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Data Descriptor

Wildfire Occurrence and Damage Dataset for Chile (1985–2024): A Real Data Resource for Early Detection and Prevention Systems

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Abstract

Wildfires represent an increasing global concern, threatening ecosystems, human settlements, and economies. Chile, characterized by diverse climatic zones and extensive forested areas, has been particularly vulnerable to wildfire events over recent decades. In this context, real, long-term data are essential to understand wildfire dynamics and to design effective early warning and prevention systems. This paper introduces a unique dataset containing detailed wildfire occurrence and damage information across Chilean municipalities from 1985 to 2024. Derived from official records by the National Forestry Corporation of Chile CONAF, this dataset encompasses key variables such as the number of fires, total burned area, estimated material damages, and the number of affected individuals. It provides an invaluable resource for researchers and policymakers aiming to improve fire risk assessments, model fire behavior, and develop AI-driven early detection systems. The temporal span of nearly four decades offers opportunities for longitudinal analyses, the study of climate change impacts on fire regimes, and the evaluation of historical prevention strategies. Furthermore, by presenting a complete spatial coverage at the municipal level, it allows fine-grained assessments of regional vulnerabilities and resilience.

Dataset: https://github.com/cvidalmsu/FONDEF-IDEA-

Dataset License: CC-TY 4.0

Keywords: spatiotemporal analysis; risk mitigation; environmental monitoring; data-driven modeling; wildfire management; public policy; ecological resilience

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1. Introduction

Wildfires are natural or human-induced phenomena with severe ecological, economic, and social consequences. Their frequency and intensity are exacerbated by climate change, land-use modifications, and demographic pressures [1,2]. Chile, stretching over a wide latitudinal range, presents varied climatic conditions contributing to complex wildfire regimes. Historical analysis indicates a rising trend in wildfire occurrences and damages, demanding robust and comprehensive data to inform mitigation efforts [3].

The increasing frequency, intensity, and spatial extent of wildfires globally and regionally have transformed wildfire research into a multidisciplinary challenge encompassing environmental science, disaster risk reduction, public policy, and advanced data analytics [1]. Effective wildfire management requires access to accurate, real-time, and historical data to design predictive models, allocate firefighting resources, and guide policymaking aimed at risk reduction and environmental sustainability [4]. Particularly in Chile, the 2017 megafires underscored the urgent need for better preparedness, early detection systems, and long-term datasets capable of supporting comprehensive risk assessments [3]. Megafires have devastating consequences for ecosystems and human settlements, although they may also trigger rapid ecological responses and early recovery phases in some cases, depending on landscape resilience and fire history [5].

Wildfires pose significant threats not only to ecosystems and biodiversity but also to all three pillars of sustainability: environmental integrity, social well-being, and economic stability. According to recent studies, wildfires globally release an estimated 8 billion tons of CO_2 annually, undermining climate mitigation efforts and sustainable development progress [6]. In Chile alone, wildfire damages cost approximately $350 million USD annually [7], diverting resources from sustainable development initiatives. These impacts directly affect United Nations Sustainable Development Goals, particularly SDG 13 (Climate Action) and SDG 15 (Life on Land) [8,9].

Despite the recognized importance of wildfire data, most studies in the Chilean context have been constrained either by the lack of publicly available records, fragmented datasets covering limited periods, or inconsistencies in data collection methodologies over time [10]. Hence, there is a critical demand for consolidated, verified, and detailed datasets that span multiple decades, facilitating longitudinal analyses and providing a robust empirical foundation for predictive modeling. While the current dataset is based solely on ground-reported records from the National Forestry Corporation of Chile (CONAF), future versions may incorporate cross-calibration with international satellite-based products (e.g., MODIS, GFED) to increase intercomparability with global fire datasets. Chile's complex geography and climate variability pose a challenge for national-scale wildfire modeling.

