Terrain as Tactics: A GIS and 3D Terrain Analysis of the Battle of Isandlwana, Southern Africa, (1879)

Aldino Bondesan[1,2], Maria Petriccione[1], Leonardo Mora[1,3], H.A.P. Smit[4]

[1]Department of Historical, Geographical Sciences, and the Ancient World (DiSSGeA), University of Padua, Via del Santo 26, 35123 Padua, Italy

[2]Department of Military Geography, Faculty of Military Science, University of Stellenbosch, South Africa (Research fellow)

[3]Dipartimento di Studi Umanistici, University of Ca' Foscari, Palazzo Malcanton Marcorà, Dorsoduro 3484 30123 Venezia, Venezia, Italy

[4]Department of Geography, University of South Africa, South Africa

The Battle of Isandlwana, fought on 22 January 1879 during the Anglo-Zulu War in Southern Africa, represents one of the most significant British military defeats of the nineteenth century. The outcome of the engagement, in which a Zulu force decisively overwhelmed a British column, has long been attributed to tactical miscalculations and intelligence failures; however, the role of terrain in shaping the spatial dynamics and ultimate course of the battle has received comparatively limited systematic attention within the framework of military geography and conflict landscape studies.

This contribution presents a terrain-centred geospatial analysis of the Isandlwana battlefield aimed at reconstructing the spatial and morphological conditions that influenced tactical decision-making and unit deployment on both sides. Using Digital Terrain Models and derived analytical products, including slope analysis, viewshed modelling, and line-of-sight calculations, the study examines how the distinctive topography of the Nqutu Plateau and the Isandlwana hill conditioned troop movement, observation capacity, and the articulation of the Zulu encircling formation known as the "bull horn" (*izimpondo zenkomo*).

A three-dimensional reconstruction of the battlefield environment has been developed through GIS-based modelling, integrating contemporary terrain data with historical cartography and accounts drawn from British

military records and Zulu oral testimony. This multi-source approach enables a spatially explicit re-examination of key tactical phases of the battle, including the initial deployment of British companies, the collapse of the defensive perimeter, and the routes of both retreat and pursuit across the surrounding terrain.

The research engages with the ongoing scholarly debate on the relative weight of terrain versus command and intelligence factors in determining the battle's outcome, proposing a geospatially grounded contribution to the literature on conflict landscape analysis in southern African historical and geographical contexts. The study also reflects on the wider methodological potential of three-dimensional GIS environments for the geospatial study and reinterpretation of pre-industrial battlefield dynamics.

The City of Ice: GIS-Based Reconstruction of the WWI Military Landscape on the Marmolada Glacier

Aldino Bondesan[1,2], Maria Petriccione[1]

[1]Department of Historical, Geographical Sciences, and the Ancient World (DiSSGeA), University of Padua, Via del Santo 26, 35123 Padua, Italy

[2]Department of Military Geography, Faculty of Military Science, University of Stellenbosch, South Africa

The Marmolada massif, the highest peak of the Dolomites, constituted one of the most extreme and strategically significant theatres of the First World War along the Italian-Austrian front. Between 1915 and 1918, Italian and Austro-Hungarian forces established an intricate system of fortifications, tunnels, trenches, and logistical infrastructure within and on the surface of the glacier, giving rise to what became known as the "City of Ice", an unprecedented example of military adaptation to high-altitude glacial environments that fundamentally altered the landscape of the massif.

This contribution presents a geospatial study aimed at reconstructing and interpreting the military landscape of the Marmolada sector through the integration of historical cartography and GIS-based terrain analysis. Historical maps, topographic surveys, and archival documents from Italian and Austrian military repositories have been georeferenced and integrated into a Geographic Information System, enabling the spatial cross-analysis of troop positions, infrastructure networks, and tactical deployment areas in relation to the morphological characteristics of the terrain.

Digital Terrain Models derived from contemporary surveys have been employed to reconstruct the glacial surface as it appeared during the conflict, supporting visibility analyses that illuminate the tactical rationale behind the positioning of defensive and offensive structures. The integration of historical and geospatial data enables a multi-temporal reading of the militarised landscape, highlighting how terrain morphology conditioned both military strategy and the spatial organisation of logistical systems at extreme altitude.

Beyond its military-geographical dimension, the study addresses the cultural heritage significance of the Marmolada war landscape, contextualising surviving material traces, periodically exposed by ongoing glacial

retreat, within the broader framework of First World War heritage conservation in high-mountain environments. The research contributes to the growing field of conflict landscape studies by demonstrating the analytical potential of combining archival sources with geospatial methodologies for the systematic spatial documentation and interpretation of extreme-environment battlefield heritage.

Evaluating HWA Outbreak Severity Measurements IOT Inform DPW Mitigation Strategies

CDT Anna Hennigan[1], LTC Lauren Koban[1], MS Kimberly Quell[1]

[1]Department of Geography and Earth Sciences, US Military Academy, West Point, NY 10996

Eastern Hemlock is a foundational tree species in northeastern forests, but it is currently threatened by the invasive Hemlock Woolly Adelgid (HWA)(Ellison et al. 2005; Godman and Lancaster (2019). This study evaluatesthe effectiveness of NDVI analysis, visual surveys, and manual egg mass counts at West Point. NDVI analysis at Bull Pond (2015–2025) showed a peak in canopy health in 2021 followed by a steady decline. While visual surveys indicated moderate infestation at Round Pond, manual counts revealed a 64.8% infestation rate, classifying it as heavily infested. This study recommends using visual surveys for broad monitoring supplemented by random manual counts for precision. By shifting management strategy toward preventing the spread of HWA rather than reacting to mortality, West Point can ensure the long-term viability and realism of its training environments, preserving essential land features for operational readiness.

