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RSS-Hydro

DEM-guided Flood Segmentation in Sentinel-2 images

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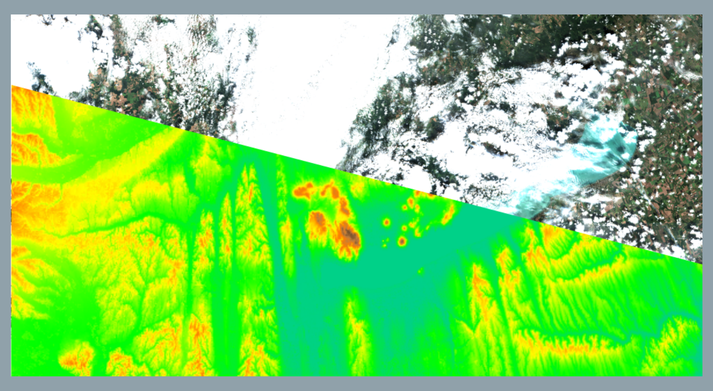
Introduction:

Sufficiently destructive floods necessitate the release of emergency funds to support the rebuilding efforts. For insurers it is critical to understand the extent of a flood and estimate damages quickly. Optical satellite data presents an opportunity for quick flood mapping and function complementary to SAR based mapping. The main challenge is to mitigate the loss of information due to cloud presence. RSS-Hydro is addressing this issue within the scope the the FloodSENS project with the support ESA's InCubed programme.

We present a case study near lake Balaton which includes rivers, lakes, urban and rural areas. The area is studied in both cloudfree and clouded conditions to map water presence using Machine Learning Methods.

Input Data:

Optical data is void of relevant information for flood mapping in clouded areas. In contrast a digital elevation model provides helpful information no matter the cloud cover. Additional auxiliary data is used.
All inputs are co-registered, resampled to 10m resolution and tiled into 244x244 pixel tiles for both training and inference.



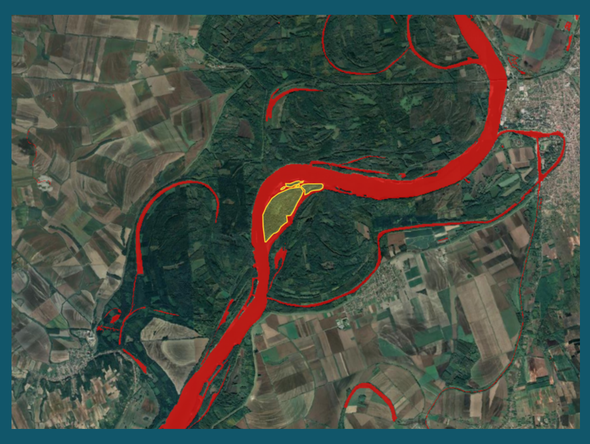
Sentinel-2 bands:
10m: B02, B03, B04, B08
20m: B05, B06, B07, B11, B12

Auxiliary Data (all 30m)**:**
Copernicus DEM
Slope
Flow Accumulation
Height above nearest drainage (HAND)
Topographic Wetness Index (TWI)

Labels:

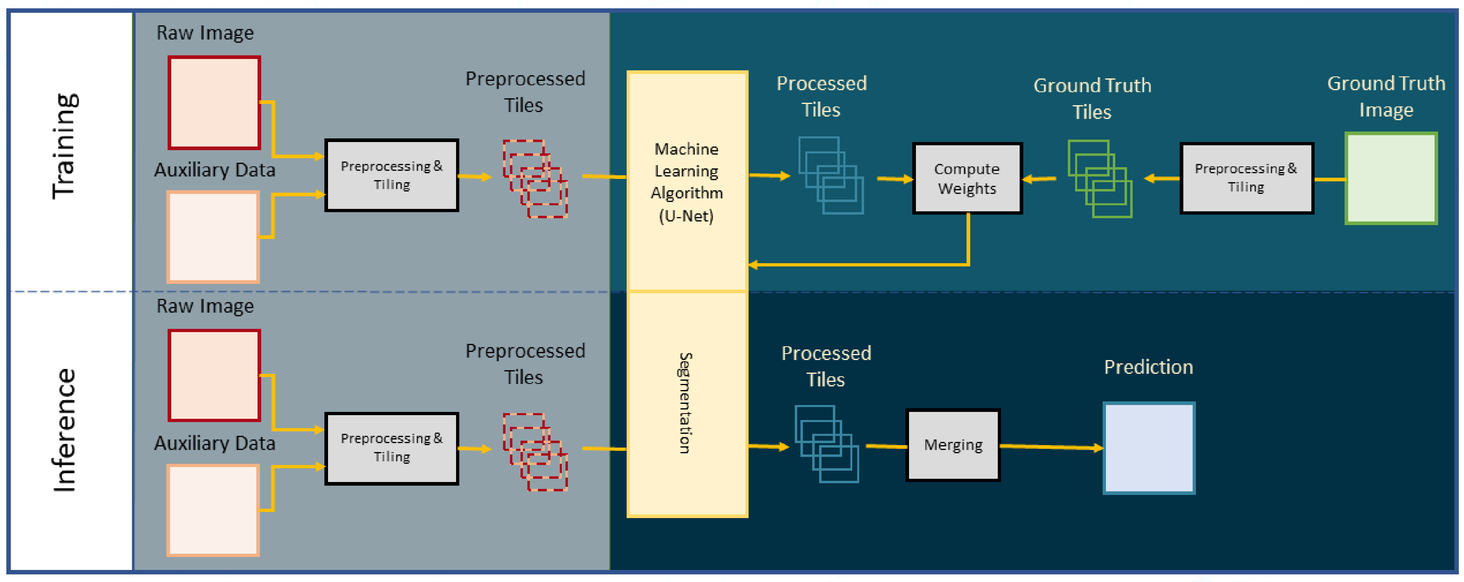
The Balaton case study considers exclusively non-flooded scenarios. Labels are created using Open Street Maps. From **OSM** all polygons and 1-D lines for "natural=water" are pulled. 1-D lines are extended to have a 2-3 pixel width. A final step involves a manual quality control step and corrections to remove systematic errors.

