal de Batuco", "Humedal El Culebrón", "Humedal de Tunquén", "Quebrada Córdova", "Humedal Urbano La Señoraza"* and *"Humedal Urbano Batuco"*.

Pablo de la Riva (pjdelariva@gmail.com)
Hydraulic Civil Engineer, Pontificia Universidad de Católica de Chile. MSc. Water resources University of Copenhagen. Project engineer Artificial wetland designer.

Sol Díaz de la Fuente (soledad@somosaldea.org)
Social worker Pontificia Universidad de Católica de Chile. Executive Director of *"Fundación Aldea Arquitectura, ciudadanía y aprendizaje"* Architecture and heritage specialist. Leader of a water participatory recovery project "Parque la Memoria de la Vertiente". Leading community design sessions of the "Parque Humedal Los Batros". Has also worked heritage, architecture, and active education. Oh! Stgo Festival Director.

Victor Lobos (vlobosg@gmail.com)
Degree in Biological Sciences, Universidad Católica de la Santísima. Concepción. M.Sc. Environmental Management and Planning, University of Chile. PhD (c) Environmental Engineering, Technical University of Lisbon. 13 years of experience in the formulation of public policies for sustainability, expert in SEA, application experience in Chile and abroad, member of academic and international research teams on the subject. Various publications in this field. Director of Stratas Consultores S.A., a company specialized in the development and application of instruments to support decision-making in matters of the environment and sustainability.

B. REGION DE LOS LAGOS DESCRIPTON

According to the MMA (2018), the Los Lagos Region is the third region with the largest wetland area corresponding to 250,923 ha. of which only 17.63% have some category of protection. The regional hydrological system is composed of four main basins - Petrohué River, Puelo River, Yelcho River and Maullín River - the latter was declared by the CONAMA (institution prior to the Environmental Ministry) as a Priority Conservation Site for the National Biodiversity Strategy, as it houses 60% of Chilean migratory birds (FLC, 2018). Moreover, is one of the regions with the most presence of wetlands in Chile.

C. SUWCP DETAILED STEPS AND SUB-STEPS

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1A Develop city-region general context	What is the general context of the study area (city-region)?	Create a general notion of the demographic, climatic and landscape description of the city and region.	To start the conservation planning process for the wetlands inside a city, a basic social, climatic/hydrological economic, ecological, political background knowledge is useful. This knowledge must come from different reliable sources of information. It may start by a desk research of the basic demographic, climatic and landscape information. Achieving these outcomes in a data-poor context demands primary and secondary sources, such as, direct interaction with urban dwellers, analysis of aerial photography and satellite imagery together with other sources such as books, policies, etc. (Johnston et al., 2013). It is also useful to look for other conservation-related projects at different scales such as city/region/basin. It is also necessary to do in-site in person visits to the prospect study area (FLC, 2018). Finally, a initial approach to defining the CS geographic scope is recommended (CMP, 2020)	1. Demographic data of the city, basin and region 2. Catchments attributes and meteorology of the city, basin and region	1. Land-use raster layer 2. Protected area regional map 3. Possible geographic scope
(ARRIVAL) 1B Analyze the hydro-spatial context of the urban wetland system	What are the basic hydro-spatial conditions of the urban wetland system?	Develop a hydrological overview of the urban wetland system to later assess the hydro-ecological status for the ecosystems	Once the general context is developed, the SUWCP recommends an hydro-spatial analysis can be done to create basic hydrological information of the area. Further on, this analysis will enable the research and understanding of potential threat to the wetland conservation. SUWCP suggest a low-data approach using GIS tool such as "Integrated ecological assessment of biophysical wetland habitat in water catchments: Linking hydro-ecological modelling with geo-information techniques" (Zhou, Gong, & Liu, 2008). This method uses just a Digital elevation model (DEM) to develop a digital water-system and a hydrological zonation. Some of the possible outcomes of the workflow proposed include: - Water bodies - Sub-catchment surfaces - Drainage hierarchy - Basin surface - Stream network - Inflow and Outflow from the individual wetland units	1. Digital elevation model	1. Hydrologic raster layer and Hydraulic Report 2. Map of potential wetlands and sub-catchment
(ARRIVAL)	Are there any other wetlands that	Complete recognition of the urban	The SUWCP takes into account that the conservation efforts will be done in an urban context, thus, it is possible that some of the potential wetlands digitally modelled in the previous steps may have been severely modified.	1. Hydrologic raster layer and Hydraulic Report	1. Map of potential wetlands and sub-catchment

Sub Step	Questions	Objective	Method description	Input	Output
1B Analyze the hydro-spatial context of the urban wetland system	I have not recognized on the field and/or with the satellite images?	wetlands based on the previous hydrologic analysis	A field recognition is recommended to compare and assess the modelled analysis. When encountered with major differences, a third low-cost input sources is recommended such as satellite images recommended in further steps. These findings, (as will be shown later in the study case of the present research) may lead to interesting findings such as previously unrecognized urban wetlands that maps, field work or other sources had do not previously shown.	2. Wetland sub-catchment map 3. Stream order map	
(ARRIVAL) 1B Analyze the hydro-spatial context of the urban wetland system	How and where does my geographic scope change if I add the sub-catchments of every wetland?	Develop a more accurate geographic scope according to the modelled sub-catchments of each recognized wetland	Once an initial hydrology-driven analysis is done it is suggested to compare the map of the initial geographic scope with the area that includes the sub-catchment of every urban wetland. Since cities are dense it may be found that the sub-catchment of the wetland may exceed the administrative boundaries of the city and or the defined geographic scope. (as will be shown later in the study case of the present research)	1. Initial geographic scope 2. Wetland sub-catchment map	1. Updated conservation geographic scope
(ARRIVAL) 1C Understand the regulations affecting linked to the urban wetlands	How do the primary and most relevant local regulations regulatory policies impact my urban wetland conservation planning?	Understand a general legal framework for the conservation planning	Select, read and identify the key components of the normative figures, spatial planning instruments that may be related to the city and its wetlands. As an example, it may be considered the Urban Wetland Law and its local relevance if there is a officially protected wetland under this law. It is also suggested to review local regulations and spatial planning instruments that may be affecting or protecting urban wetlands. The analysis of the above mentioned policies should take into account: i) general and specific objectives, ii) maps, iii) restrictions iv) spatial planning strategies and legislative frame. To aid this analysis there are some suggested literature to review: "El Ordenamiento territorial en Chile" form Precht et al. (2016), "Toolkit de humedales urbanos" from Bergamini et al. (2020)	1. Pladeco "Plan de Desarrollo Comunal" (Communal Development Plan) 2. Municipal environmental regulation 3. Wetland urbans law (Ley 21.202) 4. Urban wetland cadastre of MMA. 5. ZOIT 6. ERD, 7. PROT	1. List of existing protection policies and legislative frames 2.Main regional development objectives for the commune 3. Main communal development objectives 4. Maps of: green areas, protected areas, restricted areas, urban growth 5. Assessment chart of benefits and limitations for each instrument

