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`r.roughness` – a new tool for morphometric analysis in GRASS

by Carlos Henrique Grohmann

Introduction

This article briefly describes `r.roughness`, a shell script written to calculate the surface roughness of raster surfaces. The method is based on Hobson (1972), where roughness is defined as the ratio between surface and plan area of square cells. This script will create square sub-regions with size defined by the user; in each sub-region, the real and planar areas will be calculated by `r.surf.area`, and the results (points at the centre of sub-regions) will be interpolated with `v.surf.rst`. The user also can set the tension and smooth parameters of interpolation.

Surface Roughness

Surface roughness (or topographical roughness) was first introduced as a morphometric parameter by Stone and Dugundji (1965) and Hobson (1967, 1972). To Hobson (1972), one possible way to calculate it is the ratio between surface (real) area and flat (plan) area of square cells; in this approach, flat surfaces would present values close to 1, whilst in irregular ones the ratio shows a curvilinear relationship which asymptotically approaches infinity as the real areas increases.

Day (1979) describes surface roughness as the expression of non-systematic variability of the topographic surface, and used the dispersion of vector normals to surface plans as a roughness indicator to discriminate tropical karst stiles.

Ferrari et al. (1998) argue that surfaces with distinct characteristics can present the same roughness value, due the existence of interactions between the number and magnitude of terrain irregularities. Grohmann (2004), considers this method useful for morphological characterisation since it is mainly related with the shape of land-forms and not its elevation; thus, tectonically tilted areas have their expression shown, while it could be masked in a hypsometric map, as consequence of altimetric variations.

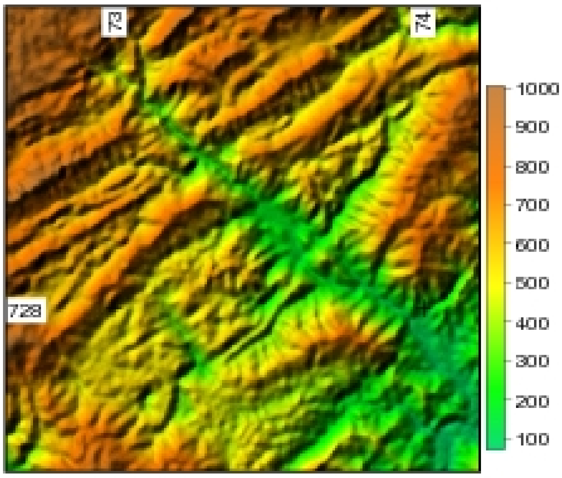

Figure 1: Study area.

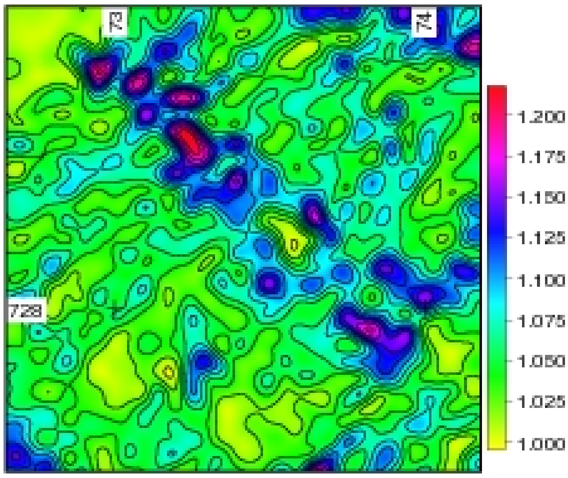

Figure 2: Surface roughness map, `grid=500m`.

The method has been applied in studies related to morphology of lake bottoms (Hakanson, 1974), as a discriminant of karstic areas (Day, 1979; Karmann et al., 1996; Ferrari et al., 1998), for structural compartimentation of sedimentary basins basement (Grohmann et al., 2005), in morphometric analysis of alkaline massifs (Roldan et al., 2006; Grohmann et al., 2007), in structural analysis of strike-slip shear zones (Steiner et al., 2006) and for macro-geomorphological compartimentation (Grohmann & Riccomini, 2006).

