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Geomorphological indices of Serifos (Cyclades, Greece)

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The central Aegean region of Greece represents an attractive field laboratory for the studies of geological processes, exposing spectacular poly-metamorphic rocks, a plethora of viscous and frictional deformation structures, and one of Europe's most active places concerning earthquake and volcanic activity. This study focuses on the landscape evolution of Serifos Island in the western Cyclades, north of Sifnos and Milos, in the back-arc region of the Hellenic arc. The island belongs to the Attic Cycladic crystalline belt, an Eocene high pressure unit with famous blueschist occurrences. During the Miocene a metamorphic core complex (MCC) formed across the island (Grasemann et al. 2004) likely associated with several, already well-studied MCCs in the central Cyclades (e.g. Naxos and Ios).

Today's topography of the Cycladic islands is characterized by Pleistocene - Holocene geomorphologic processes superimposed on remnants of preceding landforms, some of them related to extensional tectonic processes probably due to slab roll-back of the Nubian plate. A system of subhorizontal planation surfaces is common on most of the Cycladic islands (see Riedl 1995 and references therein). Interestingly, however, on Serifos, well documented planation surfaces are missing, except in the southern part of the island, where a well developed elevated plateau exists (Hejl et al. 2001).

In much of the central and south-eastern parts of Serifos, an Upper Miocene granodioritic pluton intrudes into greenschist to amphibolite facies metamorphic rocks. New Biotite Rb-Sr whole rock ages for the granodiorite of around 8 Ma constrain the minimum age for MCC formation (Grasemann et al. 2004).

The topographic evolution of the island is strongly influenced by (1) the significant seasonal variations in precipitation and (2) the lithologic contrasts between the granodioritic southern part and the gneissic and schistose northern part resulting in hilly undulose landscapes as well as V-shaped valleys respectively. Across much of the island, man-made protection against erosion (small terraces with stonewalls, so called "Xerolithies") indicates instability of its deforested slopes.

The source for our geomorphometric evaluation of the island is a conventional DEM, which is mainly based on isohypse data, kindly provided digitally by ANAVASI. Two derivatives of geomorphometric points (XYZ coordinates) and their implementations have been found to be useful to describe the altitude surface. Slope, the first derivative, is a vector with two components expressed by two angles: gradient and aspect. The second derivative is the surface curvature adding two of its components: profile (vertical) and plan (horizontal) convexity. Where convexity towards the atmosphere is positive and corresponding concavity is negative (Evans and Cox 1999).

In order to refine the method, further processing was carried out by combining the components of these two derivatives into a single value using a simple arithmetic operation. This provides unique indices for the geomorphologic development of the studied area. The combination of the derivatives (index) is projected onto the map (geo-coded) to show the spatial distribution of the index. Comparison with other morphometric indices (e.g. mountain front sinuosity) accentuates advantages or disadvantages of this method.

The studies reveal that the boundary between the landforms in the southern part of Serifos (granodiorite) and the northern part (gneiss / schist lithologies) follows the local drainage divide, about 150 m structurally above the contact of the granodiorite to the wallrock. This difference in drainage pattern is explained by differences in slope hydrology. While the runoff in the granodiorite areas is dominated by interflow and subsurface flow in the strongly weathered regolith and tectonic fractures, all other areas of the island are dominated by surface flow. Since surface equilibrium may not be assumed, the slope angles are likely related to a rapid initial surface uplift phase causing strong erosion and high relief (Székely, 2001).

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