# The use of satellite data and geospatial intelligence for flood risk assessment at UN-SPIDER RSO in Ukraine

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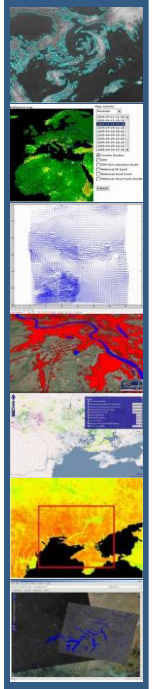
# Content

- Flood hazard mapping using satellite data
- Deforestation mapping in Ukraine
- SICH-2 – new Ukrainian Earth remote sensing satellite



# Importance

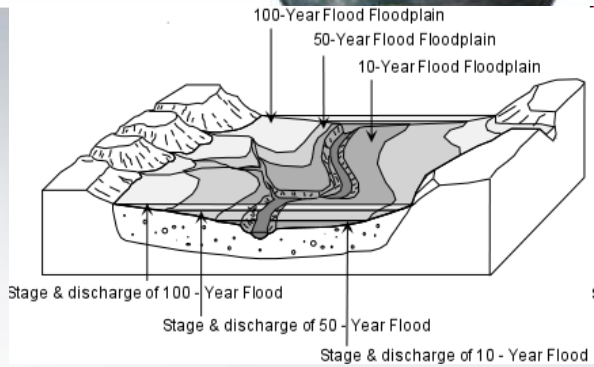
- Flood management has shifted from protection against floods to managing the risks of floods.
- In Europe, this shift is reflected in the Flood risk directive (FRD) of October 2007 (2007/60/EC; FRD).
- The FRD requires EU Member States to undertake a preliminary assessment of **flood risks** and, for areas with a significant flood risk, to prepare **flood hazard** and **flood risk maps** and **flood risk management plans**.

# Measuring "flood risk"

## Risk = *F*(Hazard, Vulnerability)

- A popular approach
  - Risk = *the probability of each possible flood event per year* x *the consequences of that event*
  - Simple risk measures:
    - average annual economic damage (AAD)
    - average annual number of casualties (AAC)
  - Problems
    - **regular flooding** with **limited consequences** and exceptional **flooding with huge consequences** may have **the same AAD**, but in practice they differ significantly: it is possible to cope with the first type but not with the second one

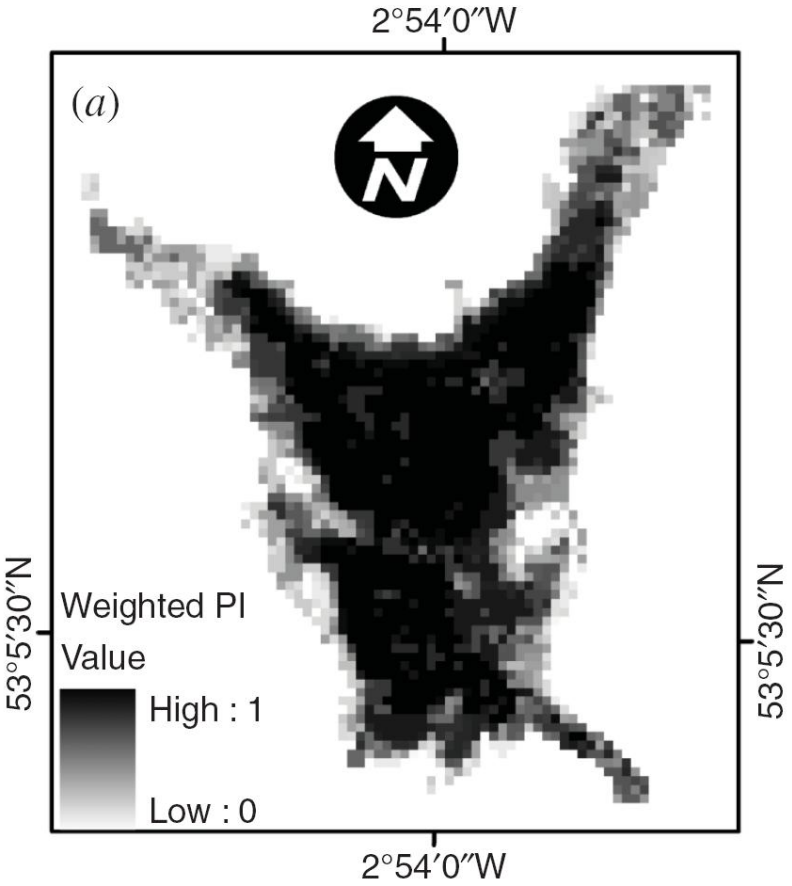
# Flood Hazard Mapping




- Flood modeling
  - Hydrological and other data are often far from complete,
  - Reliability is usually not perfect,
  - They can be analyzed in different ways, resulting in slightly or very different outcomes
  - An adequate *a priori* definition of flood inundation model parameters is very difficult
- Satellite data
  - Complementary approach to flood modeling
  - Continuous, cost-effective, man-independent observations

# Existing Approaches: Flood Hazard Mapping

- Flood hazard map based on multi-algorithm ensembles [Schumann, G. and Di Baldassarre, G. (2010) 'The direct use of radar satellites for event-specific flood risk mapping', Remote Sensing Letters, 1: 2, 75 — 84]




$$F2 = \frac{\sum_{i=1}^{n} P_i^{D_1 M_1} - \sum_{i=1}^{n} P_i^{D_0 M_1}}{\sum_{i=1}^{n} P_i^{D_1 M_1} + \sum_{i=1}^{n} P_i^{D_0 M_1} + \sum_{i=1}^{n} P_i^{D_1 M_0}}$$

