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# Landscape characterization using wavelet detail coefficients – the landslide case study

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High resolution DEMs interpolated from LIDAR Data contain many structural elements, local features as well as global features. Trying to analyze and characterize landscape features using semi-automatic and/or automatic segmentation methods often do not give appropriate results because of the information density contained in the data. We would like to discover how to generalize DEMs in order to retrieve the best fit between the scale of the DEM and the scale of the relief structure. Thus generalization processes can only be applied if their results fit a specific scale. These processes should allow multi-scale analysis of structural features covering the landscape.

The wavelet transform is similar to a Fourier transform. It is a well-known signal processing method. It consists of two functions which are applied to the same signal, one function depending on the other. The first one is the basis function (B-spline basis in our case) and the second function is defined by the wavelet transform characteristics (compact support, zero mean, perfect reconstruction . . . ).

Wavelet transforms using a B-Spline basis give good results for the generalization of DEMs. Each time the transform is applied to an elevation matrix (DEM), the resolution is divided by two. For e.g. a DEM with a 1m resolution, the first decomposition will result in a DEM with a 2m-resolution, the second in DEM with a 4m-resolution, and so forth. This transform results in low pass coefficients – the generalization - and high pass coefficients – the residuals of a “one step” decomposition. Up to seven transforms were applied to a DEM resulting in a DEM with a 128m- resolution. This level of generalization is representative for meso-scale phenomena, but the residuals

(high pass coefficients) contain specific information of landscape features with about a radius of 128m.

The wavelet transform produces two distinct results:

- If we isolate the low pass coefficient, we can show that the wavelet transform is a better generalization method than simple filtering methods. The slope to elevation ratio is more constant from one resolution to the other than with other methods (for instance mean generalization / median generalization).
- It is possible to segregate the high pass residuals from the low pass generalization. Moreover, if we inverse the wavelet transform, we can rebuild high resolution matrices from the low resolution residuals. The results show a high correlation between specific scale residuals reconstruction and the scale of landscape features.

In order to assess the observed process, the technique was applied to a DEM (8700 x 6000 pixels, 1 meter resolution) of a Swiss alpine region where well-known landslides can be detected. Multiple wavelet decompositions were applied to this DEM followed by a specific scale residual reconstruction. The analysis of the latter on specific landslides gives interesting results which can be compared to morphometric analysis. We hope to open new ways for multi-scale analysis of landscape feature. Many perspectives can be derived by the introduced method.