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D 2.1 Italian fire database 2007-2022 with fire weather data and severity classes

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Innovative Tools for Wildfire Prevention

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Executive summary

This deliverable presents two complementary sub-products developed within the FIRE-BOX project to support wildfire knowledge and risk management in Italy. The first is a harmonized geospatial database of wildfires in Italy for the period 2007–2022. The second is a methodological framework for integrating fire weather-related information and burn severity classes through remote-sensing analysis. Together, these outputs provide both a national dataset of wildfire occurrence and a basis for assessing fire impacts.

The *Italian fire database 2007–2022* was developed to address the lack of a complete and harmonized national wildfire database. It was created by integrating wildfire records from multiple agencies across Italy, extending a previous 2007–2017 dataset and updating earlier records through additional processing and quality control. The report describes the data sources, standardization procedures, main processing steps, dataset limitations, and metadata and access conditions.

The final dataset is a polygon-based geospatial database covering the whole Italian territory for 2007–2022. It includes 106,978 fire records and 1,356,851 burned hectares, in ESRI shapefile format and referenced to the WGS84-UTM 32N coordinate system. Comparison with official wildfire statistics reported by Italy to EFFIS shows an overall difference of +6.5% in number of fires and +5.5% in burned area over the study period. Despite this substantial harmonization effort, some limitations remain, including missing dates for a small number of records, uncertainties in some fire perimeters, possible redundancies, and legal restrictions that currently prevent full public release of the dataset.

The second sub-product focuses on fire severity assessment, which is essential for understanding ecological impacts and improving fire-risk analysis. This component was developed using MODIS MOD09A1 Version 6.1 imagery and the calculation of the Normalized Burn Ratio (NBR) and differenced NBR (dNBR). Burn severity estimates were validated by comparing values within mapped fire polygons and surrounding forest areas, using CORINE land-cover information to isolate relevant vegetation classes and reduce spectral confusion. The analysis highlights strong temporal variability in wildfire impacts in Italy, with major crisis years such as 2007, 2017, and 2021 showing substantial increases in both burned area and high-severity fire effects. Results also show that fire severity patterns vary across vegetation types, confirming the value of combining spatial fire records with severity-related information for a more meaningful interpretation of wildfire activity.

Overall, this deliverable provides an integrated knowledge base for wildfire research and management in Italy. By combining a harmonized national fire database with a burn severity assessment framework, it supports future applications in fire monitoring, ecological impact assessment, and evidence-based wildfire risk management.

Keywords

Wildfire dataset; wildfires statistics; fire severity;

Table of contents

EXECUTIVE SUMMARY 3
KEYWORDS 3
TABLE OF CONTENTS 4
ITALIAN FIRE DATABASE 2007-2022 5
1. BACKGROUND 5
2. DATA SOURCES 6
3. DATA CURATIONS 7
3.1. STANDARDIZATIONS 7
3.2. DATA PROCESSING AND QUALITY CONTROL 9
3.3. ERRORS AND OTHER ISSUES 11
4. DATA COMPARISON 14
5. METADATA 17
6. DATA AVAILABILITY 18
FIRE WEATHER DATA AND SEVERITY CLASSES 18
1. BACKGROUND 18
2. DATA SOURCES 19
3. METHODS 20
3.1 FIRE SEVERITY ASSESSMENT 20
3.2 VISUAL INSPECTION AND VALIDATION 21
4. RESULTS 21
4.1THE EVOLUTION OF BURNED AREA 21
4.2 FIRE SEVERITY TRENDS 22
4.3 ECOLOGICAL IMPACT BY FOREST CATEGORY 24
CONCLUSION 26
REFERENCES 27

Italian fire database 2007-2022

1. Background

Researchers should frequently gather and merge different datasets on their own to obtain a multiannual national fire dataset for Italy due to the lack of a complete and harmonized national wildfire database. A previous spatial dataset of wildfires in Italy for the period 2007-2017 (hereafter referred to as the "2007-2017 dataset") was derived in 2019 by Jose V. Moris and Professor Davide Ascoli from the University of Turin. This dataset was initially generated to facilitate geospatial analyses of Italian wildfires, such as fire severity, fire spread, fire statistics, fire weather, fire emissions, impacts on ecosystem services, etc. The 2007-2017 dataset went through comprehensive data processing and quality control, and was used in the following publications: Colonico et al. (2022), Elia et al. (2022), Spadoni et al. (2023), Scarpa et al. (2024).

The new geospatial dataset of wildfires in Italy, 2007-2022, was built on the 2007-2017 dataset. First, the new dataset was extended by adding the wildfires that occurred in Italy between 2018 and 2022. Second, some wildfires and information regarding the period 2007-2017 were updated (e.g., adding missing dates or removing redundant fires), and the complete new dataset 2007-2022 went again throughout exhaustive data processing and quality control.

The purpose of this technical report is to document the creation of a geospatial dataset of wildfires in Italy over the period 2007-2022. This report has four specific objectives:

- To describe the data sources, data processing and quality control applied to create the geospatial dataset.
- To point out the major limitations of the dataset.
- To provide a brief summary of the dataset and a comparison with official wildfire statistics.
- To inform about metadata and data availability regarding the dataset.

2. Data sources

Original wildfire datasets were provided by different agencies responsible for wildfire management and reporting in Italy (Table 1). In regions with an ordinary status ("regione a statuto ordinario"), the spatial wildfire records were extracted from annual datasets of RAPF ("Rilievo delle Aree Percorse dal Fuoco") managed by CUFAA ("Comando Unità Forestali, Ambientali e Agroalimentari dell'Arma dei Carabinieri"), while in regions with an autonomous status ("regione a statuto speciale"), the different wildfire datasets were provided by regional agencies (Table 1). Wildfire datasets from the region of Trentino-Alto Adige were provided at province level by the Autonomous Provinces of Bolzano and Trento, respectively.

Table 1. Data sources to create the geospatial dataset of wildfires in Italy, 2007-2022.