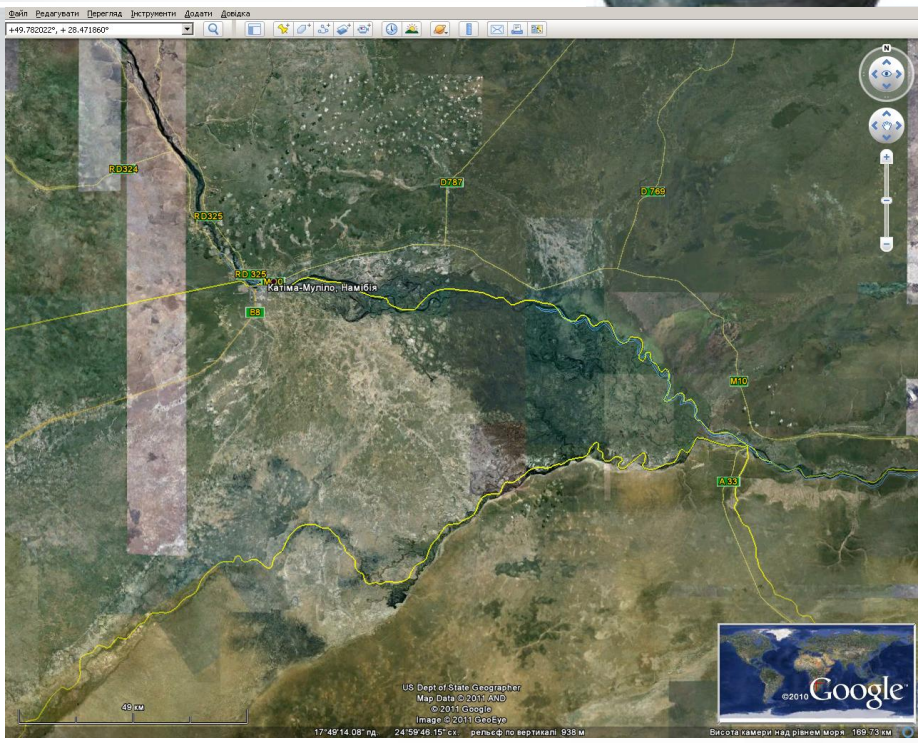
$$PI_i = \frac{\sum_{j=1}^{5} \omega_j (P_{j,\mathrm{SAR}})_i + \sum_{k=1}^{5} \omega_k (P_{k,\mathrm{ASAR}})_i}{\sum_{j=1}^{5} \omega_j + \sum_{k=1}^{5} \omega_k}$$

the weight $\omega j$ takes the value of $F2^{D,M}$ with the ASAR image denoting the reference data set *D* and the SAR image being the data set assessed *M*.

# Our approach

- Two methods proposed
  - The use of time-series of satellite data to flood hazard mapping
    - The use Landsat-5 and Landsat-7 data
    - Being used for Namibia
  - The use of neural network and SAR satellite data for event-specific flood hazard mapping
    - The use of ERS-2 and Envisat/ASAR data
    - Being used for Ukraine, preparing for Namibia

# Flood Risk Mapping for Namibia




- Region: Katima Mulilo, Namibia
- Data
  - Satellite
    - Landsat-5/TM and Landsat-7/ETM+
      - 44 images
      - Time period
        - » 2000-2010
    - TRMM
      - Time period
        - » 1999-2010
  - Ground
    - Water level and water flow
    - Time period
      - 1943-1954
        1965-2010

