Recibido: 04-12-2024
Aceptado: 24-09-2025

THE WILDLAND-URBAN INTERFACE AS NO MAN'S LAND IN THE CONSTRUCTION OF WILDFIRE RISK FOR CHILEAN COASTAL CITIES[1]

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS

EDILIA JAQUE-CASTILLO [2]
CAROLINA OJEDA-LEAL [3]
CESAR MUÑOZ-BERRÍOS [4]

1 The Vice-Rectory for Research of the University of Concepción funded this project with funds VRID 2021000383MUL (EJC) and VRID 2021000341MUL (EJC). The ANID National Doctoral Scholarship 21200455 (CO), the FONDEF project ID22I10334 (EJC), and Project 1523A009 FONDAP 2023 (CO)

2 Doctora en Ciencias Ambientales
Profesora Titular, Departamento de Geografía, Facultad de Arquitectura Urbanismo y Geografía
Universidad de Concepción, Concepción, Chile
https://orcid.org/0000-0002-6081-4204
edjaque@udec.cl

3 Doctora en Arquitectura y Estudios Urbanos
Profesora parttime, Escuela de Arquitectura, Facultad Arquitectura, Arte y Diseño. Universidad San Sebastián, Concepción, Chile.
Centro de Investigación para la Gestión Integrada del Riesgo de Desastres (CIGIDEN), Macul, Chile
https://orcid.org/0000-0002-9830-9203
carolina.ojeda@cigiden.cl

4 Geógrafo
Profesional Independiente
Concepción, Chile
https://orcid.org/0009-0009-9600-413X
cesar.munoz.berrios.12@gmail.com

https://doi.org/10.22320/07183607.2025.28.52.04

El impacto de los incendios forestales en las zonas de interfaz urbano-forestal del centro-sur de Chile ha crecido de manera sostenida en las últimas décadas, intensificándose en la temporada 2022–2023 con 1.834 incendios que afectaron más de 183.000 hectáreas en la Región del Biobío. Si bien gran parte de la literatura se ha concentrado en el área metropolitana de Concepción, este artículo analiza el caso de la comuna de Arauco, al evaluar la amenaza de incendios forestales y su correspondencia con la zonificación establecida por el Plan Regulador Comunal de 1988 (PRCA). A partir de un análisis espacial que integró variables biofísicas y antrópicas, se determinó que el 60% del área urbana presenta una alta amenaza de incendios y que más del 75% de dicha superficie corresponde a usos residenciales de alta densidad autorizados por el PRCA. Esta superposición evidencia que los instrumentos de planificación no solo omiten la amenaza, sino que también contribuyen a la construcción social del riesgo al promover la densificación en áreas críticas. El estudio concluye que la interfaz urbano-forestal en Arauco —y en muchas ciudades costeras chilenas— se mantiene sin regulación efectiva, marcada por obsolescencia normativa, fragmentación institucional y ausencia de criterios de riesgo, configurando estos territorios como “tierras de nadie”.

Palabras clave: incendios forestales, planificación urbana, zona costera, uso de la tierra

The impact of wildfires in wildland–urban interface (WUI) zones of central-southern Chile has steadily grown in recent decades, intensifying during the 2022–2023 season with 1,834 fires that burned more than 183,000 hectares in the Biobío Region. While most studies have focused on the Concepción metropolitan area, this article examines the case of Arauco, assessing wildfire threats and their relationship with the zoning established by the 1988 Municipal Master Plan (PRCA, in Spanish). Using a spatial analysis that integrated biophysical and anthropogenic variables, the study found that 60% of Arauco’s urban area has a high wildfire risk, and that over 75% of this surface is authorized for high-density residential uses by the PRCA. This overlap reveals that planning instruments not only overlook wildfire risks but also contribute to their social construction by promoting urban densification in highly exposed areas. The study concludes that the wildland–urban interface in Arauco, as in many coastal Chilean cities, remains largely unregulated, shaped by regulatory obsolescence, institutional fragmentation, and the absence of explicit risk criteria, effectively converting these areas into “no man’s lands.”

Keywords: topography, wildfires, urban planning, coastal zone, land use

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS
EDILIA JAQUE-CASTILLO, CAROLINA OJEDA-LEAL, CESAR MUÑOZ-BERRÍOS
REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607

I. INTRODUCTION

In recent decades, the frequency and intensity of wildfires have increased steadily globally, with severe impacts on ecosystems, human settlements, and critical infrastructure. In Chile, this problem is concentrated in the central southern area, where extreme climatic conditions, changes in land use, and a productive model based on highly flammable monocultures converge, resulting in high exposure scenarios. In this context, fires transcend environmental boundaries and constitute a socio-environmental risk that affects both urban and rural areas, especially in fragile territories such as hillsides, ravines, and the edges of wood-urban interfaces (WUI).

The literature has shown that most fires in Chile have an anthropogenic origin and occur recurrently in densely populated areas or near forest plantations (González et al., 2020; Altamirano et al., 2013). However, a large part of the studies is concentrated in metropolitan areas such as Concepción and Valparaíso (Jaque Castillo et al., 2021; Quinteros-Urquieta, 2019), leaving in the background intermediate or peripheral communes that face similar vulnerabilities. This gap is compounded by a weak articulation between urban planning and risk management, as reflected in regulatory instruments that fail to incorporate prevention and resilience criteria into land use regulations (Villagra & Paula, 2021; Moris et al., 2017).

The commune of Arauco, located in the Biobío Region, is a notable example of this issue. Its Communal Regulatory Plan (PRC, in Spanish), in effect since 1988, has permitted urban expansion in sectors adjacent to high-exposure areas without considering studies on wildfires. This highlights the limitations of regulatory frameworks in anticipating disaster scenarios and responding to the challenges of climate change in emerging urban areas. The objective of this article is to assess the threat of wildfires in Arauco, with a focus on the urban-rural interface, and to examine its correlation with the zoning of the PRC. Based on a spatial analysis of biophysical and anthropic variables, the aim is to provide technical inputs to strengthen territorial planning from a preventive and integrative approach to prospective risk management.

II. THEORETICAL FRAMEWORK

Over the past few decades, wildfires have intensified globally in terms of frequency, extent, and severity, affecting both natural landscapes and human settlements across diverse climatic and socio-economic contexts (Bowman et al., 2019). This phenomenon is directly linked to processes of climate change, transformations in land uses, deregulated urban expansion, and intensive productive models, generating a socio-ecological crisis that requires comprehensive approaches from territorial planning and risk management (Moreira et al., 2020).

One of the central concepts to address this problem is the Urban-Forest Interface (UFI), understood as the area where human infrastructure and combustible vegetation coexist, creating conditions of high exposure to fire risk (Syphard et al., 2021; Radeloff et al., 2005). In these environments, disorderly urban growth and proximity to continuous plant masses — such as forest plantations or native scrublands — intensify the threat, compromising both the integrity of ecosystems and the safety of communities (Stewart et al., 2007; Braun et al., 2021).