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1C Understand the regulations affecting linked to the urban wetlands	Are there other relevant legal documents and publications directly or indirectly concerning urban wetlands?	Fill the gaps of any critical piece of information that must be taken into account for wetland conservation	Once the critical information is reviewed and key components are extracted knowledge gaps should be explicitly identified and addressed through other sources, direct interaction with local policy and regulation makers.	Examples: 1. Wetland national plan 2. Urban wetland law	None
(ARRIVAL) 1D Understand the city-wetland relation	What and how many urban wetlands do I identify by satellite or aerial images?	Quickly develop a big picture identifying the urban wetland in the initial study area	In order to develop a proper plan for conservation, including a BGI spatial the relation between the city and the wetland must be clearly understood. To attain this goal objective a first approach is suggested through a quick wetland recognition. This, must be done to identify the visible wetlands and define explicitly define them as conservation object based on photo interpretation analysis and satellite image analysis. (FLC, 2018)	1. Satellite images 2. City websites 3. National and/or regional wetland census from private or government institution	1. List and map of potential conservation object
(ARRIVAL) 1D Understand the city-wetland relation	What type of wetlands do I see?	Quickly classify the identified wetland in one of the Ramsar types	Since the conservation planning is located in a data-poor and low-resources context it is recommended to run a pre-classify the wetlands by visual inspection of satellite images and/or historic photography. This pre-classification can be done following the Ramsar classification proposed in the "Recommendation 4.7: Mechanisms for improved application of the Ramsar Convention" (Ramsar, 1990). After, this pre-classification is done it must be verified doing field work. After this desk and field classification is finished it can be validated by with expert knowledge.	1. Output from 1.1A.2 (Question2)	1. Wetland type map 2. General wetland description

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1D Understand the city-wetland relation	How has the city in general and the wetlands in particular evolved over time?	Develop an informed view of the big picture of the city to understand the main dynamics in terms of urban fabric growths and their relation to wetlands.	Since the wetlands (our conservation objects) are embedded in city it is necessary to develop a basic understanding of the city growth dynamics. This must be conducted paying special attention to the past and current relation to the wetlands. For the latter, the SUWCP suggest low-cost and low-data approach to level-up the understanding of this matter. Run a historic multi-temporal photo interpretation analysis identifying qualitative and quantitative changes in the land cover of the city with special attention on the urban wetlands. This analysis must be semi-assisted, which means that together with the visual inspection of the images just as they are shown it must be complemented with local knowledge and other sources of information from previous to accurately notice the wetland. This method suggest that you draw a clear borderline for each wetland recognized from the oldest photograph or satellite image available and then continue to carefully repeat the same procedure for the following photograph/satellite images. The end-result of the methodology proposed can include arrows, borderlines, colored areas where the wetland surface was lost (or recovered) through the years. This will create a basic overview that identifies critical changes in the urban fabric in its relation to wetlands (as will be shown later in the study case of the present research), therefore contributing to a better understanding of current trends, threats and insight into how to avoid them.	1. Historic photography 2. Satellite images	1. Wetland surface evolution data 2. Wetland surface evolution chart 3. Wetland surface evolution map
(ARRIVAL) 1D Understand the city-wetland relation	What direct and indirect past, current or future threats do I recognize for the urban wetland conservation?	Clearly identify the main threats that need to be tackled for the conservation of urban wetlands	Once an initial understanding of the city dynamics is built. It is time to explicitly recognize the apparent (and perhaps self-evident) threats. This individualization of threats will be then incorporated into the Conceptual Model of the next step. For this identification, it is suggested to Visual analysis of the maps obtained in the previous sub-steps to discover and describe the threats based on the following list: deforestation, overfishing, refilling, fragmentation, poaching, contamination, draining, among others as this are the most common threats for urban wetland un Chile (Ramsar 2012; Rojas, 2018) . These direct threats must be scrutinized by a clearly defined categories, as proposed in the CS CMP (2020) and PAM from FLC (2020) as Viability Assessment, adding three independent categories to the decision-making progress to select which threats to tackle first and how. These three categories are: i) Severity, irreversibility and urgency.	1. Output from 1.1A Previous questions	1. Map of threats per wetland 2. List of wetland threats 3. Map of the conservation object temporal evolution (filling and fragmentation)

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1E Understand current hydro-ecological status of urban wetlands	Which are my wetland system hydrological basic features?	Generate a practical description of the wetlands	In the conservation planning process of urban wetland (as in other ecosystem) it is necessary the develop a preliminary conceptualization of the study area when you are situated in a data-poor context. The SUWCP understand this study area as a socio hydro ecological system. Thus, it is time to conceptualize this system. The drainage hierarchy, obtained in previous sub-steps together with the vegetation and water indexes (e.g. NDMI, NDWI) together with the field work, Ramsar classification and visual interpretation contribute to the building of a report conceptualizing the system. Method of McFeeters (1996) Method of Gao (1996)	1. Digital elevation model 2. List of existing urban wetland 3. Map of the urban wetland	1. Basic features of the wetland: Total area, shape, Maximum and mean depth, bathymetric map, nature of sediments 2. Hydrology: Inflows, Outflows and Water level changes"
(ARRIVAL) 1E Understand current hydro-ecological status of urban wetlands	Which are my wetland system vegetational basic features?	Estimate the quantity, quality and development of the vegetation	To contribute to the understanding of the hydro-ecological status of the urban wetland system. A quantitative but low-resource approach can include a Remote Sensing easy analysis to develop normalized indexes that and provide initial information. Following the previously mentioned study "Integrated ecological assessment" proposed by Zhou et al. (2008). the vegetation recognition and bodies of waters can be summarized in the normalized indexes of vegetation (NDVI). It allows to estimate the quantity, quality and development of the vegetation. It allows to estimate the quantity can be developed. quality and development of the vegetation based on the measures. To follow the proposed methodology follows Method of Monteith (1981) NDVI=((NIR-Red))/((NIR+Red))	1. Satellite images 2.	1. Vegetation indexes maps (NDVI, NDWI)

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1E Understand current hydro-ecological status of urban wetlands	What is the currently identified flora and fauna conservation state?	Collect, organize and build a list of the flora and fauna potentially involved in the conservation planning.	With all the above-mentioned sub-steps, methods, questions, inputs and outputs it is time to give special attention into the existing flora and fauna relying on the wetland system as habitat and provider of key resources. This analysis will provide invaluable information for the decision-making process that the conservation practitioners must harness in order to achieve the desired outcomes as declared in the Conservation Standards (CMP, 2020). A proposed step-by-step process is presented above. 1. Define a geographic scope of the conservation planning 2. Background review of: i) scientific papers related to the study area ii) Environmental impact assessment and studies 3. Rating the conservation state of each listed species 4. Develop a summarized chart with at least the following columns: Order, Family, Scientific name, Common name, Environment, Conservation State. An example of this final deliverable is presented in the study case of the present research. FLC, 2018	1. Scientific papers 2. Environmental impact assessment 3. Environmental impact studies 4. Local flora and fauna field books 5. National, regional or local flora and fauna conservation status	1. List of species of flora with their associated conservation status 1. List of species of fauna with their associated conservation status
(ARRIVAL) 1F Map the urban wetland stakeholders (FrASH)	Who may be the stakeholders that may have a primary and secondary interest on the urban wetlands?	Know, identify and understand the social complexity of the work area looking to include stakeholders early-on in the planning process and look to work with them and in every step of the way.	As stated on the OS manual: "You should use your stakeholder analysis to select target audiences whose behavior you want to affect" (CMP, 2013). Based on the principles stated by (Stoll-Kleemann, 2004), a participatory management approach is needed. The WETwin decision support framework (Johnston et al., 2013) acknowledges that the decision processes in the planning of wetland are subjective and driven by the needs and interest of particular groups, therefore an early recognition and engagement needs to be done. Later-on the stakeholders are involved in the construction of the conceptual model. Identifying the power institutions and individual decision makers enables the access to potential resources and influences that will have a direct impact on the evaluation of solutions step effectiveness of the management model. In a socio hydro ecological system must understand that their inhabitants/ urban dwellers/ authorities/ landowners, among other can (and must) be part of the planning process (FLC, 2020). Therefore, as the Conservation Standards describe, it is important to identify the relevant stakeholders for the conservation planning and future execution of the urban wetland conservation project (CMP, 2020). This process will eventually enable access to potential resources, key informants, useful contacts, adherence, etc. 1. Create a list of stakeholders based on city official and non-official sources 2. Desk research of social media accounts and webpages related to the city 3. Complement the list by the direct interviews with key informants 4. Run workshops for different wetland stakeholder at different administrative levels	1. Chile national cadaster of environmental NGO 2. Public meeting minutes from government and non-government projects related to the city	1. List of potential key stakeholders 2. Influence map of key stakeholders.