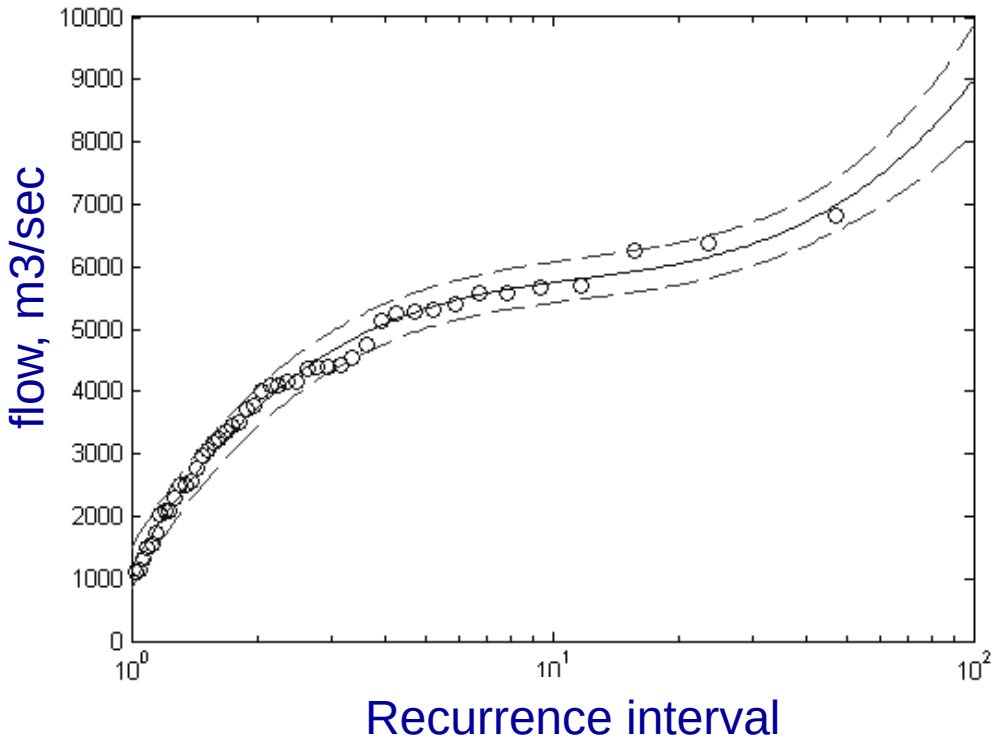
# Flood Risk Mapping for Namibia

- 10 year flood
  - Flow: 5746 m3/sec
- 50 year flood
  - Flow: 7093 m3/sec
- 100 year flood
  - Flow: 8993 m3/sec

43 year flood ←

30 year flood ←

| | year | flow, m3/sec |
|---|---|---|
| 1 | 1969 | 6817 |
| 2 | **2009** | **6365** |
| 3 | 1978 | 6251 |
| 4 | **2010** | **5704** |
| 5 | 1979 | 5675 |
| 6 | 1976 | 5568 |
| 7 | **2007** | **5564** |
| 8 | 1975 | 5409 |
| 9 | 1968 | 5312 |
| 10 | 1966 | 5276 |



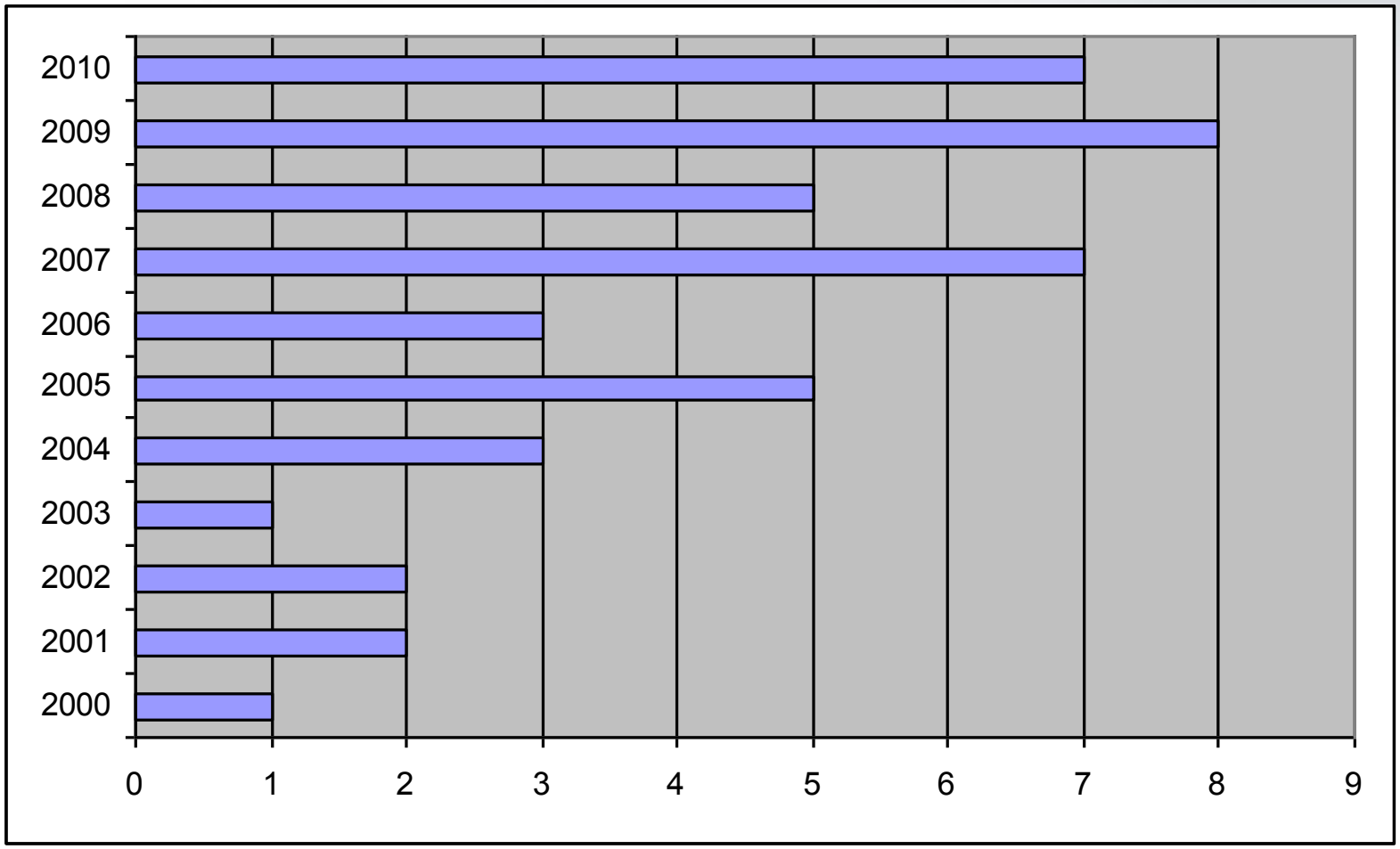

$y = 2969{,}8x^3 - 9567{,}7x^2 + 11162x + 1181{,}8$

$R2 = 0{,}9907$

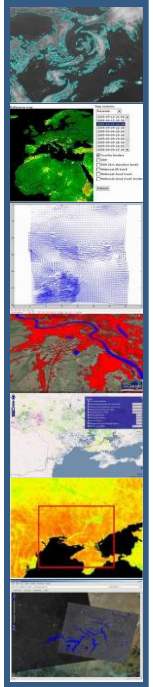
$x = \log10(R)$

# Flood Risk Mapping for Namibia

- Distribution of satellite data (Landsat 5, 7) path 174, row 072, during flood season



