Use of satellite images for the monitoring of water systems

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Satellite images are a proven source of information for monitoring ecological indicators in coastal waters and inland river systems. This potential of remote sensing products was demonstrated by recent research projects (e.g. EU-funded project Freshmon – www.freshmon.eu) and other activities by national institutions. Among indicators for water quality, a particular focus was set on the temporal and spatial dynamics of suspended particulate matter (SPM) and Chlorophyll-a (Chl-a). The German Federal Institute of Hydrology (BfG) was using the Weser and Elbe estuaries as test cases to compare in-situ measurements with results obtained from a temporal series of automatically generated maps of SPM distributions based on remote sensing data. Maps of SPM and Chl-a distributions in European inland rivers and alpine lakes were generated by the Freshmon Project. Earth observation based products are a valuable source for additional data that can well supplement in-situ monitoring.

For 2015, the BfG and the Institute for Lake Research of the State Institute for the Environment, Measurements and Nature Conservation of Baden-Wuerttemberg, Germany (LUBW) are in the process to start implementing an operational service for monitoring SPM and Chl-a based on satellite images (Landsat 7 & 8, Sentinel 2, and if required other systems with higher spatial resolution, e.g. Rapid Eye). In this 2-years project, which is part of the European Copernicus Programme, the operational service will be set up for
- the inland rivers of Rhine and Elbe
- the North Sea estuaries of Elbe, Weser and Ems. Furthermore
- Lake Constance and other lakes located within the Federal State of Baden-Wuerttemberg.
In future, the service can be implemented for other rivers and lakes as well.

Key feature of the project is a data base that holds the stock of geo-referenced maps of SPM and Chl-a distributions. Via web-based portals (e.g. GGInA – geo-portal of the BfG; UIS – environmental information system of the Federal State of Baden-Wuerttemberg; BOWIS – information system for the Lake Constance) the maps will be made accessible to the public. The aim of the project is to implement a service that automatically recognizes new satellite images covering the area of selected water systems (lake, river or estuary) and therefore is able to continually update the data base. Furthermore, the service includes a procedure to analyse newly available data with the highest possible degree of automatization. It is planned to add new maps of SPM and Chl-a distributions to the data base within a couple of days after the satellite image was taken. A high degree of automatization is the essential condition to process a large number of satellite images each year at reasonable costs. It could be demonstrated by the Freshmon Project that there are simplified but robust algorithms and procedures existing.

For the successful implementation of the service, it is important to further validate the results obtained by the service line as well as the used procedure and algorithms. Therefore, several test cases will be set up. Each case is going to include an analysis of the uncertainties to describe the expected deviation between values derived from earth observation data and the in-situ data obtained from the BfG and LUBW monitoring networks. Furthermore, it will include a description of possible sources of error and the boundary conditions which are most sensitive to the analysis. Test cases are planned to be made public with all necessary data. The scientific community is invited to use the data as a benchmark test case to develop their own algorithms and procedures.