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Application of satellite data for improved flood forecasting and mapping

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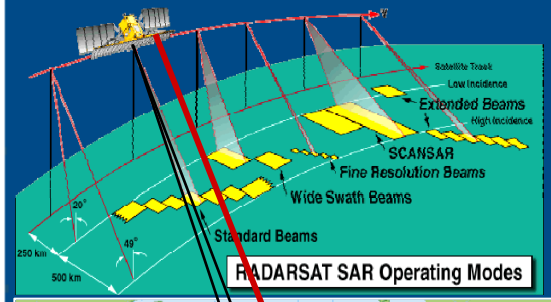
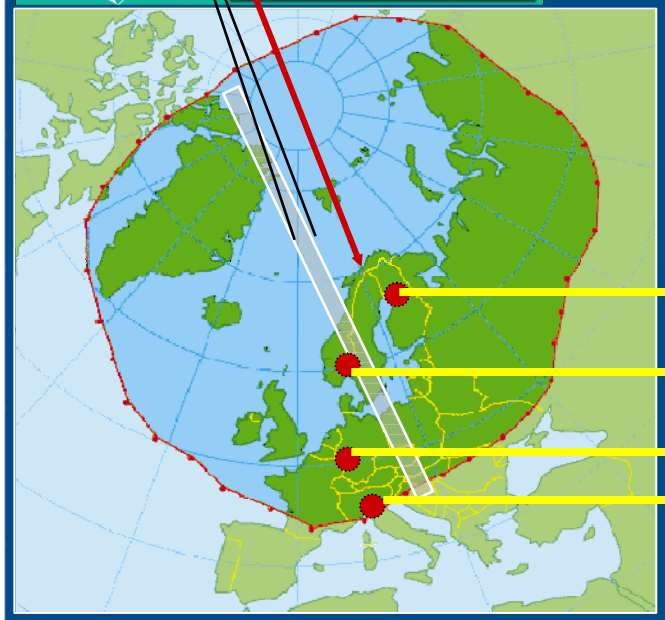
FloodMan

Contents

- FloodMAN project
- Satellite images
- Pilot studies
- Conclusions and perspective

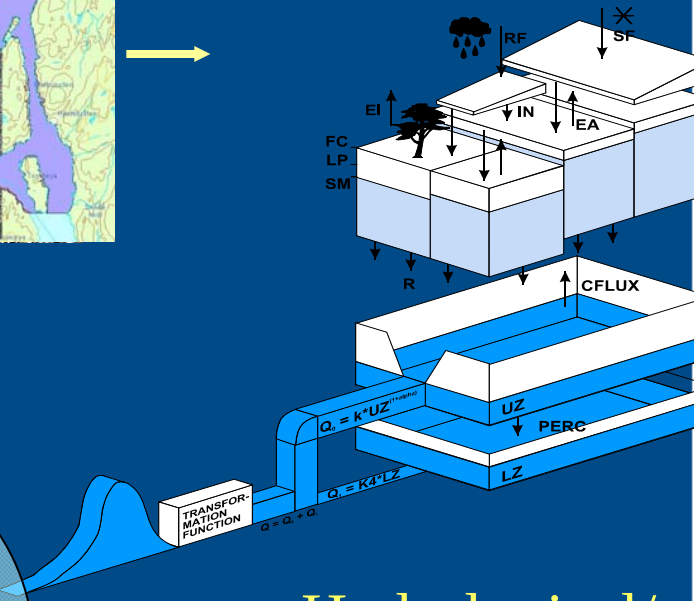


EO methods



Testsites

FloodMan System



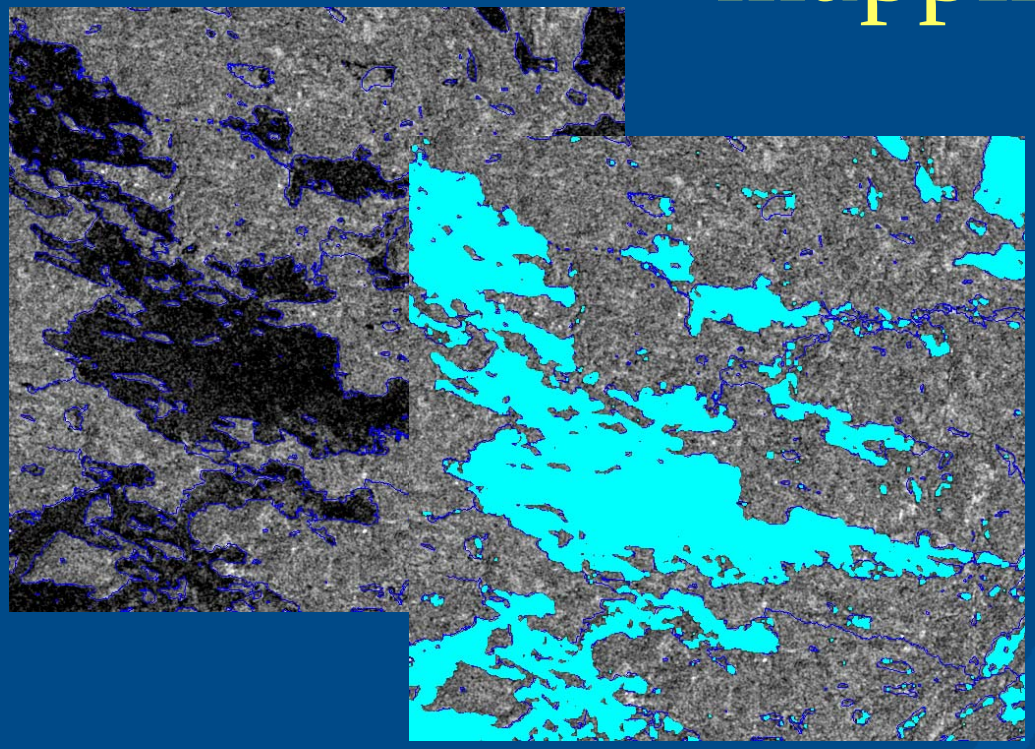
Hydrological/ hydraulic model Forecast

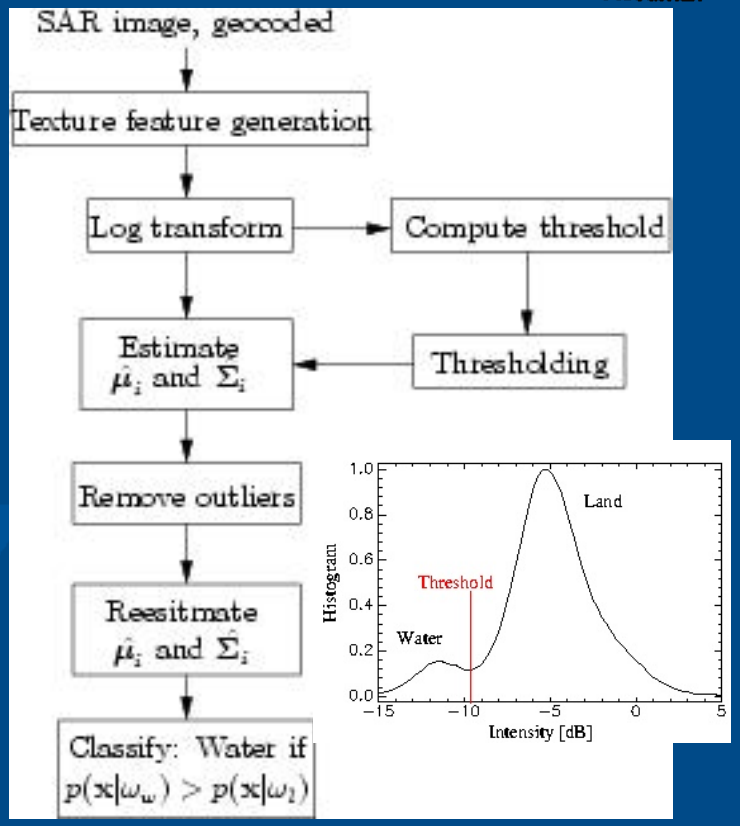
End Users

Workprogrammes

- WP1: Development EO methods
- WP2: Update Hydraulic and Hydrological models
- WP3: Development Flood Management System
- WP4: User Requirements, Validation and Demonstration
- WP5: Dissemination and Exploitation
- WP6: Management