Region	Category	Agency
Valle d'Aosta	Special status	Corpo Forestale della Valle d'Aosta
Province of Bolzano	Special status	Ripartizione Servizio Forestale
Province of Trento	Special status	Servizio Foreste
Friuli-Venezia Giulia	Special status	Corpo Forestale Regionale
Sardegna	Special status	Corpo Forestale e di Vigilanza Ambientale
Sicilia	Special status	Corpo Forestale della Regione Siciliana
Rest of Italy (15 regions)	Ordinary status	CUFAA

3. Data curations

3.1. Standardizations

The dataset faced common problems derived from the compilation of data from multiple systems of fire records (Short, 2014). The original fire datasets consisted in fire polygons (i.e., vector data) representing the burned areas and their fire perimeters, with associated attribute tables describing each fire with a collection of multiple variables. The variables reported by different agencies and years were not consistent. Therefore, we decided to keep a minimum number of variables that could be retrieved consistently from all the original fire datasets: region, year and date (see Table 2). Other variables, such as ID, region code and burned area were reassessed by ourselves afterwards.

Table 2. Variables extracted and derived from the fire datasets and used to set up the geospatial dataset of wildfires in Italy, 2007-2022.

Variable	Type	Description
ID	Numeric	Unique id number of the fire (from 1 to 106,978)
COD_REG	Character	Region code according to ISTAT (e.g., 01 for Piemonte)
Region	Character	Name of the region (according to the original sources)
Province	Character	Name of the province (only for Bolzano and Trento)
Year	Numeric	Year in which the fire occurred (from 2007 to 2022)
Date	Character	Date in which the fire started or was reported (yyyy-mm-dd)
Area_ha	Numeric	Total burned area of the fire in hectares (6 decimals)

Geographical transformations were used to ensure all polygons were aligned according to the WGS84-UTM 32N projected coordinate system. When the dataset was complete, each fire record was given a unique id number in ascending order, given that it was not possible to obtain a unique id for every record by simply combining the rest of variables. In addition, a code (from 01 to 20) was assigned to each region according to ISTAT (“Istituto Nazionale di Statistica”).

Italy is divided into 20 regions. Some fires spread over more than one region. For these fires, the region appearing within the original datasets was maintained. However, in some cases, the majority of the burned area could occur in another region. In consequence, some may have the name of a region despite only a small proportion of the burned area occurred within that region. Similarly, we decided not to extract geographical information regarding the province and municipality ("comune") in which the fires occurred. The reasons were several.

(1) We wanted to keep the dataset as small and simple as possible. Any user can apply GIS functions, such as "join attributes by location", to derive this type of variable.

(2) Depending on the algorithm applied (e.g., first feature, centroid, maximum overlap), the assigned province and municipality may change. This implies that the names of province and municipality could contradict the region for those fires that burned over different administrative units.

(3) The borders of Italian provinces and municipalities can change over time. Thus, the year of reference is important to define the names and borders of provinces and municipalities.

(4) The names of some provinces and municipalities include Italian characters. These characters are often not read correctly by some software. These names can create potential problems to users when using basic statistical and GIS functions, such as grouping or locating by name. Finally, we did include the name of the province for those fires reported inside the provinces of Bolzano and Trento. We did so because fires from both provinces came from different datasets and we did not want to lose the capacity to retrace any fire record from the original datasets.

All dates were reformatted as yyyy-mm-dd, except when dates were missing. Obvious errors in dates were corrected. When date and year did not match each other, and it was not possible to distinguish the source of disagreement, the year was adjusted to match the date. Fire areas were not retrieved from the original sources, but they were calculated by a GIS function once all issues in polygons were solved. Areas were calculated in hectares to 6 decimal places.

3.2. Data processing and quality control

Below is a summary of the main data processes carried out. We combined different automatic and manual steps in order to solve the main issues found in the original fire datasets and standardize the final dataset. The order of these processes does not entirely reflect the sequence in which they were performed.

- The variables of the original datasets were filtered to keep: region, year, date, and area.
- Where needed, geographical transformations were applied (WGS84-UTM 32N).
- All original spatial datasets were merged into one unique dataset that includes all reported fire records in Italy between 2007 and 2022.
- Fire records without an associated polygon were given a circular shape by using their point coordinates as center of the circle, and the reported burned area as circle area
- Where needed, the names of regions were corrected and standardized according to ISTAT. We exclusively added Bolzano and Trento under the province field for the corresponding fire records.
- Clear mistakes in dates were corrected. Dates were reformatted (yyyy-mm-dd). Disagreements between years and dates were solved to the best of our ability. Fire records with missing dates were identified. In some cases, we fixed missing dates by exploring ancillary data (e.g., newspapers). For fire records without information regarding the year, this was extracted from the date.
- The areas of every fire record were calculated using QGIS and corroborated with R. Calculations regarding the areas were compared with the values included in the original datasets. Fires smaller than 1 m^2 (i.e., < 0.0001 ha) were removed.

- Fires located entirely outside the borders of the Italian territory were deleted. We also removed a few fires that were positioned at sea or in another country due to errors in the coordinates, and for which we could not figure out the correct location.

- We removed redundant fire records to the best of our ability. Exact duplicates were easily identified and removed using functions such as “delete identical” from ArcGIS. However, due to inconsistencies in the original datasets, many records were redundant but not identical (e.g., due to tiny changes in geometries). There was no simple process to remove them and we used different approaches. For example, identifying fires with the same or close dates and very similar area values within the same region. Manual inspection of attribute tables and visual inspection of fire polygons were applied as well.

- Where appropriate, we combined several fire records into one. This was essentially a manual process. In some regions and years, fire records, and their corresponding spatial fire polygons were not delineated consistently. This means that, frequently, a single fire event was divided into two or more fire records, each one with its own data, id and spatial configuration. In some cases, it seems that the division of a single fire event into different records may reflect fire progression. In other cases, they seem to reflect a division of the burned area into different land use classes or another spatial classification. We tried to solve this issue by visually and individually examining all fire records > 100 ha (> 90 ha in the period 2007-2017). For some years and regions with more fire activity (e.g., Sicilia and Sardegna), we even inspected fire records > 70 ha. Where we detected fire records that were assumed to belong to the same fire event, we merged them into a single fire record (Figure 1). When the dates of the merged records differed, we chose the earliest one. If we were not sure about the merge, we decided not to proceed. During this process, we merged many other records found when inspecting large fire polygons.

