# Combining automated satellite based flood mapping with exposure mapping for flood risk assessment and management

André Twele & Franz Hummel, German Aerospace Center (DLR)

United Nations/Germany Expert Meeting "Space-Based Information for Flood and Drought Risk Reduction", 5-6 June 2014

Knowledge for Tomorrow

Flood mapping – from semi-automatic tools to fully automatic services
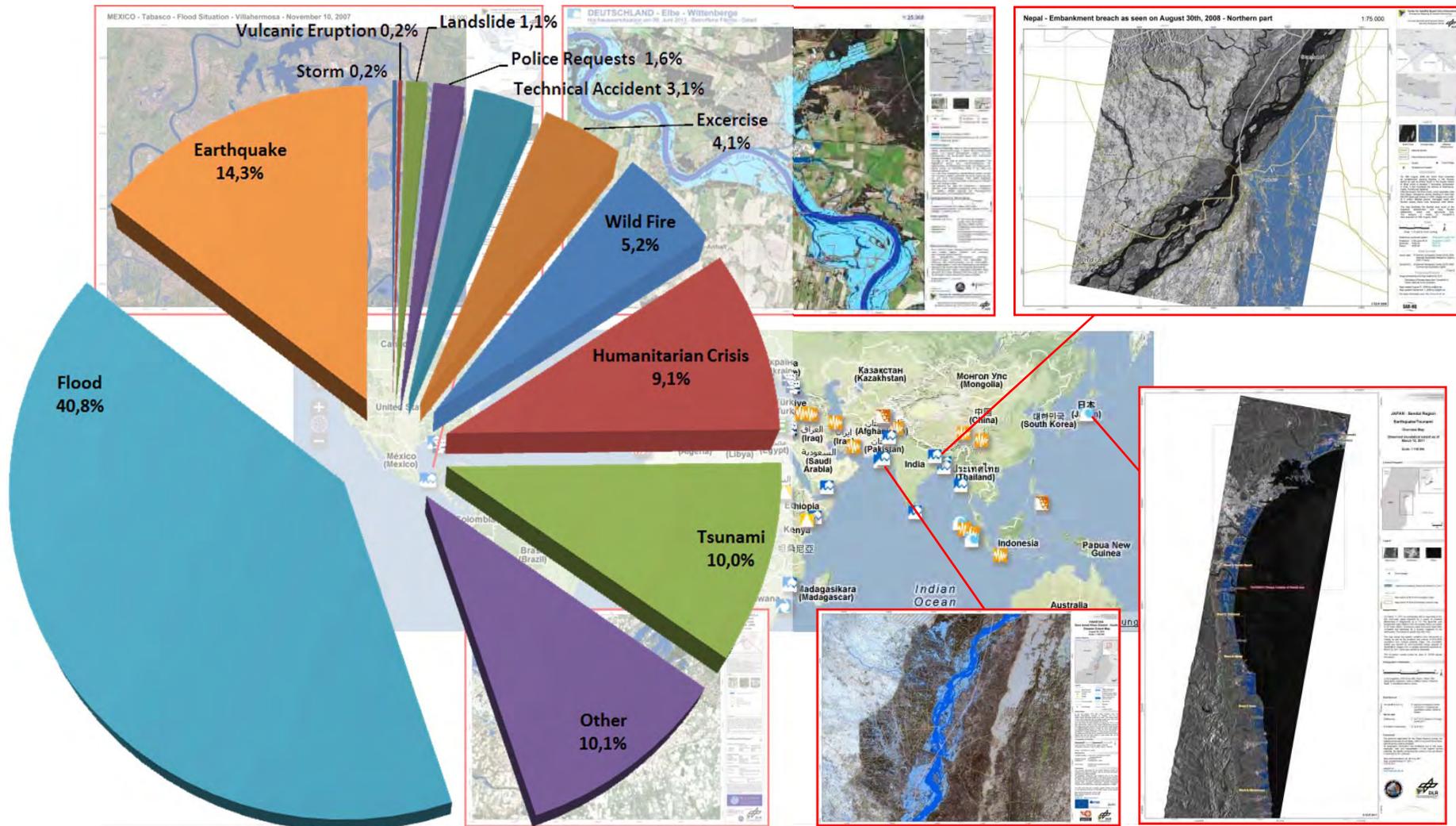
**ZKI-activations (since 2003): regions and disaster types (www.zki.dlr.de)**

# Flood mapping – from semi-automatic tools to fully automatic services

Center for Satellite Based Crisis Information
– Emergency Mapping & Disaster Monitoring –
a service of DFD

ENVI/IDL:
- Automatic split-based thresholding
- Pixel-based
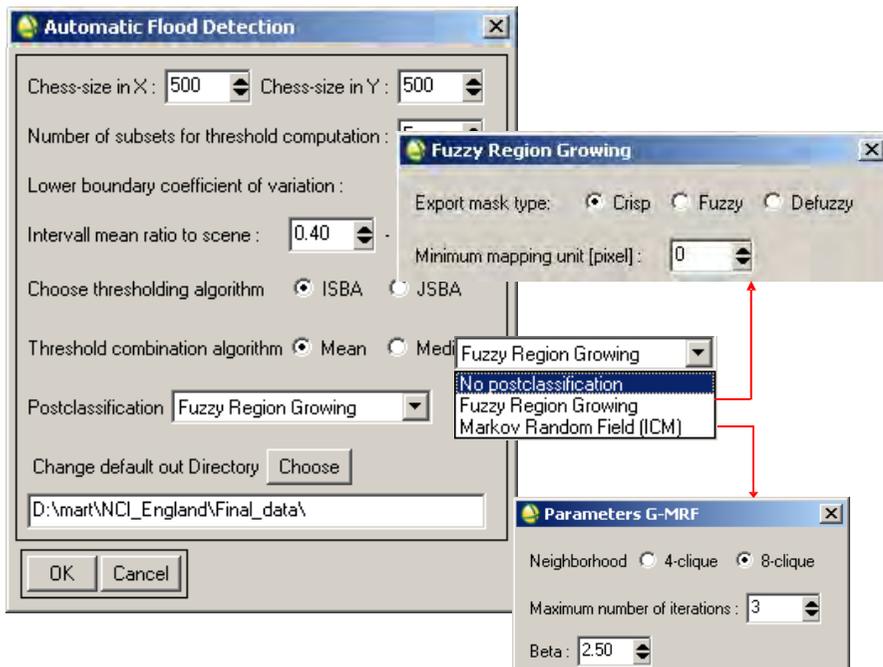
eCognition Developer:
- Automatic and semi-automatic
- Segment-based (multi-scale)
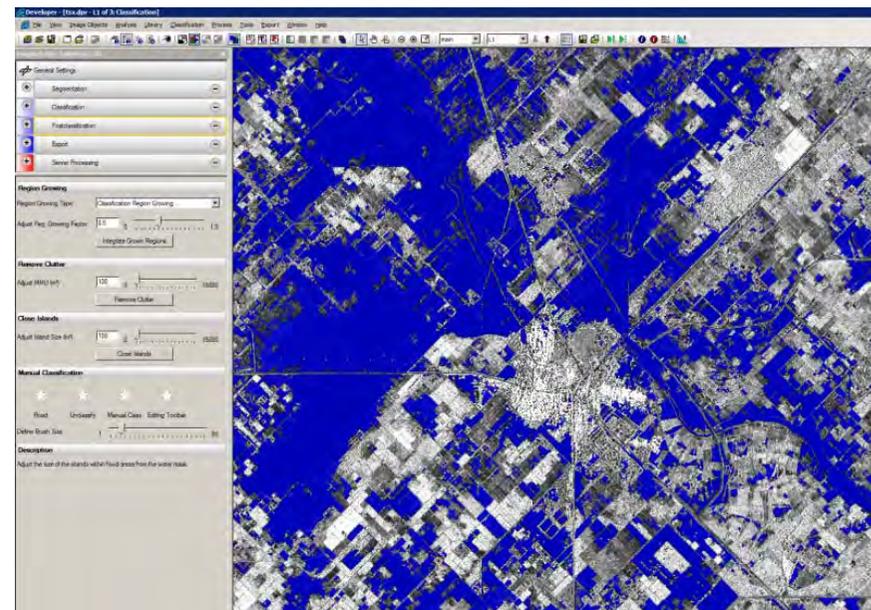
Martinis, S., Twele, A. & Voigt, S., 2011 - IEEE TGRS, 49 (1)
Martinis, S. & Twele, A., 2010 - Remote Sensing, 2 (9)
Martinis, S., Twele, A., Voigt, S., 2009 - NHESS, (9)

DLR/ZKI flood monitoring services

Automated EO-based processing chains and services


MODIS Flood Service

TerraSAR-X Flood Service

Observation Scale

1: 2.000.000   1: 20.000
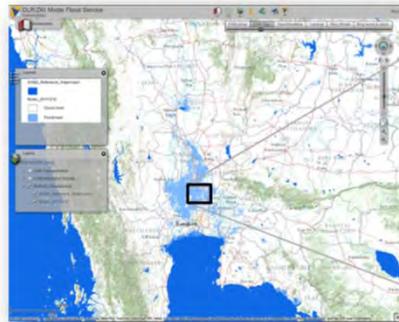
Current focus:


Sentinel-1
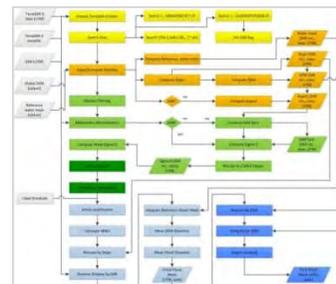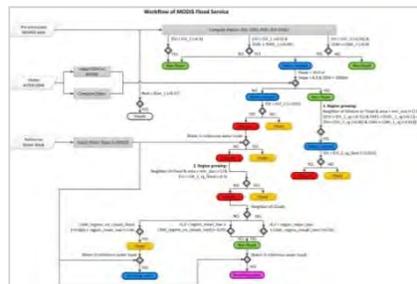
Linking both scales

Flooding in Albania

TerraSAR-X acquisition
20.03.13 (16:32)

MODIS acquisition
18.03.13 (10:33)

TerraSAR-X ordering
19.03.13 (09:32)

Alert

30 km
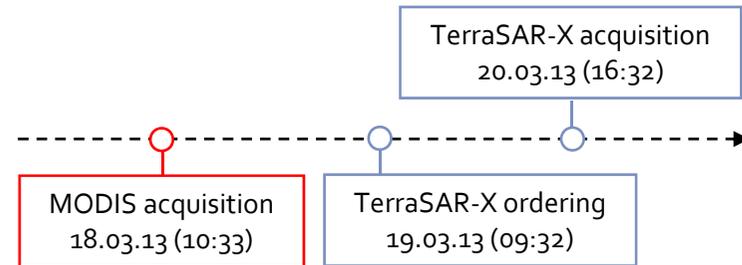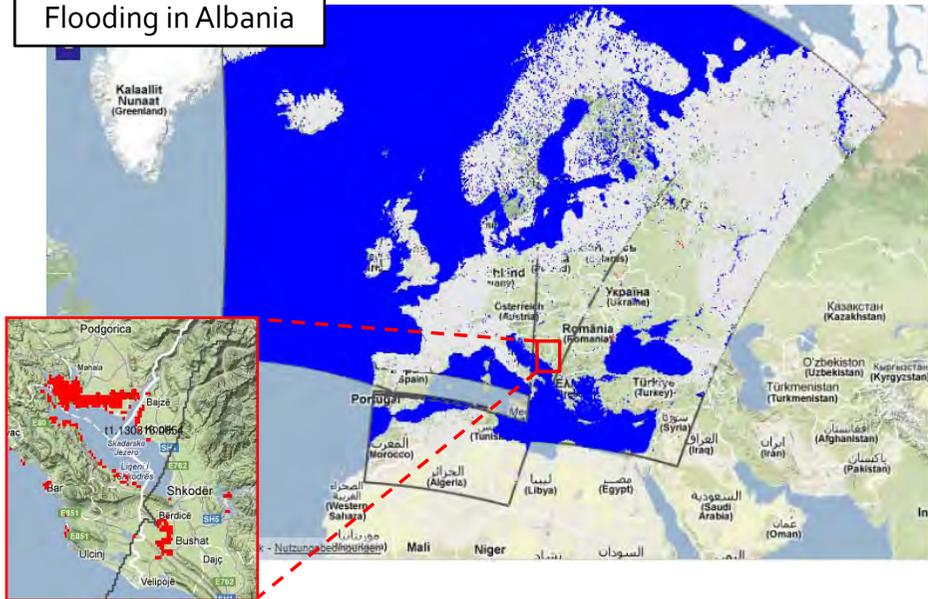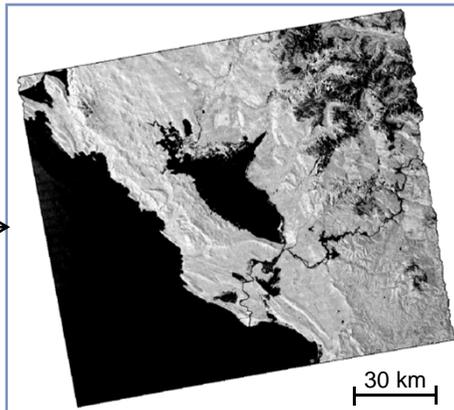
TerraSAR-X SC (20/03/2013)
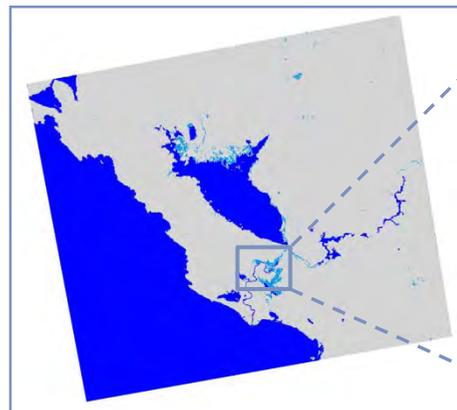
TerraSAR-X flood mask
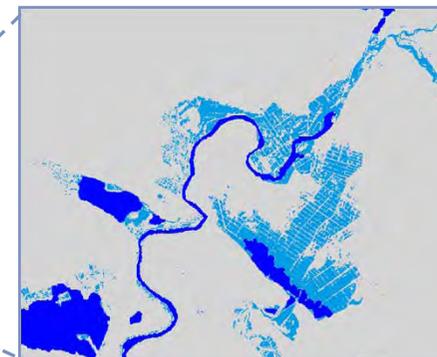
Flood

Standing water

No water

Martinis, S., A. Twele, C. Strobl, J. Kersten, and E. Stein. 2013. A multi-scale flood monitoring system based on fully automatic MODIS and TerraSAR-X processing chains. Remote Sensing

Automatic data ingestion when new satellite data is available (e.g. through LANCE-MODIS, TerraSAR-X delivery server, Sentinel Collaborative Ground Segment)

Automatic data preprocessing (radiometric calibration, reprojection to lat/lon) and **adaption/computation of auxiliary data** (e.g. DEM-information, reference water)

Thematic analysis with a high degree of robustness and transferability (e.g. automatic land/water threshold derviation). A high thematic accuracy needs to be assured independent from different environmental conditions and satellite acquisition parameters.

Storage of derived information in a geodatabase and **dissemination** of flood products via an interactive webclient

MODIS flood service

TerraSAR-X flood service
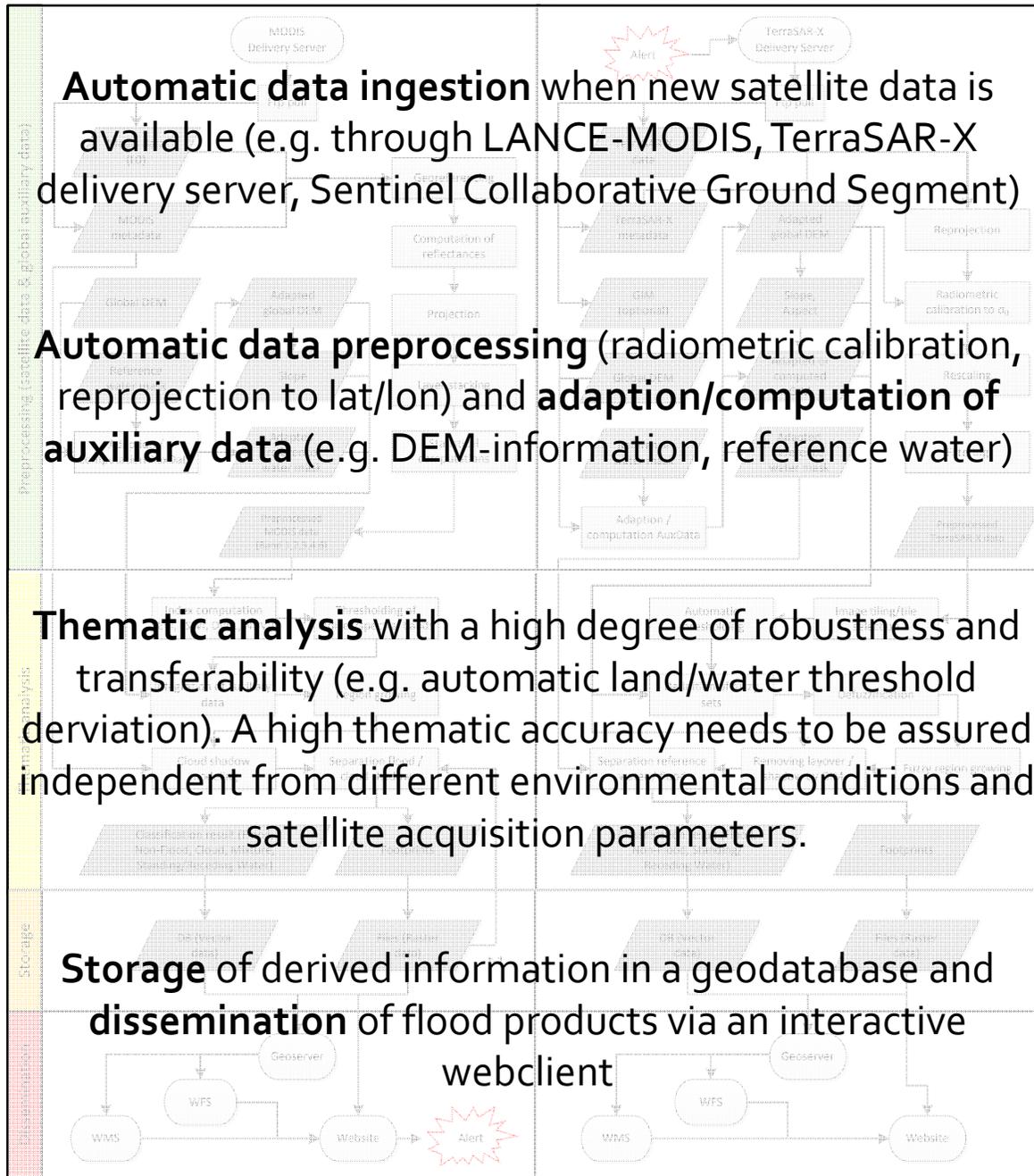
Martinis, S., A. Twele, C. Strobl, J. Kersten, and E. Stein. 2013. A multi-scale flood monitoring system based on fully automatic MODIS and TerraSAR-X processing chains. Remote Sensing

