56th Photogrammetric Week '17
September 11-15, 2017
Stuttgart, Germany

Advancement in Photogrammetry, Remote Sensing and Geoinformatics

bfg Bundesanstalt für Gewässerkunde

From Applied Research to Application - Remote Sensing Products for Waterway Management

Herbert Brockmann

Agenda

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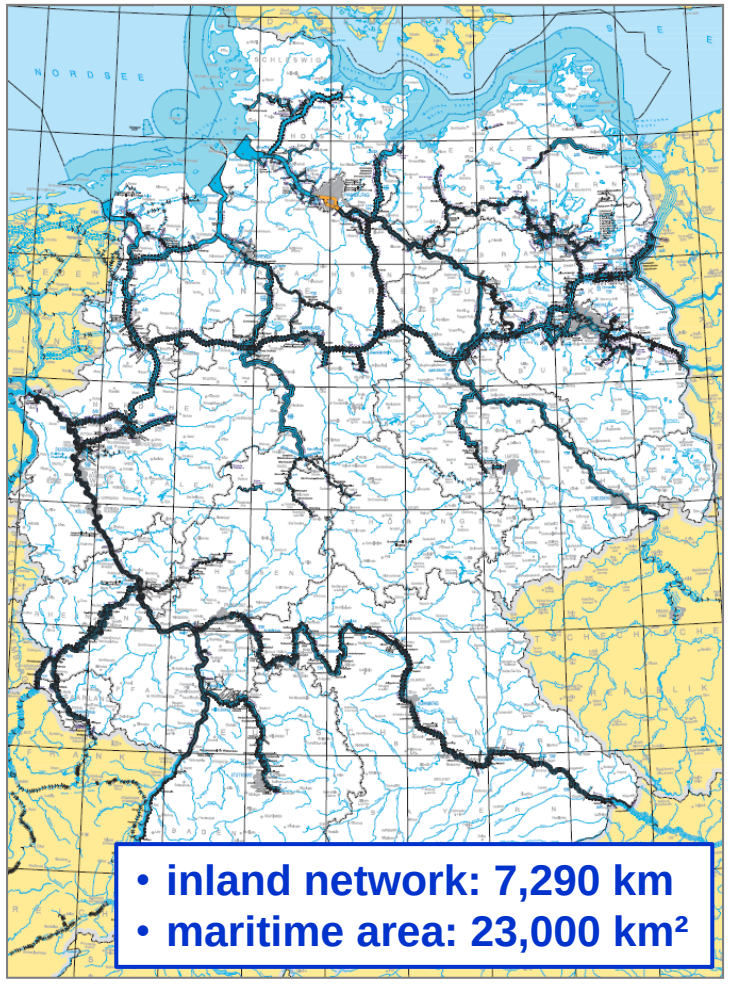
1. **Introduction**
2. **Relevant products**
3. **Selected potential applications**
   - **currently in operation**
   - **short to mid-term operational**
   - **mid to long-term operational**
4. **Perspectives**

Responsibilities

- **Federal Institute of Hydrology (BfG)**
  - scientific institute in fields of **„water“**
    - applied research
    - consulting
    - …..
  - essential users of support
    - Federal Ministry of Transport and Digital Infrastructure
    - **Waterways and Shipping Administration (WSV)**
- **BfG department Geodesy**
  - reference systems / geokinematics
  - hydrography / topography
  - hydraulic engineering geodesy



⇨ **all are working with remote sensing techniques**

Basics

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- **Understanding of remote sensing**
  - sensor platforms
    - unmanned aerial vehicle (UAV)
    - manned aerial vehicle (aircraft, helicopter, gyrocopter)
    - satellite
  - sensors
    - passive (digital cameras)
    - active (laser scanner, radar)

- **Needs based work in project teams**
  - final product user and manufacturer
  - all kinds of researchers (university, applied etc.)
  - system manufacturer

