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Rapid development and infilling of a buried gully under cropland, central Belgium

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Abstract

Analysis of contemporary and past gully erosion and infilling processes allowed to reconstruct the long-term evolution of a permanent gully system under cropland. An active and a buried gully under cropland were investigated. The recent sediment deposits within the active gully, adjacent to the buried gully, showed that the recent gully was filling in at a mean rate of 6.4 cm a^{-1}. In the buried gully, several erosion and deposition phases could be identified and the type of deposited sediments revealed a complex infilling history. Charcoal, pottery and brick fragments of different sizes were found at all depths of the gully infilling. Their age indicates that the first gully incised after the midst of the 17th century, most probably in the second half of the 18th century or the early 19th century. Gully morphology and analogy with the processes in the recent gully indicate that the buried gully filled in rapidly. Overall, five cycles of cut and fill occurred in 350 years or less and four

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cycles even within little less than a few decades, indicating that gully development and infilling under cropland can be very rapid processes.

Keywords: Central Belgium; Past gully erosion; Sediment deposition; Land use

1. Introduction

Many studies in the Belgian loess belt and in Western Europe in general have already pointed to the problem of intense gully erosion under cropland (e.g. Poesen, 1989; Poesen and Govers, 1990; Baade, 1994; Auzet et al., 1995; Vandaele et al., 1996; Nachtergaele et al., 2001). Under cropland, most present-day gullies that develop are ephemeral since they are filled in by ploughing before they can develop into permanent gullies (Poesen et al., 1993). Large permanent gullies are rarely observed under cropland, whereas in many west-European forests they can be easily found. It is often assumed that most of these large permanent gullies under forest originally formed under cropland. Consequently, most authors investigating past gully erosion study old gullies that are conserved under forest (Vogt, 1953; Gullentops, 1992; Bork et al., 1998; Poesen et al., 2000, 2003; Dotterweich et al., 2003; Gábris et al., 2003; Vanwalleghem et al., 2003). For various gullies under forest in Germany, Bork et al. (1998) and Dotterweich et al. (2003) found that they were caused by an intensive agricultural land use in combination with extreme rainfall. Vogt (1953) concluded that land use was the main driving factor for catastrophic gullying in northeastern France in the 18th century.

It is not well known, however, what happens with large gullies once they form under cropland and their catchment remains under cropland. Few studies have investigated the expansion of a gully or a gully network (e.g. Graf, 1977; Kosov et al., 1978). Nachtergaele et al. (2002a) described the evolution of a permanent gully under cropland in central Belgium over 13 years based on the monitoring of gully morphology. Gully length and surface area appeared to be expanding in time, but at an asymptotically decreasing rate. Total gully volume, however, first increased and then decreased over time due to sediment deposition in the gully. Sediment was trapped by plants colonising the gully bottom and hence increasing the surface roughness.

To our knowledge, no studies have tried to measure these infilling rates directly. Only in an archaeological context were comparable monitoring experiments made on infilling rates of experimental earthworks, mostly ditches (Wainwright, 1994; Bell et al., 1996; Bork et al., 2003). Ditches are however not directly comparable with gullies. Besides their different morphology, ditches are often adjacent to walls (made up of the excavated material), which provide a lot of sediment, and their topographical position is also completely different from gullies (respectively, parallel and crossing the contour lines).

Therefore, this study investigates the rate of infilling of a permanent gully and the long-term evolution of a gully under cropland. By monitoring the sediment deposition