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Stationary Wavelet Analysis of Digital Elevation Models to Detect Hidden Geomorphic Structures in the Gaxun Nur Basin, NW China

Hanna Haedke (1), Sebastian Hölz (2), and Kai Hartmann (1)

(1) Freie Universität Berlin, Institute of Geographical Sciences, Malteserstr. 74-100, 12249 Berlin, Germany, (2) GEOMAR, Helmholtz-Zentrum für Ozeanforschung Kiel, Wischhofstr. 1-3, 24148 Kiel, Germany

The Gaxun Nur Basin (Inner Mongolia, China) is one of the world's largest inland deltas and is located in the landscape of the Gobi desert. This large sedimentary basin is characterized by surface structures related to several geomorphic and tectonic processes, which are inter-fingered and overprinted in space and time. These surface structures can be visualized with a Stationary Wavelet Transform (SWT) of the SRTM digital elevation model (DEM).
In terms of the SWT, the SRTM DEM is regarded as a 2D signal and contained surface structures are considered as signal events. The method splits the information of the DEM into several layers, each layer containing information of different wavelengths and orientations. Thus, different layers show the information about different types of surface structures, depending on their inherent dimension, shape and orientation.
Choosing an appropriate wavelet filter and using the SWT holds the potential to not only detect, but enhance the signal of unseen surface structures. Different wavelet filters respond distinctively to particular shapes of surface structures, thus, making it possible to emphasize specific structures on different scales. Applying this approach to the Gaxun Nur Basin reveals its strengths. Diverse structures could be extracted, which are pointing to paleo-channel systems and ongoing tectonic events:

In the western basin an alluvial fan structure could be identified, which is not connected to the current drainage system. Analysis of the Gurinai graben in the eastern basin show rhomboid-shaped sub-structures, which provide more precise information about the local tectonic stress-field. Similar structures can also be identified in the northern margin of the basin. Moreover, a north-west striking lineament extending from the north-western to the north-eastern basin margin could be extracted. Under the dunes of the Badain Jaran dune field in the southeast of the basin, another east-west striking lineament could be separated from the overprinting by the dunes.

Wavelet analysis, especially the SWT, is sparsely used in geomorphology. Nevertheless it is presented here as a promising tool to find evidence of non obvious tectonic processes or paleo drainage systems in sediment surfaces. Further, we point out that wavelet analysis of DEM derived surface features provide insight about the chronology of sedimentary and tectonic processes.