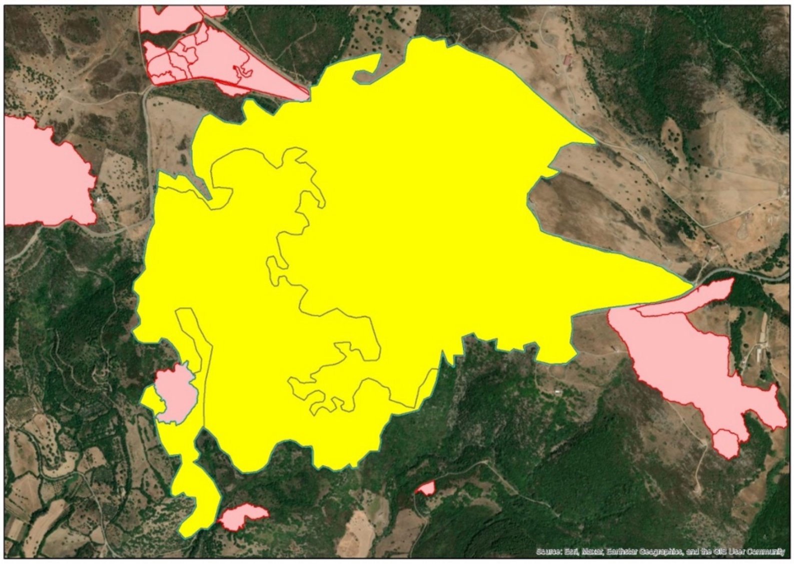

Figure 1. Example of a single fire event (in yellow) that was reported as three different records and polygons (separated by black lines) in one of the original fire datasets.

- Geometry problems (e.g., corrupt or invalid geometries of the spatial polygons) were checked and solved with the functions "fix geometries" and "st_make_valid" from QGIS and the package simple feature (sf) of R, respectively. When obvious spatial errors in fire polygons were detected during visual inspections, these were also corrected (e.g., fire perimeters partially within the sea).

3.3. Errors and other issues

Some of the problems identified during the data processing were only partially solved. We focused on large fires when prioritizing the time and effort spent on manual processes. Therefore, the dataset may be of higher quality for fire records characterized by large burned areas (e.g., fires > 100 ha). Following is a list of the major errors, potential limitations and other issues that a user may have to face, according to our own experience, when using the geospatial dataset of wildfires in Italy in 2007-2022.

The dataset does not include any coordinates of fire ignitions or fire discovery locations. The time (hour and minute) of fire detection is absent, as well as fire duration. Likewise, the cause of the fire (e.g., human or natural) is missing.

In total, 165 fire records have no date. Table 3 and Table 4 provide a summary of these fires.

Table 3. Number (#) of fires without date and associated burned area (BA) by region.

Region	# fires	BA (ha)
Piemonte	10	290.6
Lombardia	2	3.9
Liguria	2	0.4
Emilia-Romagna	3	6.4
Lazio	65	565.9
Molise	2	0.2
Campania	7	71.9
Basilicata	3	10.0
Calabria	12	155.6
Sicilia	59	1,348.2
TOTAL	**165**	**2,452.9**

Table 4. Number (#) of fires without date and associated burned area (BA) by year.

Year	# fires	BA (ha)
2007	2	28.9
2008	2	112.7
2011	4	151.1
2020	93	1,511.0
2021	64	649.3
TOTAL	**165**	**2,452.9**

Dates represent the days in which the fires started or were discovered (Table 2). Few records may include incorrect dates (e.g., mistyped dates). Nonetheless, the great majority of dates should be accurate.

In total, 627 fire records from Trentino-Alto Adige had no fire perimeters, and their polygons were created as circles. These fires burned 81.7 ha between 2007 and 2022.

We noticed that very few records are composed of non-continuous fire polygons that may not belong to the same event but possibly were grouped as a single record due to the spatial and temporal proximity of these polygons.

As described in Section 3.2. (Data processing and quality control), Point 10, numerous fire records were merged manually because we assumed that they were actually part of the same fire event. However, there are many other fire records with small burned areas that could not be merged following the same approach. The large number of fire records and the lack of an automatic process prevented us from extending this task to the whole dataset. AI may help us fix this issue in the future. Consequently, dataset users must be aware that the number of fire records may overestimate the number of wildfire events in certain zones and periods.

A few fire polygons are characterized by unrealistic and simplified shapes. Users may need to use remote sensing images or other sources to obtain more accurate perimeters for those particular fires. Nonetheless, this is not a prominent problem in the dataset.

Despite our efforts to remove as many redundant fire records as possible, some are likely to persist in the dataset.

Some fire records were deleted during the data processing and quality control. Moreover, other fires, especially small ones, might be missing from the original datasets for one reason or another. By no means, this is a complete dataset of all wildfires reported in Italy between 2007 and 2022. Nevertheless, the dataset should provide a comprehensive source of information on the spatial and temporal distribution of wildfire activity in Italy for the period 2007-2022.
The final product is a polygon-based geospatial dataset, in which each record is associated with one or more polygons that represent the location of the area burned by a wildfire event. Each fire record includes the seven fields described in Table 2: ID, region code, region, province, year, date, and area.

4. Data comparison

In total, the geospatial dataset of wildfires in Italy, 2007-2022, contains 106,978 fire records that burned 1,356,851 ha (Table 5). In the period 2007-2022, Sardegna experienced the highest number of wildfire events (22,049 records), while Sicilia suffered the largest burned area (384,552 ha). The year 2007 showed the highest number of wildfires (14,305) and burned area (226,657 ha) within the spatial dataset (Figure 2). On average and according to the geospatial dataset, Italy experienced 6,686 wildfires and 84,803 burned hectares per year in the period 2007-2022, although with a strong interannual variability in number of fires and burned area (Figure 2). August and July were the months with the highest number of fires and burned area (Figure 3). Fire size distribution in a 10-base logarithmic scale reveals that wildfires between 1 and 10 hectares were the most common fire size class, and only 3 wildfires burned more than 10,000 ha between 2007 and 2022 in Italy (Figure 4). Table 6 shows the number of fire records per region and year in the geospatial dataset, while Table 7 shows the burned areas per region and year.