At the landscape scale, the probability of fire occurrence and spread is determined by the interaction between climate, human activities, land cover, and physiographic characteristics (Dickson et al., 2006; Seidl et al., 2011, cited in Altamirano et al., 2013). Among the key factors that stand out are the availability of vegetable fuel, topography, and meteorological conditions (Thompson et al., 2025; Inzunza, 2009). Steep slopes favor the propagation speed, while the density of vegetation, especially in sectors with exotic plantations of high flammability, increases the ignition potential (Huaico-Malhue et al., 2024; Williams, 2013).

The change of land use associated with the expansion of forest monocultures - mainly *Pinus radiata and Eucalyptus globulus*- constitutes a determining factor in the alteration of the fire regime. These species accumulate fine biomass, reduce environmental humidity, and have a high calorific value, conditions that favor fires of great intensity and extension (Ruiz Murcia et al., 2015; Williams, 2013; Nahuelhual et al., 2012).

In Chile, fires of natural origin are rare. According to the Center for Climate Science and Resilience (CR2), 99% of events are caused by human actions, either intentional or due to negligence (González et al., 2020). Factors such as proximity to roads, accessibility, the presence of settlements, and the informal use of space (including stubble burning, bonfires, and garbage dumps) directly affect their frequency and distribution. This predominance of anthropic causes coincides with observations made in Mexico (Pérez-Verdín et al., 2013), Brazil (Pereira Torres, 2014), and Ecuador (Pazmiño, 2019).

The Chilean forestry model, characterized by an extractive and highly concentrated nature, has increased risk exposure, particularly in Biobío and La Araucanía (Frêne Conget & Núñez Ávila, 2010). The mega fires of 2017 and 2023 reflected the consequences of a territorial outline

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS
EDILIA JAQUE-CASTILLO, CAROLINA OJEDA-LEAL, CESAR MUÑOZ-BERRÍOS
REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607

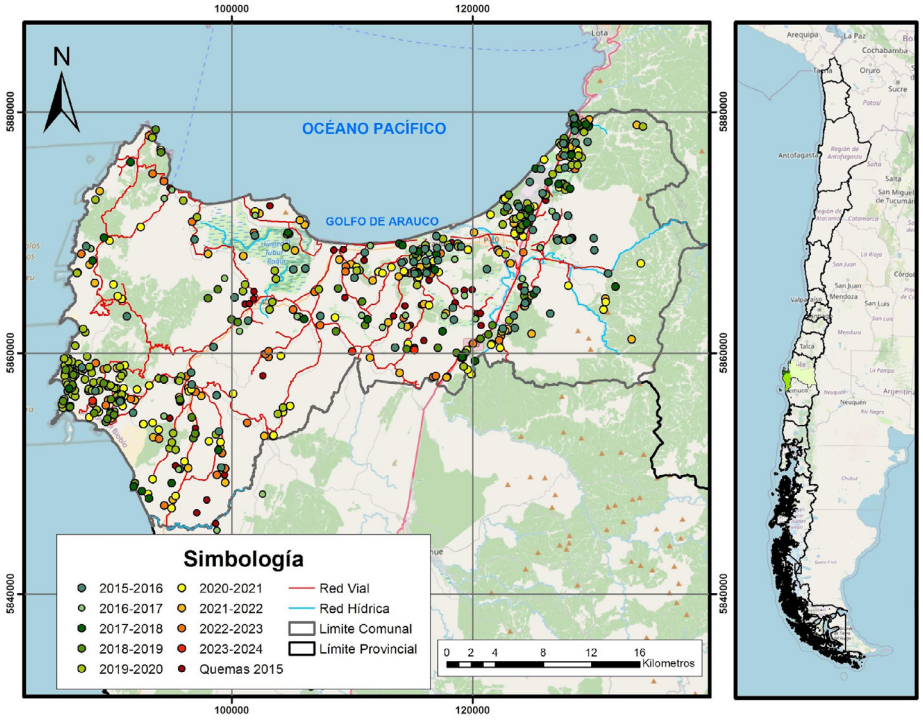

Figure 1. Commune of Arauco and foci of wildfires 2010-2024. Source: CONAF (2023).

that privileges the expansion of plantations over ecological regulation and community safety (Faúndez Pinilla et al., 2023; Jaque Castillo et al., 2021).

From the regulatory field, the General Urban Planning and Construction Law (LGUC, in Spanish) and its Ordinance (OGUC, in Spanish) establish the obligation to consider natural threats in Territorial Planning Instruments (IPT, in Spanish), such as the Community Regulatory Plans (PRC). However, several studies demonstrate the scarce incorporation of risk criteria for wildfires in urban zoning (Vicuña & Guzmán, 2025; Alvarado Peterson et al., 2023; Jaque Castillo et al., 2022). This omission has allowed the development of housing projects in ravines, hillsides, and areas adjacent to forested areas, perpetuating exposure and facilitating the emergence of other risks. Such dynamics are observed in both recent real estate projects and informal settlements (Zenteno-Torres et al., 2022; Kapstein López, 2004).

The commune of Arauco, in the Biobío Region, represents a critical node of socio-environmental risk (Pino Albornoz & Carrasco Henríquez, 2019). Three structural conditions amplify its vulnerability: urban expansion into high-risk areas, the concentration of forest plantations around inhabited sectors, and an obsolete PRC that lacks specific risk studies. This configuration reproduces socio-spatial inequalities and limits local capacities for adaptation and prevention in the face of extreme fires.

The institutional trajectory after the 2010 earthquake helps to explain this lack of response. This event exacerbated the paralysis in updating plans, such as the PRC and the PROT, revealing structural weaknesses in disaster planning (Aguirre et al., 2024; González-Mathiesen et al., 2024; Gil et al., 2024; Moris et al., 2017). To this is added the (General Urban Planning and Construction Law [LGUC], 1975; Law No. 20,249, 2008; Law No. 21,364, 2021; PROT, Regional Government of Biobío, 2019; Law No. 21,455, 2022), which have generated institutional fragmentation and overlapping of competencies between different levels of government.

Consequently, the literature emphasizes the need to reorient territorial planning towards adaptive and multiscale governance models. These approaches should integrate threat mapping, vulnerability assessments, and ecosystem-based strategies, which would reduce the exposure of communities and promote more resilient landscapes to fire in the context of the Anthropocene (Lavell, 2001; González-Mathiesen et al., 2024).

