Worldterrain – A Contribution to the Global Geomorphometric Atlas

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1. Introduction

A Digital Elevation Model (DEM) is one of the most useful sources of information for spatial modeling and monitoring, with applications as diverse as: Environment and Earth Science, e.g. catchment dynamics and the prediction of soil properties; Engineering, e.g. highway construction and wind turbine location optimisation; Military, e.g. land surface visualisation, and; Entertainment, e.g. landscape simulation in computer games (Hengl and Evans 2007). The extraction of land surface parameters – whether they are based on 'bare earth' models such as DEMs derived from contour lines and spot heights, or 'surface cover' models derived from remote sensing sources that include tree top canopies and buildings for example – is becoming more common and more attractive due to the increasing availability of high quality and high resolution DEM data (Gamache 2004).

Global DEM datasets are available in a different variety of resolutions. At 1km resolution the GTOPO30, GLOBE, SRTM30 and ACE2 datasets are available. However certain processes and function can only be detected at much finer scales. One of the most widely used DEM data sources is the elevation information provided by the 90m resolution Shuttle Radar Topography Mission (SRTM) (Coltelli et al. 1996, Farr and Kobrick 2000, Gamache 2004). A new 30m DEM of the world is expected to be released in June 2009 based on 1.5 Million single ASTER DEM scenes covering the whole world.

This detailed elevation data can be used to generate a geomorphometric atlas, which is particularly useful as a resource of surface measures and objects in support of decision-making and projects over a broad spectrum of applications (Gessler et al, 2007). Several attempts have been made - for example the USGS global 1 km HYDRO1k Elevation Derivative Database or the River and Catchment Database at 250 m for Europe (Vogt et al., 2003). Guth (2009) already showed some results for a SRTM based high-resolution continental geomorphometric atlas. The work performed did not contain some of the number of criteria that these dataset should inherit (Gessler et al. (2007): 1) precision, 2) multi scale, 3) open structure, 4) web access and 5) quality. However with the current datasets usually these parameters are not satisfied. Additional important points are the reuse of the generated parameters and the description in terms of metadata. This is of outmost importance as different software packages - even different versions of the same software - produce different results.

This paper describes a procedure to generate a geomorphometric atlas, which as a start will fulfill several of these criteria. The atlas is extendable to include additional parameters, whereupon suitable algorithms could be chosen to map them. The objective is to provide a standardized workflow and format, which can accommodate the expected growth in Geomorphometry applications in the future.

2. Method

The method projects a given input DEM (SRTM) to a UTM projection using a cubic convolution algorithm. Secondly, it checks for a spikes and sinks above/below 100 compared to its surrounding and filters them out if possible. Third, it calculates terrain parameters (TP) and aggregates them to specified commonly used resolutions (i.e. matching the resolutions of existing environmental datasets: 250m, 500m, 1km and 10km). There is no single source for a global high resolution DEM, but the SRTM data comes close. SRTM has an approximate resolution of 90 m and covers all land masses between 60N and 60S. If a more detailed global datasets appears (e.g. ASTER GDEM), then the smallest reported resolution could be as small as 100m. For local conditions (e.g. LiDAR data of 1 m resolution) the reporting resolution could be even more detailed: 5, 10 and 50 meters for example.

In the current version the calculated parameters include elevation, aspect, slope, profile curvature, plan form curvature, flow direction, flow accumulation, ridges, and a number of elevation residuals at different window sizes reflecting various landscape scales . Additionally, since the parameters are computed at fine scale and then aggregated, we report for each given output cell the following statistical parameters: Minimum, Maximum, Mean, Median, Standard Deviation, Range, Sum and for integer TP also the Majority and Minority Values. An example for a derived TP in its original resolution is given in Figure 1.

