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Original article

The impact of land use and depopulation on burial mounds in the Kazanlak Valley, Bulgaria: An ordered logit predictive model

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ABSTRACT

This article uses an ordered logistic regression (logit) model to assess the vulnerability of ancient burial mounds to human activity in the Kazanlak Valley, Bulgaria. This model yields probabilities of damage to burial mounds subject to changing conditions, based on the present condition and situation of a large dataset of mounds ($n = 773$), as estimated through direct visual assessment. Results for the Kazanlak Valley indicate that changing land use (conversion of pasture to arable land) and depopulation or de-urbanisation (increased distance to the nearest city, town, or village) represent two anthropogenic factors that degrade burial mounds. These factors likely represent threats from ploughing related to annual agriculture, and looting fostered by the decreased scrutiny associated with remoteness. After an initial survey to acquire the requisite data, local cultural heritage personnel can use this approach to predict quickly and continuously how mound vulnerability will respond to changing circumstances, and then direct resources to the most vulnerable monuments. Unlike typical predictive modelling for cultural heritage management, use of a logit regression on a large dataset quantifies the probable impact of changing circumstances on monuments without relying on site location models, prior knowledge of specific hazards, or forecasts of future development. This approach can be applied widely, wherever sufficient observational data are available. Our results also provide a reminder that agriculture is not wholly benign, and that depopulation – not just urban sprawl – can threaten cultural heritage.

1. Introduction

This article predicts the impact of human activities on ancient burial mounds in the Kazanlak Valley, Bulgaria, using ordered logistic regression (logit). Our model combines direct, visual condition assessments of 773 burial mounds with a record of each mound's circumstances (including location and surrounding land use) to estimate the probability of mound degradation should circumstances change. Two factors in particular predict mound vulnerability: land use and proximity to an urban boundary. The authors, as well as local museum personnel, expected that ploughing associated with annual agriculture would damage mounds. Likewise, we and our colleagues believed that proximity to a city, town, or village would also represent a risk, since it would expose mounds to a nexus of complex and destructive peri-urban processes [1]. Predictions of the model regarding changes to land use were therefore unsurprising; conversion from pasture to annual agriculture increases the likelihood of damage. The effects of proximity to an urban boundary, however, proved counterintuitive; mounds further from such a boundary are more likely to be damaged. Degradation associated with remoteness reveals that de-urbanisation and regional depopulation, and not only urban sprawl, threatens cultural heritage, a finding relevant to much of Eastern Europe, the former Soviet Union, and elsewhere where cities are shrinking or villages are being abandoned.

Predictive modeling is well established in both archaeology and cultural heritage management [2]. In archaeology, predictive models often use the environmental or cultural context of known sites to predict where undiscovered sites might be found [3–6]. For cultural heritage management, such models can be combined with knowledge of planned or forecasted development to reveal where areas

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likely to have a high density of sites intersect areas of impending development [7]. More frequently, however, predictive models in heritage management focus on natural disasters or other hazards that pose risks to known sites or monuments. Such models can forecast the impact of floods ([8,9], p. 101–153), earthquakes ([9], p. 61–100), typhoons ([10,11], p. 101–108; [12], p. 109–122), or effects of climate change like rising sea level [13,14].

Scholarship about anthropogenic hazards focuses on monitoring damage from urban development or looting, but models facilitating the development of mitigation strategies are lacking. The general threat from urban development is widely acknowledged [13]. Agapiou et al., for example, combine Markov urban growth models with satellite remote sensing to identify areas susceptible to damage from urban expansion and peri-urban phenomena in Cyprus (2015, p. 672). Others have estimated the threat posed by urban growth to archaeological heritage in India [15], the West Bank [16], and Africa [17]. Likewise, damage caused by looting has often been described ([18–20], p. 6–7) and Stone [21] go further, associating an increased risk of looting in Iraq with site size, proximity to a major road, and other factors, but they do not produce a formal predictive model.