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE
EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS
EDILIA JAQUE-CASTILLO, CAROLINA OJEDA-LEAL, CESAR MUÑOZ-BERRÍOS
REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607

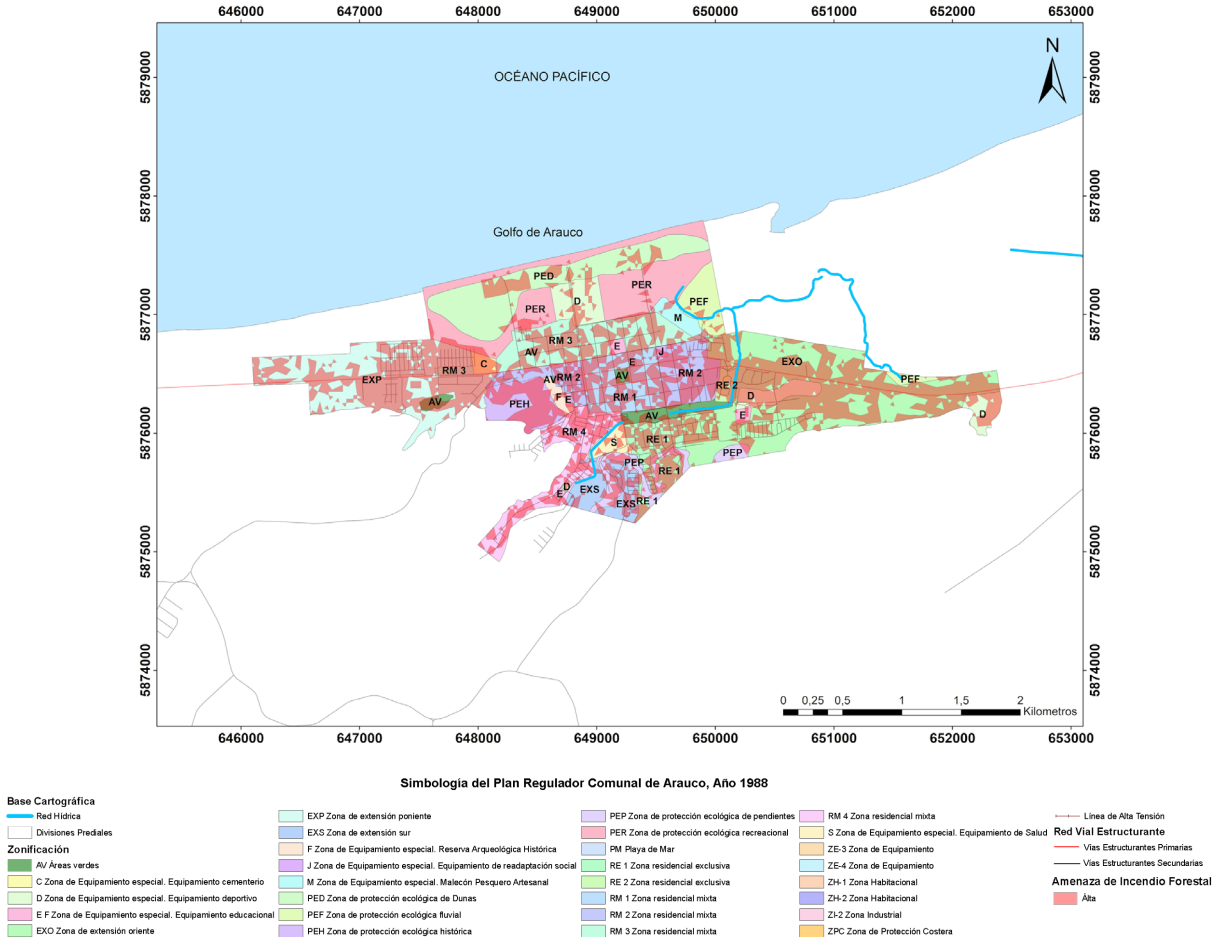

Figure 2. Areas of the Arauco Communal Regulatory Plan of 1988. Source: Prepared by the authors using information from MINVU (Ministry of Housing and Urban Development).

III. CASE STUDY

The commune of Arauco, located in the Biobío Region (37°14' S, 73°19'W), has 956.1 km^2 and a population of 36,257 inhabitants, of which 75% reside in urban areas (INE, 2017). In recent decades, it has been repeatedly affected by wildfires (National Forestry Corporation [CONAF], 2022; CONAF, 2023), in a context dominated by urban expansion towards the interface with *Pinus radiata* and *Eucalyptus globulus* plantations.

The current planning instrument is the Communal Regulatory Plan (PRC) of 1988, which establishes land uses and urban development conditions without considering risk studies associated with wildfires. To evaluate the population's exposure, this study integrated PRC zoning with threat mapping, considering both biophysical and anthropogenic variables. The overlap revealed residential areas (RE1, RE2, RM1, RM2, RM3) located in high-threat sectors, evidencing the relationship between obsolete territorial planning and disaster risk.

IV. METHODOLOGY

This study employed a quantitative and empirical approach, using Geographic Information Systems (GIS) to assess the threat of wildfires in the municipality of Arauco, with a particular focus on the urban-rural interface. The methodology integrates biophysical and anthropic variables into a multicriteria threat model (Elgueta Gutiérrez, 2023), which links the resulting mapping to the current PRC zoning, enabling the identification of exposed residential sectors and the analysis of regulatory inconsistencies in land use.

The construction of the model took 2016 as a reference. It was based on the proposal of Etxeberría et al. (2005), adapted

Dimension	Variable	Reclassification categories	Source
Natural	Hillside isolation/ orientation	Low (-1.41 to -0.49), Medium (-0.49 to 0.46), High (0.46 to 1.41)	ASTER GDEM
Natural	Slope	Low, Medium, High (according to gradient)	ASTER GDEM
Natural	Altitude	0-144 m (Low), 144-421 m (Medium), 421-945 m (High)	ASTER GDEM
Natural	Urban-forestry interface	Types of contact	PRC
Anthropogenic	Built medium	Low (burning), Medium (roads), High (roads, railways, high voltage)	CEDEUS
Anthropogenic	Ground cover	Low (uncovered soils, water, urban), Medium (native forest, wetland), High (agricultural, scrub, plantations)	CONAF-BIRF, Earth Explorer
Anthropogenic	Vegetation flammability	NDVI/NDII: low, medium, high	LANDSAT, Earth Explorer

Table 1. Variables used in the construction of the wildfire threat model. Source: Prepared by the authors.

by Jaque Castillo et al. (2019), which considers variables grouped into two categories: Natural: flammability of vegetation (NDVI/NDII), isolation (hillside exposure), altitude and slope (ASTER GDEM, LANDSAT) and Anthropic: built environment (distance to roads, paths, power lines, camping areas; CEDEUS), and land use coverage (native forest, scrub, agricultural areas, exotic plantations, urban areas, water bodies; CONAF-IBRD, Earth Explorer).

Each variable was reclassified into dangerousness ranges (low, medium, high) (Table 1), applied to raster and vector layers. Subsequently, they were integrated by means of a multicriteria heuristic equation in ArcGIS 10, assigning differentiated weights according to their influence on the propagation or ignition of the fire (Equation 1):

$$PI = 4V + 3H + 2I - A \quad \text{(Equation 1)}$$

where PI = fire hazard; V = flammability; H = built environment and coverage; I = isolation; A = altitude.

The flammability was calculated using NDVI and NDII, which reflect the density and humidity of the vegetation. The isolation was derived from the orientation of the slopes (higher on the northern slopes of the southern hemisphere). The altitude was classified into three ranges (<144 m, 144-421 m, >421 m). The built environment included 300-meter buffers for roads and 500 meters for high-voltage lines. The land cover was categorized into three types: low (uncovered soils, water, and urban areas), medium (native forests and wetlands), and high (scrub, agricultural areas, and exotic plantations).

The final threat map was reclassified into three levels of danger (low, medium, high) and overlapped with Arauco's official PRC (Arauco, 1988; MINVU, 2025). This cross-checking allowed identifying a match between authorized residential areas and high-threat areas, providing evidence to assess the relevance of the regulatory framework to the risk of wildfires.

