

Distinguishing Earthquakes from Anthropogenic Events in Madagascar

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INTRODUCTION AND MAIN RESULTS

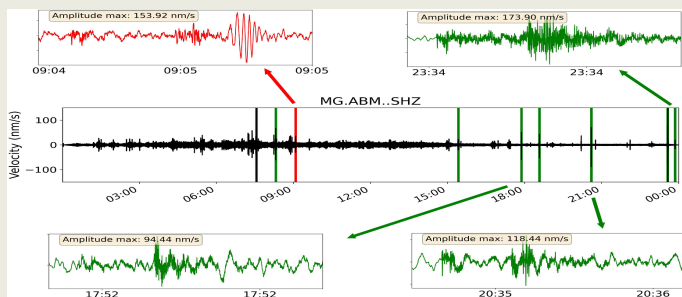
Earthquake catalogs are often contaminated by anthropogenic events, which can introduce bias into the seismic hazard assessments. This study develops a Convolutional Neural Network (CNN) that utilizes spectrograms for waveform classification. Our approach consists of three main steps: (1) generating the time-frequency representation of ground motion recordings (spectrograms); (2) a learning phase that utilizes known events, and (3) making predictions. During the learning phase the CNN model demonstrated its ability to accurately identify the nature of the events, achieving a classification accuracy. Only 2.5% of the events were misclassified. Furthermore, the prediction results indicate that the model effectively identifies the nature of events even in regions that were not included in the training phase.

DISCLAIMER (if any) [Arial Regular/ Font Size 8]

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INTRODUCTION

- Seismic record contains natural earthquakes and human activities that cause ground shaking
- Well-classified earthquake catalog: essential for seismic hazards and earthquake-related studies

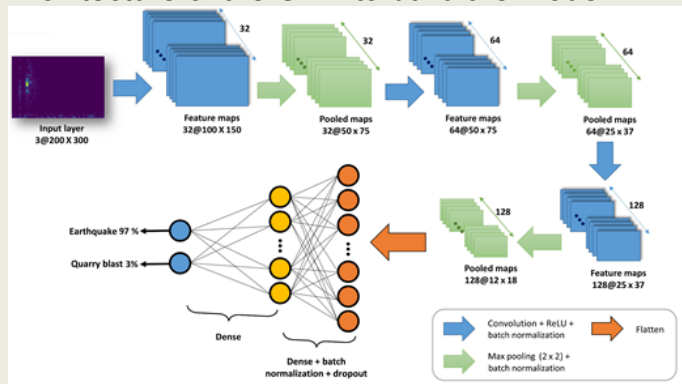


Objectives

- To discriminate human-made and natural earthquake
- To better understand Mining-induced seismicity

CONVOLUTIONAL NEURAL NETWORK

Architecture of the CNN to build the model



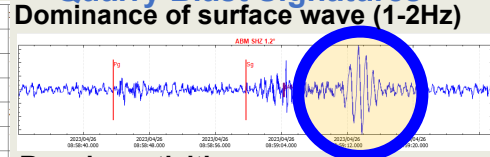
LEARNING PROCESS

Building the CNN model using **data with known class** (153 mining/quarry blasts and 2339 earthquake events).

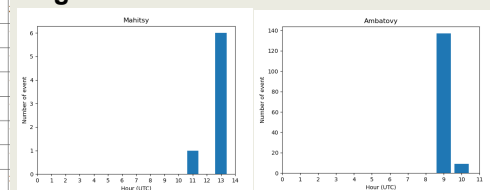
Historical activities

Date	Gomme [Kg]	Nitrate-Fuel [Kg]	Total [Kg]
19-04-01	346.25	1575	1921.25
16-05-01	171.2	1000	1171.2
25-05-01	362.4	360	722.4
09-06-01	345.5	615	960.5
02-07-01	481.16	450	931.16
15-07-01	1236.5	165	1401.5
05-08-01	646	660	1306
20-08-01	587.2	500	1087.2
08-09-01	250	325	575
19-09-01	378	400	778
11-10-01	207.1	400	607.1
10-01-02	1275	-	1275
02-02-02	150	800	950
21-06-02	904.2	5790	6694.2

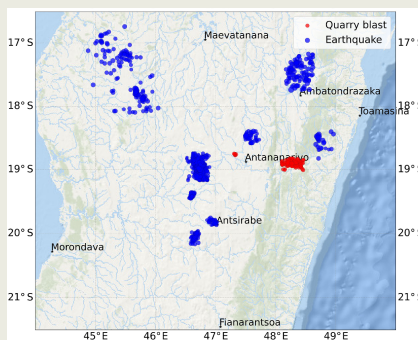
Quarry Blast Signatures



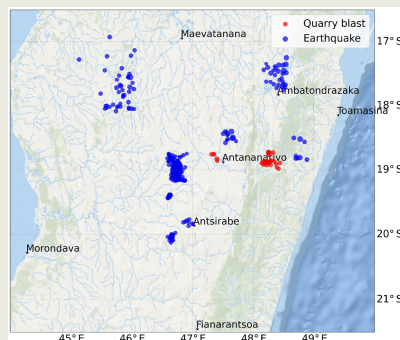
Regular activities



Data for Learning Process



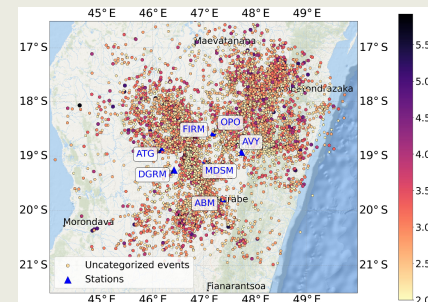
Data for Testing



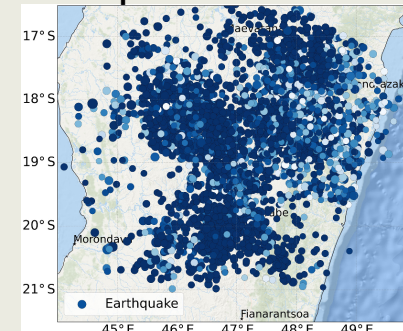
Correctly classified: 350 events (98.04 %)
Incorrectly classified: 7 events (1.96 %)

EVENT PREDICTION

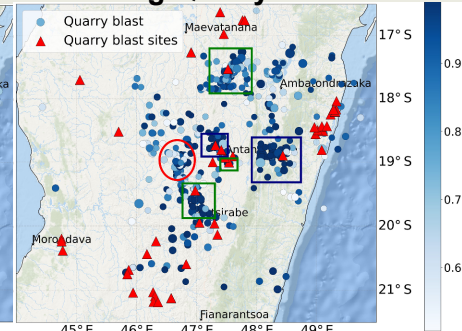
Predict the **nature of 9937 events** (46,281 spectrograms) recorded in the central part of Madagascar between 1988 to 2024



Earthquakes: 9589 events



Mining/Quarry blasts: 348



- Blasts: clustered mostly around known mining/quarry sites
- CNN model are able to identify: mining sites used in the training and new sites

CONCLUSION

- This study demonstrates the ability of CNN to categorize events
- CNN model effectively identifies the nature of events even in regions that were not included in the training
- The finding has important implication in mining control