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A new evaluation approach of World War One's devastated front zone: A shell hole density map based on historical aerial photographs and validated by electromagnetic induction field measurements to link the metal shrapnel phenomenon

Nicolas Note[a,*], Wouter Gheyle[b], Hanne Van den Berghe[c], Timothy Saey[a], Jean Bourgeois[b], Veerle Van Eetvelde[c], Marc Van Meirvenne[a], Birger Stichelbaut[d]

[a] Department of Soil Management, Ghent University, Coupure Links 653, 9000 Gent, Belgium
[b] Department of Archaeology, Ghent University, Sint-Pietersnieuwstraat 35, 9000 Gent, Belgium
[c] Department of Geography, Ghent University, Krijgslaan 281 S8, 9000 Gent, Belgium
[d] Centre for Historical and Archaeological Aerial Photography (Ghent University, In Flanders Fields Museum), Ypres, Belgium

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ABSTRACT

Since the end of World War One, only few research is performed to understand the extent of the destruction of the first meters of soil archive at the former Belgian front zone. The only existing sources identifying the by artillery destroyed landscape are maps indicating destruction at the level of administrative communities, based on war damage inventories. Even a century after the war, there is a need to gain more detail in the historical destruction at a landscape or parcel scale. Unlike in neighboring country France, the Belgian authorities allowed a complete repopulation of the front zone, which results in an ongoing confrontation between ground workers (farmers, construction workers, archaeologists, etc.), the war's heritage (trenches, bunkers, graves, etc.) and its dangers (unexploded ordnances, UXO). Metal shrapnel and the high rate of unexploded shells (up to 30% of the fired projectiles) are typical remnants of this trench warfare. The localization of these phenomena is also useful to simulate the extent of the war's environmental impact and the intensity of possible UXO-finds. To inventorize destruction and the related metal shrapnel pollution (MSP), we propose a new mapping method based on a sampling strategy to digitize shelling densities, derived from historical aerial photographs. This data source allows us to characterize almost every single parcel in this mainly agricultural area. By classifying the derived shelling densities, destruction classes can be distinguished to describe the impact on landscape and soil archive. The translation of the destruction map into a map indicating the level of buried metal shrapnel, was possible due to the direct relation between shells, metal shrapnel and shell holes. A validation with the buried metal objects was performed with metal parameters derived from electromagnetic induction field surveys. These scan results indicated a strong relation between shelling densities and the buried metal clutter. Based on the findings in this research, we offer tools to create an accurate destruction map that can be directly related to the occurrence of WW1 relicts within the soil archive.

1. Introduction and research goals

The four year stalemate in the trenches during World War One (WW1) in Belgium was concentrated in a narrow front zone between Nieuport, Dixmude and Ypres down to the French border (Keegan, 2013). The artillery shelling of the front area completely obliterated villages, towns and countryside. The landscape was in many places converted into a lunar-like environment peppered with uncountable numbers of shell holes (Debaeke, 2013; Stichelbaut, 2006). The