# Processing Workflow



Calibration
Transformation to TOA reflectance

Cloud & shadow detection

Water detection

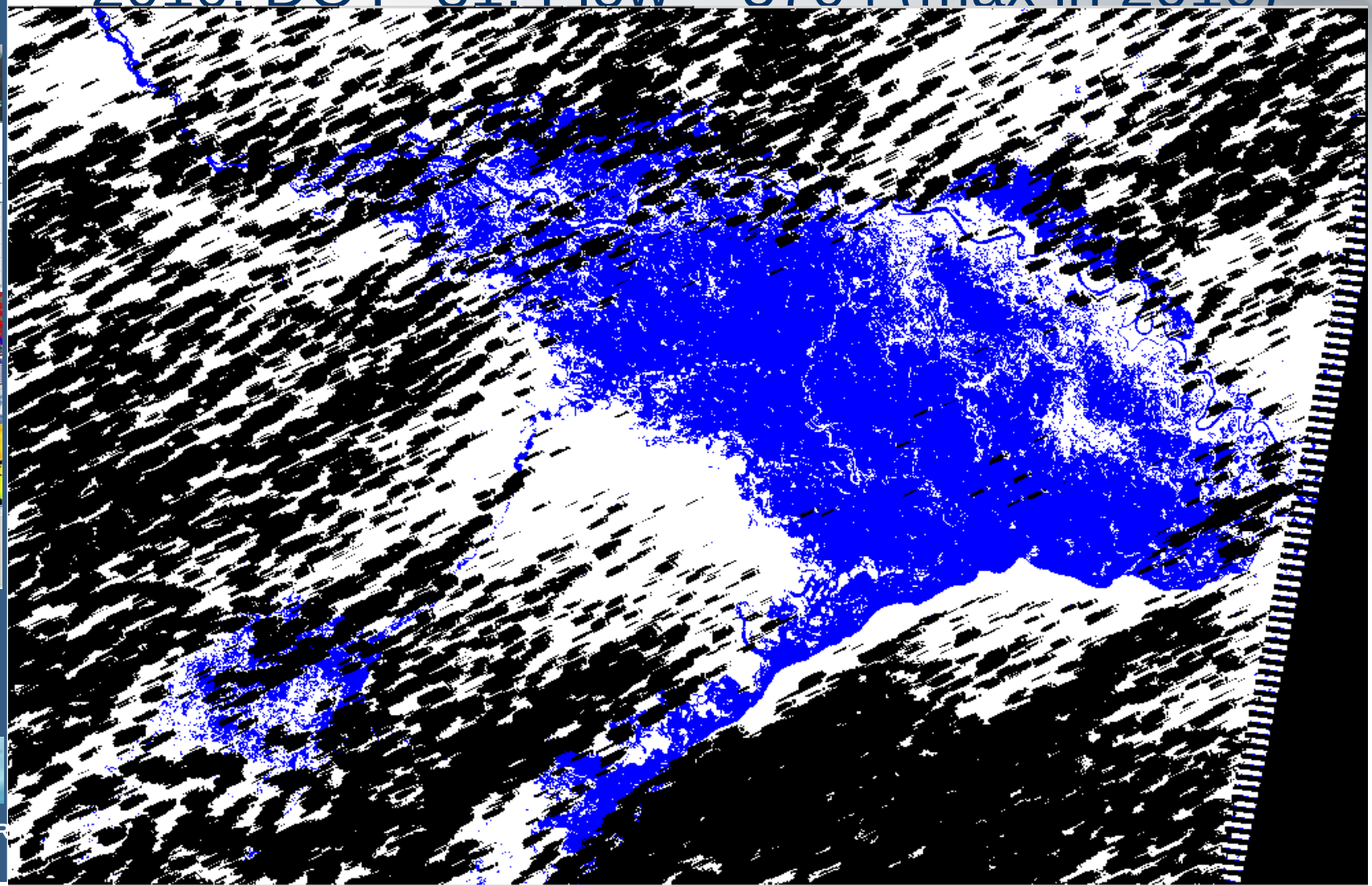
Inundation map

# Flood Risk Mapping for Namibia

- 2010, DOY=81, Flow = 5704 (max in 2010)

