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Caucasia top-down: Remote sensing data for survey in a high altitude mountain landscape

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ABSTRACT

Until recently, surveys in mountainous areas were focused on traditional survey techniques such as field walking. Remote sensing data, however, has become more and more important in this field. This article will evaluate several methods of remote sensing such as aerial photography, satellite images or images from un-manned aerial vehicles (UAV) as instruments for detecting archaeological sites in mountains. It will discuss the origin of site visibility such as relief, crop-marks or snow-markers, and the related archaeological features underground. It will also discuss internal difficulties of remote sensing data in terrain with heterogeneous height structure. On the basis of a case-study from the North Caucasus (Russia), the potential and the limits to the application of a research strategy using remote sensing in mountain archaeology will be discussed. Cross-checking with non-destructive prospection methods such as geophysics and soil sciences allows the evaluation of the percentage of the sites detectable from above ground.

1. Introduction

When in 2004 the first of a large series of archaeological settlements sites were discovered on aerial photographs of the 1970s in the North Caucasus (Russia), an entirely new mountain cultural landscape was waiting to come to light (Figs. 1–2). Former research on archaeological sites including systematic surveys had commonly focused on the lower parts of the mountain valleys and had been undertaken in the traditional way by field walking (Korobov, 2003; Afanas'ev et al., 2004; Reinhold et al., 2007). As early as the mid-1990s, however, a first advance in the systematic application of aerial imagery for the mountain area presented in this article was started (Korobov, 2001). It was an integrated part of the first archaeological GIS in Russia (Korobov, 2002; Afanas'ev et al., 2004) and shortly afterwards was followed by a comprehensive remote sensing program based on Soviet aerial photography and CORONA satellite images for the neighbouring Stavropol' region (Belinskiy, 2004, 2007; Dovgalev, 2005).

In the mountainous area near the mineral spa Kislovodsk, aerial survey first concentrated on the lower parts of the valleys, as no permanent habitation sites were expected on the windy, inhospitable plateaus. A large number of burial mounds of Bronze Age date indicated some kind of exploitation, but these were thought to be the remains of seasonal pastoralists who used short-term campsites. The first newly discovered site of Kabardinka 2 (Figs. 2.1 and 8), about one hectare in size and with ruins of massive stone architecture clearly visible on the surface, demonstrated this hypothesis to be incorrect. More than 270 new archaeological sites have been documented on the plateaus. The sites are concentrated at altitudes between 1400 and 2500 m asl (Fig. 2). They challenge fundamentally all previous conceptions of settlement dynamics between lower valley bottoms and mid- and high-altitude zones on the northern flank of the Caucasus (Reinhold and Korobov, 2007).

Archaeological survey at high altitudes is a difficult task for many reasons. High-relief energy causes a massive loss of information on archaeological sites due to erosive and colluvial processes, particularly at the valley bottoms (Rey et al., 2010). Difficult terrain obstructs access to potential sites, and closed vegetation cover of meadows or mountain forests frequently render the remains of anthropogenic presence invisible (Della Casa et al., 1999; Curdy et al., 2010). Using remote sensing data in mountainous terrain has the potential to bridge the problematic access to

