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An Urgent Dialogue between Urban Design and Regulatory Framework for Urban Rivers: The Case of the Andalién River in Chile

Amaya Álvez ^{1,*} , Paulina Espinosa ² , Rodrigo Castillo ^{3,*}, Kimberly Iglesias ^{4,*} and Camila Bañales-Seguel ⁵

¹ Water Research Center for Agriculture and Mining (CRHIAM), Faculty of Law and Social Sciences, University of Concepción, Concepción 4030000, Chile

² Unit of Urban Design, Urbanism, Landscape and Planning (Arenberg), Department of Architecture, Faculty of Engineering Science, University of Leuven/KU Leuven, Leuven 3000, Belgium

³ Water Research Center for Agriculture and Mining (CRHIAM), Faculty of Law, Universidad de Las Américas, Chile, Concepción 4070254, Chile

⁴ Independent Researcher, Santiago 7500945, Chile

⁵ Faculty of Environmental Sciences, University of Concepción, Concepción 4030000, Chile

* Correspondence: aalvez@udec.cl (A.Á.); rhcastillo84@gmail.com (R.C.); kimberly.iglesias@gmail.com (K.I.)

Abstract: Climate change scenarios predict alarming levels of water scarcity and damaging flood events worldwide. Considering hydric systems in integrated spatial planning will be crucial in mitigating, adapting, and reversing climate change's catastrophic effects. This paper focuses on fluvial restoration as part of urban and territorial regulatory frameworks in the Andalién River and the city of Concepción in Chile. We consider three work scales: (i) basin, (ii) river reaches which focus on the city–river interplay, and (iii) site-specific, deepening the discussion around the last two. The objective is to elaborate an interdisciplinary dialogue between urban design, fluvial dynamics, and the Chilean regulatory framework where property rights play a predominant role in the management of natural resources (water and land). In this regard, the 'New Latin American Constitutionalism' offers concrete possibilities to operationalize an emerging paradigm that recognizes legal personhood for Nature. The incorporation of an ecological function to property rights emerges as a new way in which the principles of resilient urban development can be applied in order to combine river dynamics and urban growth.

Keywords: climate change; ecological constitutionalism; research by design; resilient urbanism; ecological function of property; sustainable river management; socio hydrology



Citation: Álvez, A.; Espinosa, P.; Castillo, R.; Iglesias, K.; Bañales-Seguel, C. An Urgent Dialogue between Urban Design and Regulatory Framework for Urban Rivers: The Case of the Andalién River in Chile. *Water* **2022**, *14*, 3444. <https://doi.org/10.3390/w14213444>

Academic Editors: Kairong Lin and Francesco De Paola

Received: 31 August 2022

Accepted: 20 October 2022

Published: 29 October 2022

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1. Introduction

“Terrestrial and aquatic systems have for too long been treated as independent of one another, when clearly they strongly interact and have many similar properties (patchiness, connectivity, etc.)” [1] (p.1)

This article explores the conflict between two conceptualizations of water in the context of water management and urban planning in Chile. From an economic perspective, water is a key resource for productive activities such as mining, agriculture, and forestry. From a social and ecological point of view, water is a natural element that provides several ecosystem benefits, including the provision of clean drinking water and sanitation, which is a basic human right as stated by the United Nations General Assembly on 28 July 2010, through Resolution 64/292 [2]. The conflict between these two conceptualizations lies in the fact that land (cover and use) plays a key role in water production and consequently water availability for human consumption.

Since 1981, Chile has had a Water Code which regulates water allocation through private property rights. This has fostered a market-based logic as the distribution mechanism

among users [3,4]. Both sources and their management are highly ‘commodified’ [4] and consequently so are fluvial systems.

The Chilean economy may be described as extractivist as it is based on the exploitation of natural resources. Thus, the main sectors of the economy, such as fishing, aquaculture, forestry, agriculture, and livestock as well as the country’s high rate of urbanization explain Chile’s high dependency on water resources, which only increases with climate change [5]. As extractive economic activities pressure natural dynamics, changes in land use and water allocation have important impacts on the hydro-geomorphological characteristics of the water system. Some of these impacts are morphological, changing the riverbed and floodplains as well as water and sediment fluxes.

These changes in the physical system directly affect water security by destroying habitats for aquatic and terrestrial biodiversity. They also reduce the quantity and quality of available water for human consumption and increase the vulnerability of the population to natural hazards such as landslides, flooding, and debris flows [6].

Climate change will intensify all these impacts [7–9]. Consequently, Chile is defined as highly vulnerable to the impacts of climate change [10] and is projected, by the Ranking of the World’s Most Water-Stressed Countries, to become an extremely high water-stressed country by the year 2040 [11].

The “Climate Change and Land” report for policymakers of the Intergovernmental Panel on Climate Change (IPCC) [12] offers a clear diagnosis and guide regarding the relation between water management and climate change, “*Sustainable land management, including sustainable forest management can prevent and reduce land degradation, maintain land productivity, and sometimes reverse the adverse impacts of climate change on land degradation. It can also contribute to mitigation and adaptation. Reducing and reversing land degradation, at scales from individual farms to entire watersheds, can provide cost effective, immediate, and long-term benefits to communities.*” [12] (p. 23).

Chile is going through a constitution-making process that opened opportunities to discuss not only the nature and scope of private property (over land and water) but also the ecological functioning of fluvial systems. Chile is not alone in the region. The ‘New Latin American Constitutionalism’ has considered the environment as a required condition for the well-being of society [13]. As Latin-American constitutions recognize the rights of Nature, considering fluvial systems offer the possibility to operationalize these rights as collective, integrated, relational, and ecocentric [14]. Latin-American constitutionalism represents a biocentric turn that opposes the objectification of Nature.

For example, a recent study analyzed the practical implementation of the ‘Buen Vivir’ paradigm and the rights of Nature, both instituted by the Constitution of Ecuador (2008), in relation to an urbanization project in Guayaquil. The urban project, Parque Lineal, represents, “*a testimony for unfulfilled promises resulting from a dislocation between a biocentric constitution and an anthropocentric design*” [15] (p. 15). This dissociation between rhetoric and reality described by Ordoñez et al. (2022), comes as a warning to the constitutional process in Chile. Ineffective implementation, institutional weakness, and the inadequacy of the legal systems in which Nature receives recognition are at the base of the shortcomings experienced in Ecuador [16].

These arguments suggest the need to reformulate our understanding of the physical interplay between productive territories and fluvial systems, on the one hand, and on the other, the regulatory frameworks used to combine fluvial dynamics and urban growth allowing water production while cities continue to develop.

1.1. Clashes between Urban Design and Fluvial Dynamics

Regardless of projections by the United Nations (UN), according to which 68% of the world population will be living in cities by 2050 [17]. Chile has made few efforts to solve the conflicts between growing urban territories and the related fluvial systems. Consequently, the aim of this work is to develop concrete territorial planning principles with a correspondent regulatory framework.

These territorial planning principles stem from urban design research in light of geomorphological restoration [18,19] and rehabilitation of fluvial systems as a territorial strategy for urban development [20–23], water production, biodiversity recovery, and adaptation to climate change. This finds its theoretical roots in urban design approaches which advocate balancing natural systems and urbanization.

In this line, landscape urbanism [24] is a lens to address contemporary problems of cities with the capacity to go beyond urbanization limits and put landscape, its characteristics, dynamics, and work scales as structuring the urbanization processes. Aligned with this, there is a need to redefine the term urban by going beyond the traditional city boundaries to understand living systems that support human settlements [25]. Another approach is the theoretical construct of ecological urbanism [26] looking for a framework built by knowledge, methods, and codes to deal with fast urbanization and limited resources. Vigano, in this regard, has advanced an important reconceptualization of design, advocating the transition from an anthropocentric view into ecological rationality. This means, among others, integrating ever-changing biotic relations with urbanization and conceiving ecology as a guiding tool for design [27].

In practice, nature-based solutions and green and blue infrastructure have taken over the agendas of projects all around the world, adding ecological and risk management functions to urban development. Remarkable examples are Blue Dunes, Climate by Design [28], Room for the River Programme [29], and Yamuna River Project [30], among many others.

From a perspective focused on geomorphological fluvial restoration within urban environments, crucial works are the ones of Fryirs and Brierley [31], who offer a specific and more realistic concept to deal with restoration in urban contexts and fluvial rehabilitation. Kondolf's efforts of linking the technical aspects of fluvial restoration with social conditions have also opened a new perspective on urban rivers' futures redefining the complexities of human activities as part of the longitudinal connectivity of rivers [32,33].

1.2. Current Normative Paradigms for Urban Planning under a Water Market Model

The 1980 Constitution, providing the normative basis for the entire Chilean legal system, contains, in the final paragraphs of Article 19, a series of economic provisions. Some authors have argued that these rules constitute an "economic constitutional regime" [34] or an "economic public order" [35]. Under this economic constitutional regime, private property is strengthened and the economic use of natural resources is promoted [36].

These rules include, on the one hand, the freedom to acquire ownership of all kinds of things (Article 19, Section 23), with the only exception of goods that are considered common goods or goods that are considered as belonging to the Nation as a whole. On the other hand, a strong right to private property (including water rights) is established, with limitations based on a social function of property, (Article 19 Section 24) which includes the conservation of the environmental heritage, a limit that has not been thoroughly applied.

The critical situation faced by Chile in terms of the water crisis and climate change exerts considerable pressure on access to drinking water and the control of risks, especially in areas of high urban density. The case study presented examines the Municipality of Concepción where the Andalién River flows. Among the challenges presented by the urban water security standard in this Municipality, we identify: climate change and water-related risks, high frequency of floods and flood-prone areas, water pollution, and the existence or not of green drainage surfaces [6].

Both the reality described above and the design conceptualization discussed in this paper require intervention measures and a legal framework that allows the implementation of decisive actions aimed at reversing or containing ecosystem degradation [37]. However, the Chilean legal framework represents an obstacle to the development of adequate measures. Specifically, The Chilean Water Code (1981) recently amended by Law No. 21.435 (2022) that regulates water allocation through private rights has been an obstacle only recently modified. Water rights become a commodity, and as such are freely tradeable separate from the land where the water sources are located [38]. Nevertheless, after a long debate in

National Congress Law 21.435 (2022) declared the public nature of water and established a hierarchy putting first the human right to water and sanitation and then ecosystem preservation. Other relevant elements of this law are a mandatory public registration of rights over water, limitation to water used for mining activities, no rights over the basin that have been declared exhausted, and normative value to indigenous worldview recognizing the inseparable relationship between land and water.

