Damage Assessment with Satellite Imagery for the 2021 Haiti Earthquake

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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].
TODO Motivation, why remote sensing

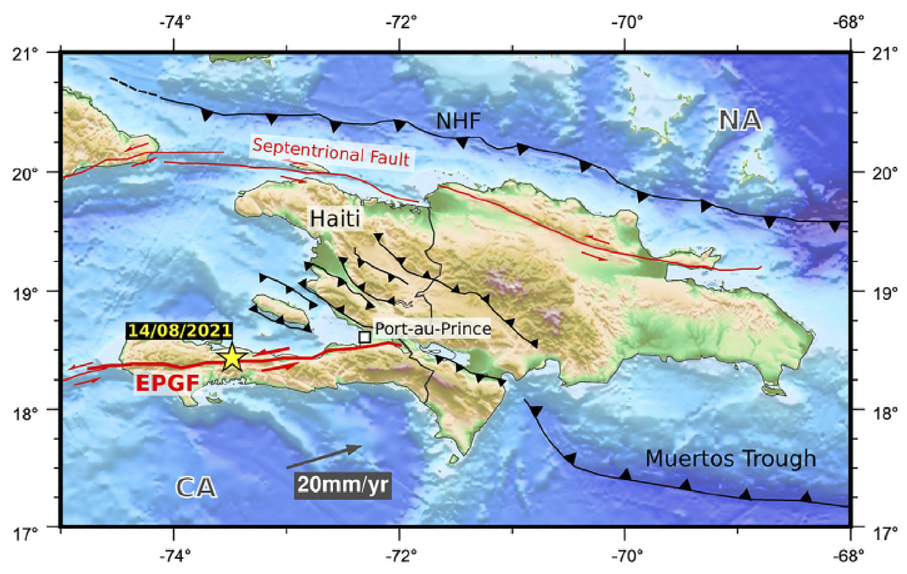

Figure 1: Regional tectonics–faults and epicentre [2]

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]. Avaiable 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.

