Monitoring and Mapping Flooding Events from Space

Testing satellite-based approaches to map and monitor flood extent as a tool to verify the accuracy of flood models.

N.G. Hansted [A], N. Balbarini [A], H. G. Muller [A], L. Færch [B], P. Landsfeldt [C], M. B. Butts [D]

A: DHI A/S B: DHI GRAS C: Vejle Municipality D: Danish Meteorological Institute

The challenge

Flooding is a challenge in many parts of Denmark, and it is a challenge that is expected to grow in a changing future climate. A quick way to assess flood extent is therefore essential for emergency services, insurance cases, etc.

Together with the Danish Environmental Protection Agency, DHI GRAS has developed a simple, data-driven flood mapping method. The method is based on water level data, cross-sections, and an elevation model and does not require complex modelling. The objective is to use the method with forecasted water levels, thus being able to predict future flood extents. The method was applied and tested in the Vejle Å basin. In order to verify the accuracy of the model, data about the extent of historical flooding events was needed.

It is a general challenge in flood mapping that traditionally modelled extents are compared with photographs. Aerial photos from planes or drones provide the most detailed, correct, and easily interpretable information but are rarely available at the time of the flooding. Photos taken from the ground are more readily available but normally lack a large, 2-D extent and thus only provide information about parts of the flooded area.

The space-based solution

Satellite images can contribute to fill this gap in the data as there is an image available almost every day, and they can provide a 2-D image with a large footprint and an adequate spatial resolution.

In this project, Sentinel-1 data was used to map the extent of previous flooding events around the Vejle Å basin to verify the flood mapping method. The extent of historic flooding events was mapped through a machine learning algorithm that determined the threshold between water and non-water on the basis of known land and water pixels. The results were subsequently postprocessed with a Height Above Nearest Drainage (HAND) model to remove water from hill tops, etc.

> **Flood models provide critical tools to inform flood management and flood mitigation processes, and satellite data provides a good opportunity to improve the accuracy and performance of flood models.**
>
> *Peter Kaarup, Danish Environmental Protection Agency*

Benefits to citizens

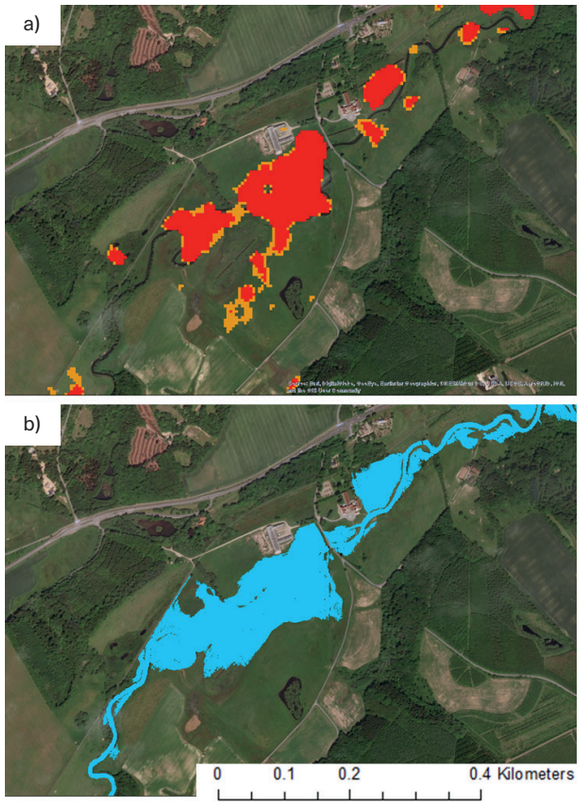
There is generally a lack of data to verify flood mapping models, especially for Danish floods where the response time is short and the flood extent changes quickly. Therefore, it is necessary to use methods that are not affected by meteorological conditions, such as cloud cover. This is where satellite-based SAR images have an advantage, as

Photo of flooding at Haraldskær which is also apparent in the satellite image and modelled flood extent. © Paul Landsfeldt, Vejle Municipality.

they are not affected by clouds. This makes it possible to map the flood extent immediately, without having to wait for clear skies. Satellite-based flood mapping thus provides critical input that can be used to improve flood models, thus improving the ability of authorities to reach to flooding events and mitigate impacts.

Outlook to the future

The high frequency and high-resolution data provided by the Sentinel satellites is a game changer for satellite-based flood mapping, and future development of deep learning approaches to automate workflows will provide potential for near-real time operational flood mapping. This will be useful for verifying modelled flood extents, not only from the simple method developed here but also from more complex hydrological methods.



a) Flood extent from satellite and
b) modelled flood extent on 17-03-2019