SAR-algorithms for surface water mapping

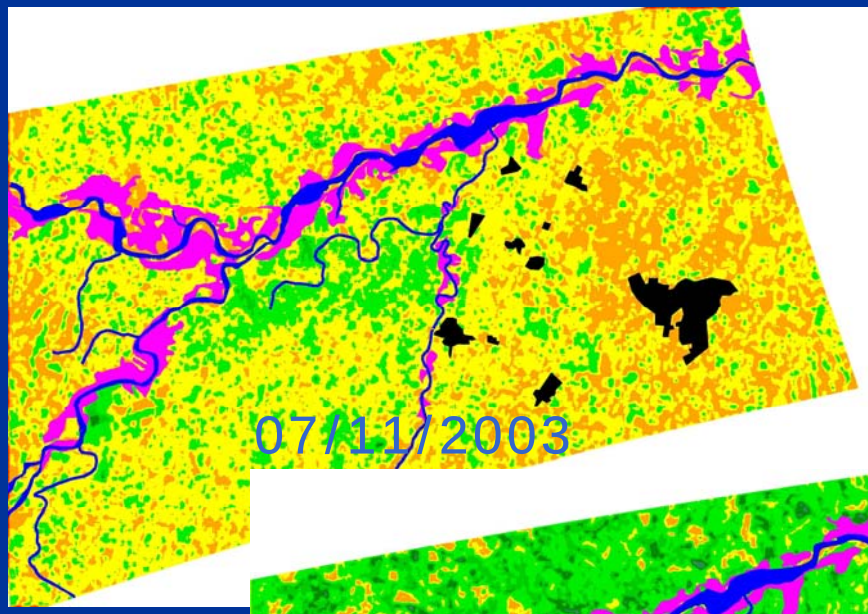


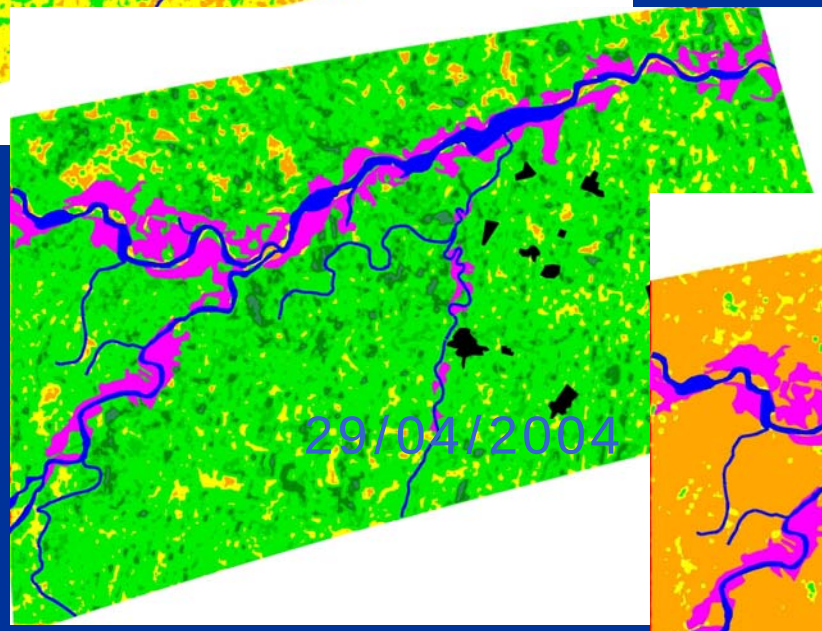


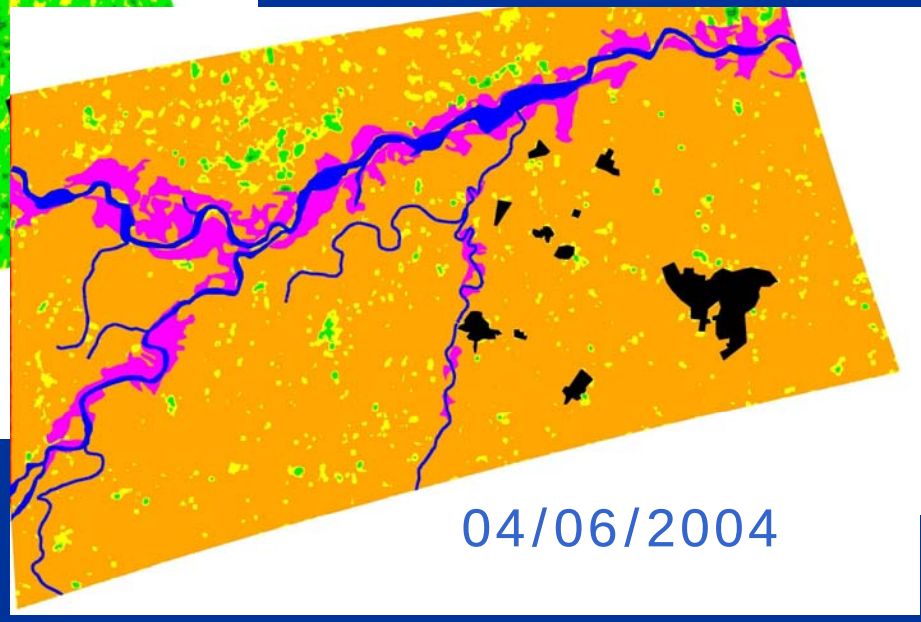
Fully automatic processing in near real time. Present limitations:

- Coverage, resolution
- Forests, urban areas

Soil moisture maps, Alessandria, Italy

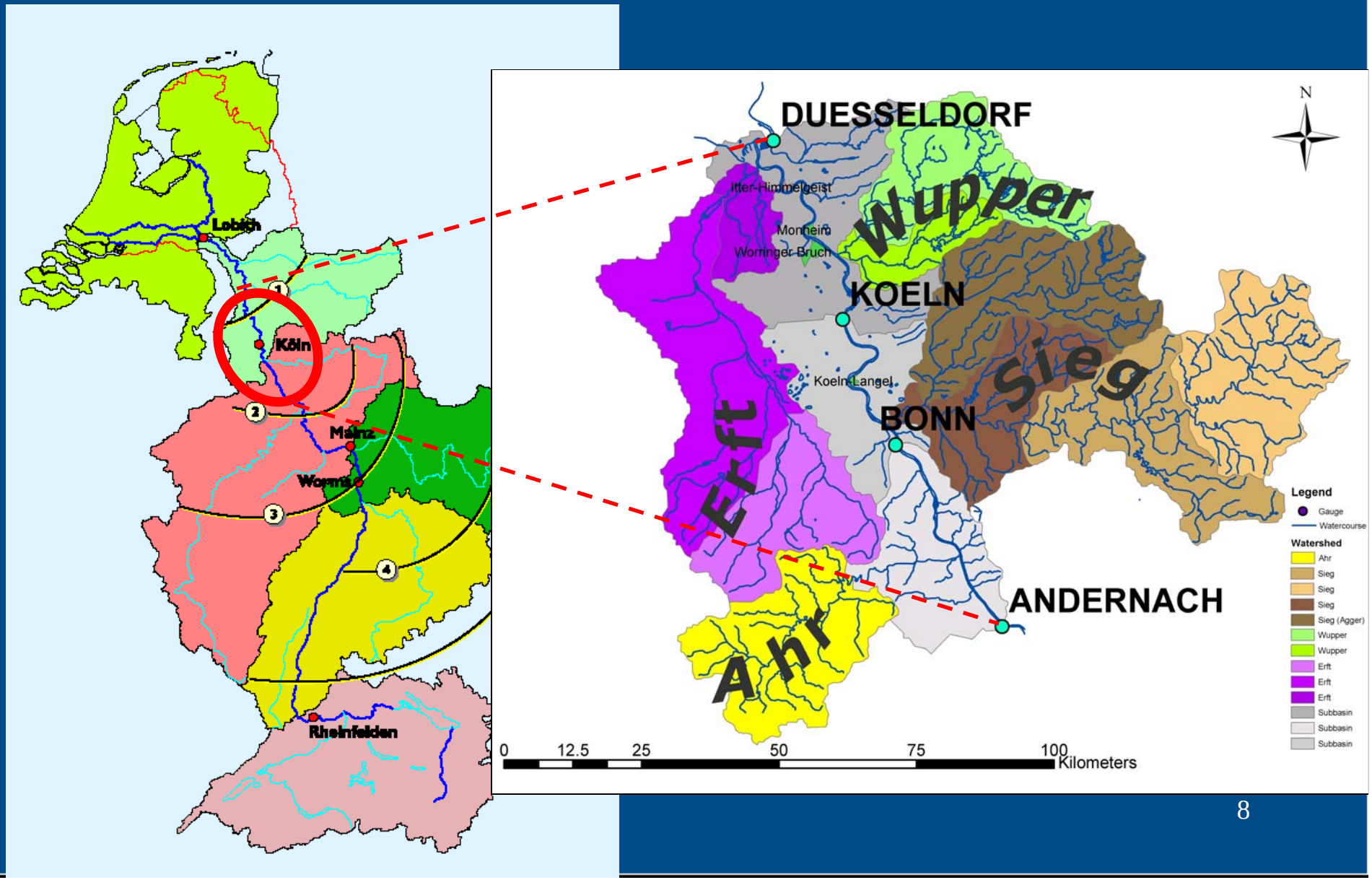






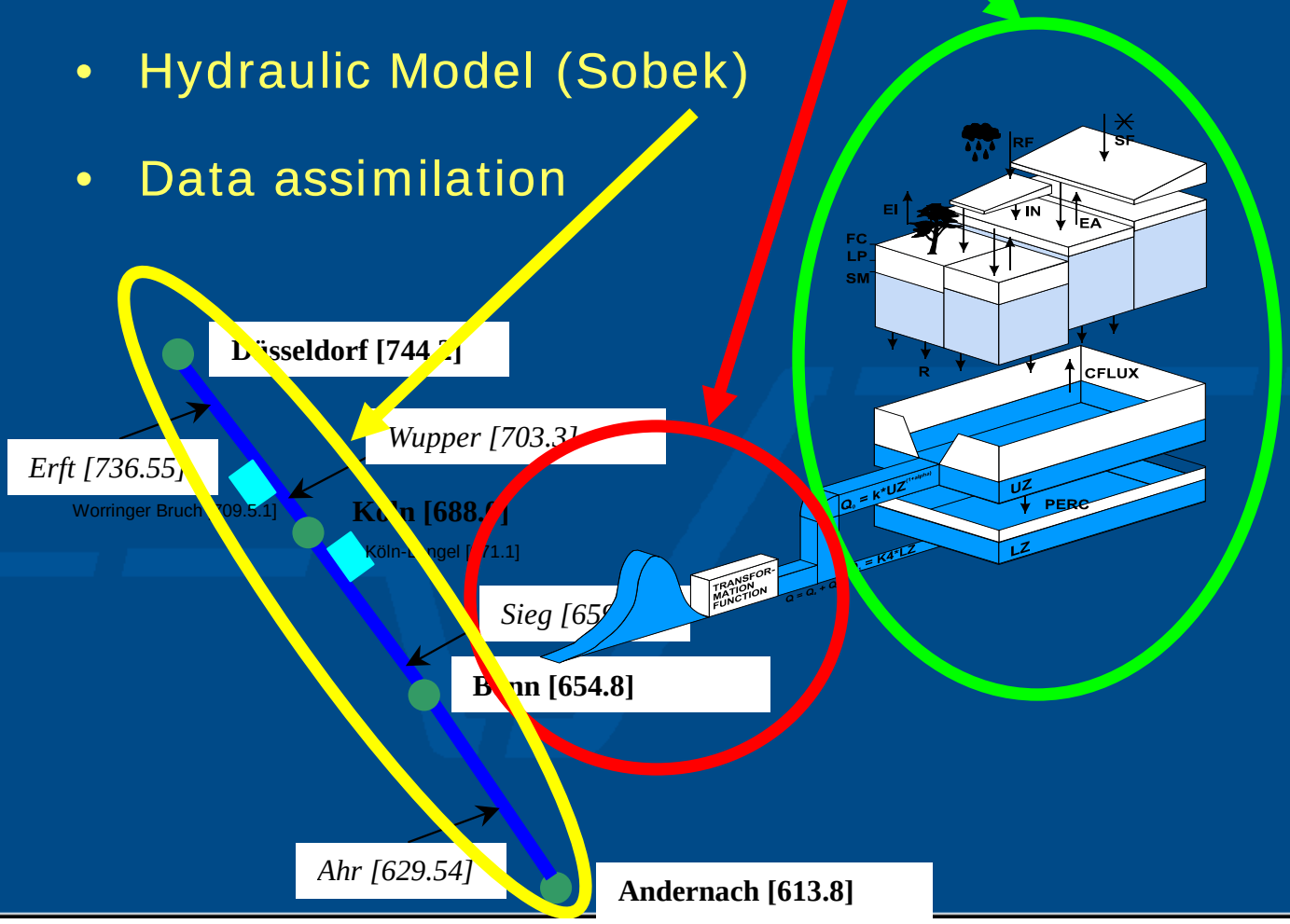
Pilot sites

Catchment Rhine



Forecasting system

- Rainfall-runoff Model (HBV)
- Water Transport Model (WTM)
- Hydraulic Model (Sobek)
- Data assimilation

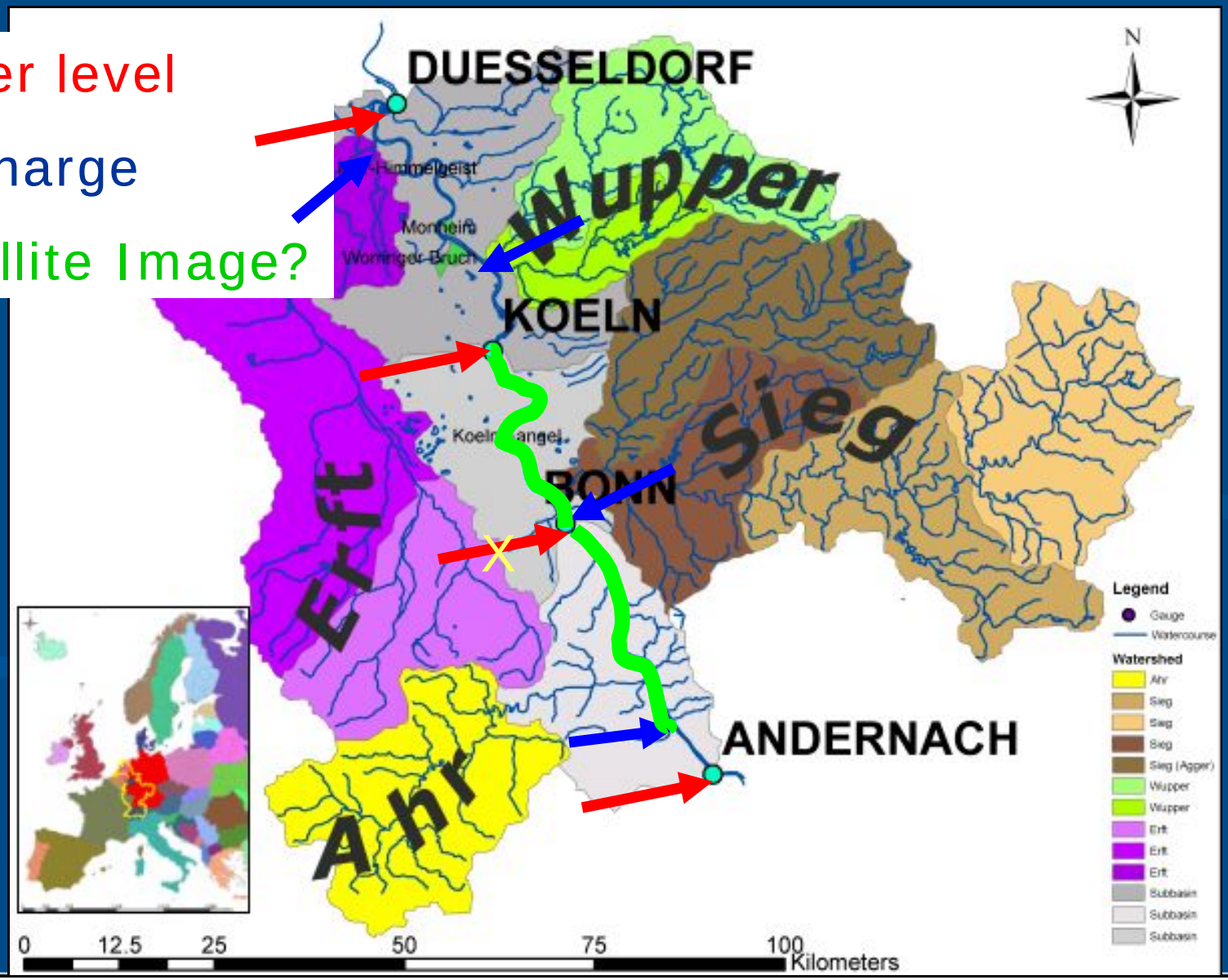


Role Satellite Images?

