Aggregation of heterogeneous data sources for the early acquisition of satellite images in case of flood events

Johanna Roll (German Aerospace Center, Department of Georisks and Civil Security)
Anne Schneibel (German Aerospace Center, Department of Georisks and Civil Security)
Martin Mühlbauer (German Aerospace Center, Department of Georisks and Civil Security)
Monika Gähler (German Aerospace Center, Department of Georisks and Civil Security)

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Satellite-based emergency mapping is crucial for supporting local disaster response in anticipation of, during and following a disaster (Gähler, 2016). With the increasing frequency of natural disasters like floods and the large availability of web-based and remotely sensed data, there is an opportunity to automate and optimize rapid mapping processes. Early tasking of satellites has already enhanced the timeliness of crisis information products (Wania et al., 2021). In this context, ongoing research focuses on automatically deriving potentially affected Areas Of Interest (AOI) by monitoring and aggregating heterogeneous data sources such as official alerts, and remote sensing-based data using a Discrete Global Grid System (DGGS). These AOIs can initiate the early tasking of very-high resolution satellites.

The automatic identification of potential areas at risk of riverine flooding is one goal of the IFAS (Indicator Monitoring for Early Acquisition of Innovative Satellite Sensors in Natural Disasters) project which focuses on the Bavarian region in Germany. Collaborating with the satellite imagery provider European Space Imaging, we aim to provide timely crisis information to end users such as the Bavarian Red Cross. The entire semi-automated processing chain consists of monitoring and aggregating different data sources, early triggering very-high resolution satellite acquisition, rapidly analyzing the data, and creating a web-based crisis information product.

For automatically determining an AOI potentially affected by a crisis we continuously retrieve information from official warnings, gauges, and remote sensing-based data such as Sentinel-1/2 or the Global Flood Awareness System. Since the data sources differ in their spatial format (e.g. raster or vector) and resolution, the hexagonal DGGS (Li and Stefanakis, 2020) H3 is implemented for the spatial and temporal aggregation which gains prominence for geospatial data integration (Fichtner et al., 2023). The H3 grid system (Brodsky, 2018) divides the world surface into uniquely identifiable hexagonal cells with 16 different spatial resolutions which facilitates the aggregation of data sources.

The current implementation converts available data into hexagons at resolution level 8 (approx. 0.74 km^2) each day. After merging and filtering the data in the H3 grid, cells with relevant data indicating potential flood events are identified. These are then transformed into vector geometry to initiate subsequent processing steps. This approach aims to approximate a general AOI relevant to the end user for more detailed operational information rather than pinpointing specific "risk zones". Since the focus is on urban areas close to the river, static datasets for the riverine network and urban areas are also considered.

Figure 1 displays currently daily aggregated data sources in Bavaria (Germany): Alerts (1a), population data (1b), and river network (1c). Merging these on the H3 grid level highlights affected regions based on the count of data sources per H3 cell (1d). Rule-based criteria are also applied, exemplified in Figure 1e by filtering the highest warning severity per H3 cell. Further refinement iterations will yield more precise AOIs, allowing experts to determine if acquiring and analyzing new satellite imagery can aid local disaster response.

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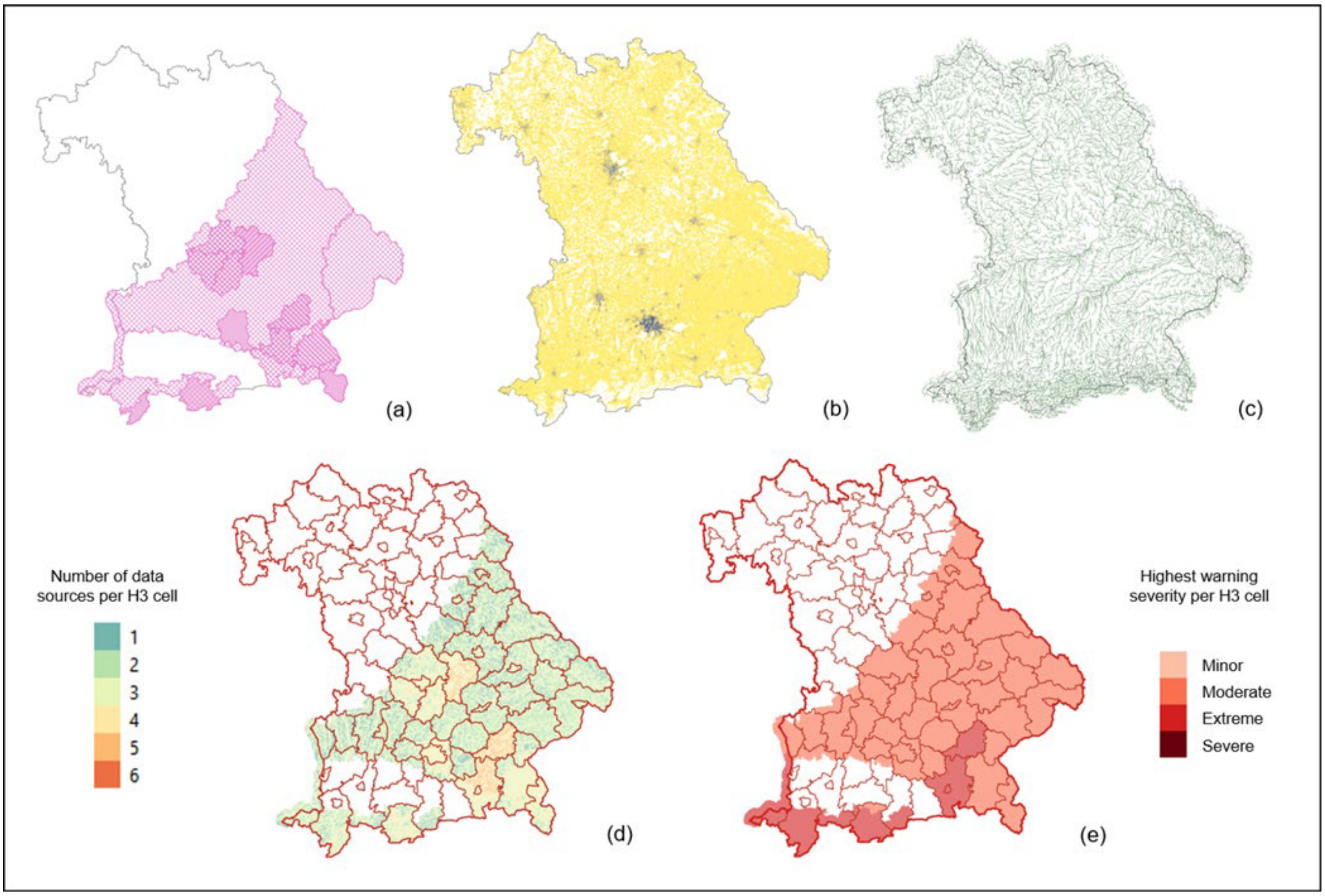

Figure: Aggregation of (a) alertssources, (b) population data and (c) river network in the H3-Grid to (d) count the number of data sources per H3 cell and (e) identify the highest warning severity per H3 cell (data sources: Warning alerts: DWD and LHP warnings from 28.08.2023, population: High Resolution Density Maps (CIESIN/Meta), river network: EU-Hydro).