Tentative Spatio-Temporal Correlation Between Indoor Radon Concentration Variations and Moderate Earthquakes in Albania: A Case-Based Statistical Approach

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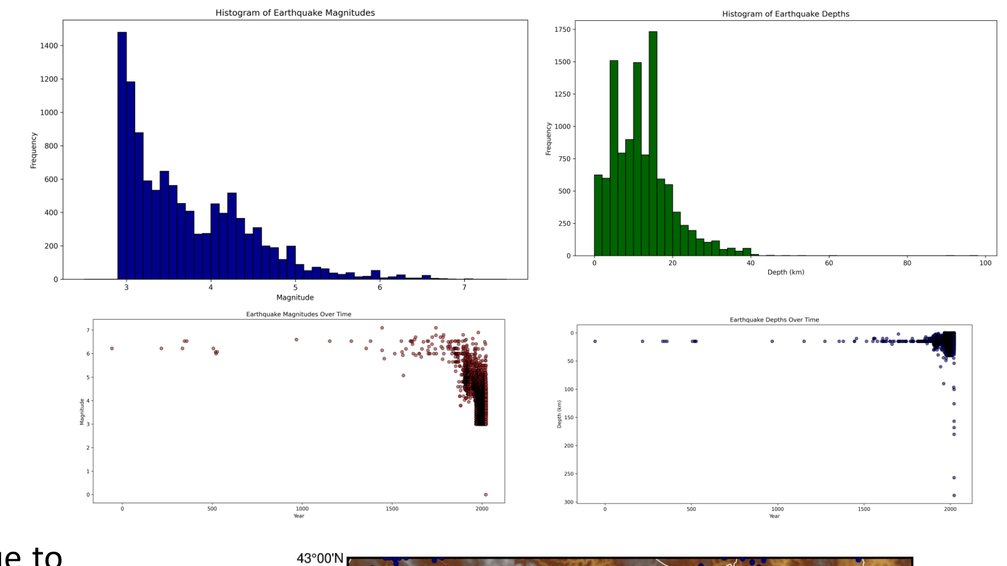
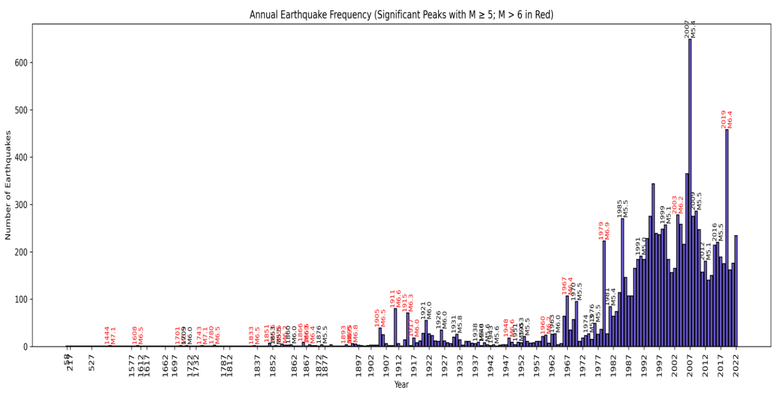
Abstract

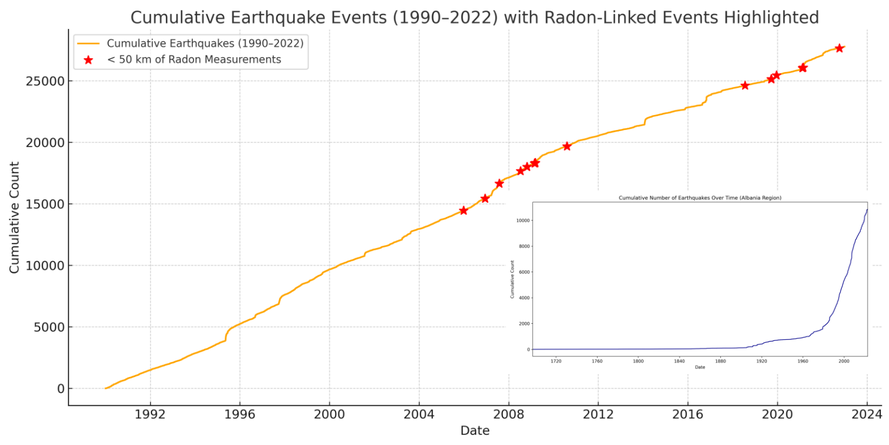
This study explores possible links between indoor radon concentration changes and moderate earthquakes (Mw ≥ 4.0) in Albania. Radon data from three campaigns (1999–2000, 2014, 2022) were analyzed at 50 repeated sites and compared to nearby seismic events within 50 km and 0.2 years. Only one case (Zall Bastar, 2022) showed clear spatio-temporal correlation with an Mw 3.7 earthquake. While this suggests potential under specific conditions, the overall weak correlation highlights the need for continuous monitoring to assess radon's role as a seismic indicator. Findings support integrating radon and seismic data in future hazard assessments.



