Building damage scale proposal from VHR satellite image

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Introduction

Natural hazards have a huge impact in terms of economic losses, affected and killed people. Current exploitation of remote sensing images play a fundamental role in the delineation of damages generated by catastrophic events. Institutions like the United Nations and the European Commission designed services that provide rapidly information about the impact of disasters. One of the approach currently used to carry out the damage assessment is based on very high resolution remote sensing imagery (including both aerial and satellite platforms).

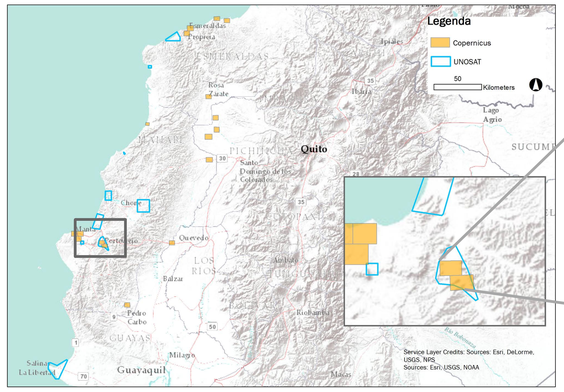
One of the main focus of the responders, especially in case of events like earthquakes, is on buildings and infrastructures. As far as the buildings are concerned, international standard guidelines that provide essential information on how to assess building damages using VHR images still does not exist.

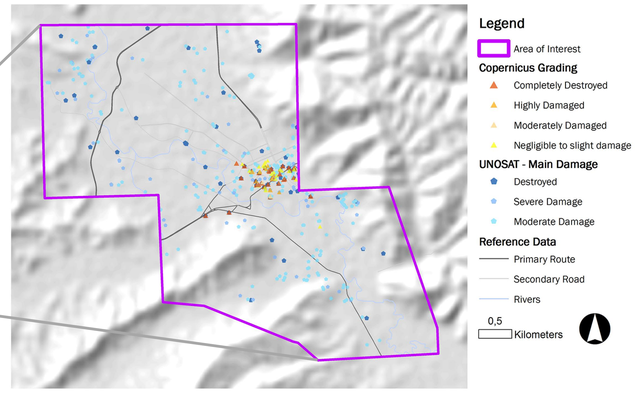
The aim of this study is to develop a building damage scale tailored for analyses based on VHR vertical imagery and to propose a standard for the related interpretation guidelines. The task is carried out by comparing the current scales used for damage assessment by the main satellite based emergency mapping services.

The study will analyze the datasets produced after the Ecuador (April 2016) and Central Italy (August and October 2016) earthquakes. The results suggest that by using VHR remotely sensed images it is not possible to directly use damage classification scales addressing structural damages (e.g the 5 grades proposed by EMS-'98). A fine tuning of existing damage classes is therefore required and the adoption of an internationally agreed standard should be encouraged, to streamline the use of SEM products generated by different services.

Methodology

Ecuador case study - 2016 April 16th, 23:58 UTC (18:58 local time), 7.8-magnitude earthquake