Italy reports every year the number of wildfires and burned areas per region to the European Forest Fire Information System (EFFIS). We used these EFFIS data to evaluate the completeness of the geospatial dataset. Table 8 shows the number of wildfires per region and year according to EFFIS, while Table 9 shows the corresponding burned areas per region and year as well. We confronted the geospatial dataset against EFFIS data for both metrics in Table 10 (number of fires) and Table 11 (burned area), respectively. The comparisons illustrate that for some regions and years, both data agree completely (differences are equal to zero), while in general, disagreements are very variable in time and space. Globally, the geospatial dataset includes 6.5% more fire events and 5.5% more burned area than the EFFIS official statistics for Italy from 2007 to 2022 (Table 12).

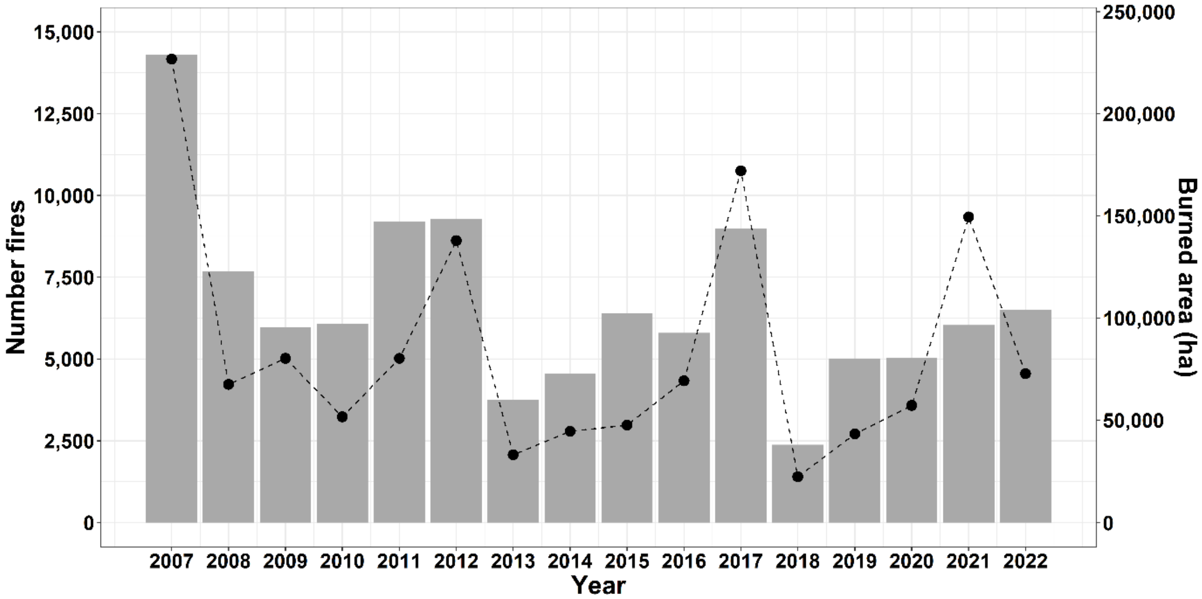

Figure 2. Number of fire records (grey bars) and burned area (black dots) per year in the geospatial dataset of wildfires in Italy, 2007-2022.

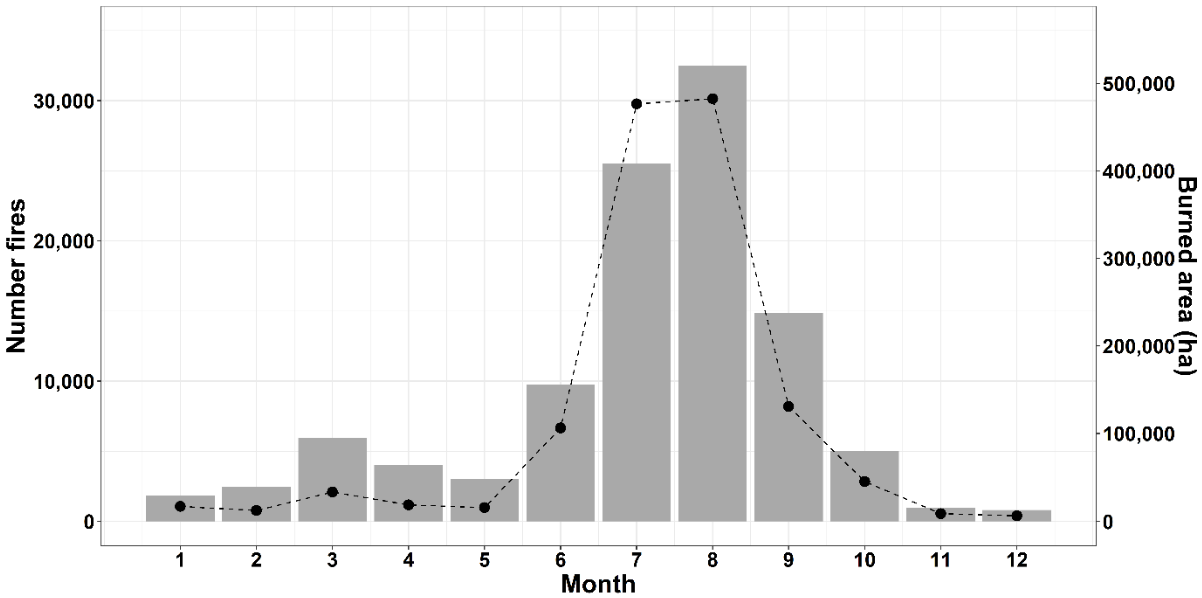

Figure 3. Number of fire records (grey bars) and burned area (black dots) per month in the geospatial dataset of wildfires in Italy, 2007-2022.