The Water Code regulates the creation of water management bodies ('organization of users of water'). These organizations are composed exclusively by private holders of water rights, and have been qualified as "private services of public interest" [39]. They fulfill only limited functions in relation to water distribution according to use rights and in relation to the administration of extraction works present in the river. This is notwithstanding some initiatives of these organizations to assume functions in other areas of management [40].

The establishment and functioning of 'organization of users of water', under the 1981 Water Code, depends on the will of water rights owners. In the great majority of cases, owners act reactively when scarcity or management problems arise [41]. This means that an important part of the basins, especially in central-southern and southern Chile, do not have these organizations, as is the case of the Andalién River.

Other initiatives promoted to achieve integrated water management have had few results, especially due to the lack of financing, legal rules that support their work, and the non-binding nature of their resolutions. Such is the case of the "Water Roundtables", which have their origin in the environmental recommendations- regarding the development of an integrated approach to basin management- of the Organization for Economic Co-operation and Development (OECD), together with the Economic Commission for Latin America and the Caribbean (ECLAC) [42]. These "Water Roundtables" were limited to some regions of the country, and they did not become a true integrated management organization [43]. The constituent process opened up the debate on the creation of an autonomous body named the National Water Agency that promoted the constitution of basin councils. It would assist them in carrying out integrated management of water basins, participatory governance, and planning of interventions in the bodies of water and ecosystems associated with the respective basin or basins.

The strong property rights protections under the current Constitution of 1980 have been debated in the constituent process. It has been proposed to recognize the "ecological function" of property [44]. This ecological function seeks to limit individual rights that negatively affect collective interests [45], for example, providing continuity for fragmented ecosystems within the city as the basic need for water production.

The incorporation of the ecological function of property overcomes the anthropocentric vision in which nature exists only to satisfy human needs [46], offering an ecocentric perspective where human life is intimately related to nature. The Urban Wetlands Law enacted in 2020 (*Ley de Humedales Urbanos*, Número 21.202) had previously adopted this shift in paradigm. This law recognizes the ecological distinctiveness of wetlands, including their role in the functioning and maintenance of the hydrological regime (both surface and underground). In order to meet this goal, the law empowers municipalities to regulate the subdivision of land plots, urbanization, and construction permits in wetlands [47] establishing a kind of dialogue between normative regulations over nature and city where the property is not at the center of the narrative.

The Chilean constitutional process may initiate a change in the regulatory framework according to a new paradigm that combines the protection of natural fluvial dynamics with urban growth. The next section of the paper examines approaches that advocate for a balance between natural systems and urbanization to embed ecological research into urban design.

2. Methodological Approach

2.1. *Interdisciplinary Dialogue*

The methodology adopted in this article is situated in a debate concerning the theoretical foundations of legal instruments that conceptualize the relationship between humans

and nature. In addressing the fieldwork done on urban design and fluvial dynamics at the Andalién River we considered an interdisciplinary framework, in order to grasp both river dynamics and urban growth. We propose an approach and methodology that integrates different disciplinary perspectives [14]. The authors held sessions to triangulate concepts in order to achieve contributions from different scholarship cultures (urban design, natural sciences, law) at the different stages: topic orientation, formulation of the theoretical framework, and discussion of results [15]. The conceptualization of the ‘why’ and the ‘what for’ of this study resulted directly from these sessions and was the product of a collective effort to construct a common language.

2.2. Case Study: The Andalién River and the City of Concepción

The case study is the Andalién River which flows into the city of Concepción. Concepción is located in the central area of Chile (30° – 45° S). The Andalién River is a Coastal fluvial system that flows into the Pacific Ocean. Its basin size is 775 km^2 [48]. It is situated in a Mediterranean climate zone, characterized by a rainy winter season and a drier and warmer summer season. The basin has a pluvial regime, with the maximum discharges occurring in winter due to rainfall intensity higher than $100 \text{ mm}/24 \text{ h}$ [49]. Concepción is the third largest urban center in Chile, with approximately 1,000,000 people in its metropolitan area.

The upper basin is inhabited by a human population of around 10,000, mostly in the Florida Municipality [50]. These people are exposed to fires and water scarcity due to the massive forest monocultures that occupy 63% of the basin, according to 2011 data [48] (p. 1). In the lower basin, if current urbanization continues occupying the floodplains, more than 10,000 homes and approximately 40,000 people would be exposed to flood for the most extreme event evaluated for a recurring time of 500 years [51] (p. 14).

In this case study, we have adopted a multi-scale approach (Figure 1). Defined by the (i) basin, (ii) river reaches which focus on the city–river interplay, and (iii) site-specific, which are the scales where geomorphological processes can be understood as a whole. This article focuses on the reach and site-specific scales, which are the scales where cities and fluvial systems interact.

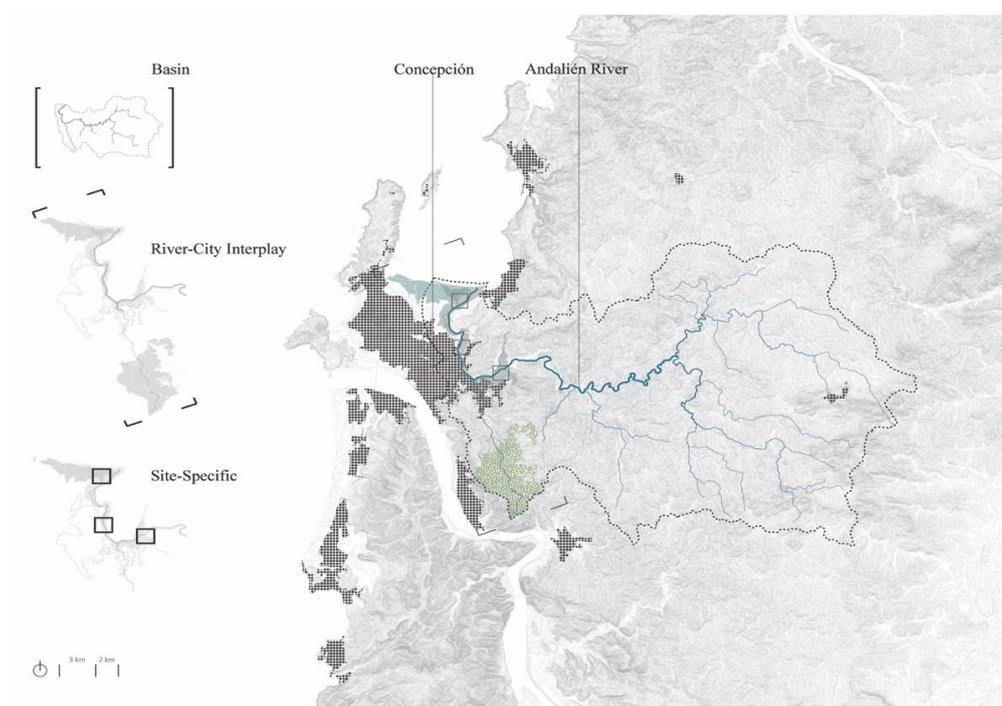


Figure 1. Concepción City and Andalién River location. Multiscale approach: Basin, river–city interplay and site specific. Source: Modified by the author Espinosa, 2020 in [52].

The territory where the Andalién River and the city of Concepción meet is highly pressured by urbanization processes. During the 1960s and early 1970s, the lower area of the river was occupied by dwelling cooperatives in what was called Site Operations [53,54]. These operations were developed to cope with the needs for housing derived from industrialization processes which attracted people from rural to urban areas. During the 1980s, changes in the regulatory framework extended the occupation of floodplains as it is demonstrated in the comparative analysis of the Concepción Metropolitan Regulatory Plan (PRMC, Plan Regulador Metropolitano de Concepción) of 1962 and 1980 [55]. In 2002, the PRMC allowed construction in floodplains along the river (Figure 2) [55]. The PRMC 15th modification of 2019 just reinforced this urbanization model. Besides the floodplain occupation, this development model has modified the river course as well.

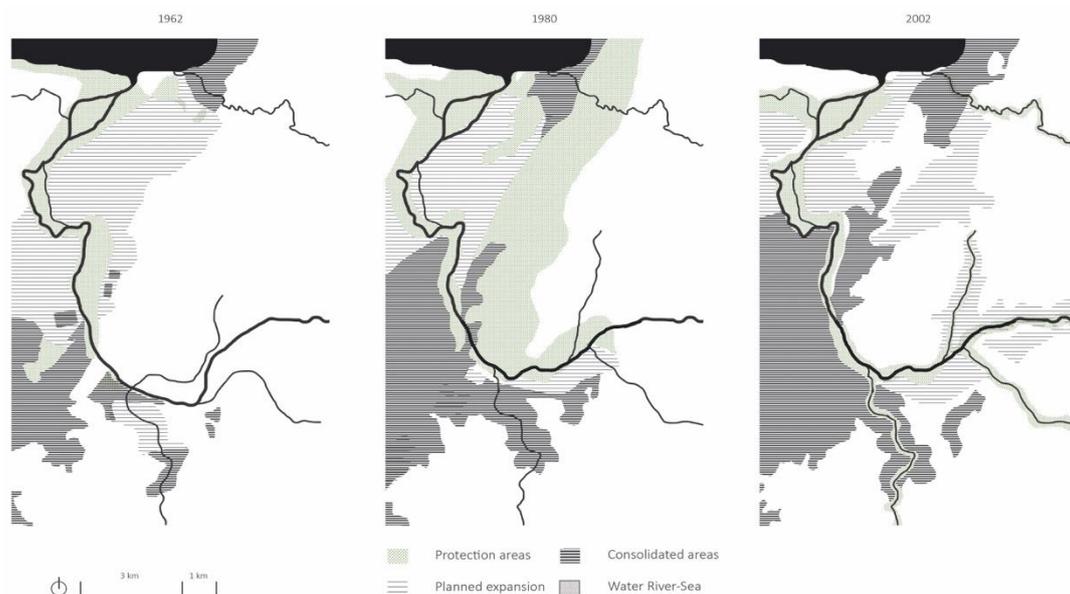


Figure 2. Concepción Metropolitan Regulatory Plans Comparative (PRMC) 1962, 1980, 2002 in the study area. Evolution of protected versus urbanization area. Source: By the author Espinosa, modified from [55].