User requirements

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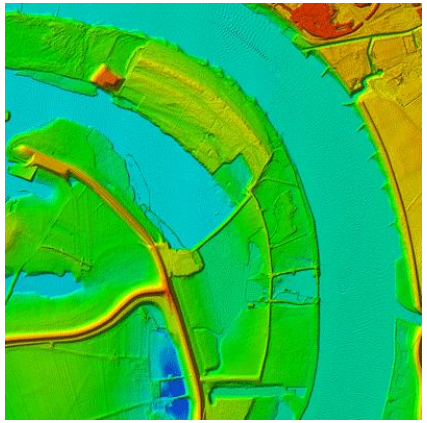
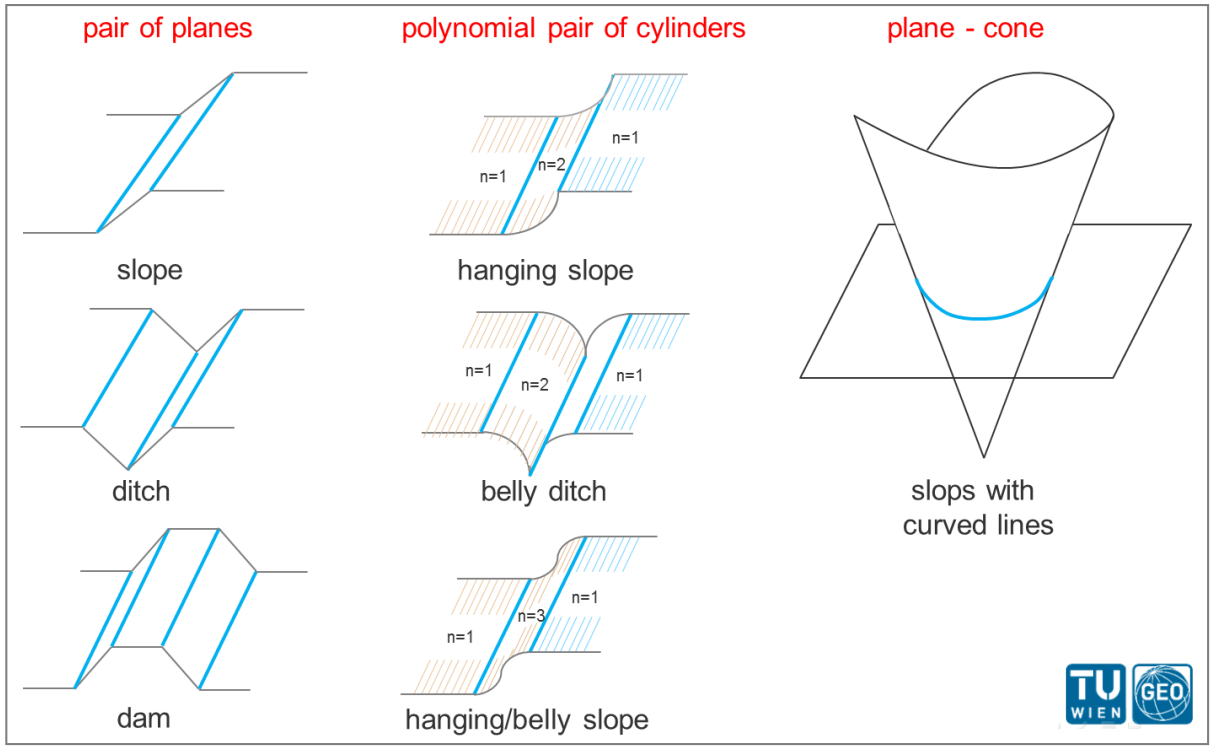
- **Standard georeferenced products**
  - classified 3D point clouds: 1 – 8 points per m²
  - 3-D structure lines: point distance ≈ 5 m
  - DTM / DSM / Δ-models: 1 m x 1 m grid
  - 1-D – 3-D deformation vectors: 1 cm per year
  - ortho photos (RGB, SAR): GSD = 0.1 m – 1 m
  - 2-D/3-D water-land-borders: point distance ≈ 5 m
  - 3-D water levels: point distance = 100 m
  - ⇨ **recurrent necessary accuracy: comparable to ALS or multibeam echo sounding**
- **Additional products with lower or higher accuracies**
  - case-by-case

3-D structure lines from point clouds

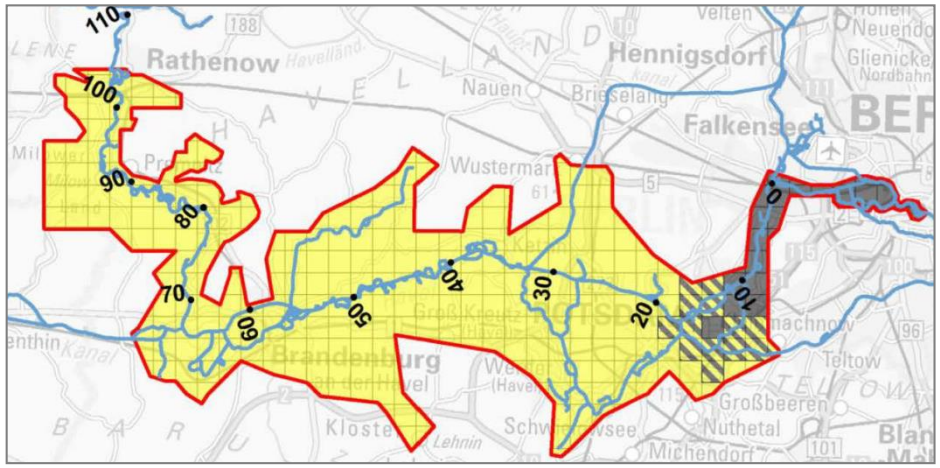
- **Research related to software OPALS**
  - detection of 2-D approximate lines based on an inclination model
  - modelling of 3-D structure lines by terrain approximation using geometry models

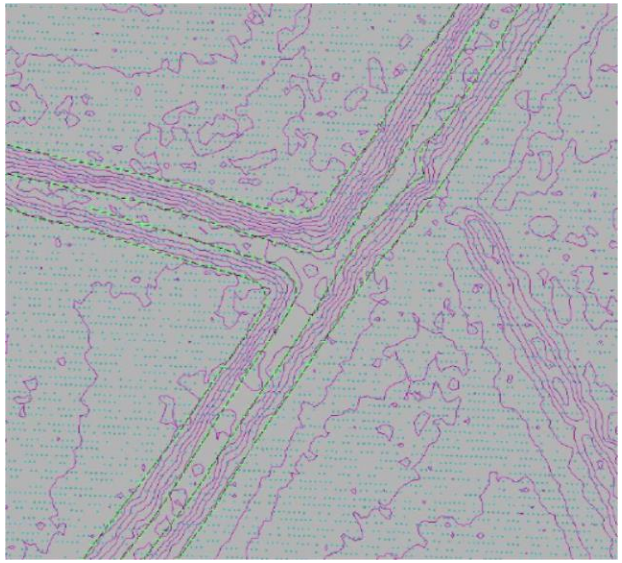


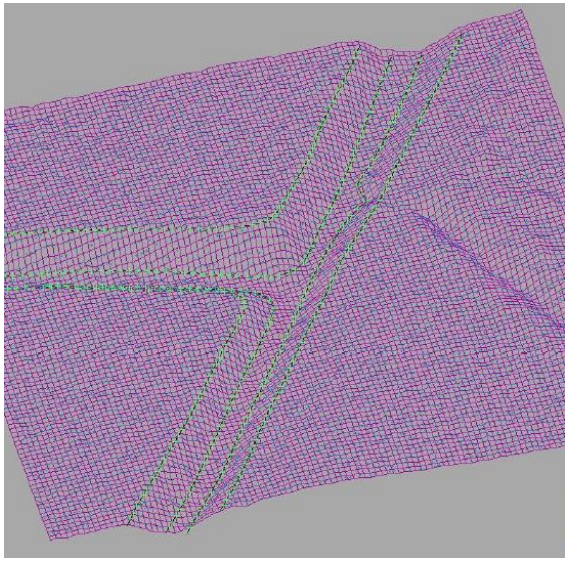


Operational pilot project

- **Havel river area**
  - 1,030 km²
  - point density ≤ 2 points per m²
  - slope change > 20°
  - accuracy corresponding to the ALS data
  - manually reworking < 30 min per km²

