

Introduction

A magnitude 7.2 earthquake struck the Tiburon Peninsula in Haiti on 14th August 2021, leading to over 2,000 fatalities, 15,000 injuries and 137,000 structural failures [2]. The Haitian Civil Protection General Directorate (DGPC) has stated that 137,000 families have been affected by the earthquake, and that 500,000 people were in need of emergency humanitarian assistance [3].

Providing assistance requires a timely analysis of the situation. In this project, we are investigating different approaches for damage assessment with satellite imagery for the 2021 earthquake in Haiti.

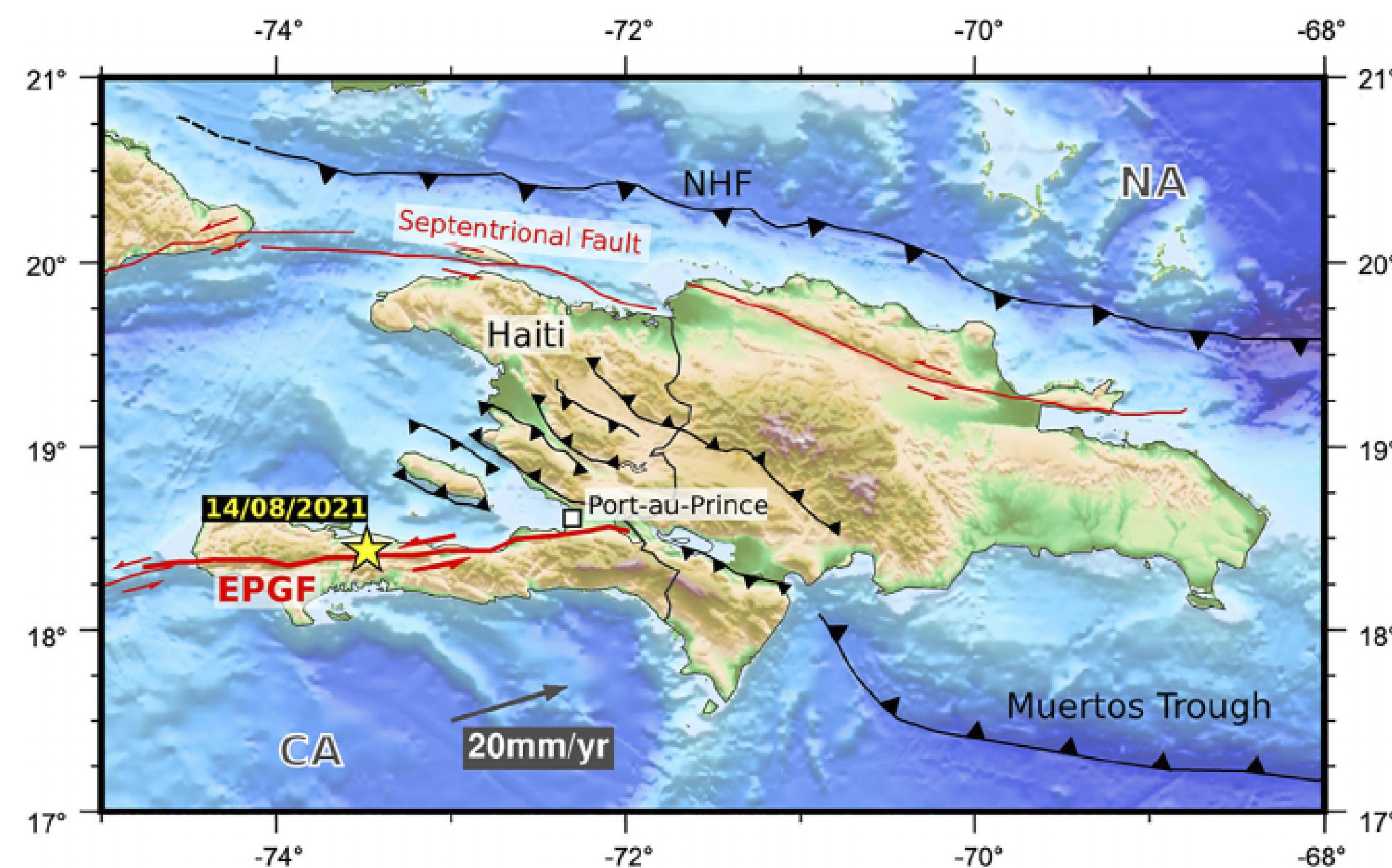


Figure 1: Regional tectonics-faults and epicentre [2]