Introduction

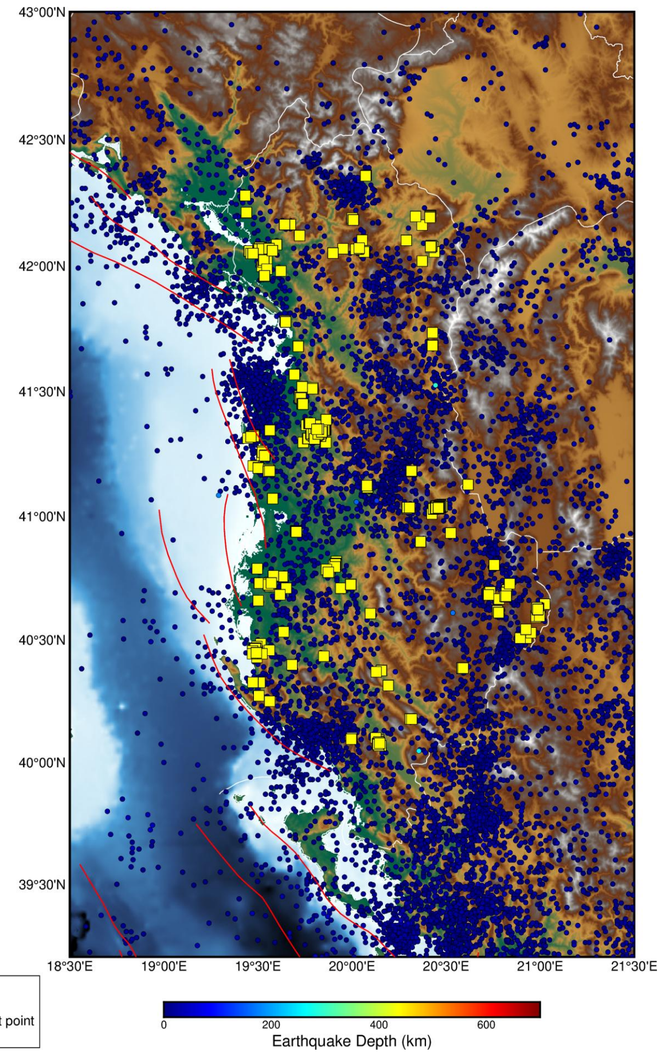
Radon (^222Rn), a gas from uranium decay, is considered a potential earthquake precursor due to its sensitivity to subsurface changes. In tectonically active Albania, radon anomalies may signal stress accumulation and crustal deformation. This study analyzes indoor radon data from three campaigns over 15 years, including a 2022 survey, to explore spatial and temporal links with moderate seismicity. Preliminary results suggest possible radon–seismic correlations, highlighting the need for further investigation.