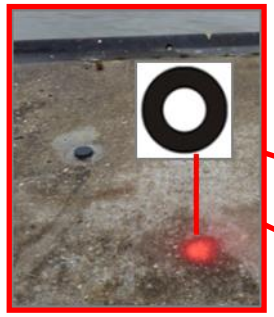


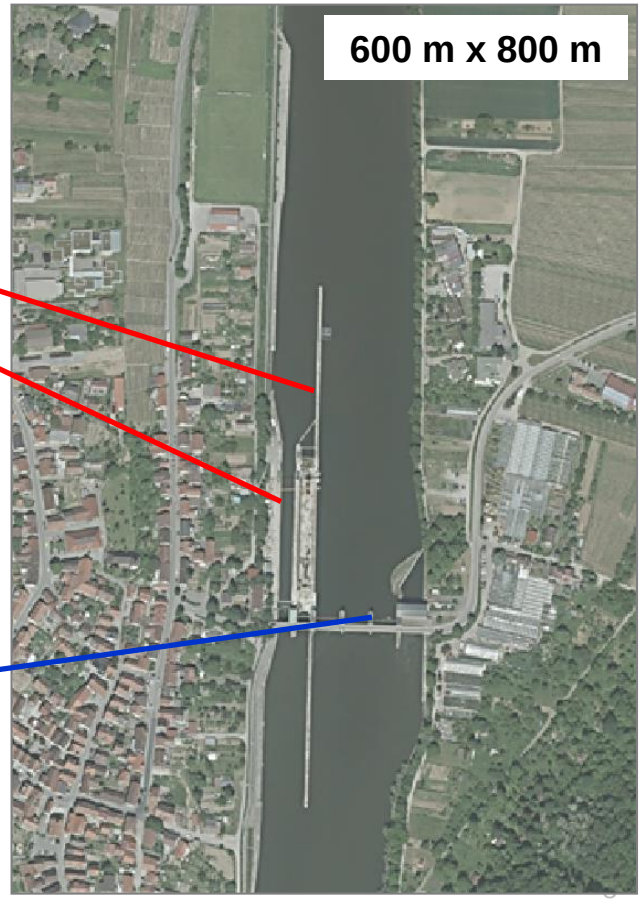




Surface data via UAS

- **Monitoring requirements**
  - classified DTM, DSM, difference models of hydraulic structures and their surroundings
    - 10 cm x 10 cm grid
    - 13 surface classes (e.g. lock pier, lawn)
  - signalized, non-signalized object points
  - difference uncertainty:
    - 2 mm per measuring epoch
- **Overarching aims**
  - usable measurement results
  - practice-oriented guideline
    - technical use
    - economic use
  - result transferability
    - other transport administrations





Evaluation / optimizing

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gyrocopter / high end sensors

digital camera (e.g. IGN Paris camlight)

laser scanner (e.g. RIEGL VP-1)

UAV / high end sensors

digital camera (e.g. DLR micro MACS)

laser scanner (e.g. RIEGL VUX-1UAV)

UAV / standard sensors

digital camera (e.g. senseFly S.O.D.A.)

BMVI Expertennetzwerk Wissen Können Handeln

WSV.de Wasserstraßen- und Schifffahrtsverwaltung des Bundes

ifp Universität Stuttgart

short to mid-term

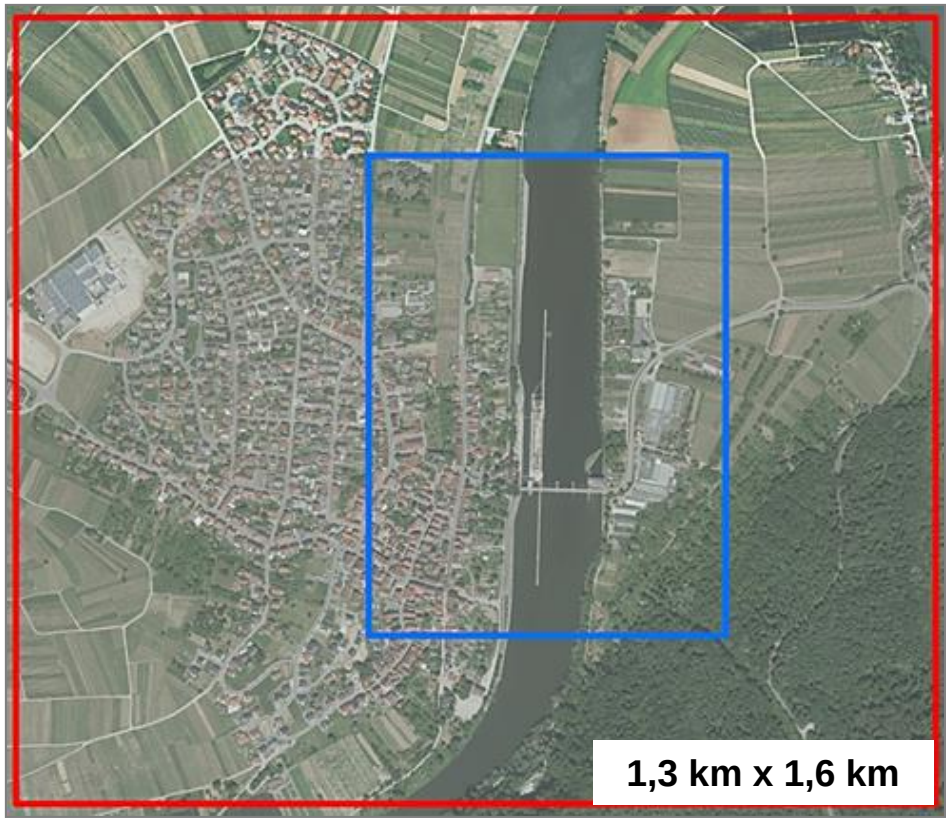
Research needs

- simultaneous sensor use
- system stability and calibration
- sensible scenarios
- …..