Reliable wildfire datasets are essential to support prevention strategies, define defense zones, and guide evidence-based policy decisions. International experiences have demonstrated the value of long-term fire records in identifying high-risk zones, informing spatial planning, and evaluating the effectiveness of early warning systems [11,12]. In Mediterranean regions of Europe and North America, for example, historical data have guided the design of firebreaks and interface protection. Similar approaches have been applied in Chile, where time series of wildfire occurrences have informed prevention strategies and the delineation of defense zones [13,14]. Moreover, the integration of mobility data and socioeconomic indicators has enhanced risk mapping and emergency preparedness in countries such as Australia and Portugal [15,16], highlighting the relevance of multi-source datasets like the one presented in this work.

This work addresses that demand by introducing a novel dataset covering wildfire occurrence and damage information across Chilean municipalities from 1985 to 2024. The dataset, constructed from official CONAF records [3], captures essential variables such as the number of wildfires, total burned area, economic losses, and human impact, all standardized across time and space. Unlike synthetic datasets or those derived solely from satellite observations, the presented data originate from ground-reported events [4,10], providing higher accuracy in event attribution and impact assessment.

Recent advances in artificial intelligence, particularly Deep Reinforcement Learning (DRL), offer promising approaches for wildfire prediction and management [17,18], but these systems require high-quality, comprehensive datasets for training and validation. The dataset presented in this work is specifically designed to support such advanced modeling approaches, providing the temporal depth and feature richness necessary for developing effective early warning systems.

The publication of this dataset aims to support diverse scientific communities in advancing early detection models, improving disaster prevention strategies, and understanding the spatiotemporal patterns of wildfire occurrence in the context of changing climate and socioeconomic factors [2,4]. Furthermore, it responds to the growing call for open-access, real-world data to foster cross-disciplinary collaborations, enhance reproducibility, and ultimately contribute to mitigating the devastating effects of wildfires at national and international scales.

The rest of the article is structured as follows. Section 2 details the composition of the wildfire dataset, while Section 3 shows how we have obtained data from official sources and the subsequent data curation. In Section 4, we explain some practical use cases of this dataset. Finally, in Section 5, we present the conclusions of this wildfire dataset compilation and how it can be enriched with additional data sources.

2. Data Description

The wildfire dataset compiled for this work covers a comprehensive range of attributes, capturing not only the number of wildfire events but also their spatial distribution, temporal evolution, burned areas, causes of ignition, human impacts, and associated economic losses. These variables are fundamental for building robust models capable of understanding, predicting, and managing wildfire phenomena, as emphasized in information theory principles regarding the maximization of available data for uncertainty reduction [19–21].

Data are collected from official CONAF records between 1985 and 2024, integrating more than 40 years of systematically reported wildfire occurrences [3,7]. Each entry corresponds to a municipality-level report, standardized across administrative changes that occurred in Chile over this period.

Spatial attributes are validated against official municipal boundaries, ensuring geographic consistency. The burned area is recorded in hectares, and ignition causes are categorized as human activities, natural causes (e.g., lightning), or unknown. For each fire event, data on human impacts (injuries, fatalities, evacuations) and estimates of economic damages are systematically incorporated.

Recent studies have highlighted that the availability of high-quality ground-based data, such as the one presented here, is crucial for advancing machine learning and deep learning models aimed at wildfire detection, mapping, and prediction [18,22,23]. Unlike datasets based solely on satellite observations, ground-reported datasets offer higher reliability for attribution studies and impact assessments [4,10].

In the specific context of Chile, the vulnerability of urban and rural zones to wildfire hazards has been a growing concern [24,25]. The dataset thus provides a critical foundation not only for scientific analysis but also for informing public policies, emergency response planning, and sustainable land management practices.

Moreover, considering the increasing complexity of wildfire dynamics under climate change [6,26], datasets like this are indispensable for training hybrid models that combine physical, statistical, and AI-based approaches. They also enable testing of novel frameworks based on reinforcement learning for proactive fire management and resource optimization [18,27]. Table 1 shows the important variables considered.

Table 1. Main variables included in the wildfire dataset (1985–2024).

Variable	Description
Date of Event	Day/month/year format.
Municipality	Official Chilean municipality name.
Burned Area (ha)	Surface affected by the fire, in hectares.
Ignition Cause	Human activities, natural causes, or unknown.
Economic Losses (USD)	Estimated direct losses adjusted to 2024 value.
Human Impact	Number of injuries, fatalities, evacuations.

