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

1. Introduction

The Federal Institute of Hydrology (BfG) is the scientific institute of the German federal government for quantitative and qualitative hydrology and ecology of water. It's a supreme federal agency within the portfolio of the Federal Ministry of Transport and Digital Infrastructure and advices all federal ministries with their subordinate agencies. Against this background the Waterway and Shipping Administration (WSV) is the main client (cf. Figure 1) of the BfG.

Fig. 1: Federal waterways

In this context the department of Geodesy is responsible for applied research, further development of already used technologies, consulting and standardization with the objectives of a professional and economic execution of geodetic tasks.

In my understanding of remote sensing all sensor platforms (unmanned and manned aircrafts, satellites) in connection with passive and active sensors (e.g. multispectral cameras, laser, radar) are included.

This contribution won't present obligatory usable remote sensing applications. In an overview selected and potential solutions for data collecting and modelling will be shown.

2. Remote sensing products

The corresponding geodetic standard products for waterway management are classified 3-D point clouds, 3-D structure lines, DTM, DSM, difference models, deformation vectors, orthophotos, 2-D flood borders and 3-D water levels. Many times the products have to represent situations of low or high water. Generally the necessary accuracies have to be oriented towards the potentials of airborne laser scanner or multibeam echo sounder. Of course lower or higher accuracies are demanded case-by-case.

3. Selected potential remote sensing applications

Currently in operation usable is a solution for the processing of 3-D structure lines based on point clouds. This software, an OPALS[1] module, was used the first time for an area of 1,030

[1] http://geo.tuwien.ac.at/opals/html/index.html

km² of the Havel river. The lines were successful processed based on airborne laser data, 2 points per m². The accuracy level of the laser data has been fulfilled. A main fact is the time of the manual post processing less than 30 minutes per 1 km². So an economic alternative to the conventional photogrammetric measurement of structure lines is given.

With the aim of a short to mid-term (up to 5 years) operational use the following applications will be pursued:

- For the monitoring of hydraulic structures, classified 10 cm grid DTM, DSM, difference models and differences in selected object points are needed. Therefore UAV systems combined with high end laser scanner and digital cameras have to be simultaneous used. These systems should be evaluated and further developed. A comparison with corresponding data collections by gyrocopter and UAV standard systems is self-evident.

- For the monitoring of hydraulic structures persistent scatterer interferometry (PSI) should be used as well. The processing of Sentinel[2]-1 data (synthetic aperture radar, C-Band) has to be developed and further optimized.

- Topographic measurement of shallow water zones will be done by laser bathymetry if possible and sensible. The reflector of the laser signal is often not clear. Sometimes 3-D documentation data of macrophytes are simultaneous demanded. For this realizations of bathymetric laser data classifications have to be developed.

- The topographic data collection of the tidal influenced dry fallen watt areas of the North Sea coast is done by airborne laser scanning. For this the water level of the middle low water minus 25 cm has to be met. Among other things it is very often not possible to meet this condition. Here, the weather independent airborne radar interferometry promises new possibilities. Up to 5-fold greater data collection outputs per permitted period of time are expected. The aim is the development of an operational complete system.

- Extreme flood events have to be documented through 2-D flood borders and 3-D water levels at peak flow. Two fields of application have to be taken into account:

  - visual 2-D information data for crisis management with a product supply as soon as possible, not later than 24 hours and

  - 3-D validation and calibration data for the hydraulic numeric modelling with product availability within 6 months.

  For these requirements two solutions of a reliable automatic data processing have to be developed. For this Sentinel-1 data (SAR, C-Band) and areal images in high resolution (color channels: red, green, blue, close infrared) should be used.

From the current point of view mid to long-term (more than 5 years) two Sentinel data applications are to be notified. To clarify the feasibility two pre-projects should be initialized:

- forecast of visible depth areas for the planning of spacious laser bathymetry data collections based on Sentinel-2 data (optical, 13 spectral channels) and

- provision of North Sea water level data by means of satellite altimetry via Sentinel-3 and Sentinel-3 data (radar altimeter).

[2] Sentinel: Satellites of the European Earth Observation Program *Copernicus,* http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview4

4. Perspectives

To establish the use of new techniques in the WSV clear and realistic professional and economic statements are required. Particularly with regard to data collection via remote sensing systems a reliable operability is an essential condition. To achieve this a cooperative team is needed in the research and development phases. The members of this team should be representatives of the final product user and manufacturer, university and applied research as well as very often the system manufacturer. Under these conditions there will be increased chances for remote sensing applications from the perspective of a departmental research institute. This also applies to satellite-based applications.

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