Evaluation of the satellite-based Global Flood Detection System (GFDS) for measuring river discharge

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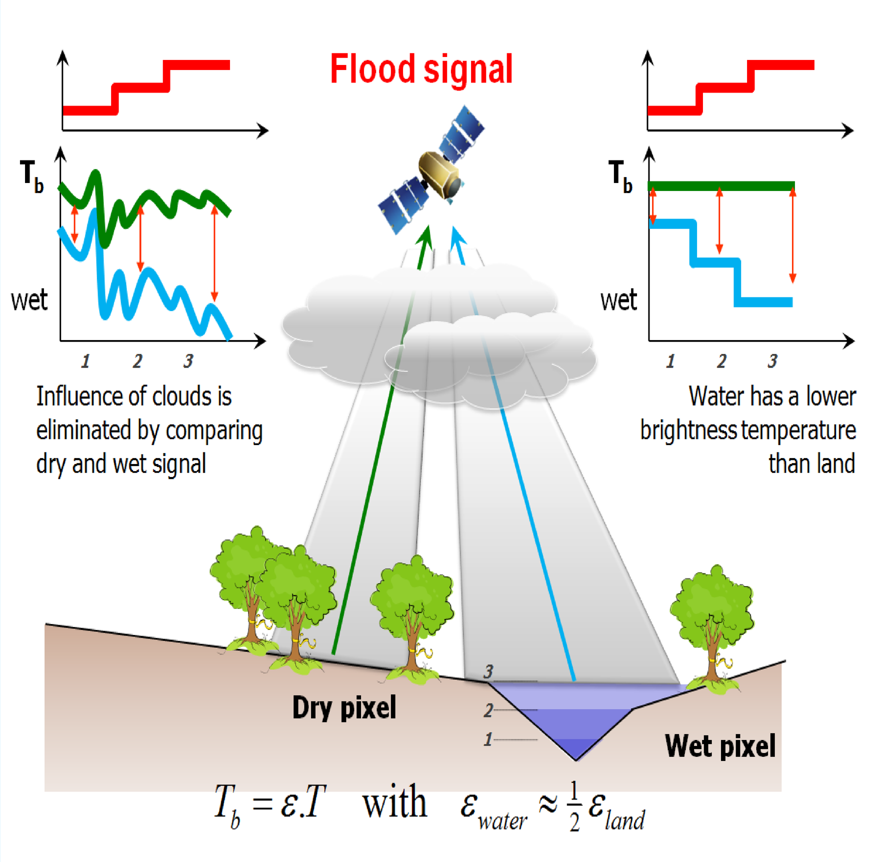
European Commission

1. Motivation: Scarce availability of real-time river discharge data

- **Challenge:** Limited availability of observational data for calibration and model verification, especially for real time applications.
- **Possible solution**: Use of satellite-based discharge measurements to substitute real-time ground measurements.
- **Aim**: test the Global Flood Detection System (GFDS) on a Global scale for converting the flood detection signal into river discharge measurements and assess influence of local characteristics.

2. Flood Detection: Global Flood Detection System



Space-based river gauging and flood monitoring system using passive microwave remote sensing. Measures **daily water surface changes**[1]. Footprint size ~ 8x12km.

