



Geocultural landscaping: Guidelines and conceptual framework to design future scenarios of exploited lands



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ABSTRACT

The environmental recovery of quarried areas is increasingly a landscaping first-order issue in many countries and relevant lessons can be learned from each case history, depending upon factors such as the terrain nature and landscape consolidation over time. The case of the Tivoli travertine quarries near Rome (Acque Albule Basin, Italy) is addressed with a multidisciplinary approach and analytic data indicating sustainable and resilient future solutions. Geological data are analyzed to know the resources and natural hazards of this territory. Historical landscape analyses are next accomplished to know the cultural heritage and evolution of man-nature interactions. Eventually, the present land use and 3D landscape are considered to know the current setting. This territory is characterized by natural hazards including earthquakes, degassing, subsidence, and river flooding, and by resources such as abundant thermal waters. Historical analyses show the occurrence of a significant cultural heritage including two UNESCO world heritage sites. The present landscape is characterized by deep quarries and unplanned urbanization. The integration of geological data with historical information provides a new knowledge forming a geocultural database that must be taken into consideration for future planning. Based on these results, general landscape and urban guidelines are proposed for the future recovery of this intensively-quarried and -urbanized territory. The main lesson learned from the Tivoli case history is twofold: (1) the integration and feedback between multiple disciplines and professionals (architects and geologists) working together on environmental improvements and (2) the careful view of the past territory and meticulous analysis of existing buildings and urban landscapes are the key to sustainably interpret the future landscape. The main novelty of this lesson is the improvement of the concept of cultural landscape (UNESCO: <http://whc.unesco.org/en/culturallandscape/>) and its expansion toward geological issues and man-geology/nature interactions. In an urban-saturated territory that is also geologically-worn by human activities (e.g., Acque Albule Basin), restoring guidelines must comply with the partly-new concept of geocultural landscaping, which consists of a sustainable and resilient planning based on the study and understanding of natural-geological hazards, natural and cultural resources, and man-nature relationships over large spaces and long terms (4D). A general conceptual framework for geocultural landscaping is eventually proposed.

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1. Introduction

During the last millennia, the advent and dissemination of humans have progressively changed the delicate natural geomorphologic equilibrium due to incrementally aggressive human

activities over the Earth's surface and to massive exploitations of natural resources (e.g., Hooke et al., 2012; Sofia et al., 2014; Arneth et al., 2017). Cities are presently among the main expressions of human molding of the Earth's landscape. These human structures represent sensible topographic reliefs that stand out on the Earth's landscape, constituting the sink of large amounts of rocks, metals, and other natural materials removed from nearby or remote areas in quarries and mines, which, in turn, can form impressive landscape scars.

