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ABSTRACT BOOK

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Peace follows war: geosciences, territorial impacts and post-conflict reconstruction

Dipartimento di Scienze Storiche, Geografiche e dell'Antichità - DiSSGeA

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ABSTRACT INDEX

KEY NOTES

Geology and the liberation of Normandy in World War II: a review to help mark the 75th anniversary of the Allied D-Day, 6 June 1944

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Keywords: beach trafficability, France, groundwater abstraction, quarrying, temporary airfields.

Planning for the Allied liberation of Normandy in northern France, which included the greatest amphibious assault in world history, was assisted by British military geologists: most notably Major (later Lieutenant-Colonel) W.B.R. King followed by Captain (later Major) F.W. Shotton (Rose & Pareyn, 1998; Rose, 2008). Additional to the few geologists who provided routine terrain analysis by the interpretation of aerial photographs, they provided technical information on the terrain to be encountered by means of specialist maps and advice. Major topics included the suitability of ground for (1) rapid construction of temporary airfields, (2) cross-beach trafficability, (3) borehole emplacement to abstract adequate potable groundwater, and (4) the quarrying of stone for the repair or enhancement of main supply routes. Boring Sections and Quarrying Companies are amongst units of the Royal Engineers known to have benefited significantly from geological guidance during and after the Battle of Normandy (Rose et al., 2010; Rose, 2012). Additionally, predictions of cross-country trafficability ('going') became important as the subsequent campaign developed. Battlefield guides in both English (Rose & Pareyn, 2003) and French (Couëffé et al., 2014) now provide innovative geological perspectives to the context of conflict in this pivotal region of World War II.

Couëffé R. with Charles N., Graviou P., Pay T., Rose E.P.F. & Vittecoq B. (2014) - Curiosités géologiques des plages du Débarquement en Normandie. BRGM Éditions, Orléans, 121 pp.

Rose E.P.F. (2008) - British military geological terrain evaluation for Operation Overlord: the Allied invasion of Normandy in June 1944. In: Nathanail C.P., Abrahart R.J. & Bradshaw R.P. (eds.), Military Geography and Geology: History and Technology. Land Quality Press, Nottingham, 215-233.

Rose E.P.F. (2012) - Aggregates pave the way to victory: work of Royal Engineers geologists and Quarrying Companies during World War II, especially for the liberation of Normandy. In: Hunger E. & Walton G. (eds.), Proceedings of the 16th Extractive Industry Geology Conference. EIG Conferences Ltd., Charlbury, 24-40.

Rose E.P.F. & Pareyn C. (1998) - British applications of military geology for 'Operation Overlord' and the battle in Normandy, France, 1944. In: Underwood J.R., Jr. & Guth P.L. (eds.) Military Geology in War and Peace. Reviews in Engineering Geology XIII. Geological Society of America, Boulder, CO, 55-66.

Rose E.P.F. & Pareyn C. (2003) - Geology of the D-Day Landings in Normandy, 1944. Geologists' Association Guide No. 64. Geologists' Association, London, ii + 98 pp.

Rose E.P.F., Clatworthy J.C. & Robins N.S. (2010) - Water supply maps for Northwest Europe developed by British military geologists during World War II: innovative mapping for mobile warfare. Cartogr. J., 47, 55-91.

"Green" militaries: The military - environment conundrum

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Keywords: Military, Environment, Environmental literacy, mission diversity.

Traditionally, the relationship between military activities and the physical and cultural environment in which they take place was a somewhat uneasy one. To a certain extent, this is still the case. On the one hand, most militaries recognise the importance of the environment in which they conduct their missions. The environment provides cover, sustenance, realistic training facilities and ultimately the battleground itself. On the other hand, traditional military activities focused on winning wars – ideally with as little own casualties as possible. In such a scenario, caring for the environment was thought of as a liability that could not be entertained without jeopardising the mission.

Over the last four to five decades big shifts in the human-environment interaction, as well as in military mission diversity took place. A growing recognition of the harm done to the environment by human activities spawned a global environmental movement demanding action against individuals, organisations, and even nations that are guilty of harmful environmental practices. The yardstick of environmentally responsible conduct is increasingly also applied to militaries.

In the military, expanding military mission diversity necessitates a more nuanced approach to the protection and care of the physical and cultural environment. Surely a military task group on a humanitarian mission must be held accountable for irresponsible environmental conduct to a larger degree than during a full-scale war. Similarly, during training, environmental care can more easily be incorporated into the planning process than under wartime conditions.

Given this conundrum of a military that relies on the environment, is held accountable for irresponsible military conduct, but must still successfully complete a wide range of military missions, this presentation seeks to address the following three questions:

- What constitutes an environmentally literate (green) military?
- Is it necessary – and possible - for the military to care for the environment in the execution of its duties?
- What damage can militaries sustain if they are not environmentally literate?

The presentation will be concluded by an analysis of the benefits to be gained from being an environmentally literate military, as well as the role military geoscientists can play in this regard.

ORAL PRESENTATIONS AND POSTERS

Geotechnical considerations for reusing foundations in post-conflict reconstruction

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Keywords: foundations, geophysics, post-conflict reconstruction.

Following periods of conflict in urban areas, there is often an immediate drive to restore vital infrastructure and key buildings, in order to allow and promote stability within the region and to generate popularity for the governing regime or peace-keeping allies.

It is, therefore, important to maximise the efficiency of any post-conflict construction whilst understanding and suitably mitigating against geotechnical risks associated with the ground conditions and conditions of the existing / historical foundations. Foundations for structures reconstructed, following a period of conflict, should account for: ground conditions; types of foundations commonly installed locally; disturbance to the ground and substructure damage caused by exploded ordinance; the presence of unexploded ordinance; availability of materials, plant and local expertise; the reuse of materials including building demolition, and; the required performance of foundations associated with temporary and permanent structures proposed. A systematic process is encouraged to account for these forenamed considerations and aim to deliver foundation solutions which provide effective post-conflict reconstruction.

Where part, or all, of a building is to be reconstructed, various simple techniques are available to assess the condition of historical foundations and mitigate geotechnical risks associated with foundation reuse in post-conflict reconstruction. The depth of piled foundations can be attained through the use of parallel seismic techniques (Butcher, 2006). A hydrophone is placed down a lined borehole, drilled adjacent to a piled foundation and the seismic signal generated through a hammer blow on the top of the pile is recorded on a seismograph. As well as housing the hydrophone, the borehole provides crucial information on the ground conditions and groundwater profile, used to derive geotechnical design parameters and determine the likely load bearing capacity of existing pile foundations.

Various non-destructive techniques can be used to mitigate the risks associated with reusing historical deep and shallow foundation types (Niederleithinger & Taffe, 2006). Methods include: ultra-sonic, low strain pile integrity methods, radar, parallel seismic, rebound hammer, electrical potential mapping and eddy current imagery. Prior knowledge of the foundation type is required, as is the opportunity to validate methods against specific material types. These methods, and an understanding of the ground conditions, can be used to evaluate the potential for foundation reuse during post-conflict reconstruction.

Butcher A.P. (2006) - The Detection of Pile Geometry using Geophysics. Reuse of Foundations for Urban Sites - Proceedings of the International Conference, 87–94.

Niederleithinger E. & Taffe A. (2006) - NDT Methods in the Foundation Reuse Process. Reuse of Foundations for Urban Sites - Proceedings of the International Conference, 123-131.

Dr. Isaiah Bowman and the Centennial of The Inquiry

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Keywords: Versailles Treaty, Paris Peace Conference, cartography, geography.

To prepare for the 1919 Paris Peace Conference, U.S. President Woodrow Wilson, turned to *then-Director of the American Geographical Society, Dr. Isaiah Bowman,* to put diplomatic peacemaking on a rational footing. A *group of 150 distinguished geographers, called "The Inquiry," laid t*he groundwork for Wilson's 14 Points and a settlement that was to ensure all peoples' rights to a peaceful existence, sovereign affiliation, and the ability to vote for their political leadership. Dr. Bowman noted that "never before has there been gathered together so large a body of men engaged in public service of an international character."

A century ago, mapping ethnic geographies was a completely new cartographic enterprise. The masterful Bowman steered the research and production of volumes of ethnic maps and human geography reports that both informed the American commissioners in Paris and impressed foreign delegations. The political maps emanating from the Versailles Treaty evinced the fullest evolution of nation states, which had begun with the 1648 Treaty of Westphalia. This paper examines Bowman's background and prior experiences that prepared the naturalized American citizen for just such an undertaking.

Martin G. (1980) - The Life and Thought of Isaiah Bowman. Archon Books.
Mitchell M. (2001) - Paris 1919: Six Months that Changed the World, Random House Publishing.
Reisser W.J. (2012) - The Black Book: Woodrow Wilson's Secret Plan for Peace, Lexington Books.

The bombing of Pantelleria Island

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Keywords: Pantelleria, Bombing, 1943, Battle Damage.

Pantelleria is a small volcanic island in the Mediterranean, located about halfway between Tunisia and Sicily. Being close to the main shipping route from east to west in the Mediterranean, the island is of prime strategic importance. Between 1920 and 1939 the Italian government reinforced Pantelleria's natural defenses completing a military aerodrome on a plateau 180m above sea level and a total of 22 shore and anti-aircraft batteries. As the Allies started planning Operation 'Husky', the invasion of Sicily from North Africa, at the beginning of 1943, Gen. Eisenhower decided to seize Pantelleria, but to obviate a full-scale assault, he thought of making the Operation 'Corkscrew' 'a sort of laboratory to determine the effect of concentrated heavy bombing on a defended coastline. To help in the planning of the bombing operation, British Professor Solly Zuckerman used systematic statistical analysis in order to perform battle damage assessment. The Allied air offensive against Pantelleria was conducted in two stages by almost 1,000 aircraft. Between May 18 and 11 June, 6,624 tons were dropped. Despite efforts to re-supply the island by sea and air, shortages in water, ammunition and supplies had serious effects on morale of Italian garrison. On June 11, the Allied invasion fleet halted about eight miles off the harbor entrance of the port of Pantelleria and by noon white flags appeared on many of the buildings. The data about battle damage accumulated by Zuckerman at Pantelleria would later be put to good use in planning the bombing of German fortifications in France prior to D-Day in Normandy. But the cost was high, as the whole of the historical harbour town of Pantelleria was wiped out. However, some eye witnesses from Pantelleria had always stated that most of destruction within the town was in reality due to a deliberate demolition which was carried out by Allied troops a few days after the landing in order to produce propaganda photos and movies. This study is aimed to demonstrate that, despite some demolitions were actually made after the battle, most of destruction are effectively due to carpet bombing. Additionally, this study shows that Pantelleria Island is still scattered with a lot of fortified gun emplacements which can be now considered an integrating part of its cultural and historical landscape.

Belogi M. & Leoni E. (2002) - Pantelleria 1943 – Mediterranean D-Day. Liberedizioni, Gavardo (Brescia), Italy 150 pp.

Belogi M. & Leoni E. (2006) - After the Battle – Pantelleria. In After the Battle Magazine, Issue 127, England 80 pp., 4-25.

Belogi M. & Leoni E. (2017) - The bombing Pantelleria Island (Italy). In the Materiality of Troubled Pasts - Archaeologies of Conficts and Wars, Edited by Anna Zalewska, John M. Scott and Grzegorz Kiarszys, Warszawa – Szczecin, Poland, 250 pp, 179-196.

Estimation of the environmental impact of military exercises on bombing ranges by employing radionuclide mapping

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Keywords: Naturally occurring radionuclides, geographic information systems, bombing range, In Situ measurements.

A GISPI (Gamma in situ Portable Device) was used to map naturally occurring radionuclides in two old South African Air Force (SAAF) bombing ranges on the West Coast of South Africa. The concentrations of potassium, thorium and radioactive progeny of uranium were measured and plotted with the help of QGIS software. The results demonstrated changes in radionuclide concentrations in specific areas of the ranges.

The bombing ranges were also extensively surveyed with a done and high definition area photographs and elevation maps were constructed. All the results were correlated with areas where weapon testing and live bombing exercises were conducted. The article finally draws conclusions as to the environmental impact of the bombing on the area. These methods can be used to quickly and effectively investigate bombed area or other bombing ranges in future.

Bezuidenhout J. (2015) - Testing and implementation of a transportable and robust radio-element mapping system. The South African Journal Science, 111, 9/10.

Bezuidenhout J. (2012) - Mapping of historical human activities in the Saldanha Bay Military Area by using In Situ Gamma Ray Measurements. Scientia Militaria, 40(2).

The Geography of Territorial Disputes in the East and South China Seas

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Keywords: Borders, Maritime, Islands, Sovereignity.

The historically disputed waters in the south and east China seas have seen increasingly aggressive behaviour from affected nations trying to strengthen their claims to the disputed areas and to develop/expand offshore fishing and energy resources. In this regard observers have noted a sharp escalation in maritime related incidents and diplomatic tensions.

The territorial disputes between the various role players in the South and East China Seas are mainly centuries and decades old while the physical tension has been rising in recent years. In the East China Sea the dispute between Japan, China and Taiwan concerns a set of Japanese controlled islets while the more complicated dispute in the South China Sea between China, Taiwan, Brunei, Malaysia, the Philippines and Vietnam concerns mainly the Spratly and Paracel Island groups. Most of the disputes revolve around possession and maritime boundary claims.

The area has seen recent aggressive actions by particularly maritime authorities such as harassing vessels, blockading areas and destroying equipment. This in one of the world's busiest waterways which must be of particular concern to ships on innocent passage who may unwittingly become involved in conflict over the enforcement of sovereignty or even the supposed protection of maritime resources.

The exploration in contested areas coupled with the increase in maritime forces in the area is bound to lead to confrontation. The implication of China's interpretation of the Law of the Sea in terms of the right (or not) of innocent passage through its vast territorial claim should ring alarm bells for all nations using the oceans (specifically the East and South China Seas) as sea lines of communication and commerce.

Landmines warfare at El Alamein (Egypt, 1942)

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Keywords: Minefield, El Alamein, WW2.

El Alamein was the easternmost site reached by Axis forces during the North African Campaign. After a series of offensives and counteroffensives, that led the contenders to alternating losses and conquests of Cyrenaica, on 30th June 1942, the Italo–Germans arrived at El Alamein. Here the British 8th Army established since 1941 the last resistance line in defense of the Delta region. After a cycle of three battles, on 4th November 1942, with Operation Supercharge, the Allies broke through the enemy lines, starting a long pursuit to Tunisia, where the Axis surrendered on 13th May 1943.

Minefields played a fundamental role in the entire Battle for North Africa and were the main defensive system at El Alamein, in a relatively bare and flat desert ground. Geological and geomorphological features, even in their micro-morphological variations, conditioned the development of the minefields, which strictly followed the local topography.

A belt of explosive devices ran through the entire front line; thousands of anti-personnel and antitank mines, laid in organized belts and scattered mines areas, some kilometres wide, covered the 80 km distance between the stronghold of El Alamein and the Qattara depression.

The minefields were usually enforced by buried aircraft or artillery bombs, or different sorts of explosive devices usually electrically operated at a distance. They were fenced with barbed wire and kept under fire by advanced positions.

An integrated study of the battlefield area was performed in the frame of the El Alamein Project.

Through a GIS project, different informative layers were compared:

1) high resolution satellite imagery, that allowed to study the geological and geomorphological features of the El Alamein's battlefield; 2) original aerial photographs; 3) minefields military maps and veterans sketch map; 4) field surveys.

The analysis was performed using some common tools of GIS software applied to a DTM obtained by SRTM data, while geological limits were obtained mainly by the comparison of ASTER images followed by ground truth control.

Minefields were a dangerous legacy of war for decades, causing a large number of casualties among the civil population, while nowadays, clearing operations conducted by Egyptian Army opened the area to oil exploration and exploitation and, more recently, to the expansion of the New El Alamein City.

Bondesan A. & Vendrame T. (2015) - El Alamein. Rivisitazione del campo di battaglia tra mito e attualità. Cierre Edizioni, 476 pp,

Bondesan A. (2012) - The El Alamein Project: Research, Findings and Results between History and Military Geography, J. Edwards, El Alamein and the Struggle for North Africa, international Perspectives from the Twenty - first Century, American University Press, Cairo, Egitto 113 - 136

Bondesan A., Furlani S., Vergara M. N., Massironi M., Francese R. (2013) - Geomorphology of the El Alamein Battlefield (Southern Front, Egypt). Journal of Maps - Abingdon, England: Routledge Journals, Taylor, Francis Ltd - London, 9 (4), 532 – 541.

Vergara N.M. (2011) - Geomorphological map of the Southern Front of the El Alamein Battlefield (Western Desert, Egypt), supervisors.: Bondesan Aldino, Furlani Stefano, Massironi Matteo, Unpublished Master thesis, University of Padova.

The Italian/Austro-Hungarian front in the middle Piave River (Northern Italy, 1917- 1918): a GIS approach to military cartography

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Keywords: Military cartography, WW1, Piave River.

After the Battle of Caporetto, in October 2017, the Italian/Austro-Hungarian frontline withdrove along the Piave River (Northern Italy). The defensive line was maintained throughout the last year of the First World War. Till the end of 1917, military elements were mapped by the Austro-Hungarian Army cartographers with great accuracy, in order to plan the next offensive action (15 June 1918, Battle of the Solstice).

Hundreds of Austro-Hungarian military maps are today collected in the Miscellaneous of Military Maps of the State Archives of Florence, published in a box set (Bondesan & Scroccaro, 1916). It is a cartographic treasure, recently discovered, that not only illustrates the general defensive and military deployments, but which draws a now-disappeared landscape of which only a few remains.

The techniques of overprinting representation, thanks to the offset printing, the possibility of continuous updating thanks to the great technological advances applied to remote sensing (both in direct observation and above all from aerial photography), the use of the different scales of representation aimed at tactical or strategic command, are only some of the elements of great interest that these documents constitute. The discrete precision of representation makes these maps completely suitable for Geographic Information System (GIS) analysis.

The maps of the middle Piave River (from Pederobba to Zenson di Piave, Treviso Province, NE Italy) were georeferenced in a GIS environment. All the thematic information were digitized in order to analyze the system of military defenses and emplacements that could face the enemy efforts to force the frontline. The analysis quantifies the defensive power of military features measured by a set of profiles drawn every 500 m across the enemy lines, 6 to 8 km long.

The result shows that some places chosen for the attack were effectively less garrisoned or less defended than the adjacent ones.

Bondesan A. & Scroccaro M. (a cura di) (2016) - Cartografia militare della Prima Guerra Mondiale. Cadore, Altopiani e Piave nelle carte topografiche austro-ungariche e italiane dell'Archivio di Stato di Firenze. Archivio di Stato di Firenze-Regione Veneto-Grafiche Antiga, Crocetta del Montello, 158 p.p. and 246 topographic maps.