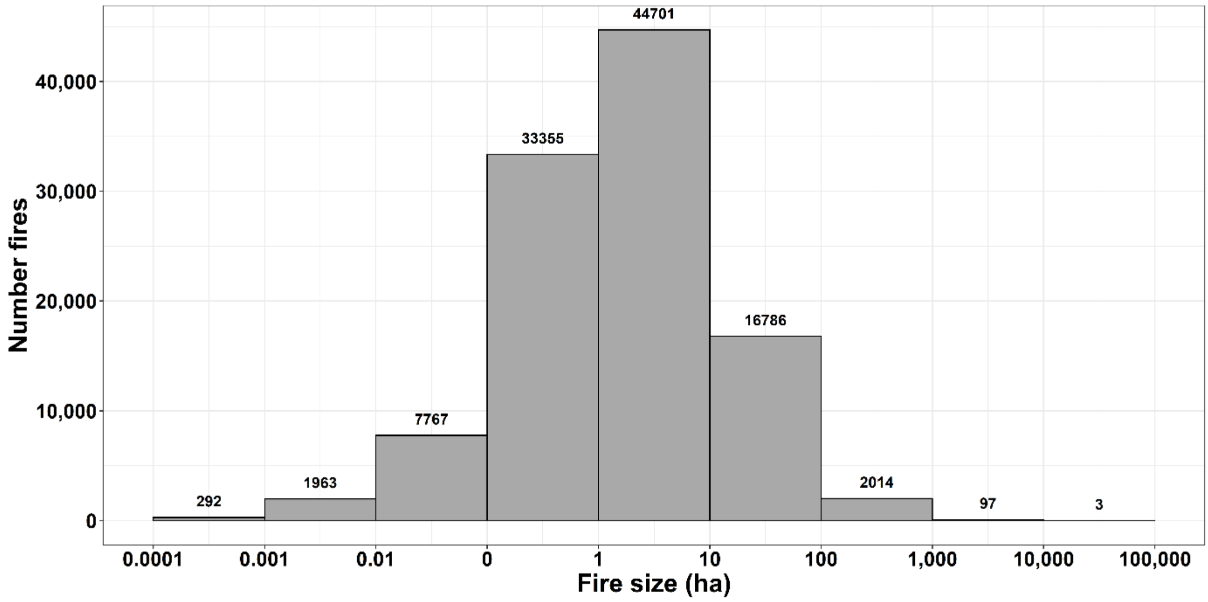

Figure 4. Number of fire records per fire size class in the geospatial dataset of wildfires in Italy over the period 2007-2022.

Table 5. Total number of fire records (# fires) and burned area (BA) per region in the geospatial dataset of wildfires in Italy over the period 2007-2022.

REGION	# fires	BA (ha)
Piemonte	2,784	32,872
Valle d'Aosta	154	306
Lombardia	3,009	20,889
Trentino-Alto Adige	836	571
Veneto	907	2,973
Friuli Venezia Giulia	1,168	5,156
Liguria	3,573	19,599
Emilia-Romagna	1,516	3,625
Toscana	6,730	21,222
Umbria	1,344	7,704
Marche	715	7,203
Lazio	6,738	89,489
Abruzzo	1,472	41,495
Molise	1,587	12,972
Campania	13,014	107,965
Puglia	6,920	93,159
Basilicata	3,633	45,438
Calabria	14,024	210,245
Sicilia	14,805	384,552
Sardegna	22,049	249,415
ITALY	**106,978**	**1,356,851**

5. Metadata

The following metadata gives additional information about the geospatial dataset described in this report.

Version: 1.0.

Format: ESRI shapefile.

Geographical extent: Italy.

Temporal coverage: 2007-2022.

Projected Coordinate System: WGS84-UTM 32N (EPSG: 32632).

Unit: meter.

Spatial data organization: polygon (vector).

Attribute table: 106,978 records and 7 fields.

Attribute information: ID = unique id number of the fire; COD_REG = region code according to ISTAT; Region = name of the region; Province = name of the province; Year = year in which the fire occurred; Date = date in which the fire started or was reported; Area_ha = total burned area of the fire in hectares.

6. Data availability

The dataset described in this report is not publicly available due to legal restrictions. Some of the original fire datasets used to compile and prepare this geospatial dataset of wildfires in Italy 2007-2022 are not publicly available at the moment. Consequently, we do not have the consent to publish the whole dataset in an open public repository. If you are interested in using the geospatial dataset for research or similar purposes, please contact Professor Davide Ascoli from the University of Turin in Italy (d.ascoli@unito.it).

Fire weather data and severity classes

1. Background

Wildfires are among the major disturbance factors affecting Mediterranean forest ecosystems. Fire severity assessment is essential for understanding post-fire impact on vegetation and the environment, as well as supporting fire risk management strategies. Within the FireBox project, the fire severity across Italy was done using satellite-derived spectral indices and evaluation of Within the FireBox project, a methodological framework was developed to classify fire severity across Italy using satellite-derived spectral indices and to assess the accuracy of burn severity estimates.

In order to do it, the calculation of Normalized Burn Ratio (NBR) and its temporal difference (dNBR) using MODIS imagery was done. Validation was applied by comparing burn severity within mapped polygons with surrounding forest areas extracted from the CORINE land-cover dataset.

Additional validation procedures were implemented by comparing burn severity within mapped fire polygons with that in surrounding forest areas extracted from land-cover datasets.

2. Data sources

The analysis used MOD09A1 Version 6.1, an 8-day composite surface reflectance product from the Moderate Resolution Imaging Spectroradiometer (MODIS). This dataset provides atmospherically corrected reflectance values in multiple spectral bands and is widely used for vegetation and disturbance monitoring.

The MODIS images were collected within a temporal window of ±400 days of the fire event. The extended temporal window allowed the identification of a suitable cloud-free image before and after the fire event.

Cloud contamination was addressed by evaluating the number of cloud pixels within the fire polygon and surrounding areas. Only images with sufficient clear-sky coverage were retained for further processing.