Study Area

The Les Cayes city is located in the Sud department of Haiti. The city has a population of 86,780 (2015).

The city is located approximately 35 km from the epicenter of the earthquake. Although it is not the closest city to the epicenter, the city was directly affected and had totally and partially destroyed buildings.



Figure 2: Les Cayes City

Satellite Imagery

Satellite imagery was obtained from the open data program from Maxar [1]. Available are pre-event and post-event panchromatic and multispectral images taken from different angles at different time of day.

Methodology

In order to detect damaged urban structures affected by the earthquake in the city of Les Cayes, three different approaches are being applied and compared. First, an object-based image analysis approach (Fig. 3) is used by segmenting the image and classifying individual segments into potentially destroyed structures. This is done by using the Orfeo ToolBox (OTB) plugin in QGIS. In this approach sample areas are chosen and serve as inputs for training the model. Secondly, texture analysis is conducted with the aim of detecting affected structures by their change in texture before and after the earthquake event using the HaralickTextureExtraction algorithm (Fig. 3). Lastly, edge detection is performed. The effectiveness of each method is being evaluated by manual visual assessment.

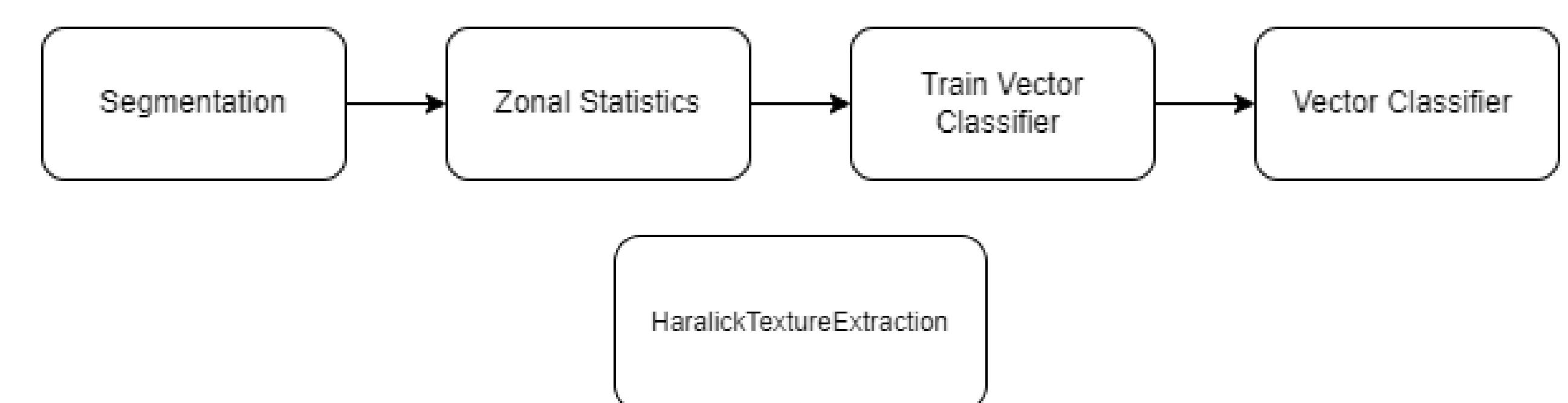


Figure 3: OBIA workflow and Texture analysis using OTB

Results

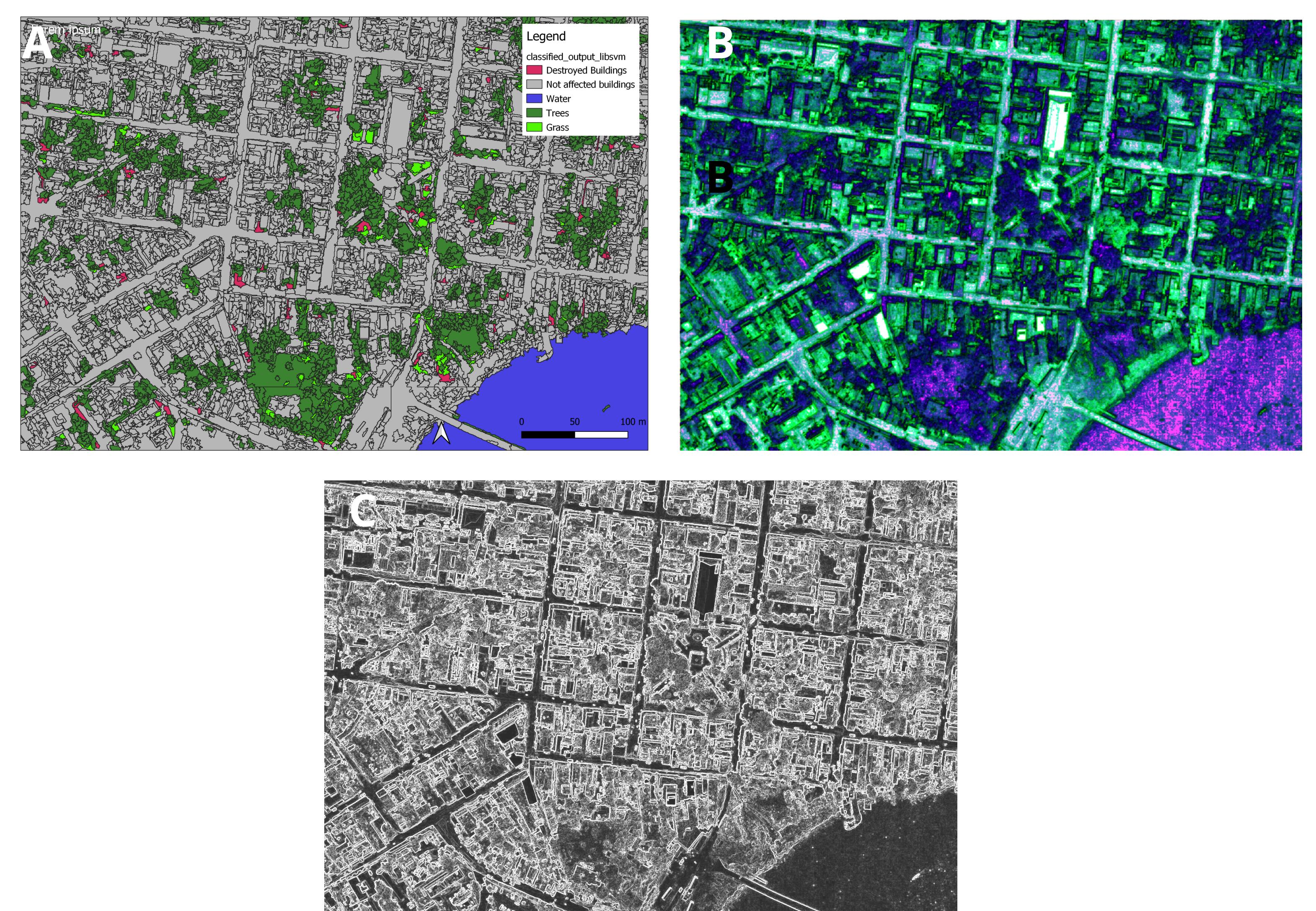


Figure 4: Preliminary Results (A - OBIA, B - Texture Analysis, C - Edge detection using Sobel filter)

Discussion

All the approaches tested struggled with the problem of large disparities between image datasets and low distinguishability of changes. Edge detection using a Sobel operator to detect changes in edge intensity on collapsed buildings proved ineffective because the pre-event and post-event images are difficult to compare due to the different viewing angles. Texture analysis in conjunction with the GEOBIA approach could prove valuable for further analyses. The first results using GEOBIA are promising, but still have errors in the classification. As a next step for this approach, more sample polygons and other classifier methods should be used to train the vector classifier model.