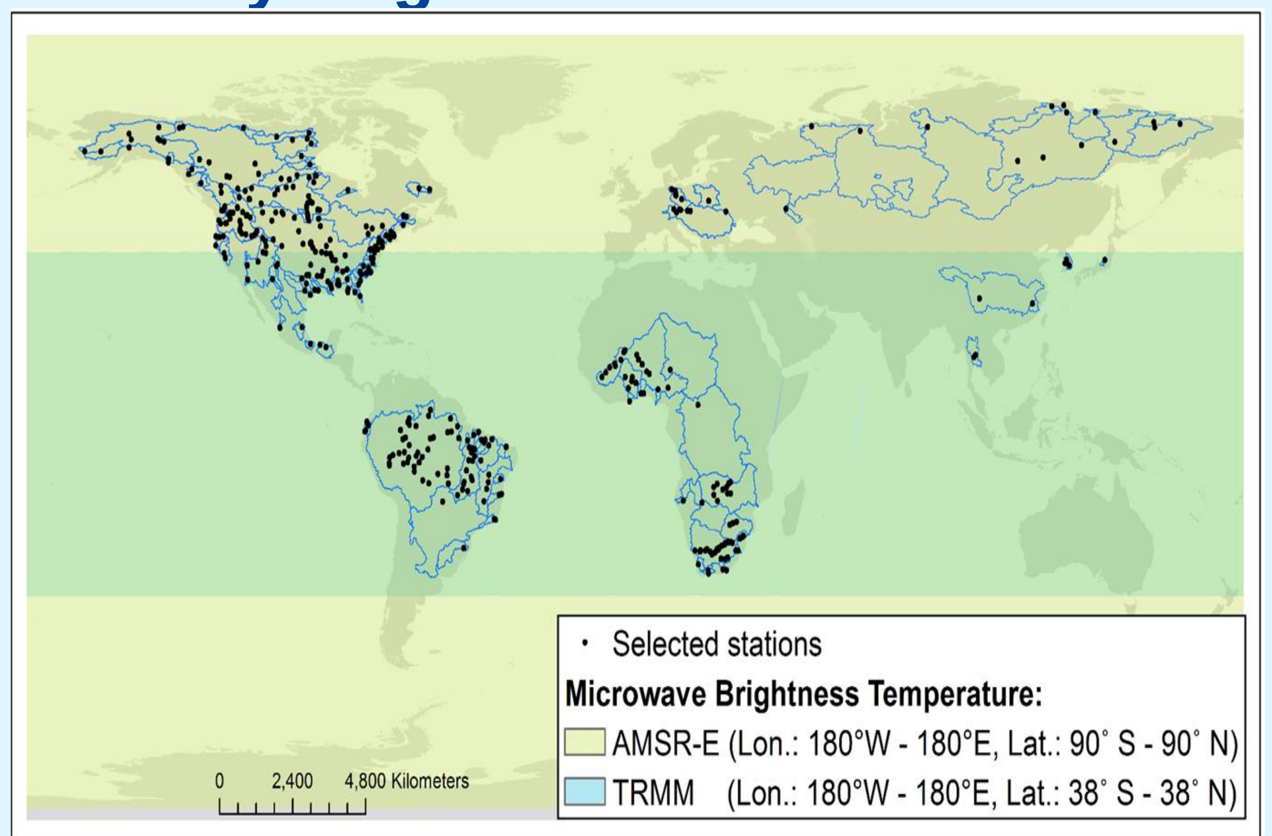
Developed by the Joint Research Centre (JRC) and Dartmouth Flood Observatory.

Flood Signal ∝ to % water coverage within the pixels: $s = \frac{M}{C} = \frac{T_{b\ measurament}}{T_{b\ calibration}}$

Flood Magnitude ∝ to anomaly of the signal

[1] http://www.gdacs.org/flooddetection

3. Study Regions and Datasets



In situ discharge → Global Runoff Data Centre (GRDC) + South African Water

GFDS Satellite signal → TRMM[2] + AMSR-E[3] (now using AMSR-E2)

Study period: 1998-2010 (or 2002-2010 were only AMSR-E)

[2] Tropical Rainfall Measuring Mission, [3] Advance Microwave Scanning Radiometer for Earth Observation System

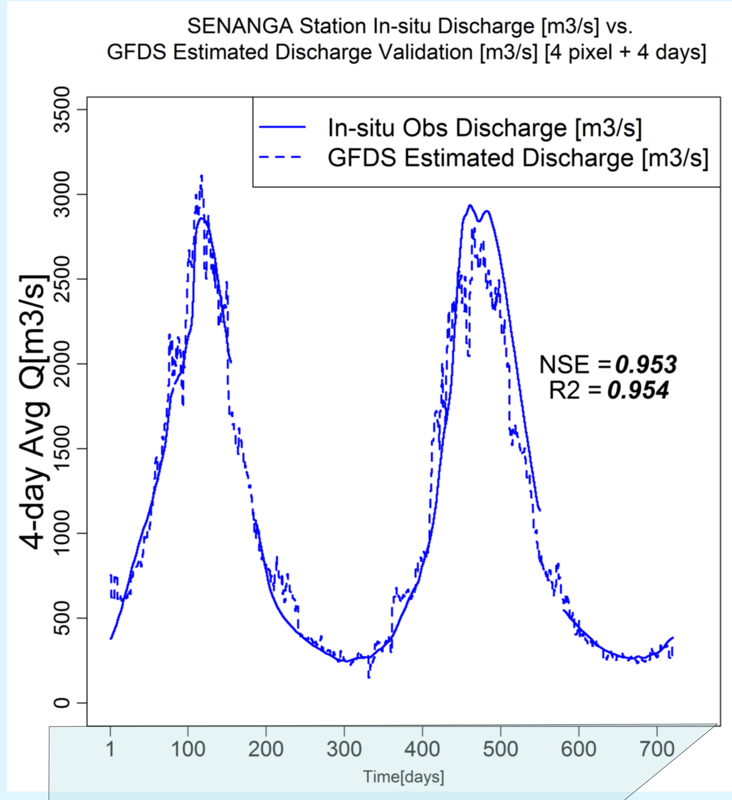
www.globalfloods.eu

4. Satellite signal calibration and validation

- **Calibration: 5 years** with 2 datasets (satellite signal and ground discharge) for selected locations. Linear regression built:

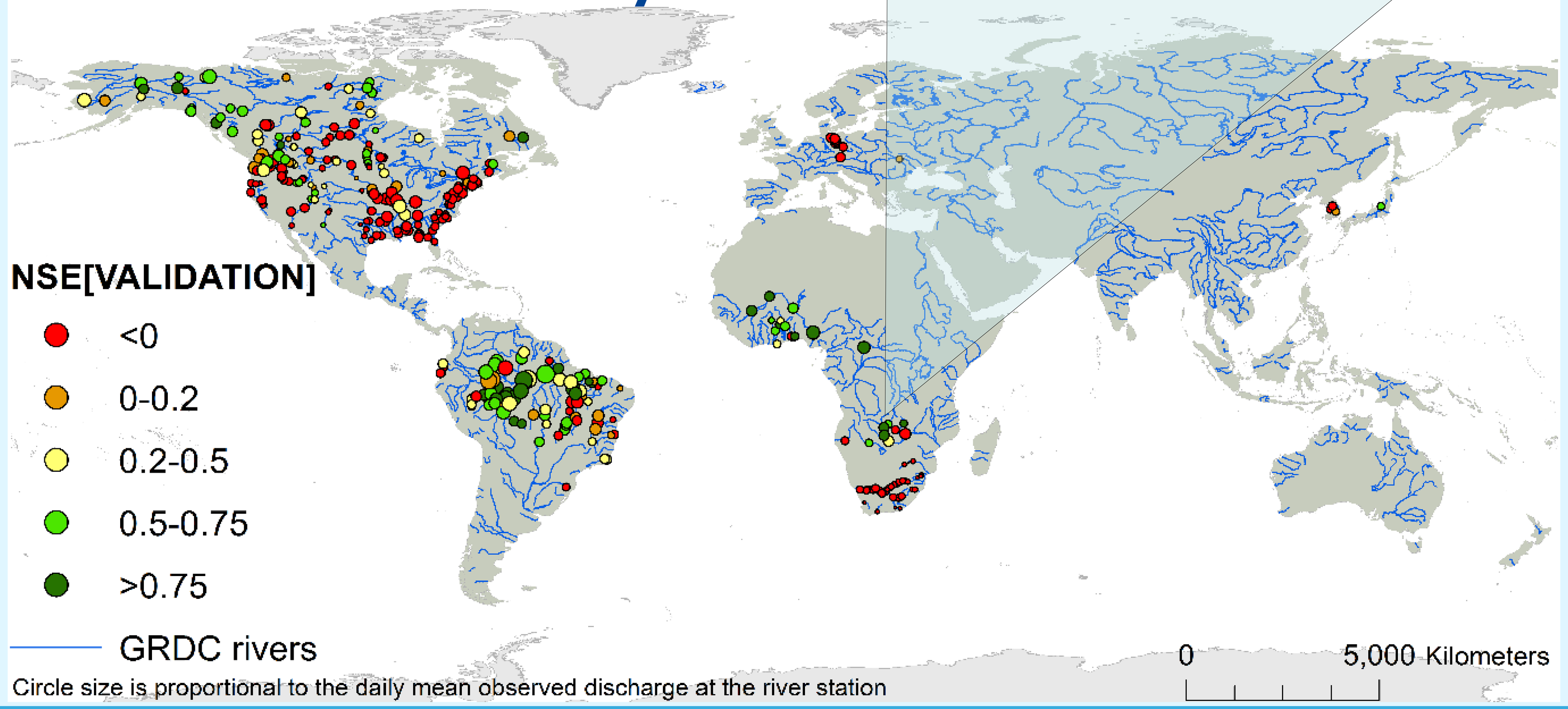
$$Q_{GFDS\ measured} = a + b\ signal$$

a, b were obtained using monthly mean $Q_{ground\ observed}$ and signal



- **Validation** using daily data

Selection 322 stations
→ both datasets ≥ 7 years



5. Performance Factors

The quality of the microwave signal detected by the satellite sensors can be influenced by local ground conditions. River flow control infrastructures and regimes can also alter the expected runoff to be measured. A number of factors were studied:

- **Mean observed runoff** and **Upstream catchment area**
- **River width:** Global River Width Database for Larger Rivers (2014)
- **Presence of Floodplains, Flooded Forest and Wetlands:** GLWD-3
- **Leaf Area Index** (LAI): 36 ten-day composites of the CYCLOPES (1 km)
- **Land Cover**: Global Land Cover 2009
- **Climatic areas**: Köppen-Geiger climate
- **Potential flood extent** (25 x 25 km cells) for a 100 year return period from the Global Flood Hazard Map
- **River Ice**: Circum-Arctic Map of Permafrost
- **Dam location**: Global Reservoir and Dam (GRanD) Database.