Example: MODIS Flood Service
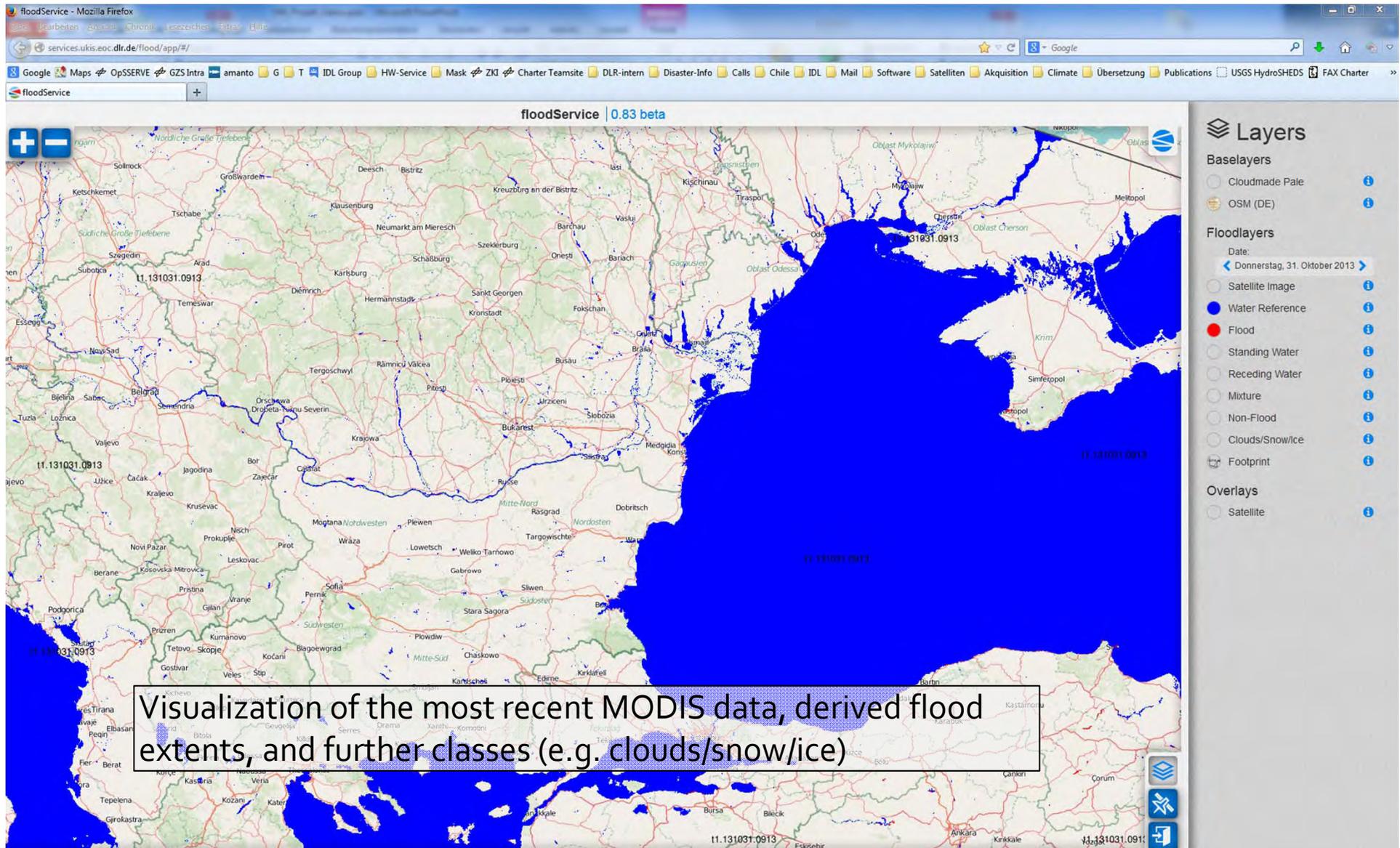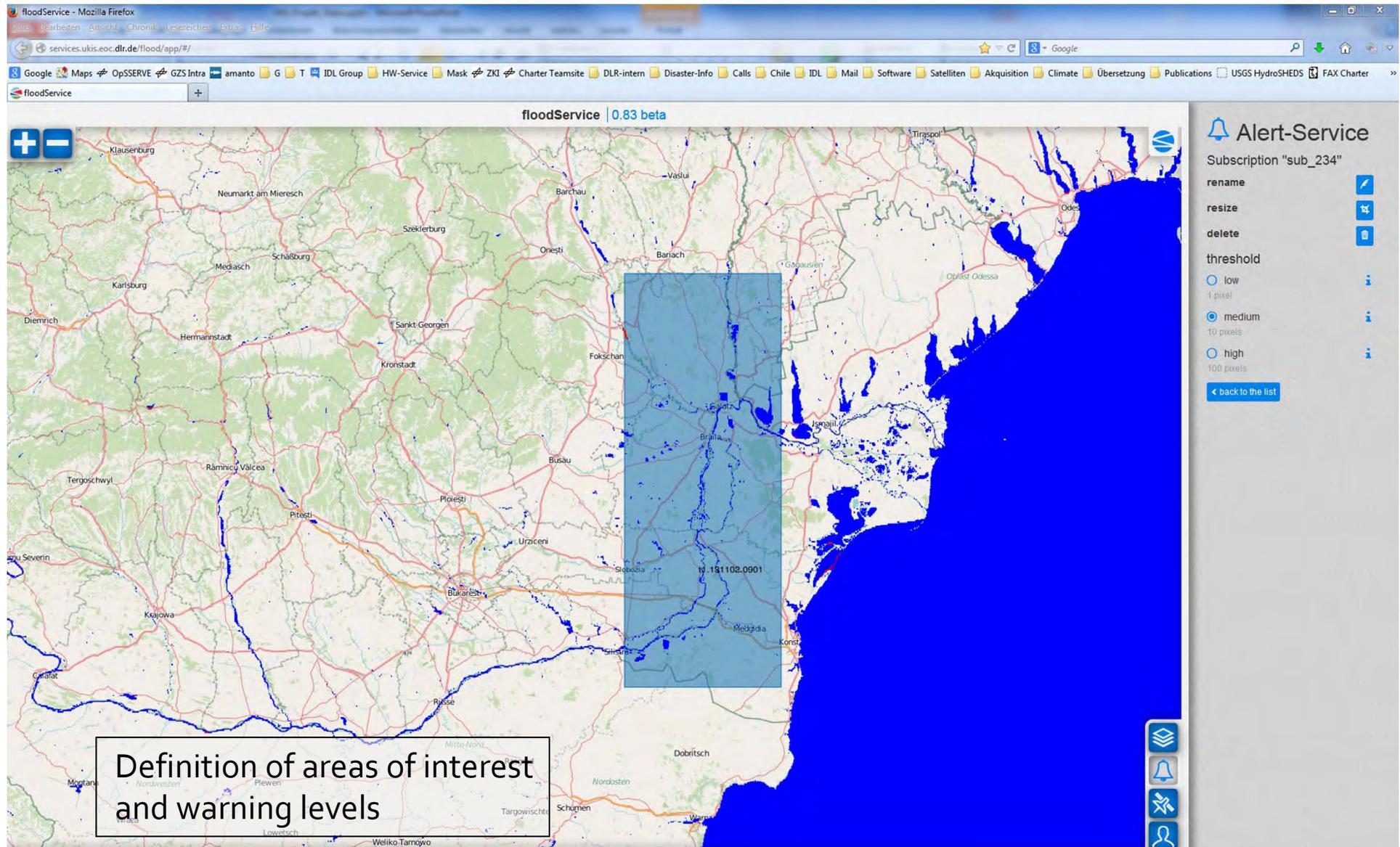
Visualization of the most recent MODIS data, derived flood extents, and further classes (e.g. clouds/snow/ice)

Example: MODIS Flood Service

Definition of areas of interest and warning levels

Example: MODIS Flood Service

Monitoring & Alerting Service:
Automatic alert notifications by SMS or Email
according to user-defined parameters/AOIs