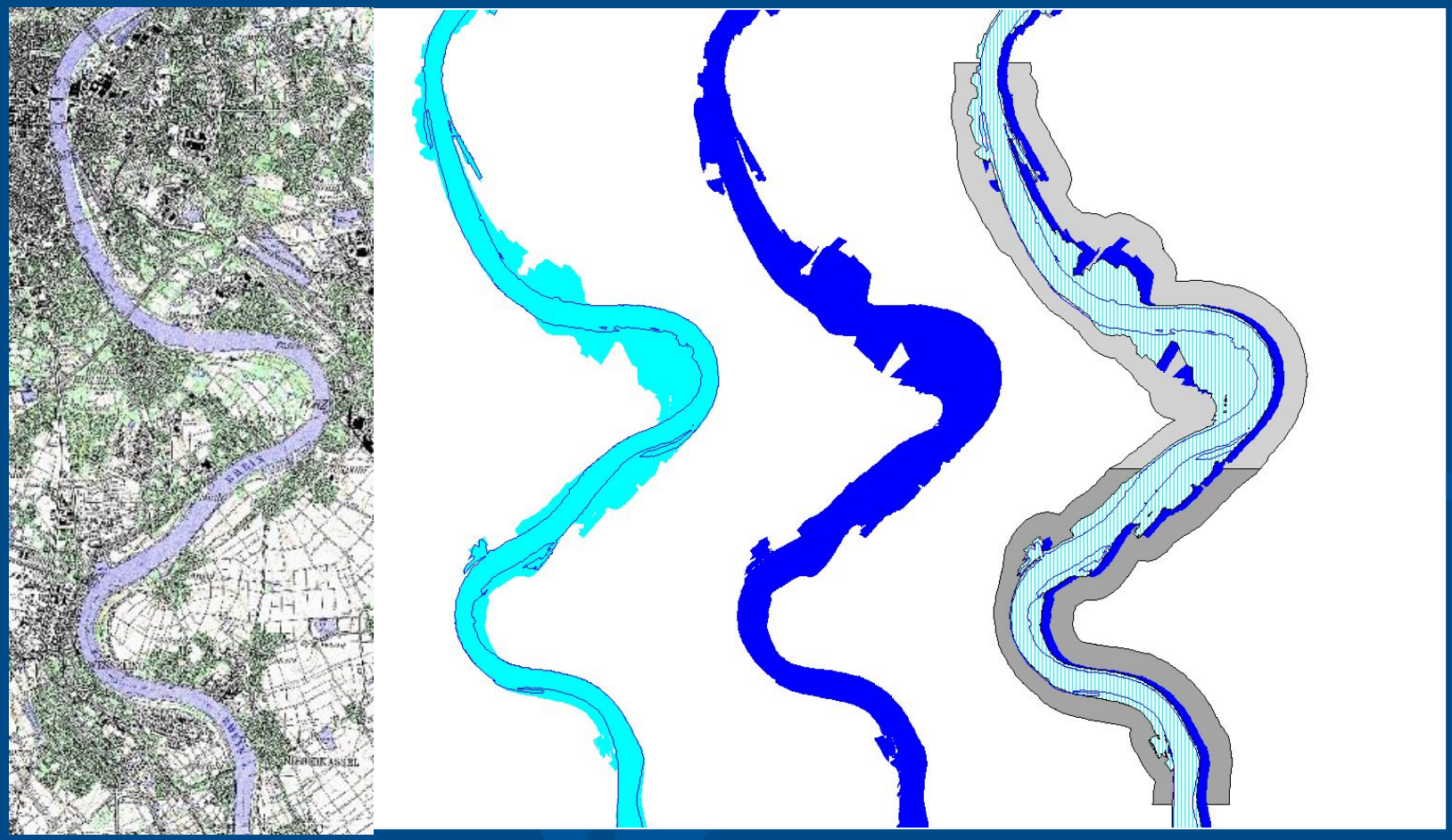
Water level

Discharge

Satellite Image?



Area Method



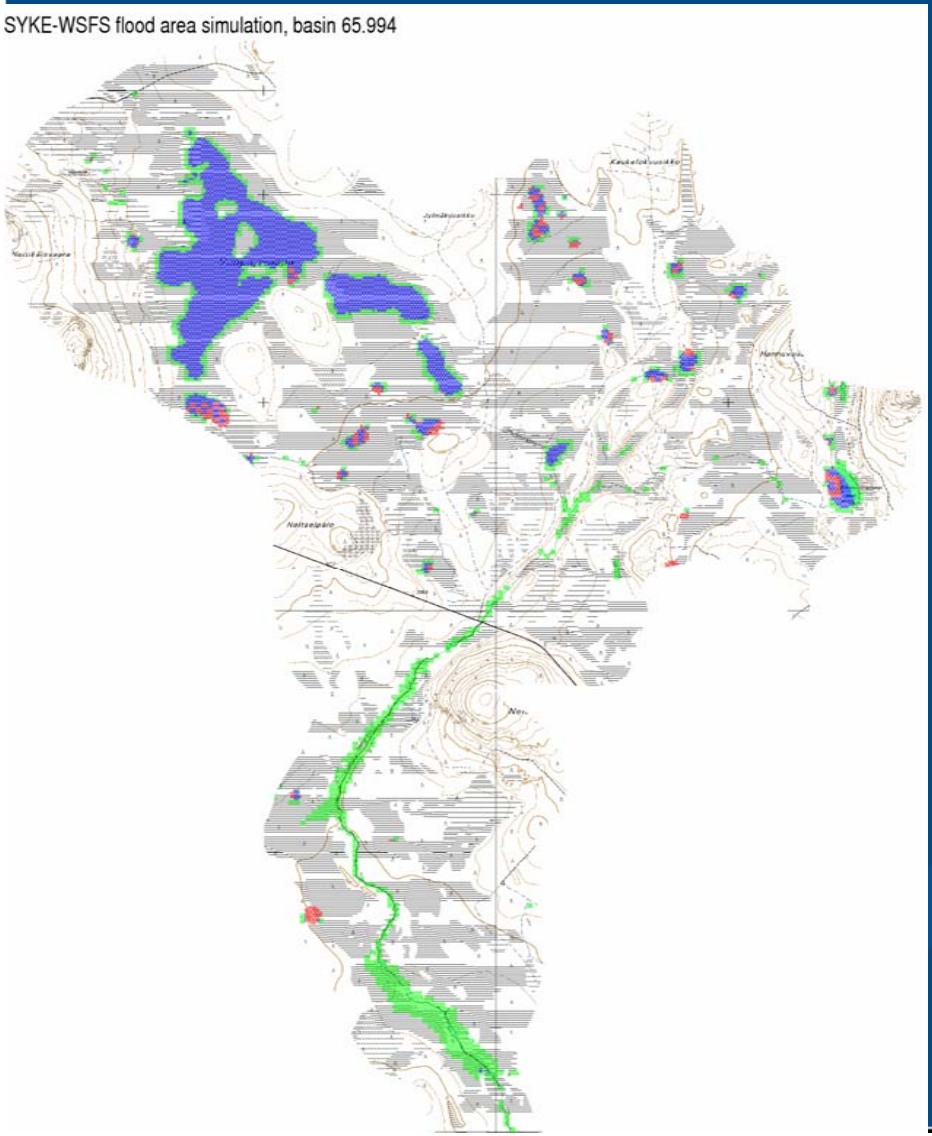
calculated satellite compare

Catchment Kemijoki

1. 51 000 km^2, 4,3 % lakes, snow melt floods
2. downstream: inhabited → most flood damages
3. upstream: uninhabited large peat land areas
   - floods are generated in these areas
   - only a few gauging stations
   - only poor DEM exists

➢ **flood water volume is difficult to estimate in these areas for initial data of hydrologic model**

Flood extent → volume

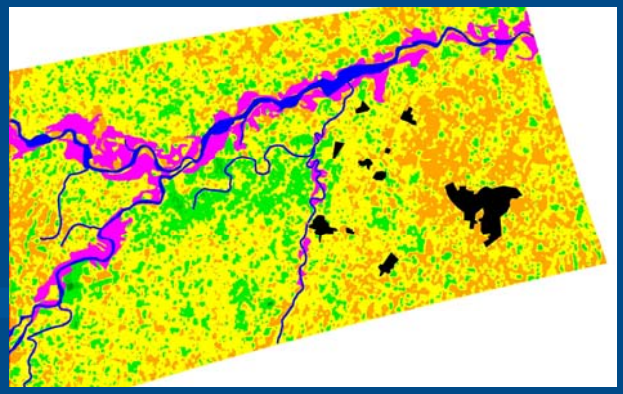


- flood extents from the satellite images
- → better estimates of water volumes
- → to improve hydrological forecasts
- satellite data can improve the 4 day discharge forecast by 10-20%