Each fire polygon corresponded to wildfire events, and they were used to identify burned area and evaluate burn severity. However, sometimes fire polygons may have some inaccuracies due to mapping errors, cloud cover or limitations in spatial resolution. Hence, additional validation procedures were implemented in order to assess if burn severity extends beyond the mapped fire polygon boundaries.

The CORINE Land Cover (CLC) dataset was used for validation and isolation of forest areas around the fire polygons. The Corine 2012 dataset was obtained from Copernicus services, and this dataset was further processed to extract forest classes. The non-forest pixels were masked, which allowed further analysis to focus on forest pixels in assessing burn severity. This step was done in order to reduce spectral confusion between burned vegetation and other land-cover types (ex. bare soil, agricultural areas, etc).

3. Methods

3.1 Fire severity assessment

The Normalized Burn Ratio (NBR), a spectral index created especially to identify burn severity in plants and vegetation loss caused by fire, was used to quantify the intensity of the fire.

$$NBR = (NIR - SWIR) / (NIR + SWIR)$$

Where:

- NIR represents near-infrared reflectance
- SWIR represents shortwave infrared reflectance

Healthy vegetation displays high reflectance in the NIR region and relatively low reflectance in the SWIR region. However, after fire, vegetation loss leads to reduced NIR reflectance and increased SWIR reflectance due to exposed soil and reduced moisture content.

Furthermore, for the quantification of burn severity the difference between pre-fire NBR and post-fire NBR values was used.

$$dNBR = NBRpre-fire - NBRpost-fire$$

Pre-fire and post-fire images were selected based on the following criteria:

- images at least 10 days before the fire event
- images at least 10 days after the fire event
- minimal cloud contamination within the analysis area

The resulting dNBR values were used to classify fire severity levels according to standard burn severity thresholds commonly applied in wildfire research.

For each fire polygon, a buffer zone of 0.5km was created around the polygon in order to evaluate the reliability of burn severity and investigate potential inaccuracies. This buffer allows comparison between burn severity inside the mapped fire polygon and burn severity in the forest pixels of the buffer area. This comparison aimed to determine whether spectral signals indicating fire damage were present outside of officially mapped burned areas.

For both the fire polygon and the buffer zone, median dNBR values were extracted using zonal statistics.

The difference between polygon and buffer severity was calculated as:

$\Delta dNBR = dNBRpolygon - dNBRbuffer$

This metric was used to inspect cases where buffer zones appeared more severely burned than the inside of the fire polygon.

Investigation of Spectral Anomalies

Several situations were observed in which buffer areas exhibited equal or higher burn severity values compared to the mapped fire polygon. This phenomenon may be explained by several factors such as:

- Spectral Confusion - disturbances not related to fire, but to drought stress or tree mortality, can produce spectral signatures similar to burned vegetation.
- Vegetation Stress - Vegetation affected by drought, disease, or environmental stress may show reduced greenness and canopy moisture, leading to dNBR values similar to those observed after fire.

3.2 Visual Inspection and Validation

To further investigate these patterns, detailed visual inspections were performed using high-resolution imagery in Google Earth.

Different burn severity configurations were observed, including:

- unburned buffer areas
- low severity both inside and outside polygons
- moderate severity inside and outside polygons
- buffer zones showing burn severity despite no mapped fire
- areas showing strong post-fire regrowth within the polygon

These observations suggested that, in some cases, the actual burned area may extend beyond the mapped polygon boundary.

4. Results

4.1The Evolution of Burned Area

An analysis of the total burned area across Italy from 2007 to 2022 was conducted utilizing differenced Normalized Burn Ratio (dNBR) values. Numbers revealed a highly episodic fire regime rather than a significant linear trend as demonstrated by the high p-value. The Italian landscape was found to experience extreme "crisis years" potentially driven largely by anomalous meteorological conditions.

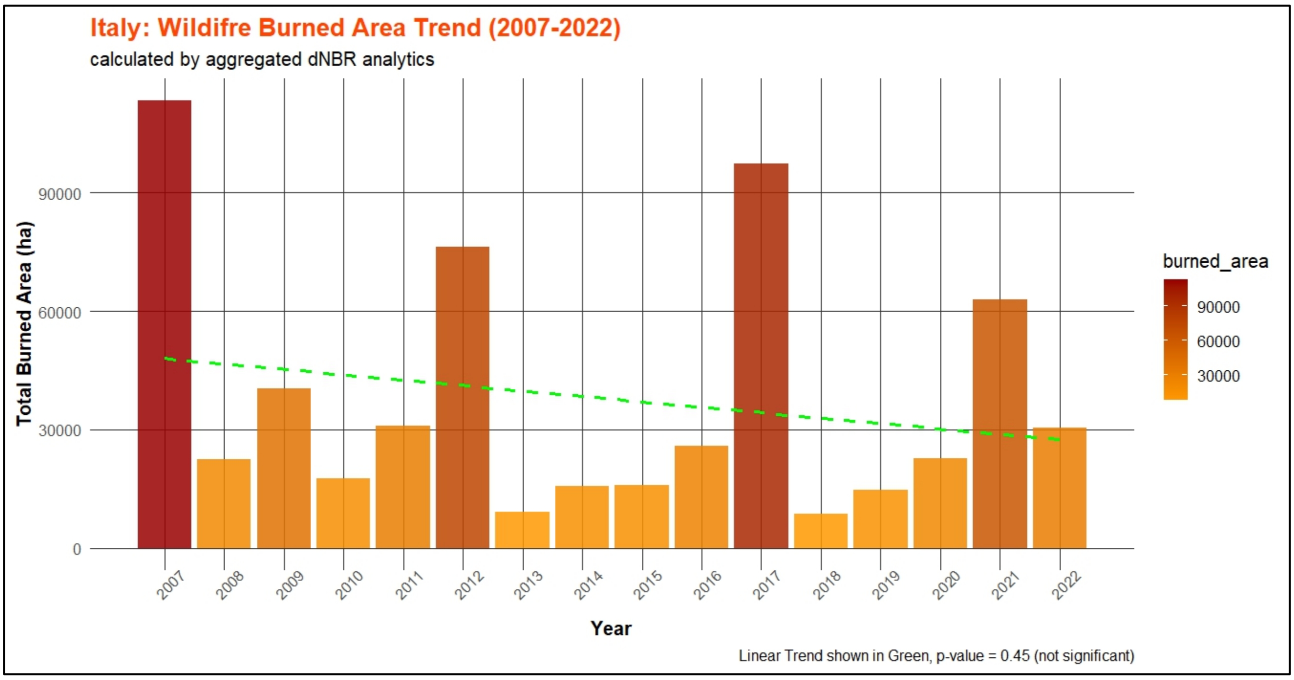

Figure 1. Burned Area Trend in Italy in the period 2007-2022.