Sub Step	Questions	Objective	Method description	Input	Output
			5. Find opportunities for engagement defining initial strategic partners to start the development of the conservation planning Some initial questions recommended to organize the key stakeholders are: What is their primary interest? Who can they influence? What are the relations between these stakeholders? What is their hierarchical position? Past and current conflicts? ES and disservices main interest? An example list of potential stakeholders in a Chilean city are presented below based on the FLC (2018) manual propose (they are presented as a list with the Chilean common name in parentheses): 1. Neighborhood committees (JJVV) 2- Local government employees and authorities 3. Regional government institutions related to environment (MMA), housing (MINVU: EP, SERVIU), Agriculture (MINAGRI: CONAF, SERNAPESCA) y Public constructions (MOP: DOP, DGA, DOH) (MMA, SERNATUR, CONAF, SERNAPESCA, MINVU, MOP), 4. Environmental responsible from private companies sector 5. Local leaders		
(ARRIVAL) 1F Map the urban wetland stakeholders (FrASH)	Which could be your i) main organization, ii) major participants, iii) minor participants?	Obtain a ordered and clearly defined potential level of key stakeholder commitments visualized in a friendly manner with the aim of achieving a conservation plan and BGI plan.	Once the stakeholders are listed, mapped, characterized and describe it is recommended to start a continuous engagement process with them. This engagement must be explicitly functional to the planning process. Thus, the SUWCP suggest following the "Framework for adaptive socio-hydrology method (FrASH)" proposed by the EPA in the Schifman et al. (2017). This method looks for a structured approach towards working with a network of stakeholders that can enable a better decision-making process for planning and situating BGI infrastructure installations in the city. Therefore, improving the generation of strategies and actions aligned with the final result of urban wetland planning conservation. Use the Chambered Nautilus Visualization Model to classify Organization types using the list and map created in previous sub-steps. The Nautilus chambered will be and internal visualization of stakeholders that will be updated periodically.	1. List of potential key stakeholders 2. Influence map of key stakeholders.	1. Nautilus visualization chamber

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1G Proximity assessment to protected area for conservation (BGI)	Are there any protected areas nearby? What are they protecting?	Identify potential connectivity zones and create steppingstones between areas.	On one hand, due to the lack of sufficient information for the planning process, the SUWCP proposes the collection of information from indirect sources such as other conservation project nearby the geographic scope. On the other hand, to develop a BGI spatial plan that connects with other relevant priorities and strategic conservation projects. A simple approach to identify these projects can be to simply look through a national map of conservation project. It can be complemented with private conservation project from other resources. As a third option, a simple proximity assessment using GIS tools is presented below: 1. Identify the private or public areas protected in the study area (in city, district or regional level) for this you can review them in the National Register of protected areas from MMA. 2. Once you have acknowledged these areas you can use the tool 'near' ArcGis to identify the AP closer to the study area.	1. Proximity map of the planning unit to the closest protected areas	1. List of nearby protected areas 2. Co-relations between the identified species in previous sub-steps and the species present in the protected areas
(ARRIVAL) 1G Proximity assessment to protected area for conservation (BGI)	What potential opportunities do I recognize from the other protected areas that could benefit my UWCP?	Look for opportunities connecting with already existing protected areas to improve the planning process	Once you have identified the closest private or public protected areas it is time to leverage on the potential opportunities. Some of the possible opportunities are listed below: 1. Recognize potential priorities for the Blue Green Infrastructure, such as, ecological corridors or corridors that can guarantee a habitat (Schifman et al., 2017) 2. Run a comparative analysis of endangered species to identify common ground and needs to build future partnerships and collaborations 3. Build stronger teams and relations with other key stakeholders 4. Assess the need for corridors to guarantee connectivity between blue-green areas (Kukkala & Moilanen, 2017) 5. Matching common interest and objective to find ways to improve the future fundraising endeavors for the strategies and actions prioritized in the third Step (PLAN) 6. Collaborate in scientific research among common grounds fields that generate win-win benefits for everyone involved 7. Obtain lessons learned from previous conservation experiences achievements and defeats	1. Protected area regional map	Protected areas proximity map Written strategy for

Sub Step	Questions	Objective	Method description	Input	Output
(ARRIVAL) 1H Building the conservation team	What are the key professions to build a team to achieve the future conservation challenges?	Define a result-driven conservation team that enables the planning and implementing process	Comprise an initial project team following the Open Standards 1A (CMP, 2020). This team must meet the requirements of the planning and implementing process. Since conservation in urban environments demands different knowledges, an interdisciplinary team is suggested to maximize the success chances. The UWCP suggest to consider a team, board of directors and advisors that meet the following criteria: - Gatekeeper to expert knowledge such as: academia, conservation scientist, research centers - Professionals closely connected to media and other relevant communication forms - Professional GIS advance trained - Business professional that may bring links between the conservation actions and the private sector for funding - Conservation standards coaches or professionals - Public sector senior advisors - Experienced conservation practitioners from other projects and fields - Urban planners/ Architects and/or fields related to decision-making in the city planning It is also suggested to create a group of ad-honorem experts and advisors that will contribute to make informed decisions, enable networks and influence the strategic decisions.	1. All the maps generated 2. Nautilus model	Description of the program team
(ARRIVAL) 1H Building the conservation team	How can I fulfill the climate change considerations into the conservation team?	Include climate change considerations	Consider including one or more climate change specialist to support the planning and implementing process by the prospect effects of climate change scenarios over the geographic scope and conservation targets (CMP, 2020).	1. All the maps generated 2. Nautilus model 3. Climate change scenarios	