V. RESULTS

The analysis of the soil cover showed the predominance of exotic plantations (Eucalyptus globulus, Pinus radiata), accompanied by scrub, meadows, and fragments of native forest. Although urban uses represent only 5% of the communal area, they are concentrated in Arauco, Laraquete, and Carampangue. Coastal wetlands, including Tubul-Raqui (2,238 ha), were classified as uncovered soils with seasonal water stress (Figure 3).

Regarding natural factors, 50% of the territory was highly flammable in areas with continuous vegetation and fine fuels, 26% exhibited medium flammability, and only 4% showed low flammability. Regarding isolation, 43% of the commune receives high solar radiation, mainly in urban and coastal areas, which favors ignition. 64% of the surface is below 140 m.a.s.l., coinciding with the most exposed urban areas.

The anthropic variables revealed that 8% of the commune is highly hazardous, particularly around Route 160, Route P-40, and Ramadillas, where the proximity of the power line to forest plantations poses a significant risk. (Figure 4)

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE
EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS
EDILIA JAQUE-CASTILLO, CAROLINA OJEDA-LEAL, CESAR MUÑOZ-BERRÍOS
REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607

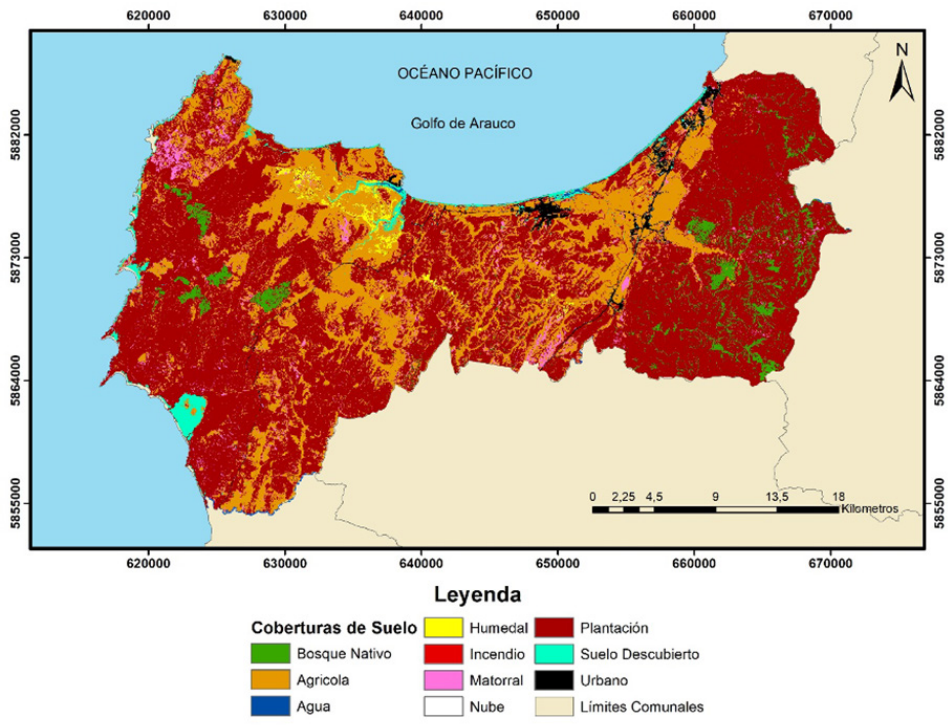

Figure 3. Ground cover map. Commune of Arauco - 2016. Source: Prepared by the authors.

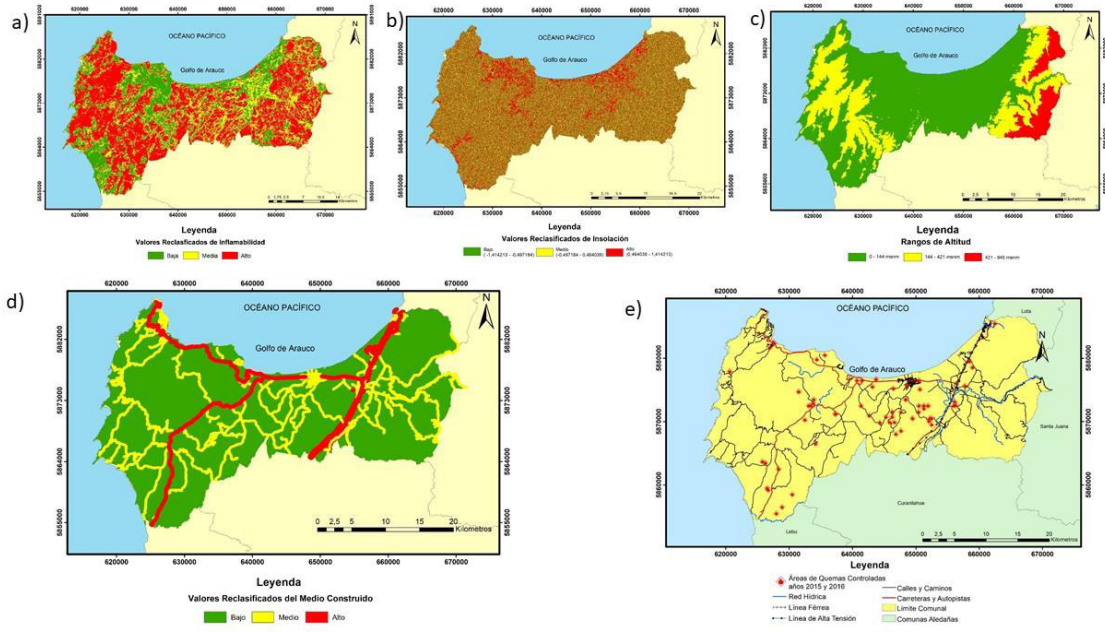

Figure 4. Natural and anthropic factors of wildfire threat: a) Flammability, b) Isolation, and c) Altitude. d) Built environment, e) Areas of influence of the built environment. Source: Prepared by the authors.

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS
EDILIA JAQUE-CASTILLO, CAROLINA OJEDA-LEAL, CESAR MUÑOZ-BERRÍOS
REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607

