

POST-DISASTER DISASTERS. ONE-DIMENSIONAL POLICIES WITHOUT POST-DISASTER ASSESSMENT AND RECURRENCE OF DISASTERS: THE CASE OF NONGUEN, CHILE, AS A CHARACTERISTIC CASE OF UNSOUND POLICIES

DESASTRE POSDESASTRE. POLÍTICAS UNIDIMENSIONALES SIN EVALUACIÓN POSTERIOR Y RECURRENCIA DE DESASTRES: EL CASO DE NONGUÉN, CHILE, COMO CASO CARACTERÍSTICO DE POLÍTICAS INEXACTAS

DENISSE SCHMIDT-GÓMEZ 2
IGNACIO BISBAL-GRANDAL 3
JAVIERA PAVEZ-ESTRADA 4

- 1 ADAPTO Project Grant, Adaptation to climate change in informal settlements/environments. Project funded by the International Research Center for Latin American and Caribbean Development. Supported by UBB.
- 2 Magíster Hábitat Residencial y Magíster en Didáctica Proyectual
Candidata a Doctora en Arquitectura y Urbanismo,
Directora Escuela de Arquitectura, Académica, Departamento Ciencias de la Construcción,
Facultad de Arquitectura Construcción y Diseño, Universidad del Bío-Bío, Concepción, Chile
<https://orcid.org/0009-0005-9172-8156>
dschmidt@ubiobio.cl
- 3 Doctor en Urbanismo
Director del Departamento Planificación y Desarrollo Urbano (DPDU),
Académico, Facultad de Arquitectura Construcción y Diseño
Universidad del Bío-Bío, Concepción, Chile
<https://orcid.org/0000-0002-8304-2040>
ibisbal@ubiobio.cl
- 4 Arquitecta
Candidata a Magíster en Gestión y Desarrollo Habitacional.
Facultad de Arquitectura Construcción y Diseño
Universidad del Bío-Bío, Concepción, Chile
<https://orcid.org/0000-0002-1782-6314>
jpavez@ubiobio.cl

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El análisis multidimensional es una herramienta de política pública basada en la gobernanza que contempla múltiples variables de análisis y que constituye una respuesta muy eficaz frente al riesgo de desastre. Si bien existen diversos ejemplos en el ámbito internacional, no se ha desarrollado hasta la fecha en Chile una orientación de este tipo en la respuesta a desastres por parte de la administración. Estas políticas públicas para la gestión del riesgo de desastres en Chile, específicamente aquellas que se aplican en la etapa pos-desastre, se proyectan para fortalecer las institucionalidades y desarrollar programas y estrategias enfocadas al manejo de catástrofes, conformándose en acciones que aspiran a disminuir la vulnerabilidad y desarrollar procesos de recuperación de lugares. ¿Qué sabemos de los efectos de estas políticas en los territorios? Esta investigación analiza cómo la ausencia de instrumentos de evaluación de estos resultados impide conocer el desempeño y la efectividad de los planes aplicados. A partir de una evaluación multidimensional del barrio Nonguén, en la ciudad de Concepción, Chile, se caracteriza un ejemplo típico de políticas públicas mal orientadas que explican cómo las intervenciones desafortunadas pueden agudizar los problemas existentes. Este barrio se ha conformado y desarrollado hasta la actualidad en una zona de riesgo de inundación, a pesar de que se era consciente de su condición gracias a registros que datan de 100 años antes de comenzar la urbanización. Se concluye que la respuesta pública, basada en intervenciones de enfoque unidireccional que no tomó en consideración los problemas de los habitantes, ha redundado en un proceso de aumento creciente de la vulnerabilidad frente al riesgo y una recurrencia de desastres dañinos. La evaluación pos-desastre bajo una perspectiva multidimensional del hábitat permitiría intervenir los territorios con proyectos que desaten procesos de desarrollo futuro.

Palabras clave: política territorial, asentamientos urbanos, desastres naturales, gestión urbana, reconstrucción.

Multidimensional analysis is a governance-based public policy tool that considers multiple analysis variables to respond to disaster risks effectively. Although there are several examples in the international arena, no such guidance has been developed in Chile for the administration's disaster response. Existing public policies for disaster risk management in Chile, specifically those applied in the post-disaster stage, are designed to strengthen institutionality and develop programs and strategies focused on catastrophe management, shaping actions that aim to reduce vulnerability and handle recovery processes. What do we know about the effects of these policies in the regions? This research analyzes how the absence of instruments to assess these results prevents understanding the performance and effectiveness of the plans applied. Based on a multidimensional evaluation of the Nonguén neighborhood in Concepción, Chile, a typical example of misguided public policies is characterized, explaining how ill-advised interventions can exacerbate existing problems. This neighborhood continues to grow and develop in a flood risk zone, albeit aware of this condition, thanks to records dating back 100 years before urbanization began. It is concluded that the public response, based on unidirectional approach interventions that disregarded the inhabitants' problems, has increased vulnerability to risk and a recurrence of damaging disasters. A post-disaster assessment using a multidimensional perspective of the habitat would allow intervening areas with projects that give rise to future development processes.