Wartime use of caves in the Italian classical karst (Austro-Hungarian front, WW1)

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Keywords: Classical Karst, Caves WW1.

The area of the Classical Karst (North-Eastern Italy) was affected during the Great War by a series of military actions known as "the Twelve Battles of the Isonzo".

Numerous natural cavities were adapted according to their purpose and geomorphological context. The modification of the caves was extremely variable. Some of them were solely used by the troops, without construction works inside; some others were partially or completely artificially dug. Bertarelli & Boegan (1926) for the first time extensively described the use of the caves of the Karst for war purposes and began to conceive the enormity of the Austrian fortifications capable of accommodating tens of thousands of soldiers.

Typically, many adaptations concern the entrance of the caves, both to close the rooms (to prevent gas attacks), to reduce the size of the accesses, or to make them safe from possible rock-wall detachments. Moreover, the presence of several entrances to the same cavity was crucial, a situation that is frequently found in the larger cavities. In nature it is rare to find caves with multiple accesses (apart the large complexes) so, for strategic reasons, artificial tunnels were dug to open a second entrance, often excavating from adjacent sinkholes. The use of multiple entrances gave greater safety both in case of direct attack by enemy forces, and in case of bombings, causing entrances to collapse; moreover, in case of overcrowding of the cavity, a second entrance, especially if placed at a slightly different altitude, allowed an optimized ventilation of the rooms. Another common modification was the union of several caves, thus, again, to obtain more entrances and greater volumes available.

Some of the more substantial changes concerned the construction of terraces inside the rooms, especially if they were developed on a slope, and the leveling of the walking surface.

The use of cement was often massive, constructing walls and staircases, to easily descend the more inclined sections of the hypogeum environments.

Natural caves were also used as water reserves, thanks to the presence of natural "gours" formations, or with the actual construction of concrete tanks filled by water leaking from layer joints or concretions.

Bertarelli L.V. & Boegan E. (1926) - Duemila Grotte, T.C.I. ed., Milano, 494 pp.

Gherlizza F.& Radacich M. (2005) - Grotte della Grande Guerra: guida alle cavità naturali del Carso triestino e goriziano utilizzate durante la prima guerra mondiale dal Regio Esercito Italiano, dall'Esercito Austro-Ungarico e dalla protezione civile. Club alpinistico triestino, Gruppo Grotte, San Dorligo della Valle: Centralgrafica, 352 pp.

Tavagnutti M. (1997) - Proposta per una classificazione delle grotte di guerra esistenti sul Carso goriziano finalizzata al loro inserimento nel catasto delle grotte artificiali. Atti del 4° Convegno nazionale sulle cavita artificiali, Osoppo, (30/31 mag.-1 giu. 1997), 239-260 pp.

Origins, Expansion and Renewal of the French Military geography (XIX-XX Centuries)

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Keywords: geology, climatology, hydrology, human geography.

The contemporary military geography results from a long evolution of knowledge. Since antiquity, the theorists of military art realized the necessity of mastering the environment.

From Sun Tse to Napoleon, from Frontin to Jomini, every strategist has been dealing with the influence of the physical geography and, sometimes, human geography preparation, conduction and exploitation of operations.

Nevertheless, it has to wait the beginning of Napoleon wars to see a different movement of thinking in military geography. Up to the World War Two, these movements are developed for military aspect: geology, climatology, hydrology, human geography.

In France, a bright school of military geography is developed between 1871 and 1939. It is a model in Europe and in the world. After 1945, people do not speak military geography, but geostrategy and geopolitics. After 1990, the rebirth of military geography is a new phenomenon.

What is the specificity of French military geography? To answer this question, three periods can be presented: the birth of the geography military thinking, its expansion between 1871 and 1939, its decline and renewal since 1945.

A new land. Shrines, military artifacts, new land use issue - Military tourism and monuments

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Keywords: Great War, Pasubio, San Michele, Mount Grappa, Sabotino.

The change of the territory caused by the Great War, highlights a path that anticipates the conflict and overcomes it; it starts from the military fortifications at the borders - the fortress -, it continues with the trenches, the shelters, the tunnels, the minefield, the forced stay of millions of men in the places, and it ends in the post-war period with the settling of corpses in the graves, the creation of shrines, the fixation of memory.

In this path, the "land of the front" will no longer be the same one, marked in the clods, but above all in the stories. For veterans, family members of the fallen soldiers and for several following generations, the lines of the front will not only be terrain, but memories, stories, mourning and epic. This equally physical and metaphysical earth, is organized around the signs left by the conflict that have as their focal point the thousands of cemeteries first and then the great shrines. Reorganizing the land of the front so permeated with signs and stories, means organizing the memory of the places. This means not only reclamation of the land, but also making real choices of what to keep of the many artifacts, what to implant to perpetual memory, how to make these real open spaces / open-air museums.

In this place, that is the land of the front, the Monumental Zones - or sacred areas, as it was in fact in the original project - are a first response to the need to fix this changed land in perpetuity. From Pasubio to San Michele, from Grappa to Sabotino. Since 1922 there has been a first historical fixation of the territory that takes its importance not in beauty or in art, but in history and suffering. This first form of war tourism, continues with alternating phases in the following years, if you consider the history of the "Roads of 52 tunnels" on the Pasubio that already in the 30s require a first renovation and repairing, and that would be practically not useable in the 70s. Only a major intervention of volunteers in the 80s would make them useable again, but we must wait for the 2000s for a real law that protects the historical heritage of the Great War and gives tourism the signs and the territory of the old front.

So the terrain tells, the terrain is a witness. The shrines, which would replace the many war cemeteries, from the second half of the 30s, contemplate both a logic of "restitution" of the terrain to its natural use: agricultural and social; it is the monumental fixation that goes to interact not only with the story but with the same landscape. Starting from the choice of the place of the construction, which must be the meaning of a story, both the panoramic location and the architectural construction contemplate a dialogue with the landscape that goes beyond the glory of a party, to embrace an idea of the perpetuity of story in eternal dialogue between death, history, memory of territory.

Shrines and places become books whose pages are flip through time.

The time that erodes beyond the war, which modifies the terrain, the artifacts and the stories gives us a heritage that today has to, a great extent, be recovered in its physicality and in its story.

If laws to protect the heritage of the Great War recover a physical fabric of important distinction, the story should put the focus back to the ability to read these places.

Simulating the trench War: the practice camps in Aube (Champagne, France), 1914-1919

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Keywords: Practice Trenchs, Champagne-Ardenne, WW1 Archaeology.

One of the little documented aspects of the rear front line is the practice camps which illustrate the military staff's willingness to prepare physically and mentally future soldiers before sending them to the first lines. These camps reproduce the spatial and architectural organization of the first line trench network (Cocroft, 2013), and allow the soldiers to become familiar with the topography of the battlefield by training to dig, to shoot, to assault and to cross rough terrain.

In France, these camps have never been the subject of an exhaustive study although these are punctually reported in the literature of the Great War (Dry & Seurat, 2018). Often presented as rare, the training camps are in fact much more numerous than the archival records show: these camps were not inventoried by the military, because they were created in an opportunistic and temporary way. No archaeological or geo-historical approach has been used to measure their actual distribution in France; they are, however, part of the archaeological heritage of the Great War.

In order to identify and map the spatial distribution of these camps and to measure their effects on the landscape, three sectors of the Aube region in N-E France were observed using aerial photographic covers made during the period 1938-1948. These battlefield reconstructions testify to the occupational intensity of the region by the military units over the period 1914-1919. The agricultural reparcelling of the landscapes, which began in the 1950s, has erased almost all visible traces of these remains (Framery, 2016).

Cocroft W. (2013) – Trenches of the Home Front. English Heritage Conservation bulletin, Issue 71, 4-5.

Dry L. & Seurat H. (2018) – L'Aube, base arrière d'une guerre mondiale. In: Cazauban É. & Pottier O. (eds.), Troyes, l'Aube, la guerre (1914-1922). Les Éditions de la Maison du Boulanger, 91-97.

Framery D. (2016) – Quelques camps d'entraînement dans la campagne auboise.

The Interface between the Civilian and Military on the Israeli Side of the Divided Jerusalem, 1948-1967

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Keywords: Jerusalem, War of Independence.

Research on military effects on the urban fabric of physically divided cities is rather limited as there are very few cities which were, or are, so divided between mutually-hostile political entities. Indeed, it could well be that Berlin and Nicosia are the only such cities other than Jerusalem (Elkins and Hofmeister, 1988; Strobel, 1994; Kliot and Mansfeld, 1997; 1999; Papadakis, 2006; Gaffikin and Morrissey, 2011).

The dearth of multiple case studies notwithstanding, the impact of the 1947-1949 War of Independence on Jerusalem has been remarkably detrimental and merits scholarly attention. This is due to the fact that the city experienced considerable damage to buildings and infrastructures, massive population dislocation and was left divided between Israel and the Kingdom of Jordan (Tamari, 1999; Israeli, 2002). The western sector of the city, declared unilaterally as Israel's capital in December 1949, was surrounded until 1967 on three sides by a volatile armistice line. During this time, it was vastly repopulated and its built-up area enlarged. This was done to revitalize Jerusalem's economy, allow for a critical mass of residents that would allow it to defend itself in case of future hostilities as well as establish firm facts on the ground as regards Israel's political intentions for the city (Gosenfeld, 1973).

Given Western Jerusalem's precarious security and geopolitical setting, military considerations have had significant weight in its urbanization process. During hostilities and shortly thereafter, thousands of soldiers and army units took up residence in abandoned houses, impacting the ability to use these to house needy Jewish refugees and immigrants. Even with large-scale post-war demobilization, observation, gun and artillery posts located in and above residential buildings laced the ceasefire line. The army had considerable influence over the populating of seam areas, the spatial layout of new residential clusters and even the design of specific structures, turning the city into an arena where the civilian and the military constantly interacted and often overlapped.

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Geological Considerations for Military Works in the Afrin Battlespace, Syria

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Keywords: Trenches, Tunnels, Excavation, Limestone.

To defend against Turkish Armed Forces (TAF) in the Afrin region the Kurdistan Workers' Party (PKK)'s / PYD-YPG constructed trenches, observations posts, tunnels and underground facilities along the border with Turkey and in-depth. Syrian Kurdish military works were constructed in mountains of limestone, sandstones and marls and in valleys in alluvial terraces and conglomerates (Syrian Ministry of Industry, 1964). These geologies are very favourable for digging and tunnelling. Construction of military works in the Afrin region may have been undertaken by PKK, KCK, PYD-YPG and Da'esh all of whom have experience fighting from them. The scale of these works represents significant defensive construction projects (Kaufmann et al., 2011). These require financing (calculated to be $400,000 for a 300 m long cut and cover hardened tunnel), experienced and skilled works teams with project managers, site foreman, plant operators, construction crews experienced in making rebar mesh, forms and working with concrete. These military works are visible in earth observing satellite data at visible, thermal and radar wavelengths.

TAF response has been extensive use of concrete sections to create walls and to overmatch these defensive positions with weapons systems. Modifications of design by the (PKK)'s /PYD-YPG appear to have incorporated lesson learned from weapons systems used by TAF. Digging in the different geologies was undertaken using hand tools and machine excavators. The rates of machine digging have been estimated and these highlight the significance of having skilled plant operators. Trenches excavated in the horizontally layered limestone with marls show them to be coherent enough to support near vertical walls. Within trenches 5 to 7 m deep and 3.5 wide, reinforced concrete was used to create tunnels 1.5 m wide, 2 m high with all sides 0.9 m thick that ran for tens, hundreds and thousands of meters. These were then covered back over with spoil (cut and cover) to provide additional overhead protection. In several locations "double-deck" cut and cover tunnels were constructed. Observation towers constructed of reinforced concrete, were connected to cut and cover tunnels and had ventilation, electrical wiring and living areas. Underground facilities in the mountains around Afrin were constructed in chalky limestone by the YPG. Rooms in one facility that was likely are command centre are 100 m long with additional tunnels. The roof has concrete reinforced arches and the floor marble tiles. The dimensions are big enough for vehicles

At the start of the Operation Olive Branch on 20 Jan 2018, cut and cover tunnels and underground facilities were the primary targets for Turkish fighter jets. On 28 Jan 2018, TAF and SFA captured Mount Bursaya from the YPG in northern Syria. On 18 Mar 2018, TAF captured the centre of Afrin. It appears that the designs of these extensive military works by the defenders could not be modified fast enough to effectively defend against TAF air supremacy, artillery, armour and engineering.

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Contemporary Use of Subterranea to Increase Survivability.

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Keywords: Survivability, Detectability, Vulnerability, Recoverability.

In military environments, survivability is defined as the ability to remain mission capable after a single engagement (Ball, 2003). There are four main system elements. The first is detectability which is the inability to avoid audio and visual detection, including by radar. The second is susceptibility which is the inability to avoid being hit by a weapon. The third is vulnerability which is the inability to withstand the hit and the fourth is recoverability. This is the longer-term processes, after being hit, of damage control, firefighting, capability restoration, escape and evacuation. The conflicts in Syria, Iraq, Afghanistan and Gaza have shown that, depending on the geology, going underground has helped avoid the first three elements whilst the fourth can be achieved through engineering. Engineering survivability is the quantified ability of a system, subsystems, process, or procedure to continue the function during and after a natural or human-induced shock (World Bank 2015). A system is a regularly interacting or interdependent group of items forming a unified whole (Backlund, 2000). During the conflicts in Syria, Iraq, Gaza, Afghanistan, Mali, and Yemen these engineering skills have improved and utilized both improvised as well as commercial products and methods.

The ability of combatants to use subterranea has been enhanced by their improved understanding of geology and geotechnics, advances in deployable civil engineering design and materials, as well as in available power tools. In the contemporary conflicts in Syria and Iraq, these have been available to non state actors within the battlespaces but have also come in from outside (Bulmer, 2018). Access to the underground has been through natural features, or through mines, quarries and by tunnelling. Practices and techniques show that knowledge came into Syria from Lebanese fighters and that these in turn had been greatly informed by engineers from North Korea. As the conflict in Syria spread and moved into Iraq, other state actors provided advice and expertise. This has led to greater understanding by attackers (Anti-IS coalition, Russia, and Syrian Army, Iran and Israel) of how to use modern weapons systems and by defenders (IS and affiliates, Syrian Free Army, Kurdish Peshmerga, Al-Qaeda and Taliban) of how to increase survivability. Critical to the defenders has been favourable geology (the marble and gneiss of Afghanistan, the limestones, chalky limestones, and marls of Syria and Iraq) and hydrogeology for going underground. However, the scale over which subterranea has been used and the rate at which it has been exploited has been driven by the need to survive. Urban areas have augmented survivability by mitigating detectability, susceptibility, vulnerability and enhancing recoverability. Increasing levels of destruction in cities such as Mosul, Aleppo, Damascus, Afrin, Raqqa over the course of the conflicts led to accumulated rubble and debris that enhanced underground survivability where detectability, susceptibility, vulnerability were reduced. In contrast, the recoverability of underground structures after being hit decreased as infrastructure of the cities was not repaired (PAX, 2015).

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The glaciated landscape across the WWI front: quantitative reconstructions based on documentary data and modern methods

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Keywords: glacier reconstructions, WWI front, documentary data, Eastern Italian Alps.

Glaciers are sensitive climatic indicators, important water sources, fascinating and appealing features of the alpine landscape, and morphogenetic factors that are relevant for the management of the geomorphological and hydro-geological risk. The knowledge of their past fluctuations is the key for understanding their dynamics and their climate-related evolution (Wanner et al., 2008).

Glacier mass balance and length changes are the two metrics normally used for reconstructing past fluctuations series of glaciers. However, length change measurements series are often discontinuous and require validation, whereas mass balance measurements are available for only few glaciers worldwide and only for the latest decades (WGMS, 2015).

In the context of long, multi-secular glacier reconstructions, other sources of information such as historical-archival, glacio-archaeological and geomorphological data, are of paramount importance because they enable the completion and validation of direct measurement series and their extension into the past (e.g. Nussbaumer et al. 2007; Nussbaumer and Zumbühl, 2012), providing spatial and temporal constrains.

A unique source of unexploited historical information dating back to the First World War (WWI, 1915-1918) exist for many glaciers in the Eastern Italian Alps, in a period with scarce documentary and geomorphological evidence elsewhere. This information include old topographic maps and photographs, which represent a good opportunity for glacier reconstructions. Unfortunately, such historical information is spread over a multitude of sources and it is often not yet digitized, and therefore hardly disposable for the scientific community or for the society.

We propose a workflow for the acquisition and analysis of terrestrial and aerial photographs from the WWI period, aimed at the reconstruction of glacier area and volume combining modern techniques of digital image processing and paleo-glacier surface reconstruction. These methods rely on the availability of high-resolution digital elevation models, which are acquired using terrestrial and aerial photogrammetry and LiDAR. This work presents the methods applied and the results obtained on several case studies in the Adamello-Presanella, Ortles-Cevedale, Dolomites, and Julian Alps.

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Sapper Geology: Part 5.
Infrastructure Support: an era of change and complexity

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Keywords: British Army, geology, HADR, subterranea, urban, infrastructure.

Rose, Hughes (1993a, 1993b 1993c) have documented the development of British Army geological technical support from its early stage of development through to the post-Cold War era and the start of prolonged operations in the Middle East and central Asia. This paper seeks to continue the story to the present day and by doing so demonstrate the breadth and depth of change and complexity experienced by former and serving reserve Royal Engineer geologists.

Now comprising the Military Geology Cell (MGC), there continues to be three formalized geology posts within the British Army. However, there is considerable depth within the Army Reserve as a whole and just within 170 (Infrastructure Support) Group there are over a dozen soldiers, at all ranks, who have a range of qualifications and specialisations within academia and industry.

Core areas of support are as follow: defence intelligence, materials, natural resources, humanitarian assistance and disaster relief (HADR), UK resilience, military aid to the civilian authorities (MACA), geohazards, infrastructure assessment, hydrogeology and subterranea. The last of these has seen significant interest in light of well documented use of tunnels in Syria and Iraq and the Levant (Roskin, 2019).

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The U.S. 10th Mountain Division in Italy, 1945: Initial Operations in the Apennines

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Keywords: 10th Mountain Division (U.S.), mountain warfare, Apennine Mountains, Riva Ridge, Monte Belvedere.

This paper examines the 10th Mountain Division's initial operations in Italy, 1945. The division's assault and capture of the Riva Ridge massif and Monte Belvedere provide valuable lessons on alpine military mobility and tactics when facing established defensive positions.

