Chapter 2
Machine Learning Algorithms for Natural Disaster Prediction and Management

Shanthalakshmi Revathy J.

iD https://orcid.org/0000-0003-1724-7117

Velammal College of Engineering and Technology, India

Mangaiyarkkarasi J.

iD https://orcid.org/0000-0003-1431-9584

NMSS Vellaichamy Nadar College, India

ABSTRACT

Natural disasters, such as floods, earthquakes, tsunamis, and landslides, pose significant threats to communities and ecosystems. This investigation explores the application of machine learning (ML) techniques in addressing the challenge. ML, a subset of artificial intelligence, involves creating models and algorithms that enable computers to learn from data, offering accurate disaster predictions without explicit programming. Various ML algorithms, including random forest for flood and wildfire prediction, support vector machine for earthquake forecasting, and decision tree for landslide risk assessment, are employed due to their ability to process complex datasets. Beyond prediction, ML plays a vital role in disaster management, optimizing resource allocation, refining emergency response plans, and enhancing evacuation strategies. Real-world case studies illustrate how ML contributes to mitigating disaster damage, emphasizing its role in proactive measures for disaster prevention and management.

INTRODUCTION

Natural disasters are harmful impacts on society created by natural hazard events. A natural disasters can cause severe damage to life, property, and causes some other impacts on environment. Such events can include a wide range of geological phenomena, such as quakes, volcanic eruption, and landslides, along with weather patterns such as hurricanes, tornadoes, floods or forest fires (Kansal et al. 2015). Across

the world, and with a demand for efficient emergency preparation, response and recovery strategies, the impact of disasters is widespread. The sudden release of energies that can lead to mass destruction is a natural consequence of the volcanic disasters caused by Earth's dynamic processes. Whereas, Meteorological disasters are due to climatic changes, and may lead to floods and landslides. These events are unpredictable and mitigation measures should be made to secure people. These disasters not only create impact on human society but also create long term consequences on economies, ecosystem and infrastructures. There is a need for some techniques and methodologies to predict the possibilities of the disasters. These may help us to be aware of the hazards and be prepared with the mitigation measures. In this paper we see how ML algorithms are used to predict natural disasters (Suliman Munawar et al. 2019). ML algorithms have wide range of knowledge based on the training data. They create patters based on the information from the learning data. Machine learning algorithms aid in the creation of resilient early warning systems by evaluating both historical and current data. They are versatile and can adapt to address different types of natural disasters. Rather than traditional methods, ML models provide more accurate predictions. ML algorithms can effectively process and analyze large data from various resources. These advantages made ML suitable for predicting natural disasters. Also, there are some other techniques to predict natural disasters. There are several algorithms in ML that are used in this prediction ranging from ensemble learning like random forests to neural networks (Gopal et al. 2020). This paper proposes an ensemble model using K-means clustering, LightGBM, and XGBoost algorithms to predict earthquakes based on seismic, GNSS, and environmental data (Joshi, Vishnu, and Mohan 2022). This study utilizes Random Forest and Support Vector Machines to predict landslide susceptibility in vulnerable areas using satellite imagery and LiDAR data (Tanyu et al. 2021). Not only for prediction, are some ML algorithms used for management after disasters. Image processing plays a major role in management after floods. ML models can analyze the damages from the satellite images and they can process data from sensors and drones to identify the affected regions. When used in disaster management, machine learning models can drastically lower the number of fatalities and property damage. The use of machine learning algorithms for natural catastrophe management and prediction is demonstrated in this study.

LITERATURE SURVEY

When using data mining and machine learning techniques for inference and decision-making in disaster situations, the literature review examines several approaches in disaster management and explores their procedural applications, strengths, and limits. The table 1 summarizes the surveyed research papers from 2015 to 2023, highlighting their methodologies, respective pros and cons, and the overall inference drawn from each study.

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