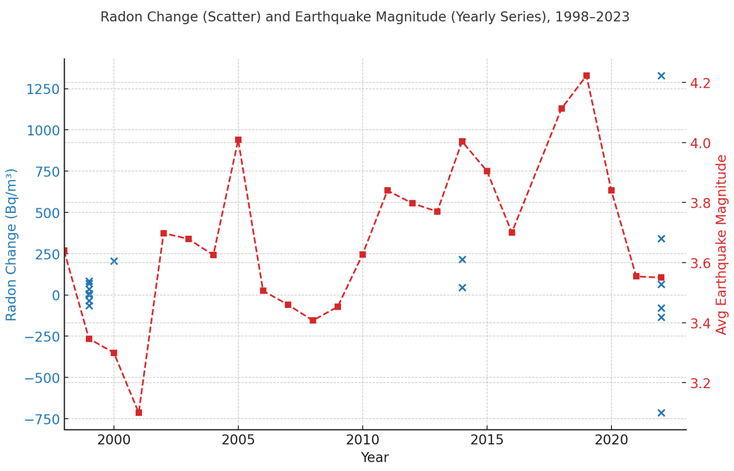


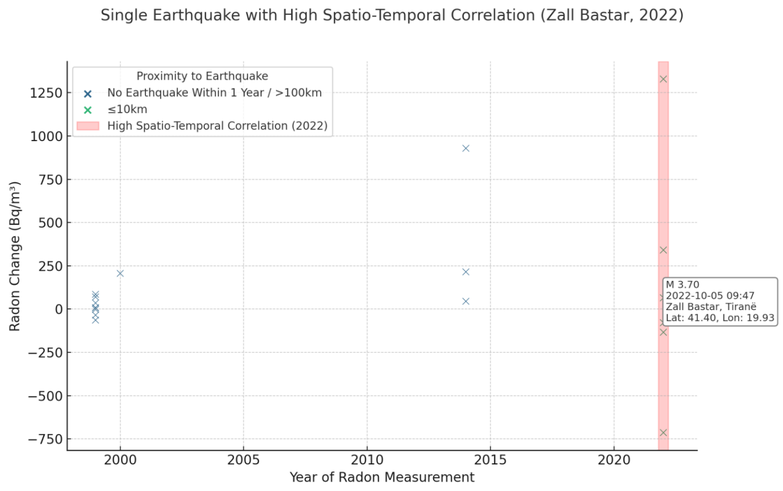


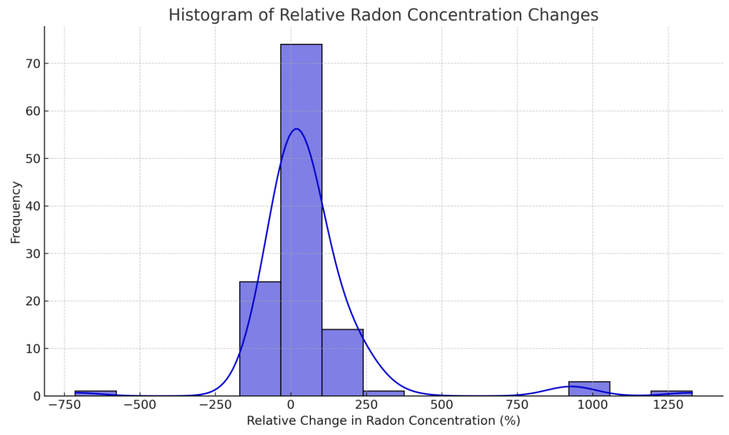
Methodology & Data

This study investigates spatiotemporal variations in indoor radon concentrations across Albania and explores potential correlations with regional seismicity. Three survey campaigns conducted in 1999–2000, 2014, and 2022 provided calibrated indoor radon data with geolocation. Sites were matched across campaigns using rounded coordinates, enabling the computation of absolute and relative radon changes (ΔRadon, Δ%). These changes were analyzed in relation to earthquakes (Mw ≥ 4.0) occurring within 50 km and 0.2 years of the measurement. For each radon anomaly, the nearest qualifying earthquake was retained. Data processing and visualizations were performed in Python, using pandas, matplotlib, geopy, PyGMT, and datetime.









Results and Discussion

The analyzed earthquake dataset includes over 10,000 events (Mw ≥ 2.5) from 58 BCE to 2022 across Albania and nearby regions. Most earthquakes are shallow and of moderate magnitude (Mw 3.0–4.5), with detection improving after 1950.Fifty radon sites had repeated indoor measurements across three campaigns. The strongest radon increase was at Zall Bastar in 2022 (+1329 Bq/m³, +800%), coinciding with a nearby Mw 3.7 earthquake. However, such matches were rare.These findings suggest that while isolated radon anomalies may align with seismicity, broader correlations are limited. Continuous, co-located monitoring is needed to assess radon's value as a seismic indicator.

References

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Conclusion

- ❑ A strong radon increase at Zall Bastar preceded a nearby Mw 3.7 earthquake, suggesting a possible link to seismic activity.
- ❑ Most radon anomalies did not coincide with earthquakes, likely due to limited site coverage, low temporal resolution, and environmental complexity.
- ❑ The approach confirms the value of repeated, site-matched radon measurements for precursor analysis.
- ❑ Continuous, high-density monitoring near active faults is essential to assess radon's role in seismic risk evaluation.