Keywords: territorial policy, urban settlements, natural disasters, urban management, reconstruction.

I. INTRODUCTION

Disaster risk management has evolved towards a multidimensional approach integrating territorial, social, economic, environmental, and political factors. This perspective says that disasters are not mere natural events, but manifestations of vulnerabilities accumulated in communities over time (Sandoval-Díaz, 2020). International organizations such as the United Nations Office for Disaster Risk Reduction [UNDRR] have promoted this change through frameworks such as the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNDRR, 2015), which fosters comprehensive strategies from urban planning to active participation of the communities.

Although agencies and instruments such as the National Emergency Office of the Ministry of the Interior [ONEMI] and the Civil Protection Law have been established in Chile, risk management continues to face important contradictions. Authors such as Tapia (2015) and Balboa, Carrasco, and Valenzuela (2019) have criticized the policies' lack of adaptation to local realities, highlighting the persistence of traditional approaches prioritizing reactive interventions, focusing mainly on infrastructure. This approach tends to ignore key elements, such as consultation with affected communities and incorporating social and cultural dimensions into strategies.

The theory of disasters as socio-natural phenomena, proposed by Larenas Salas (2016) and Molinari, Menoni, and Ballio (2017), emphasizes the importance of designing interventions that consider the particularities of each territory and community. However, in practice, Chilean public policies are still limited by a sectoral vision that perpetuates the vulnerability of the affected territories. This context leads to questioning how public policies effectively respond to local needs, especially in areas where historical and environmental dynamics demand more holistic approaches.

In this framework, this research proposes to renew the approach of Public Risk Management Policies, with one that integrates dimensions of the residential habitat that have been neglected until now in project planning and execution. Incorporating these elements would optimize territorial management and strengthen communities' capacity to prevent and mitigate the effects of socio-natural disasters. This approach seeks to develop an innovative perspective that connects interventions with a comprehensive and multidimensional post-disaster evaluation, which promotes sustainable solutions that meet local needs.

The Nonguén Neighborhood in Concepción, which has faced recurrent flooding, aggravated by real estate pressure and the backfilling of riverbeds, is an emblematic example of these tensions between urban development and risk management.

Urban development in this area has largely ignored climatic and historical conditions, exacerbating the community's vulnerability. Analyzing the dynamics of Nonguén makes it possible to show how one-dimensional policies are not only ineffective, but can also be counterproductive.

This article seeks to examine the relationship between risk management and the community context, establishing an evaluation instrument with a multidimensional approach aimed at reducing vulnerability.

It is structured around a theoretical framework that underscores the need to overcome one-dimensional approaches to risk management in Chile, incorporating social, cultural, political, and economic dimensions to reduce vulnerabilities and strengthen community resilience to disasters. This paper presents a case study in the Nonguén Valley, a biodiversity hotspot in the Bío-Bío region, affected by recurring floods aggravated by urban expansion. Based on a case-by-case approach, the methodology combines quantitative and qualitative methods, arranged in phases: theoretical review, data collection, and formulation of a multidimensional post-disaster evaluation matrix. The results examine the interventions carried out in the Nonguén Valley, analyzing the effects and interaction between the dimensions of the residential habitat. The conclusions confirm that socio-economic factors determine vulnerability to disasters and emphasize the need for comprehensive urban planning that reduces risks and promotes community resilience.

II. THEORETICAL FRAMEWORK

Disaster risk management in Chile: A multidimensional approach versus one-dimensional interventions.

Chile, as a country highly exposed to natural risks, has acknowledged the need to develop strategies that address the impact of these events, intensified by climate change. In this context, the country has implemented the 2002 National Civil Protection Plan [PNPC, in Spanish] and the National Policy for Risk Reduction: Strategic Plan 2020-2030 (ONEMI, 2020), coordinated by ONEMI. The PNPC organizes its response in four phases: preparation and mitigation, assistance and containment, restoration of basic services, and reconstruction. However, these stages usually prioritize one-dimensional approaches, primarily focused on urban infrastructure (Rinaldi & Bergamini, 2020).

