The new Sentinel-1 based global flood monitoring product of the Copernicus Emergency Management Service

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Emergency Management

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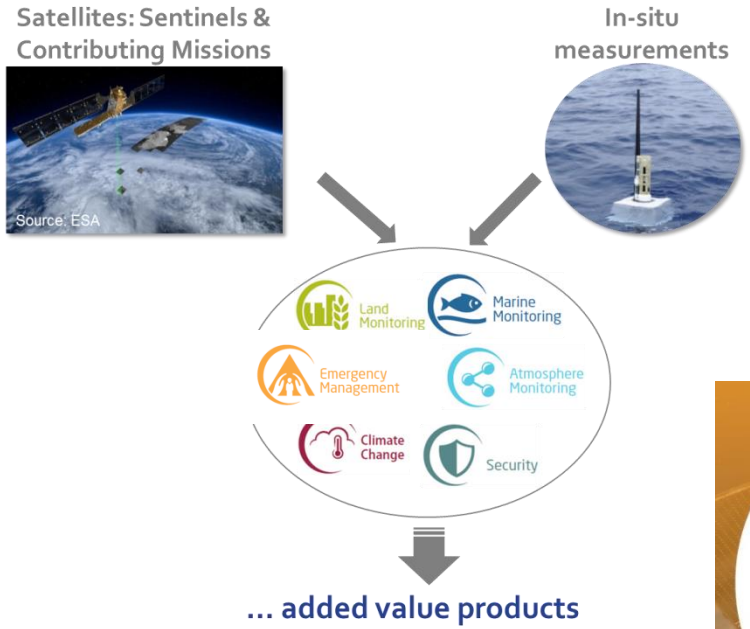
EU's Earth Observation Programme



Operational since 2012

- Managed directly by the European Commission via the JRC
- Provides disaster management information based on space data combined with other information
- Supports all phases of the disaster risk management cycle (during, before, after):
  - Preparedness: forecasts and early warnings
  - Emergency Response: increase situational awareness through rapid maps and monitoring of an event
  - Recovery: risk assessment for specific hazards and post-disaster recovery maps

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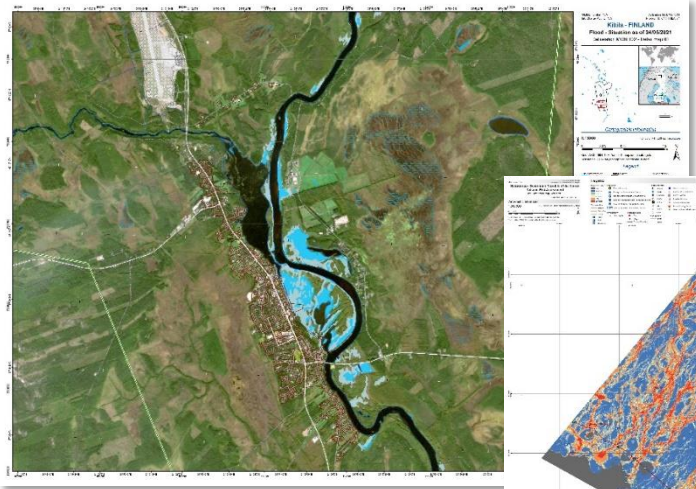
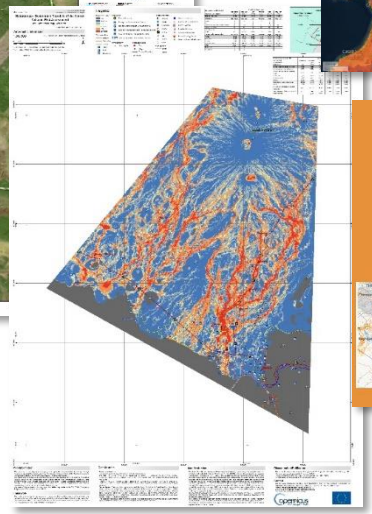
On-demand mapping