The temporal evolution of the burned area is shown in Figure 1, while the total number of wildfire events across decades is summarized in Figure 2.

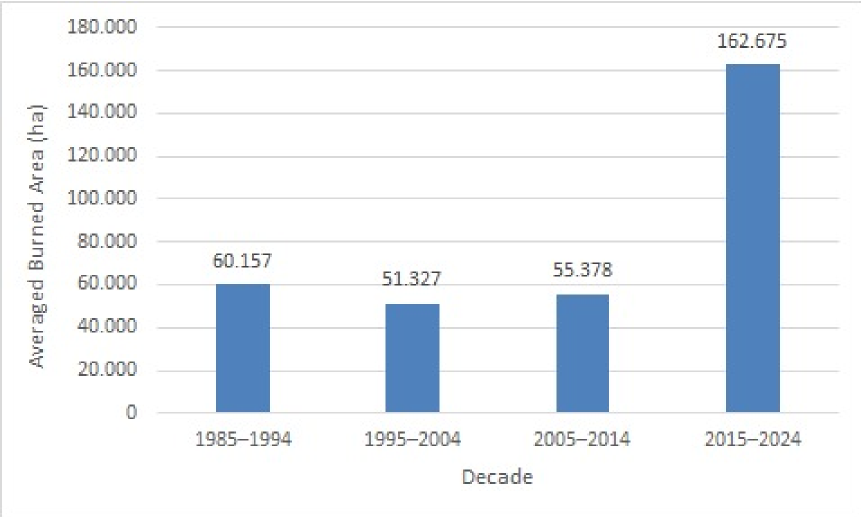

Figure 1. Average burned area per decade in Chile (1985–2024).

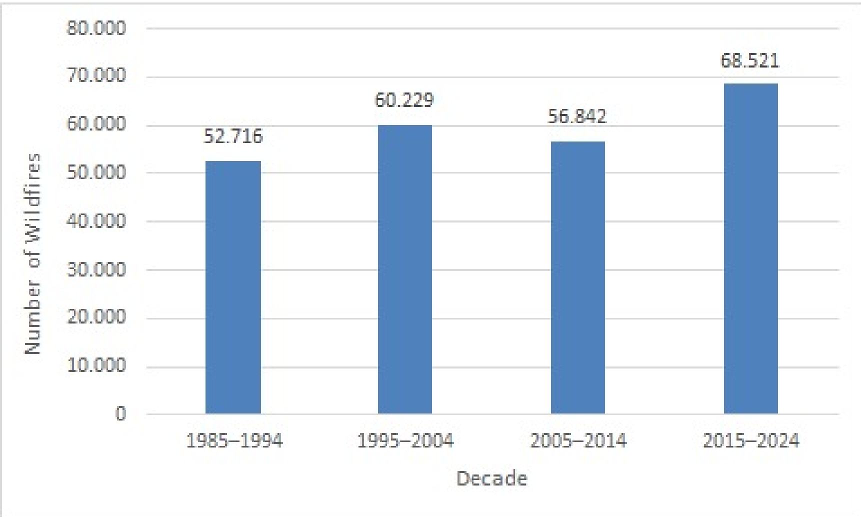

Figure 2. Total number of wildfire events per decade in Chile (1985–2024).

It is important to clarify that the severity indicators in the data set refer to reported socioeconomic consequences such as direct monetary losses, injuries, evacuations, and damage to homes based on official ground-level records. These metrics are not equivalent to remote sensing–based burn severity measures such as the differenced normalized burn ratio (dNBR), which are derived from satellite imagery. In future work, we consider integrating such indices to enable more precise ecological severity assessments and facilitate biome-scale comparisons.

Regional Statistical Summaries

To account for regional disparities and reduce the influence of extreme values, nonparametric statistics were computed for descriptive analysis. Specifically, medians and interquartile ranges (IQR) were used to characterize burned area, number of wildfire events, and human or economic impacts at both the regional and municipal levels. This approach improves robustness given that many fire-related variables exhibit skewed distributions due to large and infrequent extreme events.