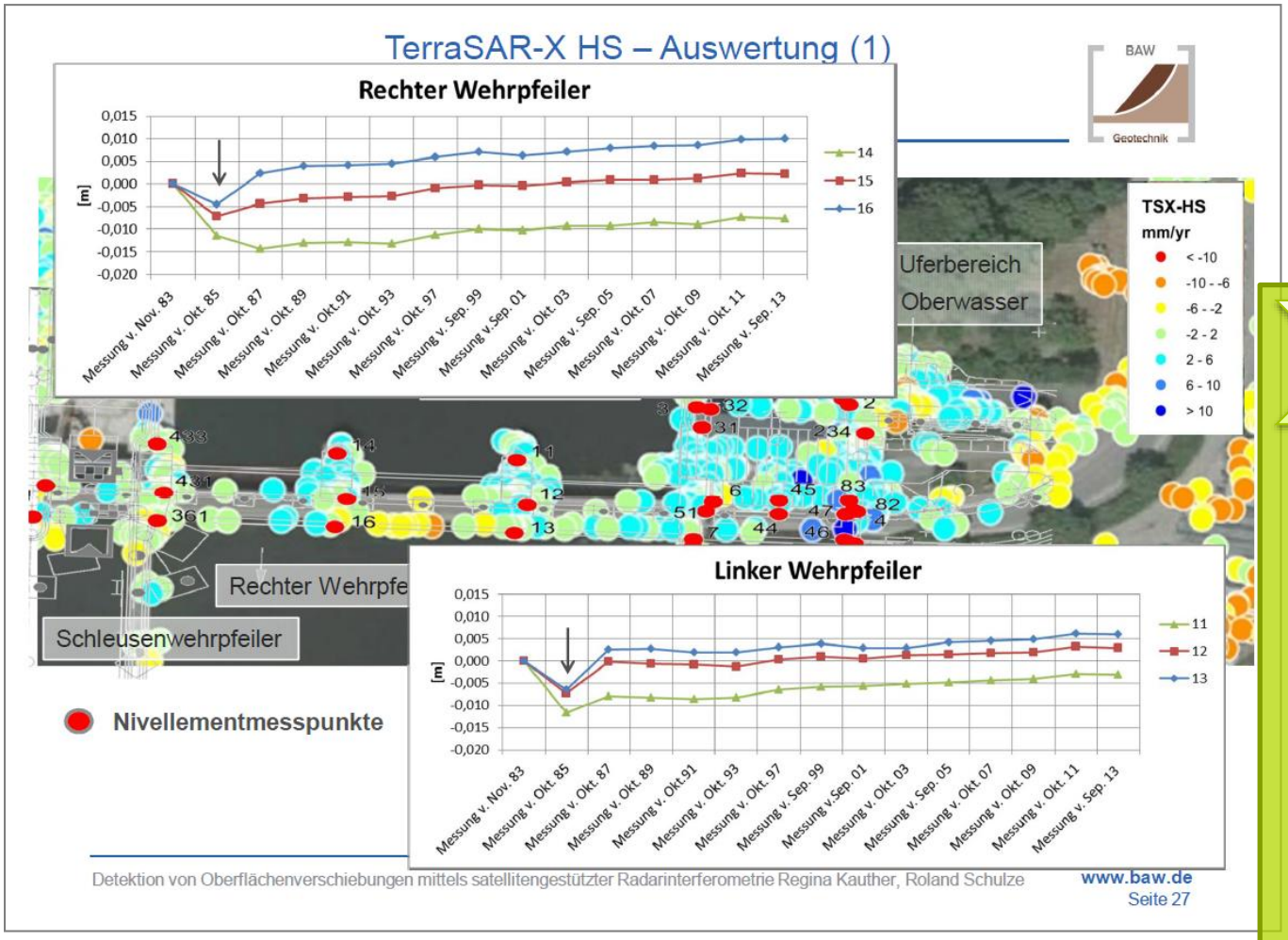
Spatial motion via PSI-SAR

- **Monitoring requirements**
  - relative motions of hydraulic structures and their surroundings
    - spatial vectors, ΔR
    - 1-D / 3-D vectors
  - difference uncertainty:
    - aimed at 2 mm

- **Overarching aims**
  - usable processing results
  - feasibility study
    - technical use
    - economic use
  - result transferability
    - other transport administrations