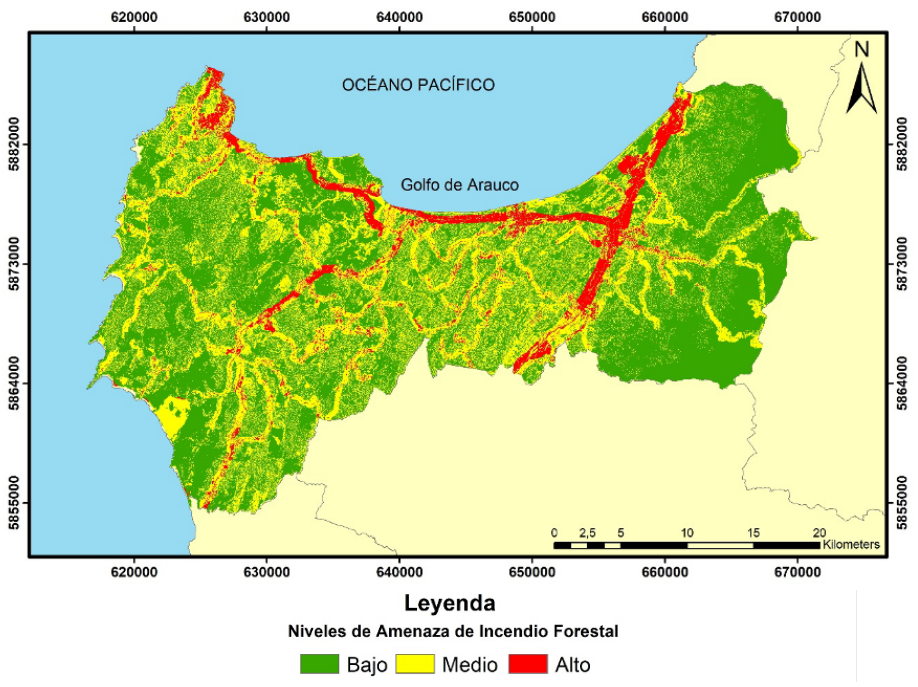

Figure 5. Wildfire Threat Map - Commune of Arauco. Source: Prepared by the authors.

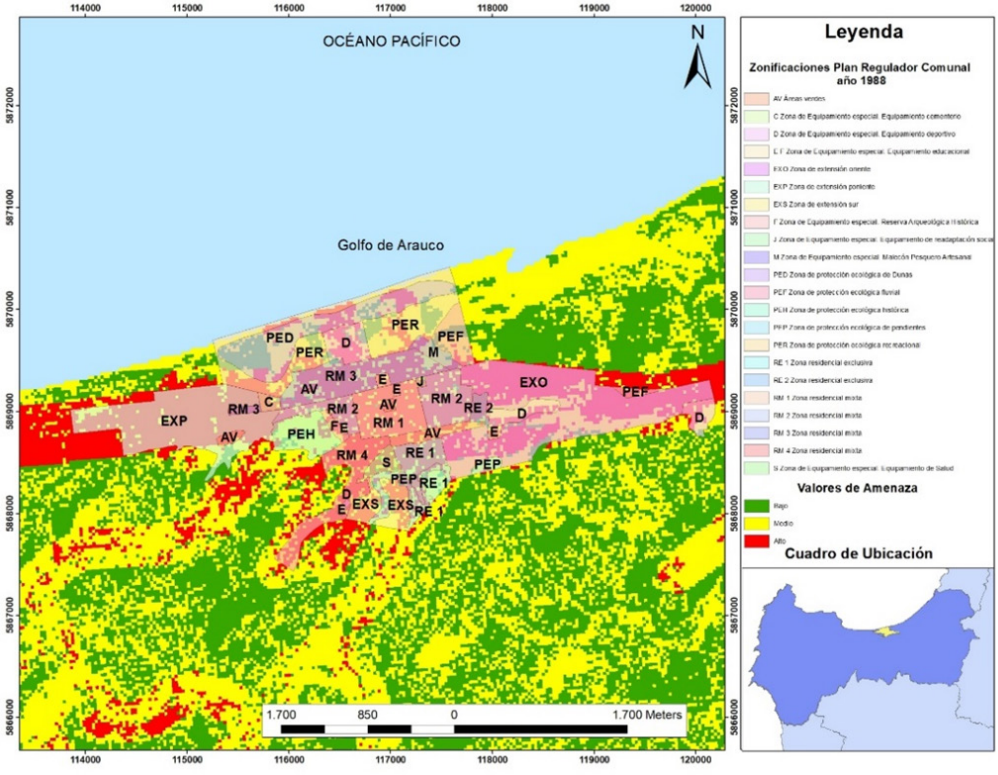

Figure 6. Overlapping of Wildfire Threat on the land use zoning of the current PRC (1988). Source: Prepared by the authors.

LA INTERFAZ URBANO-FORESTAL COMO TIERRA DE NADIE EN LA CONSTRUCCIÓN DEL RIESGO DE INCENDIO FORESTAL EN CIUDADES COSTERAS CHILENAS
EDILIA JAQUE-CASTILLO, CAROLINA OJEDA-LEAL, CESAR MUÑOZ-BERRÍOS
REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607

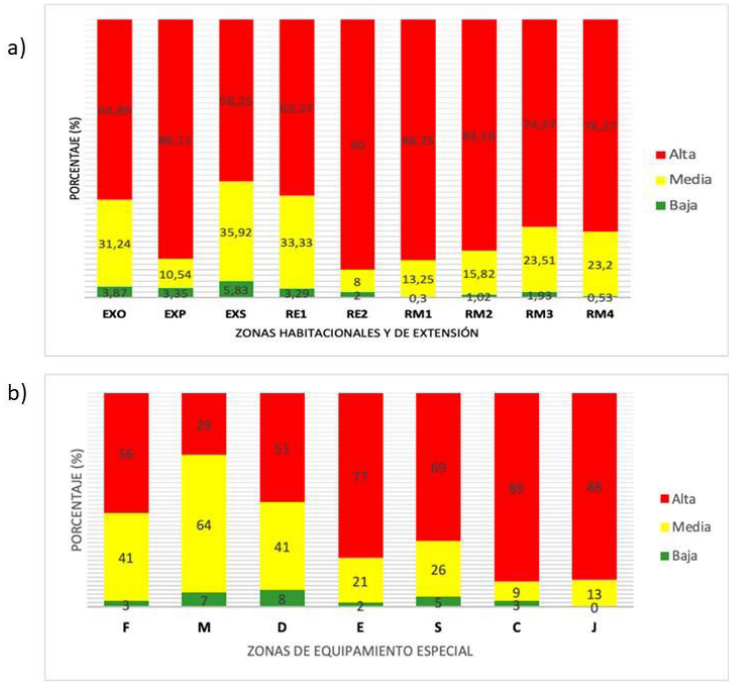

Figure 7. a) Wildfire Threat in Residential Areas b) Extension Areas and in Special Equipment Areas (PRCA., 1988). Source: Prepared by the authors.

Overall, 57.5% of the communal area presents a low threat, 35.6% a medium threat, and 6.8% a high threat. The latter are located on main roads and urban sectors, configuring a highly exposed urban-forest interface, in a context of demographic growth and deregulated urbanization (Figure 5).

The cross-checking with the PRC zoning (Figure 6) revealed that more than 75% of residential urban land is located in high-threat zones (Figure 6). The mixed residential areas (RE-2) and western extension (EXP) coincided with 90% and 86%, respectively, with areas of high danger. The special equipment zones (Arauco prison: 88%; health centers: 69%) are also located in critical areas. Overall, it is confirmed that the current PRC reproduces exposure by allowing urban uses in high-risk territories (Figure 7).

VI. DISCUSSION

The results of the wildfire threat evaluation in the municipality of Arauco indicate a high exposure in areas of the urban-forest interface, particularly in urban and expansion areas defined by the current PRC. This territorial configuration is not isolated, but part of a broader trend in the coastal areas of south-central Chile, where economic, institutional, and historical dynamics converge that condition urban planning and risk management.

