Use of remote sensing data in environmental hydraulics

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Outline

• General comments
• Applications
• Conclusions
Remote sensing

Rivers are continuous systems that vary across multiple space and time scales. To truly document the range of river structures and functions therefore requires continuous data (Lane et al., 1994) across a wide range of spatial and temporal scales (Fonstad and Marcus, 2010). Methods classically used to map rivers, such as cross-sections or detailed reach scale surveys, capture only a small portion of a river and often do not portray the range of variations throughout the system. **Remote sensing can provide continuous coverage at varying resolutions on a repeat basis, thus creating the potential to document a remarkable range of variations in river parameters.** In this case, necessity (for the river scientists) has been the mother of invention.

Remote sensing

- Acquisition of information without physical contact
  - For example: ultrasonic, radar, optical, laser, photogrammetry, etc.

- Terrestrial, airborne, and from space

Source: AWF-Wiki (Universität Göttingen)
Source: http://ccar.colorado.edu/rses/
Remote sensing

• Provides data covering small to large spatial scales with high resolution

• Repeated remote sensing allows for monitoring over time

Source: Juha Järvelä
Remote sensing data – some examples

- Determination of water levels, bed levels and water depth
Remote sensing data – some examples

- Bathymetry and digital elevation models
Remote sensing data – some examples

- Vegetation mapping
Remote sensing data – some examples

• Velocity measurements
Remote sensing data – applications…

• Google search for remote sensing data: 567 000 hits
  – Including environment: 451 000
  – Including hydrology: 305 000
  – Including hydraulics: 145 000

• Many applications for environmental hydraulics
  – Many recent publications in specialized as well as hydraulic journals…

• The use of remote sensing data in environmental hydraulics
can best be shown by some recent examples…
Flood inundation modelling

Flood inundation modelling

• New possibilities for model setup and model calibration
  • Large scale DEM’s with high resolution
  • Assessment of accuracy
  • Measurement of water surface elevations and velocities for model calibration

Characterisation of roughness

• Classical approach:
  Grain size distribution
  - ...
**Characterisation of roughness**

- Enables development of novel approaches:
  Random field approach – information on roughness structure

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**Figure 9.** Bed-structure classification based on bed-elevation distribution moments, where “R” = ripples, “D” = dunes (with fully 3D dunes tending toward “R”), “S_m” = artificially scoured uniform sands, “S_{gr}” = artificially scoured gravel mixtures, “M” = planar beds of mobile uniform sands, “A” = armoured gravel beds, and Sk = Ku = 0 at the intersection of the axes.

**Coleman et al. (2011)**

**Figure 5.** Second-order structure functions for $l_x$ (blue line) and $l_y$ (red line) and $l_z$ (green line) for the surfaces shown in Figures 2 and for the initial bed ($D_0 = 6 L_x$). The horizontal lines indicate the corresponding values of $S_{r_x}$.

**Aberle and Nikora (2006)**
We are no longer restricted to earth…

• A look into space…

  – ...

http://tharsis.gsfc.nasa.gov/slopes.html
Morphology

- A look from space on earth…

We can also stay on earth…

- …
... and look into

- Sediment transport and flow processes

  - ...
... and look into

- **Determination of floodplain vegetation characteristics**
  - ...

- **Improve approaches for flow-vegetation interaction**
  - ...
Last but not least…

• Novel possibilities for physical modelling…

Summary

- This talk provided only a glimpse of the use of remote sensing data in environmental hydraulics
- Remote sensing data will trigger further important advances in environmental hydraulics