Water cover area simulation:
Green = simulated
Blue = observed and simulated
Red = observed

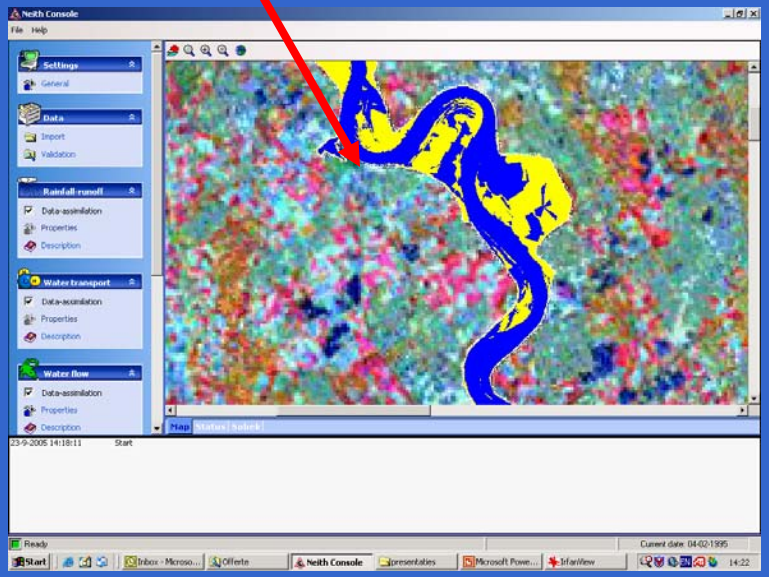
Conclusions

- Satellite images (soil moisture and flood extent) useful for nearly online presentation and analysis
- Improved flood forecasting with
  - Soil moisture maps
    - Laborious initial phase
    - Potentially feasible
  - Flood extent
    - Feasible in large sparsely monitored rivers
    - Area method already implemented in system Neith

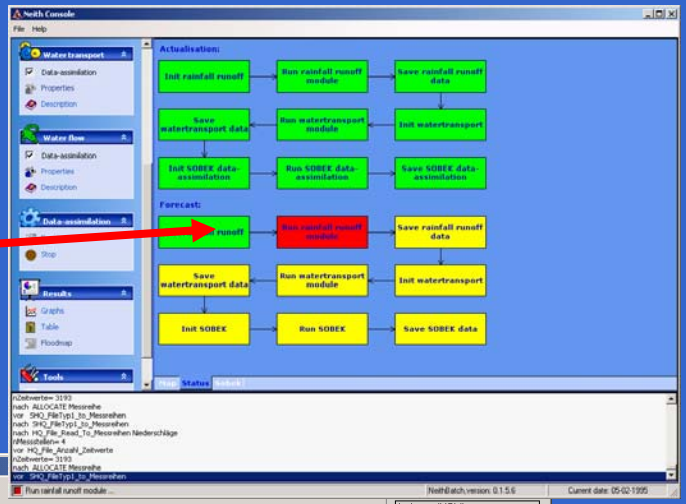


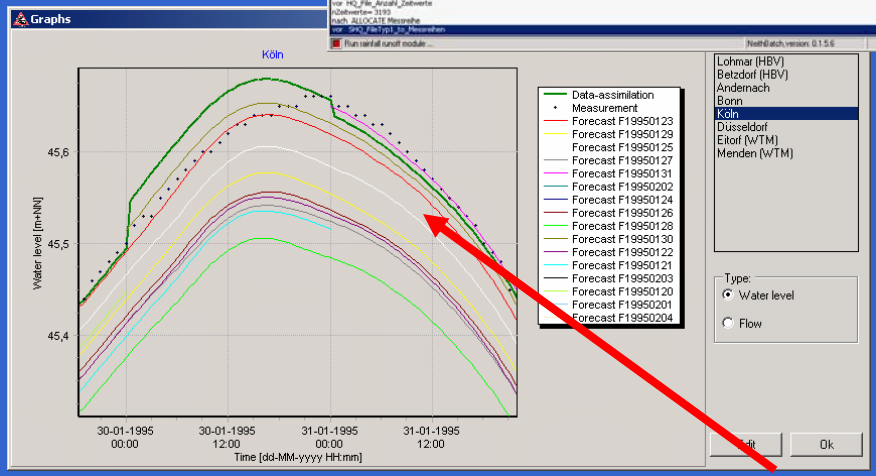
GUI Neith

Floodmaps

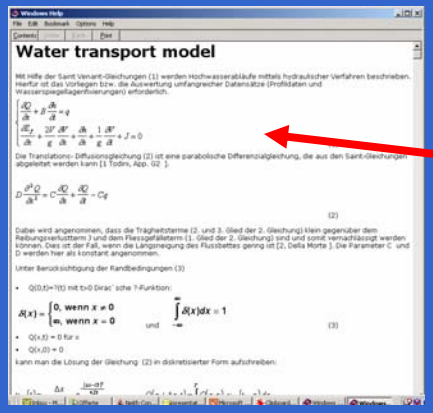


Status computation

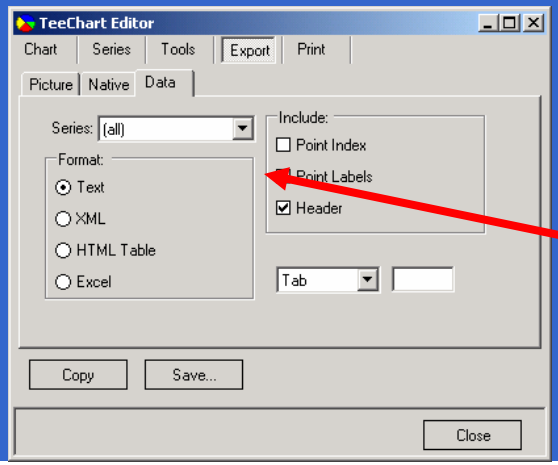




Graphs



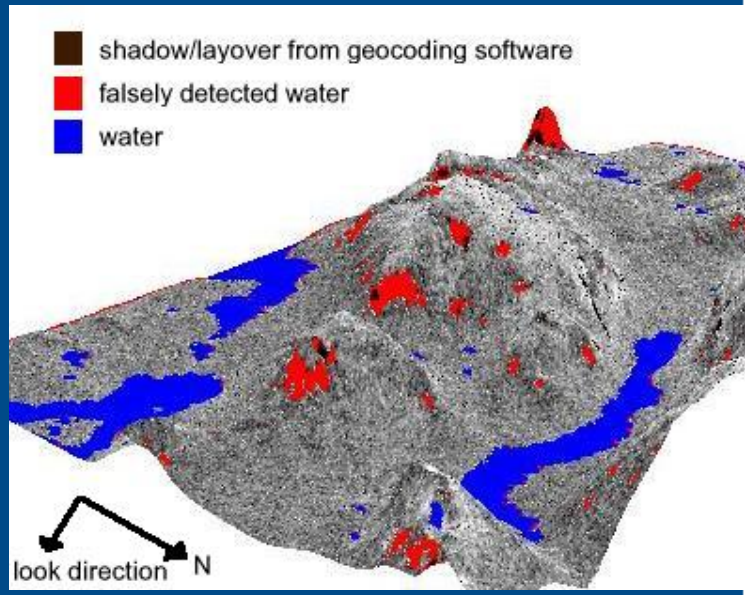
Helpfiles



Export data

What is currently realistic?

