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Surveying and Monitoring River Systems from Satellite Platforms

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The need for monitoring information on the hydrological processes and the steady decline of traditional monitoring networks triggered increased attention to remote sensing solutions that could provide the much needed data for various elements of the hydrological cycle. Recent efforts by the Surface Water Working Group of NASA (http://www.geology.ohio-state.edu/swwg) and its European counterpart resulted in two mission plans, the Water And Terrestrial Elevation Recovery Hydrosphere Mapper (WATER HM, http://www.geology.ohio-state.edu/water) and the Water Elevation Recovery (WatER, http://www.legos.obs-mip.fr/recherches/missions/water). These plans being considered by both NASA and ESA to launch dedicated satellite to monitor water surfaces.

Single satellite missions (typically orbiting at 600-700 km altitude with 12-14 orbits/day repeat frequency) have to trade between spatial density of the orbit tracks and the temporal frequency of the revisit time. Therefore, global coverage can be achieved only by using wide swath sensors (several thousands km for daily full coverage, e.g. MODIS sensors on Terra and Aqua satellites) or severely limit the temporal frequency (Landsat, IceSAT, etc). The currently envisioned water surface monitoring missions designed for both inland waters (rivers, lake/reservoirs and wetlands) and ocean monitoring are expected to have 10-20 days repeat orbits. Such a low temporal frequency clearly limits its use for river discharge monitoring and yet the planned mission could become a breakthrough in river surveying that is often overlooked.

River surveying (obtaining riverbed cross-section and long-profile) is the most expensive element of discharge monitoring. These 3D properties of river systems are poorly measured even in rich countries. The planned wide-swath altimeter has the potential to

provide snapshots of water surface elevation and extent simultaneously. However, the temporal frequency of these snapshots will be inadequate for discharge monitoring, but quite sufficient for mapping the river systems at different discharge stage levels. The water surface elevation along river courses can be used to assess the energy profiles of the river flow and to infer riverbed roughness conditions.

This presentation will demonstrate the theoretical basis of using remote sensing for river surveying and apply the theories to reconstruct riverbed geometries from remote sensing products. Power functions as idealized approximation of cross-section appear to be a convenient means to describe riverbed geometries for a wide range of rivers. The exponent and the coefficient of the power function sufficiently describe most river cross-sections. Tied to a newly emerging high resolution gridded network (derived from the Shuttle Radar Terrain Mission, SRTM products) such a the 500 m resolution gridded network HydroSHEDS (http://www.worldwildlife.org/freshwater/hydrosheds.cfm), the numerical representation of river systems globally is possible. A prototype version of such a 3D river network will be presented at 6' resolution gridded network what already provides a testbed for specification of science requirements for river surveying missions. Using 6' gridded network along with the assigned river geometries, we provide an assessment of the distribution of the river systems globally that can be monitored assuming different sensor sensitivity and corresponding minimum target sizes. An evaluation of existing remote sensing platforms with respect to river surveying will be presented and the requirements for future missions discussed.

The 3D river network representation is also essential for future discharge monitoring missions (with adequately high temporal frequency) since the cross-section geometry is necessary in establishing the relationship between monitored river flow characteristics (stage height and/or flow width) and actual discharge. The presentation will show the use of riverbed geometry information for estimating river discharge from processing remote sensing products.