Our model predicts the evolving vulnerability of sites and monuments to anthropogenic hazards. Specifically, it models the increased probability of damage to mounds as land use and proximity to an urban boundary change. Compared to other statistical approaches, ours requires a relatively large dataset, but it does not depend upon a detailed understanding of the processes behind the deterioration of cultural heritage, nor does it require projections of future agricultural or urban development. Instead, it extrapolates from current circumstances to calculate the probability that any mound's condition will deteriorate should a certain change take place, such as conversion of a pasture to annual agriculture, or the retreat of the nearest urban boundary. The approach is broadly applicable; it can identify threats and inform the allocation of resources to cultural heritage monitoring.

1.1. Threats to burial mounds in Bulgaria

Ancient burial mounds are a ubiquitous feature of the Bulgarian cultural landscape ([22], see Fig. 1). Thousands of such mounds were built from the Early Bronze Age through the Middle Ages in the western extensions of the Asian steppes and surrounding areas, including the Kazanlak Valley. They are earthen constructions ranging in size from < 10 m diameter and < 0.5 m high, to > 50 m diameter and > 20 m high. Their contents vary from nothing (cenotaphs), to a simple burial with or without an enclosure, to elaborate stone or brick tombs with much architectural and artistic refinement and intrinsically valuable burial goods [23–25].

Despite the number of burial mounds, they are an endangered class of monument. Development in Bulgaria destroys dozens of mounds annually. Most known and regulated destructions result from formal rescue excavation in anticipation of housing or infrastructure construction. In 2008, the last year for which data is available, burial mounds comprised nearly a quarter (57 of 257) of all excavations in Bulgaria ([26]; 91, fig. 2). Despite administrative and legal measures to combat illicit artefact trafficking, such as a 2013 Memorandum of Understanding with the United States, looting probably still compromises more mounds that development ([27,28,38], p. 107–124). Burial landscapes also suffer slow and continuous wear from agricultural activities [29]. Farmers plough and harrow arable fields annually, potentially affecting thousands of mounds across Bulgaria. Unlike looting (and to a lesser extent development), which captures public attention, gradual damage from agriculture generally goes unremarked. The authors saw few examples mounds that had not been damaged either by development, looting, or agriculture during three years of fieldwork, despite having inventoried over 1000 of them in two Bulgarian provinces.

1.2. Study area: the Kazanlak Valley

The Tundzha Regional Archaeology Project (TRAP) investigated the archaeology of the Kazanlak Valley, located in the Stara Zagora province of Bulgaria, between 2009 and 2011 (Fig. 2). The Kazanlak Valley, promoted as the 'Valley of the Thracian Kings', hosts a rich and varied archaeological record dating from the Neolithic through Ottoman times, but burial mounds are its most recognisable feature [30]. The fourth-century BC 'Thracian Tomb of Kazanlak' was declared a UNESCO World Heritage Site in 1979 [31,32] and, alongside the tomb of the Thracian King Seuthes II excavated at Golyama Kosmatka in 2004, attracts crowds of tourists to the valley. Decorated burial chambers and rich finds from tombs like these foster archaeological research and cultural tourism in the Kazanlak Valley.

The Kazanlak Valley does not experience catastrophic natural events that destroy mounds, as attested by the large number of small mounds (< 0.5 m high) that survive. Natural erosion rates are high (> 0.40 mm/year) in only a few areas of the valley, mostly at higher elevations; typical rates are only ca. 0.17–0.22 mm/year ([33], forthcoming), and erosion of mounds is retarded by the use of fieldstones in their construction. Consequently, people cause most of the damage to mounds in Kazanlak, as elsewhere in Bulgaria.

2. Methodology

We applied an ordered logit model to determine the vulnerability of burial mounds to anthropogenic threats in the Kazanlak

Fig. 1. Mound 2082: a medium-sized, damaged mound in the Kazanlak Valley, looking north towards the Stara Planina mountains. Photo credit: B. Weissova.

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