Example: TerraSAR-X flood service

TerraSAR-X StripMap, 26-05-2014, Bosnia and Herzegovina/Croatia

Example: TerraSAR-X flood service
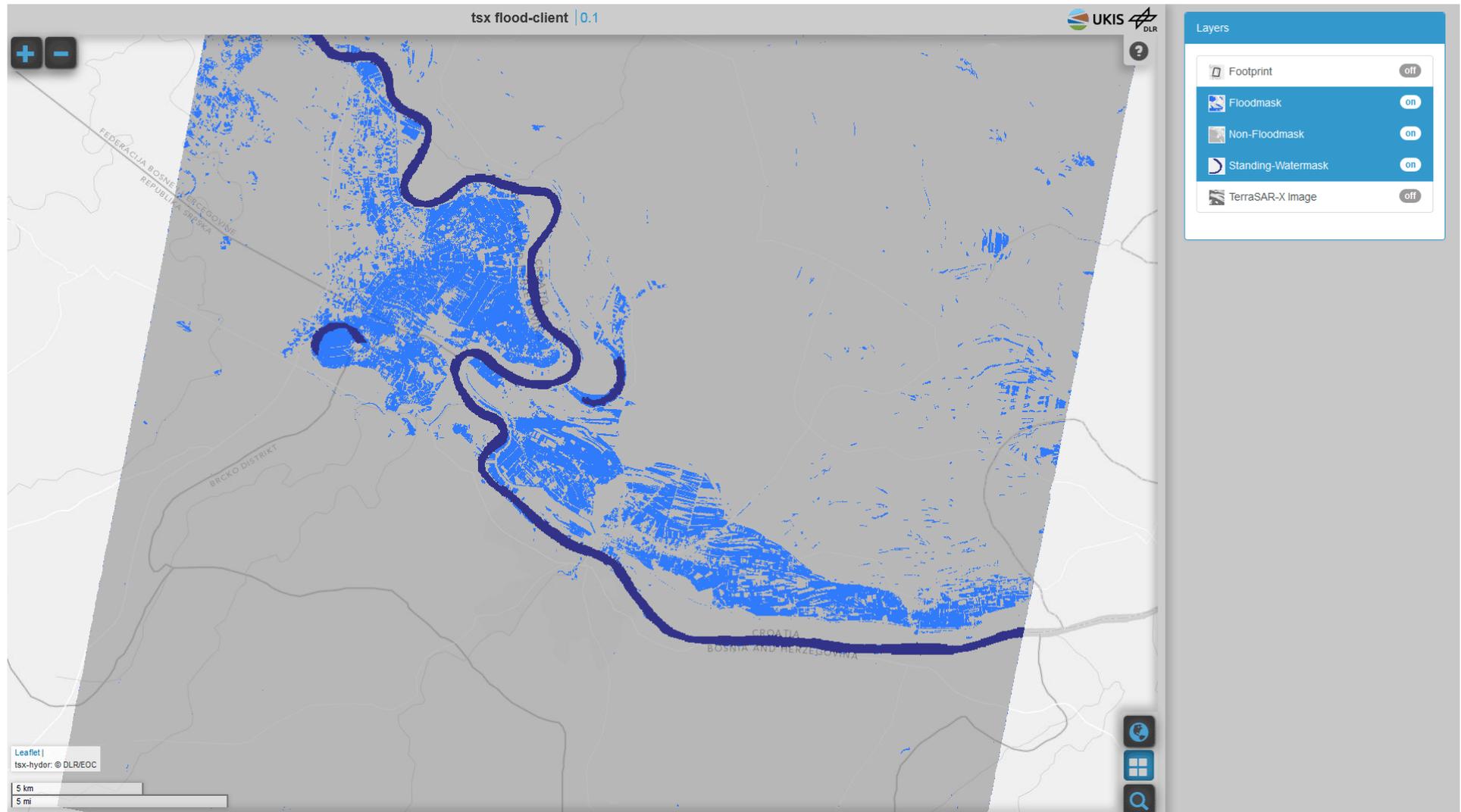
TerraSAR-X StripMap, 26-05-2014, Bosnia and Herzegovina/Croatia

Outlook: Sentinel-1 flood service
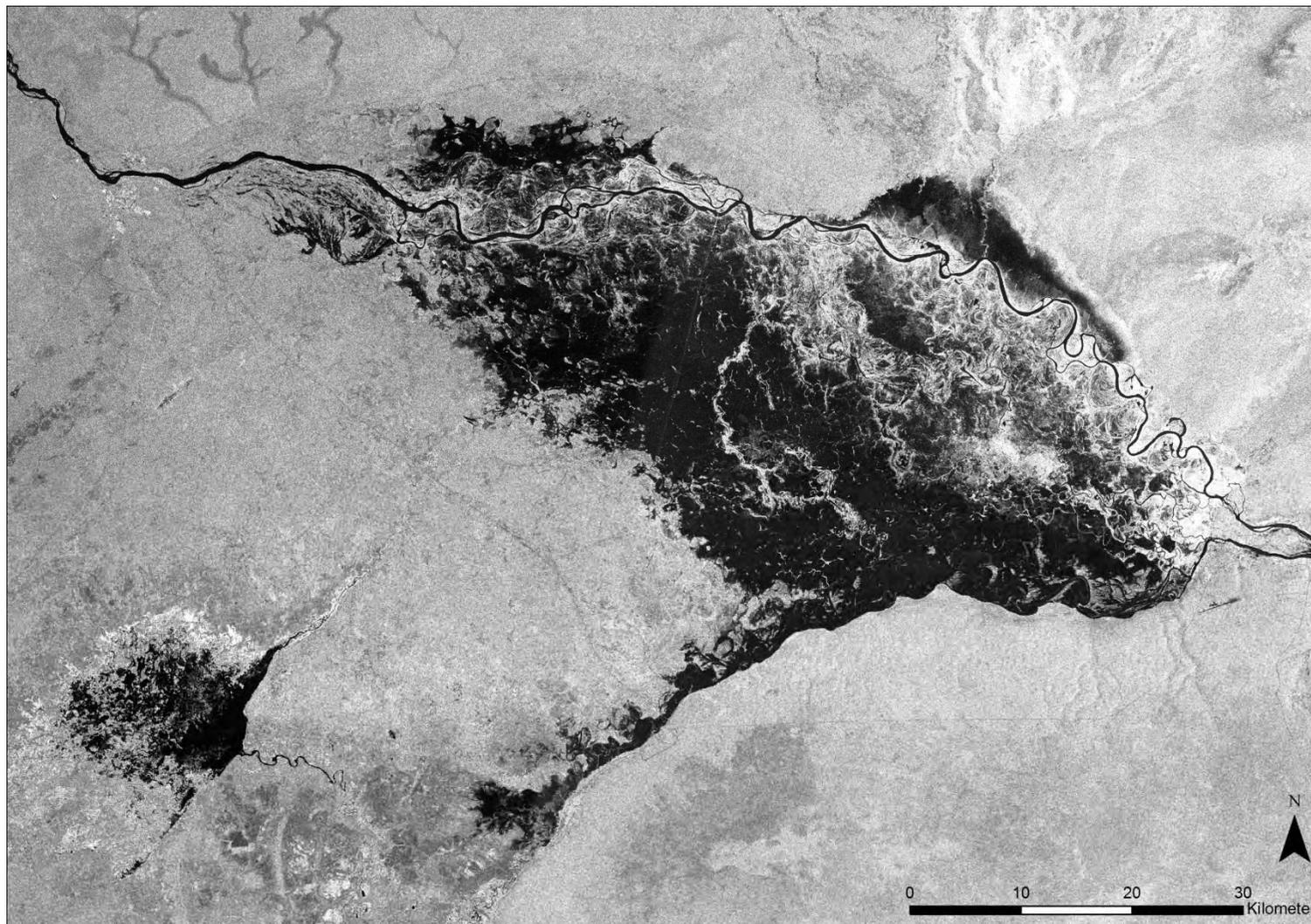
Sentinel-1 IWS
13-04-2014
Namibia, Zambezi river
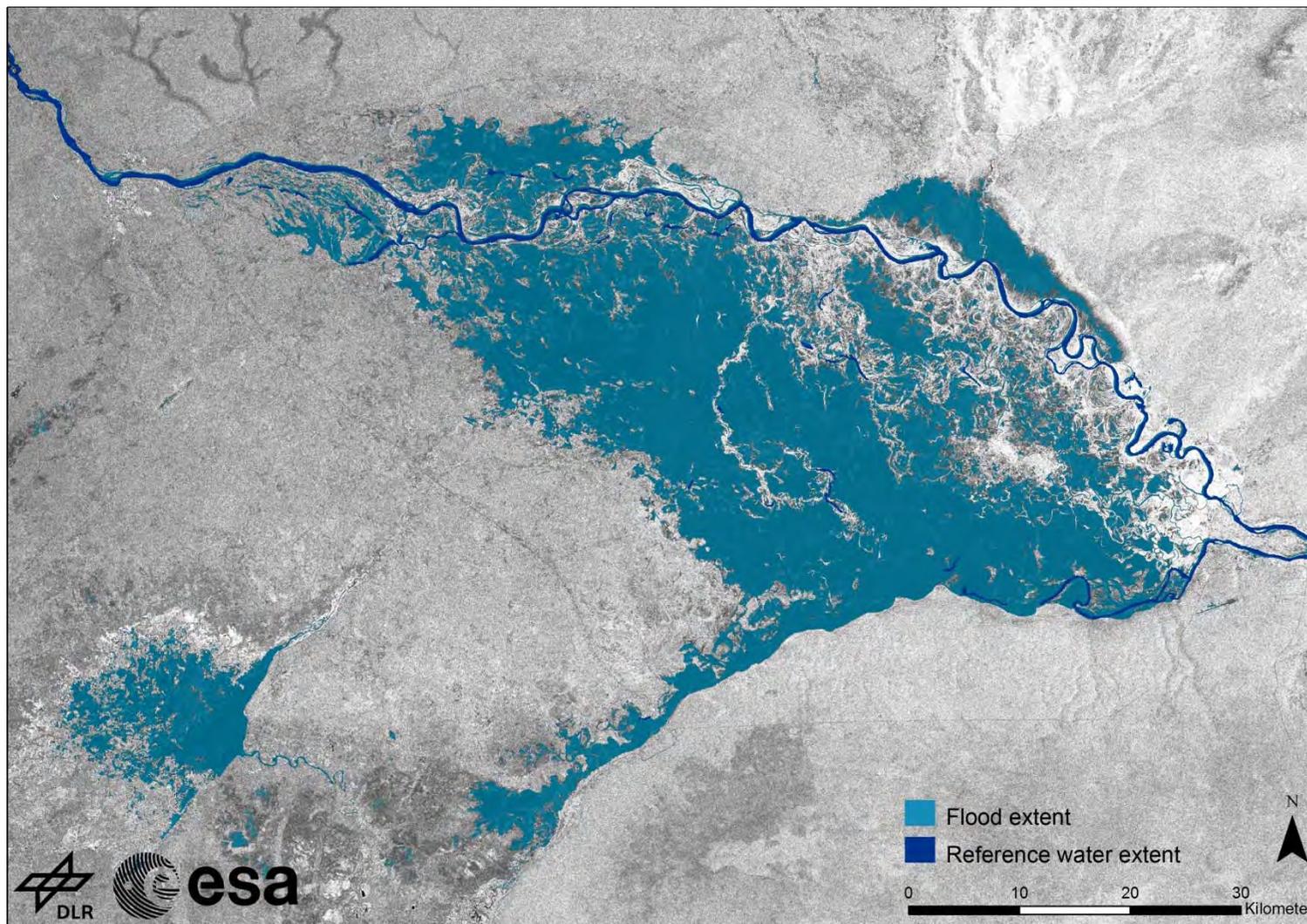
Outlook: Sentinel-1 flood service