3. Materials and Methods

3.1. Data Acquisition and Preprocessing

The wildfire dataset is assembled from raw incident reports provided by the Corporación Nacional Forestal (CONAF) [3,7]. These reports contain detailed event-level information collected through field inspections, satellite verification, and administrative declarations. Given the long time span covered (1985–2024), data standardization is critical to address evolving reporting practices, changes in administrative divisions, and regional inconsistencies. The original records were obtained as Microsoft Excel spreadsheets from CONAF's incident reporting system. These were compiled and cleaned using a combination of R and Python scripts to ensure transparency and reproducibility in the preprocessing pipeline.

Preprocessing steps included correction of typographical errors, harmonization of municipality names, removal of duplicate entries, and unification of measurement units. Spatial validation is performed using official shapefiles to ensure consistent geolocation of events. Missing attributes, when feasible, are imputed using municipal or regional statistics following established methodologies for disaster datasets [24]. Special care is taken to preserve the original information content to the greatest extent possible, following maximum entropy principles [19,20].

Figure 3 illustrates the annual evolution of total wildfire occurrences in Chile between 1985 and 2023, based on official records systematized by the National Forestry Corporation (CONAF). A clear interannual variability is observed, with a sustained increase in fire frequency from the early 2000s onward. Particularly high numbers are recorded in 2014, 2019, and 2020, each exceeding 20,000 events. This temporal information is essential to identify long-term trends, evaluate the effectiveness of prevention policies, and assess the cumulative impact of climate change on fire regimes. The time series also provides a structured input for training and validating predictive models based on artificial intelligence and deep learning.

Figure 4 presents the cumulative monthly distribution of wildfires in Chile over the period 1985–2023. A strong seasonal pattern is evident: the vast majority of events occur between December and March, corresponding to the austral summer. This concentration reflects favorable climatic conditions for ignition and fire spread, such as high temperatures, low relative humidity, and abundant dry fuel. Understanding this seasonality is crucial for optimizing surveillance resources, early warning systems, and fire mitigation strategies. Moreover, these temporal curves serve as a valuable input for risk-based spatial planning and climate-adaptive fire management systems.

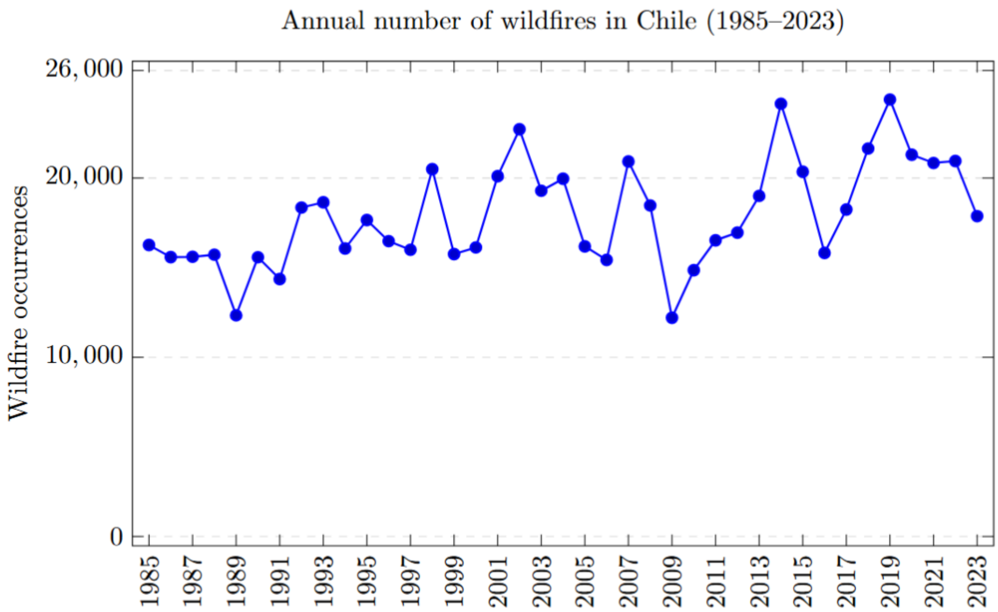

Figure 3. Annual number of wildfires in Chile based on consolidated records from CONAF (1985–2023).