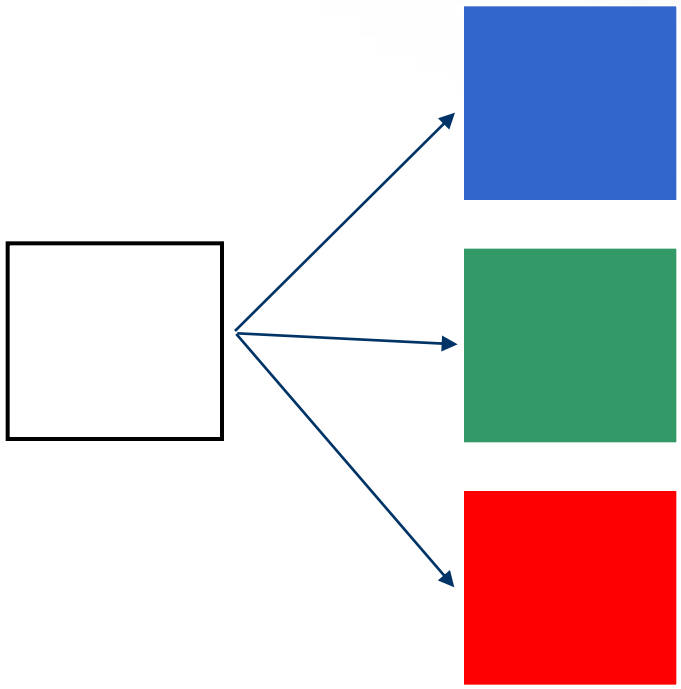
# Flood Risk Mapping for Namibia

- 2010, DOY=81, Flow = 5704 (max in 2010)



# Flood Risk Mapping for Namibia

- Probability density function estimation using a time-series of satellite data



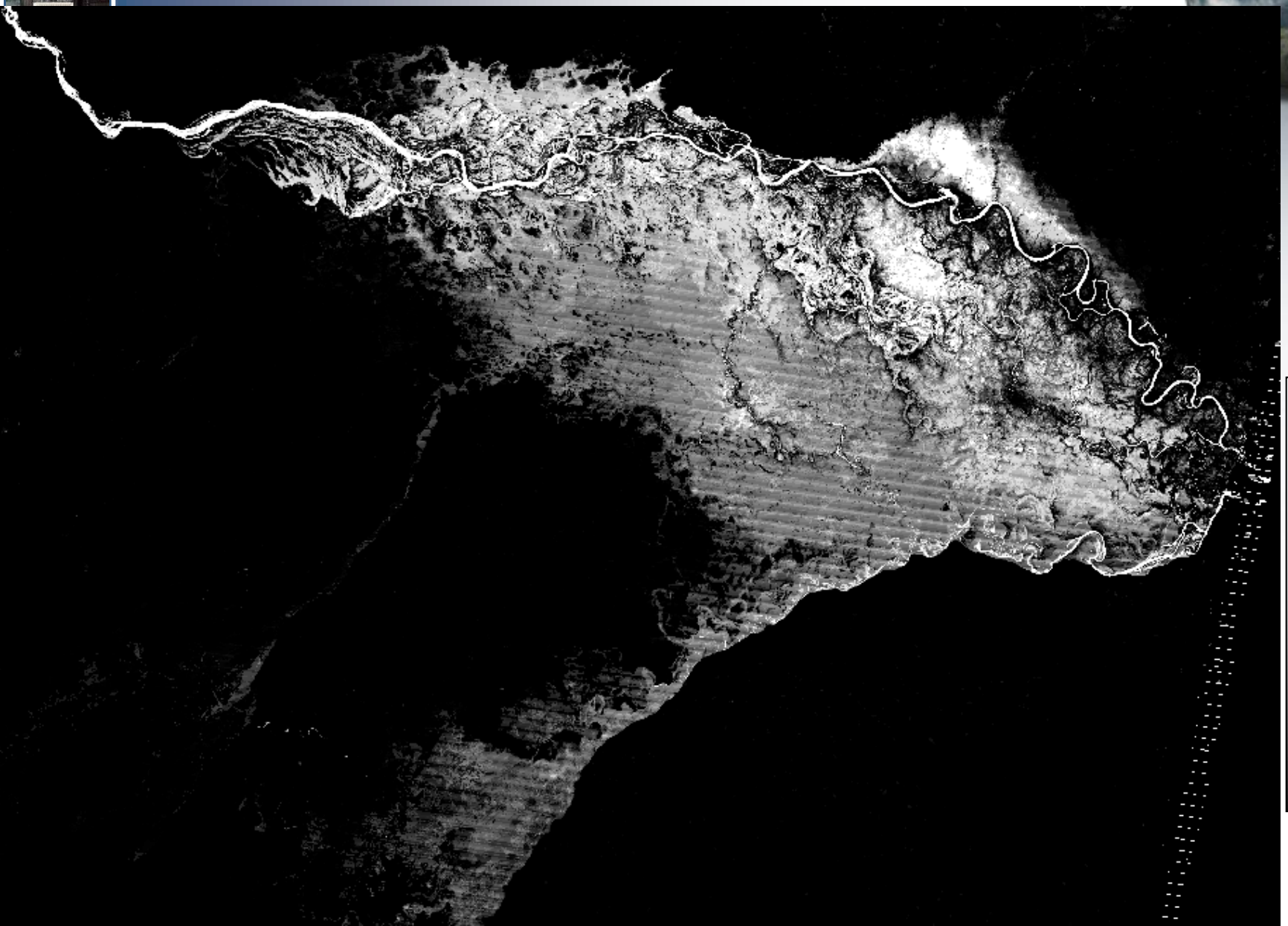
Flooded

Non-Flooded

No data (clouds, shadows, SLC-off)

$$PI_{pixel} = \frac{1}{N}\sum_{i=1}^{N} \mathbf{I}_{pixel=flooded}$$

# Possibility of Inundation Map



# Flood Risk Mapping for Namibia

## Dwelling Density

Namibia Flood Dashboard - Mozilla Firefox

Файл Правка Вигляд Історія Закладки Інструменти Довідка

Digital Life, Colorful Exper... | Gmail - Inbox - serhiy.ska... | Google Translate | GEO - Group on Earth Ob... | Від

