SEDIMENT MOBILITY AND CONNECTIVITY IN THE CATCHMENT: A NEW MAPPING APPROACH

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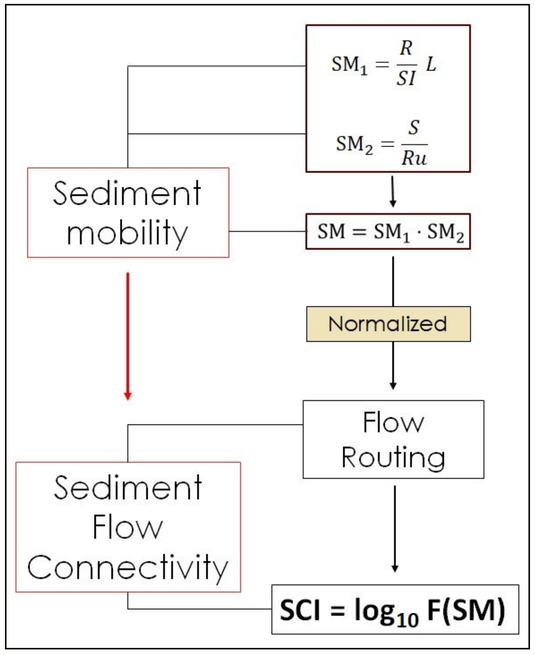
SEDIMENT CONNECTIVITY is an important element to define channel dynamics in a catchment. Sediment paths are very important to better understand erosion, transport and deposition processes. The present study explores sediment connectivity through a new approach, aiming to integrate functional and structural components.

1. MODEL-BASED METHODOLOGY



In our model, the first aspect of the connectivity is the mobilization of the sediment and, in a second time, the movement of this sediment along pathways towards the main channels. Sediment Mobility is derived from two factors (SM_1 and SM_2). In SM_1, R is Rainfall, SI is Soil stability index, L is Land use index. In SM_2, S is Slope and Ru is Ruggedness.

The final connectivity map is defined by a sediment flow connectivity index (SCI) that measures sediment transport through flow accumulation. It s obtained as the logarithm of the result of SM flow routing.

2. TEST CASE AND RESULTS

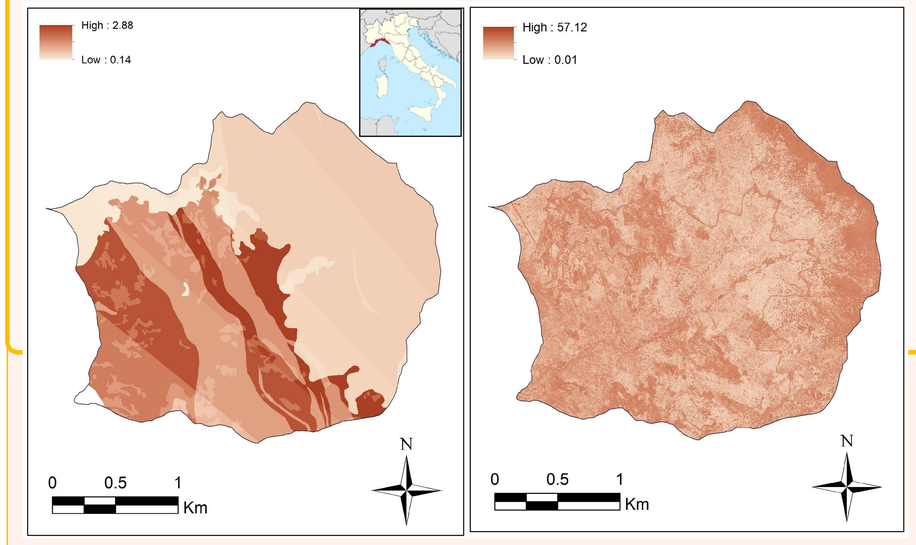
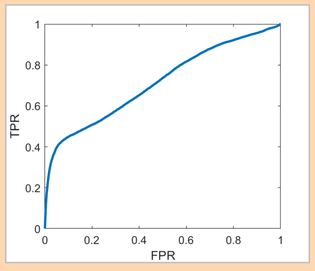


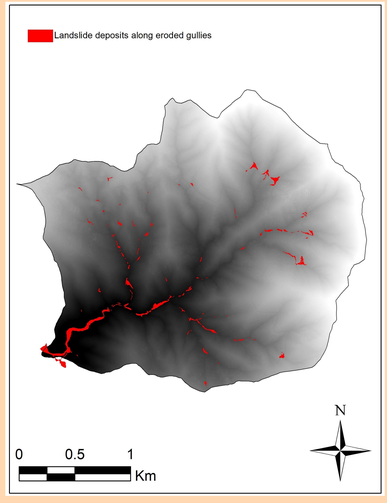
Figure shows the maps of the obtained sediment mobility factors, SM_1, and SM_2, respectively. The SM_1 map exhibits values between 0.14 and 2.88; the catchment areas with a greater mobility index are inland; conversely, a smaller mobility index characterizes upper basin areas. The SM_2 encodes the potential movement of the sediment in the Vernazza basin, considering morphological characteristics.