Spatial Polycrisis and the Militarization of Geography: A Neo-Classical and Critical Military Geography Framework for an Age of Compounding Crises

Ömer Emre Kuşcu[1]

[1]PhD Student, University of Illinois at Urbana-Champaign

The 21st century is witnessing an unprecedented transformation in the geography of conflict. Militarization is no longer driven solely by inter-state rivalries or nuclear deterrence; it is increasingly shaped by geography itself. Climate change, freshwater scarcity, mass migration, and urbanization produce spatial pressures that militarize territories, borders, cities, and subterranean environments in ways classical security frameworks fail to capture. This paper proposes the concept of spatial polycrisis to describe the compounding effect of these geographically rooted crises, arguing that crisis-driven militarization demands a neo-classical and critical military geography framework.

This study examines militarization as a multi-layered spatial phenomenon across above-ground, urban, and subterranean dimensions. Border militarization in response to climate-induced migration across the Middle East, the Sahel, and Eastern Europe demonstrates how geographic crises materialize as walls, barriers, and militarized infrastructure. Cities have become primary battlefields, from Stalingrad to Mariupol and Gaza, reflecting an inescapable logic: as populations concentrate, so too does warfare. Tunnel systems define asymmetric conflict, evidenced by Hamas's network beneath Gaza, Kyiv's wartime metro, and passages in the Syrian-Turkish border zone, illustrating that the vertical dimension of military geography demands theoretical attention.

The paper situates these developments within a neo-classical and critical military geography framework, moving beyond geography as a passive backdrop. Through the lens of spatial polycrisis, geography is positioned as an active driver of conflict: terrain generates scarcity, scarcity generates displacement, and displacement generates militarized responses. The paper synthesizes geopolitical theory, military geography,

and historical case analysis to offer a conceptual architecture for the militarized geographies of the present and near future.

The central claim is both diagnostic and prescient: the problems reshaping global security are fundamentally geographic in origin, and solutions, whether military, diplomatic, or humanitarian, cannot be formulated without military-geographic knowledge. As the world moves toward a more deeply militarized spatial order, neo-classical and critical military geography offers an indispensable analytical lens.

Critical Mineral Security: Lessons from the American Revolution and Magnetite in the New York–New Jersey Highlands

Nathaniel Marks[1], Joshua Ische[1]

[1]Department of Geography and Earth Sciences, US Military Academy, West Point, NY 10996

In 1776, the American republic faced its first critical mineral crisis. The New York–New Jersey Highlands answered it through magnetite ore drawn from their Precambrian ridges. Those deposits were both colonial equivalent of a modern day critical war mineral for the Continental Army. Without the magnetite mined, refined, and forged in the Hudson Highlands, no Great Chain would have spanned the Hudson. Before the war, the British Iron Act of 1750 had targeted colonial iron processing capacity, much as China now dominates and restricts critical mineral chains. Today's critical mineral predicament is not new in form, only a difference in commodities, with rare earths and lithium replacing magnetite. The young republic understood magnetite's importance and attempted to mitigate this vulnerability by exempting workers who mined and forged it from militia service. The Continental Congress commissioned Ramapo ironmaster Robert Erskine as the Continental Geographer bringing magnetite mining and refining, local terrain, and logistical knowledge of the Hudson Valley to the Continental Army. Geographically, the Republic's industrial-military response was centered on the Ringwood and Sterling Iron Works, the Forest of Dean Mine, Fortress West Point, and later the West Point Foundry. Drawing on geological reports, Revolutionary War records, militia statutes, and georeferenced mine data, this paper attempts to reconstruct that founding-era response and demonstrate how a focus on deliberate education, the incorporation of experts, and the co-location of extraction with processing and defense capacity offers a plausible response to the critical mineral needs of the United States today.

August 30, 1919: An American Excursion to Pompeii

Chiara Trinchese[1], Maria Petriccione[2], Elizabeth J. Shepherd[3]

[1]Department of History, Humanities and Society, Tor Vergata University of Rome, Via Columbia 1, 00133 Rome, Italy

[2]Department of Historical, Geographical Sciences, and the Ancient World (DiSSGeA), University of Padua, Via del Santo 26, 35123 Padua, Italy

[3]ICCD – Aerofototeca Nazionale, Ministry of Culture, Via di San Michele 18, 00153 Rome, Italy

We would like to share a unique story we discovered during our research on the various photographic and film campaigns on the ancient city of Pompeii in the years following World War I (late 1910s–early 1920s), carried out on multiple occasions by Italian military airships. The decommissioning of these "lighter-than-air" craft led to their use for scientific and touristic purposes, the latter being widely publicized through numerous photographs and film footage.

During our research, we also came across some interesting ground-level photos, now held in the United States National Archives, documenting the visit to Pompeii by the West Point Class of 1921, in which an airship is clearly visible in action above the Roman city. With the help of the United States Military Academy West Point Library Archives and Special Collections, it was possible to narrow down the date of the Class of 1921's visit to Pompeii to August 30, 1919; then, consulting the historical archives of the Italian Air Force and Navy, combined with reading newspapers of the time, allowed us to reconstruct the West Point cadets' visit to Europe, with particular attention to the visit that saw them welcomed as guests in Naples and Pompeii by the highest officials of the Italian state.

Thanks to this event, which was carefully documented by various sources, it was also possible to identify the airship that appeared in the sky over Pompeii on that occasion and to identify the technical photographers on board.