The case study was explored using research by design methodology which provides a new way of looking into social and spatial complexities and uncertainties [56] and uses the capacity of design to incorporate and synthesize other disciplines, taking advantage of the natural frictions between them to improve the design result [28] (p. 7).

This type of research finds applied examples in Felson et al., 2013 [57] using design experiments to embed ecological research into urban design. This positions design as a facilitator for ecologists to create ecological knowledge to be applied to enhance urban landscapes. Other applied examples of research by design are “Rebuild by Design” and “Resilience by Design” [58,59]. These initiatives were elaborated to face problems related to climate change effects in the cities of New York (Sandy Hurricane) and Los Angeles Bay Area, looking for resilient strategies to safeguard the population, environment, and economy. An example developed in the Latin American context is a water urbanism research design that looked to build a propoitive interplay dealing with Bogotá River territories, settlement patterns, and productive landscapes in Bogotá, Colombia [60].

We studied the Andalién River and Concepción city, elaborating on geomorphologic river restoration and urban design proposals in order to combine river dynamics and urban growth. The design research exercises were developed between 2015 and 2018. Research by design over urban planning were scenarios defined by conceptualizations, strategies, and images based on data, fieldwork, historical analysis, and bibliographic analysis. The data used was obtained from official governmental GIS systems and vector

territorial databases, local academic and scientific research in relation to geography and urban history. The archival review was mainly based on three relevant sources: the archive of the National Library of Chile (Biblioteca Nacional Chilena—Memoria Chilena), the University of Concepción Archive (Sala Chile), the archive of the Faculty of Architecture of the University of Bio Bio.

These scenarios are concrete results to foster a discussion and to facilitate dialogue with stakeholders. The iteration of the exercises allowed us to refine the results incorporating new insight in every step of the process.

The design research had three main steps: first, explorations in urban design developed from cartographic analysis, bibliographic research, data analysis, and fieldwork [20]. The main results of this exercise were the problematic outline, the scale definition (basin reaches which focus on the city–river interplay, and site-specific), and the first attempts at design proposals for new urban tissues and productive tissues. In order to geomorphologic characterize the river, an IHG Index by Ollero et al. 2011 [61] was applied in 2015 by Parra et al., (Supplementary IHG Results S1) [62]. This hydro-geomorphologic index (IHG) rated different quality parameters: functional, channel, and riparian in relation to the pressures on the system and their consequent impacts.

The design conclusion of the first step was tested in two urban design competitions with promising results: Second prize in IREC 2015 [63] (Supplementary IREC Competition Materials S2) (Architecture for disaster reduction and reconstruction, 7th I-A Rec student competition. “Addressing Different Forms of Vulnerability for Disaster Risk Reduction in Urban Contexts 2015”) and first prize in READU 2015 [64] Project Practice 5th Urban Design Congress) (Supplementary READU Competition Posters S3). These exercises tested initial narratives of the interplay between disasters, landscape, and urbanization under the lens of different work scales, from basin to architecture. The results served to lay the foundations for subsequent exercises.

The second step was interdisciplinary and defined an area to develop the interplay between fluvial dynamics and city growth dynamics. The concept that arose was “the minimum fluvial territory to keep the river alive” [21]. The recognition of rivers as entities with legal personhood is emphasized by the interdependence that exists between humans and rivers as structuring components of societies and of the quality of life of communities. This opens a relevant theoretical framework that studies rivers as socio-ecological systems [65].

It is very difficult to establish a holistic framework to study the health of a particular river, much less the uniform characterization of all rivers [65]. The study over the Andalién River considers the main geomorphologic elements of the fluvial system analyzed through cartography, photo-interpretation, and the application of the hydro-geomorphologic index (IHG) compromised with minimum spatial requirements to restore some of the river’s basic eco-geomorphologic functions but considering the urban context. In places where it was possible, an ideal option was proposed outlining the ideal space for the river to recover its natural vitality with a guarantee. In places where the urban tissue was consolidated alternative mitigation actions were used and compatibilized with social contests.

The proposed minimum fluvial territory (Figure 3) is a starting point to determine parameters for healthy rivers [66] that is, the physical expanse that a river needs to occupy throughout its natural fluctuations at different temporal scales. This notion highlights the lateral connectivity of a river to its riparian space, such as wetlands and frequently flooded adjacent areas [65].

The third step had two parts, one was about consolidating the information gathered in the whole process with the objective of formulating open design questions (Table 1) to interact with practitioners and stakeholders (Competition Briefing S4). This interaction was based on solving the main problem of allocating 2000 dwellings of real estate development but focusing on river restoration. The second part was an urban design exercise run through an international design competition funded by the Ministry of Cultures in Chile [67]. These exercises result in a variety of proposals for fluvial restoration as urban design strategies that turn into hybrid principles to develop the fluvial territories within the

city [23,52] (Supplementary Winning Designs S5). These proposals and principles will be used throughout the Discussion section.

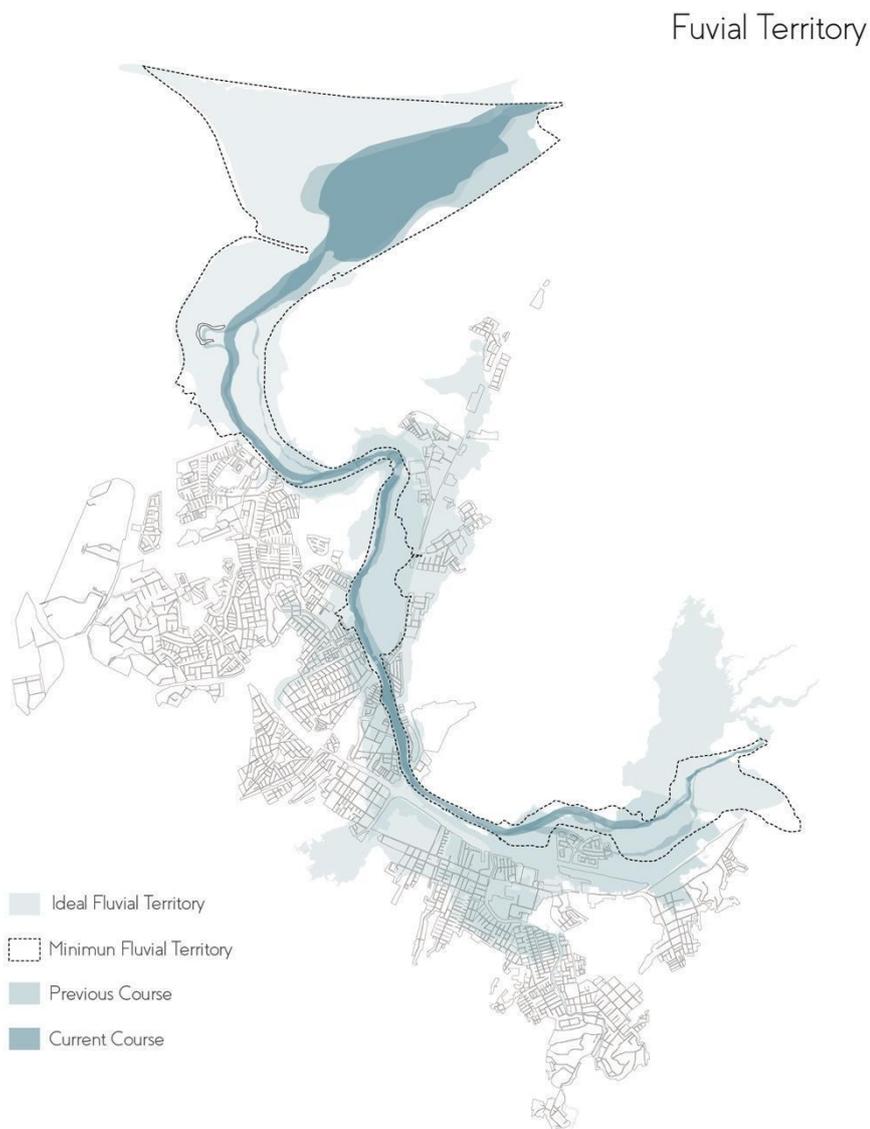


Figure 3. The minimum fluvial territory to keep a river alive. It is a hybrid area defined as a compromised area considering an ideal fluvial territory, historic or previous courses, the current course, and the urbanization. Source: By the author Espinosa, 2020 [52].

Table 1. Design questions proposed in the International Design Competition, *Concepción Living at (in) the Edge*. Source: By the author Espinosa [52].

SCALES	DESIGN QUESTIONS
Basin	Which strategies can be designed to re-balance the shifting regimes of the basin to develop integrated water management?
Stretch City-River Interplay	How to conceive and materialize hybrid and seasonal tissues in order to guide the urban expansion with social cohesion in Concepción city?

Table 1. Cont.

SCALES	DESIGN QUESTIONS
Site-Specific (i) Confluencia: Collao—Las Ulloas	Is there a way to accommodate residential development which respects and upgrades the hydrological system?
Site-Specific (ii) Zona Media	In terms of the landscape's structure, how can the river be enjoyed and give life to the city, balancing historic and systematic social conflicts?
Site-Specific (iii) Desembocadura	If it is necessary, how can it be designed in order to not interrupt the marsh's water flows and sedimentation?

2.3. The Normative Framework and the Andalién River Case

2.3.1. Territorial “Regulation” Rather Than Territorial “Planning”: Concepción’s Communal Regulatory Plan

One of the most important aspects of the Water Code is the sharp separation of water rights from land rights [38]. This separation has also an impact on territorial planning instruments. For decades after the Water Code was enacted, legislation and administrative regulations reproduced this separation. It was only recently that the law that introduced substantial changes to the Water Code—Law 21.435—recognized the inseparable relation between land and water on indigenous lands.