matsu.opencloudconsortium.org/namibiaflood

Daily Report

Noven
22

# Namibia Flood Dashboard

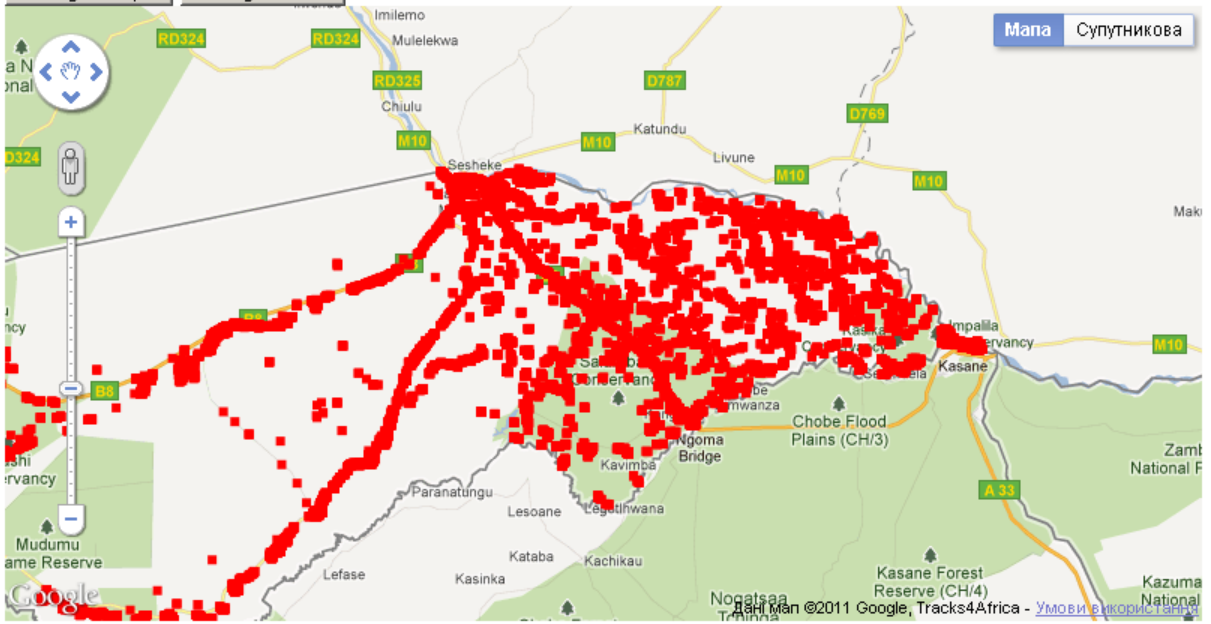
**SensorWeb enabled for early flood warning**

Configure Layers
Upload Layer

- River Stations
- SensorWeb Layers
- Water Lines and Areas
- Satelite Overlays
- Ground Pics
- Kavango Radarsat Data
- Cuvelai Radarsat Data
- TRMM Rainfall Accumulation and Flood Forecast
- Global Scene Counts
- MODIS Floodmaps
- Dwelling Database

