Geomorphological and pedological processes in badland areas of Southern Italy and their interaction with Mediterranean vegetation

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Introduction

In Mediterranean Europe generally the pressures from both climatic and anthropogenic change impel environmental systems towards irreversible erosion. The wide-ranging consequences of these changes regarding geomorphology, land degradation and erosion, and the issues that they raise for land management have been discussed in many texts (e.g. Wainwright & Thornes 2003). Vegetation patterns are likely to change with greater on-slope connectivity. Vegetation cover is reduced due to climatic and anthropogenic drivers. So, vegetation analysis yields useful indices for incorporation into geo-hydrological models (Imeson & Prinsen 2004). Our understanding of these interactions (Fig. 1) is at an early stage however, and at least three topics need further research. First, there is little, if any, differentiation between the roles of different plant growth form types, which are known to occupy preferred topographic positions (Lazaro et al. 2000). Second, scant consideration has been given to biological soil crusts (Fig. 2a-c) which often occupy the supposedly 'bare' spaces between clumps of vascular plants and are known to influence surface hydrology and microtopography (Alexander and Calvo 1990; Alexander et al. 1994, Belnap and Lange 2001). Third, most existing work is concerned with vegetation cover and thus considers only the above-ground component of biomass. Gyssels et al. (2005) have highlighted the need to consider the contribution of below-ground biomass (expressed as root density or length) to soil resistance against erosion. Existing models of process interactions in badlands (Faulkner 2004) might be of assistance in dealing with current and future process dynamics. This study will contribute to the understanding of geomorpho-logical and pedological controls of badland processes explicitly taking into account vegeta-tion pattern and their spatially and temporally dynamics. Fig. 1 shows a conceptual structure of processes, drivers and interactions in badland development. In this study we will investigate the different scales badland processes are covering from the soil aggregate to the catchment level. A focus will lay on the analysis of runoff generation processes related to vegetation characteristics as well as on surface and subsurface runoff path detection. The different aspects of vegetation types and patterns are highlighted in Fig. 2 a-e. The study area covers the southern part of the Bradanic trough in Basilicata in Southern Italy (Fig. 4).

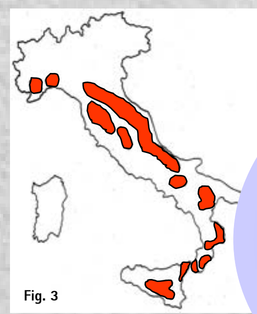


Fig. 3

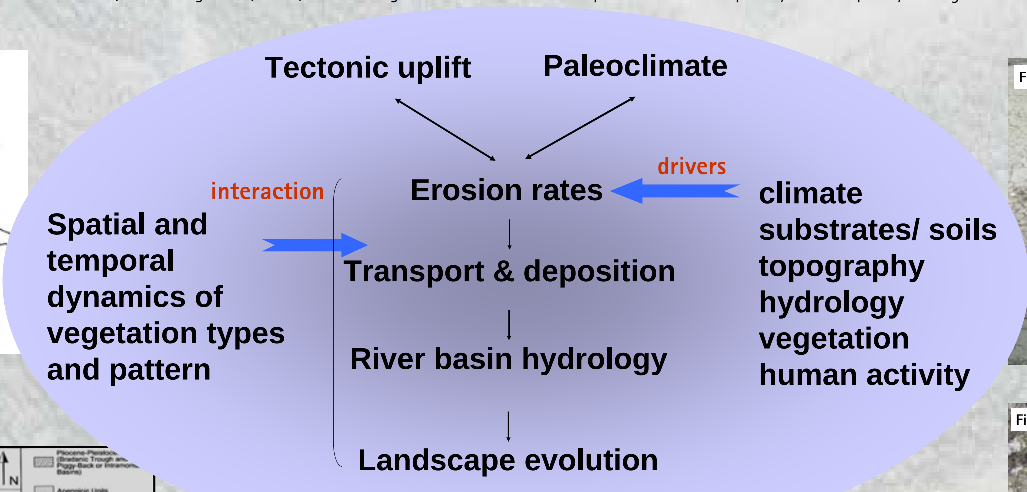


Fig. 1: Conceptual structure


Fig. 2a


Fig. 2b


Fig. 2c

Research Area

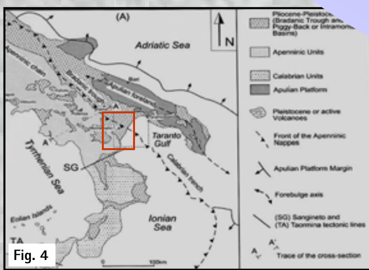


Fig. 4

Study area in red   Bentivenga et al. 2004

The study area is located in the southern parts of the Bradanic trough in the Basilicata region, Southern Italy. Fig. 4 illustrates the general tectonic settings that are responsible for the sedimentation and uplift processes in the badland areas. The study will concentrate on the Cavone, Agri and Sinni Rivers draining towards the Ionian sea. The substrates affected by badland processes are weakly consolidated marine and fluvial deposits. Fig. 3 shows the relevance of badland processes related to this deposits in the Italian context.

Key Questions

- What kind of erosion processes are active on which scale?
- What are the temporal and spatial dynamics of these processes?
- How are these processes interlinked?
- How do the erosion processes interact with the hydrological dynamics of the landscape?
- What role do these processes play in landscape development?
- What are the interactions of these processes with the vegetation types and pattern ?

Research activities:

- Analysis of factors triggering the development of badlands
  – mechanisms driving runoff genesis
- Analysis of the connectivity of badland areas
  – temporal and spatial dimensions of pipe systems
- Analysis of vegetation
  – distribution and functional relations regarding runoff


Fig. 2d


Fig. 2e

Methodologies


Fig. 5a


Fig. 5b

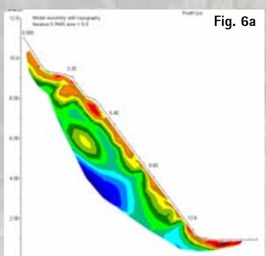


Fig. 6a


Fig. 6b

The study is based on an already existing colla-boration network with the Universities of Bari, Florence and Potenza. Within this framework preliminary studies were conducted using a wide range of different innovative methodologies such as LIDAR (Fig. 5 a, b), geoelectrical prospection methods. (Fig. 6 a, b) or non-invasive hydrological field measurements (i.e. constant head permea-meter and Amoosimeter).

Fig. 7a: Response curve – predictive habitat distribution model

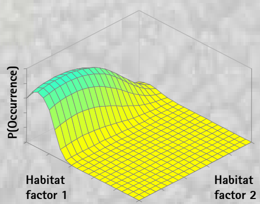
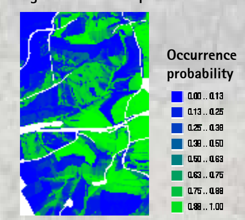


Fig. 7b: Predicted spatial distribution



The study of vegetation focuses on the following tasks:

i) Understanding the underlying mechanisms that explain the vegetation pattern by modelling the relationships between the spatial distribution of plant species and environmental (topographic, edaphic, hydrologic) conditions and disturbance regimes (Fig. 7 a). Therefore, predictive habitat distribution models will be estimated (e.g. Peppler-Lisbach & Schröder 2004), that also allow for predicting the spatial distribution of plant species depending on these variables on a larger scale (Fig. 7 b).

ii) These models are the basis for a matrix population model that explicitly models the complex interactions between abiotic processes and vegetation dynamics (cf. Pagel et al. 2005).

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