To understand these instruments’ scope and given the socio-spatial location of the Andalién River, we will limit this study to the communal regulatory plan of the city of Concepción. The purpose of this plan is to promote the harmonious development of the municipality’s territory, especially its population centers. It only regulates what is within the urban limit, defining where and how to build [68]. Through Decree No. 148 [69] issued by the Municipality of Concepción, recently modified on 6 July 2021 through Decree No. 494 [70], the “Local Ordinance of the Municipal Regulatory Plan of Concepción” is established. This Ordinance fails to recognize the basin and in consequence the ecosystemic protection of the Andalién River. For example, although territories, where construction is limited due to possible natural disasters or other anthropic phenomena, are defined as risk areas (Section 66 of the Concepción’s regulatory plan), real estate and urbanization projects are allowed near the riverbank, [71,72] in spite of the warning by many authors about the changes that urbanization produces in water systems

Moreover, in the case of real estate projects, this regulation is in contradiction with Section 97 of the Organic Law of the Ministry of Public Construction, according to which: “It is forbidden to build houses for housing and even more so to form settlements on land that is periodically flooded, even when flooding occurs in periods of up to ten years” [73]. This reflects the lack of coordination between the public institutions involved in territorial planning. Given the deficiencies of these instruments, according to Currie and Pérez [68], these mechanisms are not territorial planning since they are limited only to establishing restrictions and requirements that projects must comply with, conditioning the growth of the urban area, as opposed to what is required for territorial planning as such, which should include strategic development of urban areas in order to reduce their vulnerability and increase their resilience.

Lack of effective territorial planning has a negative impact on public and private actors involved in the management of the territory of the Andalién River and its surroundings. In the case of public institutions, they lack clear competencies regarding actions and responsibility, compromising their capacity to solve problems [74]. For neighbors and communities living around the basin, problems of environmental degradation and flood risks are evident [51]. Private actors, mainly real estate investors, although they can, on the one hand, take advantage of these planning gaps and inconsistencies to develop projects in the urban river basin [71,72], are affected by the lack of legal security in their investments, as the lack of clarity in the application of territorial planning instruments allows for changes in the application and control of these regulations [68]. They are also affected by the potential

risk of flooding and other natural disasters, as they can affect the period of execution of investment works, and cause them to incur civil liability for damages to buyers of real estate projects, in the event that these have been caused by negligence or infringement of regulations.

Regulatory instruments do not rely on design as a key part of city planning, dismissing its synthetic potential as a fundamental tool to deal with multiple disciplines from scientific realms to social problematics. City planning would open opportunities to deal with the needs and expectations of different stakeholders and address their concerns in a more thoughtful way.

2.3.2. Weak Legal Mechanisms That Do Not Control and Limit Urban Expansion on River's Territories and Other Water Bodies

In matters of urban expansion, limitations on private property, especially private ownership of land, are expressed through urban planning instruments, that is, the preservation of river space as a national asset for public use and the introduction of special environmental mechanisms for the protection of bodies of water in the law regulating urban wetlands.

Fluvial space is only indirectly defined by the law when it regulates national goods of public use. The Chilean Civil Code excludes rivers and inland waters from the private domain, (Articles 589 and 595). However, this imposes the need of defining the exact limits of the river space, a task that is the responsibility of both the territorial planning instruments and the Ministry of National Assets, which is in charge of protecting public goods. The recent constitution-making process laid the groundwork for the notion of natural commons as elements or components of nature over which the State has a special duty of custody in order to ensure the rights of nature and the interest of present and future generations.

Specifically, in the case of rivers, this public body is responsible for a definition by means of a decree, which regulates the delimitation strip, excluding private property within these limits, and subjecting to public regulation and authorization the infrastructure works to be executed within them. This faculty was granted to the Ministry of National Assets through decree No. 609, promulgated on 31 August 1978 [75].

This authorization led to the beginning of the delimitation of the boundary line between the riverbed as a national asset of public use and the riverside property, but without the current minimum standards of justification required for acts emanating from state bodies since it is a discretionary power of this public body. The consequence of this is that those decrees that delimited the natural course of the river remain immutable since their maintenance depends on the conditions that justified their dictation being maintained [76]. Therefore, a decree whose justification or considerations that merited its issuance are unknown cannot be modified. This situation continued until 2005, at which time it was introduced at the constitutional level, as an element of legitimacy of all state action, the explanation of the foundations of the act. However, on occasions, as in the case of the Andalién River, this delimitation has not been carried out by the national assets authority [77].

The lack of fixation of the riverbed or the fixation of the same through decrees prior to 2005, shows how the law makes invisible a natural element and turns out to be one more condition for the lack of protection against the advance of real estate and infrastructure projects because it does not allow the application of the protection measures proper to the national public use property. Our case study is clear evidence of the consequences of such an administrative pitfall (Figure 4) [76].

The lack of an urban expansion limit basin becomes clear as the Andalién River concentrates the highest growth percentage in Concepción city between 1955 and 2007 increasing its urbanized area by nearly 700% [78]. Between 1960 and 1991, the Andalién watershed registered 21 flood events [51]. These events have a direct relation with the urbanization of the basin's lower area [51,78] demonstrating the pitfall of the regulatory

framework or lack of territorial planning affecting the human population. In 2006, major devastating flooding occurred, counting 3400 dwellings affected [79] (p. 9).

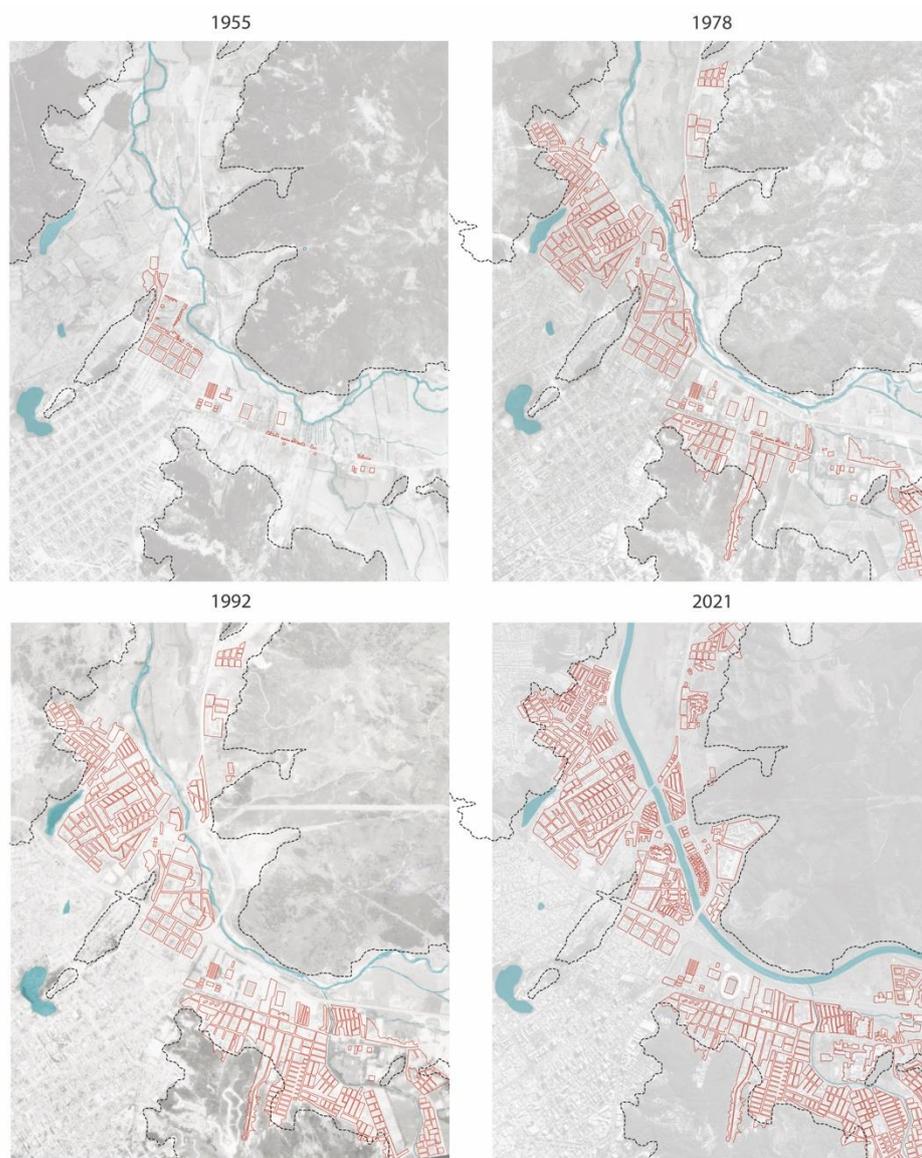


Figure 4. Comparison of the urbanization process in the Andalién floodplain. Analysis based on aerial photographs of 1955, 1978, 1992 and 2021. Red: urbanization, Blue: the river and water bodies, Black: Contour of hills. Source: by the author Espinosa.

Another conflict of urbanization within floodplains is the liquefaction processes. Liquefaction is the loss of soil stability which flows due to the soil condition of floodplains. This kind of soil is normally water and sediment saturated and reacts to tremors or earthquakes. In the particular case of the Andalién River, due to the 2010 earthquake (8.8 Richter scale), the floodplain urbanization suffered liquefaction processes causing cracks, sand outcrops, and water shocks in at least 31 dwellings within five neighborhoods along the Andalién River [80].

From the river dynamics perspective, the problems caused by urbanization in the Andalién River territory are: (i) natural system degradation due to changes in the land cover and landfills increasing runoff as a result of waterproofing, (ii) reduction in the river course complexity and lateral mobility due to channelization and the natural river course displacement, (iii) destruction of natural river geomorphology due to sediment clearance

as flooding management, and (iv) water flows blockages caused by infrastructure [62] (Supplementary Competition Briefing S4).

3. Discussion

There are 101 main watersheds in the continental territory of Chile [81]. The interrelation between the geographical scope of watersheds and the geographical delimitations imposed by regulatory and planning frameworks is vast.

In addition to potential constitutional changes, recent changes in the law offer a new terrain where regulations, territorial planning, and urban design interact, creating opportunities for an effective integration of the Andalién River and other similar cases. The two main regulations are the reform of the Water Code of April 2022, and the Framework Law on Climate Change of June 2022. Both entrust to enact a Strategic Water Resources Plan for each basin, considering various aspects of hydrological modeling, aquifer recovery, and management plans, among others. The enactment of these plans and the regulation for their elaboration opens a new opportunity to discuss the legal status, protection, and use of river basins in urban areas such as the Andalién.