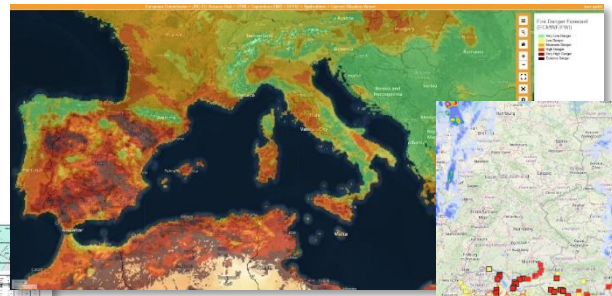
- Rapid Mapping
- Risk and Recovery Mapping

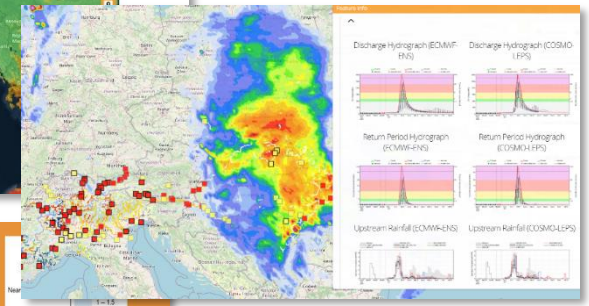
Early warning and monitoring

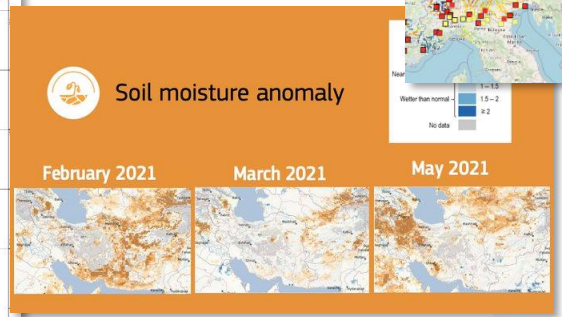
- Floods
- Fires
- Droughts











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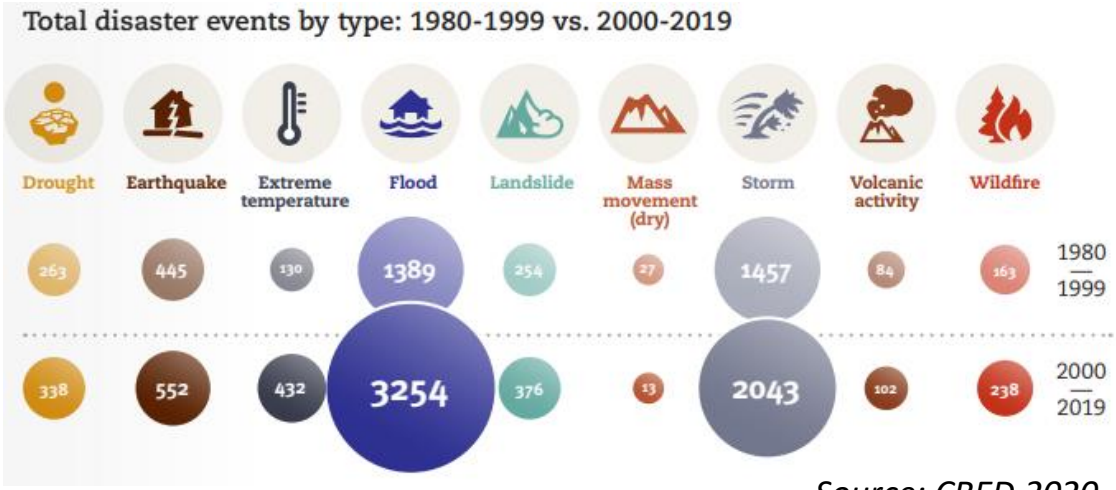
New global flood monitoring product



Source: CRED 2020

User requirements:

- **Timeliness**: better response planning
- **Frequent updates/continuous monitoring**: adapt measures depending on the evolution of the flood
- **Resolution**: needs to be adequate for impact assessment
- **Historic data**: improved prevention planning
- **Access**: as diverse as possible to account for all user needs