Usage and Examples

The script has five options: `map`, `grid`, `rough`, `tension` and `smooth`. `map` stands for the input raster surface and is the only required option. `grid` is the size of the sub-regions in which roughness will be calculated; the default value is 1000m. `rough` is the name for the output map; if a name is not provided, it will be set to `input_map_name.roughness.grid_size`. `tension` and `smooth` will be used by `v.surf.rst` for interpolation of roughness values; the default values are `tension=40` and `smooth=0.1`.

The examples presented are from an area located in southeastern Brazil, southern region of São Paulo State. Local geology consists of NE-SW trending metapelitic and metacalcareous rocks where karstic landscapes developed over the carbonatic rocks, with altimetric differences up to 700m between non-carbonatic (pelitic, psamitic and granitic) crests and karstic valley bottoms. NW-SE trending dikes cut across the area and have a strong influence on geomorphological development (Fig. 1). Surface roughness was calculated for grid sizes of 500, 1000 and 2000m.

With a grid size of 500m (Fig. 2), a good correlation with land-forms can be seen. Higher roughness values are related with the Bethary River valley, developed over a NW-SE trending dike. Also, karstic valleys have smaller roughness values than non-carbonatic crests. The general picture of the features present in (Fig. 2) can be seen in the map for grid size of 1000m (Fig. 3), although is not possible to individualise the answer from each carbonatic unit. A grid of 2000m (Fig. 4) does not give much information, indicating that land-forms within this area cannot be well described with a wavelength this large.

Concluding Remarks

Surface roughness is a useful parameter for morphological compartimentation. `r.roughness` is a shell script that automises the process, but users must be aware that it uses `r.surf.area` to calculate both real and planar area for each grid cell (sub-regions) and that raster resolution plays an important role on area estimations.

The script is available through GRASS Wiki site [3] in two versions: `r.roughness` for GRASS 6.1+ and `r.roughness60` for GRASS 6.0.x.

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[3] `http://grass.gdf-hannover.de/wiki/GRASS_AddOns`

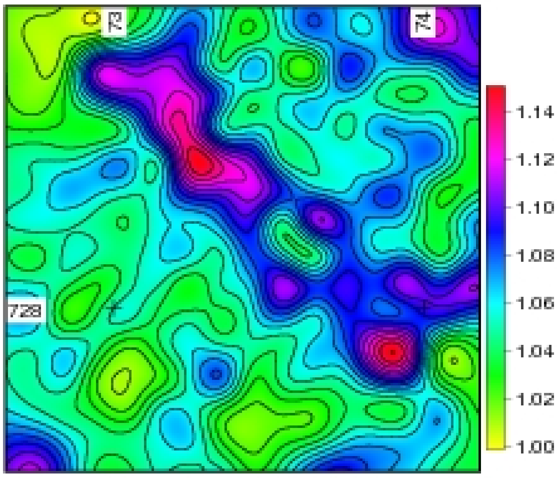

Figure 3: Surface roughness map, `grid=1000m`.

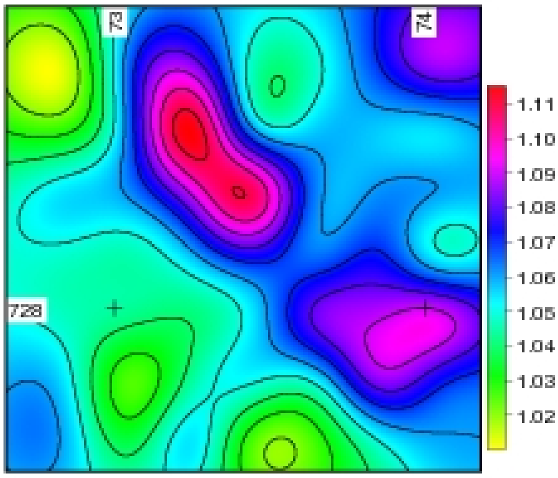

Figure 4: Surface roughness map, `grid=2000m`.

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