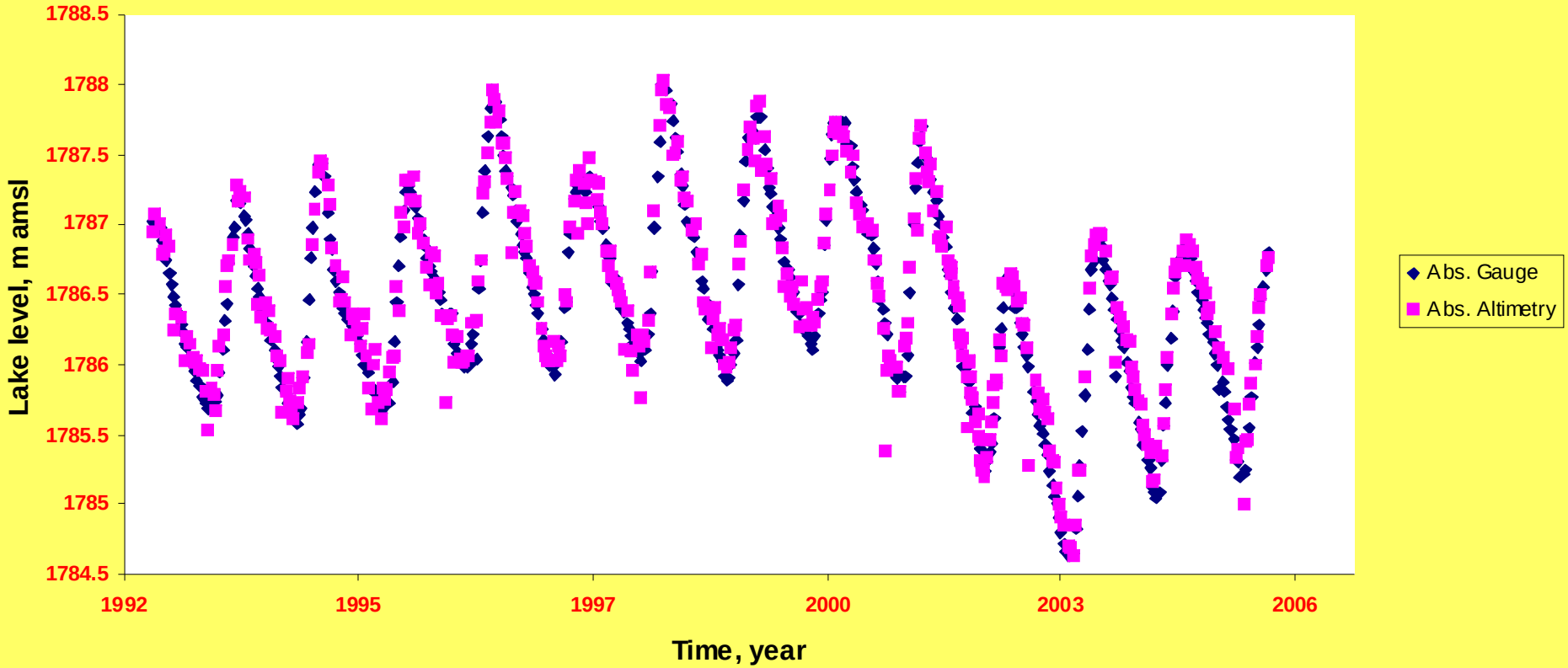
- ✓ Automatic georeferencing
- ✓ Automatic first order surface water detection
- ✓ Processing time: 1-2 hours
- Utilize whatever SAR/optical data is available
- Accuracy:
  - Narrow river stretches
  - Urban areas
  - Smooth surfaces
  - Wind and VV polarization
  - Spatial resolution
- Timeliness of satellite coverage
- Availability of world DEM and maps



Near future

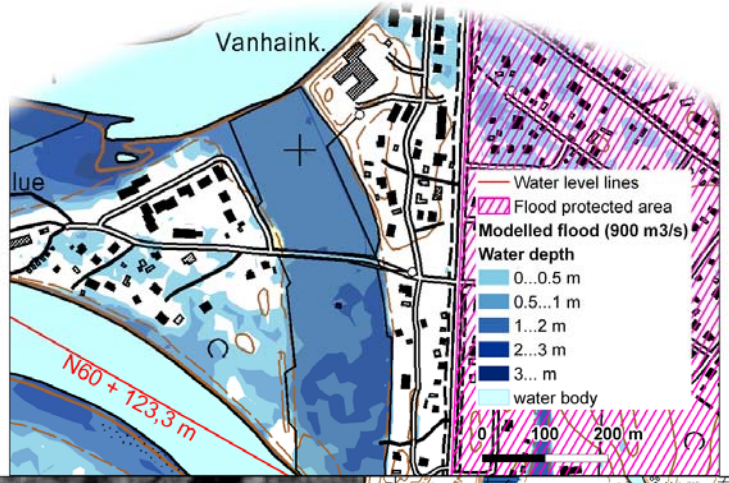
- Many new sensors (Radarsat-2, TerraSAR X, ALOS, Sentinel-1, Radarsat Constellation etc.) will ensure coverage.
- New sensors (ALOS and SMOS) have enhanced capabilities of measuring soil moisture content
- New sensor types (SAR altimeters) may measure water levels with spatial coverage (unlike conventional altimeters that only measure nadir)
- Multisensor, multitemporal and multiscale techniques may be applied to improve results

