Contextual patterns discovery in post disaster evaluation of 2011 Japan Tsunami using TSX products

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Over the last years the use of Earth Observation satellites to support disaster and emergency relief has considerably grown. On 11th March 2011 earthquake northern Japan and the tsunami that followed left thousands persons dead or missing. The epicenter was at 129 km away from Sendai, the largest city in the Northeast area of Japan, at 38.297N, 142.372S. The destructive tsunami, originated by the earthquake hit the coastline several minutes after the earthquake causing huge causalities, damages and the crisis at the Fukushima Daiichi nuclear plant. Particularly on March 12 the Sendai region was partially clouded so that only the use of microwave data SAR data, capable to penetrate clouds, allows a detailed and complete evaluation of the region.

This paper proposes a post disaster evaluation of the damages produced by the tsunami in the Tohuku-oki region considering knowledge discovery from TerraSAR-X (TSX) images, by mapping extracted primitive features into semantic classes, thus assuring an interactive technique for productive information mining.

Knowledge discovery from EO images implies mapping low level descriptors (primitive features) extracted from the image into semantic classes in order to provide an interactive method for effective image information mining. From the information theory perspective it can be considered as communication channel between remote sensing imagery and the user who receive existing information in the data sources, coded in an understandable format i.e. semantic of the image content. The communication channel involves three components - Data Source Model Generation, Query and Data Mining. The Data Source Model Generation component refers to the image content analysis, considering as input TSX images, and generates a vector of image content descriptors as output. These descriptors are actually texture features obtained through a feature extraction process. The Query component involves the user and performs an image retrieval based on image content as query parameter. The query component relies on the Support Vector Machine classifier, which is able to group descriptors into relevant semantic classes. The classifier supports rapid mapping scenarios and interactive mapping.

Further, the envisaged data mining process includes three stages: data annotation, data query and quantitative analysis of the results. The Data annotations step considers dataset description, data preparation and data classification in order to perform user annotations.

To pursue our goal two radiometrically enhanced TSX images acquired before (20.10.2010) and after (12.03.2011) the tsunami were used. For each TSX product, the image is tiled into non overlapping patches, the size of the patch (100 x 100 pixels) ensuring that the extracted features capture the local properties of a region rather than the global properties of the image. At the next level, these patches are converted into local features to be further used as content descriptors, in order to characterize image structures. Considering the extracted descriptors the next step is clustering, which aims to dissociate recognized classes. Further an active learning stage is mandatory in order to semantically label the classes. The classifier is able to almost completely retrieve all the similar patches belonging to the same semantic label.

Some query examples considering several scenarios include: Assessment of the transportation infrastructures, high risk of broken roads caused by damaged bridges, debris detection, assessment of aquaculture areas, and possible energy loss due to the damaged high voltages poles or assessment of agriculture areas, damaged crops and estimation of losses.