The National Strategic Plan seeks to move towards a broader approach, incorporating multidimensional variables, including social, cultural, and environmental aspects. Cities have prioritized measures such as channelization and flood defenses, which, although effective against smaller magnitude events, present significant limitations in the face of major

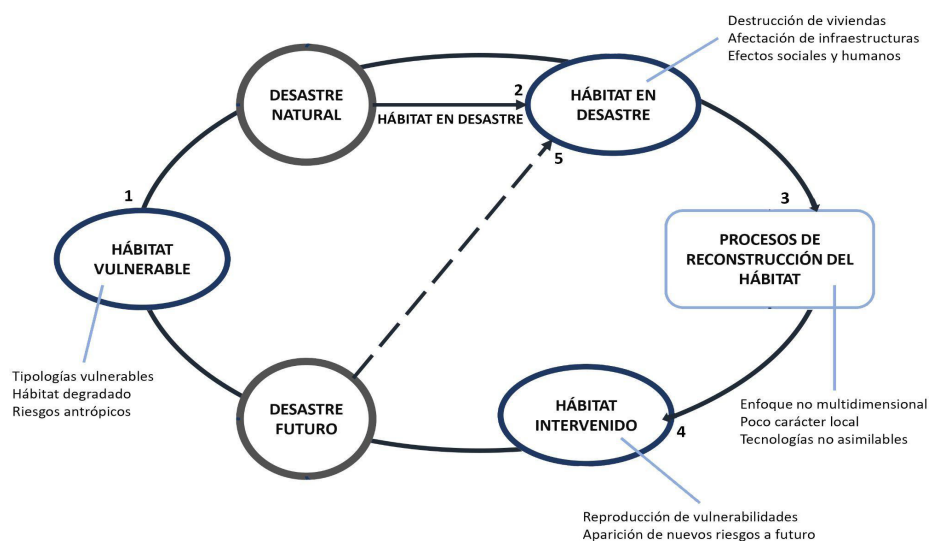


Figure 1. Reproduction cycle of the risk of post-disaster reconstruction of housing and habitat. Source: Preparation by the authors with data from Olivera and González, 2010.

disasters (González, 2017). In this sense, systemic resilience should replace the traditional vision of resistance focused on specific components, promoting a management that integrates human dynamics and natural phenomena (Larenas Salas, 2016).

Disasters affect beyond the physical sphere, generating profound changes in communities' social and cultural dynamics. One-dimensional policies tend to ignore key aspects such as citizen participation and local traditions, generating incomplete solutions and perpetuating vulnerability in the affected territories (Gordillo Bedoya, 2006; Fontana & Conrero, 2023).

Socio-economic and environmental conditions not only intensify the effects of natural phenomena, but also reflect structural and political inequities that amplify communities' vulnerability (Mileti, 1999; Quarantelli, 1998; Gaillard, 2007). These deficiencies underline the importance of a management that transcends the one-dimensional and contemplates the complexity of risk as a socio-natural phenomenon.

A critical aspect of risk management is the post-intervention evaluation, which allows measuring the impact of the policies applied and the effectiveness of the strategies in restoring communities. This assessment must address multiple dimensions, such as infrastructure, social cohesion, institutional capacity, and environmental sustainability (Canese de Estigarribia et al., 2022). On the other hand, ignoring these complementary dimensions

can be counterproductive, as it perpetuates pre-existing vulnerabilities (Berke, Kartez & Wenger, 1993).

Reconstruction strategies focused solely on the physical can contribute to perpetuating conditions of vulnerability in communities, a phenomenon conceptualized as the "Risk Reproduction Cycle" (Olivera & González, 2010). In this sense, it is essential to consider people as active agents in the recovery processes, since many interventions have failed precisely because they ignore social and cultural dimensions (Rashed & Weeks, 2003; Guha-Sapir et al., 2010).

This study proposes a renewed approach to Public Risk Management Policies, which includes dimensions of the residential habitat that have traditionally been neglected in the design and implementation of plans and projects. This approach seeks to overcome the limitations of one-dimensional strategies. It promotes a multidimensional perspective that connects the interventions carried out with comprehensive evaluations after the disaster. In this way, the goal is to improve territorial management and promote sustainable and contextualized solutions that reduce structural vulnerabilities and strengthen community resilience.

III. CASE STUDY

The Nonguén Valley, located in the Bio-Bio region of Concepción, represents an emblematic case in disaster risk management in Chile. With 44 km², this basin is part of the "Chilean Winter Rainfall-Valdivian Forests", one of the 34 global