Gauge-Altimeter lake level comparison (Topex/Poseidon-Jason2), Lake Tana



26/05/2005

Flood hazard Map of town Ivalo, Lapland



Satellite image and flooded areas derived from the image

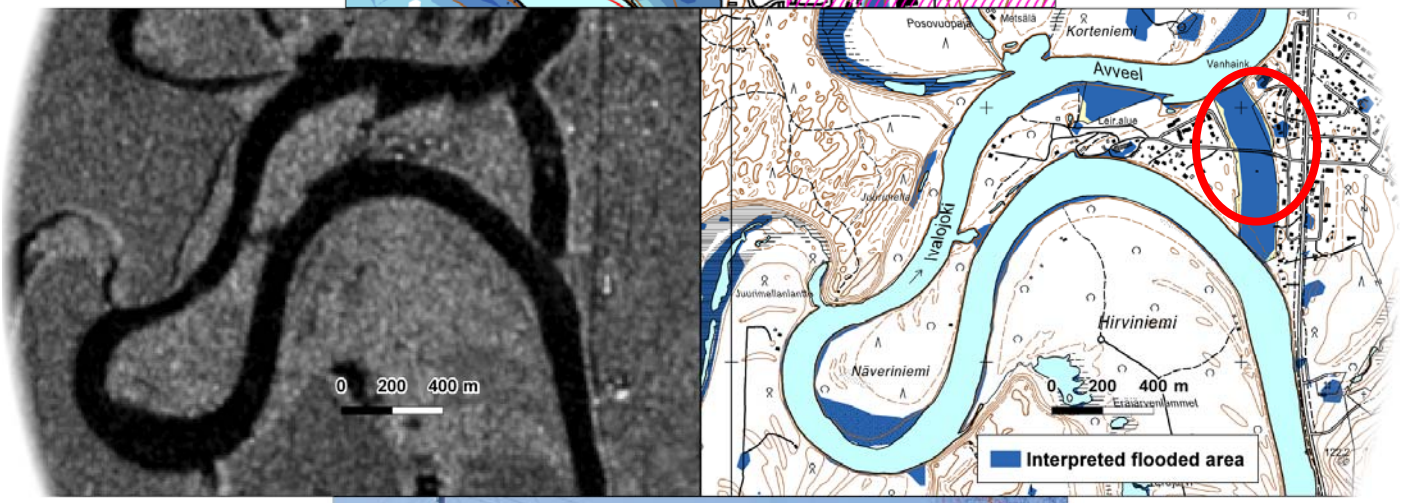
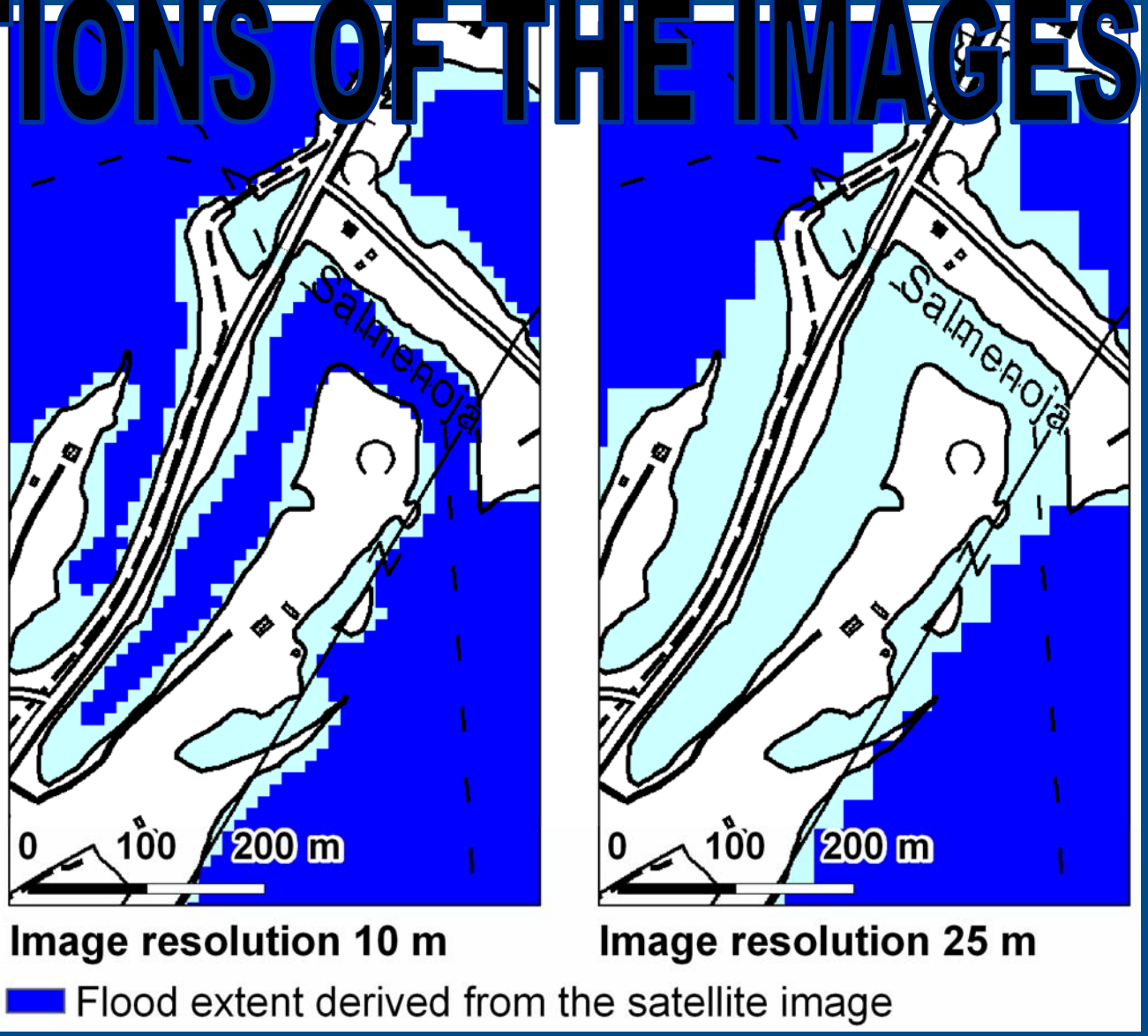
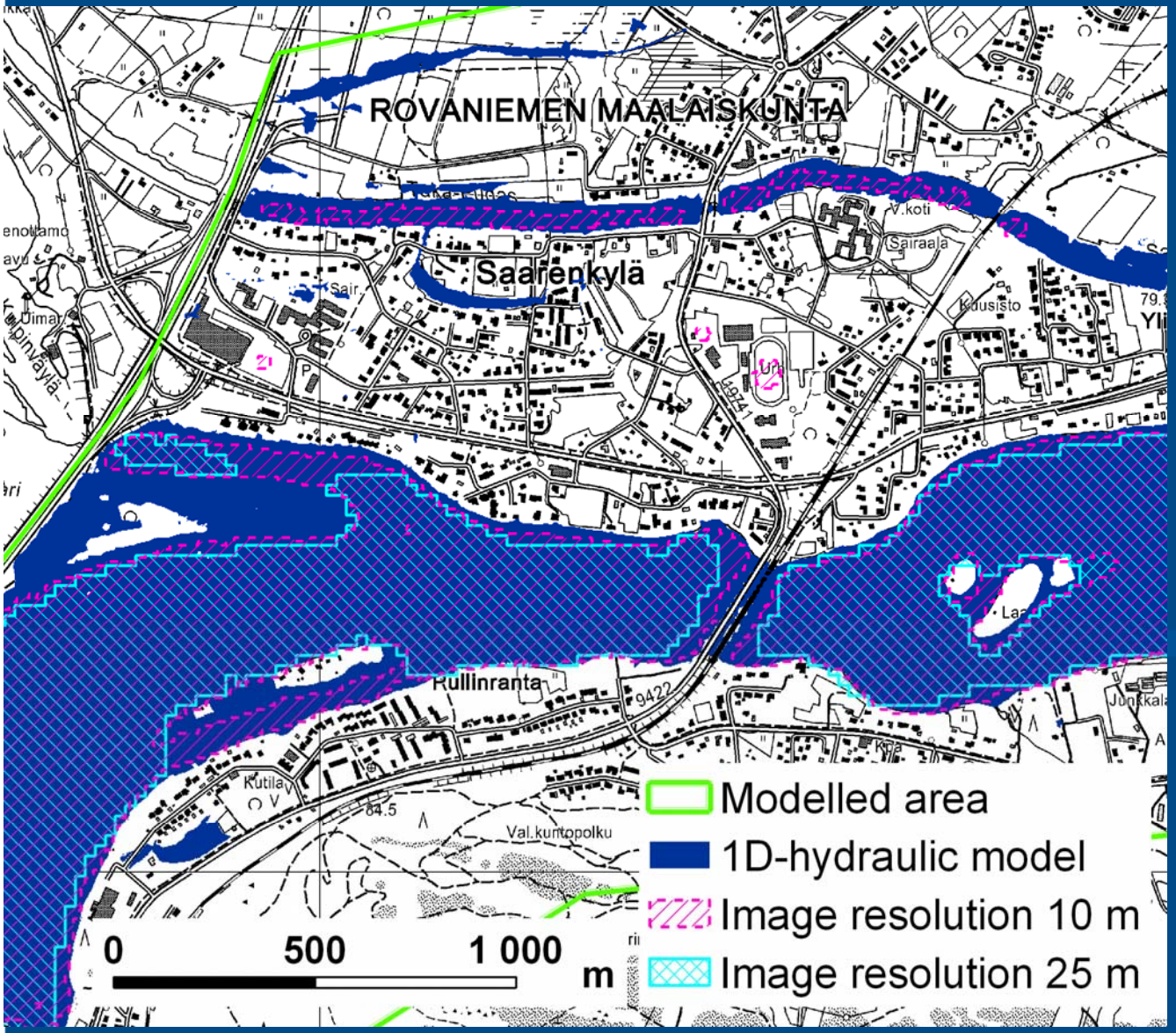


Photo from the circled area

COMPARISON BETWEEN RESOLUTIONS OF THE IMAGES

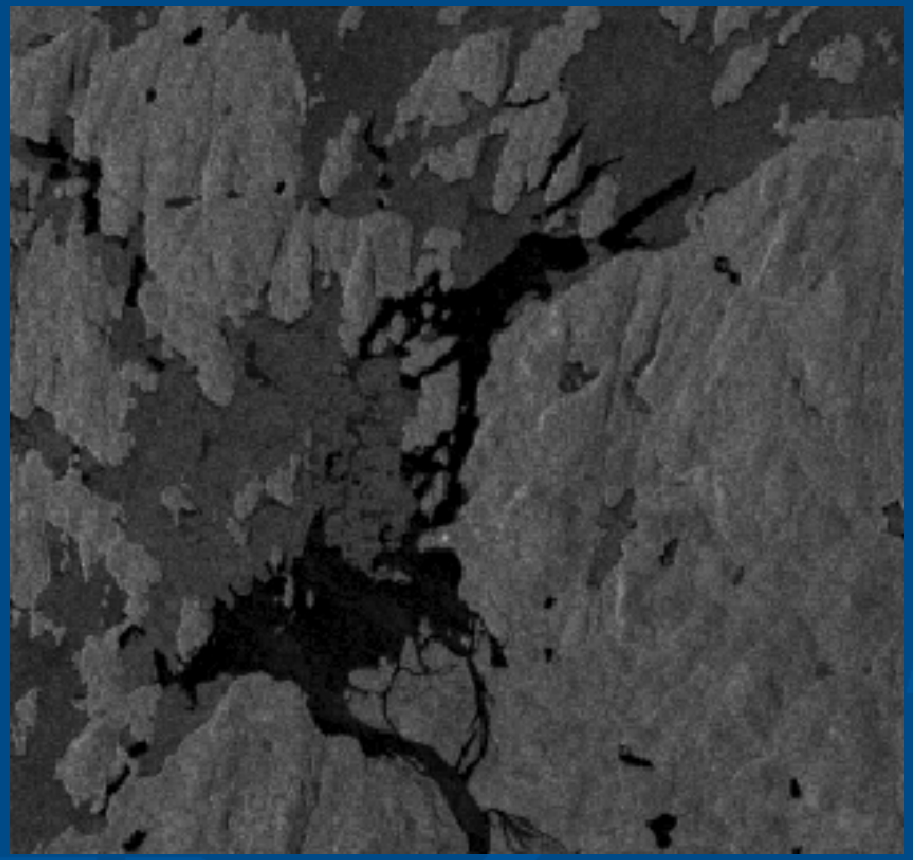
Comparison between 10 m and 25 m resolution flood extent in the city of Rovaniemi. Light blue is area covered naturally by water and dark blue analyzed water extent from the Radarsat 1 (Fine) satellite image. As you can notice from the images, narrow bays can't be detected using 25 m resolution.