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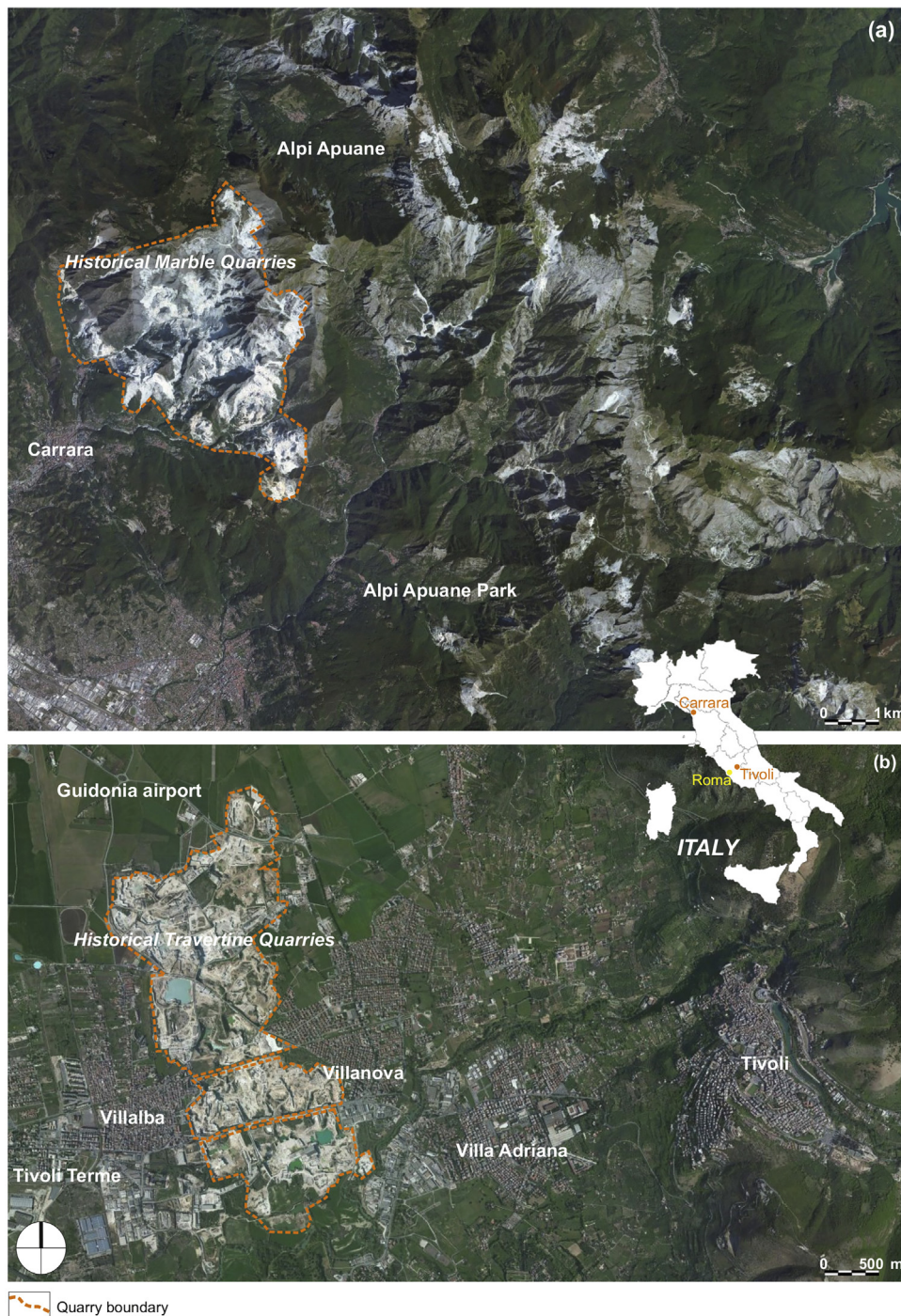


Fig. 1. Satellite images (taken in 2015 from Bing Maps) of two large quarry areas: (a) Carrara marble area (Tuscany, northern Italy) and (b) Tivoli travertine area (Acque Albule Basin, central Italy). The Acque Albule Basin is the study territory of this paper. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

While in recent years the exploitation of natural construction materials has normally occurred in intensive quarry sites typically used for a limited period of time (a few tens of years at the maximum) and then recovered (e.g., Martín Duque et al., 1998; see also www.restorequarries.eu and www.restauraciongeomorfologica.es) or simply abandoned, some particular precious and rare rocks have been quarried for hundreds or even thousands of years and are still quarried in many instances. This is the case, for example, of the Carrara marble in northern Italy (Fig. 1a) and the Tivoli travertine

(Lapis Tiburtinus) in central Italy (Fig. 1b). These two rocks are particularly valued natural materials used for construction and ornamental reasons since at least the Ancient Rome times. The scars left on landscapes by the long-term exploitation of these rocks are massive and well visible also from far away (Fig. 1). The Carrara marble and Tivoli travertine quarries have indeed constituted a landscape growing and progressing element for hundreds-to-thousands of years (Fig. 1) and the occurrence of these precious materials in their respective territories have obviously influenced

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