Flood extent
Reference water extent

Sentinel-1 IWS
13-04-2014
Namibia, Zambezi river

Outlook: Sentinel-1 flood service
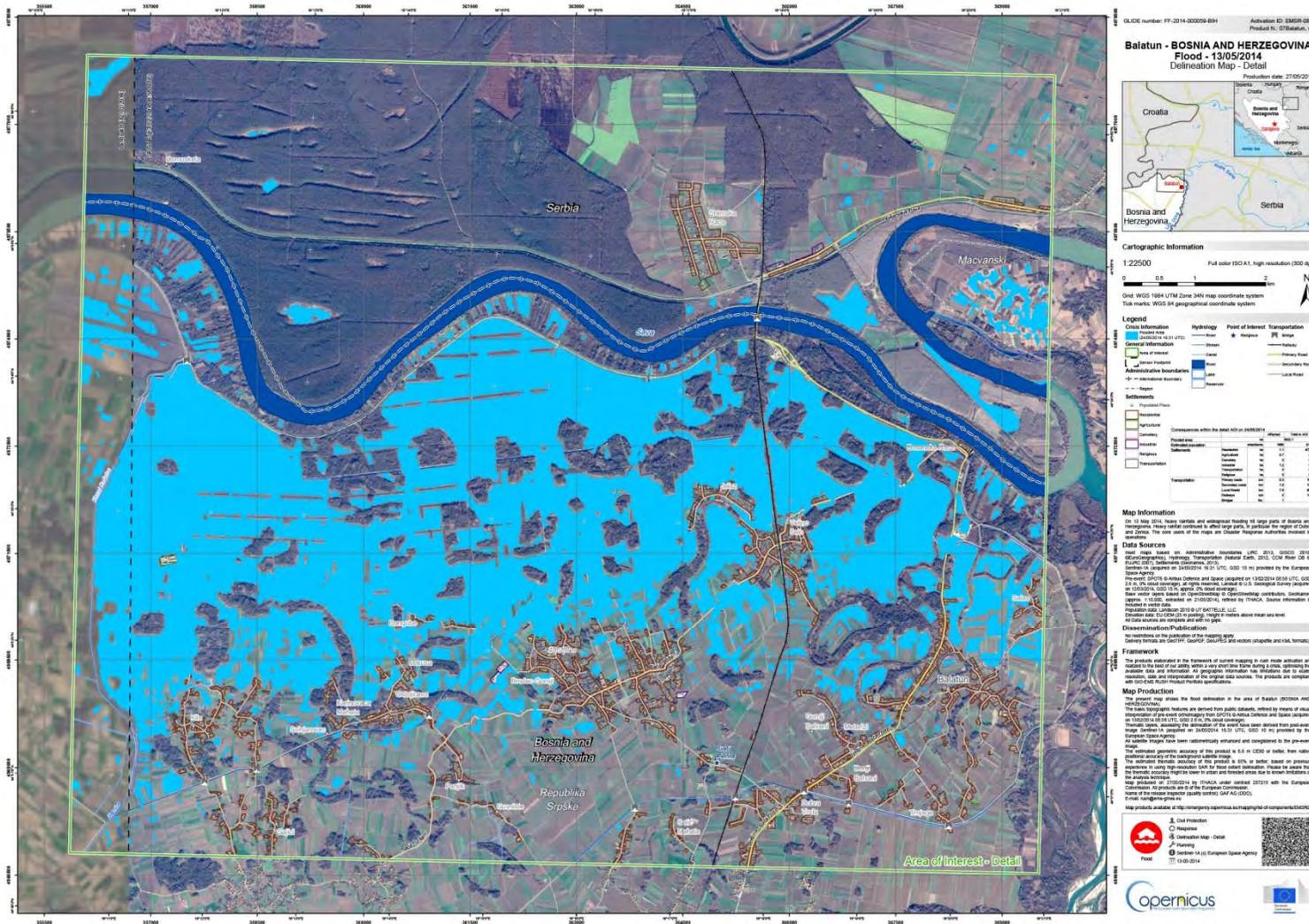
Sentinel-1 IWS, 24-05-2014
Map produced by
Copernicus Emergency
Management Service (EMS)

Outlook: Sentinel-1 flood service
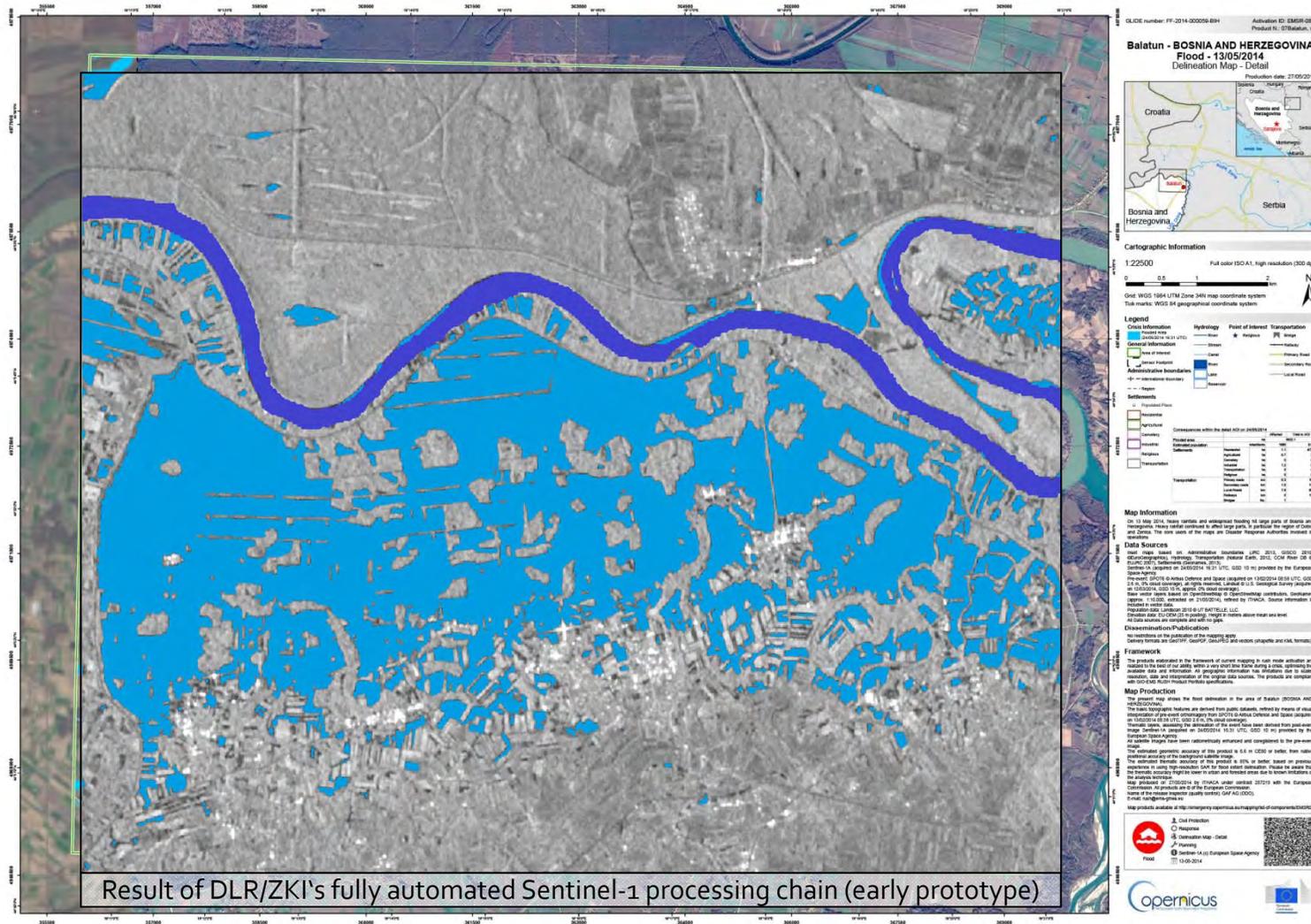
Result of DLR/ZKI's fully automated Sentinel-1 processing chain (early prototype)

Sentinel-1 IWS, 24-05-2014
Map produced by
Copernicus Emergency
Management Service (EMS)

Application cases of flood services

Flood Services (MODIS, TerraSAR-X, Sentinel-1, etc.)