After the 1943 Allied invasion of southern Italy, Allied forces moving north conducted operations in the Apennine Mountains. These mountains dominate the peninsula from the far south, or "toe," north to the Po River Valley. The terrain, rivers, adverse weather, lack of roadways, and strong German defenses resulted in what was described as "slow, spasmodic movement" from one height to the next (Imbrie, 2004). Following the June 1944, Allied entry into Rome, German forces fortified the Gothic Line, running across the Northern Apennines from coast to coast. Allied units initially penetrated this defensive system at great cost in the autumn of 1944 and advances slowed to a halt by the end of December. The Germans used this lull to strengthen defenses, including mines, trip wires, concertina, fortification of farmhouses and villages, and pre-planned artillery and mortar fire.

The 10th Mountain Division, assigned to the U.S. IV Corps, entered the front lines between the Serchio Valley and Monte Belvedere in January 1945. The division received the mission to capture Monte Belvedere. This would deny German domination of the Route 64 corridor, one of two main highway approaches to the Po River Valley in the Fifth Army sector. Major General George Hays, division commander, recognized that an attack on Monte Belvedere would only be successful if German positions on the nearby Riva Ridge massif were first captured, denying the enemy artillery observation.

On the evening of February 18, a reinforced battalion made a successful night climb and assault on Riva Ridge, securing all objectives by February 25th. To the northeast, six battalions launched their assault to capture Monte Belvedere, followed by Monte della Torraccia, the night of February 19. German counterattacks in this area also ended on February 25th. Division attacks continued north through the mountains, with the first divisional unit reaching the Po River Valley on April 20th.

Commanders attributed the success of both attacks to realistic training conducted in rugged, difficult terrain; reconnaissance; thorough explanation of plans; practice over similar terrain; physical condition and stamina; and high morale and esprit de corps. The lessons from these initial operations proved valuable as the division moved north.

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"News on the Eastern Front". The WWI tactical maps of the Italian Army in the historical archive of the 3a Armata: proposals for a semiologic interpretation and a digital analysis.

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Keywords: historical cartography, historical geography, First World War, Italian Army, Historical GIS.

Innovations in war practices during the First World War have been widely documented by international historiography (Fox, 2018). Nevertheless, trench warfare necessities and their consequences in military maps production still needs to be studied in deep (Chasseaud, 2013).

Following this line, the paper aims to present the military cartographies of the Italian 3° Army Historical Archives of Padua, focusing on tactical maps, or the maps that were continuously updated in proelio to represent the evolution of forefront positions and activities (Traversi, 1968; Bondesan & Scroccaro, 2016). The 3° Army had a crucial role in the conflict, as it settled along the Piave river after the Caporetto retreat and later it led the final advance toward Istria.

The analysis of this cartographic collection, still unedited, aims to open a new research path for the development of semiological analysis and typological classification categories of military maps; main attention has been paid for the maps produced in fieri, or printed IGM maps that were continuously handwritten and updated during war operations (Cantile, in press). First, the maps corpus is illustrated; second, a typological classification and semiological decoding (based on the interpretation of the used symbols) is presented. Finally, a digital elaboration using the georeferencing and vectorising of data is presented. Solutions for the digital representation of troops movements and field battle dynamics are presented.

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Footprint of a disaster. The wreckage of Regia Marina Ship Leonardo da Vinci

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Keywords: geophysics, Citri, wreckage, seismic, remediation.

Mar Piccolo of Taranto is a small semi-enclosed basin affected by complex environmental issues due to occurrence of heavy steel industry and since 18th century of historical Italian Navy Base.

In the last years a large project of remediation has been planned by Government Commissioner for the Remediation of the Taranto area. In order to direct a general policy and accurately plan in field for remediation activities, a field survey has been planned and performed by UniBa, PoliBa, CNR, CoNISMa. The UniBa Department of Geo-environmental Science has entrusted to execute a high resolution geophysical marine survey in order to define Mar Piccolo shallow geology features and morphology seabed, performing 250 km of high resolution Sub Bottom profile seismic, multibeam, side scan sonar, magnetometer surveys.

Many seabed features detected in order to identify possible pollution source and 350 point sonar targets and 70 potentially pollution areas detected and mapped. Mainly anthropic features (small wrecks, barrels, anchor scars, etc.) are detected together small sub-circular depressions of submarine karst springs, locally known as "Citri" (Cerruti, 1938), characterized by a deep and steep inverted cone surface and by a high groundwater velocity determining an outflow effect visible on seawater surface (Zuffianò et al., 2016).

Two "Citri"-like uncharted features clearly detected in the middle of Mar Piccolo: a sub-circular depression 100 m wide, at 12 m w.d. 17°15'E 40°29'N and a rectangular dredged area 300 m width at 13 m w.d. 17°15'E 40°29'N.

The first one was supposed as natural origin but never reported as active 'citro' and, historically, was surveyed directly by divers in order to identify source of magnetic anomaly in the area. Dive inspection highlighted occurrence of metal frames lying on bottom but no final results were obtained on its origin or evolution, reporting as 'ghost' or "Lost Citro" and not more considered. The second feature surveyed was classified as dredged area but with unknown purposes.

Key clues for identify real origin of the feature issued correlating acquired geophysical information and historical source reported in Caroppo & Portacci 2017 and Rizza 2017 about Leonardo Da Vinci wreckage. Basing on reported location of Italian Navy fleet anchored in Mar Piccolo on the 02/08/1916 night a perfect fit in position of lost ship and 'lost citro' clearly appeared. In this way, "Lost Citro" features correctly interpreted as seabed depression resulted from excavation activities performed for removing Leonardo Da Vinci wreck from sinking position, while, rectangular feature clearly correlated to planned position for righting dredged basin. Other seabed features not connected to Leonardo da Vinci event were finally interpreted as dredging channel to Arsenal wreck final destination.

Finally, old naval disaster remains as hidden footprint below Mar Piccolo waters now revealed confirming story of life and death not to be canceled from memories.

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Remarking Warscape Archaeology: Fresh News from the Not-Quiet Central-Alpine Front

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Keywords: First World War, 3D modelling, DEM analysis, Formation Processes, Northern Italian Front

Since the end of the Great War, the material remains of the conflict have undergone a progressive destruction, first as a source of metals for resale and later as collector items. After almost three decades, Conflict Archaeology continues to play a leading role in the study of modern conflicts and in the preservation of war landscapes (Warscapes), often employing innovative technical approaches.

With this contribution, we aim to underline the significance of Conflict Archeology in the study of the Frist World War and to present an updated review of the methods and approaches used for this purpose from a theoretical and practical perspective. The use of the most recent archaeological methods combined with cutting-edge techniques derived from the fields of geography, geology, computer sciences and physical anthropology is contributing to renew the discipline by focusing on issues sometimes neglected by the historical chronicles, but crucial for the evolution and transformation of the society and the landscape as we know them today. Landscape itself, in fact, retains traces of natural and man-made changes caused by the conflict as well as of the depositional and post-depositional events underlying the formation of the archaeological record. The incompleteness of the archaeological record is strictly entangled with the study of the formation processes, as the short chronological gap allows us to analyze the archaeological structures in a phase of incipient formation (mainly affected by natural processes) or primary obliteration (mainly related to anthropic processes).

From a methodological point of view, the contribution intends to analyze (and to show with practical examples) different approaches for the study of warscapes, starting from totally non-invasive methods such as remote sensing, 3D modeling and (semi)automatic recognition, to targeted field, geophysical and aerial (UAV) surveys, to verify the reliability of the remotely sensed investigations and the preservation of the structures. We will also present the use of micro-invasive methods, such as half-sections and analysis of exposed stratigraphic windows, to identify the causes that determined the highly heterogenous preservation degree of the archaeological record during the pre- sin- and post-depositional processes.

Landform inventory and classification on the battlefield of Verdun (France) using high resolution DTM

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Keywords: LiDAR, conflict-induced landforms, WWI battlefields, landform inventory, morphometric classification.

In 2013, an airborne LiDAR mission conducted over the Verdun battlefield has brought to light landforms from the First World War. Concealed by a large forest cover of 10,000 ha, these landforms, called polemoforms (Amat, 1987), have a significant archaeological value because they constitute artefacts from the past. They should be inventoried to improve their conservation for the sustainable management of the forest. However, at the scale of the entire site, this work is only possible if an automated mapping method is developed (De Matos-Machado, 2018). To achieve this, the methodology used is threefold: (i) It consists in extracting landforms from the digital terrain model by means of a semi-automatic algorithm; (ii) Landforms geometry is studied using a combined approach of multivariate analyses, which allows to classify similar polemoforms; (iii) Classes interpretation is carried out on the field site and supplemented by historical documents collected in ten French and German archives centers. The resulting map reveals the presence of a huge number of remaining polemoforms, approximately 600,000, in addition to more than 400 km of fire and communication trenches (De Matos-Machado, 2018, De Matos-Machado et al., 2019). Their morphological signature is rich and due to the different ways of building facilities. Their location is determined by clearly defined spatial patterns such as distance to the frontline and pre-war landscapes parameters (De Matos-Machado et al., 2019). Beyond the reproducible nature of the method, which may contribute to the fundamental research development on other battlefields, this research provides operational tools for management and conservation of the historical, cultural and natural heritage of the Verdun forest. As a result, the produced iconographic and cartographic corpus will be directly used in the next forest management plan, in order to optimize the safeguarding of polemoforms and associated remnants.

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A new automated method to map large-scale battlefields using high resolution DTM

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Keywords: LiDAR, conflict-induced landforms, automated inventory, large-scale battlefields, reproducible method.

In 2013, the use of LiDAR imagery on the Verdun battlefield greatly extended our knowledge of the Verdun battlefield (De Matos-Machado, 2018). By using the canopy penetrating capabilities of near-infrared light to see through the vegetative forest cover, an exhaustive method of mapping surviving shell craters and war remnants has been performed. At least 600,000 shell craters have been mapped over 100 km2 of battlefield, revealing the 'craterized' aspect of the Verdun forest. Furthermore, approximately 18,000 soldier-made landforms have been detected including shelters and gun positions. Because the proposed method is readily useable by geographers (image processing and mapping using GIS), it can be reproduced on other battlefields and other types of landforms. Comparisons with other battlefields (Stichelbaut, 2011; Gheyle et al., 2018) highlight the interest of such an initiative by revealing the existence of similarities between polemoforms issued from different battlefields (not only WWI). The extrapolation and adjustment of our methodology to other conflict landscapes is therefore possible taking into account the availability of LiDAR data or other kinds of topographical datasets. This is even more likely feasible since dozens of European conflict landscapes are now covered with high-resolution DTMs (e.g. Normandy, Argonne and Champagne forests in France, Ypres Salient and Ardennes forests in Belgium, Finnish Lapland). In order to allow optimal use of the proposed method, two conditions must be fulfilled: (i) DTM must be detailed enough to accurately visualize landform contour geometry; and (ii) the studied landforms must have a well-defined morphometric signature. The conservation state of the landforms is thus an important factor.

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The 10th Mountain Division at Camp Hale, Colorado: The Origin of Mountain Alpine Warfare Testing and Training in the U.S.

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Keywords: Mountain Alpine training, 10th Mountain Division (U.S.), Camp Hale, Colorado.

This paper examines the origins, geography and legacy of how and where the U.S. Army established Camp Hale, located in the Colorado Rocky Mountains, from 1942-44 and the inception of the 10th Mountain Division. The construction of Camp Hale was an engineering feat and the site represents an important geo-military cultural heritage for the Army and the State of Colorado.

In selecting a site for its mountain/alpine training U.S. Army planners identified several critical criteria for the site. The selection of Camp Hale at 9,000 feet elevation near Leadville, Colorado met all of these criteria. Once the appropriate site was identified a massive, federally funded construction effort began in June 1942 with over 40,000 construction workers descending upon this mountain valley to construct a military camp. This large scale project was completed in one year. A full military city was constructed complete with all of the facilities typical of a permanent encampment. In July 1943 the 10th Light Division – Alpine was designated at Camp Hale. At Camp Hale, the U.S. Army conducted rigorous training, including military skiing, mountaineering, altitude training, and the use of pack mules and weasels (sled cargos). Over 16,000 soldiers and their animal companions trained at Camp Hale between the years of 1942-43. Officials of the National Ski Association and the American Alpine Club recruited a number of civilians skilled in ski and mountaineering techniques to join the ranks.

Ironically, in June 1944, only a year after its arrival at Camp Hale, the 10th Mountain Division was moved to Camp Swift, Texas for flat land training as part of the so-called “Louisiana Maneuvers” in anticipation of combat in the European Theater. Only six months later the Division was converted to a standard U.S. Infantry Division and deployed to the Italian Campaign Theater where it fought gallantly in the assault up the Italian peninsula, to include difficult fighting in the Italian mountains.

After the War, several 10th Mountain Division veterans returned to the Rockies and created and designed Colorado’s major ski areas including Vail and Aspen. In 1986, the U.S. Army Corps of Engineers razed the entire Camp Hale cantonment area. Remaining today are only a few foundations and remnants of the rifle range. The site was designated a National Historic Site by the National Park Service in September 1992. The Camp Hale site and its close relationship to the 10th Mountain Division have been aptly memorialized at the original location. The lands are open to the public and there are numerous plaques detailing the history of the site and the training conducted there. About seven miles south of the Camp Hale site, at Tennessee Pass (10,424 feet elevation), a memorial has been established in honor of the 992 fallen heroes and the over 4,000 wounded veterans of the 10th Mountain Division. The memorial was dedicated on Memorial Day of 1959 and each Memorial Day a service is held there.

Fortress Wijtschate: geological controls on the German 1914-1917 frontline in Flanders, as revealed by archaeology

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Keywords: First World War, Western Front, Mesen-Wijtschate, trenches, military geology.

The Battle of Messines (Wytschaete Bogen) of June 1917 is hailed as a triumph of military engineering, with the simultaneous explosion of some 19 mines (though 24 were laid) and an effective barrage leading to the Allied destruction of the German frontline positions. This story is well known and rightly celebrated; but less well understood and often overshadowed by this success is the story of the effectiveness of the German fortress positions. These were first constructed in late 1914 to maintain the strategic aims of standing on the defensive in the west while the Russians were pressed in the east – and which were highly effective, even in the face of continuous Allied bombardment This paper seeks to redress this unbalance in our understanding, drawing on archaeological evidence and archival resources to present a clearer picture of the nature of the German positions. Over the last ten years, two major archaeological investigations have been carried on the Mesen–Wijtschate (Messines-Wytschaete) ridge that have revealed the complexity of a German fortress that was composed of trench lines that contoured the ridge top and which had the two ridge-top villages and other features built into its frontline. This was a fortress that was to hold the Allies at bay, from the capture of the ridge top in 1914, through to the loss of the fortress in the aftermath of the 1917 battle – only to be regained in spring 1918. The complexity of its construction is manifest in the nature of the fieldworks exposed in archaeological investigations. At Mesen, German defenders were challenged by poor drainage and waterlogged conditions of the Eocene sediments that caused the lines to suffer – conditions that were exposed in the large infrastructure development of 2013, with trenches, dugouts and tunnels evident. At Wijtschate, at the ridge-top fortress of Höhe 80 – subject to a detailed excavation in the Summer of 2018 – was better served with mostly free-draining Quaternary sands that nevertheless presented difficulties to trench digging due to iron-pan development. Here the complexity of the trenches and the use of building remnants was much in evidence. Both examples show how maintaining frontline positions in good condition, capable of maintaining the strategic capabilities, were nevertheless subject to the vagaries of stratigraphy and topographic position, requiring much engineering skill.

Disputed Earth: geology and trench warfare 1914-1918

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Keywords: First World War, trenches, Western Front, military geology.

The First World War has become known as the 'war of the trenches' as the Allies in the west (and on other fronts) faced their adversaries in extended siege across Europe. This was a war that descended from the open battles of Autumn 1914 to the closed siege warfare of the winter of the same year. As siege tactics developed, the war quickly became one of position; all too often a war in which the trench warfare of the military engineers became challenged by the 'siege breaking capabilities' of the artillery (Doyle, 2017). Between them, in a technological 'no man's land', were the infantry who faced taking the opposing trenches by direct assault. But where the specialists ready for the nature of this war? This poster poses the question 'Did terrain influence trench war relative to expectations?'. Examining archive resources (military manuals, documents, reports, etc), this position is judged relative to recent archaeological findings in the Ypres Salient, Belgium. What emerges is a clear indication that trench warfare evolved and adapted to meet challenging ground conditions from 1915 to 1918.

Doyle P. (2017) - Disputed Earth: Geology and Trench Warfare on the Western Front, 1914-1918. Uniform Press, London, 285pp.

The demarcation of the Czechoslovak border in the period 1918-1924

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Keywords: border demarcation, Czechoslovak border, Vaclav Roubik, Czech National Archive.

Whole Europe has undergone two bloody conflicts in the last century. Both conflicts evoked the subsequent changes in the political and geographic arrangement in Europe. There was a collapse of the Austria-Hungarian Monarchy in Central Europe after the end of World War. New successor states engendered and their basic aim was the definition of their own territory. On the political level within the Saint-Germain peace treaty, on the basis of "historical" borders and on geographical level their real demarcation in the field. Leaving aside the political discrepancies in determining of the new borders of the Czechoslovak State (Vitogradsko, Kłodzko) and a short war on the Czech-Polish border in the area of Těšín/Ciezyn (in January 1919) establishing of new boundaries in terrain was technically and organizationally a really challenging task.

So called "Paris Conference of Ambassadors" was created, whose main task was the definition of new the state border in terrain and solving minor territorial disputes. At the same time the Paris Conference of Ambassadors was the superior body to the Delimitations Commissions that staking-out the boundary line in the field and built up border stones.(Smida, 2016) For precise measuring over the borders the historical materials were used and of course all documents of field work were handled in the border report that became the basis documents for the later maintenance of the border maintenance (Instrukce,1938). These materials are part of "Vaclav Roubik s Archive" kept in the Czech National Archive. This archive pool consists of different government documents, plans and map sheets, demarcated sections, original hand written map sheets to the disputed Těšín/Ciezyn region with the calculations of polygonal points of individual border stones, surveyors walking logs on the Czech-Saxony border and many other historical materials.

The aim of the paper is to present extensive documentary materials from the building of the Czechoslovak border in the period 1918-1924 that are a testament to the technical and professional prowess of Czech surveyors.

Václav Roubík (1872-1948) was an Austro-Hungarian and Czechoslovakian state official, politician and after 1919 he was the Minister of public works. In 1920 he was a member of the International Commission for demarcation of Czech State Borders with Germany, Austria and Hungary (Encyklopedie Brna, 2012).

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Defending Britain's Soft Underbelly: Invasion, Fortification and Geology along the English Channel

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Keywords: coastal defence, English Channel, 16th century forts, 19th century forts.