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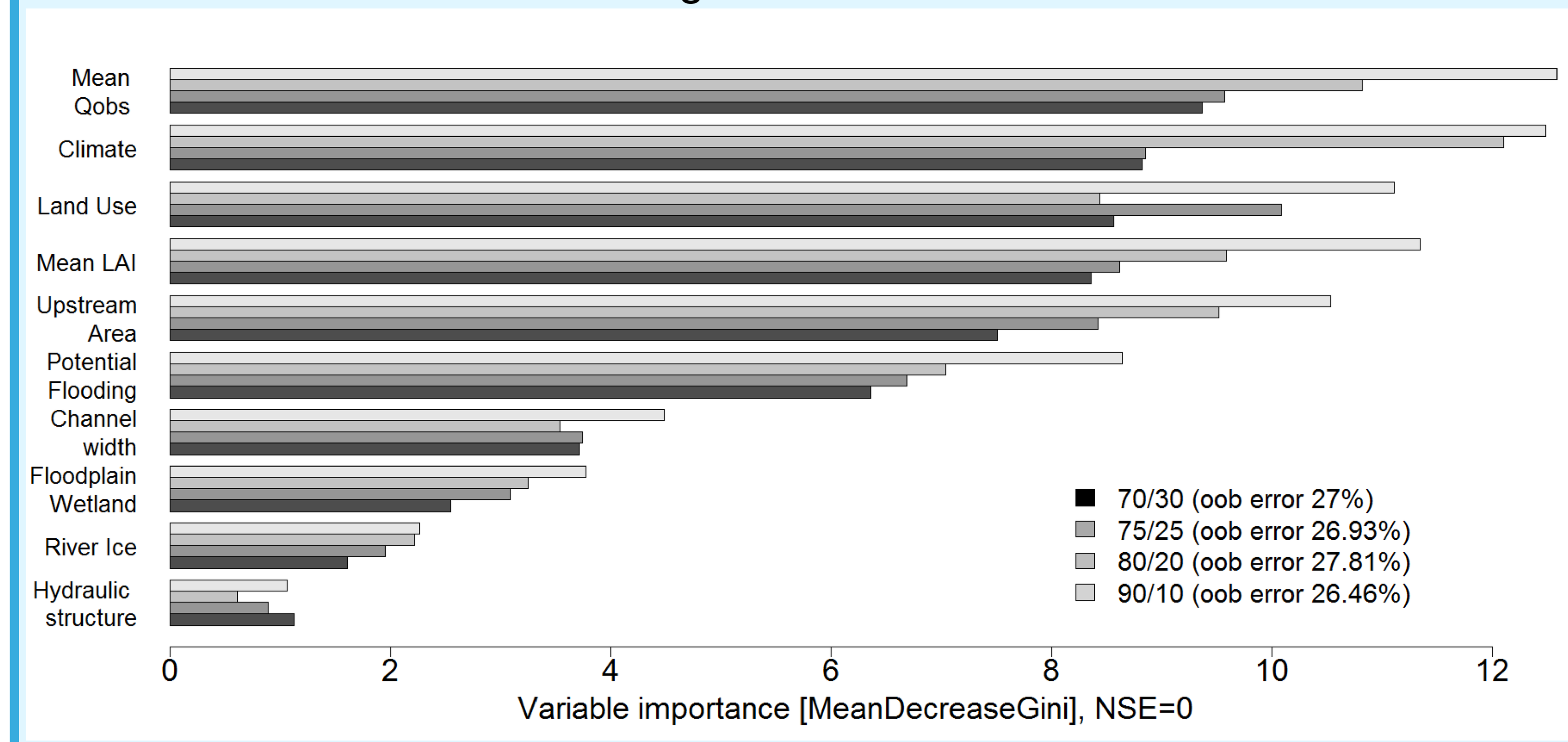
6. Ranking: Variables Influencing the GFDS performance

- Based on the Random Forest **decision tree analysis** (Breiman, 2001). Average of 200 runs, tree no.=500

  4 training sets (random) 70%/75%/80%/90% and Validation with remaining 30%/25%/20%/10%



- **Result**: Highest importance → Mean observed runoff, climate, land cover/LAI and upstream catchment area

7. Conclusions and future work

- It is **feasible to measure discharge from GFDS signal**.
- Validation resulted in **46%** of stations with **NSE>0**
- Highlight: **Good scores (NSE >0.75) for stations Africa**: Eg. Niger, Volta and Zambezi
- **Major Influence factor**: **Mean Observed Runoff**
- Ongoing work and Future steps:
  - Testing the **potential of derived discharge from** the satellite-based GFDS for calibration of the Global Flood Awareness System (GloFAS) flood forecasting model
  - **Data integration** into GloFAS model for improving flood forecasting.

References

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