The data distinctly highlights three catastrophic seasons: 2007, 2017, and 2021. The year 2007 stands out as the most devastating on record within this timeframe, with total burned area exceeding 200,000 hectares. A decade of relative calm followed, punctuated by massive spikes in 2017 and 2021, where burned areas consistently breached the 150,000-hectare mark. The intervening years (such as 2010, 2013, and 2018) showcase the baseline resilience of the landscape, dropping below 50,000 hectares. This volatility suggests that while background fire activity is constant, extreme seasons are dictating the total footprint.

4.2 Fire Severity Trends

To understand the true impact of these fires, we classified the severity of the burns using dNBR, categorizing the damage into severity classes proposed by the United States Geological Survey

(Keeley, J. E., 2009). The severity trends perfectly mirror the burned area trends, but with a critical ecological insight: extreme fire years do not just burn more land; they burn hotter. During baseline years, the vast majority of fires remain low-to-moderate in severity, suggesting fast-moving surface fires that leave mature canopies mostly intact. However, during the crisis years of 2007, 2017, and 2021, the absolute area of "Moderate-High" and "High" severity fires expands dramatically. In 2007 specifically, the footprint of catastrophic fires reached its peak. This indicates that extreme drought years prime the landscape to sustain much more destructive fire behavior, contributing to deeper soil damage and higher canopy mortality.

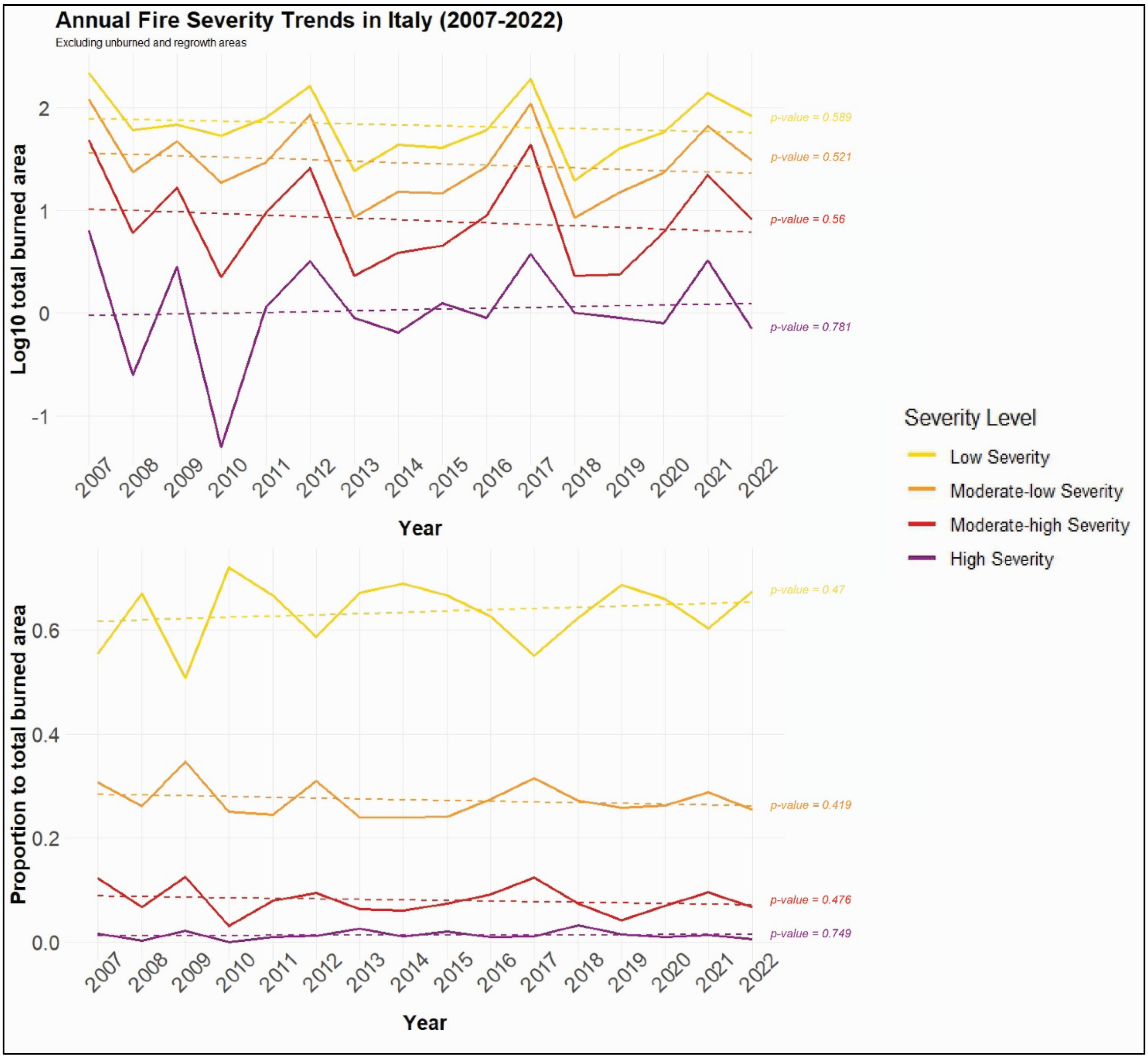

Figure 2. a) Total Burned Area trend broken down by severity classes as defined by the United States Geological Survey (USGS). b) proportion of burned area trend of each severity class.