The Henrician castles (1539-1545) and Palmerston forts (1853-1874) along the English Channel owe their origins to Pleistocene megafloods that formed the Channel and drowned the river valleys feeding into the pre-Pleistocene Channel River. Because most of the Channel coast consists of cliffs, only these deep-water estuaries could be used for invasions from the Continent so forts were built to protect them. The most important area along the Channel coast was Portsmouth Harbour in Hampshire, the site of the oldest and one of the largest dockyards in England. The Hampshire coast is protected by the Isle of Wight to the south, with the deep-water Solent between the two allowing restricted access to Portsmouth Harbour. The coastline here is composed of spits, beaches, lagoons, marshes and islands. The bedrock is primarily Eocene sands and clays that form a series of terraces caused by fluctuating sea levels during the Pleistocene. Cretaceous Chalk forming an anticline is present behind and above this coastal area. This paper addresses four forts built as a result of invasion threats during the reign of Henry VIII and in the mid-Victorian period, the first periods in which coastal defence structures were planned and built on a national scale. The Henrician forts are located on shingle spits and beaches along the Solent and the Palmerston forts, on the high ground west and north of Portsmouth Harbour. Two forts from each period will be described. Hurst Castle is located at the west end of the Solent, protecting the Needles Passage and Southsea Castle is located at the east end guarding the Spithead Anchorage. Fort Brockhurst is one of a line of five forts on a north-south axis across the harbor from Portsmouth on high ground, and Fort Widley, also part of a line of five forts, but extending east-west, is 8 km behind the city above the steeply dipping south flank of the anticline. The Henrician forts are low, stone-built structures constructed primarily for coastal defence, and the Palmerston forts were built of brick and soil to defend against land attack. These differences reflect in large degree the fast-developing advances in artillery technology and naval tactics that began in the 1840s. The armament mounted in both types of forts was upgraded over time to address reoccurring threats of invasion but by the mid-20th century the Henrician forts, having been used primarily for accommodation since the early 1900s, were decommissioned. Some of the Palmerston forts live on and have been retained in military ownership into the current century, but not as artillery forts.

The White War in the Italian Alps: a geophysical approach

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Keywords: Geophysics, WW1, Marmolada glacier, war tunnels.

The world wars have affected large parts of the Italian territory, inducing profound transformations in the landscape. The overdeveloped road network had a re-employment in civil life, while defensive works and military structures were largely dismantled immediately after the war. Some remains of the war have been preserved in the subsoil up to the present day due to burial phenomena, both of natural and human origin.

The recent phase of withdrawal of the alpine glaciers has been characterized by a marked reduction of the thickness, even at the higher elevations, where the bedrock is progressively outcropping, bringing to light trenches and military facilities of the so called "White War"

Historical research in the field can now take great advantage from the use of geophysical methods that allow the identification and rediscovery of buried structures. There are several methods that can be used: georadar, electromagnetic, geoelectric and seismic. They have found application both in plain and mountain contexts, including glaciers. Some exemplary case studies are presented.

At Punta Linke, in the Ortles Cevedale Group, some high-resolution geophysical surveys have been performed through a GPR, working with 500 MHz and 200 MHz antennas. The GPR data allowed the reconstruction of the bedrock, recognizing the thickness of the glacier and its internal structure.

Moreover, in correspondence with the glaciated saddle between the Punta Linke site and the Mount Vioz, a glacial tunnel has been detected.

Mt. Marmolada is the highest relief of the Dolomites, hosting a large glacier on the northern slope. During the First World War, the summit of Mt. Marmolada was the site of fighting in the years 1916 and 1917. Here, Austro-Hingarian troops opened underground passages inside the glacier allowing the soldiers to carry supplies to advanced positions without being exposed to enemy fire. Quickly, several large shelters and 12 km of tunnels were excavated giving rise to the Eisstadt (Ice City). Magnetic, geoelectric and GPR surveys were performed in order to detect the last remains of WW1.

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Italian military memorials architectural review – conservative restoration and territorial promotion

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Keywords: architecture, Fallen, memorials, restoration.

Italian Ministry of Defense Commissariato Generale per le Onoranze ai Caduti, the military highest authority for honoring the Fallen, founded in 1919, is the repository of the collective memory of all war tragic events that marked Italian recent history. It currently promotes and manages the Military Memorials architectural heritage, either in Italy or abroad, and honors all the Fallen that sacrificed their lives for the unity and freedom of our Country.

The essay describes, within the First World War reconstruction activities and the proliferation of war monuments (dedicated to victory, to the fallen, etc.), the architecture of the main Italian military Memorials built during the Twenties and the Thirties.

The monumental ossuaries share with the above-mentioned proliferation the impelling need to turn an anonymous and mass death into a "good death" under the supervision of an ideological orientation that was long far away from repudiating war. However, they also have their own technical specifications and purposes. First of all because they respond to a more "functional" requirement: to provide a definitive resting place to the enormous quantity of human remains which the bloodbath left in temporary graves.

The process that drove to their construction is as particular as the results they achieved. During the Twenties and the Thirties Fascism exalts the war heroic death.

The buildings, in addition to already existing religious constructions used as ossuaries, refer to two separate architectural frameworks. In the first group, the ossuary is usually a case, landscape dominating, that contains the Fallen rests within a crypt like space. In the second group, on the contrary, the Fallen battle formation generates itself the Site architecture, that is walkable alone "en plein air" and, generally, gently fits into the landscape. Masters of this second season are Giovanni Greppi (architect) and Giannino Castiglioni (sculptor).

The essay presents, in the second part, the Redipuglia Military Memorial as a case study of territorial promotion and conservative restoration. In details, the restoration aims to protect the three main surface materials - stone, concrete and bronze - and to give them back their original look modified by nature and time as years went by.

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Seasonal Impacts on Maneuver in Highly Organic and Gravelly Soils

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Keywords: Seasonal, Mobility, Soil.

Renewed interest in northern regions as a result of global warming effects and recent Russian military activities has highlighted our lack of preparedness for moving across these terrains on all but prepared surfaces. The unique climate and past geomorphological history have resulted in terrain features and soil types not commonly found elsewhere. Of particular interest to this study are the large extent of peat and gravelly soils. Historically, gravelly soils are assumed to be able to support any vehicle at any time while peat soils are assumed to be too weak except when frozen to a significant depth. In this paper I will first discuss challenges involved in interpreting in-country, regional, and global soil data for engineering practices. This will be followed by seasonal impacts on soil strength. I will end by discussing how off-road mobility is affected by these seasonal impacts including the presence of snow using Scandinavia and the Baltic states as an example.

Visualizing the Impacts of Topography: A Geographic Perspective of the Battle of Marathon

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Keywords: military geography, battlefield visualization, Marathon.

In 490 BC Miltiades and his army of hoplites routed Datis's numerically superior Persian invasion force. While Herodotus's earliest account of the battle is relatively bereft of tactical detail, scholars have nevertheless offered an enormous body of speculative literature on the subject. Seeking a fresh view of Marathon, this paper views the battle primarily through the lens of geography. Employing a GIS-aided visualization of the battle environment, we examine the key geographic factors which impacted the tactical decisions made by Miltiades and Datis on the plain of Marathon.

This paper argues that Miltiades, in elongating his phalanx formation, stretched the Greek front lines from the sea to the mountains, leaving no maneuver space for the Persian cavalry along the Greek flanks. Additionally, the Greek camp was positioned higher on the coastal plain, making Miltiades' famous running approach to contact with the Persians a downslope maneuver. This effectively closed the gap between the Greeks and Persians more rapidly, diminishing the effects of the Persian archers.

We conclude that the topographic features of the battlefield afforded the Athenians the geographic advantage which effectively neutralized the two greatest strengths of the Persian army - its cavalry and its archers - despite the fact that the Persians chose the Marathon plain specifically for its suitability for cavalry operations.

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Borders, Boundaries, and Governance: A Geospatial Analysis of Trends in Maritime Piracy, the Security Implications of Crime on the High Seas

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Keywords: piracy, governance, military geography, borders, maritime chokepoints.

It is often said that piracy is the maritime ripple effect of anarchy on the land. Maritime piracy is broadly defined as armed robbery against ships to include acts of violence or detention on the high seas or within territorial waters. The realities of maritime geography and governance have fostered crime and violence on the world's oceans and this paper examines piracy from a geospatial perspective. Events in sea lanes adjacent to Somalia brought piracy sharply into focus when Somali pirates introduced a new, more violent business model; that is, the seizure of ships and crew for ransom. By 2011 Somali piracy reached its zenith, and since that time, Somali pirates have been repressed and globally, the number of attacks have stabilized.

However, pirate attacks persist in places where it has been historically endemic. More importantly, contemporary data indicates that, notwithstanding a general decline in pirate attacks, the violent seizure of crew for ransom has increased dramatically, especially in places where it was not formerly a problem—pirates in many other places have now adopted the Somali 'business' model. Thus, despite the reduction in pirate attacks, the financial cost of piracy and its effects on the global economy have moved it to the top of the global security agenda. The threat to commerce cannot be understated because some 80 to 90 percent of global trade moves by sea, and nearly every aspect of daily life is influenced by goods and services provided by maritime trade. This paper uses a geospatial perspective to analyze contemporary pirate attacks, which are highly spatially concentrated in four regions. The spatial pattern of contemporary pirate attacks are enabled by three key factors: governance, contested borders and boundaries, and adjacency to maritime chokepoints. Finally, the data suggest that new pirate hot spots are emerging on the security landscape in places with failing governments. This paper will present Venezuela as a case study of this trend.

Outline of geology of battlefields of the Italian Campaign: the Mountain Warfare from the Gustav (Lazio-Abruzzo) to the Gothic Line (Toscana-Emilia Romagna)

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Keywords: Italian Campaign; Gustav Line; Gothic Line; Mountain Warfare; battlefield.

In recent decades, the study of battlefields has greatly expanded from the point of view of the implications of the terrain on military strategy and tactics (Underwood and Guth, 1998; Rose and Nathanail, 2000; Ehlen and Harmon, 2001). The aim of this work is to illustrate how the geology of the battlefields have influenced the outcome of the war events along the Gustav and Gothic Lines (WWII Italian Campaign, 1943-1945). The Central Appennines are composed by Meso-Cenozoic carbonate stratigraphic sequences, sorrounded by mainly clayey-sandy hilly foothills. The different lithologies played an important role for military strategy (Narebski, 2011). The defense lines were located in the narrowest points (*isthmuses*) of the Central Apennine. The Gustav line, from Garigliano river mouth in Lazio country (Tyrrhenian Sea), to Ortona in Abruzzo (Adriatic Sea), and the Gothic Line, from La Spezia (Tyrrhenian Sea) to Pesaro (Adriatic Sea) are the emblem of how a deep knowledge of natural element can be a multiplier of forces for an army (Chasseaud and Doyle, 2005). The German strategy to choose the mountainous carbonate massifs for their defense lines, using the available lithoid material, managed to slow down the progress of the allies, forced to operate on landslides and easily erodible hilly area (slopes> 30 °, alternation of gorges and ditches), aided by the harsh climate and hydrography, with rivers that served as natural trenches. From the allied point of view, the inaccurate perception of the geographical environment in front of which their own men found themselves operating is evident (Cori, 1994). The territory close to the Maiella Massif, trapped between the high and impervious mountain, controlled by the Germans, and the adjacent hilly belt, sometimes under the Allied control, will be indicated in the war maps as "No man's land" (Forman, 1991). In such a complex geological context, it was fundamental for the allies to collaborate with local rebel groups, as happened in Abruzzo with the Maiella Brigade (Patricelli, 2013). The Maiella highlanders later fought alongside the 2nd Polish Army Corps (Narebski, 2011), mainly in the inner part of the battlefields of the Adriatic countryside, between the Apennines and the coast line, characterized by a flyschoid clayey-marly soil. Notable were the difficulties they faced, due to the landslides and strong erosion of soil.

After seventy-five years, a first comprehensive geological reading of the Italian battlefield has brought new research cues, underlining the importance of territorial planning and prevention (*A mountain to win*, Conference OGR Abruzzo, Ortona, 2015; *The impact of the terrain on military operations*, Seminar by R. Deere, Chieti University, 2017).

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Optimizing the display of lidar topography to enhance terrain analysis

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Keywords: lidar, digital topography, terrain analysis.

The proliferation of lidar data provides very high resolution topography with unparalleled capability to show both elevations and categories of land cover. While the huge data volumes initially appear daunting, users interested in detail at the meter scale usually will be walking and have small areas of interest. Lidar data covering such areas of operation can easily be stored and manipulated on a modern cell phone without a network connection. The easiest displays to interpret in the field grid the original lidar point clouds, and display the topography in hillshade onscreen; they are most useful in regions with a mix of vegetation, man-made features, and open areas. The maps can include partially transparent color layers from co-registered aerial imagery, the classification of the lidar point clouds, vegetation canopy height, or calculated parameters like slope or aspect. These displays can simplify the view compared to imagery, and require less training or mental effort from the user who could be constrained for time. Imminent changes in these capabilities will include: more free lidar available online to augment the already impressive volume of data for much of western Europe and the United States; improved automatic classification of the lidar scene using machine learning; virtual reality to combine the view from the cellphone camera with the lidar depiction; drone surveys to rapidly update topography and man-made features after change from military operations, natural disasters, or urbanization; and miniature displays directly in front of the user's eyes. Structure from motion (SfM) can produce 3D terrain models, but the photography rarely penetrates foliage and thus provides only the top elevations, in contrast to full 3D structure within and below the canopy available with lidar. These capabilities have obvious appeal for military users, but many other scientific and professional users will also benefit, and the technology will also serve recreational users for hiking or orienteering.

Evaluation of Military Vehicle Mobility through UAS Photogrammetry and Digital Terrain Modeling

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Keywords: UAS, photogrammetry, terrain modeling, GIS.

New techniques utilizing high-resolution point-cloud data created with photogrammetry from UAS (Unmanned Aircraft Systems) imagery has broad applications towards modeling and evaluation of terrain elements critical to military vehicle mobility. The existing metrics commonly used to evaluate and quantify terrain for military vehicle mobility operations are surface roughness and grade, derived from elevation data collected with laser-based measuring systems on either plane or vehicle. These existing techniques were applied to modeled UAS imagery derived datasets representing previous or natural conditions prior to any anthropogenic alteration (e.g. constant vehicle use). Military operations on cross-country roads generally cause a decrease in roughness and grade, as well as dig into the soil through time. This poses problems for off-road operations caused by repeated use for vehicle testing of durability and mobility. The UAS-modeled road surface produced through this technique can accurately model the previous topography prior to any military operations and provide an estimate of grade and roughness for previous unaltered surfaces. Techniques utilizing UAS imagery and photogrammetry allow for direct comparison and quantification of change in cross-country roads caused from extreme use, and provide a better assessment for the role of terrain in military vehicle mobility and testing requirements.

Photogrammetry uses the geometry of overlapping images to build a 3D point-cloud model of terrain with a very high point density. Survey-grade ground control points are used in this model to georeference the point-cloud into a commonly used coordinate system, where further GIS analysis can be performed. These point-cloud datasets cover large areas, with orthoimagery maintaining a nominal ground pixel size of approximately 1 cm (0.39 in), and digital elevation models (DEMs) with 5 cm (2 in) resolution, while maintaining that approximately 99.4 % of the cells in the DEM have 3 or more points used to estimate elevation values. Datasets created through this technique have approximately 2250 points per square meter, a significantly higher point spacing than conventional Light Detection and Ranging (LiDAR) data. The additional data resolution allows for use of different resampling and modeling techniques, so this data can be analyzed with the same techniques as data collected through other laser-based instruments. These laser-based systems are limited by either area or resolution; UAS imagery can be collected over almost any area and at a very high-resolution from an off-the-shelf UAS and can be processed to be compatible with the same metrics currently used by engineers for evaluating trafficability and mobility conditions. With these high-resolution datasets made possible with UAS photogrammetry, evaluation of digital terrain at an unprecedented scale was conducted and temporal terrain elements that can affect vehicle mobility were assessed.

Examples of German Trafficability Maps from the Eastern Front in Europe 1941-45

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Keywords: World War II, military geology, trafficability, Forschungsstaffel z.b.V.

Examples of German off-road trafficability maps are presented that were designed at various scales by both military geology teams ("Wehrgeologenstellen") of the Army High Command ("Oberkommando des Heeres") and the "Forschungsstaffel z.b.V.", a staff for special terrain evaluation duties of the Supreme Command of the Armed Forces ("Oberkommando der Wehrmacht"). Archive documents exemplify that during the Second World War at least 130 German and Austrian military geologists were deployed to the eastern front. They supported fortress engineers as well as higher engineer officers of three army groups, seven armies and four armoured armies, respectively. Several thousands of military geologic reports generated by about 23 military geology teams give an insight into terrain evaluation of the attacking and retreating German armies of the Army Groups North, Center and South.

The military geology teams dealt with a wide range of geotechnical problems: water supply, earthworks, provision of construction material for roads and railways as well as the assessment of off-road trafficability for both tracked and wheeled vehicles. Examples of tank trafficability maps designed during Operation Barbarossa, the Axis invasion of the Soviet Union in 1941, highlight terrain evaluation for operations of German army staffs at regional scales 1:300.000 and 1:200.000 (Häusler, 1995, 2018). More detailed trafficability maps were designed at scales 1:100.000 and 1:50.000, based on the geomorphologic interpretation of Russian topographic maps, of soil maps, aerial photos and local reconnaissance. Russian engineer instructions on passing over moors and frozen rivers in addition to statistical data of the Minsk Climate Institute on thawing and flood periods of rivers allowed for a detailed prognosis of the off-road trafficability. Even during the retreat of the German Panzer armies in 1944 in Poland, military geology teams still investigated off-road mobility and tested the passability of antitank trenches blasted into various soils for both Russian T-34 and German "Panther" tanks.

Timely paralleling the deployment of these military geology teams, the "Forschungsstaffel z.b.V." developed new methods for integrated terrain analysis. Based on a combination of plant sociologic interpretation of aerial photos, reconnaissance flights and local expeditions, maps of, e.g., the Konka-depression south of Zaporozhe 1:50.000 or of the Pripet Region 1:300.000 were printed.

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German Military Specialist Maps of the North Italian Theatre of War 1945

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Keywords: World War II, military geology, maps for terrain evaluation, Forschungsstaffel z.b.V.