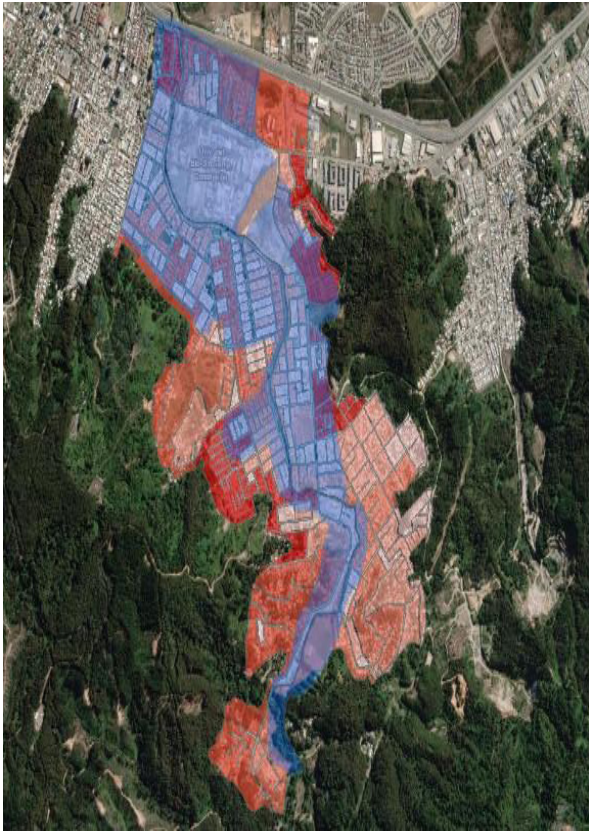


Figure 2. Planimetry of the population exposed to flooding by heavy rain. Source: Preparation by the authors, GIS with data from the 2017 Census and 2016 Flood Plan - Sernageomin, National Geography and Mining Service of Chile.

biodiversity hotspots, standing out for its high biological diversity and endemism. Throughout its history, the valley has endured recurring floods, with records dating back to 1890, which have affected its inhabitants' infrastructure and social and economic life.

The first settlements, which took advantage of the fertile and accessible land next to the Nonguén River, were formed during the agrarian reform in the 1960s. This sector, located 5 km from the city, not only catered for the food and housing needs of the city of Concepción, which was relocated here after the 1960 earthquake, but also continued to grow despite the risks. The city's recovery promoted an economic model based on state investment and industrial growth, accelerating the metropolization process in the region (León Aravena, Saravia Cortés & Bisbal, 2018).

Over the years, the anthropization process and the demographic growth in the neighborhood significantly altered the natural environment. The floods, aggravated

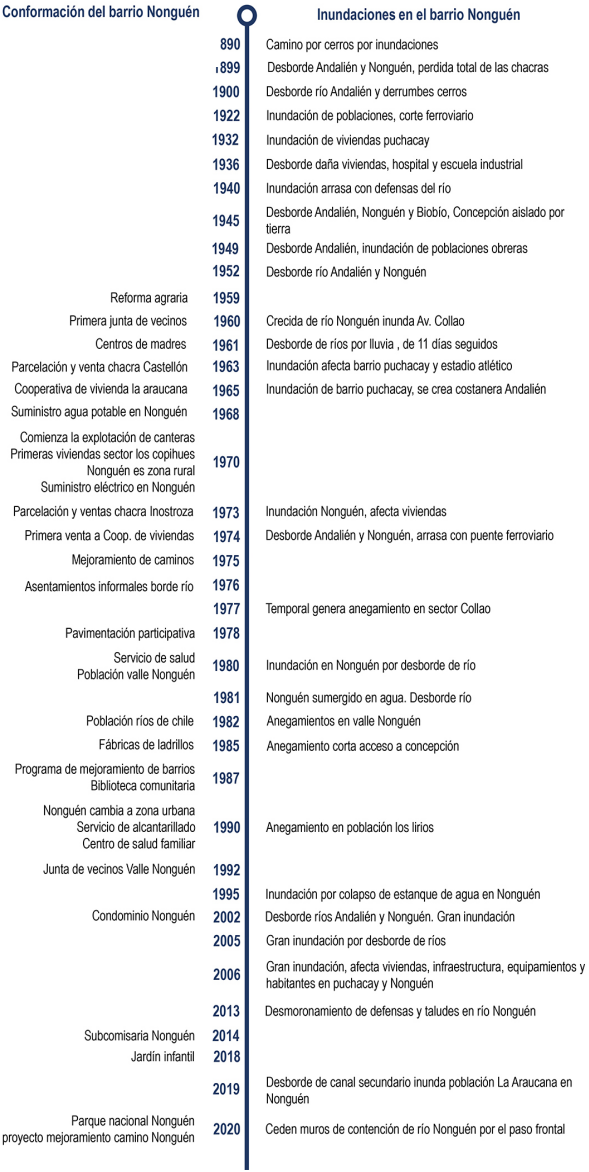


Figure 3. Timeline of the anthropization process and flooding in the Nonguén Valley. Source: Preparation by the authors.

by this real estate expansion that has backfilled river beds, have only increased the risk of exposure to natural phenomena. Rojas et al. (2014) point out that factors such as geomorphology, climate, and human intervention have triggered these floods, which makes the Nonguén Valley a relevant case study that can be extrapolated to other contexts, as the following mapping shows.

