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Copernicus Emergency Management Service (CEMS)- Risk and Recovery Mapping

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Abstract:

This paper gives a demonstration of how Copernicus Emergency Management Service (CEMS) Risk and Recovery Mapping (RRM) activations are carried out by looking at two activations. CEMS is an operational earth observation service overseen by the European Commission. Its aim is to provide tailored geospatial products on disaster and crisis management in two temporal modes: Rapid Mapping, which provides geospatial information within hours or days following a disaster, and Risk and Recovery Mapping (RRM), providing on-demand geospatial information in support of disaster management activities. RRM operations are usually carried out within 5 days up to 2 months and the outcomes are geospatial data and maps to be used for further analysis.

The RRM activations discussed in this paper are the activations in response to the volcanic eruption on the island of La Palma in 2021 (EMSN119: Digital Elevation Models of the Cumbre Vieja Volcano in La Palma, Spain) and to support the WFP (World Food Program) to assess the food security situation in Nigeria (EMSN113: Crop change detection in conflict-affected areas of Nigeria, agricultural season 2021).

After the volcanic eruption on the island of La Palma, an up-to-date information on the terrain topography was essential to better plan mitigation measures and improve post-event modelling. Both optical and SAR data were considered. While optical data lacks the capability to acquire data independent of the sun’s illumination or cloud conditions, it was kept to enhance comparison instead of using a single sensor. TerraSAR-X and TanDEM-X (TDX) SAR missions are for the generation of DTM compared to other SAR missions. The CoSSC acquisition method was used as it offers a single-pass acquisition, reducing considerably the noise originating from atmospheric distortions and preserving the overall coherence.

The TanDEM-X CoSSC product was coregistered and an interferogram was formed. The flat-earth effect was removed from the interferogram and a Goldstein filter was applied to reduce phase noise. The coherence was derived, indicating the ratio between coherent and incoherent summations of the returned signal. To resolve the 2π ambiguity inherent in the interferogram, phase unwrapping was applied using the Minimum Cost Flow method. Finally, the absolute calibrated and unwrapped phase is re-combined with the synthetic phase, and it is converted to height and geocoded into a map projection.

By subtracting the post-event DTMs generated in this activation with a pre-event DTM, it was observed that a maximum elevation change of approximately 187 m was observed in the area affected by the lava flow, with the highest value in the proximity of the cone area. The total volume of erupted material was estimated to be 215 million m3, and a Time Average Discharge Rate (TADR) of approximately 2 million m3/day or 24 m3/sec was derived. Figure 1 shows the filtered interferogram, coherence and DTM (m) obtained from the TDX CoSSC product. Figure 2 shows a subset of the DTM obtained from optical data over the cone area.

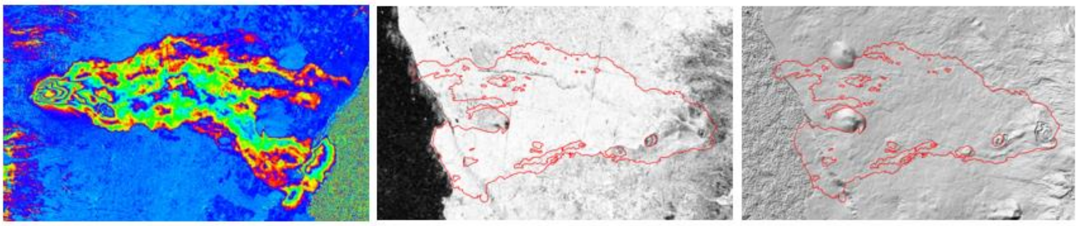

Figure 1: Interferogram (left), coherence (middle) and DTM (right)

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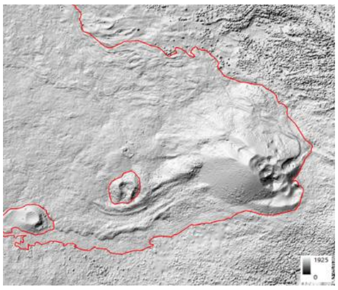

Figure 2: DTM over the cone area obtained from optical data processing

Activation EMSN113 assessed the agriculture status in order to determine the food security of 57 Local Government Areas (LGAs) in Nigeria. As a result of the ongoing armed struggle in the northern part of Nigeria applying EO technologies becomes a viable option to monitor changes in cropland and to estimate the affected population in the event of cropland loss. Three separate time stamps of the vegetation cycle were joint to a colour composite of NDVIs based on S2 (see Figure 3). In correlation to the data available, these colour composites are very heterogeneous, different spectral appearance does not necessarily correspond to different crop classes. Fast growth of crops and management effects as well as shape criteria separate them from sparse or natural vegetation, indicating the potential destruction of the local population.

Analysis of relative changes took place within surroundings of the interpreted villages in relation to their likely geospatial relationship and size of the village considering the Theissen polygon analysis. In case villages located close to each other, surroundings were considered asymmetric following logic of distance and likelihood. Classes were separated according to strength and direction of change within the close surrounding of the populated places given as locations (point features). Quality assurance was highly important to reach required quality criteria of over 85%, considering a wide range of data quality.

Villages (extracted from OpenStreetMap and other) were linked to population information (WorldPop and other) to determine numbers on population in order to address those potentially affected by loss (or gain) of agricultural areas (see Figure 4). The results of this analysis were applied onto different time intervals, suitable to monitor the changes and impact of the conflict over the recent 14 years.

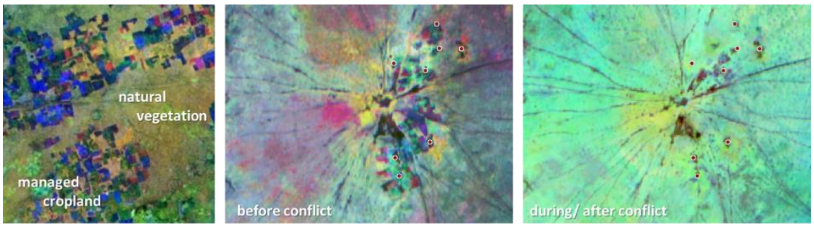

Figure 3: Sentinel-2 NDVI composite showing different land cover; scattered village (points) before and during the conflict

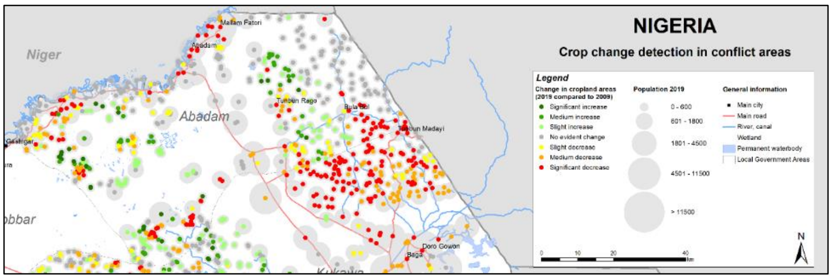

Figure 4: Upper: S2 NDVI composite showing decrease in agricultural areas; lower: crop change detection in conflicted areas in the Borno region in Nigeria between 2010 and 2020.

Acknowledgements

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