Early Warning/Monitoring
(using daily acquired data)

Alert

Combination with ancillary geodata:
rapid loss estimation, exposure
mapping, risk assessment

Detailed NRT flood assessment
(using HR/VHR SAR data)

Base layer for subsequent
rapid mapping products
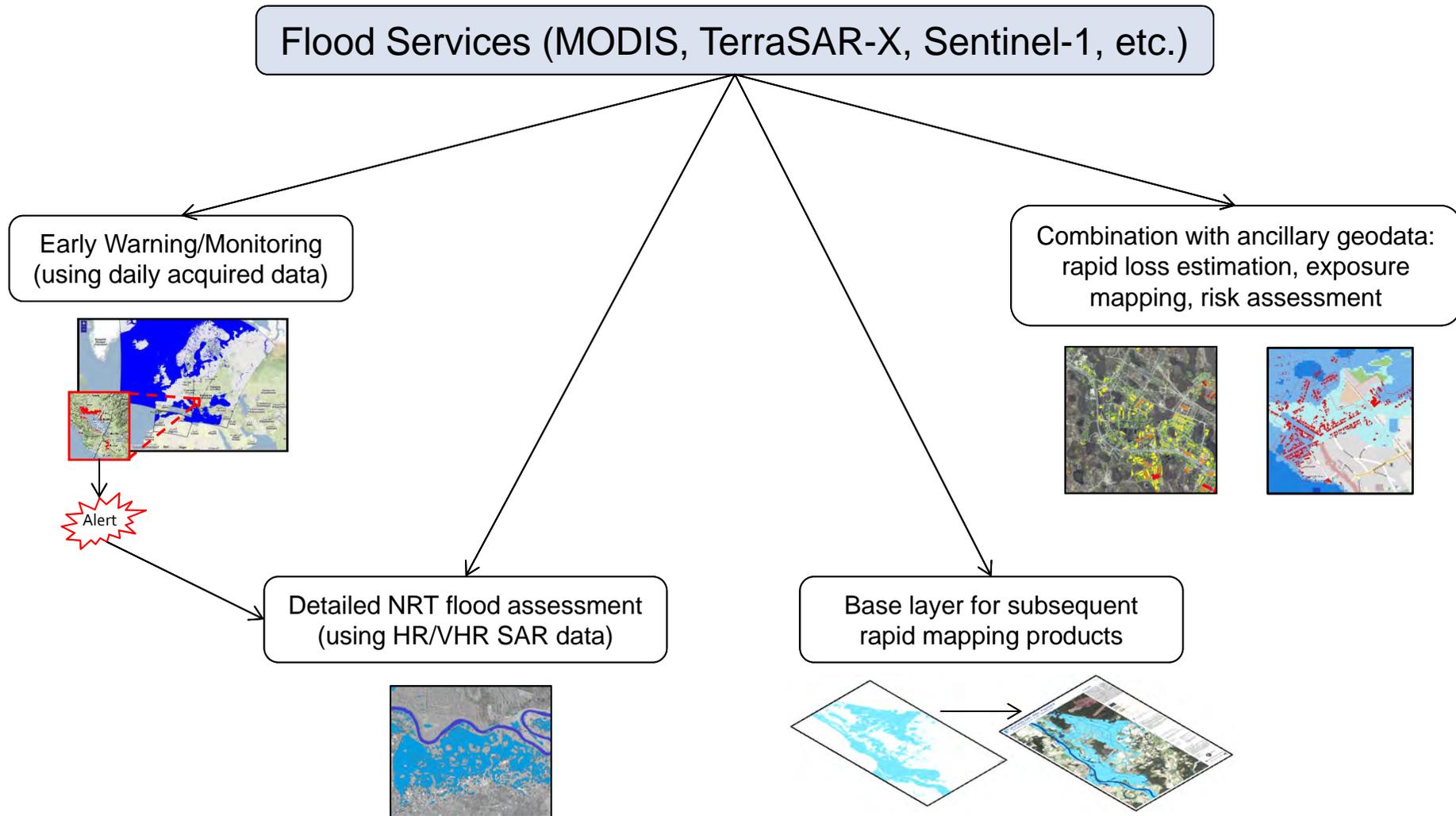
Quantifying Risk

Risk = f { Hazard, **<u>Exposure</u>**, Vulnerability }

Potentially damaging event

- Likelihood
- Magnitude
- Duration
- Speed
- Spatial extent

Sentinel-3   Sentinel-1

MODIS Flood Service   TerraSAR-X Flood Service

Observation Scale

1: 2.000.000   1: 20.000

Objects potentially adversely affected

- People
- Property
- Infrastructure

Present attribute that decribes possible future harm

- Physical
- Social
- Economic
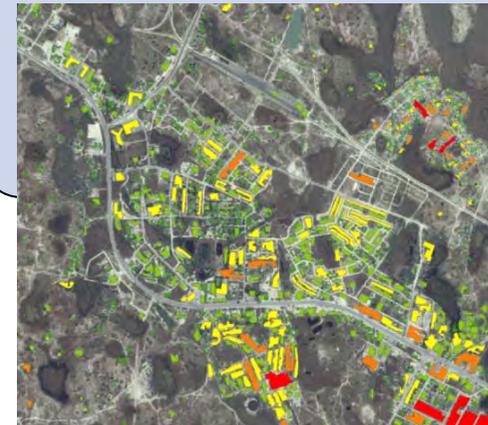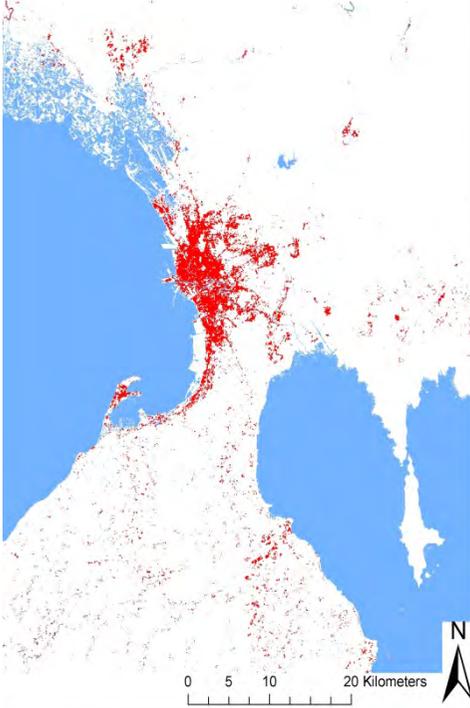
Manila, 1975   Manila, 1990   Manila, 2000   Manila, 2010
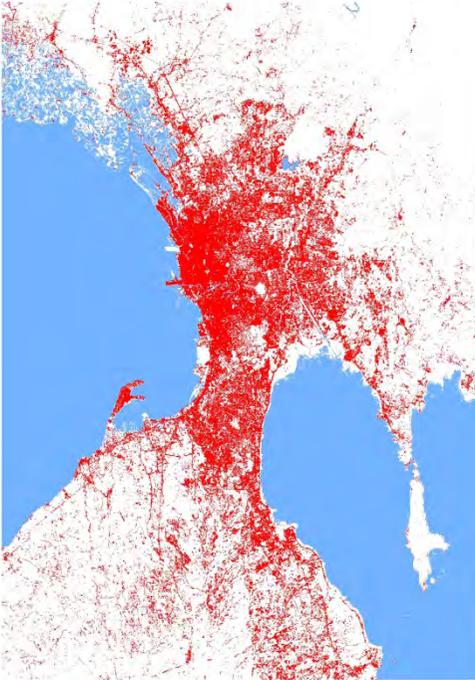
0 5 10   20 Kilometers