Currently, the sector has about 14,000 inhabitants, organized into 9 neighborhood boards and 54 social organizations that actively manage the community's needs (Burdiles et al., 2023). However, interventions to mitigate floods have been mixed. While some community initiatives address microzones, larger-scale public projects, such as the canalization of the Nonguén River in 2009, affected the entire area without adequate consultation with the inhabitants. These partial and disjointed solutions reflect a disconnect with local problems.

Figure 3 shows a timeline of anthropization and floods in the Nonguén Valley, a history marked by the transformation of the natural environment and the inherent vulnerability of the population. Despite the historical floods, the neighborhood has continued to be formed, highlighting the need to adopt comprehensive and multidimensional approaches in risk management. These approaches should consider the local context's particularities and promote the community's active participation in decision-making. Only in this way can effective and sustainable solutions be developed that mitigate the risk of disasters in the future.

IV. METHODOLOGY

The study adopts a case study approach, using quantitative and qualitative methods to establish extrapolations between the case study and the Public Policies of Disaster Risk Management [PGRD] in Chile. Given the multidimensional nature of the topic, it is suggested to proceed in the following phases:

Phase 1: Theoretical Framework. This addresses the operation of public risk management policies in Chile and multidimensional analysis as a tool for evaluating actions in post-disaster territories (Villacreses Viteri, 2024). A review of relevant national and international scientific literature between 1990 and 2024 will permit establishing a theoretical context that justifies the work and will lay the foundations for further analysis.

Phase 2: Based on the research question about the effects of post-disaster interventions on the residential habitat, a survey of actions and programs is carried out in the case study of Nonguén. This stage involves characterization and evaluation of post-disaster interventions. The objective of each action is recognized, and responses are analyzed to determine how they relate to the problems they seek to address and other dimensions of the habitat. A quantitative and qualitative data collection of the interventions is made using four sources of information: (1) documents; (2) private and public agents in the region; (3) inhabitants, through neighborhood meetings and interviews; and (4) specialized observation. The situation before 2006, the year of the most significant historical flood, is analyzed. Data from the 2002 Census were used in contrast

to data after 2006, with data from the 2017 Census and information collected up to 2021. Table 1 lists the post-disaster interventions, indicates whether they have been evaluated, and categorizes them by type of evaluation.

Phase 3: Formulation of a Post-disaster Evaluation Matrix. 32 indicators were selected in a matrix that contemplates the dimensions of the habitat and incorporates innovative variables, relevant to the case and extrapolable to other contexts. The definition of Residential Habitat of the Housing Institute of the University of Chile [INVI, in Spanish] will be adopted, structured in three dimensions: 1) Physical-Spatial Dimension; 2) Socio-Cultural Dimension; and 3) Political-Economic Dimension.

Table 2 shows the results of a self-assessment of the typical case.

Phase 4: Post-disaster Public Administration Effects Analysis. This section will discuss the multidimensional impact of public administration on vulnerability.

V. RESULTS

From this phase, a record is prepared, Table 1, which reveals three key aspects: (1) a trend of interventions towards the Physical-Spatial dimension is identified, with a particular emphasis on improving infrastructure, river works, and territorial planning, which are based on technical resolutions aimed at improving basic urban structures. This finding reinforces the hypothesis that post-disaster interventions tend to be unidirectional; (2) the survey indicates that 60% of the projects analyzed do not have a subsequent evaluation; (3) only three have been evaluated by state institutions, four by citizen organizations, and five are registered in scientific research.

In this case, a multidimensional evaluation matrix was designed to evaluate the interventions and indicators, which are also extrapolated. This tool measures the effects of Public Disaster Risk Management Policies on an area's vulnerability in the post-disaster stage. The objective of the matrix is to compare the area's situation before the main disaster (in this case, the flood of 2006) with its current state (until 2021) to determine how public policies have influenced the conditions of vulnerability. Table 2 presents the results derived from the self-assessment matrix applied to the case study. It classifies the indicators by habitat dimension. The pre- and post-disaster data are determined with a positive or negative valuation according to the indicator. It is confirmed that 69% of the indicators are evaluated with negative evolution, 22% with positive evolution, and 9% remain in the same situation. Similarly, the column "Affected dimensions" observes that these predominantly territorial interventions