Damage assessment from satellite imagery can help identify destroyed structures, but often severe damage to structures is not visible on satellite imagery, so on-site damage assessment is essential.

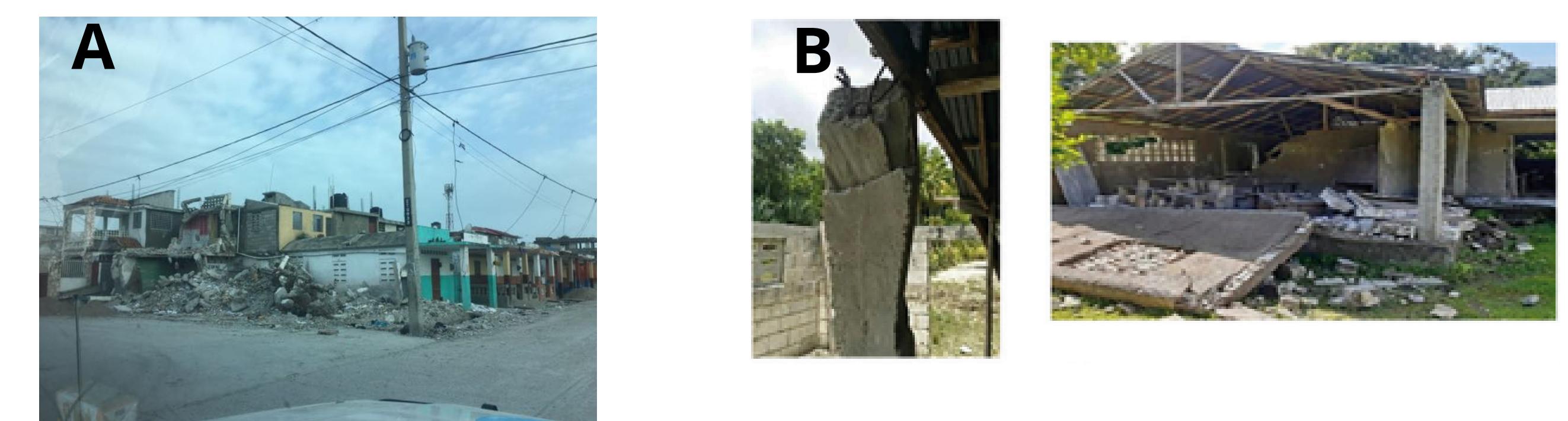


Figure 5: A - Streets of Les Cayes after the Earthquake, B - Example of type of damaged [2]

References

- [1] <https://www.maxar.com/open-data/haiti-earthquake-2021>
- [2] Michael R. Z. Whitworth, Lessons for Remote Post-earthquake Reconnaissance from the 14 August 2021 Haiti Earthquake, <http://dx.doi.org/10.3389/fbuil.2022.873212>
- [3] 14 August 2021 M7.2 Haiti Earthquake. Preliminary Satellite-Based Comprehensive - Damage Assessment Report - Grande'Anse, South, and Nippes departments of Haiti (27 August 2021), <https://reliefweb.int/report/haiti/14-august-2021-m72-haiti-earthquake-preliminary-satellite-based-comprehensive-damage>
- [4] Ellen M. Rathje, The Role of Remote Sensing in Earthquake Science and Engineering: Opportunities and Challenges, https://www.researchgate.net/publication/228372530_The_Role_of_Remote_Sensing_in_Earthquake_Science_and_Engineering_Opportunities_and_Challenges