Sub Step	Questions	Objective	Method description	Input	Output
(ASSESS) 2A Define geographic scope and conservation targets	What is the geographic scope for the conservation project?	Define a place-based scope for the conservation planning	After the ARRIVAL step is done, it is time to define a scope. The SUWCP proposes a place-based scope initially defined by the administrative city limits and then expanded by the hydro-spatial analysis, hydro-ecological assessment and city-region considerations done in previous steps. This geographic scope must be represented in a clear map that can be then socialized with stakeholders and other audiences. Also, as the CS defines: climate change views must be taken into account. Are the ecosystems or species ranges likely to shift (latitudinally or altitudinally) or the distribution of species within an ecosystem is likely to change. If this is the case, you will probably need to increase the size of your project scope.	1. Wetland sub-catchment map 2.	1. Geographic scope map
(ASSESS) 2A Define geographic scope and conservation targets	What will my limited conservation targets be?	Define the wetlands that you are going to protect as a group of conservation objects	As was previously defined in the ARRIVAL STEP, conservation targets must be clearly defined. For the case of the SUWCP, the suggested conservation object should be the identified urban wetlands. To clearly define the wetlands the ARRIVAL step provided with spatial information from the temporal evolution as well as the current state. These potential conservation target should be visited on site.		1. Conservation target map
(ASSESS) 2B Study of the city dynamics for the BGI	What is the current and planned city land-use?	Deepen the understanding on the city dynamics	To progress in the pursuit of the understanding of the basic dynamics in which the urban wetlands (already defined as the conservation targets) are located. It is recommended to study the land-use. This study should start by analyzing the critical differences between current land-use and valid spatial city plan land-use to recognize current or potential threats and opportunities for the conservation of the urban wetlands (Grêt-Regamey et al., 2017). This analysis must be driven by the best available information such as, current and old spatial plans (land-use, land-cover) and field work to deepen the understanding of the city dynamics looking for their effects on wetland conservation. It can also be aided by the previously obtained maps of normalized indexes and city photographs(Zhou et al., 2008). Examples of possible finding may be refilling of wetlands, un-planned threatening construction projects, vacant lots with potential for wetland conservation. In Chile, the permitted planned land-use and urban limits may be obtained from the Communal Regulatory Plan or Intercommunal Regulatory Plan. This information must be contrasted with field work across the city.	1. Multi-temporal images 2. City spatial planning instruments	1. List of critical differences between current land-use and valid city spatial planning 2. Map of differences

Sub Step	Questions	Objective	Method description	Input	Output
(ASSESS) 2B Study of the city dynamics for the BGI	How does these city dynamics represent an opportunity for the masterplan of BGI as a strategy for urban wetland conservation?	Find explicit opportunities to develop a BGI masterplan	Now that you have a big picture of the city dynamics from STEP ARRIVAL complemented with the land-use analysis from previous sub-step BGI opportunities can be looked. 1. List the explicit opportunities that the critical differences between the regulated plan use and the current empirical land-use offer for the development of a BGI plan (e.g. planned restricted or protected land-use in the city that have not yet been materialized in urban infrastructure and might be addressed as urban blue-green infrastructure) 2. Classify the different land-use as the category of risk to the urban wetland and/or upgrades. 3. Identify large elements (linear and non-linear) of the city that may act as nodes, corridors or areas for blue-green infrastructure interventions (Moreno, 2019). 4. Generate a map that show the potentiality of this BGI infrastructure potential interventions to the enhancement of the relation between the city and its wetlands	1. List of critical differences between current land-use and valid city spatial planning 2. Map of differences	1. Map of the spatialized opportunities 2. List of opportunities
(ASSESS) 2C Rapid assessment wetland health	What is the current health of the urban wetlands?	Create a general overview of the urgency and irreversibility of the urban wetland ecosystems health	Build an ecosystem health report, such as the Rapid Assessment of Biodiversity (Ramsar Convention Secretariat, 2012). As said in the GUIDELINES FOR THE RAPID ECOLOGICAL ASSESSMENT OF BIODIVERSITY IN INLAND WATER, COASTAL AND MARINE AREAS: "This health report should involve collection and analysis of qualitative and/or quantitative information on the occurrence of various kinds of organisms in a defined area or habitat of interest, by actual field surveys." This assessment can go as one of the following types: 1. Baseline assessment - Baseline inventory - prioritization; conservation; identification 2. Species-specific assessment - Conservation of specific species; status of alien species 3. Change assessment - Change detection 4. Indicator assessment - Overall ecosystem health or condition, and 5. Resource assessment - Sustainable use of biological resources This information may contribute in the recognition of the general ecological health of the landscape related with urban wetlands.	1. List of existing urban wetland 2. Field observation	1. Wetland Rapid Ramsar Assessment Biodiversity 2. NDVI, NWI and NDMI maps 3. Health Viability Assessment

Sub Step	Questions	Objective	Method description	Input	Output
(ASSESS) 2D Characterize the ES from each wetland and link them to key stakeholders	What are the current ecosystem services that the wetlands are providing?	Obtain qualitative and/or quantitative information	To develop a participatory conservation planning it is important to start working from the map and basic features of the wetlands systems as recognized firstly in the ARRIVAL STEP. Now it is time to explicitly define (and hopefully quantify) the ES supply and demand. In data-poor context a first approach must be made by the qualitative description made in previous steps. It can also be aided be the use of TESSA Toolkit for Ecosystem Service Site-Based Assessment. These tools serve low-data context with a systematic approach to quantitatively or qualitatively assess ecosystem service. Once these first two steps are reached it may be supported by modelling and mapping tools (e.g. InVEST modelling). To assist the selection of the specific tool for the ES mapping the ValuES Project tool (http://aboutvalues.net/) is recommended. This analysis will support the definition of the BGI masterplan, prioritization, fundraising and negotiation with stakeholders.	1. TESSA ES Assessment 2. ES Maps	Raster layer for each prioritized UES
(ASSESS) 2D Characterize the ES from each wetland and link them to key stakeholders	Who benefits from this ES?	Identify the different groups receive as human-wellbeing benefits from the demand of ES from the urban wetland system Characterize the benefits that each wetland provides to the neighbours and other urban dwellers.	Characterize the benefits that each wetland provides to the key stakeholders such as neighbors and other urban dwellers. To develop a participatory conservation planning it is important to explicitly recognize who is actually receiving the wetland ecosystem services and disservices. 1. Develop a initial guess of the ES that each urban wetland is providing and who could be the beneficiary 2. Link the ES to human-wellbeing (CMP, 2020) 3. Spatial analysis using a GIS software such as ArcGIS or Q-GIS. Run a proximity or buffer analysis to map the 900 meters that is considered a walkable distance. 4. Run a series of workshops or participatory cartographies with the urban dwellers of the city to clearly identify who are receiving the ES and what services are they receiving (FLC , 2018) 5. Characterize the benefits of each wetland ecosystem services. 6. Synthesize the results via visualizing the ES, human-wellbeing, beneficiary groups	1. Wetland maps 2. List of ecosystem services 3. List of human-wellbeing targets	1. Natulius chamber visualizing ecosystem services and the groups that receive them 2. Conservation situation including the ES and human-wellbeing targets 3. Map of proximity to wetlands