CEMS Rapid Mapping component:

- Fast provision of flood extent info from satellite imagery
- 24/7/365 on-demand service

Current limitations:

- No constant automatic monitoring
- Requires user activation
- Activation requests usually arrive late (missing flood peak)
- Currently not possible to map all floods (resource limitations)

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CEMS – automatic global flood monitoring

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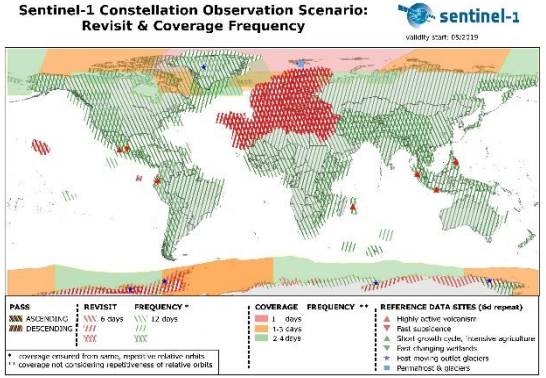
Sentinel-1 based:

- SAR enables **all day and all weather** flood monitoring
- High **spatial resolution of 20 m**
- High **revisit frequency**: Europe **~ 1 – 3 days** World **~ 3 – 14 days**

Automatic:

- **High timeliness** of the product – **less than 8 hours** between sensing and product delivery
- **Continuous monitoring** for large areas



Source: ESA

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	Algorithm 1 LIST	Algorithm 2 DLR	Algorithm 3 TU WIEN
Characteristics	Hierarchical split-based approach enabling re-calibration of parameters in NRT	Fuzzy logic-based approach enabling a post classification and region growing taking advantage of topography-derived indices in addition to SAR backscatter	Exploiting per-pixel full Sentinel-1 signal history in data cube (backscatter probability distribution);
Input remote sensing data	Pair of SAR intensity images acquired from same orbit (any sensor) and model parameters derived from historical time series	Single-temporal SAR intensity data	Single SAR acquisition and model parameters derived from historical time series
Auxiliary data	HAND index map, exclusion layer, reference water layer, water and flood extent map computed at previous time step	HAND index exclusion map, reference water extent, DEM, optional: low backscatter exclusion mask based on S-1 time-series data	HAND index, exclusion mask, reference water map for generating the fresh flooded areas
Exploitation of time series of SAR obs.	Yes (short-term)	No	Yes (long-term)

Ensemble Algorithm (Algorithm 4) “consensus map”

Combine results of Algorithms 1-3 into a single product

Pixel based classification based on number of algorithms detecting a flood based on a majority decision
[flood: value >= 2 | no flood: value < 2]

