- Optical satellite pictures –
The up to date source for discharge determination

in arid countries

Geologist Michael Mett*
Professor Engineer Markus Aufleger*

* University of Innsbruck, Institute of Hydraulic Engineering (IWI)
Technikerstraße 13, A-6020 Innsbruck

1. Introduction – Motivation

Lack of discharge data in many arid regions
(missing gage stations or specialists; no information about intensity, duration and frequency)

Water resources are lost…
(disappear to the sea, evaporate in basins or get saline or polluted)

…but they could be used …
(if discharge data are available
to plan and run infrastructural measures
like artificial groundwater recharge dams)

1. Introduction – Fluviomorphologic changes

Gage Station

1. Introduction – Principal approach

Methodology

Fieldwork

Discharges ground based

February 2003
May 2003

02/2003 05/2003 Structural changes

Project area – Wadi Hawasinah, Sultanate of Oman

Hawasinah Groundwater Recharge Dam

Gage Station
2. Project area – Field observation

1. Which structures can be observed in the field?

- Channels - erosion
- Flat basins - deposition
- Micro structures - variable

2. Which of these structures can be recognised in satellite data of different spatial solutions?

Channels can be recognised.

3. Crucial question: Which of these recognizable structures will change during a runoff event?

4. Workflow – Image processing

- Raw data, without orientation
- Rectified data (fit in coordinate systems)
4. Workflow – Image processing

Colour adjustment, atmospheric correction

4. Workflow – Spectral classification

Spectral classification “Cleaning” of the classified picture

4. Workflow – Image analysis

Classified data River patterns Fractal analysis

Change analysis Fluvio-morphologic changes

5. Module – Discharge estimation

Comparison of Satellite Data

Fieldwork and Satellite Data

Discharge

6. Summary

Main goal: Fast and economical determination of water resources management data in arid river basins.

Secondary goals:

- Context between flood events and morphological changes.
- Demands on satellite data to recognize morphological changes.
- Acquisition and compilation of presently available and adequate satellite data.
- Demands on future satellite sensors.

- Optical satellite pictures –

The up to date source for discharge determination in arid countries?
Thank you very much for your attention

Appendix – River features

River dimensions: Observed river width is displayed by sedimentation of fine material (clay, silt) during the maximum stage of the flood event. Also the total area of wadi streams and length gives evidence about the flow behaviour of the river system.

River sinuosity: Sinuosity is defined as the length of the river divided by the length of the floodplain. River sinuosity is already used by Smith et al. (1996) to estimate discharges in flowing braided rivers in alpine regions and offers promising potential for this research application in arid areas without water.

River patterns: Erosion and deposition processes can be observed by studying sand bars and gravel bars. Deep channels occur in river reaches of high fluid energy, whereas deposition of fine material displays low stream energy.

Appendix – Fractal analysis

Fractal analysis: Fractal analysis exhibits great potential to describe structural patterns. Fractal geometry is based on the self similarity of patterns and allows (1) to characterize structures quantitatively, (2) to gather information about anisotropy of pattern and (3) to derive information about pattern forming processes (Kruhl et al., 2004).

The preferred technique for fractal analysis within the research project is the "box counting method" which can be applied easily to the extracted river patterns.

Appendix – Energy estimation

Energy estimation: Geomorphologic changes depend on river energy. For energy estimation basic information about river patterns, slope conditions and approximated water levels can be derived from satellite data.

With the observation of erosion and deposition processes a valuation of bed load transport (river energy) is possible.

In this context works of Zern (2003) and Hunzinger (1998) about the relation between river extension, river slope and water depths deliver valuable approaches for the project.

Appendix – Discharge estimation

Alsdorf et al. (2000) observed interferometric radar measurements to monitor water levels in reaches of the Amazon basin. Combined with information about river bed geometry and flow velocity the discharge can be estimated.

Meinel et al. (2003) derived information about maximum flow depth and flow width from optical sensors of high resolution to calculate discharge of the river Elbe whilst the flood.

Radar altimeter data were used to monitor sea level height by Birkett (1998). Attempts to derive discharge information from structural components of the river and fluviomorphologic changes due to changing flow regimes are in the focus of recent research.

For example Smith et al. (1996) used Synthetic Aperture Radar (SAR) data to estimate discharge in braided river systems. They used effective river width.

Bjerklie et al. (2005) estimated discharge in rivers by using remotely sensed hydraulic information like river width from air photos and airborne SAR imagery.

Appendix – First results
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<tr>
<th>Länder</th>
<th>Institutionen</th>
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<tr>
<td>Österreich</td>
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<td>Arbeitsbereich Vermessung und Geoinformation der Universität Innsbruck (Prof. Harto)</td>
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<td>Lehrstuhl und Versuchsanstalt für Wasserbau und Wasserwirtschaft (Prof. Strobl)</td>
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<td>Ministry of Regional Municipalities, Environment and Water Resources (Ali al-Abri)</td>
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