Development / optimizing

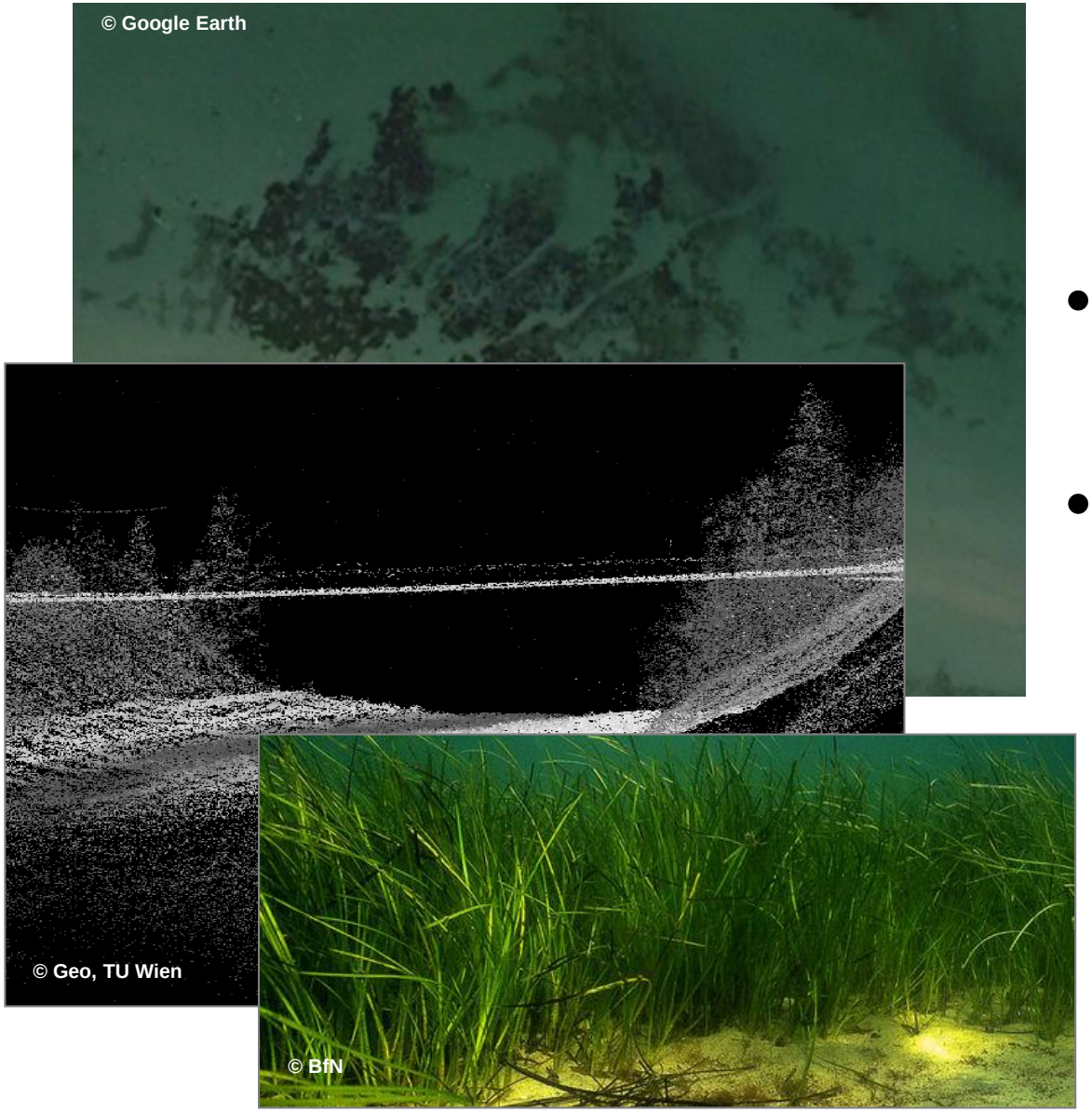


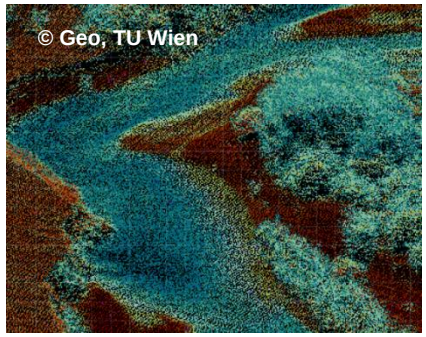
short to mid-term

Research needs

- targeted potentials
  - resolution
  - temporal image distances
- impact of corner reflectors
- comparison of Sentinel-1 and TerraSAR-X products
- …..

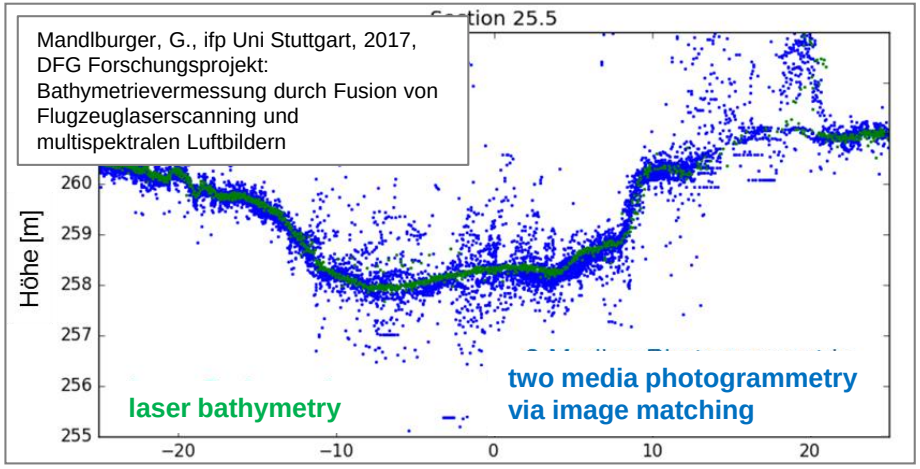
Laser bathymetry data





- **Requirement**
  - identification of the reflector
- **Potentials through ALS data classification**
  - non-ground points
    - identification
    - reflection classes
  - macrophytes
    - biotope types
    - roughness
  - …..

Classification of laser bathymetry data



- **Multidisciplinary object catalog**
  - river bed including the foreland
    - shallow water zone
      - free-flowing
      - regulated
    - …..
  - macrophytes
  - …..