Several studies have highlighted that the contradictions between planning, governance, and actual land use in coastal areas are attributed to the pressure exerted by strategic sectors, including ports, industries, and forestry, as well as formal and informal urban expansion in highly vulnerable territories (Andersen Cirera & Balbontín Gallo, 2021). These transformations have intensified the fragmentation of the landscape, increasing the exposure to wildfires, as has been documented in the Metropolitan Area of Valparaíso (Quinteros-Urquieta, 2019), in Greater Concepción (Jaque Castillo et al., 2021), and in the commune of Arauco itself (Jaque Castillo et al., 2022).

These structural pressures are compounded by socio-economic factors that limit local institutional capacities. The shortage of technical personnel in municipalities, the dependence on the Municipal Common Fund and Government Funds (2025) to finance tenders for territorial planning instruments, as well as the low quality of life in many coastal areas — marked by a deficit of services, low income and housing precariousness — make it challenging to develop and update plans with a risk approach (Silva & Mena, 2020; Guerrero et al., 2023).

Even when attempts have been made to incorporate wildfire risk into planning, these efforts have faced institutional barriers. In 2014, the Ministry of Housing and Urban Planning [MINVU] issued Circular 350/DDU-269, which instructed to include the risk

of fires in the IPT. However, the Office of the Comptroller General dismissed this initiative, maintaining that the circulars could not impose new requirements on regulatory plans, limiting themselves to guiding the application of current regulations, such as the LGUC and the OGUC. This ruling highlighted the legal and structural limitations to integrating fire risk into Chilean territorial planning (González-Mathiesen et al., 2024), reflecting tensions between technical knowledge, institutional willingness, and regulatory constraints.

In this scenario, the wood-urban interface is configured as a critical space of institutional vacuum. Although it is recognized as a highly vulnerable area, there is no systematic integration of its management into urban, environmental, or forestry policies. This regulatory absence generates a condition that can be assimilated to a "no man's land", where no public entity assumes responsibility for regulating or mitigating risk. As a result, urban planning not only omits an essential component of risk but also, in many cases, reproduces it by allowing residential uses in highly exposed sectors.

The case of Arauco thus constitutes a concrete territorial expression of a structural problem of national scope. The obsolescence of the PRC, the absence of well-founded risk studies, and the lack of a coherent policy for the wood-urban interface reflect systemic failures in territorial governance. Overcoming this situation requires articulating risk planning and management, explicitly integrating anthropogenic threats into regulatory instruments and moving towards more resilient territorial development models (Villagra & Paula, 2021).

VII. CONCLUSIONS

This study confirms that the threat of wildfires in Arauco is concentrated at the urban-forest interface, where residential areas are highly exposed. The overlap between the 1988 PRC zoning and high-threat areas reveals that planning not only overlooks risk but also reproduces it by allowing densification in critical sectors.

The absence of risk criteria in the current PRC reflects the disconnect between disaster risk planning and management. This omission aligns with the literature on the social construction of risk, which highlights how regulatory frameworks often perpetuate exposure by failing to incorporate emerging environmental threats.

At the national level, the results contribute to the evidence on the limited integration of natural threats into territorial planning, particularly in communes with urban expansion, forest monocultures, and climatic conditions conducive to fires. Internationally, they provide empirical evidence on the challenges of wood-urban interfaces in the context of climate change.

The methodology, based on GIS and the integration of biophysical and anthropic variables, proved helpful in spatially assessing the threat and is replicable in other communes of the country. In terms of implications, the study reinforces the need to update the PRCs by incorporating informed risk studies and linking planning with territorial adaptation policies, in line with the Sendai Framework. Risk-sensitive, evidence-informed planning is crucial for reducing exposure and improving resilience to the growing frequency of socio-environmental disasters.

VIII. CONTRIBUTION OF AUTHORS CRediT:

Conceptualization, E.J.C.; Data Curation, C.M.B.; Formal analysis, C.O.L.; Acquisition of financing, E.J.C.; Research, E.J.C.; Methodology, C.M.B.; Project management, E.J.C.; Resources, E.J.C.; Software; Supervision; Validation, C.M.B.; Visualization, E.J.C.; Writing – original draft, C.O.L.; Writing – revision and editing, E.J.C.

IX. BIBLIOGRAPHIC REFERENCES

Aguirre, P., León, J., González-Mathiesen, C., Román, R., Penas, M., y Ogueda, A. (2024). Modelling the vulnerability of urban settings to wildland–urban interface fires in Chile. *Articles, 24*(4), 1521-1537. https://doi.org/10.5194/nhess-24-1521-2024

Altamirano, A., Salas, C., Yaitul, V., Smith-Ramirez, C., y Ávila, A. (2013*). Influencia de la heterogeneidad del paisaje en la ocurrencia de incendios forestales en Chile Central. Revista de Geografía Norte Grande*, (55), *157–170.* http://dx.doi.org/10.4067/S0718-34022013000200011

Andersen Cirera, K., y Balbontín Gallo, C. (2021). La planificación del borde costero chileno. Una regulación insuficiente. *Revista de Geografía Norte Grande*, *(80)*, 227–247. https://dx.doi.org/10.4067/S0718-34022021000300227

Alvarado Peterson, V., Paulsen-Espinoza, A., y Hidalgo Dattwyler, R. (2023). *Seguridad ontológica y propiedad residencial. Vivienda, bienestar y naturaleza en los suburbios del sur chileno (2011–2023). Revista De Direito Da Cidade, 15*(3), 1454-1478. https://doi.org/10.12957/rdc.2023.78910

Bowman, D. M. J. S., Moreira-Muñoz, A., y Kolden, C. A. (2019). Human–environmental drivers and impacts of the globally extreme 2017 Chilean fires. *Ambio, 48*, 350–362. https://doi.org/10.1007/s13280-018-1084-1

Braun, A. C., Faßnacht, F., Valencia, D. y Sepulveda, M. (2021). *Consequences of land-use change and the wildfire disaster of 2017 for the central Chilean biodiversity hotspot. Regional Environmental Change, 21, 37.* https://doi.org/10.1007/s10113-021-01756-4

Chile. (1975). *Ley General de Urbanismo y Construcciones (LGUC)*, D.F.L. N.º 458, de 13 de abril de 1976 (texto fijado). Recuperado de https://www.leychile.cl/Navegar?idNorma=13560&idParte=8632116

Chile. (24 de marzo de 1988). *Plan Regulador Comunal de la comuna de Arauco* (D.S. N.º 23 de 5 febrero 1988, D.O. 24/03/1988). Recuperado https://centrodeestudios.minvu.gob.cl/planes-reguladores/

Chile. (2008, 19 de febrero). Ley N° 20.249. *Crea el Espacio Costero Marino de los Pueblos Originarios*. Recuperado de https://www.conadi.gob.cl/storage/docs/Comunicaciones/Leyes/Ley_20249.pdf

Chile. (2021, 7 de agosto). Ley N° 21.364. *Establece el Sistema Nacional de Prevención y Respuesta ante Desastres, sustituye la Oficina Nacional de Emergencia por el Servicio Nacional de Prevención y Respuesta ante Desastres…* Recuperado de https://www.bcn.cl/historiadelaley/nc/historia-de-la-ley/7900

Chile. (2022, 13 de junio). Ley N° 21.455. *Ley Marco de Cambio Climático.* Recuperado de https://www.leychile.cl/navegar?idNorma=1177286

Corporación Nacional Forestal [CONAF]. (2022). *Plan de protección contra incendios forestales, Comuna de Los Álamos*. Municipalidad de Los Álamo y Corporación Nacional Forestal (CONAF).