Timely paralleling the northward retreat of German Army Group C along defence lines crossing the Apennines, special military geoscientific maps of coastal regions of the Adriatic Sea were developed by the "Forschungsstaffel z.b.V.", the staff for special use of the Supreme Command of the German Armed Forces ("Oberkommando der Wehrmacht"). The geoscientific staff of its Southern Command consisted of 25 specialists, two plant sociologists, two (up to three) geologists, two interpreters of aerial stereo photos, one hydrologist, one geodesist, one specialist for mountain roads, one map specialist, one tank specialist, ten cartographers, two specialists for Slavic languages and one copyist. The maps for terrain evaluation ("Truppenkarte der Geländebeurteilung") were designed at a scale of 1:100.000 such as sheets 51 Venezia and 65 Adria, both printed in March 1945. In addition, sheet 40 Palmanova was printed as "Panzerkarte" in February 1945. The newly developed method of terrain classification for this tank map is described below.

For "Panzerkarte Palmanova" the geographic information of German, Italian and Slovenian civil offices was compiled and merged with the results from terrain reconnaissance, and of the geoscientific interpretation of aerial stereo photo pairs which covered the whole sheet. Areal information comprised off-road trafficability, dense irrigation or melioration nets and forests. Linear information enhanced slopes and dams and at certain points material and safe strength of bridges was marked. As a result, off-road trafficability comprised of three classes. It was assessed as good ("befahrbar") where only a thin loam layer covered coarse fluvial deposits, and as bad ("unbefahrbar") where wet coastal mud even caused walking problems. Poor trafficability ("bedingt oder zweifelhaft befahrbar") was further subdivided into three numbers (1 to 3). Number 1 characterised coastal areas covered by thick layers of clay that caused trafficability problems during wet periods from October to April. Number 2 delineated the wet area between villages Cervignano and Codroipo that was covered by bogged soil. Number 3 comprised coarse clastic fluvial beds that were intensively flooded from October to April, but less in January. In addition, the two-dimensional signature for deciduous forests and coniferous forests were differentiated as brushwood or timber forest. The "Truppenkarte zur Geländebeurteilung" comprised a table with remarks for the military use. Special signatures for airborne landing became visible when the map was held against light. In summing up, the specialist maps themselves were not designed as terrain evaluation maps for specific purposes, but as integrated geoscientific maps that had to be evaluated by the military user.

War Geology of the Imperial and Royal Army at the Isonzo-Front 1918

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Keywords: World War I, military geology, Isonzo-Front.

From June 1915 to November 1917, the armies of the Austro-Hungarian Empire and the Italian Kingdom fought a series of twelve battles along the Isonzo (Soća) River which at that time ran entirely inside Austria-Hungary, flowing from the Julian Alps to the Adriatic Sea.

Though since 6 November 1916 the German War Geodetic Survey comprised of war geologists, before 1918 a comparable deployment of military geologists in the Austro-Hungarian army was missing. Not until February 1918 the High Command of the Imperial and Royal ("k.u.k.") Army installed a section of War Geology ("Referat für Kriegsgeologie") in the Command of the War Geodetic Survey ("Kommando des k.u.k. Kriegsvermessungswesens"). Only one month later, on 17 March 1918, Captain Dr. Leo Tschermak called-up the first course for war geologists in Vienna. Since then about 60 war geologists were organised within geology groups ("Geologengruppen") and deployed to in total six commands of the War Geodetic Survey serving the troops of the Danube Monarchy.

It was the Austrian geologist and geomorphologist, first lieutenant Dr. Artur Winkler von Hermaden, who, at the south-western front, headed the "Geologengruppe Isonzo" of the "k.u.k. Kriegsvermessung 5" (Häusler, 2013). On 23 March 1918 he proposed military geologic mapping of the Austro-Italian border region at a scale of 1:25.000, investigating all natural karst caves, yield of springs, wells and cisterns as a base for a water supply map, the use of available construction material and the use of local hydro power for operating drilling machines. Furthermore, he emphasized the importance of geologic expertise for road- and railway constructions and the design of geologic profiles of all tunnels and caverns. The deployment of his group, then consisting of six younger geologists, is documented in the Austrian War Archive in Vienna. From April to November 1918 "Geologengruppe Isonzo" worked along the southern Isonzo Valley between Flitsch and Tolmein in the north and Monfalcone near the Adriatic Coast in the south. From April to May 1918 the war geologists were commanded to St. Luzia and Tolmein, north of Görz (Gorizia). From June to July 1918 they investigated the Kolowrat Plateau south and in August 1918 the Krn Mountain north of the Isonzo, and in October 1918 the Doberdo Plateau southwest of Görz. On 3 November 1918, the Armistice of Villa Giusti outside Padua in the Veneto ended warfare between Italy and Austria-Hungary on the Italian Front. However, further activities of the "Geologengruppe Isonzo" are documented until 6 December 1918.

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Importance of Remote Sensing as part of the Military Geography curriculum at the South African Military Academy

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Keywords: SA Military Academy, Remote Sensing, ERDAS IMAGINE.

The SA Military Academy (SAMA) houses the Faculty of Military Science of Stellenbosch University since January 1961, with the purpose to develop future military leaders of South Africa. Various undergraduate and postgraduate programmes, which are fully accredited by the Council for Higher Education, are offered by this Faculty. These programmes consist of a wide range of academic modules (Military Science, 2013). This paper investigates the importance of Remote Sensing (RS) as one of six modules of the undergraduate curriculum of Military Geography presented at the SAMA.

Remote Sensing provides a synoptic bird's eye view of physical phenomena on the Earth's surface. It is a technique of acquiring information about objects without having to physically visit an area of interest (Avery & Berlin, 1992). The importance of RS for the military dates back to 1859 when the photographic camera was used to obtain balloon photographs. But, it was World War I and World War II in particular that introduced scientific uses of RS (Campbell & Wynee, 2011).

In the military, RS provides information of a military force's equipment, infrastructure, movement, activities, and offers significant potential ability to predict military operational intent. Its importance as a strategic force multiplier is recognized by militaries around the globe. The theory of RS as well as the practical applications thereof, using a dedicated image processing software (e.g. ERDAS IMAGINE, ENVI and PCI Geomatics) are equally important. Understanding both theory and practical application of RS will greatly benefit any military operator who produces geospatial products in support of military operations.

Consequently, this paper asserts that the curriculum of RS for military students should gain prominence and recognition among military academic professionals. The structure and contents of this curriculum should emphases the importance of RS by considering relevant theory and practical application, specifically military application through dedicated image processing software. Currently, the theoretical and practical components of the SAMA RS curriculum are well defined, but more emphasis is placed on the theory than on the practical application of RS. In addition, practicals lack military application per se, and dedicated image processing software to conduct military-specific practicals does not exist in the institution.

This paper analyses the importance of the RS curriculum in Military Geography studies at the SAMA. It defines a practicum method of teaching military students both theory and practical applications of RS. An important contribution to this study is that it reviews the incorporation of the ERDAS IMAGINE image processing software in the existing curriculum.

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Suitability of the TanDEM-X 90 m DEM compared with the SRTM 30 m DEM on the calculation of a visibility analysis for military operations

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Keywords: visibility analysis, DEM, military operations, TanDEM-X 90 m, SRTM 30 m.

Visibility analysis, commonly known as viewshed, is a valuable function in any geographic information system (GIS) and is a critical tool used for many applications, including the military, for representing the overall visibility and surface characteristics of the terrain (Kim et al., 2004). The first step to perform a visibility analysis is selecting the digital elevation model (DEM). Selecting the best elevation data is dependent on the quality elements, namely: completeness and precision/resolution. The SRTM 30 m Void-Filled DEM (SRTM30) is a well-known global, free elevation dataset (Luedeling et al., 2007) and numerous analyses and research have been conducted to evaluate its terrain application capabilities, even in support of military operations. It is generally known that the better the elevation data, the better the viewshed result will be, hence the wide use of the SRTM 30 m elevation dataset. This statement beg the question: Will a low resolution DEM be able to produce an accurate and reliable viewshed analysis that is suitable to support military operations? A comparative viewshed analysis was conducted between the recently released and fairly unknown TanDEM-X 90 m DEM (TDM90) and the SRTM 30 m DEM to determine if the TDM90 is suitable to deliver accurate and reliable viewshed analysis results for military purposes. Three observer points were placed on strategic locations within the area of interest to calculate the viewshed analysis and determine if specific target areas (military bases) will be visible or not from these locations, using both the TDM90 and SRTM30 datasets. The visibility results and comparisons indicated that it is unavoidable that the accuracy of a visibility analysis is influenced by the quality of the elevation data source. However, it was interesting to note that all military bases were either visible or not visible from the observer point locations for both DEMs utilised. The knowledge gained from these tests can definitely be used by military commanders to influence decision-making regarding the type of elevation data source to use (depending on the type of military function required) when considering a visibility analysis in support of a military operation.

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Preliminary Assessment of Landform Soil Strength on Glaciated Terrain in New England

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Keywords: soil strength, geomorphology, glacial, mobility.

Accurate terrain characterization is important for predicting vehicle mobility in off road environments. One of the most significant terrain characteristics which affects vehicle mobility is soil strength. In-situ observations are spatially and temporally sparse, due to the laborious nature of collecting soil strength measurements. To resolve this issue, research efforts have focused on providing soil strength estimates through the use of remote sensing techniques. While these data can provide large spatial and temporal estimates, the results are frequently not accurate when validated with field observations. Prior researchers have attempted to quantify the soil properties of arid environments through the use of land-form assessments, however, many military operating environments are located in high latitude regions where landscapes are dominated by glacial deposits. This study focuses on providing preliminary strength measurements for glacial landforms that were deposited from the Laurentide Ice Sheet in New England. A range of common glacial landforms were identified and sampled to assess: shear strength, bearing capacity, and volumetric moisture content. The glacial outwash landforms had the highest average shear strengths, while the glacial deltas had the lowest. There was a significant negative correlation between silt content and shear strength of the soil. There was also a significant positive correlation between bearing capacity and clay content, while a significant negative correlation was observed with sand content. The moisture content of soils was inversely correlated to the abundance of gravel in the deposit. This work provides initial insight to this approach on glaciated terrain, but continued sampling will be of great importance to provide more robust correlations.

Modeling Overland Sediment Movement on the South Carolina Training Center from an Extreme Hazardous Rainfall Event

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Keywords: army training, change detection, LiDAR, modeling, hazard.

Preparation for national defense and war involves training with multiple scenarios and across broad landscape types. The United States armed forces includes the national guard armed forces within each state. The South Carolina National Guard conducts their infantry training at the McCrady National Guard Training Center located in the sand hills region near Columbia, SC. This training center is a 6,036 ha area occupying a rolling topography of small perennial and intermittent creeks overlain on one to two meters of sandy topsoil. With the exception of the military buildings and housing in the southeastern portion of the center all of the roads are composed of sandy soils. While the sand covered clay road environment is an ideal training environment for many recent military conflicts this environment presents a management challenge that can be sensitive to hydrologic events. A recent extreme rainfall event (the largest on record and is regarded as a 500-year event) in Columbia, SC occurred in a 24-hour period on October 4, 2015. A total of 55-cm of rainfall occurred in the Gill's Creek watershed during a 3-day period between October 3 and 4th. The McCrady National Guard Training Center experienced substantial damages to the sand-clay roads throughout. Heavy rains, overland flow, and stream flow caused substantial movements (sheet flows over 1-m in depth) of alluvium. Just prior to this large-scale rainfall the management staff had requested and received an airborne LiDAR dataset covering the center. This high accuracy dataset would aid in center management for assessing road stability, detecting historic activities, and mapping the network of channels and ditches. In the month after the October rainfall event a second high resolution airborne LiDAR data collection was performed. Using the two LiDAR datasets a change detection analysis was conducted to map sediment erosion and accumulation areas. The contributions of this research were in 1) the development of a change detection modeling approach for LiDAR data that incorporates the spatial variation in change/no-change thresholds, and 2) application of the LiDAR-based approach to the sediment movement in an extreme rainfall event. Field-based data (237 observations of no-change areas and 47 locations of verified change) was in the form of high precision/accuracy GNSS RTK data, total station surveyed data, manual boreholes of sediment depth, and field reconnaissance. The overall accuracy of the pre- and post-event LIDAR data of no-change land cover were 11-cm and 13-cm RMSE, respectively. By combining the independent error sources, a 20-cm change threshold was used to map changes across the McCrady Training Center. The results clearly demonstrate the large depositional features observed emanated from uphill erosional features that were largely from the sand roads and road scarps.

Early 1917 Aerial Photo Mosaics of the Isonzo Front: A Closer Study

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Keywords: Aerial Photo Mosaic, Isonzo, 1917.

Two Austro-Hungarian aerial photo mosaics from 26 February and 17 March 1917 show trenches, landform features, geomorphological constraints, and impact of military operations of the embattled Isonzo Front, extending from Tolmin, Slovenia to the Adriatic, a combined linear distance of some 47 km (National World War One Museum and Memorial 1 & 2 2018). These landforms include dolines utilized for defensive positions on the Carso/Kras limestone plateau while artillery craters with their light rim of ejecta, appear smaller and sometimes overlapping near Vrtojba, and plainly visible in the alluviums of the Vipava valley. The ruins of Kostanjevica and Adriawerke Chemical Factory are clearly noticeable.

Large numbers of overlapping photo strips, compiled and credited to a two-man flight crew that utilized a 35mm Reihenbildner (Rb) serial camera at an altitude of 2400m, would be converted into maps for infantry support of the heavily contested Carso, Vipava valley and Bainsizza. A combined length of about 5.7 meters, these aerial photo mosaics show front lines marked in enemy/red and friendly/blue lines.

The flight crew was composed of pilot Capt. Arpad Gruber, Commanding Officer of Flying Company #12, and observer, Reserve Lt. Alois Erlach (Veinfurter 2017), utilizing Ajdovščina airfield and flying a Hansa-Brandenburg C.I two-seater biplane. Ajdovščina was roughly 25 km from the southern locations photographed and 35 km from Tolmin.

The floor mounted Rb camera, which produced 6 x 24 cm aerial photos, provided overlapping frames allowing stereo coverage for more accurate interpretation while making excellent mosaics covering aircraft ground trace (Manek 1941).

Aerial photo reconnaissance, in its primacy during WWI, was an intelligence gathering system, focused on front line positions, to better pinpoint enemy emplacements, for evaluating, prioritizing and targeting the opposition with limited military resources (Finnegan 2007). This early form of remote sensing and geospatial intelligence provides us a unique glimpse into the history of the Isonzo Front.

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Environmental impact of military shooting ranges

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Keywords: bullets, pollutants, environment.

Shooting range operations, particularly by the military, burden the environment mainly through the shot and bullets containing metals that are harmful to the environment. The main pollutants in the bullets most commonly used are lead, copper, antimony, and zinc. The main pollutants in hot are lead and antimony. The gunpowders used in the cartridges and their additives, such as nitroglycerin, may also be harmful to the environment.

Gun range activities do not cause immediate or short-term environmental impacts; the migration of pollutants to the environment is typically slow. When the bullets and shot left in the range structures get into contact with the environment (air, water and soil), they are subjected to physical and chemical reactions. As a result, metals may in time dissolve into rain and melt water, precipitate in the varying conditions of the soil layers into different minerals, and bond with the small particles in the soil. Metals may migrate to surface waters along rainwater, or deeper into the soil layers and even to groundwater along the percolating water absorbed by the soil. Environmental conditions such as the type, water permeability and pH of the soil, and the amount of rainfall have a significant impact on the speed and amount of bullet and shot erosion takes place, and the resulting migration of the released pollutants to the environment.

Unexploded ordnance (UXO) destruction facilities, commonly located at military shooting ranges, cause serious environmental concerns. Unexploded ordnance, however old, may explode. Even if it does not explode, environmental pollutants are released as it degrades. Recovery, particularly of deeply-buried projectiles, is difficult and hazardous—jarring may detonate the charge. Once recovered, explosives must either be detonated in place—sometimes requiring hundreds of homes to be evacuated—or transported safely to a site where they can be destroyed.

Unexploded ordnance from at least as far back as the mid-19th century still poses a hazard worldwide, both in current and former combat areas and on military firing ranges. A major problem with unexploded ordnance is that over the years the detonator and main charge deteriorate, frequently making them more sensitive to disturbance, and therefore more dangerous to handle. Construction work may disturb unsuspected unexploded bombs, which may then explode. There are countless examples of people tampering with unexploded ordnance that is many years old, often with fatal results. For this reason, it is universally recommended that unexploded ordnance should not be touched or handled by unqualified persons. Instead, the location should be reported to the local police so that bomb disposal or Explosive Ordnance Disposal (EOD) professionals can render it safe.

Croatia's armed forces use 4 shooting ranges, the same ones operated by the army of former Yugoslavia. Two of these ranges are located in karstic terrains which are particularly environmentally sensitive realms. The largest of the four guns ranges located near the town of Slunj has been investigated for toxic metal and depleted uranium (DU) contamination.

The evolution of the Italian Treatises about military geography and geology during the last two centuries

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Keywords: Italian works on military geography and geology, Geo-military cultural heritage.

The author inspects the evolution of the most significant works relating to geography and military geology produced over the past two centuries by Italian authors and their contribution to the knowledge and assessment of the conditions of environmental and operational frameworks of military activities. In particular, it considered the figures of some senior officers like Annibale di Saluzzo (1776-1852), master of the Piedmontese army headquarters, author of a large and complex project related to the physical conditions of the Alps (1845), the brothers Luigi (1814-1885) and Carlo (1817-1905) Mezzacapo, both army officers of the Kingdom of Two Sicilies and then of the Kingdom of Sardinia and finally officers and politicians in the new Kingdom of Italy, authors of an detailed study on Italian topographic conditions (1859), like the milanese Carlo Porro (1854-1939) author of the first comprehensive treatise on military geography (1898). Are also considered the works of two very different personality like Costantino Mini, a young historian and geographer, author of a treatise on the geography and military history of Italy (1850-51), and Felice Orsini (1819-1858), the Patriot known for failed attack on the French Emperor Napoleon III, author of a concise treatise on the military geography of the Italian peninsula (1852). After the birth of the new Italian State and the end of the last war of independence (1866) the national military structure is completely reorganized, also favoured by the unification of the existing cartographic services (1872) in the new Military Geography Institute placed in Florence. Meanwhile, since 1856 appeared the journal "Rivista Militare", still active, with frequent contributions from senior State Officials on military geography and geology topics and relevant about the land and physical environments where military activities are carried out normally. Among them appears in 1872 a contribution related to the defense of some mountain passes by the staff officer Giuseppe Perrucchetti (1839-1916) to whom we owe the initiative of the constitution of the Alpine troops. In the same magazine will appear in 1883 a long text of the Lieutenant Colonel of staff Giovanni Riva-Palazzi (1838-1913) dedicated to the importance of the military geology in the study of the soil. Of particular interest will be in following years the so called "monographs of military geography" related to certain regions and territories, both in Italy and outside, particularly strategic, with environmental and historical interest, many of which developed by Delfino Deambrosis (1871-1945), senior officer and then Professor of geography at the University of Pisa.