Sub Step	Questions	Objective	Method description	Input	Output
(ASSESS) 2E Connect ES to human-wellbeing targets	What are the current human-wellbeing targets that the wetlands are providing? -	Enable a direct linkage between conservation targets and human well-being targets	Since wetlands deliver a wide range of ES, benefiting people it is recommended to explicitly link their ES to human wellbeing targets. These may be argued through practical purposes such as increase the influence over the decision makers, wider the fundraising opportunities, increase stakeholder's engagement. Conservation practitioner face negotiations were the conservation effort must be judged against other dimensions. Thus, ES enable a direct transformation from nature to explicit human benefits. Some human-wellbeing targets are: Livelihoods, Social cohesion, Security, Health and Social development. (governance). It is suggested to review Ecosystems and Human well-being: wetlands and water from Millennium Ecosystem Assessment (2005)	With the data obtained in the previous activities	1. Conservation situation model draft
(ASSESS) 2E Connect human well-being targets to SDG	What SDG could be met when the human-wellbeing targets are effectively achieved?	Enable a direct linkage between human well-being targets and SDG	It is also recommended to connect the conservation targets, human well-being targets and ES with the SDG. This will open up opportunities with private sector and international grants. As an example, in Chile there are platforms that present industries linked to SDG such as www.accionempresas.cl	1. Conservation situation model draft	1. Framed ES-Human-Wellbeing-SDG linkages
(ASSESS) 2F Describing the direct and indirect threats	What are the current critical direct and indirect threats to my urban wetlands?	Understand the direct threats and the drivers of these threats	Now, it is recommended to extensively describe and define the causes and effects of the threats. These threats, as presented in the ARRIVAL STEP were recognized by different analysis including satellite images, detecting implicit threats through the understanding of city dynamics focusing on the city-wetland relation. This study must also be complemented by the Rapid Assessment produced in previous steps. Finally, direct engagement with city dwellers, local authorities and expert opinions.	1. Framed ES-Human-Wellbeing-SDG linkages 2. Conservation situation model draft	1. Conservation situation model
(ASSESS) 2G Execute an additional study of social urban dynamics	What complementary local social information could benefit the conservation planning?	Expand the social comprehension of the city	As a complementary approach for the enhancement of the "conservation situation" a social dynamics study is proposed. This study aims to deepen the understanding of the social dynamics of the people that will be potentially affected by the outcomes of the conservation actions. Thus, by improving the decision-making process related to behavior change strategies that will be later defined for the Theory of Change in the PLAN STEP. This knowledge gaps needs social research and can be based in qualitative methods such as interviews, focus groups. Some of the topics suggested by FLC Manual for the social interactions are: - Main economic activities	1. Interviews, focus groups, informal conversation and other interaction with potential stakeholders	1. Complementary social report

Sub Step	Questions	Objective	Method description	Input	Output
			- Past relations with the - Social and political conflicts - Local identity and territory history - Recognition of urban environmental threats - Natural and cultural heritage - Beliefs, behaviors		
(ASSESS) 2H Assess the conservation situation	What does your OS conceptual model look like?	Build the CS situation model for the conservation of the urban wetland (OS conceptual model)	Now that all the previous analysis has been done (Barlow et al., 2017; CMP, 2013). Create a Conceptual model as proposed in the OS manual. This Conceptual model must include: i) geographic scope ii) vision iii) biological targets iv) direct threats v) indirect threats vi) ecosystem services vii) human well-being targets.	With the data obtained in the previous activities	1. Conservation situation model
(ASSESS) 2I Finding opportunities BGI	What are the main opportunities for a BGI master plan development	Strengthen the conservation planning process	Since the SWUCP focuses in spatial conservation there is a direct need to convert the conservation actions and requirements into a future master plan that the urban dwellers, city council and urban planners understand and support. Therefore, it is suggested to identify the most important opportunities for later to develop the plan addressing city, neighborhoods and house scales. These opportunities should holistically include hydrologic functions that could also enhance ecosystem services. This enhancement of ecosystem services should guarantee the conservation of biodiversity. At the same time, these opportunities should be recognizing and addressing the social concerns and behaviors described in previous steps. An example of this opportunities, the study case presents what was developed for Llanquihue city.	1. ES Maps 2. Land-use analysis map 3. Wetland maps 4. Conservation objects map 5. Wetland sub-catchment map	
(PLAN) 3A Understanding ES	What are the most relevant ES recognized by the community?	Recognize community priorities for the prioritization of the different	Since the city is understood as a socio-ecological system, there is a need to include the social dimension of the conservation planning process. Therefore, the ES priorities must be settled by the recognition of the diverse communities' priorities. Since stakeholders may differ in interests, locations, worldviews, among others it is suggested to: 1. Run a series of activities to ensure every voice is considered and pondered. These	1. Nautilus chambered visualization of stakeholders 2. OS Conceptual model	1. List of ES prioritized by communities 3. Modelling

Sub Step	Questions	Objective	Method description	Input	Output
community interest		E.S. provided by each wetland	outcomes can be met by methods such as a workshop, participatory cartographies, surveys, focus groups, etc. These results can be obtained from prior participatory engagements. 2. Visually display the community priorities to show different stakeholders. 3. Run a trade-off analysis (quantitatively or qualitatively depending on the available data and resources) to explicitly tackle the differences among groups of stakeholders. This trade-off analysis may be approached via multi-criteria analyses, biophysical modelling that connects with social value, economic value, among others. These recommendations are mentioned in the WETwin: A structured approach to evaluating wetland management options y Johnston et al. (2012) (G. Brown & Fagerholm, 2014)(Espada, Apan, & McDougall, 2017).	3. Stakeholder lists 4. Stakeholder maps - such as, stakeholder analysis done in Activity 1.4. and ES mapping used in Activity 1.5.	analysis 4. Scenarios
(PLAN) 3A Understanding ES community interest	What is the link of the ES with the SDG?	Enable a direct link between ES and SDG for practical purposes	Urban conservation is a social endeavor that necessarily involves changes in human behaviors, community-based socio ecological restoration and monitoring, scientific research, political agreements, landscape management, environmental education, among others. As such, fundraising to achieve the desired conservation goals will benefit by recognizing that the implementation of the conservation planning addresses human well-being targets. Nationally and internationally the SDG from the 2030 agenda has been wildly recognize, thus the planning of programs and projects for the urban wetland conservation should explicitly inform what of the SDG aims to contribute. 1. Direct link between the ES and the SDG 2. Label each work package from the ToC with the primary SDG	1. SDG list 2. ES list 3. ES maps	1. List of prioritized ES linked with SDG 2. SDG derived from the prioritized ES 3. Potential grants connected to the SDG objectives
(PLAN) 3B Relations with stakeholders	What are my stakeholders expecting from me? What do they need? Do you see any organization redundancy?	Build relations with the local government, organized civil society, companies, academia and the urban inhabitants.	Communicate the UWCP interests publicly and specifically to each of the relations stated above - Empower the community with information, tools such as the Toolkit - Persuade authorities on the values of ecosystem services - Apply for national and international funding creating partnership with the stakeholders - Create agreements with companies - Communicate and coordinate the academia to collaborate in the collection and analyze of the critical information that could directly contribute to the decision-making process of the UWCP in a data-poor context - Review, understand and include regional and national objectives in the creation of conservation projects - Inform, present and discuss relevant information and results to local, regional and	1. Notes from interviews, field visit, local people meetings	1. Nautilus model 2. Stakeholder list 3. Stakeholder map 4. Chambered Nautilus Visualization 5. Stakeholder characterization

