SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

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Spatial-Temporal Distribution of b-value in Albania and its Sorroudings Over the Last Decade

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INTRODUCTION AND MAIN RESULTS

We analyzed seismicity in Albania using the parameters of the Gutenberg-Richter relation in both time and space, and found a decrease in the b-value prior to large earthquakes, such as the ML 6.3 event in Durrës.

The spatial variation of the b-value aligns with known seismogenic zones and corresponds with areas where major earthquakes have occurred.

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Introduction

Albania is located along an active collision zone between the Adriatic and Eurasian plates. The country experiences moderate to high seismic activity.

The present study investigates the spatial and temporal variations of b-values across Albania using ZMAP (Wiemer, 2001) and a declustered catalog covering the period 2015–2024. The objective of this study is to identify seismicity patterns, potential precursory signals, and implications for seismic hazard.

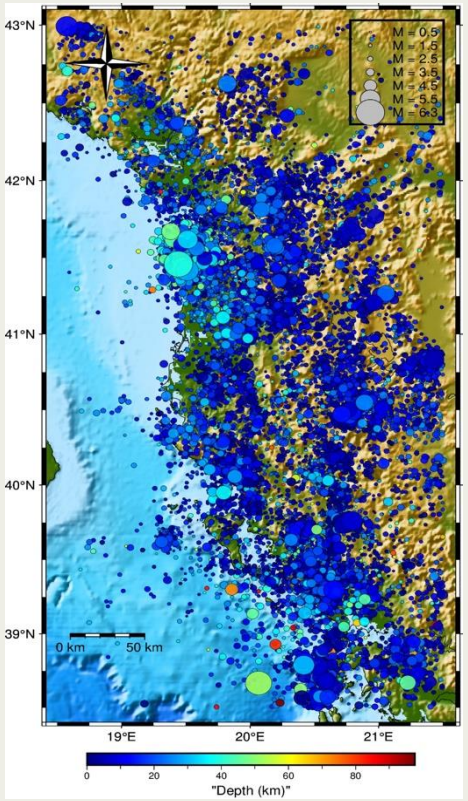

Fig. 1 Epicenters of earthquakes in Albania and surrounding

Data

A total of approximately 20,000 local earthquakes were recorded in the area between 38°–43°N and 18.5°–21.5°E during the period from 1 January 2015 to 31 December 2024 (10 years), with local magnitudes (ML) up to 6.3. The dataset used in this study was compiled by the Institute of Geosciences.

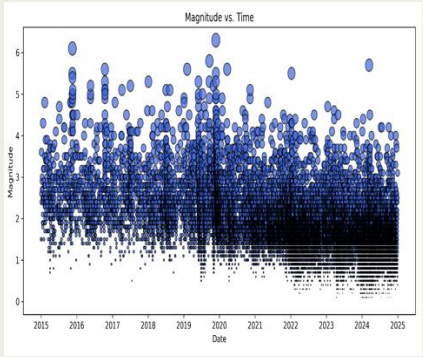

Fig. 2 Plot of earthquake magnitude versus time

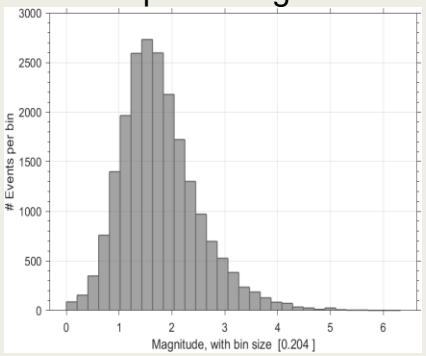

Fig. 3 Histogram of the distribution of earthquake magnitudes.

Seismic events can be classified by magnitude into five categories (Havskov and Ottemöller, 2010): great, large, medium, small, and micro. The dataset has been grouped according to these magnitude classes, as shown in the corresponding table:

Magnitude Range	Number of Earthquakes	Percentage (%)
Great (M > 8)	0	0
Large (6 < M < 8)	2	0.01
Medium (4 < M < 6)	228	1.07
Small (2 < M < 4)	7227	34.03
Micro (M < 2)	13778	64.88

Table 1 Magnitude classes of earthquakes and their percentage distribution in the dataset.

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Methodology

To remove aftershocks and swarms, the catalog was declustered using the Gardner-Knopoff algorithm (Gardner & Knopoff, 1974), as implemented in ZMAP. The declustered catalog has 10,000 events. Of these, 1,162 are main shocks and the rest are background seismicity.