The poster highlights maps excerpts, cover pages and directories of the most significant works, as well as an extensive bibliography.

Cultural Property damage case studies in Afghanistan military operations

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Keywords: Cultural Property Protection, Afghanistan, Damage.

This preliminary study, which is shown as a Power Point, started from an input of Cultural Property Protection NATO WG in 2016. The aim of this study is to make a first evaluation of the impact of military infrastructures related to military operations on Cultural Property (CP) sites in Afghanistan (2001-2014).

The matching between Afghan CP sites and military locations was through a Geographic Information System (GIS). Archaeological sources were from the 1286 archaeological and monumental sites recorded by W. Ball in 1982. Thanks to high resolution aerial/satellite images from NATO unclassified archive, these sites had been accurately positioned through direct photointerpretation, while unpublished archaeological sites were also found.

This study shows that, among all military sites known from open sources or direct research, only eight are located on or immediately adjacent to archaeological sites. Among them, four inflicted heavy damage (bulldozer made trenches/pits or roads/infrastructures) and other four inflicted light damage or could inflict future damage. For this reason, impact for CPP directly and indirectly due to military operations in Afghanistan is assessed medium-low.

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The Vietnam War: A Geographic Analysis

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Keywords: military geography, Vietnam War, spatial analysis, conflict.

Research on the spatiality of armed conflict reveals that military activities and violence is clustered in time and space and can be correlated to a multitude of factors, including aspects of the physical, cultural, and militarized landscapes. Historical qualitative and quantitative studies of the Vietnam War clearly indicate similar findings, noting that the strategies of the combatants were driven by geographic considerations such as proximity to boundaries, population density and settlements, military bases, critical infrastructure, as well as topography, vegetative cover, and seasonal weather patterns. This paper explores the spatiality of the Vietnam War, examining the relationship between locations of conflict incidents and other geographic factors and activities which have been theorized to correlate to such patterns. Using conflict incident and geographic data from the Vietnam War, as well as qualitative analyses and historical reports, this research seeks to empirically test the correlation between these variables and the patterns of armed conflict during the Vietnam War.

Charge and Preserve - How does the IAA (Israel Antiquity Authority) help the IDF (Israel Defense Force) to balance operational and training needs with protecting national treasures

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Keywords: terrain analysis, military exercise, heritage.

Israel is a very small country. Land use conflicts within this small country are abundant. One of the major land users is the military, which controls 40 percent of the country's area. At the same time, there are over 30,000 designated archaeological and heritage sites, which cover over 15 percent of the land. These numbers imply that a conflict between military activities and conservation of heritage sites is apparently inevitable.

As part of its basic values, the IDF is obliged to the preservation of the national heritage and historical treasures. Over the last ten years the IDF emphasizes the process of quality planning of training practices to avoid damage to heritage and nature sites.

In order to manage the interface between the operational needs of the military and the protection of national treasures, a position of an archaeological coordinator to the IDF was created. The coordinator, an employee of the IAA, accompanies all relevant IDF activities. The scope of the job includes education, participation in planning processes and overseeing activities on the ground.

The coordinator has the authority to approve or reject training plans, and even to stop an activity in case of damage to a site.

Assessing the possible damage to archaeological sites during an exercise requires a long process of preparations. It includes data collection, terrain analysis, characterization of the exercise, involvement in the military planning process and eventually supervision of the actual drill.

This presentation will describe the main steps in the authorization process of every major military exercise of the IDF, from the IAA perspective.

The Italian Corps of Engineers in WW1: Innovations in Mining and Tunnel Warfare

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Keywords: Tunnel Warfare, Mining techniques, Corps of Engineers, Geophones.

The origin of the Italian Corps of Engineers dates back to June 11th, 1775, with the foundation of the Royal Corps of the Engineers at the service of the Army of the king of Savoy. During WWI, the Italian Corps of Engineers, already reorganized many times after the Italian Unification (1861), consisted of a considerable number of Departments of various specialties (sappers, miners, telegraph and radio communications, bridges, railways, lagoon troops, searchlight units, etc.) that were widely used during the war. The miners' experience in dealing with explosives, together with their knowledge of mining techniques, was very useful for the Corps, for both defensive and offensive activities.

At the outbreak of WWI, many English and French mining companies operating in Italy stopped the activities and dismissed their workforces; later, also German companies were obliged to leave the mining leases, and the Government nationalized the productive sites. The Military Authorities confiscated and strictly organized and controlled the National mining production, and managed the production sites according to the warfare needs. In addition, the mining workers were militarized and subjected to military discipline and chain of command.

The specialist miners of the Corps of Engineer (Genio minatori) performed very dangerous tasks during WWI, working hard in difficult high-mountain areas, engaged in a challenging tunnel warfare aimed to undermining the inaccessible Austro-Hungarian fortifications. Central was the risk of being spotted before firing the mine, or the hazard of neutralization and death caused by enemy counter-mine attacks. On the Italian high peaks of the Dolomites front, the area most affected by tunnel warfare was Col di Lana and Piccolo Lagazuoi, where between 1916 and 1917 five large mines were blasted, and the power and the extent of some of these modified permanently the local landscape.

The ISCAG Archive (Istituto Storico e di Cultura dell'Arma del Genio, the Historical and Cultural Institute of the Italian Corps of Engineers), located in Rome, preserves a large collection of original documents and technical reports. The efforts and challenges of soldiers and officers of the Corps, employed as miners in tunnel warfare against the Austro-Hungarian Army, has been examined based on the documents preserved in the ISCAG Archive. It was thus possible to study and reconstruct the methods, the engineering concepts, the technical innovations and the strategy of the Corps itself, and, last but not the least, the true war life of miners. A large number of documents concerns the "auscultation" methods and instruments, i.e., the application of the then-novel geophysical methods, involving the technologic development and construction of geophones, recording "microseismophones", together with a number of special devices named "telegeophones", "seismomicrophones" and "seismostethoscopes", etc., most of which have been thoroughly examined in this study.

A study on military pillboxes in Sicily between 1935 and 1943: structural diversity and typologies linked to the strategic needs arising during the WW2

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Keywords: Pillbox, Sicily WW2, Census, Mediterranean Sea, Operation Husky.

Sicily has always been popular for the geographical central position in the Mediterranean Sea. Starting from the Ethiopian crisis of 1935, it was characterised by an intense and progressive militarisation of the territory and its coasts.

Military buildings (i.e., airports) were carried out and focused on strategic roles in accordance with naval routes control in the Mediterranean Sea and the supervision of the maritime connections with North Africa, supplying this front and protecting from possible opposing actions (i.e., strongholds, seaplane base, anti-ship, and anti-aircraft batteries) (Marcon, 1993; Mattesini, 1995; Rovighi, 1995).

Starting from Second World War, the number of military buildings and fortifications was progressively increased and aimed to the defence of Sicilian coasts (Clerici, 1993) from possible enemy landing operations.

This research focuses on the Italian military fortifications analysis, particularly on coastal pillboxes and their structural variance in accordance with the strategic function and the needs arising during the war. In November 2017, the "Palermo Pillbox Finders" Cultural Association launched the project (CE.R.CA.MI.) (CEnsimento e Rilevamento di CAsematte MIlitari) for the census of the WW2 military sites still existing in Sicily. The purpose of the aforementioned project is connected to the identification and the survey of the military sites and fortifications, in order to study their typology, strategic roles, structural and functional differences with respect to surrounding environment, state of conservation, and construction materials.

The data were collected over a period of 14 months and 1.329 military sites, including anti-ship and anti-aircraft batteries, strongholds, airports, landing strips, fuel depots, trenches and pillboxes, have been localized using sat-technologies.

The satellite research and the geo-mapping have allowed the study of the Italian coastal defence system located in Sicily from 1935 to 1943. They, also, allowed to know the strong correlation among the typologies, the strategic purposes, and the fortified areas. The pillboxes, identified and considered to be of greater interest for constructive and strategic attributes, have been subsequently reached. The military sites have been catalogued through a census sheet, collecting data regarding the building variety, such as presence of masks or camouflages (Silvestri, 1937), construction materials used, state of conservation of the structure and any related problems arising from the instability of the geotechnical foundation. During the period November 2017-December 2018, 455 pillboxes have been reached and catalogued. The data collected will be presented to local Authorities with the aim to assess and define the safeguard of the main military sites, not only for their technical and strategic characteristics, but also for inserting them into tourist circuits and, thus, spreading their knowledge.

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Napoleon in the amphitheatre: geomorphological constraints on tactics and use of terrain during the battle of Rivoli (1797)

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Keywords: Geomorphology, Adige River, Glacial Amphitheatre.

The proper exploitation of the landscape features during armed conflicts is one of the foremost principles of military tactics. On the battlefield, knowledge of the territory and the ability to employ it tactically to one's own advantage is one of the winning elements in combat. Complex landscapes, as the result of multiple processes intermingling in time, possess a topographical diversity that strongly constraints the range of actions armies can deploy, thus adding a layer of complexity to the course of the battle. While many studies on military geomorphology aim to record and understand the impact of warfare on the landscape, we instead try to reconstruct in which way the landscape influenced the events and decisions taken dynamically during a battle. In historical times, many examples of remarkable grasp of the principles of topography and geomorphology in warfare can be found. In this paper, we analysed the geomorphology of the Adige River Glacial Amphitheatre and its surroundings, theatre in 1797 of the battle of Rivoli, which ended the First Campaign of Italy of Napoleon and allowed establishing France as one of the great powers in Europe.

The amphitheatre was built by the Adige Glacier during the Last Glacial Maximum and consists of two major moraine arcs (the outermost ones), aggraded during at least two positive pulses of the glacier. The innermost three moraine arcs are instead smaller and less preserved and correspond to subsequent withdrawing/advancing steps of the Adige Glacier. Flat areas, filled by gravel sediments from meltwater outwash streams, separate the moraine arcs. The current valley of the Adige river lies several hundred meters below, cut to the Eastern side of the amphitheatre into its sediments and flowing into a narrow canyon in rock (Chiuse d'Adige).

Reconstructions and documentary data available of the battle of Rivoli suggest that Napoleon was able to employ the natural conformation of the amphitheatre as a stronghold to his advantage. Under his command, the Last Glacial Maximum moraine arcs became a bulwark and a vantage line against the advance of the Austrian troops coming from the North. The height advantage of the amphitheatre over the Adige River valley was also key in keeping on hold the rest of the Austrian army, deployed at its bottom.

Geographical realities, military training areas and future sustainable ecologies on the West coast of South Africa

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Keywords: South Africa, SANDF, facilities, ecosystems, MIEM (Military Integrated Environmental Management).

On the West Coast of South Africa (SA), the South African National Defence Force (SANDF) manages pristine pieces of land where four units, namely 4 Special Forces Regiment (4SFR), Langebaanweg Air Force Base (AFBLW), SAS Saldanha and the Military Academy are positioned. These military bases are situated in areas of which the dimensions were calculated to prepare forces for warfighting for an onslaught that concluded in the "bush war", the last war that South African forces were actively involved in. In these areas of land the ecological balance of pristine natural resources are in a state of survival. Unfortunately, the military units of SA do not have the expertise, resources or manpower to manage the property under its command ecologically friendly resulting in areas being neglected and some going to ruins. The question arises if the four mentioned units can still claim all of the property after the "bush war" has ended three centuries ago?

Although under the management of the SANDF, these military facilities is not exempted from the critical eye of the outside world, especially as one of the units, namely 4SFR, is part of the Langebaan Lagoon, a wetland of international importance according to the criteria of the Ramsar Convention (Cowan, 1995). Bordering a Wetland of International Importance and situated on peninsulas with very sensitive ecosystems oblige the managers of these military areas to implement sound Military Integrate Environmental Management (MIEM) practises, but this was neglected and numerous environmentally harmful impacts ('real-world problems') evolved (Marx, 2014). The consequent impacts of military activities went unnoticed on the West Coast of SA because the military areas were restricted and access controlled.

All four of the mentioned units are situated in delicate ecological systems that sustain endangered fauna and flora. One example of fauna is the endangered black harrier (Circus maurus), the most range – restricted raptor in the world. These birds has an estimated population of less than a thousand birds with its core breeding range centred in the Cape Floral Kingdom of SA (Garcia – Heras, 2015). These birds have been observed at 4SFR and at the SAS Saldanha Nature Reserve (Garcia – Heras, 2015). Regarding the flora, the military bases are situated within the West Strandveld Bioregion with the conservation statuses of the vegetation occurring in the military areas all being vulnerable or endangered (Mucina & Rutherford, 2006).

It is suggested that the unused or neglected military properties should be incorporated into MIEM plans as protected ("no go") areas to enable the military in contributing to the guarantee of the survival of the vulnerable fauna and flora under its management. If this is not feasible the land should be handed over to governmental organisations, such as Cape Nature, or private enterprises, such as aquaculture developers, that must manage the land according to National Environmental Management Act (NEMA) regulations. As positive outcomes could be an economic growth prospect with possible job creation as an objective.

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An Evaluation and Comparison of Ordinary Least Squares and Geographically Weighted Regression Tools for Predicting Surface Soil Texture, Using Remote Sensing Data

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Keywords: Remote Sensing, South Africa, Landsat 8 OLI/TIRS.

Since the advent of democracy, South Africa has utilised its defence force in United Nations (UN), African Union (AU) and bilateral agreements missions primarily on the African continent for peacekeeping and peace enforcing missions. It is a standard procedure for military operations to be planned thoroughly before they are undertaken. The planning of these operations often includes a report by the military geospatial engineers known as a terrain analysis report. Soil texture analysis for the purpose of forecasting soil trafficability form a crucial part of this report. Conventional soil sampling and laboratory analysis cannot effectively provide this information because they are slow, expensive and cannot retrieve all temporal and spatial variability.

Remote sensing has in the past three decades shown a high potential in soil characteristics retrieval. Different methodologies have been proposed for the estimation of soil parameters based on different remote sensors and technologies. Even with these efficient methods, characterizing soil parameters has not worked beyond a scale with sufficient homogeneity due to local calibration models. This presentation reports the possibility of utilizing Landsat 8 OLI/TIRS data at surface reflectance (LaSRC) as auxiliary variables for the estimation of surface soil texture using a limited number of legacy soil samples provided by The Agricultural Research Council; Soil, Climate and Water (ARC-ISCW) taken from Lejweleputswa district municipality, Free State province, South Africa. Ordinary least square regression (OLS) and geographically weighted regression (GWR) tools were utilized for predicting and assessing the variability of surface soil texture.

The correlation analysis showed that surface soil sand, silt and clay contents significantly correlated with some of the LaSRC digital numbers (DN) on the seven bands. The DN of Band 6 explained most of the variability in surface sand and silt, while Band 5 DN explained most of the surface soil clay contents. The DN of band 6 for surface soil and silt, and band 5 for surface clay were used as explanatory variables and the ARC-ISCW legacy soil texture attributes as response variables. The cross validation results showed that the key explanatory variables were too complex to be represented by the global OLS regression model. Using the same key explanatory variables GWR significantly improved the surface soil texture estimates. The prediction accuracies provided by GWR were deemed to be reasonable considering the high variability in land-use practices, environmental variables and the size of the study area.

A Blueprint for mapping Bare-Soil Areas Using LANDSAT 8 OLI/TIR Data at Surface Reflectance

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Keywords: Difference Vegetation Index, Soil Adjusted Vegetation Inde, Tasselled Cap Transformation Brightness, Optimised Bare Soil Index.

Rapid population growth, urban expansion, deforestation and issues with water environmental management necessitates proper planning for military operational regions in order to avoid profound negative environmental and socioeconomic impacts. Mapping these regions at varying scales has traditionally been used by military commanders and their operational planners. However, the rapidly changing battlefield of 21st Century warfare, demands dynamic mapping solutions. Considerable efforts have gone into simplifying the process of mapping land covers using remote sensing feature indices. Many indices have been developed based on different land surfaces; however, there are no existing reliable methods to automatically extract bare soil areas using indices. This presentation report evaluated the performance of three commonly used indices for delineating bare soil areas, these are: Normalised Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI), and Tasselled Cap Transformation Brightness (TCB). This evaluation was used to develop an Optimised Bare Soil Index (OBI) by using a mathematical function of the two best performing indices. Unlike previously developed bareness indices, the OBI makes use of surface reflectance data which gives a realistic depiction of the elements on the surface of the earth. The results show that the OBI has a better contrast between bare soil and other elements identified, which means that OBI gives better bare soil detection. The results further indicated that; for accurate outcomes using OBI, the mathematical function should be tailored for the area under investigation by utilising other arithmetic functions available in the software.

TTP`s for Underground Warfare maneuver

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Keywords: challenges, SubT, Training facility, 3D.

This paper analyzes the complexity of Subterranean Warfare Operations and the necessary elements for maneuvers to adapt to the Army standard. To answer this question, we have to compare the performance of Non Trained Subterranean military forces entering a tunnel with the performance and accomplishments of Subterranean Trained Troops entering and operating in an underground field.

Trained Tunnels Forces accomplished and succeeded the operation and were able to transfer their military skills to the subterranean complex conditions. A Non Trained SubT Forces didn't have any adaptive skills as:

- effectively navigate and 3D scan,
- communicate,
- breath,
- breach heavy obstacles,
- body protection,
- training
- and attack enemy forces in underground mazes ranging from confined corridors to tunnels.

Their expertise and abilities as soldiers not adaptive while entering the Enemy Tunnel. This study emphasizes the need to take into account this new type of warfare and the impact of new training and equipment to operate in conditions such as complete darkness, bad air and lack of cover from enemy fire in areas that challenge standard Army.

In June 2005 Sergeant Gilad Shalit was kidnapped and in August 2014, during operation Protective Edge, the body of Second Lieutenant Hadar Goldin was also kidnapped and taken through the tunnel network.

During that time, the strategy was "We will not fight them in the tunnels, we will collapse the tunnels on them" – Chief of Staff Benny Gantz. After operation Protective Edge, the strategy changed to fighting within the tunnels. In order for the Army to be combat-ready, the forces must undergo intensive training in Tunnel Training Facilities (TTF).

Since the beginning of mankind, most wars were fought above ground. However, in modern times, war has more often moved below ground. This is especially the case where one side has been at a technological disadvantage and, in order to gain the upper hand, moved underground. The question is: how a soldier will react when fighting underground since them only trained above ground.

Digging memories. Archaeology of the Great War in Trentino, Northern Italy.

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Keywords: Archaeology of the Great War, Corpses of soldiers, Ortles Cevedale Group, Pasubio Group, Adamello Group.