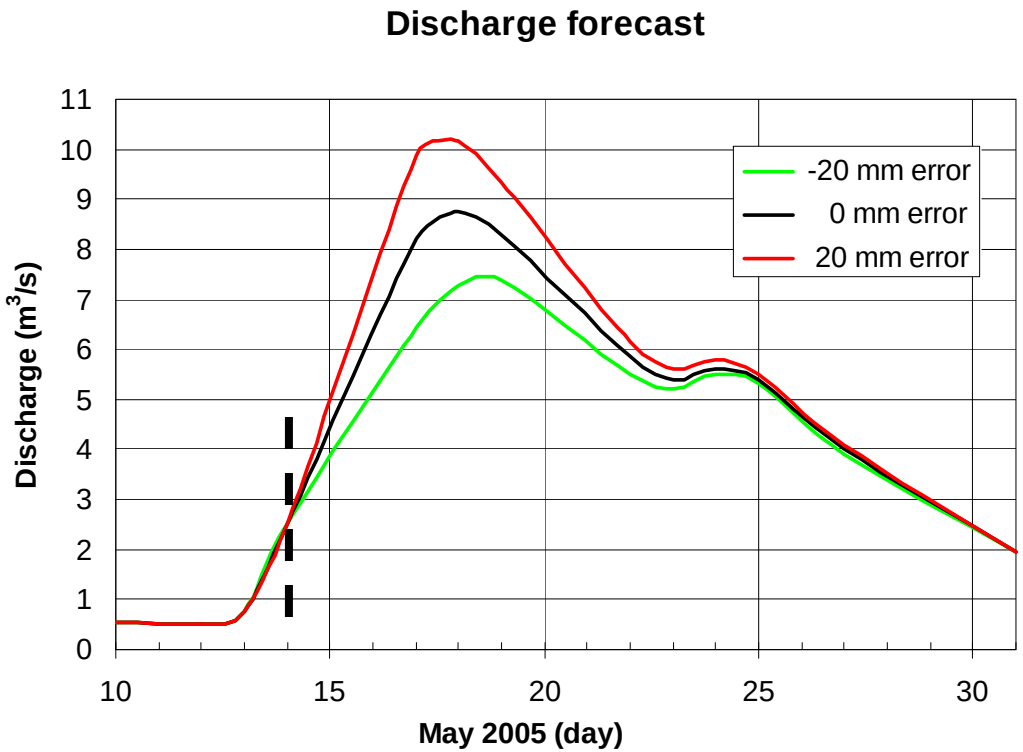
1D-hydraulic model and Radarsat-images are compared in the city of Rovaniemi. The narrower a reach, an island or a bridge is, the more likely it is unnoticed. An interesting feature is the northern bank which is not verified by the algorithm. The reason could perhaps be the incidence angle of the satellite. Around 80% of the inundated area was detected with a 10 meter resolution. As a rule of thumb satellite scene resolution should be at least 1/3 of the river width.

Breaking up of ice in Lake Inari




ENVI 4.1
File Basic Tools Classification Transform Filter Spectral Map Vector Topographic Radar Window
#1 Band 1:Envisat_IMPG_asc_07-NOV-2004_210447_+00487_mds1_fsar_utm
File Overlay Enhance Tools Window
#2 Band 1:decryptdem
File Overlay Enhance Tools Window
xload
almar3.itek.norut.no
Thank you
FloodMan
stian@heimbert:~
xload
ENVI 4.1
#1 Band 1:Envisat_
#1 Scroll (0.06130)
#1 Zoom [4x]
#2 Scroll (0.06130)
#2 Zoom [4x]
#2 Band 1:decrypt
stian@almar3:~
Lookup
5°C 14:55

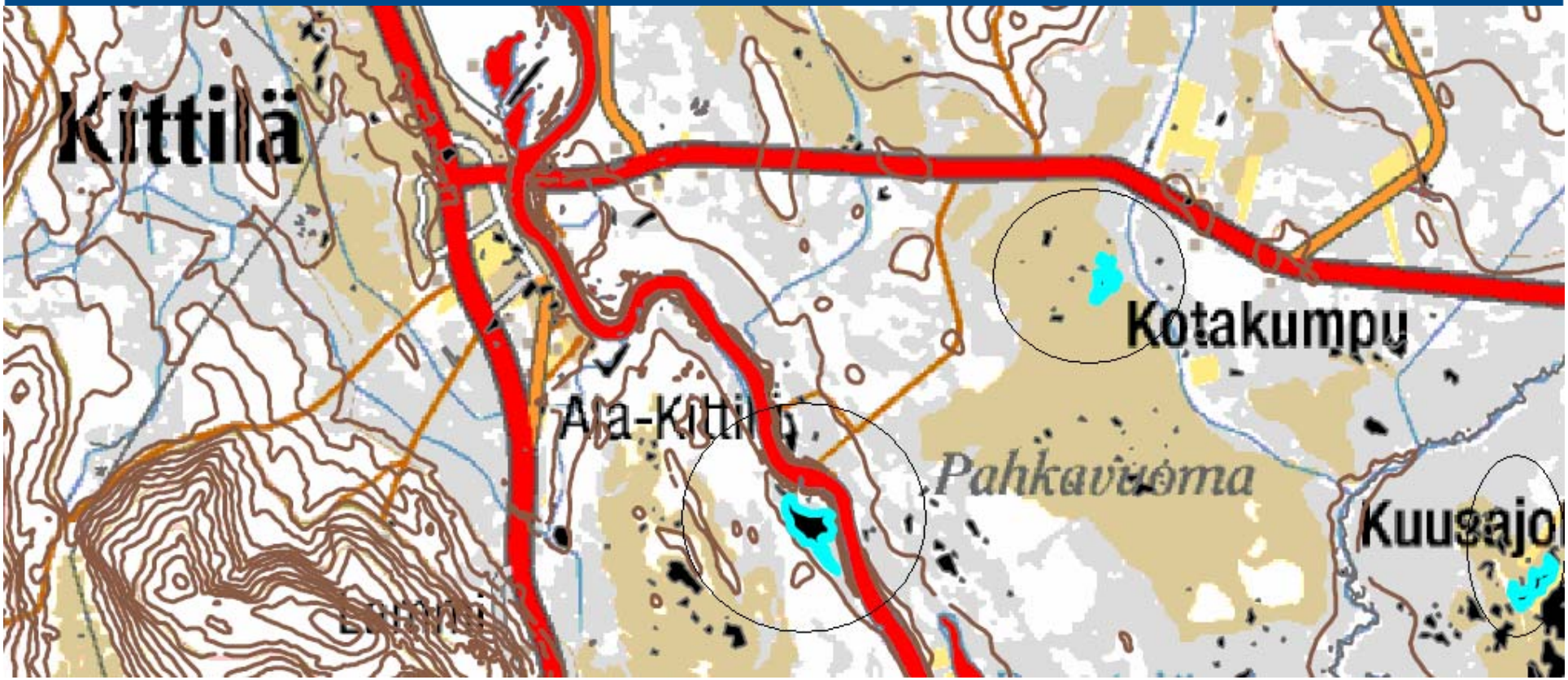
Potential improvement



- effect of 20 mm uncertainty in surface water volume (e.g. high precipitation during the snow melt period) on accuracy discharge forecast
- satellite data can improve the 4 day discharge forecast by 10-20%

Detecting water detention areas

- the satellite information was later on also used for **floodplain mapping** and evaluated for its potential use for detection and quantification (volume assessment) of **floodwater detention areas** intended for floodwater storage



Gauge-Altimeter lake level comparison (Topex/Poseidon-Jason2), Lake Tana