	INTERVENTIONS	Approach according to habitat dimensions	EVALUATIONS	
			YES/NO	Evaluating Agent
1	Filling in wetlands for urbanization	Physical-Spatial	NO	
2	River edge interventions	Physical-Spatial	YES	Research
3	River works	Physical-Spatial	YES	State
4	Housing Deficit	Political-Economic	NO	
5	Location of community facilities	Physical-Spatial	NO	
6	Length of main roads - safety	Physical-Spatial	YES	State
7	Loss of natural landscape	Physical-Spatial	YES	Citizenry
8	Population exposed to floods	Socio-Cultural	NO	
9	Urbanization in rural areas	Physical-Spatial	YES	Citizenry
10	Vulnerable housing	Physical-Spatial	YES	Research
11	Changes in land use and vegetation cover	Physical-Spatial	YES	Research
12	Geographical dangerousness	Physical-Spatial	YES	Research
13	Fire Risks	Physical-Spatial	YES	Research
14	Rains	Physical-Spatial	NO	
15	Paving	Physical-Spatial	NO	
16	Poverty	Socio-Cultural	NO	
17	Access to Emergency Rooms (ER)	Physical-Spatial	NO	
18	Access to the Police	Physical-Spatial	YES	State
19	Access to Firefighters	Physical-Spatial	NO	
20	Waste management	Political-Economic	NO	
21	People affected by disasters	Socio-Cultural	NO	
22	Employment	Socio-Cultural	NO	
23	Governance	Political-Economic	YES	Citizenry
24	Community participation	Political-Economic	YES	Citizenry
25	Planning with risk reduction	Physical-Spatial	NO	
26	Planning instruments	Physical-Spatial	NO	
27	Cooperation	Political-Economic	NO	

Table 1.Record of interventions and evaluations after the 2006 flood. Source: Preparation by the authors.

DIMENSION	INDICATOR	RESULTS AND EVALUATION						
		OWN EVALUATION			DIMENSIONS AFFECTED			
		PRE-DISASTER DATA	POST-DISASTER DATA	VALUATION - NEGATIVE + POSITIVE = NO CHANGE	PHYSICAL-SPATIAL DIMENSION	DSOCIO-CULTURAL DIMENSION	POLITICAL-ECONOMIC DIMENSION	
PHYSICAL SPATIAL DIMENSION	IFE 1	Percentage of wetlands	1.73%	0.52%	-	X	X	X
	IFE 2	Proportion of the river edge following the natural landscape of the place.	92% Total Length	92% Total Length	=	X	X	X
	IFE 3	Requirement for new housing	1078 UN	968 UN	-	X	X	X
	IFE 4	Surface area of camps	2600 M2	They are none	+	X	X	X
	IFE 5	Percentage of facilities located in flood zones.	92% in the flood zone	95% in the flood zone	-	X	X	X
	IFE 6	Percentage of facilities located in areas of landslides or erosion.	10% in the landslide risk area	15% in the landslide risk area	-	X	X	X
	IFE 7	Length of main roads on the surface of the functional urban area.	Average roads 663 ML	Average roads 2263 ML	+	X	X	
	IFE 8	Percentage of non-built-up area (vacant sites)	3.27%	0.63%	-	X	X	
	IFE 9	Population density	7,217 Inhab/km2	8,899 Inhab/km2	-	X	X	
	IFE 10	Percentage of loss of natural areas of environmental and cultural value, due to urbanization.	0.035 Km2	0.255 Km2	-	X	X	X
	IFE 11	Percentage of the population exposed to flooding.	79.60%	85.30%	-	X	X	
	IFE 12	Number of building permits in rural areas.	235	584	-	X		X
	IFE 13	Percentage of vulnerable housing.	HIGH in 3 of 4 conditions		-	X	X	X
	IFE 14	Relationship between infrastructure and property subdivision.	541 km/235	618 km/584	-	X		X
	IFE 15	Relationship between land use and vegetation cover.	Analysis of various data.		-	X		X
	IFE 16	Condition of dangerousness of the territory.	HIGH in all conditions		-	X	X	
	IFE 17	Proportion of surface area with fire risk.	Without records	1.11 Km2 37.5% of total surface.	-	X	X	
	IFE 18	Flooding of land.	Without records	96.64%	-	X		

DIMENSION	INDICATOR		RESULTS AND EVALUATION					
		OWN EVALUATION			DIMENSIONS AFFECTED			
		PRE-DISASTER DATA	POST-DISASTER DATA	VALUATION - NEGATIVE + POSITIVE = NO CHANGE	PHYSICAL-SPATIAL DIMENSION	DSOCIO-CULTURAL DIMENSION	POLITICAL-ECONOMIC DIMENSION	
SOCIO-CULTURAL DIMENSION	ISC 1	Percentage of people in poverty.	13.18%	42.51%	-		X	
	ISC 2	Distance to emergency services.	4.8 km on average	4.8 km on average	=		X	X
	ISC 3	Number of micro-landfills by urban area.	5	7	-		X	X
	ISC 4	Distance to police stations.	5.5 km on average, approx.	850 m on average, approx.	+	X	X	
	ISC 5	Distance to fire stations.	1.7 km on average	1.7 km on average	=	X	X	
	ISC 6	Number of people killed, missing, and affected, attributed to disasters.	18,141 pp	22,785 pp	-	X	X	X
	ISC 7	Exposure of the population.	HIGH in all conditions		-		X	X
ECONOMIC POLITICAL DIMENSION	IPE 1	Unemployment Rate	3.63%	4.34%	-			X
	IPE 2	Number of existing and participating regional and community organizations.	65	48	-		X	X
	IPE 3	Number of non-governmental groups participating in the design and approval processes of projects for public spaces.	Without records	15	+		X	X
	IPE 4	Existence of communal studies that establish risk areas and define restrictions on use and building, for disaster risk reduction.	YES	YES	+	X		X
	IPE 5	Existence of communal territorial planning instruments.	YES	YES	+	X		X
	IPE 6	Coverage and validity of territorial planning instruments.	30 years	30 years. Every / 10 years approx.	+			X
	IPE 7	Existence of cooperation organizations in the territory	2	without records	-			X