Sub Step	Questions	Objective	Method description	Input	Output
			national stakeholders. As an example, some institutions are presented below: o Local government: City major, City council, Planning secretary (SECPLAN), Communal Development Department (DIDECO), Environmental Department of Regional Government: Gobierno regional (SEREMI ambiente, MINVU)		
(PLAN) 3C Creating a citizen commission	What is your stakeholder engagement strategy? How could you improve the stakeholder engagement?	Find ways to develop and/or improve stakeholder engagement and also positive relations between groups	Stakeholder engagement plays a key role in the conservation planning process. Thus, special and conscious efforts must be made to foster engagement among every step of the conservation planning process. 1. Develop an audience that wants to be informed about the conservation planning process 2. Visualize the positive relations that each stakeholder has with the urban wetlands 3. Involve the stakeholders in the decision-making process through consultations (e.g.: workshops, focus groups, participatory cartography, individual discussion, etc.). These recommendations are mentioned in the WETwin: A structured approach to evaluating wetland management options y Johnston et al. (2012)	1. List of potential stakeholders 2. Influence map of stakeholders 3. List of ES links with human well-being and SDG targets	1. Multisectoral commission created
(PLAN) 3C Creating a citizen commission	What do they all have as a common interest?	Identify the common ground of the multiple stakeholders in order to promote present and future collaboration and agreements	To develop an articulated spatial plan for BGI along with other conservation strategies, common ground must be built among the subjective interest of the stakeholder groups. 1. Evaluate common interest among the urban wetland declared and non-declared ES and human-wellbeing targets 2. Hold individual discussion with representatives of different stakeholder groups themed around the established conservation priorities 3. Identify key elements in the declared vision of the city 4. Prioritize projects related to industries in which the benefits of the outcomes will be perceived by multiple stakeholder groups These recommendations are mentioned in the WETwin: A structured approach to evaluating wetland management options y Johnston et al. (2012)	1. Notes from previous participatory activities 2. OS conceptual model 3. OS Theory of change 4. Nautilus chambered visualization groups	1. Multisectoral commission created
(PLAN) 3C Creating a citizen commission	What is your initial proposal to present to them?	Clearly define an initial message and dream to open up the dialogue	The approach to the stakeholders must be with a simple and clear message and desire. Selection base on learning	1. Conservation situation model	

Sub Step	Questions	Objective	Method description	Input	Output
(PLAN) 3D Drafting a community desired state	What is the collective vision that the stakeholders hold as a whole?	Achieve a draft of a written vision of the desired state of the urban wetland system of the city that will be accomplished through the conservation planning and implementation	Following the CS Manual CMP (2020) and the working paper “Planning and management of conservation projects in urban ecosystems” FLC (2018) a vision must be collectively drafted. This by the multi-sectorial commission according ... of the Recognize the Lone Rangers, Situated GI, The Collective, Specialized (Schifman et al.,2017)	1. Conservation objects map 2. Conservation situation	Written desired state of the urban wetland of the city
(PLAN) 3D Drafting a community desired state	What do they see for each Conservation Object selected?	Develop a clear collective vision of the Conservation Objects desired future state	Detail the collective vision drafted in previous step to be specific about the conservation object. This vision must include presence of species, area, S.M.A.R.T. objectives, coverage, urban design		
(PLAN) 3E BGI master plan	What is the distance of every citizen to a natural area?	Identify the level of walkability of the city to natural areas	Load the map conservation objects map and the green area map and create a 900 meter buffer from the road net in ArcGIS. First define which are the green areas that they want.	1. Conservation object map 2. Green areas map	1. Walkability map to conservation objects 2. Walkability map to green areas

Sub Step	Questions	Objective	Method description	Input	Output
(PLAN) 3E BGI master plan	What are the linear elements in the urban landscape? What potential do they represent?	Look for linear and non-linear elements as opportunities for the BGI plan	Visual inspection of old city maps, current land-use plan and other relevant spatial plans in the search of interesting linear and non-linear elements of the urban landscape.	1. Multi-temporal images (Zhou et al., 2008 2. City spatial planning instruments	
(PLAN) 3F Developing the Theory of Change	What areas do I recognize as needing urgent protection and recovery?	Identify key areas for recovery	After the Marxan has developed the zoning the areas for recovery spatial analysis must divide the key areas for urban design protection projects and restoration (Li et al., 2014). This division indicates different action plans for each area. While the first look to preserve a zone mainly as it is the second demands direct actions to improve ecological process in order to have a better ecosystem health.	Marxan zoning development	Raster layers for protection and recovery areas.
(PLAN) 3F Developing the Theory of Change	What is the viable conservation object to protect and recover?	Prioritize the conservation objects to work.	Strategic planning requires a viability assessment of the defined conservation objects in the CS conceptual model. As it is mentioned in CS manual CMP (2020) and PAM manual FLC (2018). This process determines the current and desired ecological condition of the conservation objects. 1. Define the key ecological attributes that would define a conservation object as healthy 2. Select indicator(s) that could serve as measurements in order to monitor the conservation objects 3. Describe the current state of the conservation object 4. Define a desired state for the conservation object	1. CS conceptual model 2. CS Theory of change 3. Conservation object map 4. Green areas map	
(PLAN) 3F Developing the Theory of Change	How does your CS theory of change look like?	Build an explicit strategy of the conservation planning that layouts the work packages for each direct and indirect	Participatory develop of the theory of change implementing workshops, surveys, phone calls. Include commitments of the formal institutions is recommended porting to the city council	1. CS conceptual model 2. Nautius stakeholder visualization 3. Common vision 3. Conservation objects maps "Chambered Nautilus Visualization	

Sub Step	Questions	Objective	Method description	Input	Output
		threat to the conservation objects		Stakeholder characterization"	

D. EXAMPLE OF FUNDING OPTIONS

Table 0.1 Example of wetland conservation funding options.

Funding Chilean name	**Grant institution**	**Main objective**	**Amount [USD]**
Fondo de Protección Ambiental (FPA): Conservación de Humedales Urbanos	Environmental Ministry	Improve urban wetlands ecological state, conservation and governance funding call-to-action activities.	$9,600-.
Reto de innovación CONAF "KO-UNA-YAKU Monitoreo de Humedales"	CORFO	Develop an autonomous system to monitor water parameters for the wetlands.	$273,000-.
Fondo de Humedales para el Futuro (FHF)	Ramsar	Benefits institutions and individual contributors from Latin America and the Caribbean through training for wetland conservation.	$10,000-.
Fondo regional de incentivo local (FRIL)	GORE	Fund small infrastructure projects requested by local governments.	$123,300-.
Prototipos de innovación social	CORFO	Enhance the co-creation of innovation through practices that generate social impacts in various territories.	$82,200-.
Ley de aportes al espacio público	Housing Ministry	Improve the public space through mitigation of real-estate impacts.	Depends on the individual project
Patagonia Grant	Tides Foundation	Fund grassroot organizations call-to-action environmental projects.	$12,000-.

Source: Own elaboration (2020)