4.3 Ecological Impact by Forest Category

Breaking down the dNBR data by the Italian National Forest Inventory (INFC) categories allowed us to profile the vulnerability of specific ecosystems . The analysis reveals distinct fire regimes across different vegetation types:

- Highest Average Severity: Conifer forests (Boschi di conifere and Boschi di pino nero) burn with the highest intensity. Due to the high resin content and structure of these forests, when they ignite, they are highly susceptible to severe canopy fires.
- Largest Spatial Footprint: Deciduous woodlands (Altri boschi caducifogli) and temperate shrublands (Arbusteti di clima temperato) account for the vast majority of the total burned area in Italy. These are the primary fuels driving the country's fire statistics.
- Total Damage Burden: When combining frequency and severity, deciduous woodlands carry the heaviest ecological burden, absorbing roughly 35% of the nation's total fire severity over the 16-year period, followed closely by temperate shrublands and evergreen broadleaf forests (Macchia Mediterranea).

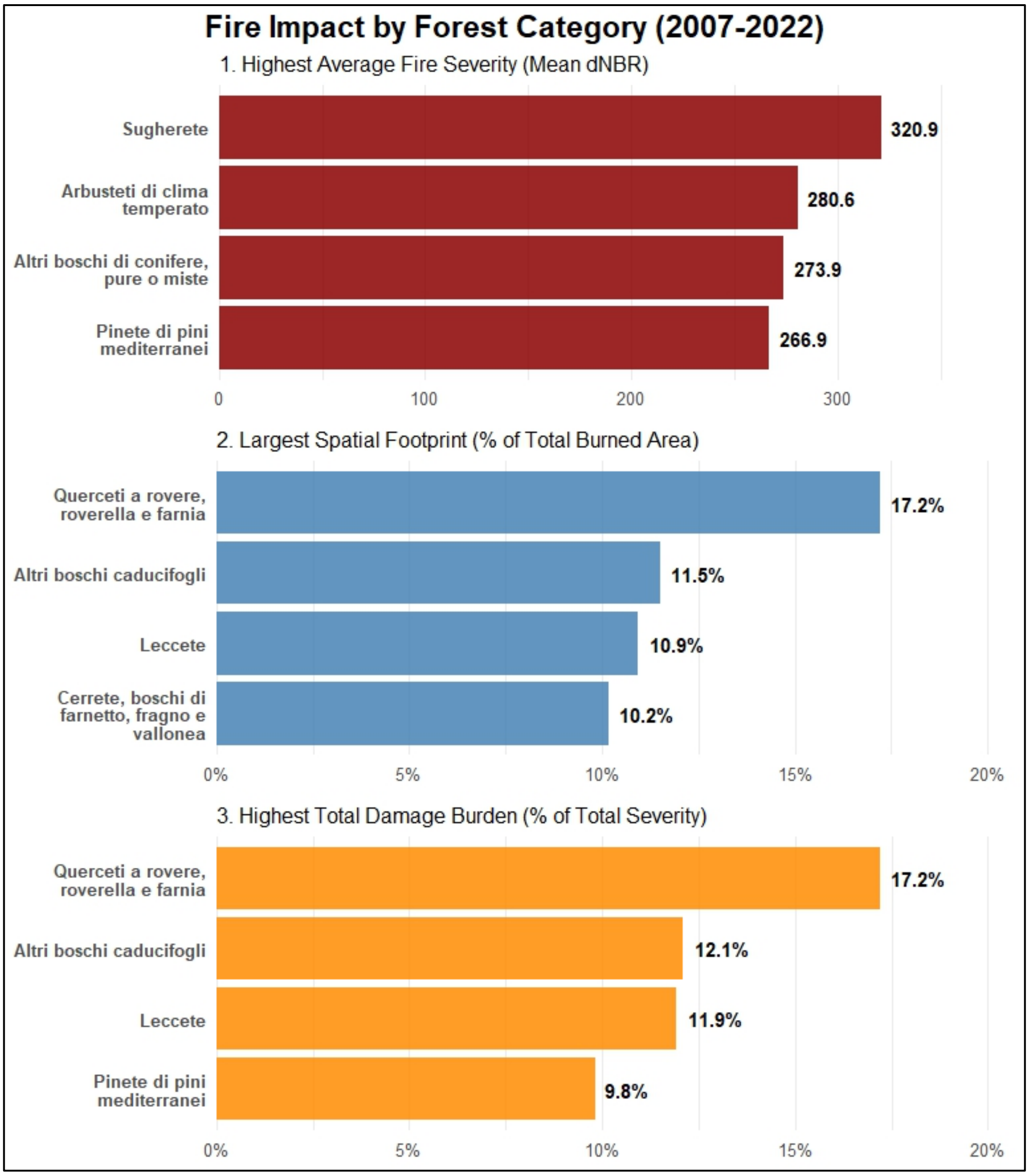

Figure 3. Fire impact per Forest Category defined by the Italian National Forest Inventory (INFC)

CONCLUSION

This deliverable provides an integrated contribution to wildfire research and management in Italy by combining two complementary outputs: a harmonized national geospatial fire database for the period 2007–2022 and a methodological framework for the assessment of fire severity based on remote sensing data. Together, these products improve the consistency, comparability, and analytical value of wildfire information at the national scale. The Italian fire database 2007–2022 represents an important step toward overcoming the fragmentation of wildfire records in Italy, offering a structured and quality-controlled dataset that can support spatial analyses, long-term assessments, and future research applications. At the same time, the fire severity component adds ecological and interpretative depth by enabling the evaluation of burn intensity and post-fire effects through satellite-based indicators and validation procedures. Although some limitations remain, including gaps in original source data, uncertainties in fire perimeters or dates, and legal restrictions on public data sharing, the deliverable establishes a solid basis for advancing wildfire knowledge and risk-oriented decision support. Overall, the two sub-products presented here should be understood as mutually reinforcing tools that can support future developments in fire monitoring, severity assessment, and evidence-based wildfire risk management in Italy.

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