Corporación Nacional Forestal [CONAF]. (2023). *Ocurrencia y daño histórico nacional, 1985–2024*. Corporación Nacional Forestal (CONAF). https://www.conaf.cl/centro-documental/ocurrencia-y-dano-historico-nacional-1985-2023/

Dickson, B. G., Prather, J. W., Xu, Y., Hampton, H. M., Aumack, E. N., y Sisk, T. D. (2006). Mapping the probability of large fire occurrence in northern Arizona, USA. *Landscape Ecology, 21*, 747–761. https://doi.org/10.1007/s10980-005-5475-x

Elgueta Gutiérrez, V. N. (2023). *Clasificación de la amenaza por incendios forestales en campamentos del Anfiteatro de Valparaíso. Revista Cartográfica,* (107), 35–56. https://doi.org/10.35424/rcarto.i107.3566

Etxeberría, P., Edeso, J. M., y Brazaola, A. (2005). Metodología para crear mapas de peligros naturales en Guipúzcoa utilizando SIG. *Revista Internacional de Ciencia y Tecnología de la Información Geográfica*, (5), 250–267. https://www.geofocus.org/index.php/geofocus/article/view/68

Faúndez Pinilla, J., Castillo Soto, M., y Navarro Cerrillo, R. M. (2023). *Impactos de los incendios forestales de magnitud en áreas silvestres protegidas de Chile central. Bosque (Valdivia), 44*(1), 83–95. http://dx.doi.org/10.4067/s0717-92002023000100083

Fondos de Gobierno. (2025). *Fondo Concursable 2025 – Programa de Gestión del Riesgo de Desastres*. https://fondos.gob.cl/ficha/senapred/programagrd/

Frêne Conget, C., y Núñez Ávila, M. (2010). *Hacia un nuevo modelo forestal en Chile. Revista Bosque Nativo*, (47), 25-35. http://revista.bosquenativo.cl/volumenes/47/2_opinion.htm

Gil, M., Cruz, F., Gilabert, H., Campos, K., González-Mathiesen, C., y Vicuña, M. (2024). *Gestión del riesgo de incendios forestales en Chile: aprendizajes y temas emergentes.* Centro de Políticas Públicas UC, Temas de la Agenda Pública. https://politicaspublicas.uc.cl/publicacion/gestion-del-riesgo-de-incendios-forestales-en-chile-aprendizajes-y-temas-emergentes/

González, M. E., Sapiains, R., Gómez-González, S., Garreaud, R., Miranda, A., Galleguillos, M., Jacques, M., Pauchard, A., Hoyos, J., Cordero, L., Vásquez, F., Lara, A., Aldunce, P., Delgado, V., Arriagada Ugarte, A. M., Sepúlveda, A., Farías, L., García, R., Rondanelli, R. J., Ponce, R., Vargas, F., Rojas, M., Boisier, J. P., Carrasco, C., Little, C., Osses, M., Zamorano, C., Díaz-Hormazábal, I., Ceballos, A., Guerra, E., Moncada, M., y Castillo, I. (2020). *Incendios forestales en Chile: causas, impactos y resiliencia.* Centro de Ciencia del Clima y la Resiliencia (CR)2, (ANID/FONDAP/15110009), 84. https://www.cr2.cl/incendios/

González-Mathiesen, C., March, A., y Yunis-Richter, F. (2024). Integrando la gestión del riesgo de los incendios forestales y la planificación territorial: Una reseña del contexto histórico de Chile. *Revista de Estudios Latinoamericanos sobre Reducción del Riesgo de Desastres - REDER, 8*(2), 68–82. https://doi.org/10.55467/reder.v8i2.158

Guerrero, N., Contreras, M., y Chamorro, A. (2023). Social vulnerability in Chile: challenges for multi-scale analysis and disaster risk reduction. *Natural Hazards, 117*, 3067–3102. https://doi.org/10.1007/s11069-023-05978-z

Huaico-Malhue, A., Carrasco-Cabello, C., Ojeda, C., y López-Briones, J. (2024). El reemplazo de la vegetación de tipo mediterránea: Los desafíos para la planificación territorial y el riesgo de desastres en una cuenca de Chile central. *Revista de Estudios Latinoamericanos sobre Reducción del Riesgo de Desastres - REDER, 8*(1), 254–267. https://doi.org/10.55467/reder.v8i1.150

Región del Biobío (Chile). (2019). *Plan Regional de Ordenamiento Territorial (PROT) de la Región del Biobío.* Documento síntesis. Recuperado de https://eae.mma.gob.cl/storage/documents/04_Anteproyecto_PROT_Biob%C3%ADo.pdf.pdf

Ruíz Murcia, F., Gutierrez Valderrama, J. E., Dorado Delgado, J., Eduardo Mendoza, J., Martínez Zuleta, C., Rojas Laserna, M., Hernández Gaona, D., y Rodríguez Salguero, M. (2015). *Nuevos escenarios de cambio climático para Colombia 2011–2100 Nivel Nacional - Departamental: Herramientas científicas para la toma de decisiones*. Instituto de Hidrología Meteorología y Estudios Ambientales - IDEAM, Ministerio De Ambiente y Desarrollo Sostenible - MADS, Programa de las Naciones Unidas para el Desarrollo -PNUD, Ministerio de Relaciones Exteriores, Departamento Nacional de Planeación – DNP. https://www.andi.com.co/Uploads/NUEVOS%20ESCENARIOS%20DE%20CAMBIO%20CLIM%C3%81TICO%20COLOMBIA%202011%20-%202100.pdf

INE. (2017). *Resultado Censo de Población y Vivienda 2017.* Instituto Nacional de Estadísticas de Chile. https://redatam-ine.ine.cl/redbin/RpWebEngine.exe/Portal?BASE=CENSO_2017&lang=esp

Inzunza, J. C. (2009). The relation between Puelche wind and the occurrence of forest fires in Bío Bío region, Chile. *Ingeniería y Ciencia, 5*(10), 33–48. https://publicaciones.eafit.edu.co/index.php/ingciencia/article/view/54

Jaque Castillo, E., Castillo, C., Ojeda Leal, C., y Díaz, P. (2019). Vulnerabilidad educativa ante incendios forestales en el Área Metropolitana de Concepción. Caso de estudio: Penco, Chile. *Estudios Socioterritoriales. Revista De Geografía,* (25), e022. https://doi.org/10.37838/unicen/est.25-022

Jaque Castillo, E., Fernández, A., Fuentes Robles, R., y Ojeda, C. G. (2021). Data-based wildfire risk model for Mediterranean ecosystems - case study of the Concepción metropolitan area in central Chile. *Natural Hazards and Earth System Sciences, 21*(12), 3663–3678. https://doi.org/10.5194/nhess-21-3663-2021

Jaque Castillo, E., Ojeda, C. G., y Fuentes Robles, R. (2022). Landscape fragmentation at Arauco Province in the Chilean forestry model context (1976–2016). *Land, 11*(11), 1992. https://doi.org/10.3390/land11111992

Kapstein López, P. (2004). Análisis de asentamientos precarios en Valparaíso y su incidencia en el crecimiento urbano. *Revista INVI, 19(49).* https://doi.org/10.5354/0718-8358.2004.62210.