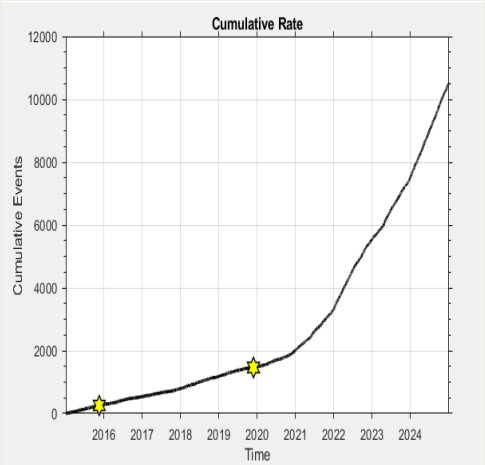

Fig. 4 Cumulative number of earthquakes (declustered catalog) for the period 2015–2024.

The cumulative rate shows a clear increase after 2021, reflecting improvements in the seismic network.

The magnitude of completeness was estimated using the maximum curvature method (Wiemer & Wyss, 2000). The fitted Gutenberg-Richter relation gives b = 0.84 with Mc = 1.8.

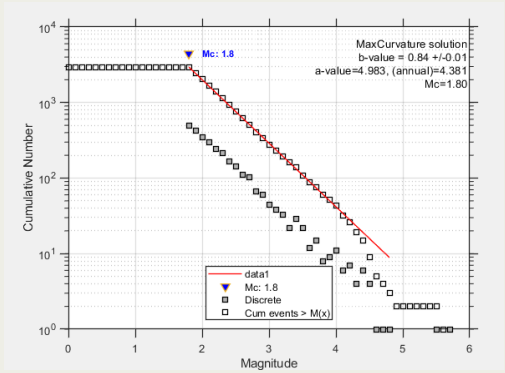

Fig. 5 Frequency–magnitude distribution

The b-value was estimated using the Maximum Likelihood Estimation (MLE) method proposed by Aki (Aki, 1965), expressed as:

$$\hat{b} = \frac{\log_{10}(e)}{\bar{M} - \left(M_c - \frac{\Delta M}{2}\right)}$$

The correction term $\Delta M/2$ accounts for the discrete nature of magnitude bins, following the formulation by Bender (1983).

To construct the spatial distribution map of b-values in Albania, the program ZMAP was used. A minimum of 50 events above Mc were required for b-value computation per grid node.

An Mc correction factor of 0.1 was applied to adjust for catalog sensitivity limitations. For each node, earthquakes were selected applying a maximum radius limit of 35 km.

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Results

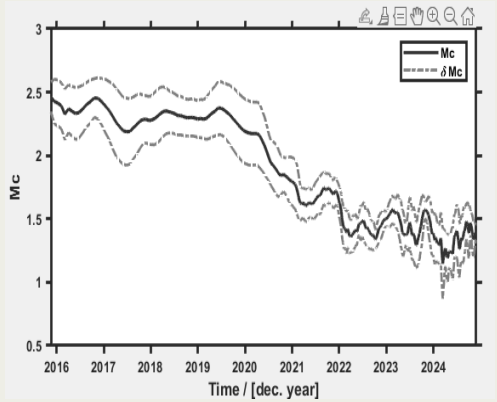

Fig. 6 Temporal variation of magnitude of completeness (Mc) for the period 2015–2024.

The temporal analysis of completeness magnitude (Mc) reveals fluctuations over the investigated period. The most complete section of the catalog is from 2021 to 2024. Therefore, this interval was selected for constructing the b-value map.

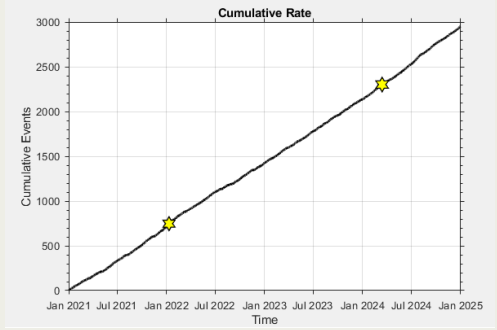

Fig. 7 Cumulative number of events in the catalog during 2021–2024.