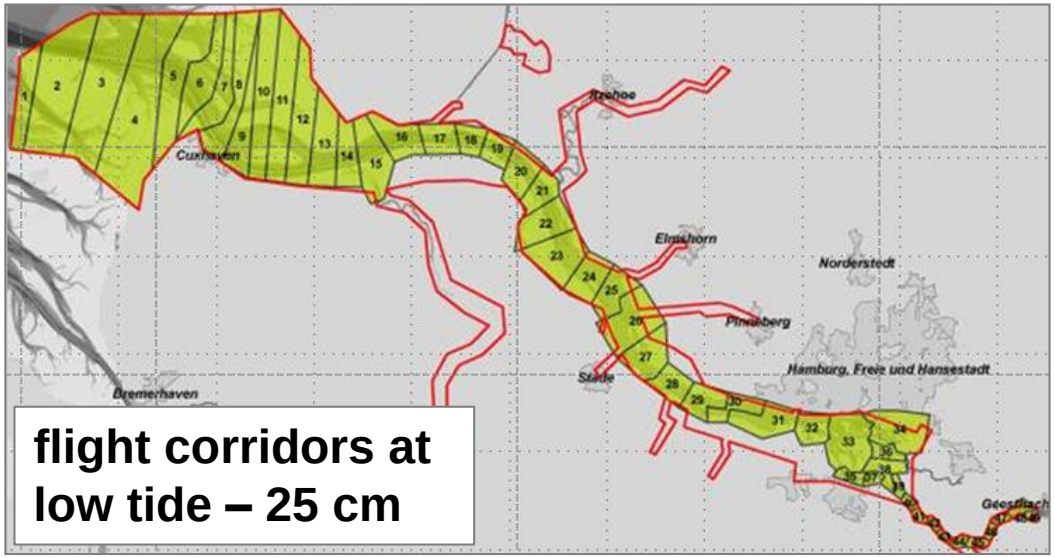
short to mid-term

Research needs

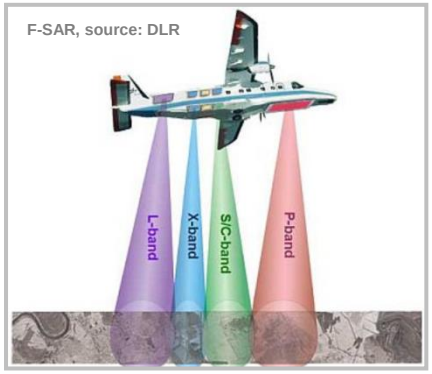
- simultaneous sensor use
  - ALS (red and green light)
  - RGB(Nir) camera
  - hyperspectral camera
- geometry
  - data fusion
- radiometry
  - ground/non-ground separation
  - deduction of relevant reflection classes
- …..

Watt topographies via InSAR

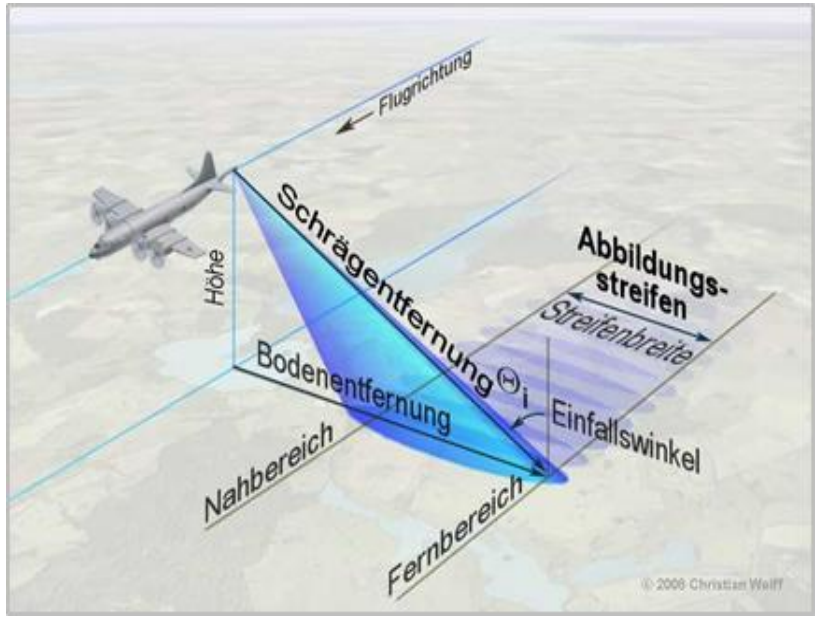
- **Main problem**
  - only few possibilities of data collection



