Military inundations at the Yser front: the groundwater perspective

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ABSTRACT

The last week of October 1914 was a decisive period during the Great War. The German advance through Belgium could only be stopped by a military inundation of the polders near the river Yser. A number of hydro(geo)logical questions about this famous inundation are discussed. It is shown how water management of the polder area, composition of the subsurface and a chance factor, i.e. the weather, all contributed to the efficient realization of the inundation and the successful maintenance of it until 1918.

INTRODUCTION

On 9 October 1914, after two months of constant retreat for the Belgian and Entente armies, the Belgian king elected to make a stand at the river Yser to defend the last part of Belgian soil (figure 1). However, the situation was desperate: the worn-out Belgian army faced a far better equipped German IVth army. Therefore a plan to inundate part of the polders was implemented.

The coastal town of Nieuwpoort was of crucial importance since it is the location of a lock complex (Ganzepoot, translated as 'goose foot') where six waterways come together (figure 1a): three canals used for shipping and three canals used to discharge drainage water from the polders. Consequently, the Ganzepoot provided the key to inundate the polder. This was put into effect when on the night of 21 to 22 October the polder of Nieuwendamme was flooded by opening a spring sluice of the Ganzepoot during high tide. The objective was to protect the left flank of the Belgian army from German attacks. But the main action to stop the German advance was to inundate the polder between the Yser and the Nieuwpoort to Diksmuide railway. The inundation combined with the topographical height of the railway embankment would form a strong defensive position. After less successful attempts starting on 26 October, an effective inundation started on the early morning of 30 October. Seawater was able to enter the area during a number of consecutive nights during high tide. This was right on time to initiate a retreat of the German army to the right bank of the Yser. An initial period of open warfare evolved into a dead-end positional warfare whereby the inundation was maintained until 1918. Although the military history and operation of the lock system during these dramatic days is known (Van Pul, 2006), a number of hydro(geo)logical questions remain.

CURRENT DAY GROUNDWATER QUALITY

The water quality distribution was mapped by De Breuck et al. (1974) 50 years after the conflict using a geophysical survey. It shows a fresh-saltwater distribution which is typical for the coastal plain (figure 1b): saline water is close to the surface in topographical low areas and freshwater lenses occur under the higher areas. This is a result of the displacement of old saline water by freshwater due to the impoldering which occurred during the Middle Ages. The topographical lower areas contain a dense drainage system which means that almost no recharge takes place to flush the saltwater. The topographical low areas have also less permeable sediments (peat, mud and clay) in the subsurface than the higher grounds (loam and sand). A top clay layer is in general thicker in the topographical low areas. Interestingly, the observed distribution does not provide evidence of (relatively) recent recharge by saltwater.