Table 2. Results of the multidimensional evaluation matrix. Source: Preparation by the authors.

affect other dimensions of the habitat, such as socio-cultural and political-economic dimensions. This supports the idea that post-disaster evaluations should be approached from a multidimensional perspective.

The most striking indicator in the physical-spatial dimension is the percentage of wetlands. Urbanization in the Nonguén Valley has significantly impacted local ecosystems, especially wetlands, whose area decreased from 1.73% in 2002 to 0.52% in 2015. This loss has compromised the soil's percolation capacity, increasing the risk of flooding. The inadequate channelization of the river and the construction of houses on swampy land have exposed families to greater risks, evidencing deficiencies in territorial planning. In addition, 95% of community facilities are in flood-prone areas, and 15% are at risk of landslides. Between 2002 and 2017, the population density rose by 15%, reaching 8.9 inhabitants per square kilometer, further increasing exposure to natural disasters. The expansion of the road infrastructure grew from 541.9 km to 618.4 km, and the rise in rural buildings, which went from 548 in 2006 to 1,204 in 2021, reflects deficiencies in urban planning.

Another important factor in this dimension is that most indicators affect the socio-cultural dimension. 92% of the population near the river lives in risk areas, which shows the community's vulnerability. There is also a housing deficit of 10.3%, which requires the construction of 1,078 new homes. The increase in housing in irretrievable conditions is due to prolonged exposure to floods. In addition, the existence of camps demonstrates community organization in search of housing solutions, although the location of critical facilities in disaster-prone areas generates distrust among residents.

It also affects the political-economic dimension; local economic activities, such as aggregate extraction and brick production, have intensified soil erosion and increased the area's vulnerability. Although the communal regulatory plan establishes urbanization regulations, it lacks requirements for evaluating the environmental impact of these activities. This highlights the need for an integrated territorial management that addresses the territory's challenges collaboratively and adaptively, promoting sustainable development and improving the quality of life in the Nonguén Valley.

VI. DISCUSSION

The analysis of the three main dimensions—physical-spatial, socio-cultural, and political-economic—reveals complex interactions that directly affect the community's development and vulnerability. These interrelated dimensions condition the population's well-being and ability to face social, economic, and environmental challenges.

In the physical-spatial dimension, interventions on the banks and urbanization backfills are critical aspects that significantly alter the natural environment and increase disaster risks. According to census data from 2002 and 2021, the percentage of wetlands has decreased from 1.73% to 0.52%, which negatively affects the terrain's percolation capacities and increases the flood risk. This loss of wetlands reduces the soil's absorption capacity, amplifying surface runoff and vulnerability to flooding. In addition, insufficient channeling of rivers and building houses on marshy land expose families to greater risks. Uncontrolled urbanization has modified ecosystems, intensified erosion and sedimentation, and generated little urban planning, which affects the natural landscape and biodiversity. This evaluation supports the idea that one-dimensional approaches focused mainly on urban infrastructure are usually prioritized in the post-disaster stages (Rinaldi & Bergamini, 2020).

In the socio-cultural dimension, 13.18% of the population lives in poverty, a structural problem intertwined with other social and economic factors. This high poverty rate profoundly impacts access to essential services such as health, education, and security, limiting individual and collective development opportunities. Poverty also reinforces the inhabitants' vulnerability to natural disasters and adverse environmental conditions. For example, 85.30% of the population is exposed to floods, which aggravates the risks to human life and local infrastructure. This exposure is linked to population density, since more than 200 inhabitants per block occupy high-risk areas, which shows the insufficiency of urban planning to mitigate these dangers. In addition, the average distance to emergency services, 4.8 km, hinders rapid access to medical care, especially in critical situations, reflecting a lack of investment in adequate health infrastructure. This reality is manifested in many overcrowded family nuclei and close households, where 81 families live in overcrowded conditions and 708 households are in vulnerable situations, which highlights the difficult living conditions. Under the approach of the phenomenon conceptualized as "Risk Reproduction Cycle," it is essential to consider people as active agents of recovery (Olivera & González, 2010).