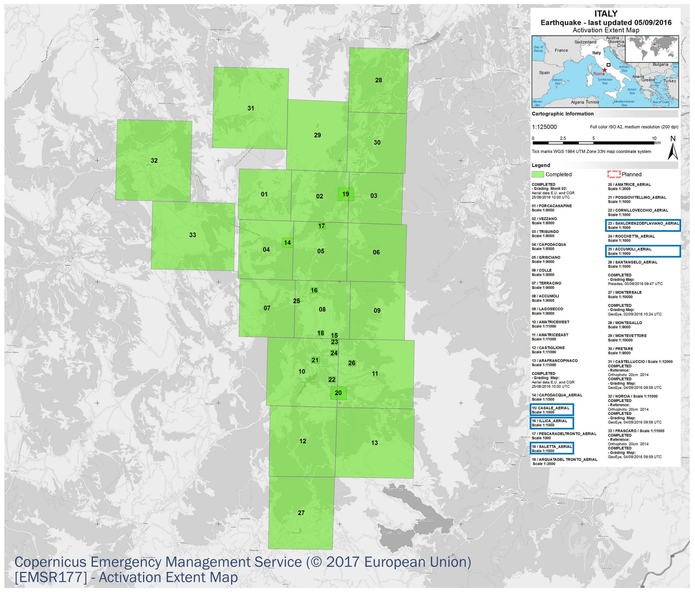
Comparative Analysis

Buildings classified by both the services have been identified in the Area Of Interest and, comparing the post-disaster satellite images with respect to pre-disaster images, the level of damage has been reassigned adopting the European Macroseismic Scale '98.

Example of analysis

Comparison between reference data and 3 different post event satellite images.

Central Italy case study - 2016 August 24th, 01:36 UTC (03:36 local time), 6.2-magnitude earthquake.



Copernicus Emergency Management Service (© 2017 European Union)
[EMSR177] - Activation Extent Map

Comparative Analysis

Damage classification of buildings of the town of Saletta, Casale, San Lorenzo e Flaviano, Accumoli and Illica, with reference to the European Macroseismic Scale '98.

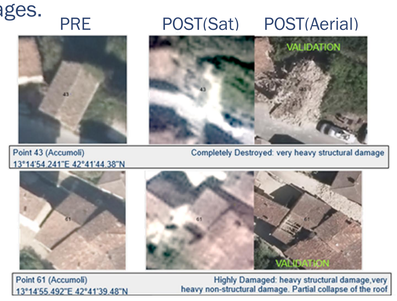
Images used for the analysis:

Post event image:

- WorldView-2 © Digital Globe, Inc. (2016) GSD 0.5m
- Aerial data © European Commission (2016) GSD 0.1m

Example of analysis

Comparison between reference data and 2 different post event satellite images.



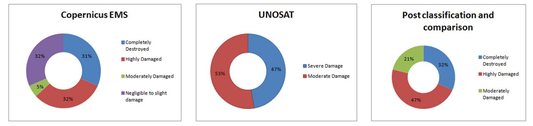
Conclusions

Ecuador case study

Considering the damage scale of EMS-'98 it's not possible, to identify a Grade 1 damage (Negligible to slight damage) from satellite imagery.

"Severe Damage" and "Completely Destroyed" grades, are sometimes used improperly because the EMS'98's Grade 5 (Completely Destroyed) should be assigned also when only a part of the building collapses, not necessarily the whole building.

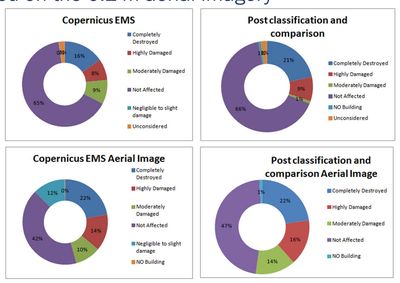
Most of the buildings classified as "Negligible to slight damage" resulted to be underestimated, since they have been validated as "Moderately damaged".



Central Italy case study

Considering the damage scale of EMS-'98 it's not possible, to identify a Grade 1 damage (Negligible to slight damage) from a satellite imagery.

In most cases, it's possible to assign a Completely Destroyed or a Not Affected grade to the buildings. Moderately Damaged was not used due to the limitation of the available 0.5 m satellite imagery. Nevertheless it can be detected on the 0.1 m aerial imagery



Although the study is subjective it can be noted that the "Negligible to slight damage" damage grade is not identifiable. Only the "Completely Destroyed", "Highly Damaged" and "Moderately Damaged" grades are identifiable.

Nevertheless, we propose to aggregate "Highly Damaged" and "Moderately Damaged" into a "Damage" grade class.

Future activities:

1. Quantitative evaluation of the damage grade accuracy of the datasets for the selected case study;
2. Integration with ground data and terrestrial georeferenced images (e.g Mapillary, OpenStreetCam).