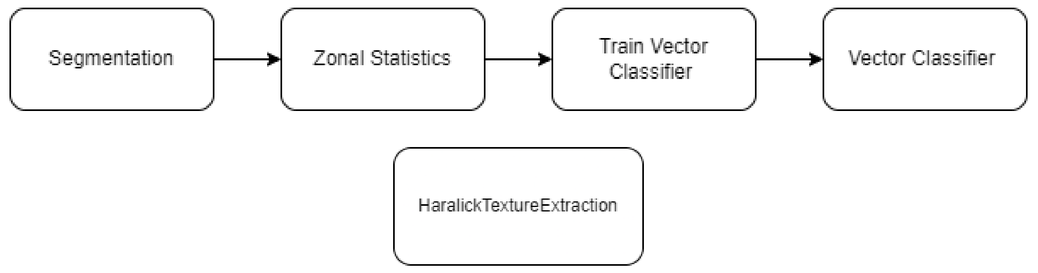

Figure 3: OBIA workflow and Texture analysis using OTB

Results

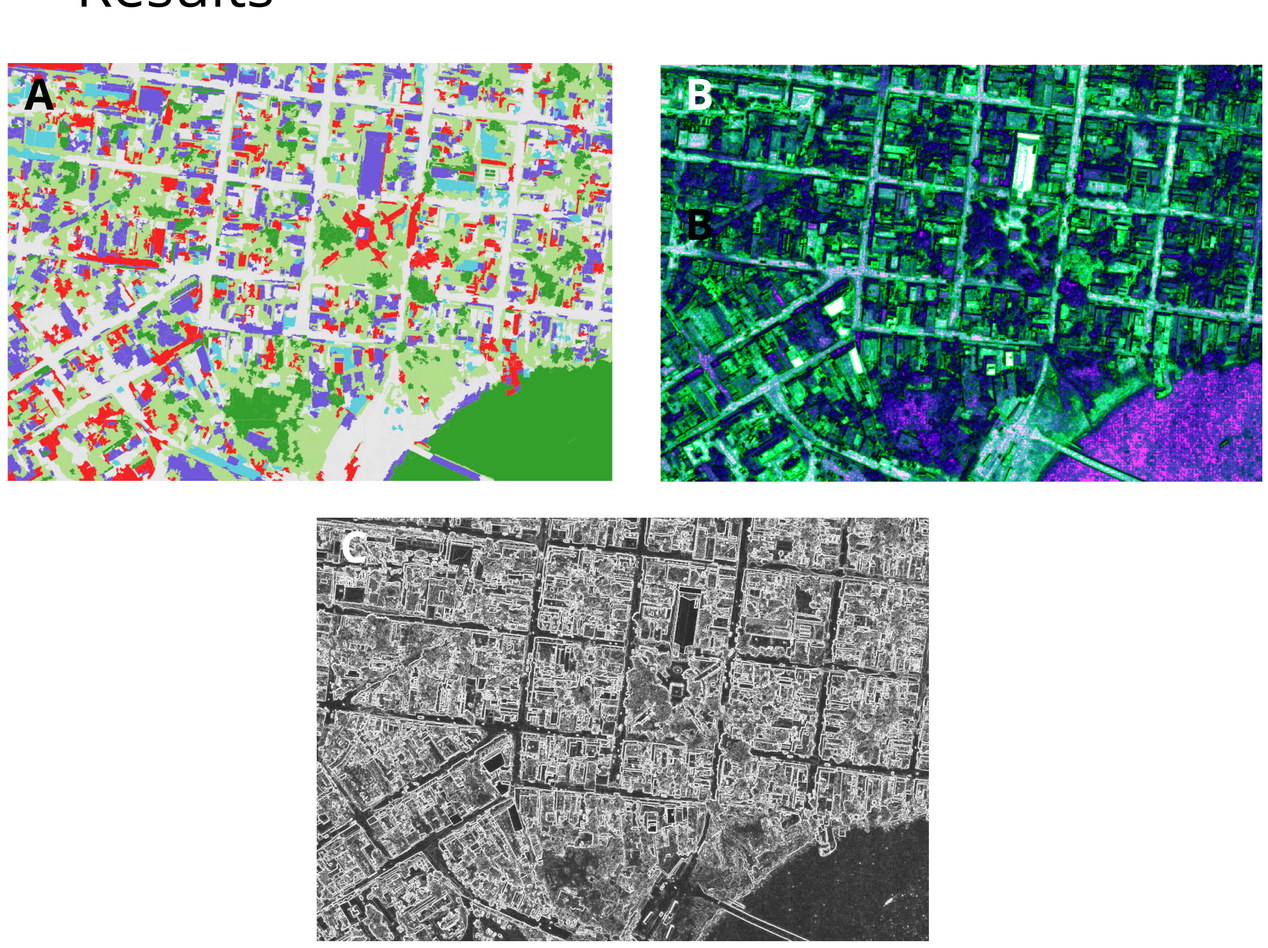

Figure 4: Preliminary Results (A - OBIA, B - Texture Analysis, C - Edge detection using Sobel filter)

Discussion

All the tested approaches dealt with the same problem. Edge detection using a Sobel operator to distinguish collapsed walls from intact buildings proved ineffective because the images before and after the event are difficult to compare due to the different viewing angles. The first results using OBIA 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.
Automatic damage assessment using satellite imagery can help identify destroyed structures, but often severe damage to buildings is also not visible on satellite imagery and therefore damage assessment on the ground is essential.

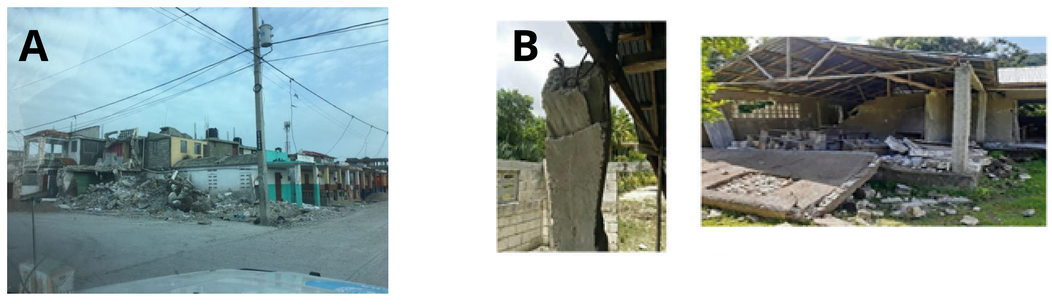

Figure 5: A - Streets of Les Cayes after the Earthquake,
B- Example of type of damaged [2]

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

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