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Correlation of space observed morphologic changes with ground based discharge measurements - Case study Al-Batinah plain (Sultanate of Oman)

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The intention of this case study is to correlate space observed fluvio-morphologic changes of ephemeral rivers with ground based discharge measurements. Observations of five Wadi in the Al-Batinah plain (Oman) show, that there is a correlation between intensity and duration of a flood and the resulting changes in riverbed structure. The kind of changes gives evidence of stream power and flow behaviour of the observed river systems.

The Al-Batinah plain is a coastal plain in the North of Oman. It is situated in the North and Northeast of the Hajar Mountains and is mostly composed of alluvial sediments of differing grain sizes which are locally cemented. Several Wadi drain from the Hajar Mountains to the Gulf of Oman, crossing the Al-Batinah plain and forming pronounced braiding river systems.

Despite of small catchment areas in the range of a few 100 square kilometres, the peak discharge of the wadi can reach several thousand cubic metres per second. Heavy and very local precipitation events in the mountains of the Hajar cause mayor flash floods. These scarce flash flood events significantly alter the geomorphology of a wadi river system due to the mainly sparse vegetation cover which enables mobilisation and transport of large amounts of bed material during flood events.

In the presented case study, five Wadi in the Al-Batinah plain are observed with optical satellite images from different dates regarding flash flood related pattern changes. Several optical satellite sensors like Landsat, JERS, SPOT, IKONOS and ASTER were applied to monitor fluvio-structural changes. Each observed satellite image represents the maximum stage of one distinct flashflood event. Ground based discharge measurements enable to correlate structural development with the discharge intensity and extensive field work was performed to support the study with further hydrological information such as river geometry and riverbed roughness. The overall observation period comprises the early 1980ies until now.

Several braiding indices like sinuosity, total sinuosity, channel count- and bar/island- indices are applied to the river patterns to describe and quantify structural changes. With the help of spectral classification, braiding patterns are extracted from the satellite data and investigated regarding effective river width and fractal appearance.

Results for all observed Wadi in the Al-Batinah plain show clear trends when correlating structural patterns to increasing discharges: (1) The sinuosity of the main Wadi reaches decreases, (2) the total sinuosity increases, as well as (3) the channel count and bar/island indices increase. (4) Furthermore, the effective river width increases with a rising discharge. Rating curves work well to visualise this context and enable an estimation of discharges for satellite data without adequate discharge information.

With additional hydraulic information it is also intended to develop a methodology to derive spatial distributed discharge information for large and inaccessible ungauged river basins in arid areas. Statistical approaches and time series analysis may allow deriving information about the general flow behaviour (e.g. repeat interval of discharge and probable maximum flood) of these river basins.