3.1. Fragmented Legal Framework Applicable to Water and Land Management in Chile

The fragmentation of the legal framework applicable to water and land management can be explained from two standpoints:

First, the regulation of rivers and other water bodies is fragmented into various legal bodies which grant competencies to a multiplicity of public institutions and private services, weakening the framework for effective action [74].

Second, there are no territorial planning instruments that contemplate a national and integrated vision of the geographic space and basins. On the contrary, there are different instruments that operate with different regulations and under the supervision of different sectoral agencies. Among these instruments, we find the Intercommunal Regulatory Plans, the Metropolitan Regulatory Plans, the Communal Regulatory Plans, the Sectional Plans, and the urban boundary delimitation. Urban design and regulatory framework should acknowledge local conditions. Territorial planning instruments include only urban areas, ignoring both water basins and rural areas.

These instruments contain the policies, plans, norms, institutions, and procedures that make it possible to project, manage and administer land use [82]. However, given the lack of coordination between them and the absence of integrated management tools, it is possible to identify the following deficiencies: (i) they do not take into account the current climate change scenario or the ecological function, (ii) they do not incorporate adequate mechanisms to plan, design and regulate peripheral areas, where urban and rural areas coexist, and (iii) there are no powers and mechanisms and to protect relevant social-ecosystems, such as rivers and wetlands, that are located within cities and population centers [68].

The above-mentioned deficiencies are reinforced by the establishment, at the constitutional level, of a public economic order that strengthens the right to property and permeates the rest of the sectorial norms.

Nevertheless, in the last years, an initial change in the dominant paradigm has been introduced in the legal system with the enactment of Law no. 21.202 on urban wetlands in Chile. The new law redefines the link between city design and bodies of water [47]. Although wetland regulations may improve the protection of water systems in urban contexts, they also raise a number of questions, the exact boundaries of wetlands, how to prevent the exclusion of neighboring sectors that are relevant for the function of, and how to prevent landowners and developers use legal action to stop wetland protection [83]. These problems respond to a challenge shared by the legal protection enshrined in Law no. 21.202 mechanisms: the need to have a global vision of the regulation of water bodies in the urban context, which goes beyond the urban-nature or city-river duality, implementing measures to integrate the fluvial ecosystem into the city as a whole.

The regulation of protected areas and territorial planning that incorporate the river-city relationship, can be strengthened by the Strategic Water Resources Plans, introduced by the reform of the Water Code [84] and the new Framework Law on Climate Change [85]. The key starting point for these instruments will be the regulatory implementation by the Chilean Ministry of Public Works.

This regulation should be especially cautious when basins in urban areas, such as the Andalién River. This implies the incorporation of institutions in charge of urban planning, such as municipalities, and stakeholders with social, economic, and environmental preservation interests involved in the urban use of the river. A strong presence in the decision-making process and the supervision of its implementation through these plans can strengthen the commitment of the affected stakeholders in the fulfillment of the planning and management objectives of the urban basin. In this regard, it is relevant to note Chile's recent accession to the Escazú Agreement on participation and information in environmental matters [86], which incorporates into the Chilean legal framework basic standards for decision-making in instruments such as the Water Resources Plans.

The need for stakeholders' participation does not preclude the establishment of special protection zones, such as the riverbed, floodplain, or urban wetlands. Instead, it demands a standard of urban planning with a solid and comprehensive regulatory basis to ensure water security. This stresses the urgency to redefine this interplay moving from a mere protective perspective to a propulsive one.

3.2. A Dialogue for the Future. An Ecological Constitution and the Ecological Function of Property as a Paradigm

It is difficult to predict if the current historical moment in which our country is building a new constitution, will allow a shift in the legal paradigm towards Nature. The 'New Latin American Constitutionalism' [87] appears as an option to guarantee the preservation of the environment. This constitutionalism, which we can also call biocentric [88], finds its foundations in the Constitution of Ecuador (2008), which recognizes nature as a subject of law, as well as in the Constitution of Bolivia (2009), although with relevant nuances. The current constitutional debate recognizes Nature as a right's bearer and the duty to respect and protect its existence, regeneration, maintenance, and restoration of its functions and dynamic equilibrium. Including natural cycles, ecosystems, and biodiversity. The law may establish restrictions on the exercise of certain rights to protect the environment and nature.

Along the same line, if Chile and its inhabitants are willing to shift from a Constitution strongly based on ordering the economy and those who profit short term from water resources to a Constitution to wish to plan and protect for long-term sustainability and urban planning, it opens a new way to understand the relationship between human beings, nature and natural resources [89] and consequently, questions the way in which private property rights have been understood up to now. The legitimacy of a constitution adopted as a fundamental rule through a democratic process could be a way in which those who benefit economically and control water resources will need to give up partially the control for a common good aim.

The necessary shift of a normative paradigm from the traditional and anthropocentric perspective to the one proposed by ecological constitutionalism could imply indirectly the revision of territorial planning mechanisms. Conceptually territorial planning that considers ecology as a way to develop the country, will need to evolve regulations and limitations that open planning and adaptive actions to look for new ways of physical development in changing scenarios.

One aspect that arises from the ecological function is the existence of geographical situations in which the design of a strict delimitation between public and private action may be insufficient for the requirements of governance. This is precisely the case of rivers in urban contexts, in which, on the one hand, there are opportunities for the development of projects of private interest, but on the other hand, its ecological dynamics and the interests of the community are compromised in the intervention.

In a context such as Chile's, where, as evidenced, the public/private division of territory has played in favor of reducing the limits of public control, the idea of creating a hybrid management system can be disruptive. However, from an academic perspective, in the fields of law [90], economics [91], and urban planning [92], options for overcoming this dichotomy have been put forward, in what we call a "hybrid system". The constitutional debate guarantees public participation in territorial planning processes and housing policies. It also promotes and supports community habitat management.

The definition of a hybrid management area allows the field of intervention on the river to be extended beyond the minimum protection polygon. In it, the development of infrastructure projects of both public (roads, bridges, urban parks) and private origin (mainly, in the case of the Andalién, those of real estate interest) can be allowed. As part of its design, the regulation must consider the maintenance of permanent or seasonal areas with permitted degrees of intervention (total, medium, or low restriction), and directed forms of construction that adapt to the continuity of the river system, in which the implementation of green infrastructure [93] with the characteristics defined by the public authority becomes mandatory.

The introduction of a hybrid system on the territory, in the Chilean context, is hindered by the existence of a strong regulatory tradition of continental civil law [94]. In relation to this, alternatives for implementation at the legal level are presented as both the existence of a special property regime within a framework of private property (individual or community), and the forced constitution of limited real rights or easements in favor of the continuity of the river system in the urban sphere, protected by the ecological function of property.

Previously, we have pointed out that one of the main risks of the delimitation of protected areas as the only form of river regulation in the urban context is the possibility of massive challenges through administrative or judicial channels. Although this alternative should exist to guarantee the proper exercise of the rights of individuals vis-à-vis the public authority, its massive use can hinder the fulfillment of the protection objectives.

In order to guarantee the use of this route as a form of conflict resolution in the last instance, and to preserve a harmonious treatment of the river-city relationship that resolves the problems beyond each "affected" landowner, it is necessary to have planning instances that commit the actors involved in the fulfillment of the river management design in the urban sphere.

In this line, the results of the research by design exercises for keeping rivers alive through establishing the minimum fluvial territory in urban (Figure 5) contexts encourage urban planning and design to be able to address at least three design principles: (i) Effort to propose land use toward hybrid programs going beyond the parks and conservation. This operation is durable over time and jeopardizes neither the ecological value of the area nor the productive possibilities of the territory. This is possible as thinking beyond the idea of parks and conservation allows the testing of new hybrid economies and urbanities such as sustainable agriculture, agroforestry, or green infrastructure for risk management and consequently offering safer urbanization. (ii) Designs for restoring or keeping the continuity of the river system. This physical continuity goes in all dimensions of the rivers, streamwise, spanwise, and depthwise. Therefore, guaranteeing water, sediment, and energy fluxes to the aquifers, and floodplains. (iii) Thinking about urbanization for a hybrid geomorphological-urban unit. The spatial conceptualizations of the hybrid fabrics adapt to the seasons and respond to the fluvial territory assigned characteristics of bed roughness, permeability, and type of riparian vegetation, and propose special characteristics of the construction type [23].

Dialogue within these bodies must involve different perspectives that must converge in this effort. Thus, the convergence of visions for river planning at the urban scale should consider the different factors that influence the preservation of water security in the urban context: the availability of water for human consumption and sanitation, the maintenance of the ecosystemic dynamic equilibriums, the control of water-related hazards, and the development of economic activities [6], understanding the latter not only in terms of water

and sediment extraction but also the use of land on the riverbed or in the immediate vicinity of the river to the extent that it affects the hydrological cycle.

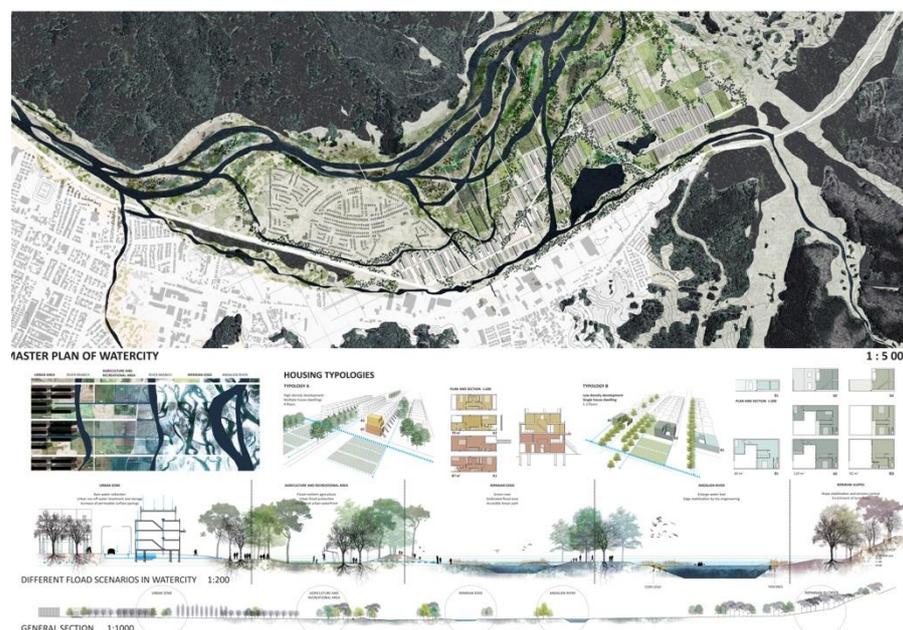


Figure 5. Three river sequence. The design strategy that dialogues with the principles is the definition of urban-river tissue where the river can move and reconnect the watercourses with existing wetlands. A section is designed as a dialogue between housing which considers permeable spaces between buildings to allocate water flows. Source: By the authors: Cummings, Malcolm, Pirks, Priore and Urgelles Calvet in [52].

