AI Use for Natural Disaster Prediction in Portugal

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ABSTRACT

Portugal faces significant natural hazards, including wildfires, floods, and seismic activity, which are intensified by climate change and the nation's geographic characteristics. Artificial Intelligence (AI) presents transformative opportunities to enhance disaster prediction and management. By analyzing large datasets in real-time, AI-driven models improve the accuracy of forecasts, enabling faster, more effective responses to imminent threats. This article examines the application of AI in Portugal's disaster prediction landscape, highlighting technologies such as machine learning, natural language processing, and computer vision. Practical implementations are explored, from wildfire hotspot identification and flood forecasting to experimental seismic monitoring. Challenges such as data accessibility, infrastructure limitations, and ethical considerations must be addressed. Through strategic investment, interagency collaboration, and public engagement, Portugal can strengthen its resilience against natural disasters, ensuring safer communities in a rapidly changing environment.

1. INTRODUCTION

Portugal is uniquely positioned at the intersection of various climatic and geological influences, making it vulnerable to a range of natural hazards (Abioye et al., 2021). Among these, wildfires, floods, and seismic activity have historically posed significant challenges. Wildfires are particularly acute in Portugal, where dense forests and dry summers create a high-risk environment, especially in rural and mountainous regions (Cruz et al., 2024). Climate change has further exacerbated this problem, with rising temperatures and prolonged droughts increasing the likelihood of fires that spread rapidly and devastate large areas (Sharifi et al., 2024).

In addition to wildfires, Portugal frequently experiences coastal and riverine flooding, especially during the winter months when Atlantic storms bring intense rainfall (Ahmed et al., 2022). Cities such

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as Lisbon and Porto, as well as lower-lying regions along the Tagus and Douro rivers, are prone to flash floods, which can damage infrastructure, disrupt transportation, and threaten lives (Gupta & Degbelo, 2023). Coastal regions face the added risk of storm surges, which can lead to erosion, property damage, and habitat loss (Pigola et al., 2021). Flooding is expected to become even more common as sea levels rise and weather patterns grow increasingly unpredictable due to climate change (Milojevic-Dupont & Creutzig, 2021).

Seismic activity also remains a latent but serious threat, particularly in areas like the Azores and Lisbon, which are situated near tectonic fault lines (Reis et al., 2019). While large earthquakes are less frequent than other types of natural disasters in Portugal, the potential impact on densely populated urban areas is considerable (Kogan et al., 2019). The Lisbon earthquake of 1755, one of the most devastating in European history, serves as a stark reminder of the risks posed by seismic events (Rezvani et al., 2024).

Considering these growing challenges, Portugal has recognized the importance of adopting innovative solutions to enhance disaster preparedness and resilience (Sharifi et al., 2024). Artificial Intelligence (AI) has emerged as a transformative tool for predicting and managing natural disasters (Huseien & Shah, 2022). By analyzing vast amounts of data in real-time and identifying emerging patterns, AI can offer timely, accurate predictions that are essential for early disaster response (Adityawan et al., 2023). Unlike traditional prediction models, AI-driven approaches can continuously learn from new data, improving their accuracy over time and adapting to evolving environmental conditions (Dias et al., 2020).

The application of AI in disaster prediction goes beyond simply forecasting events; it has the potential to transform the way authorities and communities prepare for and respond to natural hazards (Pwavodi et al., 2024). For instance, AI can optimize the allocation of resources, enabling firefighting teams to strategically position personnel and equipment in high-risk areas (Balogun et al., 2020). It can also assist in evacuation planning by identifying the safest routes and predicting traffic patterns in real-time (Subburaj et al., 2024).

Portugal has already taken significant steps to integrate AI into its disaster management strategies (Cruz et al., 2024). From pilot projects that use machine learning to predict wildfire hotspots to collaborations with European agencies on flood monitoring, the country is beginning to harness AI's potential to protect its communities (Aguilar et al., 2021). However, the full-scale implementation of AI in disaster prediction requires continued investment, interagency collaboration, and public engagement (Goralski & Tan, 2020). This article explores how Portugal can leverage AI for natural disaster prediction, examining current applications, technological challenges, and future possibilities. By adopting AI-driven solutions, Portugal can enhance its resilience against natural disasters, ultimately creating safer, more prepared communities in the face of a changing climate (Akhyar et al., 2024).

Methodological Framework

This research is based on a qualitative review of academic, institutional, and policy documents published between 2019 and 2024. It combines a systematic literature review with case study analysis of AI-based disaster prediction systems implemented or tested in Portugal (e.g., IPMA, ESA–Sentinel, and PREDENA prototypes). Data were synthesized thematically to identify key technologies, limitations, and policy implications.