In the political-economic dimension, the insufficiency of resources and the absence of adequate legislation that guarantees an equitable distribution of services are evident. Although access to security services has improved, the new police station's location in flood zones compromises its operability, highlighting the need for more strategic spatial planning. The lack of adequate legislation and public investment in critical infrastructure, such as water services and waste management, indicates a weakness in local governance. The existence of 21 rainwater evacuation projects, of which 16 have been built, is a step in the right direction, but the lack of integrated planning and adequate supervision limits their effectiveness. The lack of public responsibility in

maintaining these works and low community participation in decision-making highlight the need for more inclusive and sustainable policies. In this sense, systematic resilience should replace the traditional vision of resistance focused on specific components, promoting a management that integrates human dynamics and natural phenomena (Larenas Salas, 2016).

In summary, the three dimensions analyzed are closely interrelated and show how problems in one dimension affect the others. Interventions on the river banks and urbanization problems in the physical-spatial dimension generate vulnerabilities aggravated by poverty and lack of access to basic services in the socio-cultural dimension, as well as insufficient planning and resources in the political-economic dimension. A comprehensive approach that addresses these challenges in a coordinated way, promotes sustainable urban development, and considers the territory's social needs and environmental conditions is necessary to improve the quality of life and reduce the community's vulnerability. Implementing public policies with these dimensions will promote a safer and more equitable environment for all inhabitants.

VII. CONCLUSIONS

The hypothesis is partially verified, since a comprehensive intervention in the analyzed dimensions could reduce the habitat's vulnerability. While the analysis shows that the interactions between the dimensions are complex and directly affect the population's well-being, limitations are also identified. For example, the sanitary and rainwater drainage infrastructure has improved, but significant deficiencies persist that limit the effectiveness of these interventions. The lack of adequate planning and supervision is a limitation in the improvement process that can compromise the sustainability of the progress achieved.

Additionally, some aspects, such as the mental health of the post-disaster population, were not addressed in depth, a critical issue that deserves to be investigated. This approach could have offered a more holistic view of vulnerability in the Nonguén Valley, given that the psychological consequences of living in a risky environment can have a lasting impact on quality of life.

The generalization of the findings of the Valle Nonguén case study presents challenges. Although the problems identified may represent other urban contexts in Chile and Latin America, each region's socio-cultural, economic, and environmental particularities must be considered. The factors contributing to vulnerability are often contextual and specific, implying that solutions must be adapted to local circumstances.

However, the analysis offers valuable lessons that could be applied to similar contexts. For example, the interrelationship between dimensions and their influence on vulnerability can be a conceptual framework for assessing other post-disaster urban habitats. The evidence that poverty and lack of access to services are critical factors that aggravate vulnerability could be generalized, as long as the specific context's particularities are considered.

In conclusion, the study of the Nonguén Valley highlights the need for a multidimensional approach to address vulnerability in post-disaster habitats. The interaction between the physical-spatial, socio-cultural, and political-economic dimensions highlights the importance of comprehensive urban planning that considers local realities and promotes community participation. Despite the limitations and the difficulty in generalizing the results, the conclusions drawn provide a solid basis for future research and the formulation of policies that seek to improve the quality of life and the safety of communities in similar contexts.

The analysis results of the physical-spatial, socio-cultural, and political-economic dimensions in the Nonguén Valley corroborate and enrich the concepts presented in the theoretical framework. The literature on urban vulnerability and resilience argues that natural disasters are not only environmental phenomena, but are profoundly influenced by social and economic factors. This is manifested in the Nonguén Valley, where, according to the data provided by the censuses in 2002 and 2017, 13.18% of the population lives in poverty, and an alarming 85.30% is exposed to floods. These data reflect the inherent vulnerability in the community's socio-economic structure, aligning with theories arguing that poverty and inequality amplify disaster risk. In addition, the theoretical framework emphasizes the need for comprehensive urban planning to mitigate risks. The results reinforce this approach, indicating that urbanization's interventions on the river's edge and backfills have exacerbated the area's physical vulnerability. The lack of adequate infrastructure for drainage and uncontrolled urbanization are also consistent with studies highlighting how urban development decisions can increase exposure to disasters.

VIII. CONTRIBUTION OF AUTHORS CRedit:

Conceptualization, D.S., I.B.; Data curation, D.S., I.B.; Formal analysis, D.S., J. P.; Acquisition of financing, D.S.; Research, D.S., I.B.; Methodology, D.S., I.B.; Project management, D.S.; Resources, D.S.; Software, D.S.; Supervision, I.B.; Validation, D.S., I.B.; Visualization, D.S., J. P.; Writing - original draft, D.S., I.B.; Writing - revision and editing, D.S., I.B.

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