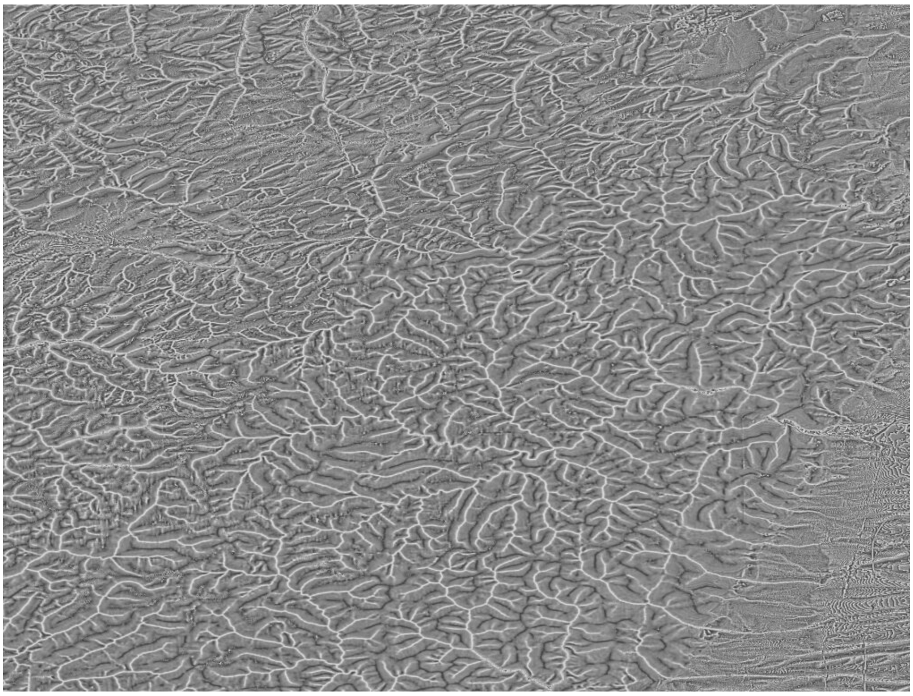

Figure 1 Deviation for a 5 x 5 window for a DEM

A aggregated version of the elevation values calculated from SRTM for some parts of the tropics in danger for deforestation is shown in Figure 2.

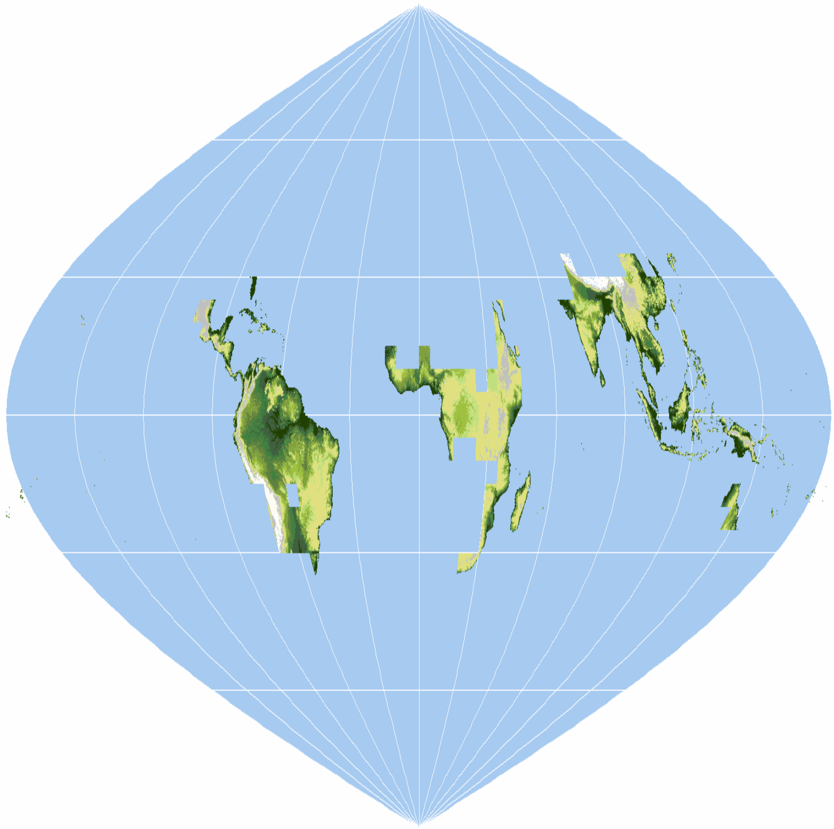

Figure 2 Mean Elevation at 1km resolution generated from SRTM for the tropics.

3. Conclusion

The Geomorphometric Atlas will deliver essential parameters for understanding global, regional and local problems and solutions for example for the global soil map project (www.globalsoilmap.net) for fighting poverty in Africa, for understanding deforestation in the tropics or for calculations of travel times to major cities (Nelson, 2008). We expect that with the increase in computer power the calculations will evolve and new algorithms/sensors will allow for decision making in different spatial-temporal scales. The atlas will fill an important gap and aims to become a key dataset for environmental and socioeconomic applications.

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