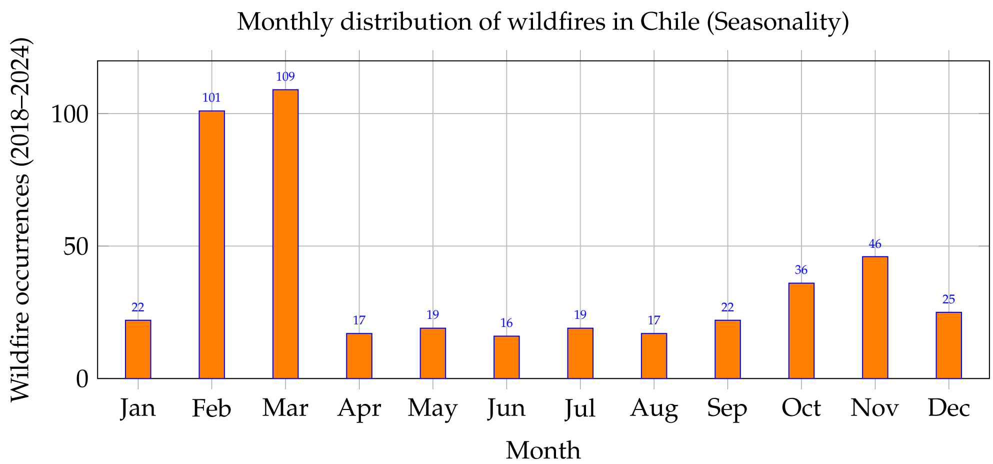

Figure 4. Monthly distribution of wildfires in Chile based on validated CONAF records (2018–2024).

3.2. Variable Engineering

Each wildfire event is enriched through additional engineered variables to facilitate downstream modeling and analysis. Following recommendations from recent reviews on wildfire data preparation [18,28], the dataset includes the following:

- Standardized ignition cause categories: Events are recoded into anthropogenic, natural (e.g., lightning), or unknown, improving consistency across decades.
- Severity indicators: Burned area is normalized by municipal area, producing a relative severity index (burned area per square kilometer).
- Economic adjustment: Reported direct damages are corrected for inflation to constant 2024 US dollars, based on official Chilean CPI data.
- Temporal metrics: New variables such as “fire seasonality” (month of occurrence) are derived, enabling seasonal trend analyses.

These engineered variables are carefully separated from raw fields to avoid information leakage in future machine learning tasks [29]. They also facilitate the construction of predictive models, including classification of high-risk periods and identification of socio-environmental vulnerability patterns.

3.3. Temporal Aggregation

To support both macro-level and fine-grained temporal analyses, the dataset was processed at multiple aggregation levels. For long-term trend detection, we generated decadal summaries spanning four periods: 1985–1994, 1995–2004, 2005–2014, and 2015–2024. These summaries include the total number of wildfires, total and average burned area, reported economic losses, and human impacts. This aggregation facilitates the identification of structural shifts in wildfire regimes under evolving climate and land-use dynamics [6,26].

Given the strong interannual variability that characterizes wildfire activity in Chile, year-by-year analysis is essential. Figure 3 presents the annual number of wildfires from 1985 to 2023, highlighting critical fluctuations that would otherwise be masked in aggregated views. This resolution is particularly valuable for identifying anomalous fire seasons, evaluating short-term impacts of policy interventions or climate events, and calibrating predictive models.

In addition, monthly aggregation was applied to assess intra-annual behavior. Figure 4 shows the seasonal distribution of wildfires, with a strong concentration of events between December and March (austral summer). This temporal signature supports the development of seasonally informed early warning systems and preparedness strategies.

Overall, while decadal summaries offer a high-level perspective of long-term dynamics, the dataset retains full event-level resolution, enabling flexible disaggregation for annual, seasonal, or even monthly modeling applications.

3.4. Quality Assessment

Data quality assurance is a central component of the dataset construction. First, internal consistency checks are performed by comparing reported burned areas and event counts across years and municipalities. Second, totals are cross-validated against official national aggregates reported by CONAF [7], with discrepancies above 5% flagged for manual review.