The presence of these actors (representing water security factors) may include, for the situation of the Andalién in Chile, currently existing bodies, such as those relating to territorial planning at the communal level, as well as the design of new decision-making bodies at the basin level, such as the river basin councils proposed by various bodies [43,82], which for these purposes, should have a particular design that takes into account the agents and characteristics of the urban sector.

Participation in urban or semi-urban water planning bodies not only contributes, in our opinion, to promoting agreements and avoiding legal or de facto conflicts but is also a way of fostering a climate of peace and political stability [95], within which it is possible to meet water security objectives. Furthermore, integration of novel disciplines in water management strategies, such as socio-hydrology can provide conceptual inputs of the human–hydrological interplays giving relevant feedback for governance models [96,97].

This effective participation, and the adherence to a new deal between public and private agents for a sustainable coexistence of the river and the city, can be achieved if a commitment is made, which gives certain powers to regulate the ecological function, in exchange for economic and legal certainty and secure conditions for life, investment and development around the Andalién River. We think that the constitutional momentum that Chile is facing currently could provide an adequate scenario to have relevant discussions among these lines.

4. Conclusions

This article develops an interdisciplinary dialogue based on concrete design principles obtained by design research and the conceptualization of regulations needed to implement real changes in the city–river interplay areas.

For the Chilean context, in the midst of a constitutional process that opened opportunities to discuss, not only the nature and scope of private property (over land and water)

but also the ecological functioning of fluvial systems. This is a relevant step towards disentangling the existing Constitution from its economic-centric framework, so that new conceptualizations based on the ecological value of nature could be imagined. The current constitutional process provides a real possibility of shifting constitutional paradigms in the direction analyzed in this paper.

The need for interdisciplinary dialogue between territorial planning and urban design is based on a fruitful exchange and co-construction of a new language to visualize real actions to promote resilience in rivers as social ecosystems. The objective is to take on the challenges of integration, decision-making mechanisms, and coordination between different levels, adapted to the water and social reality of the Andalién River case.

Effective implementation would require institutional strength and reforms to the legal system. One interesting example examined in this paper is the legal reform to urban wetlands in Chile.

These concrete actions are until now highly pressured by a normative framework that prioritizes private property over ecological concerns. This article places the ecological function of property as a decisive counter-concept to build a way through a constitutional process to allow water production, biodiversity recovery, and adaptation to climate change within urban contexts.

Supplementary Materials: The following supporting information has the aim to show the process behind the design research elaborated in this article and can be downloaded at: <https://www.mdpi.com/article/10.3390/w14213444/s1>, IHG Results (Poster) S1; IREC Competition Materials S2; READU Competition Posters S3; Competition Briefing S4; Winning Designs S5.

Author Contributions: Conceptualization and formal analysis, P.E., K.I. and R.C.; methodology, P.E. and C.B.-S.; writing—original draft preparation, P.E., R.C. and K.I.; writing—review and editing, C.B.-S.; supervision, A.Á.; funding acquisition, A.Á. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Universidad de Concepción, project ANID/FONDAP/15130015, which creates the Water Resources Center for Agriculture and Mining (CRHIAM) at Concepción, Chile. Camila Bañales-Seguel was supported by the Agencia Nacional de Investigación (ANID) PhD grant No° 2018-21190264.

Data Availability Statement: Not applicable.

Acknowledgments: We thank the anonymous external reviewers, the journal's editors and our colleagues José Aliaga and Arnulf Becker for their feedback to improve the discussion presented in this manuscript. Moreover, we would like to thank Bruno de Meulder, and Kelly Shannon from KU Leuven and Alfredo Ollero from University of Zaragoza as promoters of Paulina Espinosa's PhD thesis that lays the foundation of this article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Lindenmayer, D.B.; Hobbs, R.J. *Managing and Designing Landscapes for Conservation: Moving from Perspectives to Principles*; Blackwell: Oxford, UK, 2007; p. 21. ISBN 978-1-4051-5914-2.
2. General Assembly- United Nations. The Human Right to Water and Sanitation; Resolution adopted by the General Assembly; A/RES/64/292. 2010. Available online: <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N09/479/38/PDF/N0947938.pdf?OpenElement> (accessed on 25 November 2021).
3. Rivera, D.; Godoy-Faúndez, A.; Lillo, M.; Alvez, A.; Delgado, V.; Gonzalo-Martin, C.; Menasalvas, E.; Costumero, R.; García-Pedrero, A. Legal Disputes as a Proxy for Regional Conflicts Over Water Rights in Chile. *J. Hydrol.* **2016**, *535*, 36–45. [CrossRef]
4. Bauer, C.J. *Contra la Corriente. Privatización, Mercados de Agua y el Estado en Chile*; Lom Ediciones: Santiago, Chile, 2002. ISBN 956-282-533-7.
5. World Bank Group. Climate Change Knowledge Portal for Development Practitioner and Policy Makers. Available online: <https://climateknowledgeportal.worldbank.org/country/chile> (accessed on 18 December 2021).
6. Aboelnga, H.T.; Ribbe, L.; Frechen, F.-B.; Saghir, J. Urban Water Security: Definition and Assessment Framework. *Resources* **2019**, *8*, 178. [CrossRef]

7. Rosenzweig, C.; Karoly, D.; Vicarelli, M.; Neofotis, P.; Wu, Q.; Casassa, G.; Menzel, A.; Root, T.L.; Estrella, N.; Seguin, B.; et al. Attributing Physical and Biological Impacts to Anthropogenic Climate Change. *Nature* **2008**, *453*, 353–357. [[CrossRef](#)]
8. Intergovernmental Panel on Climate Change Special Report. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*; Cambridge University Press: Cambridge, MA, USA, 2012.
9. Spratt, D.; Dunlop, I. *What Lies Beneath: The Scientific Understatement of Climate Risks*; Breakthrough-National Center for Climate Restoration: Melbourne, Australia, 2018.
10. International Institute for Environment and Development (IIED). Nature-Based Solutions to Climate Change: Stories from Chile. Available online: <https://reliefweb.int/report/chile/nature-based-solutions-climate-change-stories-chile> (accessed on 25 November 2021).
11. Maddocks, A.; Young, R.S.; Reig, P.; Ranking the World's Most Water-Stressed Countries in 2040. World Resources Institute. Available online: <https://www.wri.org/insights/ranking-worlds-most-water-stressed-countries-2040> (accessed on 15 November 2021).
12. Intergovernmental Panel on Climate Change (IPCC). *Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*; Shukla, P.R., Skea, J., Calvo Buendia, E., Masson-Delmotte, V., Pörtner, H.O., Roberts, D.C., Zhai, P., Slade, R., Connors, S., Van Diemen, R., et al., Eds.; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2019.
13. Wilhelmi, M.A. Nuevo Constitucionalismo, Derechos y Medio Ambiente en las Constituciones de Ecuador y Bolivia. *Rev. Gen. Derecho Público Comp.* **2011**, *9*, 1–24.
14. Fischer-Lescano, A. Nature as a Legal Person: Proxy Constellations in Law. *Law Lit.* **2020**, *32*, 237–262. [[CrossRef](#)]
15. Ordóñez, M.F.; Shannon, K.; d'Auria, V. The materialization of the Buen Vivir and the Rights of Nature: Rhetoric and Realities of Guayaquil Ecológico urban regeneration project. *City Territ. Arch.* **2022**, *9*, 1–17. [[CrossRef](#)]
16. O'Donnel, E.; Macpherson, E. Voice, power and legitimacy: The role of the legal person in river management in New Zealand, Chile and Australia. *Aust. J. Water Resour.* **2019**, *23*, 35–44. [[CrossRef](#)]
17. United Nations Department of Economic and Social Affairs (UN DESA). Revision of the World Urbanization Prospects. Available online: <https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html> (accessed on 22 November 2021).
18. Downs, P.; Skinner, K.; Kondolf, M. Rivers and Streams. In *Handbook of Ecological Restoration*; Perrow, M.R., Davy, A.J., Eds.; Cambridge University Press: Cambridge, UK, 2002; pp. 267–291. ISBN 0-521-79129-4.
19. Bernhardt, E.S.; Palmer, M.A.; Allan, J.D.; Alexander, G.; Barnas, K.; Brooks, S.; Carr, J.; Clayton, S.; Dahm, C.; Follstad-Shah, J.; et al. Synthesizing U.S. River Restoration Efforts. *Science* **2005**, *308*, 636–637. [[CrossRef](#)]
20. Demarsin, M.; Naulers, R. *Living in the Edge, Water Urbanism in Chile: The Case of Andalien River in Concepción*; KU Leuven: Leuven, Belgium, 2015.
21. Espinosa, P.; Horacio, J.; Ollero, A.; De Meulder, B.; Jaque, E.; Muñoz, M.D. When Urban Design Meets Fluvial Geomorphology: A Case Study in Chile. In *Urban Geomorphology Landforms and Processes in Cities*; Thombush, M.J., Allen, C.D., Eds.; Elsevier: Oxford, UK, 2018; pp. 149–174. ISBN 0128119519.
22. Espinosa, P.; De Meulder, B.; Horacio, J.; Ollero, A. Diseñando el (al) límite. negociaciones agua y ciudad en Chile. In *Diseñando el (al) Límite. Negociaciones Agua y Ciudad en Chile*. In Proceedings of the Primeras Jornadas de Investigación “Ríos Urbanos. Nuevas Perspectivas para el Estudio, Diseño y Gestión de los Territorios Fluviales, Buenos Aires, La Plata, Argentina, 2–3 November 2017.
23. Espinosa, P.; Agurto, L. Principios híbridos de diseño urbano (no sólo) para adaptarse al cambio climático sino también para combatirlo. El caso del río Andalién en Concepción. In *Aprendizajes e Innovación para la Resiliencia Urbana. Convergencia: Ciencia, Estado y Ciudadanía. Estudios y Enfoques para el Desarrollo de Ciudades Resilientes*, Consejo Nacional de Desarrollo Urbano e Instituto de Estudios Urbanos y Territoriales UC; RIL Editores: Santiago, Chile, 2021; pp. 226–244. ISBN 978-956-6057-29-1.
24. Waldheim, C. Landscape urbanism: A genealogy. *Prax. J. Writ. Build.* **2002**, *4*, 10–17.
25. Orff, K. *Toward an Urban Ecology: Scape/Landscape Architecture*; illustrated edition; the Monacelli Press: New York, NY, USA, 2016; ISBN 1580934366.
26. Harvard University Graduate School of Design. *Ecological Urbanism*; Mostafavi, M., Doherty, G., Eds.; Lars Müller Publishers: Zurich, Switzerland, 2016; ISBN 978-3-03778-467-9.
27. Viganò, P. Urbanism and Ecological Rationality. In *Resilience in Ecology and Urban Design. Linking Theory and Practice for Sustainable Cities*; Pickett, S.T.A., Cadenass, M.L., McGrath, B., Eds.; Springer: Berlin/Heidelberg, Germany, 2013; pp. 407–426. ISBN 978-94-007-5340-2.
28. Keenan, J.M.; Weisz, C. *Blue Dunes. Climate Change by Design*; Columbia University Press: New York, NY, USA, 2017. ISBN 9781941332153.
29. Rohde, S.; Hostmann, M.; Peter, A.; Ewald, K.C. Room for rivers: An integrative search strategy for floodplain restoration. *Landsc. Urban Plan.* **2006**, *78*, 50–70. [[CrossRef](#)]
30. University of Virginia and Tulane University. The Yamuna River Project. Available online: <http://www.yamunariverproject.org/> (accessed on 29 August 2022).
31. Fryirs, K.; Brierley, G. A geomorphic approach to the identification of river recovery potential. *Phys. Geogr.* **2000**, *21*, 244–277. [[CrossRef](#)]