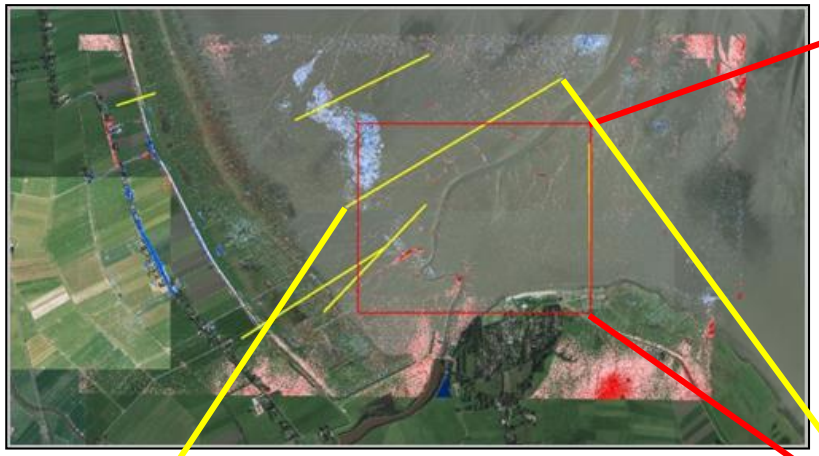
flight corridors at low tide – 25 cm

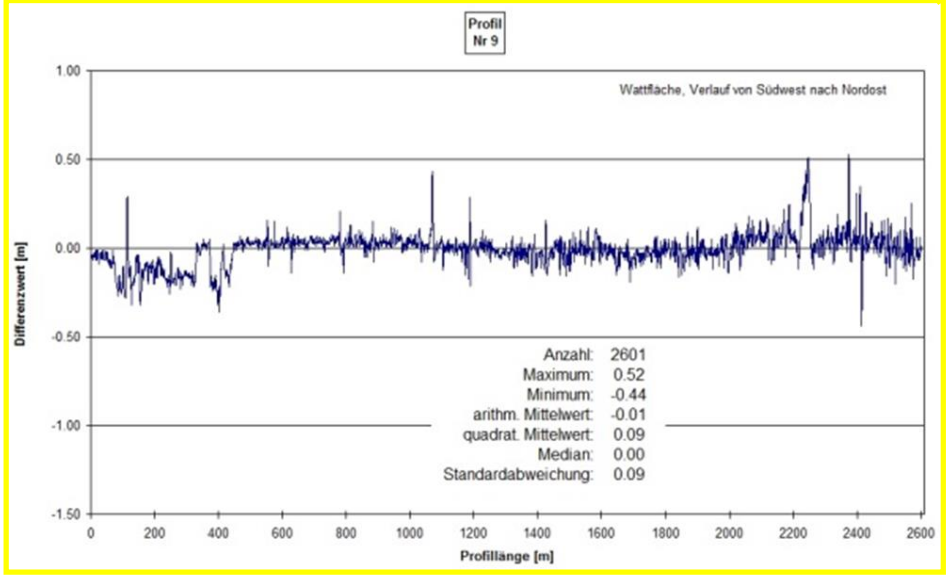


- **Potentials compared to ALS**
  - up to 5-fold larger data collection output
    - flight configuration
    - regardless of weather conditions
    - few surface classes



Development to operational use





short to mid-term

Research needs

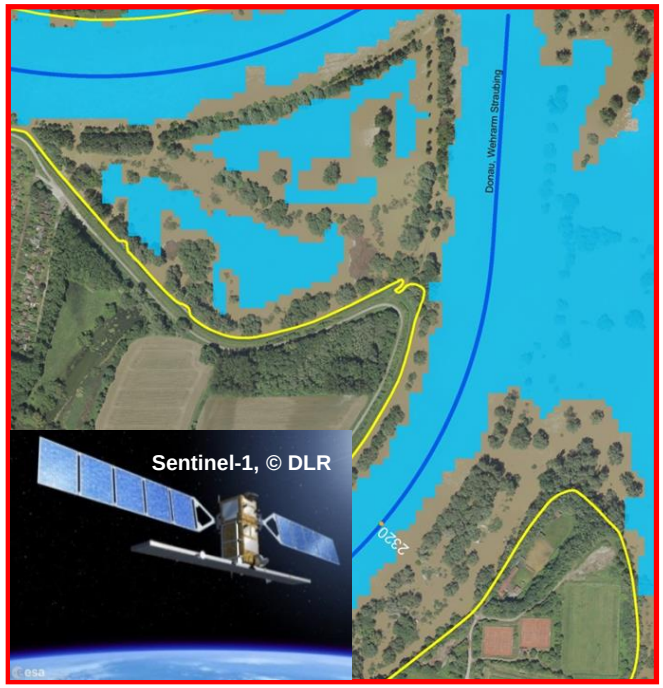
- simultaneous data collection and processing, X- and S-band
- system calibration
- data georeferencing and classification
- …..

Flood zones via remote sensing data

- **Problems and simultaneous potentials**
  - operational on time availability of collection systems
  - important data parameters
    - resolution
    - accuracy
    - reliability

Automatized processing of flood borders

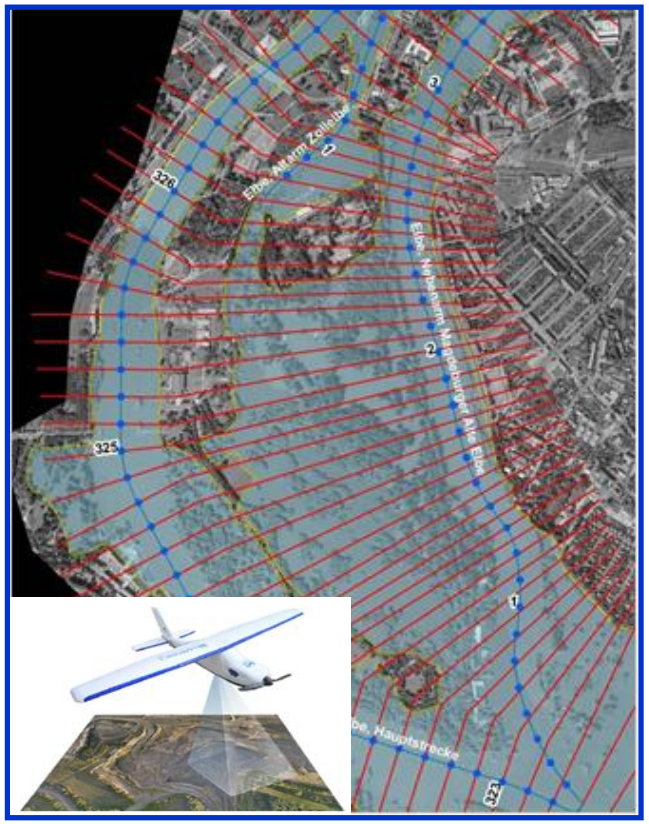
- **Acquisition of exhaustive flood scenarios**
  - **use case 1**: visual 2-D information data for crisis management; supply as soon as possible, max. in 24 hours
  - **use case 2**: 3-D validation data for hydraulic modeling; supply approx. after 6 month



short to mid-term

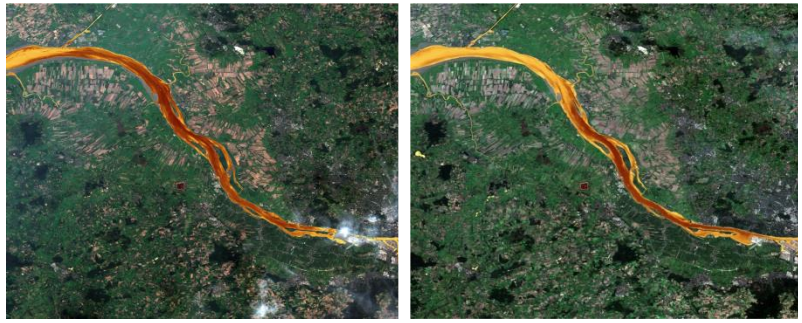
Research needs

- processing algorithms
- plausibility check
- supply of additional meta information
- …..