E. NDVI CALCULATED FOR THE STUDY CASE

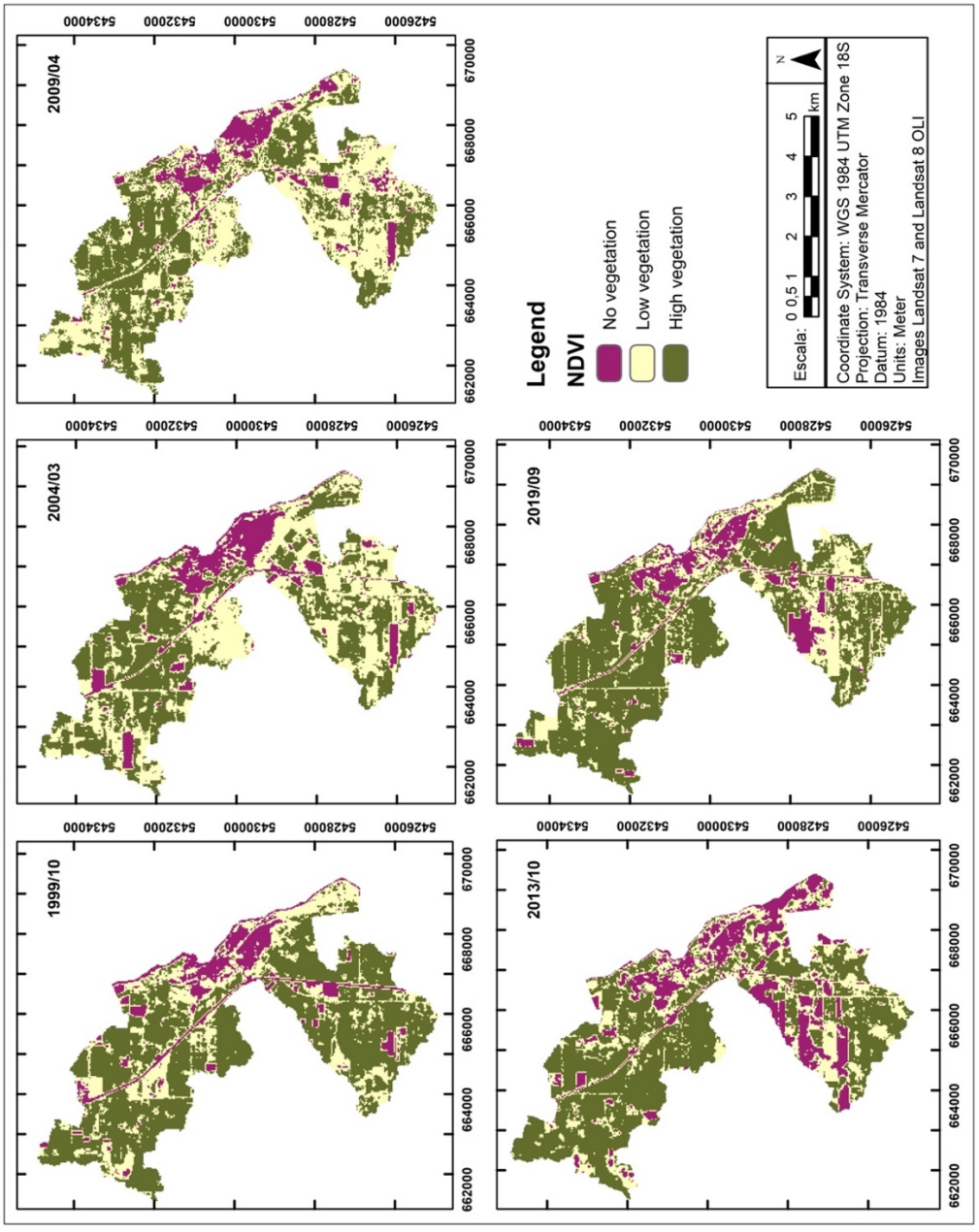

Figure 0.1 Temporal evolution of NDVI from 1999, 2004, 2009, 2013 and 2019 from the Landsat 7 and Landsat 8 enabled a recognition of changes

Source: Own elaboration (2020)

F. NDMI CALCULATED FOR THE STUDY CASE

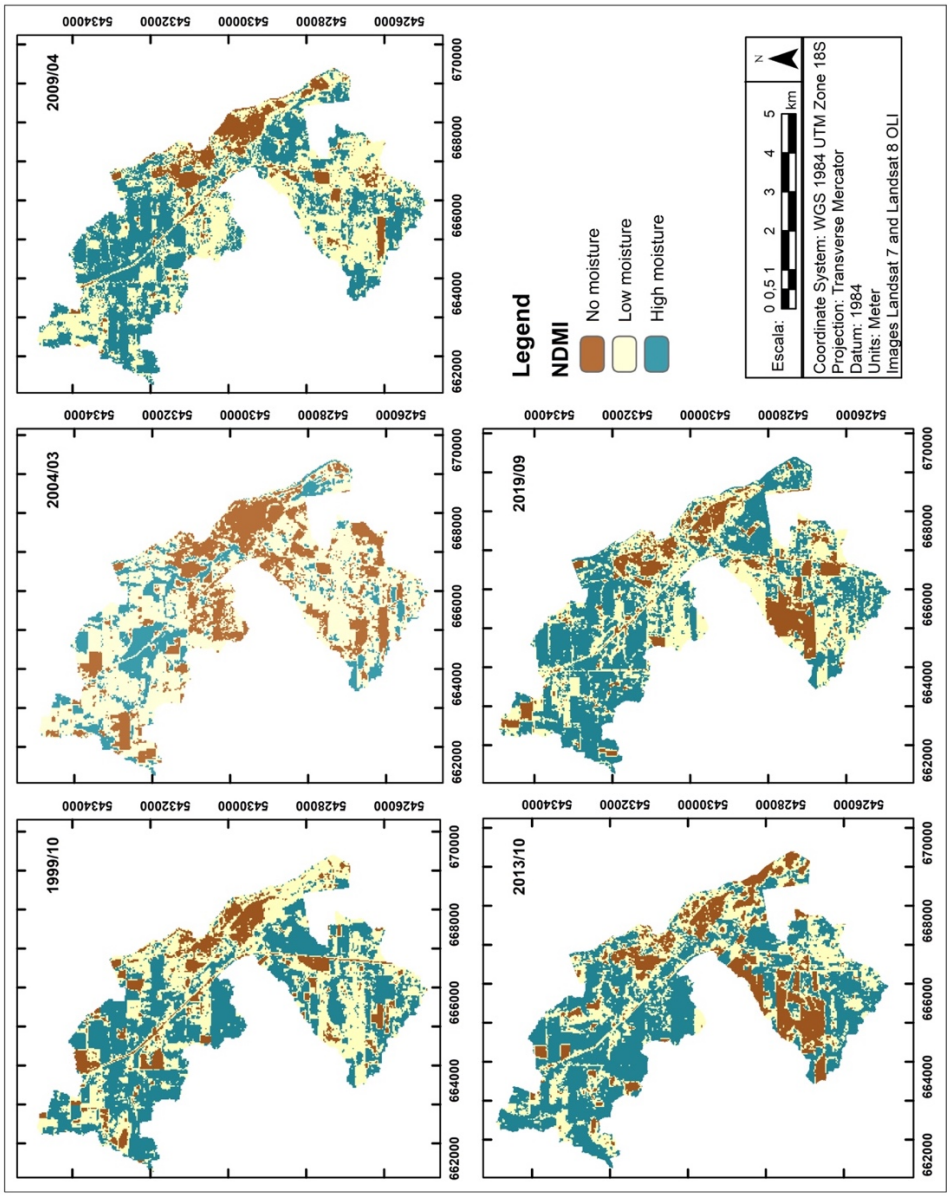

Figure 0.2 Temporal evolution of NDMI from 1999, 2004, 2009, 2013 and 2019 from the Landsat 7 and Landsat 8 enabled a recognition of changes

Source: Own elaboration (2020)