N
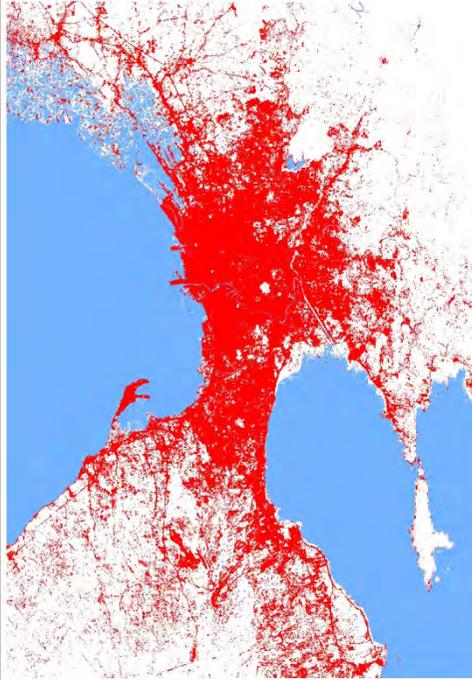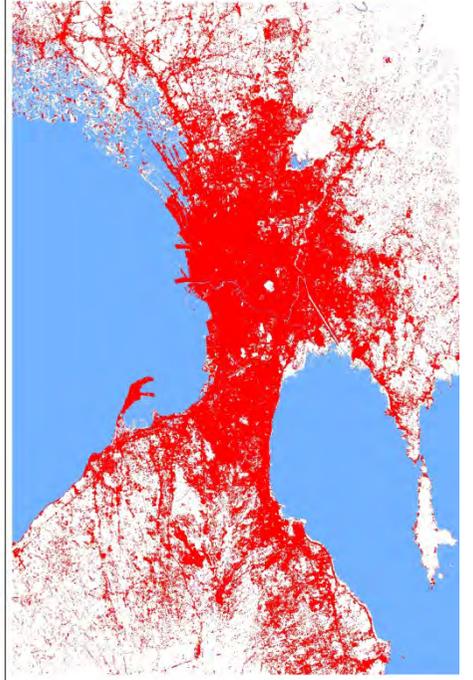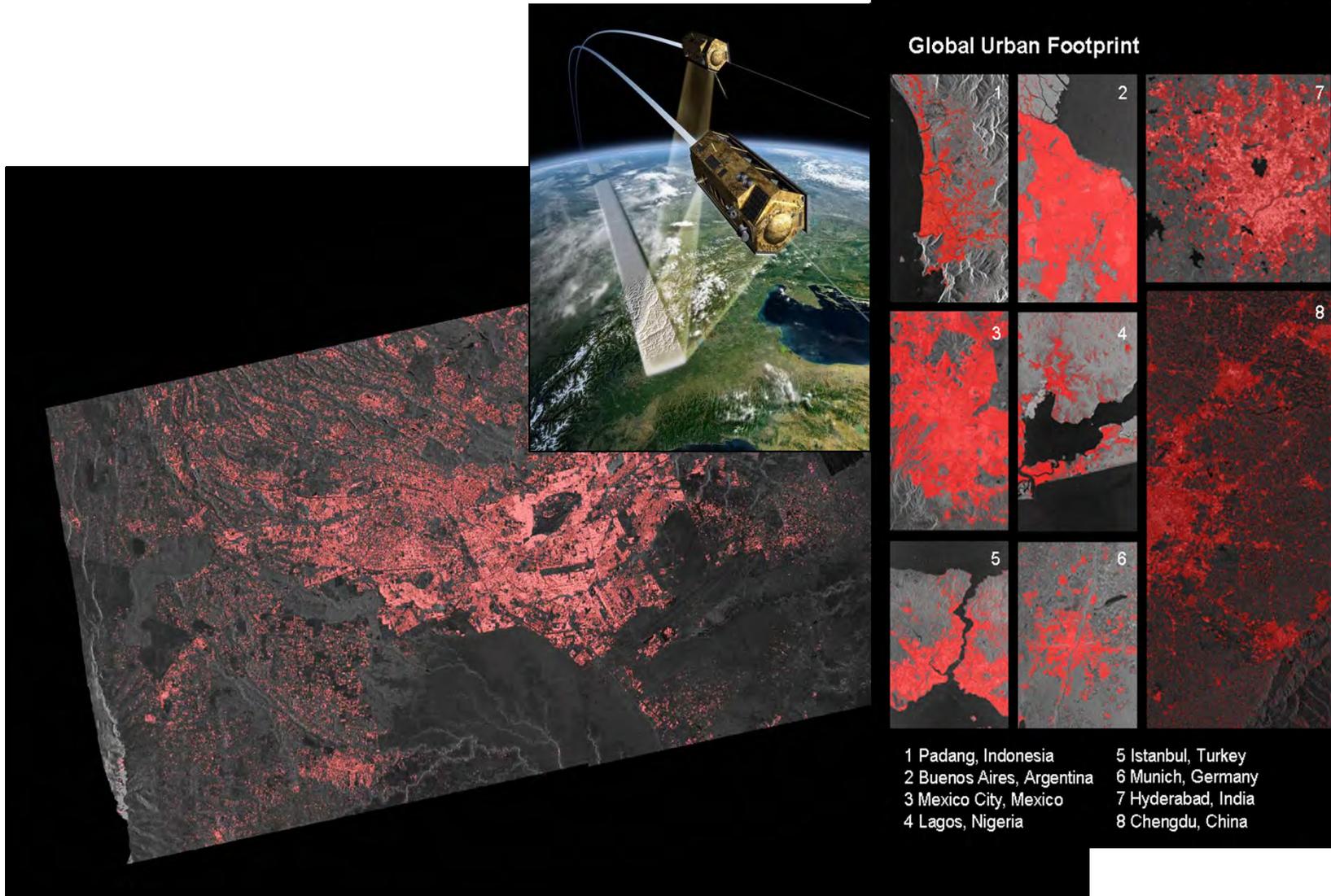
Mapping of urban areas from TerraSAR-X data (3m), Nairobi, Kenya

City
Stadtbezirk

District
Statistischer Bezirk

Block

Building

0 0,5 1   2 Kilometer

b)

c)