In Italy archaeology is traditionally identified with the science that studies antiquity, in particular the classical one. Archaeology is actually a discipline that aims at reconstructing in a diachronic sense the anthropic processes of all the past, even the contemporary one, through the analysis of human actions that have left evidence on the ground and the study of the material culture. Its method is the stratigraphic archaeological excavation.

The Office of Archaeological Heritage of the Autonomous Province of Trento carried out in the last years several experiences of archaeology of the Great War, both in traditional contexts (Luserna Plateau, Pasubio massif) and in places of the so-called White War, that took place at very high altitudes high, often above 3000 meters and even in glacial environment.

In this paper the result of the researches conducted at some of these sites will be presented. The first is that of Punta Linke (Ortles Cevedale Group, 3629 meters a. s. l.), one of the most important Austro-Hungarian stations of the entire Alpine front characterized by the presence of a double cableway system.

The second is the Valico del Menderle (Monte Pasubio, 1679 m a. s. l.), located in a sector of the Trentino front which in the late spring and summer of 1916 was affected by the so called "Strafexpedition", where a small "battlefield" has been excavated.

A discussion on the recovery of the soldiers' bodies will follow. Nowadays the consequences of global warming also include the frequent emergence of corpses of soldiers. The archaeological approach to this kind of evidence needs to find the right balance between scientific methodology and ethical issues which arise from the fact that we are excavating "identities" in the field of memory, though the great part of these identities are unknown soldiers. Some examples of recoveries will be presented, in particular the one conducted in Adamello in 2017, thanks to which it was possible to give back the identity to an Italian soldier.

The Durand line: a fragile border in the heart of Asia

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Keywords: Afghanistan, Pakistan, British India, Greater Pashtunistan, Contested Borders.

The Durand line was agreed in 1893 as the border between British possessions in north-west India and the lands of the 'amir' of Kabul. It was the last border of the Raj to be defined, more than twenty years after the Indo-Persian border. The picketing proved quite difficult, lasting more than two years. The status of contested sectors in Kurram and Kafiristan was settled in 1894-95, while the final status of the Khyber Pass was agreed upon only in 1919.

The Durand line was also a weak border. Cutting across Pashtun tribal areas, it triggered controversies since the beginning. At the same time, allowing the most troublesome groups to find safe haven in Afghan territory, it led to increasing trans-border violence. The establishing of the North-West Frontier Province, the withdrawal of British forces behind the administrative border, and the transfer to local headmen of the task of maintaining law and order, confirm the line's difficulties in insulating British possessions from their turbulent neighbourhood.

Things did not change after 1947. In post-colonial years, the ambition to integrate part of Afghanistan and Pakistan into a so called 'Greater Pashtunistan' stretching on both sides of the border challenged the same idea of a separation between the countries, while between late 1980's and early 2000s, Afghanistan's political instability led to pressures to revise the Durand line, a request that President Hamid Karzai endorsed after 2001. Not surprisingly, the Afghan-Pakistani complex has imposed as a key spot for regional security, thus emphasizing the weakness of an instrument that has proved largely unable to play the role for which it was conceived.

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Outfoxing the Fox: How Commonwealth military geologists, surveyors and mapmakers helped defeat Rommel at Alam Halfa and save Egypt in 1942

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Keywords: geology, cartography, Qattara Depression, Western Desert Egypt.

In this fully illustrated presentation, I will examine the work of Commonwealth geologists, surveyors and mapmakers in the Western Desert of Egypt in 1942. In particular I will look at 'going' maps, especially a false one which is claimed to have deceived Rommel during the battle of Alam Halfa and contributed to the defeat of his last attempt to break through the Alamein position.

With its ridges, impassable areas and areas of soft going, the geology and topography of the Alamein position gave it great natural strength, which is why it was chosen as the place to stop Rommel's drive into Egypt. The position could not be outflanked because of the sea to the north and a vast area below sea level to the south: the Qattara Depression. Because of its salt lakes/pans, high cliffs/escarpments and 'fech fech' (very fine powdered sand), the Qattara Depression was impassable to tanks and all but the lightest vehicles. Between the Qattara Depression and the sea, there were several smaller depressions (known as deir) and two major ridges: Ruweisat and Alam Halfa.

Special 'going' maps were produced by the Commonwealth forces as an aid to the movement of armoured units. The 'going' information was overprinted in colour on the map: Red = firm and fast; Blue = generally impassable; Green = recce essential before movement; Yellow = fair. To refine the colour coding, overprinted text was used, such as: "Treacherous soft going"; "Very good hard sand"; "Open featureless country covered with scrub".

The presentation will examine claims that: a false 'going' map was made and planted by the Commonwealth forces on Rommel; that Rommel used this false map; and that using this false map contributed to his defeat. The presentation will examine information from both British and German sources. It will demonstrate that despite their best efforts and the production of their own version of 'going' maps, German geologists, surveyors and mapmakers were inferior to their Commonwealth counterparts in the Western Desert. Hence Rommel's use of a captured enemy map. The presentation will conclude that on the balance of probabilities the claims are true. Rommel's defeat at Alam Halfa therefore stands as a tribute not only to Commonwealth guile but to superior Commonwealth military geologists, surveyors and mapmakers.

Forte Beisner- Opera 4 Ugovizza: A Vallo Alpino del Littorio bunker reused during the Cold War in northeast Italy

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Keywords: Battlescape, Vallo Alpino del Littorio, Cold War, Heritage, Community engagement.

This paper aims to present the activities undertaken to study and enhance an underground commando bunker and the surrounding historical landscape. This bunker, known as Forte Beisner-Opera 4 Ugovizza, was built as part of the "Vallo Alpino del Littorio" between 1938 and 1940. It was used throughout the Cold War to as late as 1992.

The fortification is the most extended structure in the area and develops inside the low hill known as "Monte Palla", on the plain of Ugovizza, in the northeast of Italy. The local multi-ethnic population living in proximity to the hill could never enter or see this off-limit military area. The activities carried out by the members of the association "Landscapes" (in charge of the site since 2014), eventually allowed both ex-soldiers (who once had served on this site) and the local Italian, Austrian and Slovenian communities to be involved in the preservation of this site.

Dipl.-Ing.Volker Pachauer and (Österreichische Gesellschaft für Festungsforschung | OeGF) and Pinagli Anita, helped the association uncover a previously unknown set of wartime structural remains dating from the 17th century to the end of the Cold War era hidden on top of the hill.

"Monte Palla" and its hidden bunker are now slowly becoming the new visible reference key points of an unstudied historical battlescape. The initial results of this research will be presented, alongside possible future study developments of these sites.

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A Military-Engineered Flood in WWI: the Case Study From the Adige and Fratta-Gorzone Rivers (Italy)

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Keywords: flooding, risk analysis, geomorphology, hazards, WWI.

The use and the manipulation of the environment in wartime is an ancient practice; water was often used as a tool. Water, in particular, has been used since the ancient time to provide a defensive/offensive weapon against the enemy through human-induced floods. This work presents the case of an artificial flood planned during the First World War in northern Italy. After the Austrian-Hungarians broke through the Caporetto front in the fall of 1917, the Italian Army established new defense positions in the Veneto plain along the Piave River. Subsequently, in late 1918 the Italian Command made contingency plans for another Austrian-Hungarian offensive that might overrun this new Piave River defensive line. These new plans were based on a southern line called the Mincio-Po line and were based on engineering-controlled breaks along the mighty Adige and Fratta-Gorzone rivers (Tchaprassian, 1994); thus, creating a massive anthropogenic flood stretching from the Adriatic Sea in the east to almost the city of Mantua in the west. Such a flood would have severely hampered Austrian-Hungarian movements but would have also caused agricultural impacts and an unknown displaced population of Italians. Although a few large scale anthropogenic induced floods have been used as desperate war-time measures, these activities are rare. Little is known of these secret plans to inundate the Adige River floodplain and almost nothing is known of the resulting impact to the population, infrastructure, and agricultural landscape. In this research we used a geo-historical approach (GIS, historical cartography, aerial imagery) to model the location and extent of the planned flood. Using a dasymetric approach we modeled the population distribution during 1918 and estimated the displaced population (more than 50,000 people), and impacts on agricultural, roads, railroads, and poultry.

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The Paths of General Sherman's Army Through the Wetlands of South Carolina

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Keywords: General Sherman, wetland, American Civil War, historic map, historical GIS.

General Sherman's armies visit to Georgia and South Carolina during the American Civil War is well-known throughout the Southern states. His march is remembered primarily through the plundering and devastation by his armies in Sherman's quest to end the war. What are little known are the individual paths his five armies made through South Carolina and uniquely, their treks across the wetlands and rivers. This research offers a summary of the paths made by the five Union armies under General Sherman's command in South Carolina. This description was derived from the memoirs of Sherman and a historic map. With the use of historic topographic and a modified form of the contemporary National Wetland Inventory a GIS geospatial database of wetlands and rivers representing the landscape in 1865 was constructed. An analysis of the intersection between the armies' paths and wetlands of South Carolina was conducted. The results of an integrated geo-historical approach using a geographic information system show how the armies' paths have, on average, about 20% of their journey on wetlands, with a preponderance for swamp with forests and shrubs. The cavalry trekked over the least amount of wetlands as the cavalry traveled the farthest inland from the coastal plain characterized by numerous wetlands.

Piovan S.E., Maugeri E., Luconi S. & Hodgson M.E. (2017) - I percorsi delle armate del Generale Sherman attraverso le aree umide del South Carolina. Bollettino dell'Associazione Italiana di Cartografia, 159, 93-107.

Geographical representation of the Royal Italian Army war sectors and sites during the First World War

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Keywords: WWI, Military geography, Geographic information system, Gazetteer.

The commonly agreed representation of the 'Italian front' localizes it along the border between the Austro-Hungarian empire and the Kingdom of Italy. As a matter of fact during the First World War Italy sent 450,000 of its troops to the Macedonian and Albanian fronts, 250,000 to the French front, 60,000 to the Palestine front, 200,000 to Libya and Eritrea, and minor contingents to Northern Russia and Siberia (Cotillo, 1922).

The geographical knowledge related to troops deployment along these war fronts is well depicted in terms of place names within the documents, official reports and memories while it often lacks in details about the actual position of those places.

After a five years research, it is now possible to represent through geographical tools the places that have been involved during the four years of war and their position. The research is based on a geodatabase and on a geographical information system aiming at identifying, cataloguing and georeferencing the so-called places of war or Luoghi della Grande Guerra in Italian (Plini et al. 2017).

The dissemination of this information relies on two different but complementary tools, a gazetteer and an online GIS. The gazetteer has been compiled in order to ease the search function of the online GIS providing univocal and unambiguous results. It contains at present 19,048 entries Corresponding to 11,091 sites. 4,711 entries correspond to alternative names, formal and/or lexical variants, misspelled names. 3.246 entries correspond to name of places in French, German, Slovenian and other languages; they also include the local names in Friulian language referred to places located into Friuli, the north-eastern part of the Italian territory.

The online GIS has been designed in order to display the results of the work clustering the information into different subgroups such as modern and historical cartography, borders, front lines, sites and accessory elements. The user has the possibility to display the information about sites in relation to the displacement of the different military units, airfields, war cemeteries, POW camps. It is also possible to display the places mentioned into the Austro-Hungarian and Italian official history of WWI and perform queries based on more than one name as well as SQL complex statements.

Both gazetteer and online GIS are intended to provide a geographical support not only to historical studies but also to represent a valuable tool for the preservation of local history and memory of men and events (Till, 2007).

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Plini P., Di Franco S. & Salvatori R. (2017) - Geography of WWI sites along the Italian front by means of GIS tools. In: Cefalo R., Zieliński J.B. & Barbarella M. (eds.), New Advanced GNSS and 3D Spatial Techniques. Lecture Notes in Geoinformation and Cartography, Springer, 229 - 235. DOI 10.1007/978-3-319-56218-6.

Till K. (2007) - Places of Memory. In: Agnew, J., Mitchell, K. & Toal, G. (eds.) A Companion to Political Geography. Blackwell Publishing, Malden, 494 pp.

The Italian Army in Russia during WWII, GIS representation of small-scale historical events

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Keywords: WWII, Military geography, Geographic information system, Operation Barbarossa.

An abundant literature has been produced dealing with the participation of the Italian Army to the events of the Second World War and in particular those related to the Nazi's invasion of Russia (Operation "Barbarossa"). In those texts several names are quoted in relation to troops arrival and departure, military routes, deployment areas, fights, cemeteries and prisoners-of-war (P.O.W.) camps. These site names are usually mentioned without providing their actual geographical position in eastern Europe and in the former Soviet Union territory.

Geographical Information Systems (GIS) being able to combine spatial and attribute data provide an infrastructure for the representation of the results of the analysis and study of documents and cartography. GIS allow to manage and 'spatialize' geographic data and to interact, at the same time, with a great amount of historical data, previously collected and duly recorded in a database, thus providing an alternative reading key for the comprehension of texts and evidences written by the protagonists and witnesses of these events.

Considering the geographical coverage of the studied area, this work allows to verify the ability of modern and up-to-date information systems like GIS to support usability and readability of small-scale historical data. Due to the great amount of available data, particular attention has been paid firstly to military operations of the Alpine Army Corps and secondly to the whole Italian Expeditionary Corps (1941-1942) and to the 8th Italian Army (1942-1943).

Among others, information on paths of troops from their arrival to the deployment areas, deployment of various groups and headquarters displacement, front line sectors, location of the main battles, paths covered by various units during military operations and the retreat period and P.O.W. camps localization were collected and handled into the GIS.

A specific task was represented by the normalization of all the different versions of geographic names (totaling 3,455 occurrences) of cities, villages, rivers, collected, identified in the original Cyrillic name and transliterated according to International rules.

Among latest activities an analysis of the geological structure of some sample areas was carried out in order to evaluate how some war events have been influenced by landforms.

Fortress Mount Baldo. Definition and evolution of a military landscape

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Keywords: Military landscapes, military geography, venetian military history, history of northern Italy.

Mount Baldo is a mountain ridge located in north-eastern Italy between Lake Garda and Adige river, that is characterized by the succession and mixture of very different natural environments, and that shows the dual aspect of a still wild natural space and an anthropized area, on which several signs of history are clearly marked. Its unique geohistorical and geopolitical location, linking and straddling the Germanic world and the Mediterranean area, has attributed to it the typical signs and characteristics of a military landscape, since the beginning of the 18th century through the end of WW2.

Military landscape, we would point out, and not war landscape; or rather, and more correctly, military landscape as a stratification of different and diverse war landscapes, often considered worth of interest by many Italian military geographers in the last two centuries. Military landscapes will be defined, in this paper, as those formed by the sedimentation and by the overlap in the medium and long term of material and immaterial traces of militarism on a given territory; places «produced, read and responded to as an outcome» (Woodward, 2014) of military activities, of which they still bear traces. These are material traces, of which physical or documentary memory remains, but also immaterial traces, identifiable in the testimonies of the protagonists of militarism in the area, described by their various and different points of view. These traces can ultimately represent the key-notion of landscape as a footprint, as human legacy (Besse, 2008).

So, the military landscape is to be considered as a cultural landscape that integrates even «minor, but morphologically and visually important functional elements» (Pinchemel, 1996), giving them a precise place in the folds of the history of a given territory. Provided that the cultural geographies that characterize this particular representation, generated by military practice, might be detected.

The aim of the paper is to unfold the landscape of Mount Baldo in a new perspective, and to reconfigure it experimentally as a military landscape. Rather than an in-depth analysis of the physical spaces in which the wars and the battles took place on such an area, it will be a research about how this territory has been transformed into a landscape, and how it has been approached, lived, represented, described, and perpetuated as a landscape. Rather than the effects of the physical and geographical characteristics on the outcome of the operations, we will favour instead the tangible or intangible signs of the presence of militarism on the territory and its populations, in a study of how military operations and actions have interfered with the invariants of this landscape. That is, in other words, answering about why it is possible to consider Mount Baldo a unique and paradigmatic military landscape.

British military geology breaks new ground: the Italian Campaign of 1943–1945

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Keywords: British Army, geology, Italy, terrain evaluation, World War II.

British armed forces made professional use of only two military geologists as staff officers in World War I, and initially only two in World War II. Appointment of a third, Captain (later Major) J.V. Stephens on 1 June 1943, was a notable development. Stephens was to serve in Allied Force headquarters for the Sicilian and Italian campaigns (Rose & Clatworthy, 2007). He landed in Sicily on 10 July 1943, D-Day of the Allied invasion, and served successively in Sicily and mainland Italy as the Staff Officer (Geology) for the Allied armies until October 1945, five months after the war in Europe had ended. He assisted planning for advances into enemy-occupied terrain ('operations') and development of a military infrastructure within regions when held by the Allies ('works'). As the Italian campaign progressed, his role in 'works' was taken over by a second geologist: Major W.A. Macfadyen. Their tasks were facilitated by geological maps reprinted by the Geographical Section General Staff of the British Army; by thematic maps and literature compiled in the UK by the Inter-Service Topographical Department (Rose & Clatworthy, 2008) and in the USA by the Military Geology Unit of the US Geological Survey; and initially by brief deployment of a detachment from 42nd Geological Section, South African Engineer Corps. Boring Sections and Quarrying Companies of the Royal Engineers were amongst the units to benefit especially from geological guidance (Rose, 2012, 2019). As the war in this Central Mediterranean theatre drew to an end, 'soil' maps for northern Italy were prepared with geological assistance to guide military 'going' during the final months of advance. All British military geologists returned to civilian careers after the war, Stephens to employment as a senior geologist by the Geological Survey of Great Britain.

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Identification and analysis of the 1968-1973 Egyptian army field preparations for crossing the Suez Canal and the internal conflicts between Israel Defense Forces intelligence research units

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Keywords: Geographic intelligence, GEOINT, Yom-Kippur/October 1973 Arab-Israel War, spatial analysis, military geography, aerial photographs.

Much has been written about the intelligence fiasco of the Israel Defense Forces (IDF) with respect to the 1973 Yom Kippur (October) War. Less than a handful of papers have highlighted one of the main reasons that led to the intelligence blunder, namely, the main intelligence research agencies' refusal to accept geographic intelligence. This paper, based mainly upon the 2nd author's personal experience, reviews the five-year process of the IDF geographic intelligence research prior to the surprise Egyptian offensive. This research, based upon aerial photo interpretation and terrain analysis, identified and explained step-by-step tactical infrastructural changes in the Soviet-supported Egyptian military field preparations for crossing the Suez Canal that were verified from ground observations and personal recollections of commanders and intelligence personnel from both sides during and after the War.