Dwellings Database

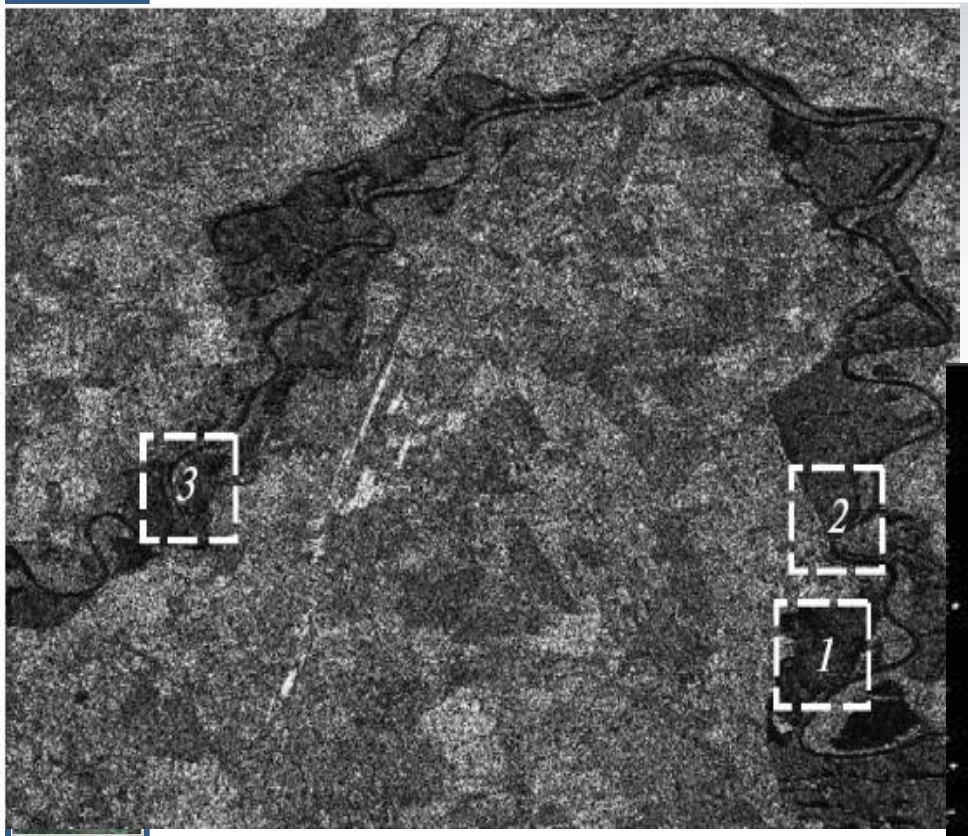
Google Maps | Google Earth



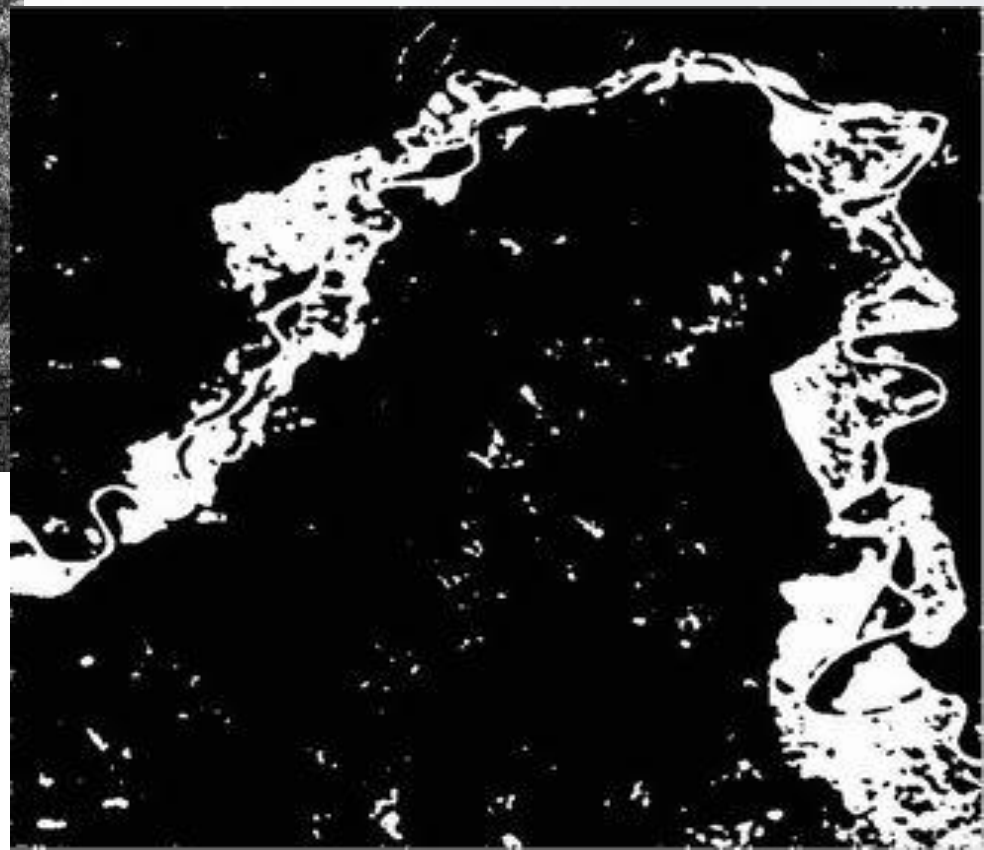

**Legend:**

| | Class 1 | Class 2 - | Class 3 - | Class 4 - | Class 5 - | Class 6 - | Class 7 - |
|---|---|---|---|---|---|---|---|

