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Invited review article

Human topographic signatures and derived geomorphic processes across landscapes

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ABSTRACT

The Earth's surface morphology, in an abiotic context, is a consequence of major forcings such as tectonic uplift, erosion, sediment transport, and climate. Recently, however, it has become essential for the geomorphological community to also take into account biota as a geomorphological agent that has a role in shaping the landscape, even if at a different scale and magnitude from that of geology. Although the modern literature is flourishing on the impacts of vegetation on geomorphic processes, the study of anthropogenic pressures on geomorphology is still in its early stages. Topography emerges as a result of natural driving forces, but some human activities (such as mining, agricultural practices and the construction of road networks) directly or indirectly move large quantities of soil, which leave clear topographic signatures embedded on the Earth's morphology. These signatures can cause drastic changes to the geomorphological organization of the landscape, with direct consequences on Earth surface processes. This review provides an overview of the recent literature on the role of humans as a geological agent in shaping the morphology of the landscape. We explore different contexts that are significantly characterized by anthropogenic topographic signatures: landscapes affected by mining activities, road networks and agricultural practices. We underline the main characteristics of those landscapes and the implications of human impacts on Earth surface processes. The final section considers future challenges wherein we explore recent novelties and trials in the concept of anthropogenic geomorphology. Herein, we focus on the role of high-resolution topographic and remote-sensing technologies. The reconstruction or identification of artificial or anthropogenic topographies provides a mechanism for quantifying anthropogenic changes to landscape systems. This study may allow an improved understanding and targeted mitigation of the processes driving geomorphic changes during anthropogenic development and help guide future research directions for development-based watershed studies. Human society is deeply affecting the environment with consequences on the landscape. Therefore, establishing improved management measures that consider the Earth's rapidly changing systems is fundamental.

Contents

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1. Introduction

Landscapes are characterized by distinctive morphologies that are mainly caused by major forcings such as tectonic uplift, erosion, sediment transport, and climate that have shaped the Earth's surface and left characteristic topographic signatures. In addition to these processes, biota forcing might play a role in shaping the landscape, but, of course, at a different scale and magnitude than geological forcing. In biotic landscapes, vegetation through its roots influences soil formation and surface erosion. Biota also influence climate and, as a consequence, the mechanisms that control erosion rates and the evolution of the landscape. Dietrich and Perron (2006) compared the hypothetical frequency of occurrence of landform properties for the present Earth and an abiotic Earth. They suggested that the frequency distributions of measurable landform properties (such as mountain height, steepness, and curvature) could greatly differ, although all observed landform types would be found in both biotic and abiotic worlds (Fig. 1a). The question is, if we can suppose that there is evidence of biota forcing, what is the role of humans? Fig. 1b shows a real case study of the relative likelihoods that landform slopes will take a given value (probability density

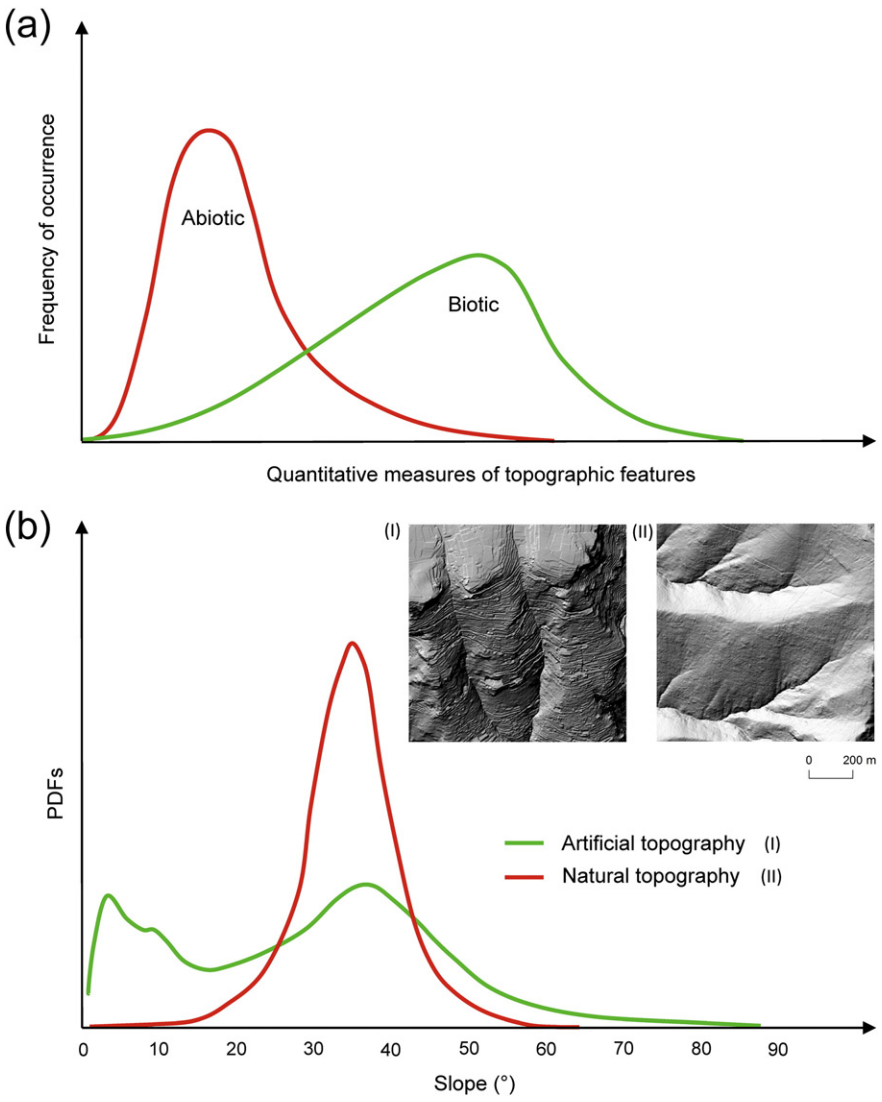

Fig. 1. (a) Hypothetical frequency distributions (PDFs) of landform properties for the present Earth and an abiotic Earth (from Dietrich and Perron, 2006); (b) PDFs of slope for natural and terraced landscapes in northern (Trento province) and southern (Salerno province) Italy, respectively. Fig. 1b also shows shaded relief maps of the two study areas obtained from 2 m LiDAR topography.