This paper exemplifies how earthworks, and modifications and construction of fortifications, can be observed, analyzed and interpreted at a strategic level by geographic intelligence methods. The paper is also an account of the organizational processes, difficulties and challenges of collection, analysis, interpretation, and dissemination of spatial field data and as such, exemplifies how concrete geographic intelligence, combined with an understanding of military operations, can often generate intelligence that is superior to intelligence based on SIGINT and HUMINT. Organizational tension between geographic and usually dominating research intelligence units, though possibly inherent, must be continuously addressed and coordinated to provide for a holistic intelligence assessment.

Cross-borderTunnels between Lebanon and Israel: Geography, Geology, and Underground Invasion Strategies

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Keywords: underground warfare, cross-border tunnels, invasion, Hezbollah, Operation Northern Shield.

On December 4th 2018, the Israel Defense Forces (IDF) launched Operation Northern Shield. It begun with the first-ever disclosure of the existence of cross-border tunnels dug by Iranian-supported Hezbollah guerillas. Many tunnels originated from civilian structures in southern Lebanon and burrowed under the Lebanon-Israel border into the subsurface of northern Israel. At the tactical level, the operation, which did not involve any intrusion into Lebanese territory, aimed to expose the threat and engage in novel anti-tunnel measures. At the operational level, the operation aimed to create a new strategic equation between Hezbollah and Israel. According to the IDF, the operation was designed to fold Hezbollah's plan to launch a massive and surprise ground invasion into Israel partly via these tunnels. Based on news reports, open-source IDF material, years of research and previous data on underground threats, and a field survey on the Israeli side of the border, this paper analyzes the impact of human and physical geography, and geology on Hezbollah's underground digging, the features of the tunnels, their purpose, and the measures used by the IDF to contend with the threat.

First, this paper explores the suspected purpose of the tunnels – namely as an important axis and dimension for supporting an invasion into the upper Galilee of northern Israel – in a historical and military context. We show that Hezbollah's plan at launching a cross-border invasion by combined ground and underground movement stands out in the history of tunnel warfare. Even in contemporary times, only North Korea's cross-border tunnels into South Korea sought to achieve a similar purpose. Then we show the tactical, geographic and geologic considerations for choosing and developing the tunnel locations.

Second, the paper analyzes the factors that contributed to the success of Operation Northern Shield. Since contending with Hamas' cross-border tunnels from the Gaza Strip in 2014, Israel invested considerable resources building anti-tunnel capabilities – from military training, to the creation of units and commands specializing in underground warfare, the use of innovative intelligence gathering methods, and the development of "ground-breaking" technology for tunnel detection and neutralization. These efforts enhanced the operation abilities of the IDF to cope with underground threats, as witnessed by the discovery and neutralization of five cross-border tunnels in less than a month since the onset of Operational Northern Shield.

Ultimately, we stress that clandestine tunnels can be dug in a wide variety of settings and lithologies and sedimentologies and that know-how, resources, and operational flexibility serve as the main motivating factors behind such efforts. We conclude with a forward-looking warning to many states that underground invasion tactics are likely to be reproduced elsewhere by extremists.

The impact of landscape micro-relief forms on the mobility of military vehicles

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Keywords: micro-relief, terrain analysis, cross-country movement, off-road navigation.

The terrain forms of the micro relief can be defined as man-made and natural both elevated and depressed topographic forms that cannot be expressed with regard to its relative small height differences by use of contour lines or by the means of other principal method of terrain representation. Micro-relief shapes such as: small slopes (terrain steps), rock cliffs, landslides, terraces, erosion forms of watercourses, gullies, craters, holes, embankments, rock groups, boulders and other relief forms created by impact of natural forces and anthropogenic activity can have an important influence on the military operations. The aim of the article is to describe the methodology of evaluation of the influence of micro-relief shapes on the mobility of military vehicles. The article is based on the statistical determination of the extent of micro-relief shapes in the territory of the Czech Republic. These shapes were detected in various geomorphological relief types using topographic maps of 1:10,000 and the Digital Elevation Model (DEM 5) with the density of 1 x 1m. The article describes both the methodology of calculations of possible collisions of the vehicle chassis with the terrain, as well as the calculation of the optimal route of the vehicle avoiding micro-relief obstacles.

Impact of the physical geographic sphere on the cross-country movement

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Keywords: physical geographic sphere, terrain analysis, cross-country movement map, off-road navigation.

The landscape, including the physical and socio-economic sphere, has always the great impact on military operations. Terrain analysis is extremely important during all phases and levels of military planning. One of the main terrain assessment provided by the military geographic services is cross-country movement analysis. The aim of the article is to analyse the historical development of cross-country movement mapping in the Czech Army Forces and to describe the research focused on the methodology of assessing the off-road mobility of military vehicles across the natural terrain. There are only physical features analysed in article, which are synthesized to produce an estimated vehicle speed, based on landscape surface configuration (slope), surface material (soil type), hydrology (speed and depth of the river steam), vegetation type (stem spacing and stem diameter). The main objective of evaluating these physical elements is determining the most efficient path between two locations. Depending on the data (and parameters), the end user can find a route that is the fastest, shortest, or safest.

Military cemeteries as anthropogenic shapes of the physical earth's surface

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Keywords: military cemetery, physical landscape, anthropogenic landform, object location.

This paper documents the factors and specifics of the location of the military cemeteries in the physical earth's surface. Military cemeteries represent a specific category of cemeteries. Their creation is linked to dramatic historical warfare. Our research shows that they are a source of historical and geographical information, which does not affect their primary functions, namely funeral, pious and spiritual. Military cemeteries must also be seen as an integral element of cultural and physical landscape, as part of its identity and a site of memory. The locations of the military cemeteries are dependent on specific physical-geographical preconditions of the site. So far, military cemeteries have not been considered as military landforms. However, we argue that they are part of military area, have their own characteristics and typical features and fulfil the criteria to be defined as anthropogenic landform. From a spatial point of view, in our research we focused on the area of north-east Slovakia where the majority fighting took place on the Eastern Front during the First and Second World Wars. The historic military region of the Dukla battlefield is also part of the study area. This area is particularly interesting from a physical-geographic point of view because it is located in the Carpathians. The rough mountain relief and dense forests determined not only the progress of the army and the course of military operations but also the location and character of the military cemeteries in the studied area.

Investigating Remote Measurement of Sub-Surface Soil Moisture for Military Operations

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Keywords: UAS, subsurface soil moisture, mobility.

One of the biggest challenges in predicting soil strength for mobility of military vehicles is estimating soil moisture content in the soil subsurface (i.e. depths to 1 m). For this study, we developed a strategy to investigate the utility of using the Normalized Difference Vegetation Index (NDVI) and Apparent Thermal inertia (ATI) data, derived from remote sensing measurements acquired with Unmanned Aircraft Systems (UAS), to infer soil moisture below the soil surface. NDVI is a remote measure of vegetation cover/health while ATI is a measurement of the surfaces ability to retain heat. Since wet soils retain heat better than dry soils, ATI can relate to soil moisture. Ultimately, we plan to investigate the correlation between these parameters on surface types ranging from bare soil to completely vegetated ground. Here, we report initial results from our data collected at Ft Hunter-Liggett, CA, within a vegetated California Grassland-Chaparral region in the California Central Coast that we are using as an analog for dry temperate military operating environments such as southern Korea and southeast Ukraine.

UAS overflights collected Visible (VIS), Near-Infrared (NIR), and Thermal Infrared (TIR) image data over three areas with different soil characteristics. Individual data frames were processed into mosaicked scenes, geospatially registered, and calibrated to reflectance (VIS and NIR) or temperature (TIR). During the overflight, soil moisture measurements were collected from 33 total locations at depths of 0, 15, 30, 45, and 60 cm. These were made by using a soil auger to excavate soil at the specified depths and inserting HH2 Hydrometer to measure soil moisture at each depth interval. The remotely sensed image data was subsequently processed into NDVI and ATI images and compared to the soil moisture data. In this initial test of the approach, vegetation cover was high (95-100%) at all the sites. The R2 values for the correlations between soil moisture and NDVI were best in vegetated, well-drained soils/soil layers (0.5 – 0.77) and decreased in poorly drained soils (< 0.5) and are likely related to root depth. ATI correlations, measured at only one of the three areas, were generally less than NDVI (as expected), showed high correlation only at a depth of 60cm (0.67). Based on these results ATI is likely best applied in the context of soil moisture estimation to soils with little or no vegetation cover; making the application of this method in a well vegetated, dry temperate military environment a worst-case test for possible soil moisture/ATI correlation. The positive correlations, even though not as strong as NDVI, are encouraging and need further study; specifically, as they relate to different environments on different soils, during different seasons. It is likely that NDVI will not be useful on bare or minimally vegetated soils. Soils-adjusted vegetation indices such as SAVI and MSAVI may prove more useful in these arid conditions, as well as ATI.

The quality of EIA reports for projects affecting military activities

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Keywords: Environmental Impact Assessment Report; EIA report quality.

South African Environmental legislation requires that Environmental Impact Assessment (EIA) be conducted for various activities that might have adverse impacts on the environment. The requirement for EIA is determined by lists and thresholds published in the EIA regulations, and include activities conducted by the National Defence force, as well as other activities that influence military exercises and operations, with the intend to facilitate environmentally sustainable development.

The effectiveness of the EIA process, and its influence on the military, is determined inter alia by the quality of EIA reports, on the premise that good quality reports are more likely to result in good decisions, which in turn contributes to sustainable development. Research on EIA report quality is growing in South Africa, but nothing has yet been done on the quality of EIA reports for projects that could affect military activities.

A sample of such EIA reports was obtained and the quality was reviewed using the widely used Lee and Colley review package.

Results reveal that the quality of EIA reports for projects affecting military activities is generally in line with findings for report quality in South Africa and abroad. Some interesting observations regarding accessibility of reports, responsibility for management and the issue of classified military information are also explored in this paper.

The utility of soil-landform relationships in terrain mobility models based on soil-strength characteristics in different environmental and geologic settings

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Keywords: soil strength, trafficability, mobility, geomorphic landforms.

Continuing efforts to improve vehicle mobility models highlight a growing concern over our ability to predict terrain conditions for military planning and operations globally. The NATO reference mobility model (NRMM), developed in the 1970's by the United States Army Tank Automotive Research, Development and Engineering Center (TARDEC) and Engineer Research and Development Center (ERDC) as the go-to military mobility model has been subjected to rigorous technical improvements over the last 50 years and is still being overhauled at present. Common criticisms of the model cite a lack of theoretical physics-based approaches and of parameter constraints to allow model reliability. Although much attention is geared towards exploring the implementation of numerical and stochastic methods and the improvement of GIS capabilities to enhance model predictions, knowledge of the ranges of environmental soil-strength parameters remains a significant data gap for mobility modeling and model validation. We present a novel database of in-situ soil-strength data to show how characteristics of soil/landform assemblages relate to soil strength with the goal of supplying parameter constraints to achieve increased reliability for prediction and validation of mobility models.

We collected soil strength data from a variety of soil types and associated landscape elements at two military posts and surrounding areas in the western United States. Site selection was motivated by fundamental geomorphic principles which allow remote forecasting of soil characteristics, controlled by dominant soil-forming processes, based on the distribution of geomorphic landforms throughout the landscape. Data were collected from 18 common desert and temperate landforms spanning 10 common soil series recognized by the national soil survey, totaling 29 unique soil/landform assemblages. We measured common soil geotechnical parameters (e.g., bearing capacity, penetration resistance, shear strength, stiffness, and bulk density) to characterize their distribution over the suite of soil/landform assemblages. Marked differences between soil strength values from the different soil/landform assemblages allow remote predictions of the range of soil strength properties commonly used in mobility modeling. The most common parameters used to assess mobility conditions with the Next Generation NRMM include the shear modulus, soil cohesion, and friction angle, which are easily derived from parameters included with our dataset. These can be used in mobility models to examine NOGO conditions for vehicle performance, including small unmanned robotic vehicles, and for landing and/or drop zones. Our unique dataset highlights the utility of geomorphic landform considerations for use in predictive terrain modeling that should be included in future iterations of mobility reference models. Additional research activities are required to validate predicted soil/landform soil strength relationships.

Italian prisoners of war in South Africa: circumstances and contributions

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Keywords: Second World War, Italian prisoners of war, Zonderwater prison camp, East Africa Campaign. North Africa Campaign.

On 6 September 1939 South Africa declared war on Germany and its allies. After a period of intense reorganisation of the South African military and large scale training, the First South African Infantry Brigade left for East Africa on 16 July 1940. Their mission - to support the Allied war effort against the Italian colonies in East Africa.

The first campaigns in East and North Africa brought a flood of prisoners of war (POW's) to South Africa. By far the largest contingent was Italians, and by 1942, more than 70 000 Italian POW's were held in South Africa. Most Italians were held in the Zonderwater camp near Pretoria.

Many of the Italian POW's were used to work on numerous public projects during their incarceration in South Africa. The most notable of these projects was the road and bridge building projects and the building of mountain passes in different parts of the country. Many of them also served on farms and in a variety of other spheres of life in South Africa.

This presentation aims to reconstruct the conditions in which the Italian POW's were kept in South Africa and their contributions during their stay in the country. Analysis of selected historical documents and interviews with descendants of these POW's who stayed behind in South Africa after the war, or who returned to South Africa later, will be used to do the reconstruction.

Managing emergencies for the safeguard of the art heritage cities by means of the Corrado Ricci's Correspondence: Ravenna "open city" without air defenses (1916 -1918)

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Keywords: First World War, cultural heritage, safeguard, Ravenna, Corrado Ricci.

The purpose of this paper is to highlight a dramatic and crucial episode of the Italian history which took place during the First World War from the privileged point of view of an important institutional figure of the Fine Arts during the period in which Giovanni Giolitti held power: Corrado Ricci (Spadoni & Emiliani, 2008). For the entire period of the war he held the onerous position of General Director of antiquities and fine arts.

His unpublished correspondence – the Corrado Ricci Archive, conserved at the Classense Library of Ravenna (Secchiari,1997; Stella, 1997; Giuliani, 2005) – represents a precious testimony which documents the work carried out under his general direction and describes the immense transport and protection operation undertaken for mobile artworks: paintings, frescoes, sculptural complexes, entire museums, private collections, as well as the protective measures adopted for the more notable monuments of the Triveneto region (Italy). Though, it should be stressed, ineffective from the point of view of preventive actions, it was effectively the first rescue operation of unified Italy and was carried out across the national territory (Ricci, 1917; Stella, 2018).

This paper intends to examine in particular detail the dramatic events which involved Ravenna and its historical Pinewood since 1916. In that terrible year the centre of the monumental city of the ancient Byzantine capital was for the first time targeted by Austrian bombs, which also threw civilian life into disorder. The emergency also affected Ravenna's ancient Pinewood – a unique piece of natural heritage, rich with history – whose survival was threatened because of the, often questionable, decisions and military priorities of the Italian Supreme Command.

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A decade later in Afghanistan: effectiveness of US Army Agricultural Development Teams' efforts

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Keywords: stabilization, sustainability, humanitarian aid, CERP.

The World Bank suggests that the impact of foreign aid is unknown (Baker, 2000); with development efforts in Afghanistan being the most challenging in the world. Major gaps between donor-country policies and host-nation realities, a primacy of output over outcomes and the "militarization" of aid make development efforts unlikely to achieve large and persistent effects (Iyengar et al., 2017). Despite these views on foreign-aid, the US government has provided over $125 billion in reconstruction efforts in Afghanistan since 2002. Innovatively, the US Army developed Agricultural Development Teams in 2008, which were comprised of hand-selected, soldier-experts from select state national guards (cf., Stewart, 2014; 2016). These egalitarian, specialized counterinsurgency teams spent a mere 0.0004% of the reconstruction budget across Afghanistan to improve agriculture. Unlike other aid efforts in Afghanistan, from USAID to NGOs, ADTs were ahead of their time—they implemented Afghan-first projects requested and developed by working directly with(in) local communities with QAQC and follow-ups included in the project scope—all things expected of improved aid efforts after ADTs were disbanded in 2013. As a case study, the Texas ADT II (2009, Ghazni Province) developed and implemented 50 projects during the 2009 calendar year with 27 being detectable using time-stamped satellite imagery (n=6 years available). Diachronous photogrammetric analysis (2009-2018), including seasonal changes (e.g., agricultural growth), structure-extent changes and target-specific recognition, was used to record project longevity/impact. Over the past decade, 18% of project impacts are considered "positive," 59% are considered "no change" and 21% are considered a "loss" (2% were unplanned effects). Only two of the 27 projects are "positive" for the entire 10-year period - Ghazni Agriculture Complex and the Ghazni Minarets. The Arbaba National Environmental Protection Park showed no progress after 2010; however, it did spark adjacent home construction. Some failed projects were the Ghazni Experimental Farm (razed in 2010) and the cessation of operations at the Ghazni Demonstration Farm. It appears that even well-thought and meaningful development efforts provided by specialized soldier-expert teams working in and with the local communities on Afghan-first projects were not enough to overcome the exceedingly complex and difficult conditions that are development in Afghanistan. Despite these disappointing, "break-even," decade-scale results of ADT efforts in Afghanistan, the cost-benefit analysis of the ADT effort should be positive. Being years ahead of the academic and NGO literature, ADTs were what development agencies dream of and should be included in future military-development efforts.

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History of an Unexpected Enemy: Meteorology and Avalanches in the Alps during the First World War

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Keywords: First World War, extremely inhospitable environments, archival research Geographic Information Systems.

International historiography has paid little attention to the fact that certain characteristics of the First World War (WWI) (such as industrial warfare, total warfare, attrition warfare and mass-conscripted armies) have given, for the first time in history, the opportunity and determination to the armies to extend the battlegrounds to some extremely inhospitable environments.

In the Alpine mountain range, along a front approximately 600 km long, which even ran through places where no man had ever set foot, the armies of Italy and Austro-Hungary found themselves at war with an unexpected foe—nature. At times, this was more lethal than the weapons of the opposing army. For instance, according to some estimations, avalanche accidents determined one third of the total number of casualties on that front and resulted in two times more deaths than poison gas on the Western Front.

Despite many authors have recognized the importance and influence of meteorology and avalanches during the war, these studies still look fragmentary both from a disciplinary and methodological perspective. Starting from this consideration, my project aims to develop an interdisciplinary research focused on the role of these natural phenomena during WWI from a geographical, environmental historical and military historical perspective. The methodology is primarily based on archival research of military documents as well as on the use of Geographic Information Systems. The results will present a large scale picture of the consequences (such as characteristics of casualties) and causes (for instance, uncommonly extreme weather conditions, lack of the armies' preparation and haughtiness of the commanders) of avalanche accidents.

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ME VE
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Montebelluna

IAG Geomorphology Geomorphologie AIG

Società Geologica Italiana 1881 Mente et Malleo

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AIGeo Associazione Italiana di Geografia Fisica e Geomorfologia

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