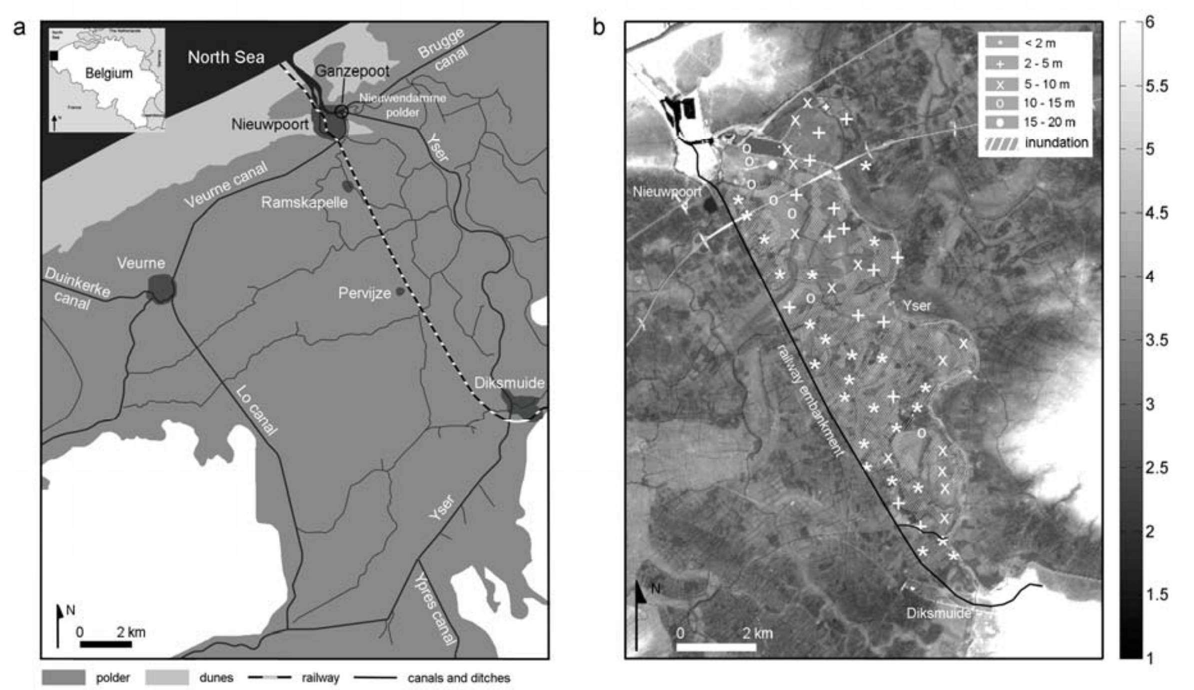

Figure 1. General map of the study area (a) and topographic map (m TAW, whereby 0 mTAW corresponds with low sea water level) of the inundated area with indication of the depth of the 1.5 g/L interface (symbols) (b).

Also, a more detailed look at water samples does not show recent salinization due to the inundation or freshening due to the restored freshwater recharge after the war. Water chemistry, and base exchange index is in line with what is found in the remainder of the coastal plain typified by the freshening due to the impoldering. Moreover, the brackish and saline samples indicate a lagoonal type, characterized by high alkalinity combined with extremes in sulphate reduction. This is in line with the mud-flat landscape present before the impoldering.

A 2D conceptual groundwater flow model (using SEAWAT) was made to better understand the lack of remnants of the inundation in the current water quality. It represents an east-west cross-section through the inundated area at a location where the current topography is considered more or less equal to the 1914 levels. In a first step, the formation of freshwater lenses due to the Medieval impoldering is simulated using the data of De Breuck et al. (1974) as an indication of the interface location. Interestingly, the top clay layer must be assigned a very low permeability to obtain the observed thicknesses for the freshwater lenses. Otherwise, almost the complete aquifer becomes fresh to brackish. Consequently, almost no saltwater recharges the aquifer when the effects of the inundation are simulated. It is therefore not surprising that no remnants of the inundation become obvious in the current-day salinity distribution.

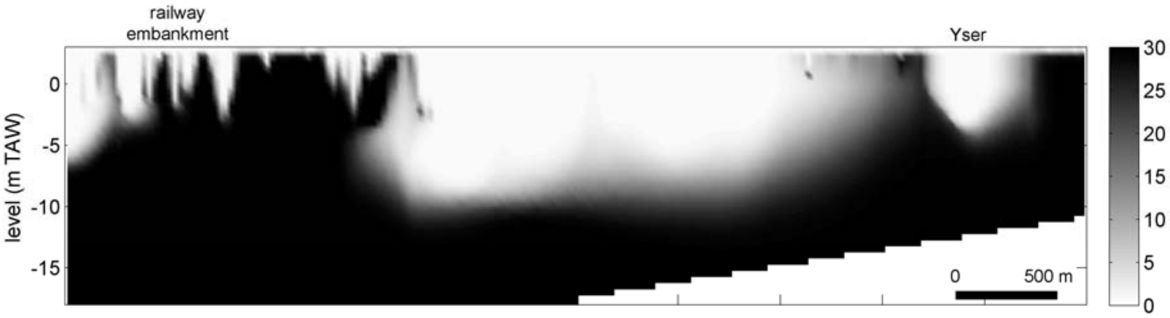

Figure 2. Simulated salinity distribution (g/L) before the inundation.