32. Kondolf, M. An Environmental Perspective in City River Relationships. In *Cities and Rivers, Perspectives towards a Sustainable Partnership*. En *Livro N° 8 da Coleção Expoentes*; Núcleo de Comunicação Da Parque Expo: Lisbon, Portugal, 2009.
33. Kondolf, M.; Pinto, P.J. The social connectivity of urban rivers. *Geomorphology* **2017**, *277*, 182–196. [CrossRef]
34. Vallejo, R. The Chilean Economic Constitution: An Essay in (de)Construction. *Estud. Const.* **2016**, *14*, 247–290. [CrossRef]
35. Fernandois, A. El orden público económico bajo la Constitución de 1980. *Ius Publicum* **2000**, *4*, 63–78.
36. Contreras, Y.; Prieto, M. *Agua, Suelo y Propiedad en una Constitución Sociológica para Chile Propuestas Integradas*. En *una Constitución Sociológica para Chile: Propuestas Integradas*; Galdámez, L., Millaleo, S., Saavedra, B., Eds.; Red de constitucionalismo ecológico: Santiago, Chile, 2021; pp. 107–110. ISBN 978-956-16-0841-2.
37. Wuijts, S.; Driessen, P.P.J.; Van Rijswijk, H.F.M.W. Towards More Effective Water Quality Governance: A Review of Social-Economic, Legal and Ecological Perspectives and Their Interactions. *Sustainability* **2018**, *10*, 914. [CrossRef]
38. Prieto, M.; Fragkou, M.C.; Calderón-Seguel, M. Water Policy and Management in Chile. In *Encyclopedia of Water: Science, Technology, and Society*; Maurice, P., Ed.; Wiley: Hoboken, NJ, USA, 2020; pp. 2589–2600. ISBN 978-1-119-30075-5.
39. Rojas, C. The juridical category of “private services that are of public interest”. The case of rivers surveillance boards. *Rev. Chil. Derecho* **2014**, *41*, 171–204. [CrossRef]
40. Fundación para la innovación agraria. *Resultados y lecciones en Gestión hídrica del río Elqui para mejorar la eficiencia del agua. Proyecto de Innovación En Región De Coquimbo*; Fundación para la Innovación Agraria: Santiago, Chile, 2020; ISBN 978-956-328-264-1.
41. Rivera, D. Gestión colectiva y conjunta de aguas: Perspectiva jurídica de una deuda subterránea. *Rev. Derecho* **2016**, *46*, 311–346. [CrossRef]
42. OECD-ECLAC. *OECD Environmental Performance Reviews: Chile 2005*; OECD Publishing: Paris, France, 2005.
43. Institute of Engineers of Chile. *Hacia una Gestión Integrada de Recursos Hídricos: Una Propuesta*. 2012. Available online: <https://www.iing.cl/wp-content/uploads/2022/08/2012-Hacia-una-Gestion-Integrada-de-Recursos-Hidricos.pdf> (accessed on 21 December 2021).
44. Saavedra, B.; Galdámez, L. Bases para la incorporación de la función ecológica de la propiedad en la Constitución chilena. In *una Constitución Sociológica para Chile: Propuestas Integradas*; Galdámez, L., Millaleo, S., Saavedra, B., Eds.; Red de constitucionalismo ecológico: Santiago, Chile, 2021; pp. 115–119. ISBN 978-956-16-0841-2.
45. Rodríguez, G.A. La función ecológica de la propiedad en Colombia. *Justicia Ambiental y Climática. Rev. Derecho Ambient. La ONG FIMA* **2019**, *11*, 169–196.
46. Domanska, E. Beyond Anthropocentrism in Historical Studies. *Historiein* **2011**, *10*, 118–130. [CrossRef]
47. Law 21.202 Which Amends Several Legal Bodies in Order to Protect Urban Wetlands. 2020. Available online: <https://www.bcn.cl/ley-chile/navegar?idNorma=1141461> (accessed on 12 January 2022).
48. Arriagada, L.; Rojas, O.; Arumí, J.L.; Munizaga, J.; Rojas, C.; Farias, L.; Vega, C. A new method to evaluate the vulnerability of watersheds facing several stressors: A case study in mediterranean Chile. *Sci. Total Environ.* **2019**, *651*, 1517–1533. [CrossRef]
49. Mardones, M.; Vidal, C. La zonificación y evaluación de los riesgos naturales de tipo geomorfológico: Un instrumento para la planificación urbana en la ciudad de Concepción. *EURE* **2001**, *27*, 97–122. [CrossRef]
50. Instituto Nacional de Estadísticas (INE). Censo de Población y Vivienda 2017. Available online: <https://www.ine.cl/estadisticas/sociales/censos-de-poblacion-y-vivienda/informacion-historica-censo-de-poblacion-y-vivienda> (accessed on 21 December 2021).
51. Rojas, O.; Mardones, M.; Arumí, J.L.; Aguayo, M. Una Revisión de Inundaciones Fluviales en Chile, Período 1574-2012: Causas, Recurrencia y Efectos Geográficos. *Rev. De Geografía Norte Gd.* **2014**, *57*, 177–192. [CrossRef]
52. Espinosa, P.; De Meulder, B.; Ollero, A. Restauración fluvial como estrategia de diseño urbano. Un diálogo entre investigación y diseño. Concurso río Andalién, Concepción, Chile. *AREA Agenda Reflexión Arquít. Diseño Y Urban* **2020**, *26*, 14.
53. Hidalgo, R. Políticas de vivienda social en Santiago de Chile: La acción del Estado en un siglo de planes y programas. *Scr. Nova Rev. Electrónica Geografía Y Cienc. Soc.* **1999**, *45*.
54. Quintana, F. Urbanizando con tiza. *ARQ* **2014**, *86*, 30–43. [CrossRef]
55. Flores, R. *Crecimiento del Área Metropolitana de Concepción y su Relación con los Planes Reguladores Metropolitanos 1962-2002, Seminario de Investigación para Postular al Grado Académico de Licenciada en Arquitectura*; Unidad de Planificación Territorial, Centro EULA, Universidad de Concepción: Concepción, Chile, 2008.
56. Joost, G.; Bredies, K.; Christensen, M.; Conradi, F.; Unteidig, A. *Design as Research: Positions, Arguments, Perspectives*; Birkhäuser: Berlin, Boston, 2016; ISBN 9783035607383.
57. Felson, A.J.; Bradford, M.A.; Terway, T.M. Promoting Earth Stewardship through urban design experiments. *Front. Ecol. Environ.* **2013**, *7*, 362–367. [CrossRef]
58. Rebuild by Design Home Page (2014-Ongoing). Available online: <http://www.rebuildbydesign.org/> (accessed on 20 January 2022).
59. Resilient by Design Home Page (2017-Ongoing). Available online: <http://www.resilientbayarea.org/> (accessed on 20 January 2022).
60. Rojas Bernal, C.L.; Shannon, K.; De Meulder, B. Designing water infrastructure and context-responsive housing: A case study in the Sabana de Bogotá. *Landsc. Res.* **2020**, *45*, 873–891. [CrossRef]