Pre-project „visible depth“

- **Problem**
  - sufficient visible depth for laser bathymetry use in larger areas (e.g. closed to North Sea coastlines)



- **Solution idea**
  - forecast of visible depth areas
    - use of Sentinel-2 data
    - use of existing turbidity and sediment measurement networks
    - …..

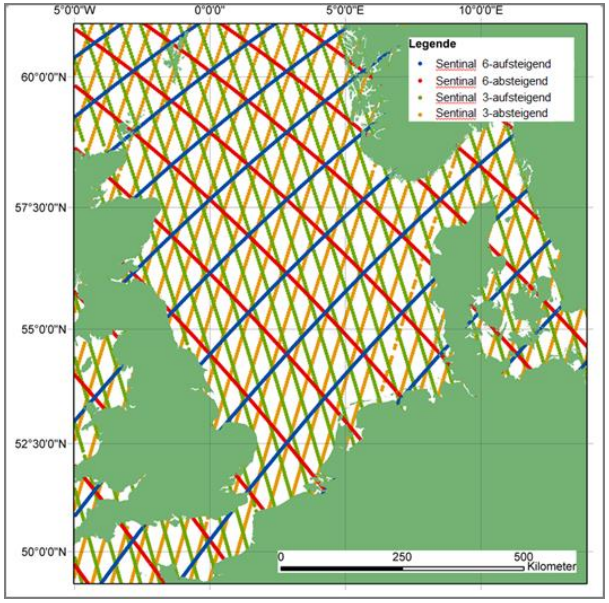
mid to long-term

Preliminary studies

- fundamental feasibility
- if feasible:
  - expectable products
  - professional framework
  - research needs
  - necessary expense

Pre-project „gauge at the sky“

- **Requirements for forecasting**
  - operational availability of areal North Sea water level
    - sections
    - 5 cm uncertainty
    - all 10 – 30 days
- **Satellite altimetry**
  - use of Sentinel-3/-6 data
  - with additional in-situ measurements



mid to long-term

Preliminary studies

- fundamental feasibility
- if feasible:
  - expectable products
  - professional framework
  - research needs
  - necessary expense

Conditions of success

- **Essentials**
  - user orientation
  - use of necessary and accepted standards
    - **G**uide to the Expression of **U**ncertainty in **M**easurement (ISO/BIPM, 2008)
    - …..
  - focus on operational solutions
  - feasibility statements
    - clear and realistic
    - including professional and economic efficiencies
  - general inclusion of applied research
    - more use of funding programs by public administrations
    - work in teams with cooperating partner institutions
  - realization of pre-projects in advance by fundamental issues
  - …..

Future importance of remote sensing in the WSV

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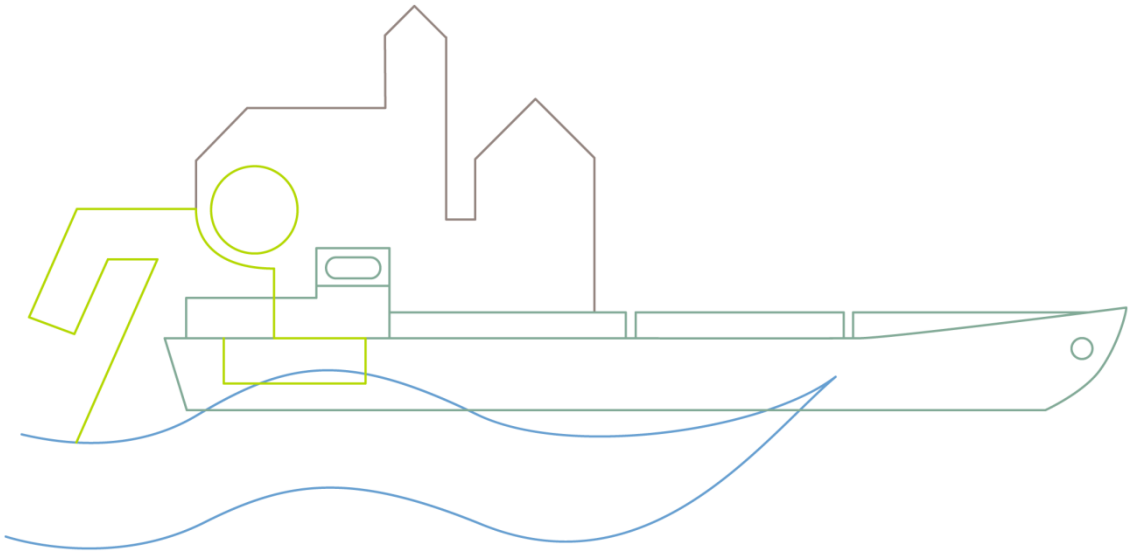
- **Unmanned areal systems**
  - more important local supplement
- **Manned areal systems**
  - still upward trend
  - additional partial solutions
  - new complete solutions only in particular cases
- **Satellite systems**
  - slowly rising
  - still greater efforts
  - Copernicus Europe's eyes on Earth gives and gets new opportunities



Many thanks for your attention

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