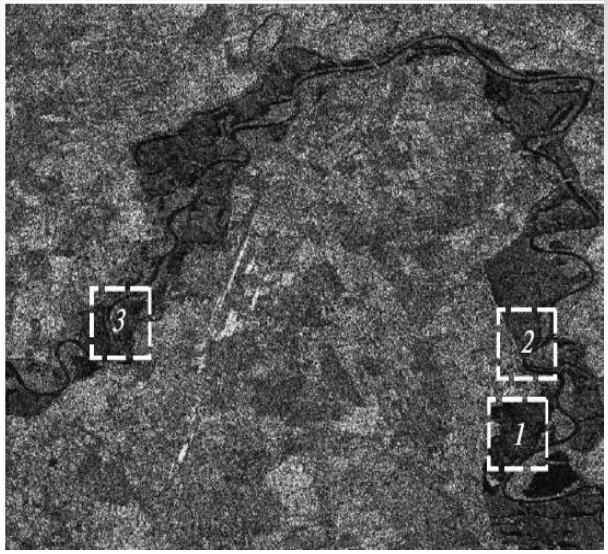
# Event-specific flood hazard mapping

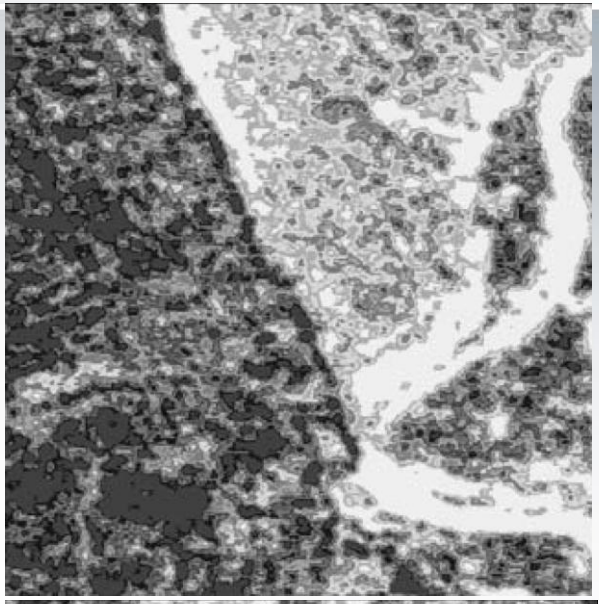


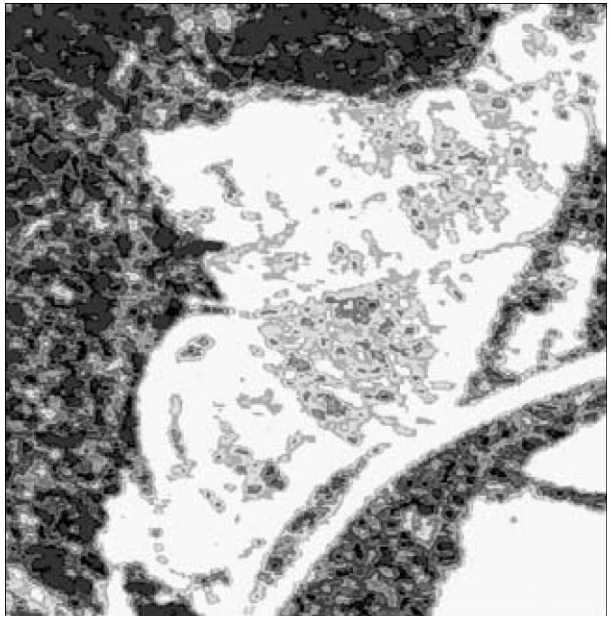

SAR/ERS-2, 2001, Ukraine

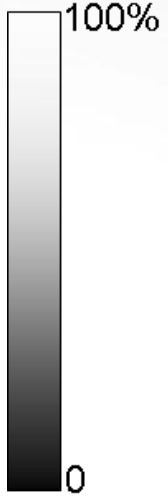


# Event-specific flood hazard mapping



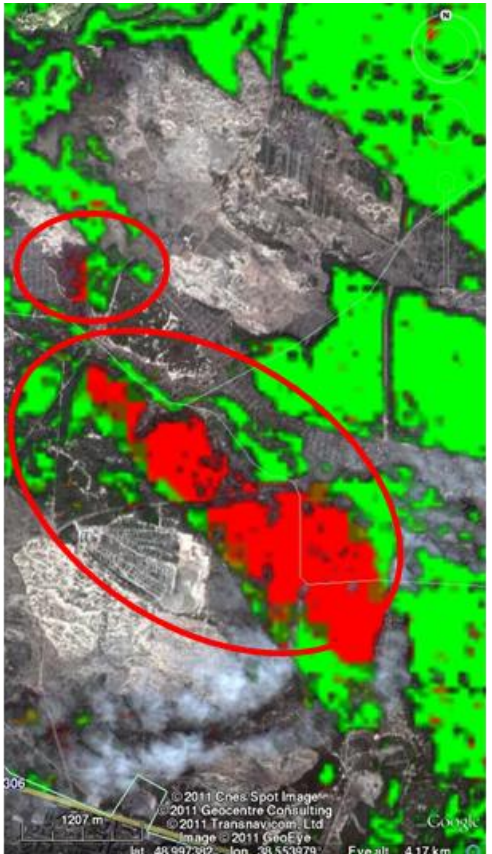







# Deforestation monitoring in Ukraine

- Rapid mapping of potential deforestation areas
- Area: Lugansk oblast, Ukraine
- State Agricultural Inspection
- Estimated deforestation area: 2300 ha




# Sich-2 Earth Remote Sensing Satellite

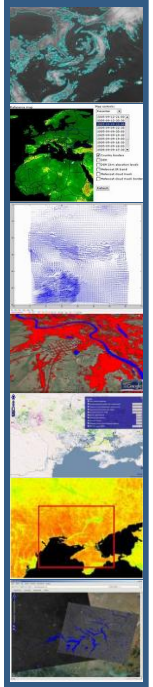
- First Ukrainian ERS within new National Space Program
- Optical
  - VNIR (8 m), SWIR (40 m)
  - 48.8 km swath
  - Inclination angle: ± 30°
- Launched 17 August 2011
  - Ukrainian Dnipro launcher



Kyiv, 1 September 2011

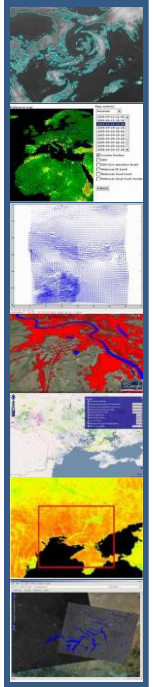
# Conclusions

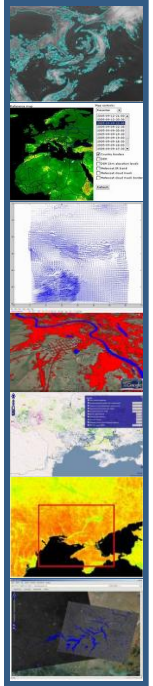
- Satellite data provide cost-effective approach to flood hazard mapping
- Integrated use of optical & radar data
- Should be exploited in conjunction with flood models to decrease errors and uncertainties



# Future actions

- Integration of optical and SAR data for flood risk mapping
- Event-specific flood hazard mapping from SAR data
- To provide flood risks maps with vulnerability parameters such as:
  - Dwelling density (estimate number of people effected by floods)





# Thank You!