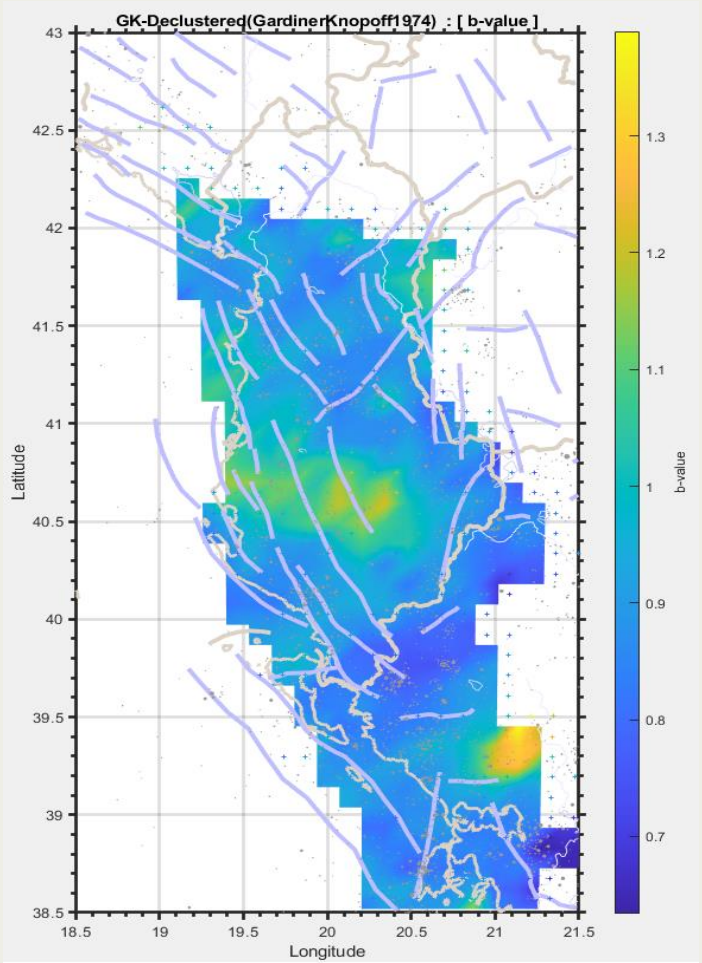

Fig. 8 Spatial distribution of b-values in Albania (2021–2024)

The map (Fig 8) illustrates the spatial variations of the b-value. In the outer regions, no estimates are provided, as the minimum criterion of 50 events per node (Wiemer & Wyss, 1997) was not satisfied.

The b-value in Albania exhibits a characteristic range between 0.85 and 1.2, consistent with seismically active continental domains.

Relatively low values (~0.85) are identified in: the Durrës, the Ionian coastal belt, the north of Albania and the Korça seismogenic zone.

These areas coincide with enhanced seismic activity and tectonic deformation. In the Elbasan region, b-values are slightly above unity (~1.2).

The b values are consistent with the findings of previous studies (Muço et al 2001, Öztürk & Ormeni 2021)

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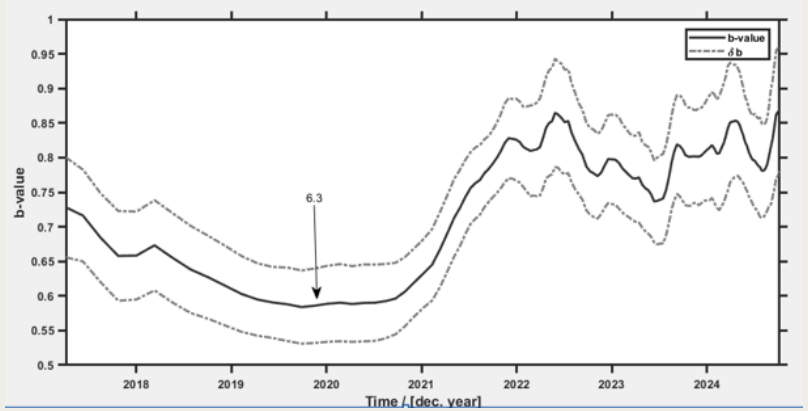

Fig. 10 Temporal variation of the b-value for the Durres region.

The analysis of the Durrës region reveals a marked decrease in the b-value prior to the ML 6.3 mainshock, the largest event in the study period. As noted by Wyss et al. (2004), pronounced decreases in b-values are more consistently observed before major events (M ≥ 6), while smaller earthquakes may not always show such a clear precursor pattern.

Conclusions

This study highlights the effectiveness of b-value analysis, conducted using the ZMAP software, as a key tool to study seismicity in Albania.

The spatio-temporal analysis of seismicity in Albania highlights clear variations in the b-value, both before and after major earthquakes.

A systematic drop in b-value is observed prior to significant events (e.g., Durrës), while the spatial distribution shows heterogeneous patterns, with lower values concentrated along active fault zones.

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