The most prevalent systematic error in the OSM labels are islands in the Danube that are wrongly marked as water. The Figure to the right highlights such examples in yellow and shows correct labels in red.



FloodSENS

https://github.com/gaffinetB/floodsens
https://pypi.org/project/floodsens/

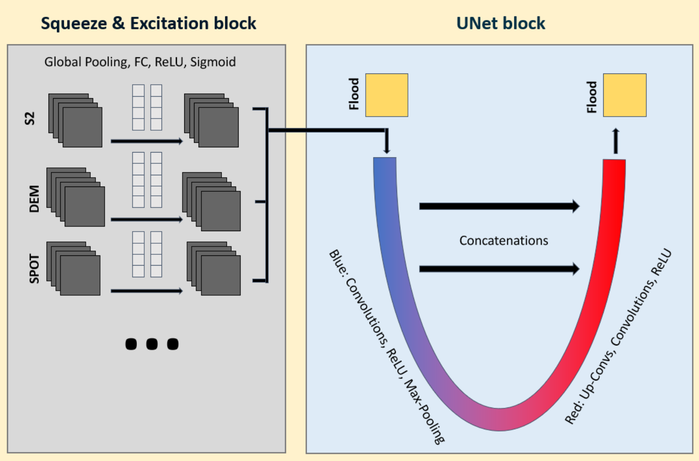


Architecture:

The architecture is composed of **two blocks**:

UNet forms the backbone for the image segmentation task. It is adapted to the 14 input bands and outputs a single band image with float entries.
SENet assigns a weight to each channel which can be interpreted as the channel importance.

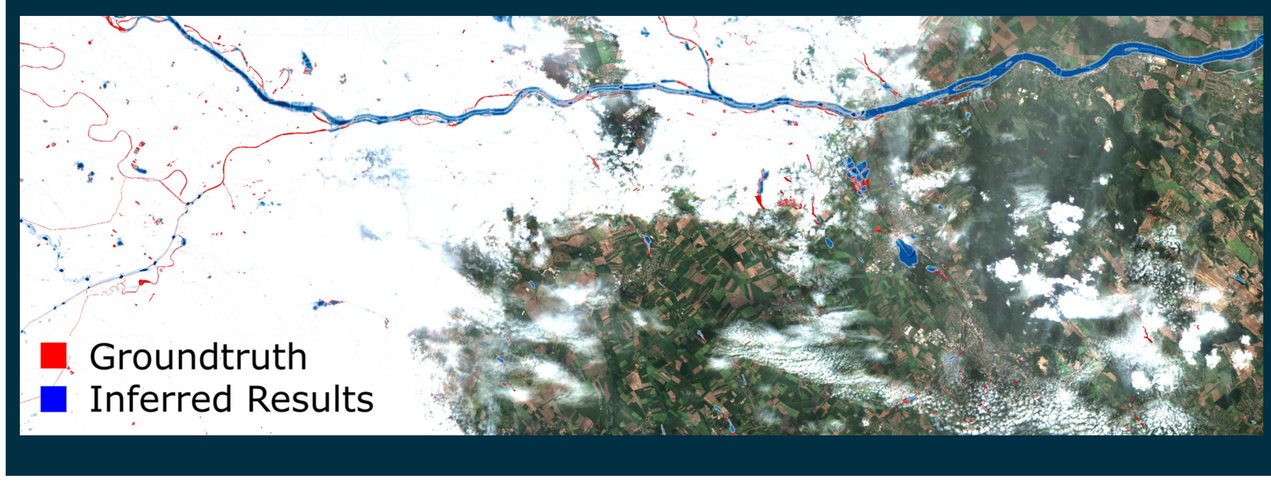
The use of SENet has a positive impact on performance and enables analysis of the redundancy between input channels.



Results:

Intersection over Union (IoU) is used as a metric. The **cloudfree** case achieves solid results with high importance for the Sentinel-2 input channels. Performance decreases for **clouded** conditions but remains surprisingly good. The model has learned to correlate flat slopes to the presence of water.

Performance (IoU)	
cloudfree	93.6%
clouded	88.9%



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