Lavell, A. (2001). *Sobre la gestión del riesgo: Apuntes hacia una definición*. https://desastres.unanleon.edu.ni/pdf/2004/mayo/PDF/SPA/DOC15036/doc15036-contenido.pdf

Ministerio de Vivienda y Urbanismo [MINVU]. (2014). *Circular Ordinaria N.º 350 DDU 269: Definición de áreas de riesgo por amenaza de incendio en los instrumentos de planificación territorial.* Ministerio de Vivienda y Urbanismo. https://www.minvu.gob.cl/wp-content/uploads/2019/06/DDU-269.pdf

Ministerio de Vivienda y Urbanismo [MINVU]. (2025). *Planes Reguladores Comunales de Chile.* MINVU.

Moreira, F., Ascoli, D., Safford, H., Adams, M. A., Moreno, J. M., Pereira, J. M. C., Catry, F. X., Armesto, J., Bond, W., González, M. E., Curt, T., Koutsias, N., McCaw, L., Price, O., Pusas, J. G., Rigolot, E., Stephens, S., Tavsanoglu, C., Vallejo, V. R., Van-Wilgen, B. W., Xanthopoulos, G., y Fernandes, P. M. (2020). Wildfire management in Mediterranean-type regions: paradigm change needed. *Environmental Research Letters, 15*(1), 011001. https://doi.org/10.1088/1748-9326/ab541e

Moris, R., Contrucci, P., y Ortega, A. (2017). El riesgo en la actualización post-desastre de instrumentos de planificación territorial comunales en Chile 2010–2014. *Revista de Estudios Latinoamericanos sobre Reducción del Riesgo de Desastres - REDER, 1*(1), 85–100. https://doi.org/10.55467/reder.v1i1.6

Nahuelhual, L., Carmona, A., Lara, A., Echeverría, C., y González, M. E. (2012). Land-cover change to forest plantations: Proximate causes and implications for the landscape in south-central Chile. *Landscape and Urban Planning, 107*(1), 12–20. https://doi.org/10.1016/j.landurbplan.2012.04.006

Pazmiño, D. (2019). Peligro de incendios forestales asociado a factores climáticos en Ecuador. *FIGEMPA: Investigación y Desarrollo, 7*(1), 10–18. https://doi.org/10.29166/revfig.v1i1.1800

Pérez-Verdín, G., Márquez-Linares, M. A., Cortés-Ortiz, A., y Salmerón-Macías, M. (2013). Análisis espacio-temporal de la ocurrencia de incendios forestales en Durango, México. *Madera y Bosques, 19*(2), 37–58. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-04712013000200003

Pereira Torres, F. (2014). *Estudos sobre incêndios em vegetação nas áreas urbanas de Ubá e Juiz de Fora – MG* [Tesis de Doctorado]. Universidade Federal de Viçosa. http://www.locus.ufv.br/bitstream/handle/123456789/606/texto%20completo.pdf

Pino Albornoz, A. P., y Carrasco Henríquez, N. G. (2019). Extractivismo forestal en la comuna de Arauco (Chile): internalización y formas de resistencia. *Revista Colombiana de Sociología, 42*(1), 207–226. https://doi.org/10.15446/rcs.v42n1.73233

Quinteros-Urquieta, C. (2019). Transformaciones urbanas postdesastre en Valparaíso. Estado y planes de reconstrucción. *Bitácora Urbano Territorial, 29*(2), 151–158. https://doi.org/10.15446/bitacora.v29n2.70070

Radeloff, V. C., Hammer, R. B., Stewart, S. I., Fried, J. S., Holcomb, S. S., y McKeefry, J. F. (2005). The wildland–urban interface in the United States. *Ecological Applications, 15*(3), 799–805. https://doi.org/10.1890/04-1413

Seidl, R., Fernandes, P. M., Fonseca, T. F., Gillet, F., Jönsson, A. M., Merganicova, K., Netherer, S., Arpaci, A., Bontemps, J.-D., Bugmann, H., González-Olabarria, J. R., Lasch, P., Meredieu, C., Moreira, F., Schelhaas, M.-J., y Mohren, F. (2011). Modelling natural disturbances in forest ecosystems: a review. *Ecological Modelling, 222*(4), 903–924. https://doi.org/10.1016/j.ecolmodel.2010.09.040

Silva, N., y Mena, C. (2020). Identifying the underlying risk factors of local communities in Chile. *Disaster Prevention and Management, 29*(5), 681–696. https://doi.org/10.1108/DPM-04-2020-0105

Stewart, S. I., Radeloff, V. C., Hammer, R. B., y Hawbaker, T. J. (2007). Defining the Wildland–Urban Interface. *Journal of Forestry, 105*(4), 201–207. https://doi.org/10.1093/jof/105.4.201

Syphard, A. D., Rustigian-Romsos, H., y Keeley, J. E. (2021). Multiple-scale relationships between vegetation, the wildland–urban interface, and structure loss to wildfire in California. *Fire, 4*(1), 12. https://doi.org/10.3390/fire4010012

Thompson, V., Mitchell, D., Melia, N., Bloomfield, H., Dunstone, N., y Kay, G. (2025). Detecting rising wildfire risks for South East England. *Climate Resilience and Sustainability, 4*(1), e70002. https://doi.org/10.1002/cli2.70002

Vicuña, M., y Guzmán, S. (2025). *Atlas del riesgo de desastre: Áreas de riesgo en los instrumentos de planificación territorial en Chile*. Centro de Investigación para la Gestión Integrada del Riesgo de Desastre – CIGIDEN, Instituto de Estudios Urbanos y Territoriales PUC. https://www.cigiden.cl/atlas-del-riesgo-de-desastre-areas-de-riesgo-en-los-instrumentos-de-planificacion-territorial-en-chile/

Villagra, P., y Paula, S. (2021). Wildfire management in Chile: Increasing risks call for more resilient communities. *Environment: Science and Policy for Sustainable Development, 63*(3), 4–14. https://doi.org/10.1080/00139157.2021.1898891

Williams, J. (2013). Exploring the onset of high-impact mega-fires through a forest land management prism. *Forest Ecology and Management, 294*, 4–10. https://doi.org/10.1016/j.foreco.2012.06.030

Zenteno Torres, E., Muñoz Salazar, P. & Rosso Ávila, B. (2022). Urbanización subalterna en tiempos de pandemia. Asentamientos informales en Chile. *Bitácora Urbano Territorial, 32(2), 267–280.* https://doi.org/10.15446/bitacora.v32n2.99624

REVISTA URBANO Nº 52 /NOVIEMBRE 2025 - ABRIL 2026
PÁG. 52 - 63
ISSN 0717 - 3997 / 0718 - 3607