Spatial validation ensured that event locations fell within administrative boundaries valid for the event year, correcting for changes in municipal boundaries over time [24]. Outlier detection procedures identified extreme events (e.g., burned areas exceeding historical maximums) for manual verification. As shown in Table 2, 0.8% of records were removed due to duplication or irrecoverable errors, while 1.6% had one or more imputed fields. The validation procedures confirmed the geospatial and temporal consistency in 100% of the dataset.

Table 2. Summary of data cleaning and preprocessing operations.

Operation	Affected Records (%)	Description
Removed	0.8%	Duplicates, missing key fields
Imputed	1.6%	Ignition cause, municipality code, etc.
Validated	100%	Geospatial and temporal consistency

To contextualize the value of the presented dataset, it is important to compare it with widely used international wildfire datasets such as MODIS MCD64A1 [30,31] and the Global Fire Emissions Database (GFED) [32]. These global products rely primarily on satellite-derived burned area estimates with high temporal resolution and consistent global coverage. However, they often face limitations in detecting small fires, under canopy burning, or events obscured by clouds [31,33]. In contrast, the dataset presented here is built from official ground-reported events compiled by Chile's national forestry agency (CONAF), capturing not only fire occurrence and area but also economic damages and human impacts. This level of granularity and validation is not typically available in global satellite datasets. As such, the dataset complements satellite-based products by providing high-fidelity event-level data that is especially valuable for local modeling, national policy development, and post-event damage assessments.

Following information theory principles, no transformations are applied that would suppress significant variability or artificially smooth distributions [21]. This preserves the richness of the data, critical for training advanced predictive models, including deep reinforcement learning systems recently applied to wildfire management [27].

3.5. Data Availability and Ethical Considerations

The dataset adheres strictly to the FAIR (Findable, Accessible, Interoperable, Reusable) data principles. Metadata is provided to ensure transparency, including definitions of variables, preprocessing decisions, and data quality control processes.

Sensitive information, such as private property data, precise geolocation of residential damages, or personally identifiable information, is excluded. All records correspond to aggregated municipal-level statistics, ensuring compliance with ethical standards for disaster-related data sharing [34].

The dataset is published under an open-access license, facilitating its use in research, policy development, and operational applications in wildfire management, consistent with best practices for environmental data dissemination.

4. Scientific Relevance and Considerations

Wildfires represent a complex socio-ecological phenomenon influenced by climatic, environmental, and anthropogenic factors [2,6]. High-quality datasets are critical for advancing our understanding of fire regimes, evaluating risk, and informing mitigation and adaptation strategies at local, regional, and global scales.

The dataset presented in this work fills a significant gap in wildfire data availability for Chile, a country identified as highly vulnerable to increasing wildfire risks under climate change scenarios [24,25]. Unlike remote-sensing-only datasets, which may suffer from detection bias due to cloud cover or rapid vegetation regrowth, this ground-reported dataset captures real incident reports validated by administrative and field processes [3,7]. This feature provides a higher level of attributional accuracy, essential for effective fire modeling and operational risk management [18,22].

This wildfire dataset represents a critical component in a broader strategic initiative to understand the complex interrelationships between water resources and fire occurrence in Chile. Previous work by Pizarro-Tapia et al. [35] established methodologies for rescuing and digitizing historical rainfall intensity data from pluviograph strip charts, while Pizarro et al. [36] developed *WEBSEIDF*, a web-based system for estimating rainfall intensity-duration-frequency curves. Together with this wildfire dataset, these complementary resources could create a foundation for sophisticated environmental risk assessment. Precipitation patterns directly influence vegetation moisture content and fire susceptibility, with prolonged drought periods significantly increasing wildfire probability. By integrating these datasets, emergency management authorities can optimize resource allocation for fire prevention and suppression based on precipitation history and forecasts. Moreover, Sangüesa et al. [37] demonstrated techniques for estimating rainfall parameters in sparsely-gauged areas, which when combined with spatial wildfire data, can enable more accurate fire risk mapping across diverse Chilean landscapes, including remote regions with limited monitoring infrastructure. This comprehensive approach to water-fire dynamics supports both immediate tactical decisions in firefighting resource deployment and long-term strategic planning for climate adaptation.