EFFICIENCY OF THE INITIAL INUNDATION

In the night of 29 to 30 October, a gate at the Ganzepoot was opened for the first time. Surprisingly, Germans soldiers near Ramskapelle already stood ankle-deep in mud and water during the morning hours of 30 October. The next day, only the higher grounds protruded above the water almost up to Diksmuide. The speed and the effect of the inundation is intriguing.

A number of factors contributed here. Although October 1914 was not exceptionally wet (42 mm at Ukkel), a number of days with heavy rain occurred: 13, 19, 25, 26 and 28 October. The low permeability of the top clay layer hampered infiltration of this rainwater and the soil was thus saturated. Rainwater must normally be collected by the different ditches and be discharged at low-tide through the Ganzepoot system. However, the lock staff left the construction on 18 or 19 October because it became too dangerous to stay. This meant that the polder between the Yser and the railway embankment was not drained for more than a week at the time of the inundation. Letters from German soldiers describe indeed the difficulty caused by the waterlogged fields during this period. So, the combination of a number of factors resulted in an already water saturated polder when the seawater was allowed to enter, explaining the efficiency of the inundation. It should be noted that the sea level was not especially high. Moreover, the inundation was realized during a period of neap tide. The minor importance of the sea level can be explained by the fact that the amount of water discharged into the polder was mainly determined by the dimensions of the gate.

PRESERVING THE INUNDATION

The inundation was preserved until the final offensive in 1918 and the crucial Ganzepoot was only destroyed by artillery fire in October 1918. The maintenance of the different hydraulic constructions is well-known (Thys, 1922). However, details of how the inundation was maintained are lacking. A key question is for instance how rainwater contributed relative to sea water.

The fact that the hydrography of the area is completely artificial already provide an answer. Without drainage and discharge of surplus water to the sea, the polder is flooded. This suggests that addition with rainwater was sufficient to maintain water levels during winter. During summer, due to the higher evaporation, water levels lowered, urging the need to bring additional seawater in the area. The low permeability of the subsurface is also an important factor since it prevents the infiltration (and loss) of large amounts of water. It also prevents important seepage of water in the adjacent fields, for instance west of the railway where the Belgian positions were. Descriptions of when extra seawater was allowed to enter the inundated area are scant. However, in the winter of 1914-15, water had to be evacuated from the inundated area because stability of the railway embankment was at risk, endangering Belgian positions. During summer 1915, it is known that sea water had to be routed to another inundation southwest of Diksmuide. It would be surprising if this was different for the inundation between Nieuwpoort and Diksmuide. Finally, Massart (1920) identified gradients of fauna and flora in the area. He argued that the area north of Pervijze was dominated by saltwater. An in time variable water quality, i.e. because of rainwater, was present between Pervijze en Diksmuide.

Figure 3. View on the inundated land near Ramskapelle (Thys, 1922).

DISCUSSION AND CONCLUSIONS

The subsurface and the water management system made the polder at the Yser an ideal environment for an inundation. Low permeability of the soil, rainy weather, inactivity at the Ganzepoot to discharge drainage water during the preceding week and the audacity of a few men to operate the gate in full view of an enemy all contributed to the efficient inundation realized at the end of October 1914. The with rainwater waterlogged fields, provided a welcome chance factor to obtain a rapid inundation. The same factors made that the inundation could be sustained until 1918. Careful water management, i.e. managing the surplus rainwater in winter and adding seawater during summer but meanwhile maintaining the drainage of unoccupied polder land, was thereby the key issue.

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