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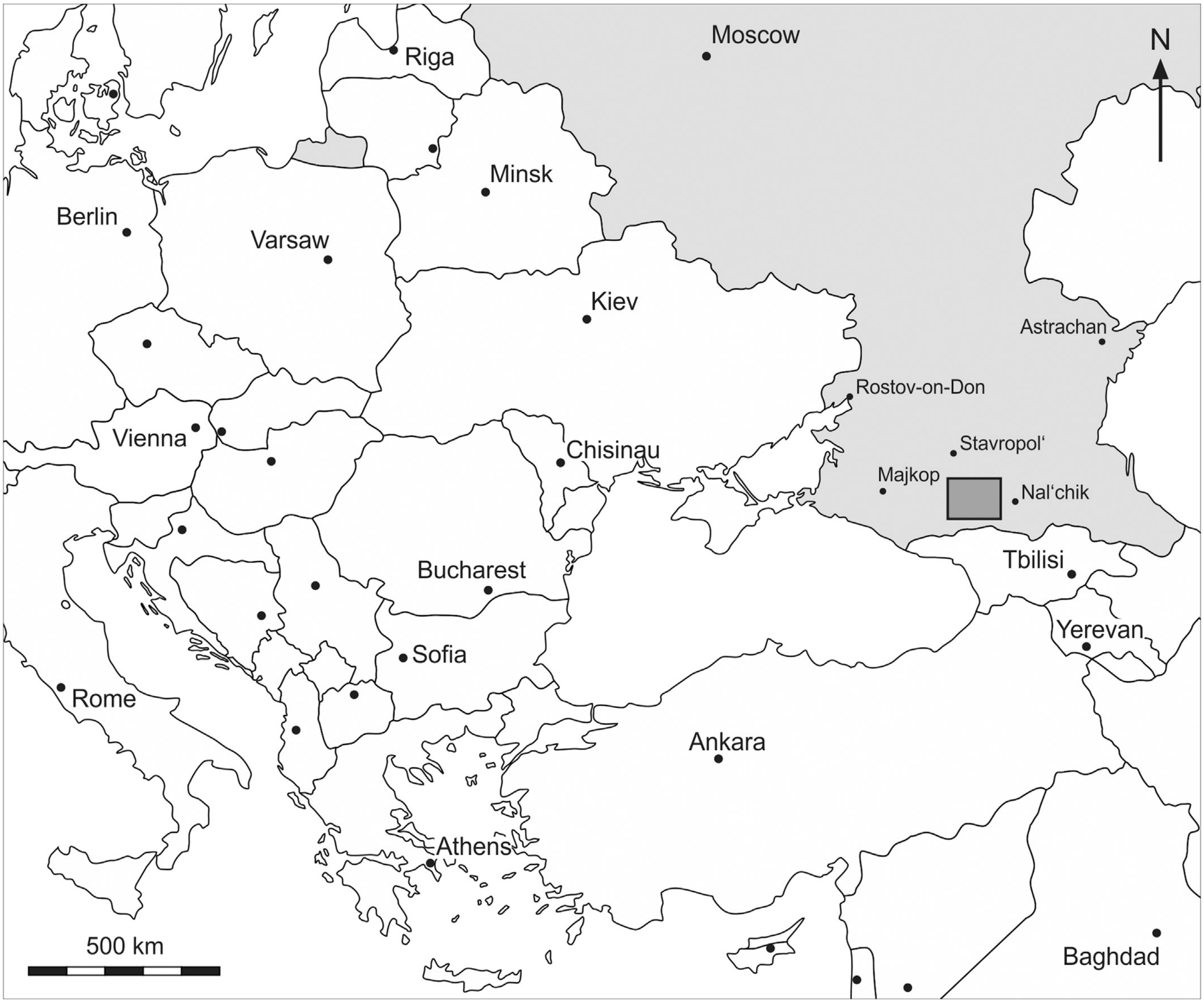

Fig. 1. Location of the study area in Russia.

archaeological features. Nevertheless, systematic archaeological surveys in mountains involving remote sensing have started only recently, for instance in the Altai mountains (Russia) (Gheyle et al., 2004; Goossens et al., 2006; Plets et al., 2012), the Andes (Peru) (Lambers, 2006), the Caucasus (Korobov, 2002; Afanas'ev et al., 2004; Reinhold, 2005; Faustmann and Palmer, 2005; Smith et al., 2009) and the Alps (Lambers and Reitmaier, 2013).

Survey methods generally are challenged with the topics of site formation, preservation and visibility (Doneus, 2013). Site formation processes can be characterised as the interplay between the intensity of anthropogenic impact and the subsequent taphonomic processes. To understand these processes and, thus, the prehistoric human landscape (Förster et al., 2013), it is crucial to develop detailed scenarios of potential economic and social activities for the actual study area and epoch. Mountain terrain aggravates constraints in the reconstruction of past human activities. Verticality restricts movements, limits actions or causes additional high costs, for example, in transport. The altitudinal zonation of climate and vegetation require seasonal shifts of humans and animals. An increased mobility with short durations of stay at some places and a high functional specialisation of sites, often closely related to the vertical environmental zonation, is characteristic for mountain economies (Grötzbach, 1982; Ehlers, Kreutzmann, 2000; Nüsser, 2003). Numerous activities are ephemeral and have only slight impact at most on the surroundings. For a comprehensive study of three alpine landscapes, Phillipe Della Casa, therefore, proposed a three-dimensional model that estimates the potential of activities and the detectability of their remains as a background for archaeological survey in mountains (Della Casa, 2002, 11–13, Fig. 2.1). One axis represents the topographic location ranging from disposed to random. The intensity of activities and the functionality of a site in the respective cultural and economic framework adjust the other dimensions. This allows predicting sites and direct survey activities, and it calls attention to aspects that are missing in the archaeological record. The application of remote sensing data in this concept is surely limited to the most intensive activities, such as stone architecture, burial mounds, infrastructure, agricultural features or the remains of mining. However, it benefits from the large coverage and the visualisation of sites as seen against their topographic background, which helps to understand their environmental setting and spatial structure (e.g. Lambers, 2006; Smith et al., 2009).