b)
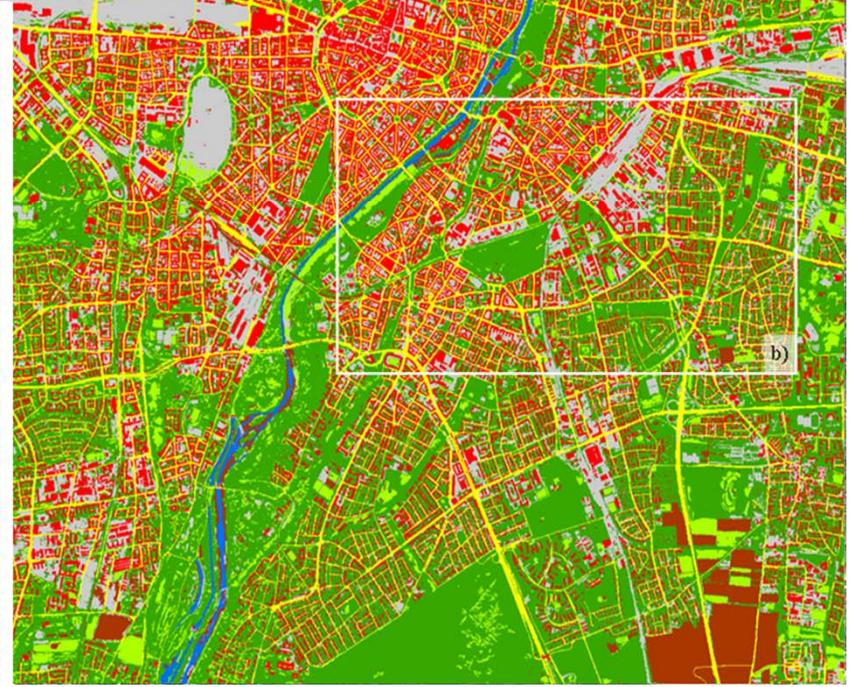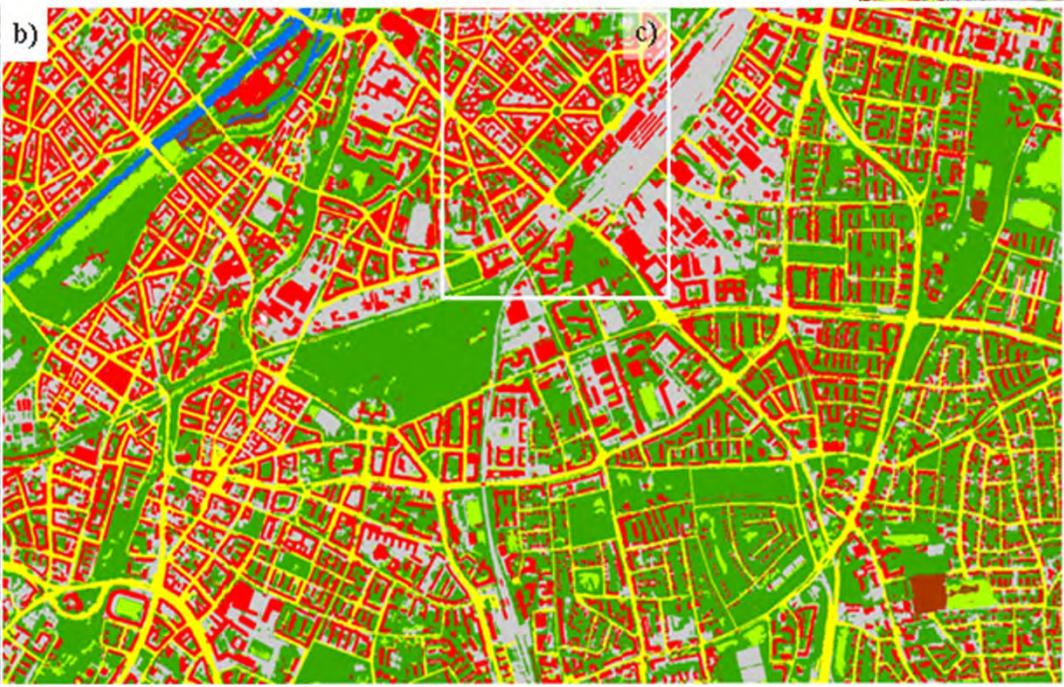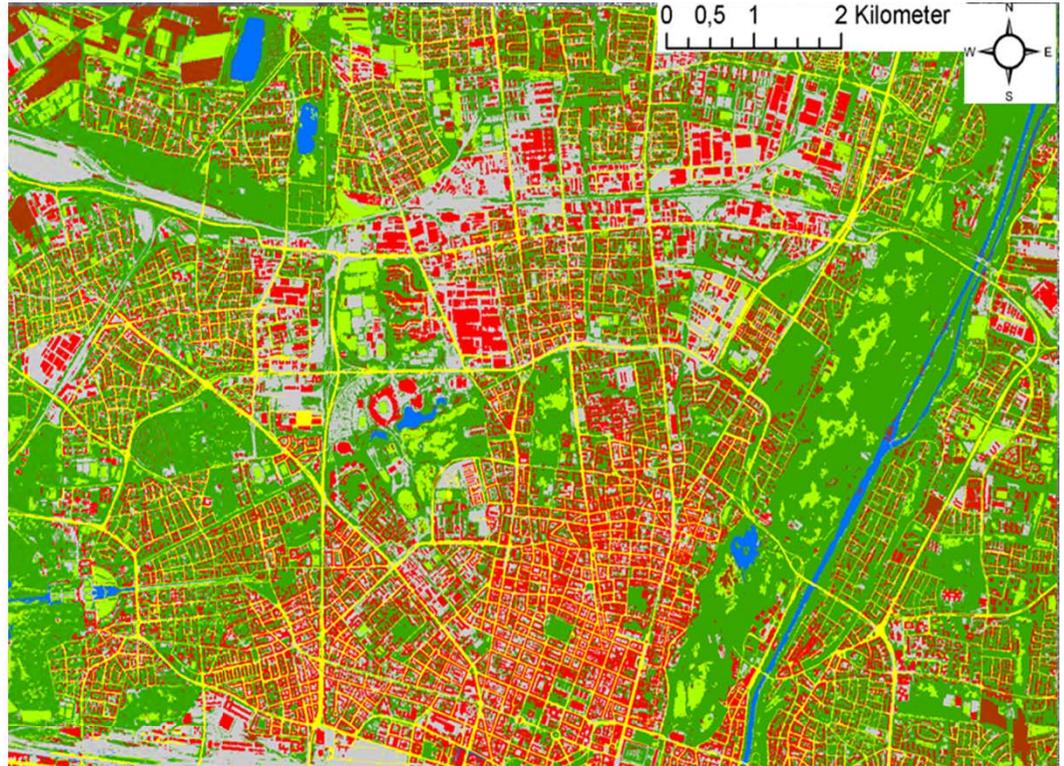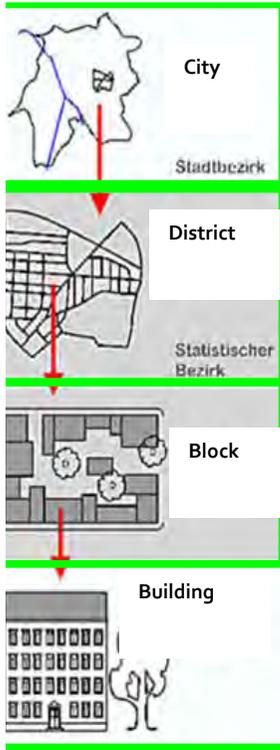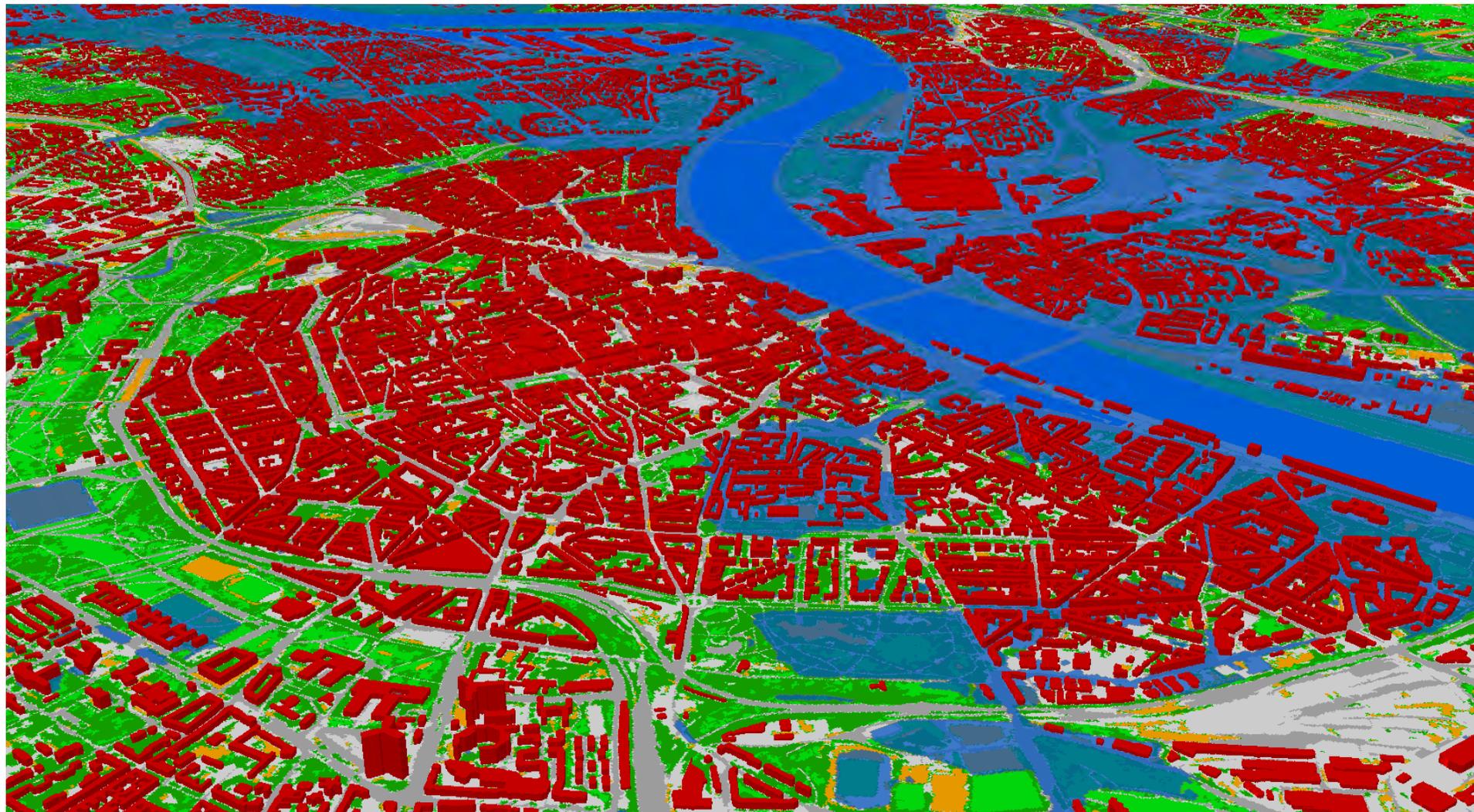
Flood extent

| Building	Number	Percentage
Sum	156	100,00%
< 100 m²	7	4,5%
100 m² – <250 m²	17	10,9%
250 m² – <500 m²	122	78,2%
>500 m²	10	6,4%

Rapid Flood Loss Estimation

Sentinel-3

Sentinel-1

MODIS Flood Service

TerraSAR-X Flood Service

Observation Scale

1: 2.000.000

1: 20.000

+
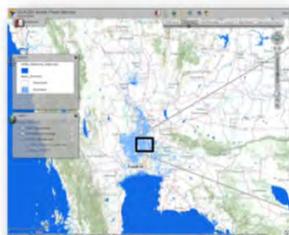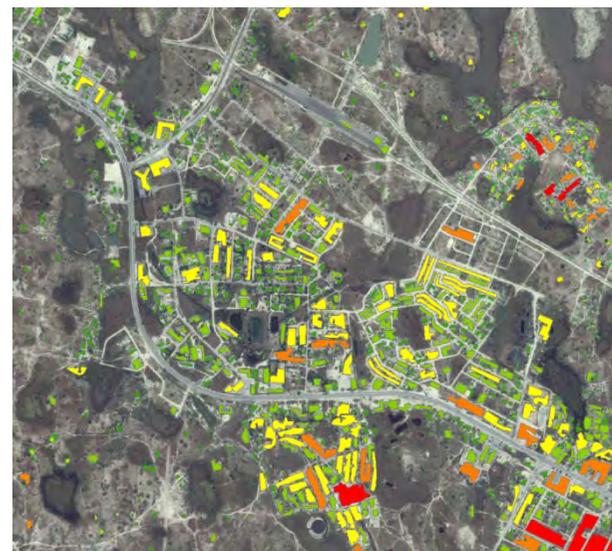
Building inventory / Population information
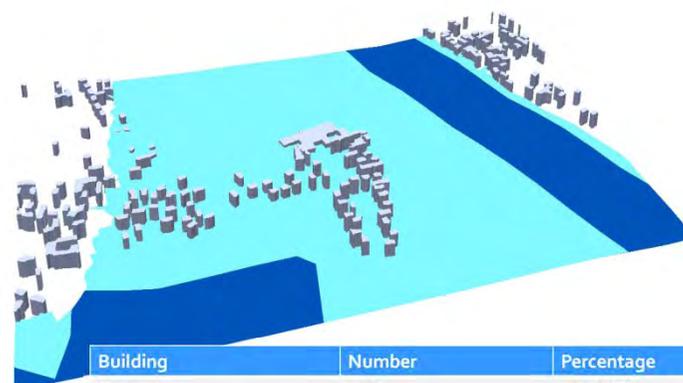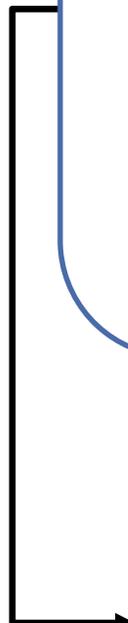
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