G. LULC CALCULATED FOR THE STUDY CASE

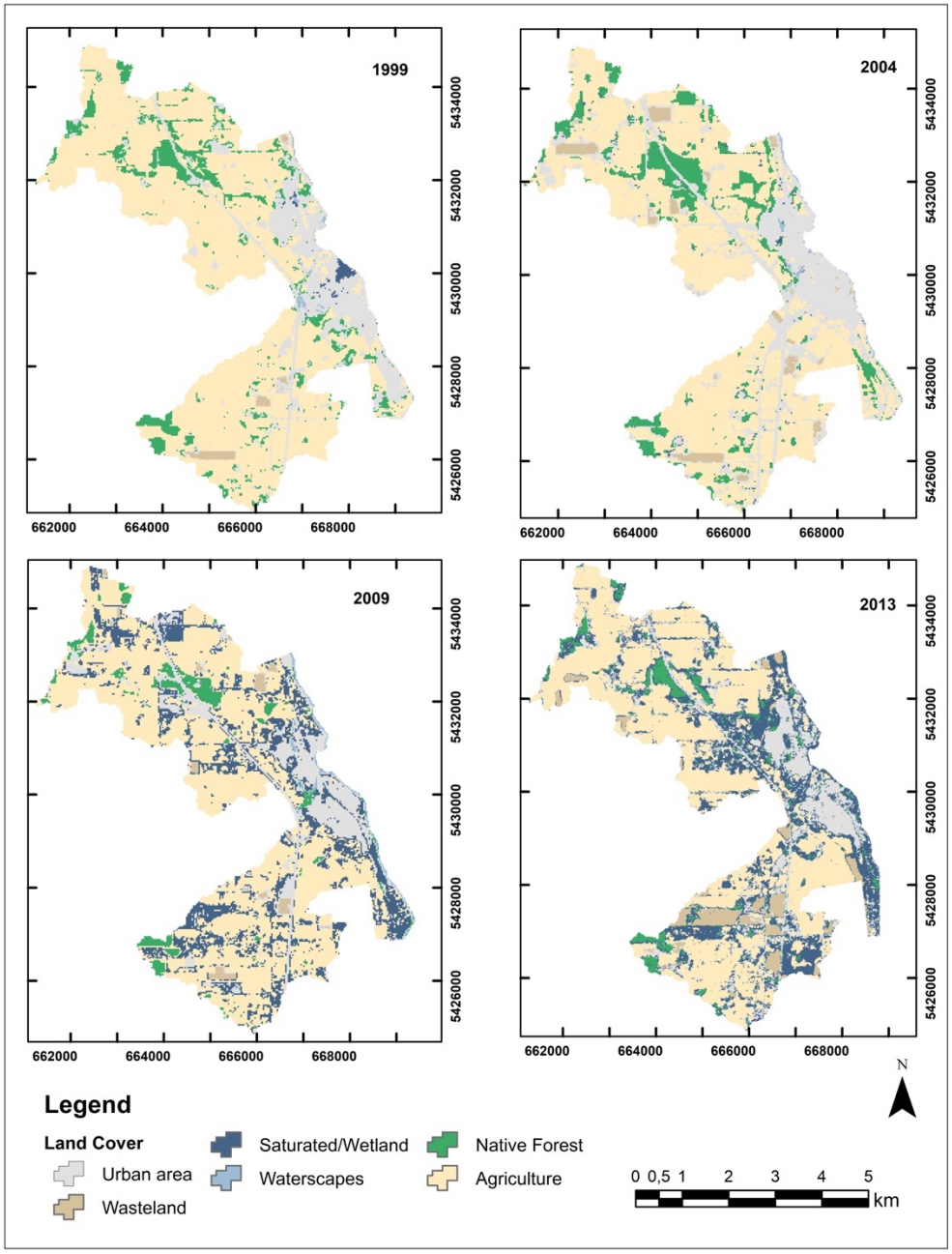

Figure 0.3 Temporal evolution of LULC from 1999, 2004, 2009, 2013 from Landsat 7 and Landsat 8

Source: Own elaboration (2020)

H. RECREATION AND COGNITIVE DEVELOPMENT FOR THE STUDY CASE

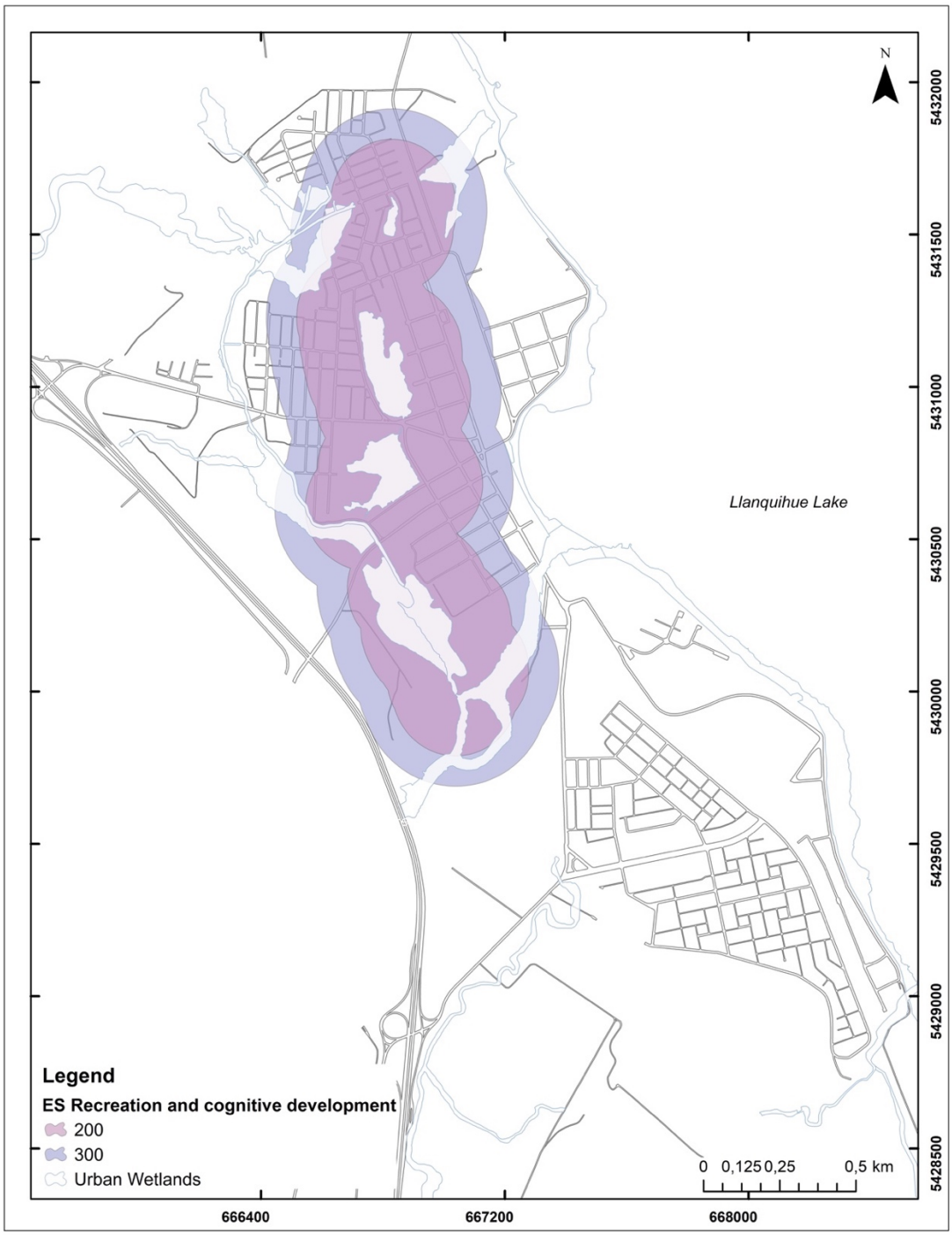

Figure 0.4 Recreation and cognitive development ES supply. Source: Own elaboration (2020)

I. MATERIALIZED BGI URBAN INTERVENTION IN PALUSTRINE WETLAND "HUMEDAL BAQUEDANO

Figure 0.5 Materialized BGI urban intervention in palustrine wetland "Humedal Baquedano"

Source: Own elaboration (2018)