artillery's environmental impact in this part of the WW1 front zone was amongst the most impressive examples in history (Pearson et al., 2010). The effect of heavy shelling had an enormous destructive impact on the first meters of the soil archive. If we look at the number of shells fired during the preliminary bombardments prior to the two most heavily fought over battles in Belgium (battles of Messines and Passchendaele, 1917), an accumulated 7.8 million projectiles were used (His Majesty's Stationery Office, 1922). The battles in this region reached a climax during the summer of 1917. Hundred years after the start of WW1, the
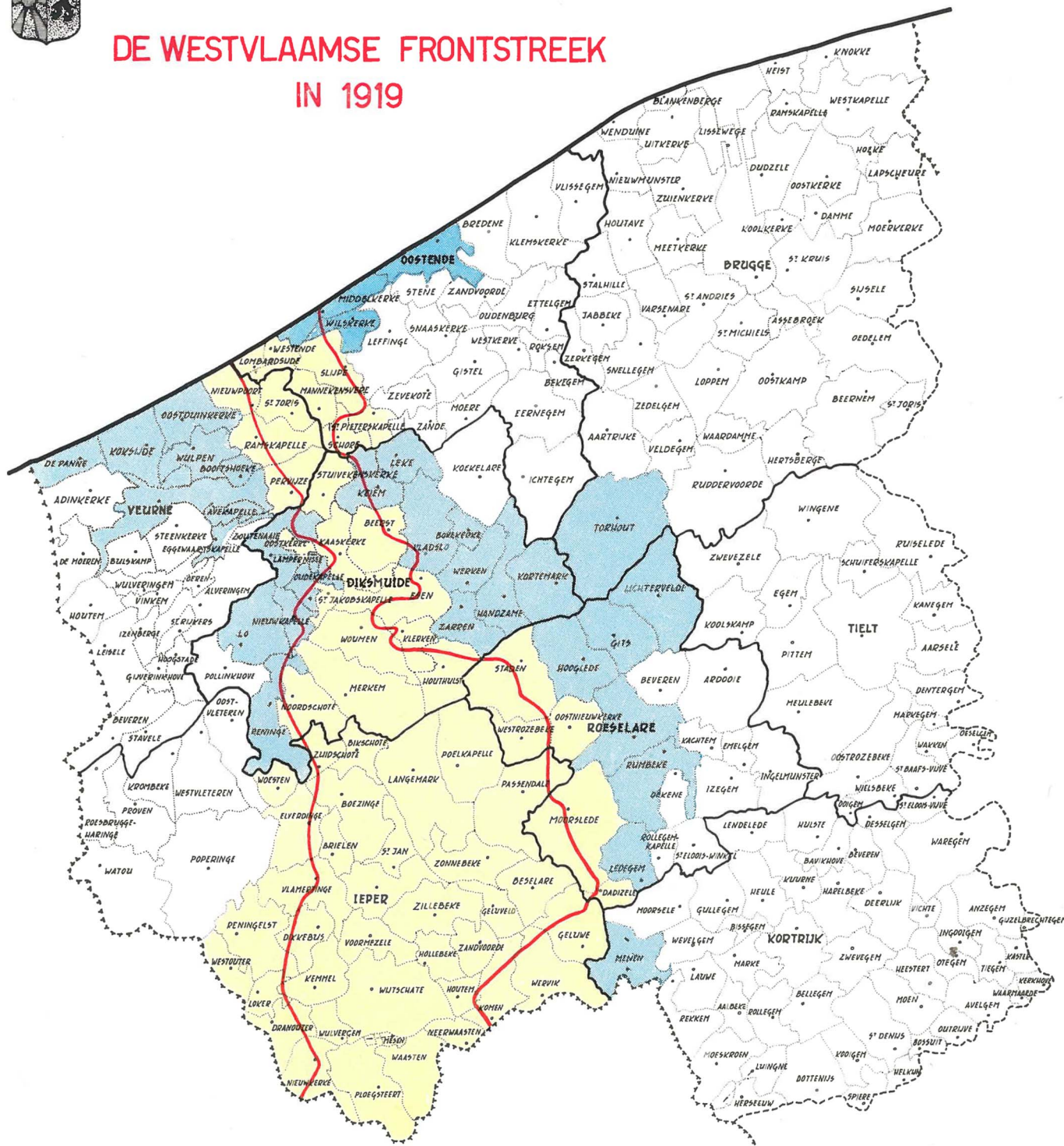

Fig. 1. The map of the devastated regions in Belgium, published by Van Outryve d'Ydewalle and Viaene (1958), indicating the destroyed villages (yellow), the partial destroyed villages (blue) and the complete destroyed agricultural grounds (between the red lines). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

actual extent of the destroyed landscape and its traces within the soil are still unclear. Iron clutter such as metal shrapnel, shells and construction materials are still omnipresent today, even after clearance of the fields directly after the war (Desreumaux, 2011).

Unlike the French government, the Belgian authorities allowed after the war a repopulation of the front zone without any restrictions. As a result, the front zone inhabitants and ground workers are confronted with war related dangers on a daily basis. A detailed and objective historical destruction map on parcel level does not exist, although such map and its derivatives would be useful instruments in government related administrative procedures, such as decision-making steps for land development in formal war zones. Therefore a high quality map is