61. Ollero, A.; Ibisate, A.; Gonzalo, L.E.; Acín, V.; Ballarín, D.; Díaz, E.; Domenech, S.; Gimeno, M.; Granada, D.; Horacio, J.; et al. The IHG index for hydromorphological quality assessment of rivers and streams: Updated version. *Limnetica* **2011**, *30*, 255–262. [[CrossRef](#)]
62. Parra, J.; Espinosa, P.; Jaque, E.; Ollero, A. Caracterización y evaluación hidrogeomorfológica para la restauración fluvial urbana en la cuenca del Andalién (Región Biobío, Chile). In Proceedings of the VV.AA, Proceedings of the II Congreso Ibérico de Restauración Fluvial, Pamplona, España, 9–11 June 2015; pp. 692–696, ISBN 978-84-606-9015-3.
63. IREC; Espinosa, P.; Naulers, R.; Checa, A.; Espinosa, P.; Agurto, L.; Naulers, R.; Checa, A. 2nd Prize: Reconstruction and Recovery in Urban Contexts. (Other). In Proceedings of the International i-Rec Conference and Student Competition, The Bartlett Development Planning Unit, University College, London, UK, 6–8 July 2015.
64. Red Académica de Diseño Urbano; Espinosa, P.; De Meulder, B.; Agurto, L.; Naulers, R.; Demarsin, M.; Checa, A.; Tapia, F.; Espinosa, P.; De Meulder, B. 1st Prize: Posters Competition of Design Practice in the 5th Congress of Urban Design. Venue: Congress of Urban Design. In *Water and City*, 5th ed.; UCN: Antofagasta, Chile, 2015.
65. Cabello, V.; Wilaarts, B.; Aguilar, M.; Del Moral Ituarte, L. River basins as social-ecological systems: Linking levels of societal and ecosystem water metabolism in a semiarid watershed. *Ecol. Soc.* **2015**, *20*, Art. 20. [[CrossRef](#)]
66. Buffin Bélanger, T.; Biron, P.; Larocque, M.; Demers, S.; Olsen, T.; Choné, G.; Ouellet, M.A.; Cloutier, C.; Desjarlais, C.; Eyquem, J. Freedom space for rivers: An economically viable river management concept in a changing climate. *Geomorphology* **2015**, *251*, 137–148. [[CrossRef](#)]
67. Espinosa, P.; Agurto, L.; Jaque, E.; Santa Cruz, J.C.; Muñoz, M.D.; De Meulder, B.; Shannon, S.; Ollero, A.; Horacio, J. Concepción, Habitando el (al) Límite. Organizing a Design Competition. (Plan, Website, Other). FONDART Nacional 2018. Project Number: 462038. Ministry of Cultures, Chile. Available online: www.ideasandalien.com (accessed on 20 January 2022).
68. Currie, R.; Pérez, G. Cambio Climático y Planificación Urbana: Desafíos y Oportunidades para la Evaluación Ambiental Estratégica. *Rev. De Derecho Ambient.* **2021**, *16*, 73–107. [[CrossRef](#)]
69. Decree, No.148 about Local Ordinance of the Communal Regulatory Plan of Concepción, 22 April 2004. Available online: <https://www.bcn.cl/leychile/navegar?idNorma=224142&idVersion=2021-07-06&idParte=8650556> (accessed on 4 December 2021).
70. Decree No. 494, Introduces the 15th Modification of the Regulatory plan of the Municipality of Concepción. Available online: <https://www.bcn.cl/leychile/navegar?idNorma=1162293> (accessed on 4 December 2021).
71. Miller, J.D.; Kim, H.; Kjeldsen, T.R.; Packman, J.; Grebby, S.; Dearden, R. Assessing the impact of urbanization on storm runoff in a peri-urban catchment using historical change in impervious cover. *J. Hydrol.* **2014**, *515*, 59–70. [[CrossRef](#)]
72. Rojas, O.; Mardones, M.; Rojas, C.; Martínez, C.; Flores, L. Urban Growth and Flood Disasters in the Coastal River Basin of South-Central Chile (1943–2011). *Sustainability* **2017**, *9*, 195. [[CrossRef](#)]
73. Chilean Ministry of Public Works. Decree with force of law Law N° 85015.840. Establishes the consolidated, coordinated and systematized text of law No 15.840, of 1964 and of decree with force of law No 206, of 1960. Section 97. 1998. Available online: <https://www.bcn.cl/leychile/navegar?idNorma=97993> (accessed on 4 December 2021).
74. World Bank. Chile: Estudio Para el Mejoramiento del Marco Institucional para la Gestión del Agua. 2013. Available online: https://bibliotecadigital.ciren.cl/bitstream/handle/20.500.13082/33281/BANCO_MUNDIAL_2013-Estudio-para-el-Mejoramiento-del-Marco-Institucional-para-la-Gestion-del-Agua-DGA-BM-2013.pdf?sequence=1&isAllowed=y (accessed on 12 January 2022).
75. Decree, No.609, Derogates Decree No 1204, of 1947, and Establishes Norms to Set Boundaries between Riparian Owners and the National Public Property on the River Banks, Lakes and Estuaries. Available online: <https://www.bcn.cl/leychile/navegar?idNorma=133741> (accessed on 28 August 2022).
76. Cabrera, A. Determination and fixation of natural water sources in Chile. The limit between a national asset for public use and the private property. *Derecho Público Iberoam.* **2018**, *12*, 13–41.
77. Chilean Ministry of Public Works. Response of access to public information No: AQ-001W0024973. Available online: <https://drive.google.com/file/d/1ykK3j5LagwYHDkm91ecvhmZirbtuffwL/view?usp=sharing> (accessed on 28 August 2021).
78. Romero, H.; Vidal, C. Efectos Ambientales de la Urbanización de las Cuencas de los Ríos Bío Bío y Andalién sobre los Riesgos de Inundación y Anegamiento de la Ciudad de Concepción. In *Concepción Metropolitana (AMC)*; Pérez, L., Hidalgo, R., Eds.; Editorial Universidad de Concepción. Serie GEOlibros: Santiago, Chile, 2010; pp. 287–304.
79. Ascui, H.; Muñoz, M.D.; Sáez, N. Que es lo que queda cuando el agua se va. *Ciudad Y Agua* **2007**, *25*, 4–29.
80. Falcon, M.; Arenas, M.; Ramírez, P.; Marín, M.; Creixell, C.; Huerta, S. Peligro de licuefacción: Área Concepción-Talcahuano-Hualpén-Chiguayante, Región del Biobío. *Servicio Nacional de Geología y Minería, Carta Geológica de Chile*. 2012. Available online: https://biblioteca.sernageomin.cl/opac/datafiles/CGCH_GAMB_14_Mapa.pdf (accessed on 29 August 2022).
81. *Ministerio de Obras Públicas (MOP) Gobierno de Chile*; Atlas del Agua: Santiago, Chile, 2016.
82. Cozzi, A.; Burdiles, G.; Rojas, Y. *Planificación Ecológica en Instrumentos de Ordenamiento Territorial de Competencia Municipal*; ONG FIMA con el apoyo de la Fundación Heinrich Böll: Santiago, Chile, 2021.
83. Jiménez, C. Commentaries to Law 21.202 which modifies several legal bodies, with the purpose of protecting urban wetlands. *Rev. De Derecho Ambient.* **2021**, *15*, 123–144. [[CrossRef](#)]
84. Chilean Ministry of Public Works. Law N° 21.435: Water Code reform. Section 293 bis. 2022. Available online: <https://www.bcn.cl/leychile/navegar?idNorma=1174443&idParte=10322783&idVersion=2022-04-06> (accessed on 28 August 2022).

85. Chilean Ministry of Environment. Law N° 21.455: Framework law on Climate Change. Section 13. 2022. Available online: <https://www.bcn.cl/leychile/navegar?idNorma=1177286> (accessed on 28 August 2022).
86. United Nations. Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean. 2018. Available online: https://repositorio.cepal.org/bitstream/handle/11362/43583/1/S1800428_en.pdf (accessed on 19 January 2022).
87. Martínez, R. Fundamentos para el reconocimiento de la Naturaleza como sujeto de derechos. In *en la Naturaleza como Sujeto de Derechos en el Constitucionalismo Democrático*; Estupiñán, L., Storini, C., Martínez, R., Antonio de Carvalho, F., Eds.; Universidad Libre: Bogotá, Colombia, 2019; pp. 31–47. ISBN 978-958-5578-09-8.
88. Sarmiento, J.P. La protección a los seres sintientes y la personalización jurídica de la naturaleza aportes desde el constitucionalismo colombiano. *Estud. Const.* **2020**, *18*, 221–264. [[CrossRef](#)]
89. Iacovino, Angela. Constitucionalismo ecológico en América Latina: De los derechos ambientales a los derechos de la naturaleza. *Cultura Latinoamericana. Rev. De Estud. Intercult.* **2020**, *31*, 267–311. [[CrossRef](#)]
90. Nedelsky, J. *Law's Relations: A Relational Theory of Self, Autonomy, and Law*; Oxford University Press: New York, NY, USA, 2011. ISBN 978-0199332168.
91. Ostrom, E. Reformulating the commons. *Swiss Political Sci. Rev.* **2000**, *6*, 29–52. [[CrossRef](#)]
92. Koppenjan, J.F.; Enserink, B. Public–private partnerships in urban infrastructures: Reconciling private sector participation and sustainability. *Adm. Rev.* **2009**, *69*, 284–296. [[CrossRef](#)]
93. Vásquez, A.; Giannotti, E.; Galdámez, E.; Velásquez, P.; Devoto, C. Green infrastructure planning to tackle climate change in Latin American cities. In *Urban Climates in Latin America*; Henríquez, C., Romero, H., Eds.; Springer: Cham, Switzerland, 2019; pp. 329–354.
94. Peñailillo-Arévalo, D. *Los Bienes. La Propiedad y Otros Derechos Reales*, 2nd ed.; Thomson Reuters: Santiago, Chile, 2019.
95. UN-Water. *What Is Water Security? Working Definition 2013*; United Nations University. Institute for Water, Environment and Health: Hamilton, ON, Canadá, 2013; ISBN 978-92-808-6038-2.
96. Sivapalan, M.; Thompson, S.E.; Harman, C.J.; Basu, N.B.; Kumar, P. Water cycle dynamics in a changing environment: Improving predictability through synthesis. *Water Resour. Res.* **2011**, *47*, 1–7. [[CrossRef](#)]
97. Baldassarre, G.D.; Viglione, A.; Carr, G.; Kuil, L.; Salinas, J.L.; Blöschl, G. Socio-hydrology: Conceptualizing human-flood interactions. *Hydrol. Earth Syst. Sci.* **2013**, *17*, 3295–3303. [[CrossRef](#)]