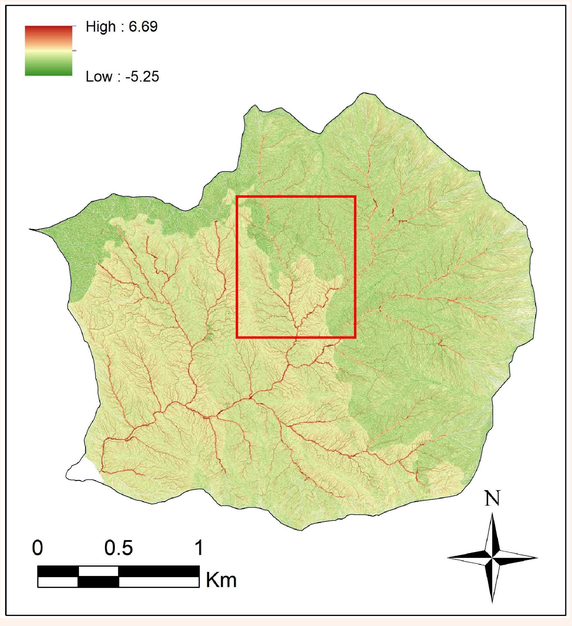
The method has been applied to the Vernazza basin, a Mediterranean coastal catchment located in the "Cinque Terre" area (eastern Liguria, northwestern Italy). The main characteristics of the catchment are short streams with ephemeral hydrological regime, slope steepness and a widespread agricultural terraced environment, currently mostly abandoned. These geomorphological aspects coupled with the substantial extent of abandoned terraces determine a strong soil instability, mostly during intense rainfall, which occur during autumn and winter, with meaningful differences between coastal and internal areas.

3. VALIDATION

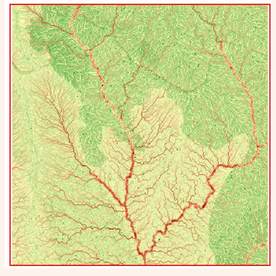
We tested the produced connectivity map in relation to sediment mobilization caused by an exceptional rainfall event, which hit the Vernazza basin on October 25th, 2011. We then applied a quantitative testing utilizing the mentioned landslide deposits along eroded gullies as a binary classification reference map. The evaluation was performed through the ROC (Receiver Operating Characteristic) curve in order to verify the class recognition capabilities of the connectivity map. The ROC curve shows a shape which denotes a fair classification capability, with an area under the curve (AUC) corresponding to 0.68.



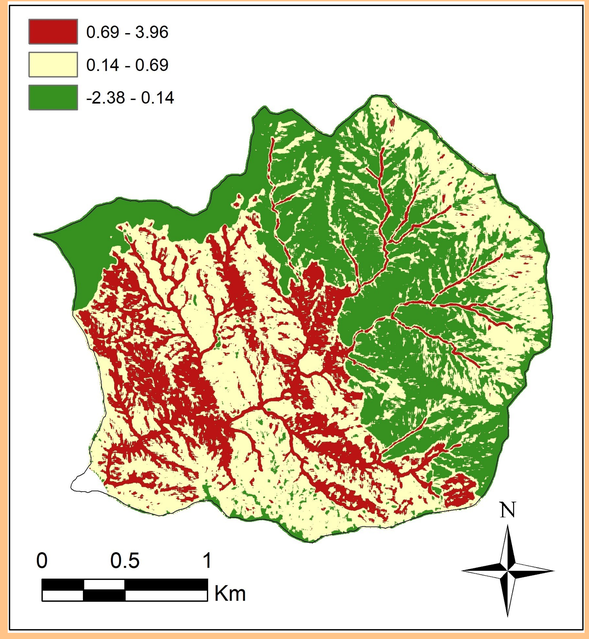




The final sediment connectivity map shows a larger and more marked connectivity on the principal channels of the drainage area, though variations along the streams describe spatial differences of flow continuity (detail box on the bottom) and, in some cases, over the hillslopes, a disconnected flow.



4. MONITORING APPLICATION



The sediment flow connectivity map was thus further post-processed in order to better highlight the areas with high, medium and low connectivity. Areas characterized by a high connectivity intensity could become observation spots in the catchment so as to detect their evolution.Thus, the map appears more practically applicable for fluvial monitoring and land planning in the catchment.