Beyond regional applications, the dataset enables several critical research and development directions:

- The development of machine learning and deep learning models for wildfire prediction, including convolutional-recurrent architectures [18,22,23].
- The construction and evaluation of deep reinforcement learning (DRL) frameworks focused on wildfire early warning and prevention, as explored in recent comparative studies [38].
- The assessment of socioeconomic and environmental impacts of fire events over extended periods, facilitating cross-regional comparative analyses [6,26].
- The design of dynamic risk maps and decision-support systems for public safety and resource allocation.

Moreover, the temporal depth of the dataset (spanning 40 years) enables studies on long-term wildfire trends, interactions with climatic oscillations, and the evaluation of historical fire prevention policies. This is particularly relevant for evaluating changes in fire seasonality, frequency, and intensity under evolving climatic conditions.

The integration of heterogeneous environmental datasets has proven highly valuable in Chilean research, particularly for addressing data gaps and enhancing regional analyses. For example, Sangüesa et al. [37] developed regionalization techniques to overcome the scarcity of hydrological data in sparsely monitored areas—a methodological approach that aligns with our efforts to compile a comprehensive wildfire dataset from historically fragmented records. Similarly, the work of Pizarro et al. [39] on the links between land use change and water resource sustainability offers a conceptual foundation for understanding the interplay between human activity, environmental stressors, and extreme events such as wildfires.

The wildfire dataset presented here paves the way toward a unified environmental monitoring system that integrates wildfire occurrences with climatic and hydrological variables. When combined with existing rainfall intensity datasets—such as those rescued through the Pluviograph Strip Charts Reader project [35] or generated by web-based platforms like Pizarro et al. [36]—this dataset could support the development of robust predictive tools. Such integrated platforms would enable advanced analyses of the relationships among precipitation trends, drought conditions, and fire activity, revealing potential thresholds and feedback mechanisms. This systemic approach would significantly enhance Chile's capacity for environmental risk assessment and climate-resilient planning.

Importantly, the dataset's design adheres to FAIR (Findable, Accessible, Interoperable, and Reusable) data principles, promoting open science practices. By releasing these standardized, real-world data openly, we aim to foster multidisciplinary collaborations across environmental science, artificial intelligence, disaster management, and public policy communities.

Finally, the demonstrated utility of this dataset for training and validating deep reinforcement learning models for wildfire occurrence prediction [38] underscores its immediate value in advancing operational early warning systems. These applications hold promise for substantially reducing wildfire-related damages through more timely and informed decision-making.

5. Conclusions

This study introduces a novel, extensive wildfire dataset for Chile covering the period 1985–2024, constructed from official CONAF ground-reported records. Furthermore, the dataset supports climate-zone-specific analyses. For example, municipalities within Chile's Mediterranean zone can be used to benchmark wildfire patterns against global

Mediterranean-type climates. This opens opportunities for comparative modeling and transnational policy assessment across fire-prone landscapes.

Through rigorous data cleaning, validation, and standardization processes, the dataset achieves a high level of completeness and reliability, essential for advanced fire modeling and risk assessment studies.

Key conclusions from this work include the following:

- The dataset significantly enriches the available resources for studying wildfire occurrence, burned areas, human impacts, and economic losses in Chile, a country facing increasing wildfire risks due to climate and land-use changes.
- Temporal aggregation and standardized variable engineering facilitate its direct application to machine learning, deep learning, and statistical modeling tasks aimed at fire prediction, risk mapping, and policy evaluation [18].
- Scientific relevance extends beyond national boundaries, as the dataset provides a valuable benchmark for cross-country comparative studies and contributes to global efforts in understanding and mitigating wildfire hazards.

A limitation of the current dataset is the absence of direct indicators related to wildlife losses and broader ecosystem damage. While human casualties and economic losses are systematically reported, official incident records do not include data on fauna mortality, habitat destruction, or biodiversity impacts. Future versions of the dataset could address this gap by incorporating remote sensing-based habitat loss indices or by collaborating with environmental agencies to expand the ecological dimension of wildfire impact assessments. Additionally, this dataset could be integrated with satellite-derived variables (e.g., vegetation indices, drought indicators) [18] and socioeconomic data (e.g., population density, land-use patterns) to enable multi-factorial wildfire risk modeling under evolving climate scenarios.

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