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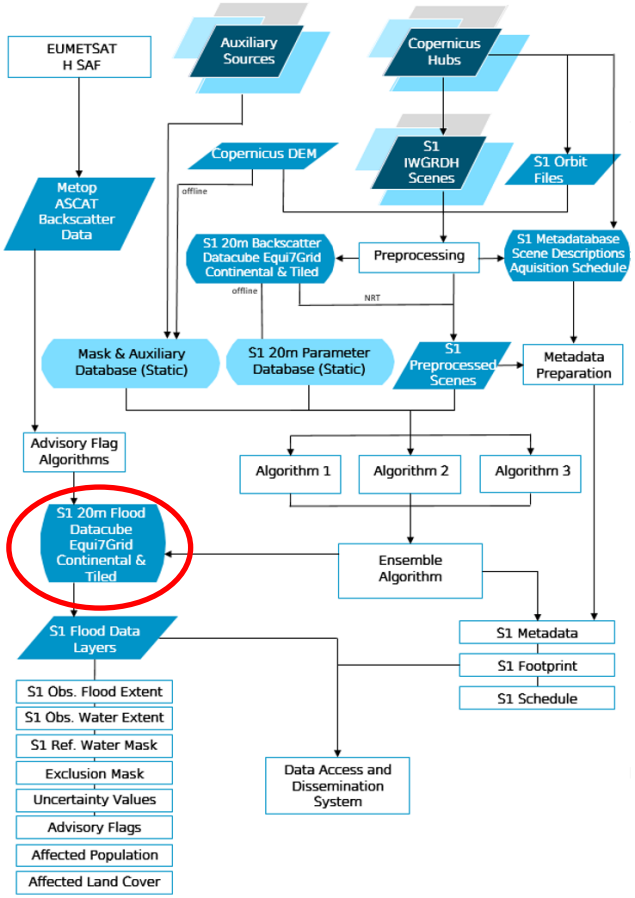
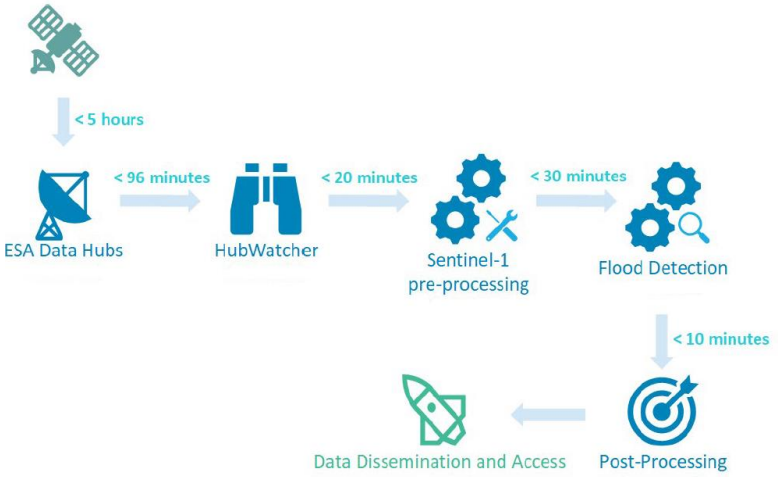
NRT processing chain and timeliness





- ~ 12 auxiliary datasets required to be pre-processed to serve as input
- ~1000 S1IWGRDH scenes to be processed per day
- Data cube principle applied (see talk from Bauer-Marschallinger!)
- 11 output layers will be produced
- Product timeliness of less than 8 hours!

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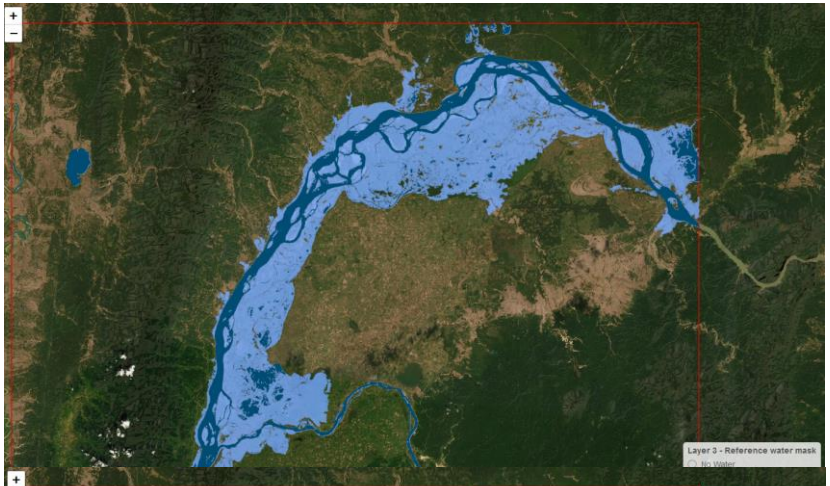
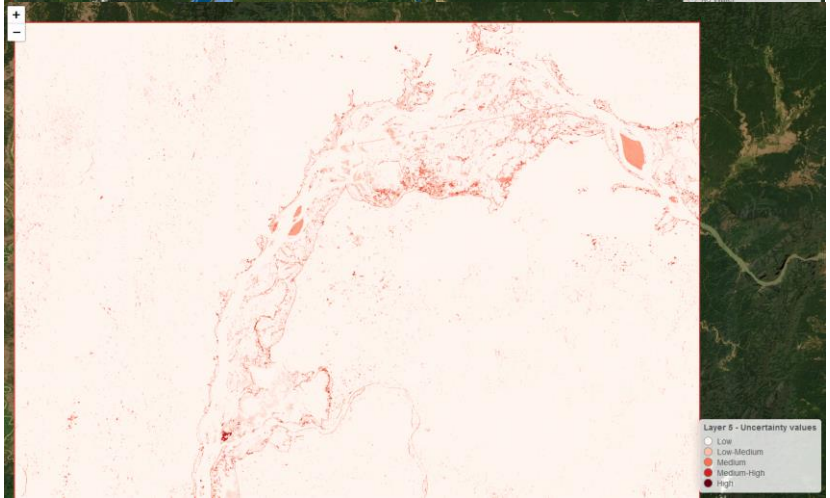
Products:

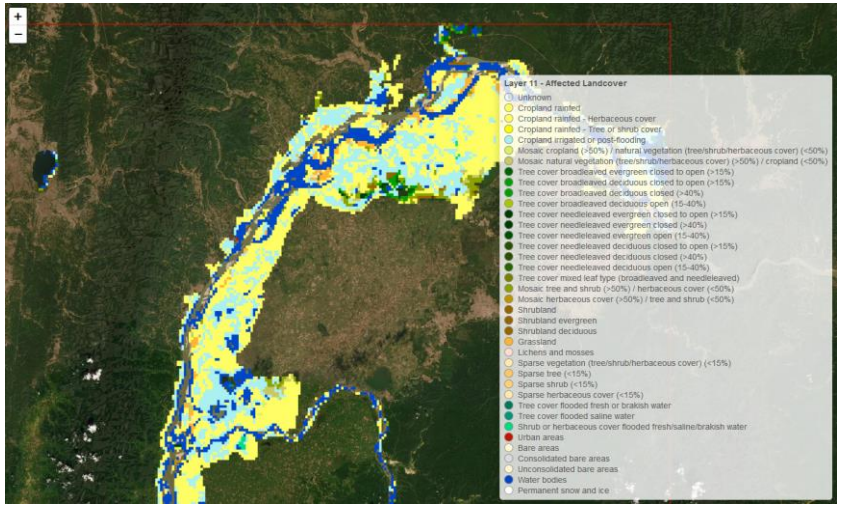
- Observed flood extent
- Reference water mask
  - Seasonal/permanent
  - based on historical Sentinel-1 time-series
- Ensemble uncertainty
- Advisory flags (snow, ice, frost, dry soil, wind)
- Exclusion layer (urban, dense vegetation, radar shadows, low backscatter)

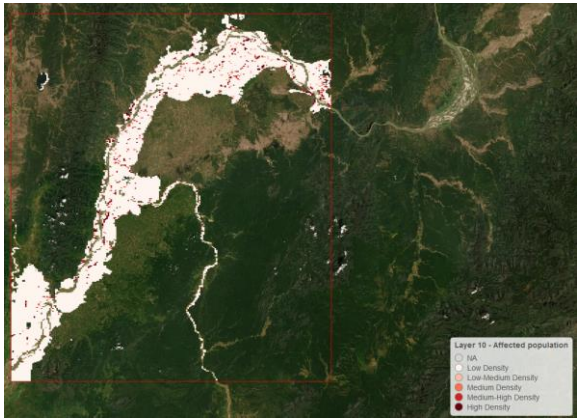




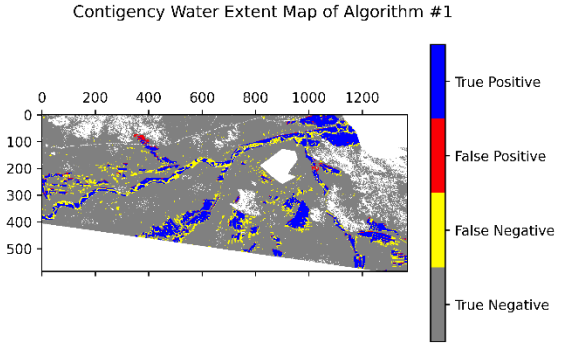
Products:

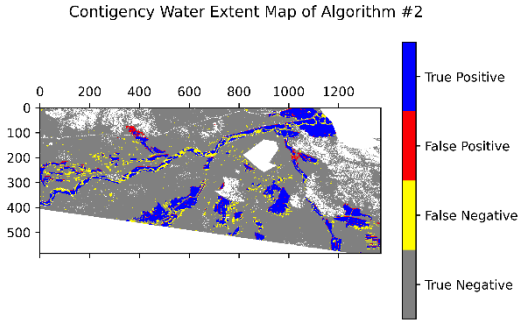
- Impact information
  - Landuse (GlobCover)
  - Population (Global Human Settlement Layer)
- Sentinel 1 metadata - footprint - schedule

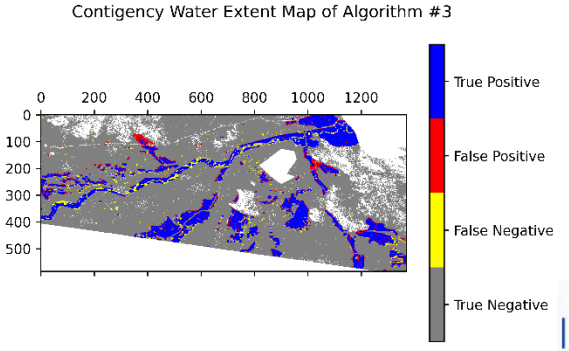




- The Validation is carried out **globally**
- Flooded areas are in general **regions with a very small area** in comparison to the earths land surface - Uniform random sampling is not possible; therefore, a subset must be chosen.
- **Stratified random sampling** reduces the amount of sample points needed and increases the confidence level of the validation.
- Validation datasets from different sources (e.g. Global Surface Water Explorer, etc.)





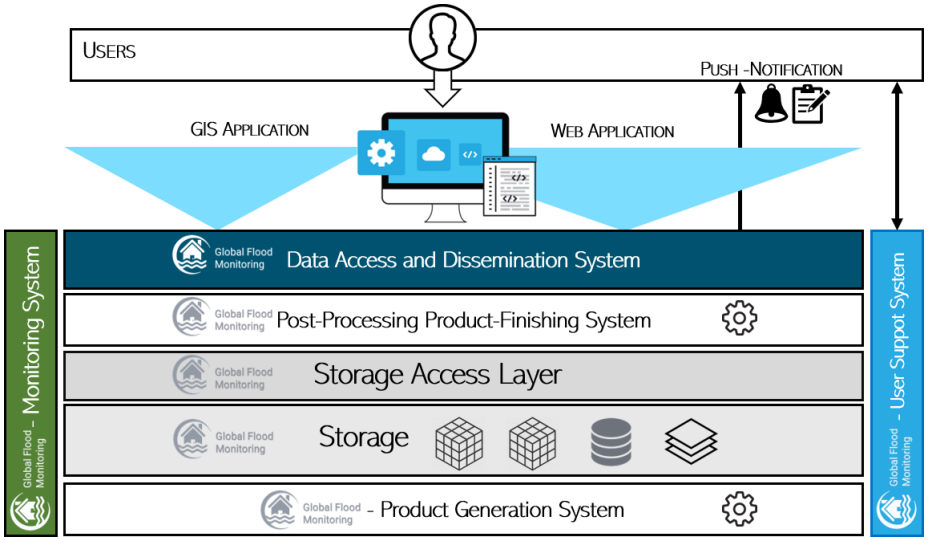


Product access:

- Free and open
- EFAS & GloFAS web interface
- Web services (WMS)
- API

Planned implementation timeline:

- Start: November 2020
- Operational: September 2021



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