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EDITORIAL

Gully erosion as a natural and human-induced hazard

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Gully erosion is an important environmental threat throughout the world and affects multiple soil and land functions. There is ample physical evidence of intense gully erosion occurring at various times in the past in different parts of the world. Gullies are one of the few sources of morphological evidence in the landscape of past phases of intense soil erosion, reflecting the impact of environmental change (especially due to interactions between geomorphological features, changes in land use and extreme climatic events).

Gully erosion represents a major sediment source, although gully channels often occupy <5 % of the area of a catchment. The development of gullies increases run-off and sediment connectivity in the landscape, hence increasing the risk of flooding and reservoir sedimentation (Verstraeten and Poesen 1999; Poesen et al. 2003). Assessing interactions between environmental change and land degradation is a key issue for environmental scientists, land managers and policy-makers.

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Over recent decades, significant progress has been made in understanding gully erosion, its controlling factors and associated processes. However, many research questions remain, including gullying mechanisms, human impacts on gully erosion and gully control measures. These questions pose major challenges to the scientific community (Poesen 2011). Gully erosion is a potentially lethal geomorphological process and thus constitutes a major threat to life and property. Hence, geomorphologists can play vital roles in decreasing the threats posed by gully erosion.

Gullying is one of many natural processes that shape the surface of the earth and represents a manifestation of catchment instability. It is only when gullies threaten humankind that they represent a hazard. In the loess regions of Europe, Asia and America, for example, gully erosion might be the most important geomorphic natural hazard. Under these circumstances, geomorphologists face major challenges in making society aware of the impacts of gully erosion.

There are two generally accepted definitions of "hazard." The first refers to a potentially damaging process or situation (such as a landslide or gully). The second definition is more technical and refers to both processes and the probability of occurrence in a unit of time of a given magnitude event (Crozier and Glade 2005). However, population pressure and specific human activities (such as deforestation, improper land use and agricultural practices) have generally increased land degradation and particularly the hazard of gully erosion. From this perspective, gully erosion hazards could be natural, human-induced or both. Some studies emphasized that phases of gully erosion in historical periods were directly related to intensive agricultural land use and more erosive rains (Dotterweich 2008, 2012; Dotterweich et al. 2012; Avni 2008).

Gully erosion causes numerous environmental and socio-economic consequences, and most of them are negative (Poesen et al. 2003; Valentin et al. 2005; Marzolff et al. 2011; Ionita 2011). The initiation and development of both ephemeral and permanent gullies can be regarded as an indicator of land degradation (Poesen et al. 2006; Boardman et al. 2003;

Fig. 1 Valcioaia gully in the Falciu Hills of eastern Romania (10 May 2005). Mean depth is 11 m, and mean width is 17 m at 20–25 m downslope from the headcut

Schuler et al. 2006). Gully development decreases the extent of agricultural land, can decrease farm productivity by incision into land and/or depleting soil resources and can thus decrease crop yields (Li et al. 2004; Zgłobicki et al. 2015; Ionita 2006; Ionita et al. 2006; Solé-Benet 2006). Negative economic effects of gully erosion have been reported in numerous case studies (e.g. Kuhlman et al. 2010; Moges and Holden 2008; Yitbarek et al. 2012; Frankl et al. 2013).

This Special Issue comprises 14 papers, most of which were presented at the "6th International Symposium on Gully Erosion in a Changing World (6th ISGE)." This Symposium continued the sequence of successful meetings held in Leuven (Belgium, 2000), Chengdu (China, 2002), Oxford (USA, 2004), Pamplona (Spain, 2007) and Lublin (Poland, 2010). The 6th ISGE, hosted by the "Alexandru Ioan Cuza" University of Iaşi (Romania) from 6 to 12 May 2013, brought together over 50 scientists from all continents to discuss the latest advancements and challenges in gully erosion research. The objectives of the Symposium were to communicate exciting scientific developments, to identify current gaps in knowledge and to discuss ways in which soils and land can be better managed to meet the challenges of protecting the environment against the impacts of climate change and increased human-induced pressure. Two field excursions illustrated various aspects of severe gully erosion in the Moldavian Plateau of East Romania (Figs. 1, 2).

Since the order of papers is logical, we decided not to formally divide the Special Issue into sections. The Volume begins with a paper by Bennett et al. who describe the emergence, persistence and organization of rill networks within an experimental flume. The authors tackle an important research question concerning morphometric constraints in gully formation and its spatio-temporal dynamics. Then, the paper by Maerker and Zakerinejad tries to integrate different approaches (i.e. use of remote sensing techniques and models) for estimating soil loss due to rill and inter-rill erosion with a stochastic method for predicting "gullied" soils, in an area subjected to severe erosion in south-west Iran. The

Fig. 2 Puriceni-Bahnari active gully head during snow-melt on 20 March 2006. Mean gully depth is 12.4 m, and mean width is circa 21 m downslope from the bifurcation

next paper by Torri et al. contributes to an important ongoing discussion about the definition and interpretation of slope–area thresholds for gully initiation. The establishment of such thresholds is a widespread technique to compare gully initiation under varied land use, climatic and other environmental conditions and represents a promising tool for models aiming to predict gully initiation or erosion. Vergari proposed a new tool to evaluate soil erosion hazard in a severe gullied area (calanchi or badlands) of central Italy. Momm et al. offer an automated methodology to enable detailed monitoring, in both space and time, of the width of eroded channels in laboratory conditions. Based on long-term field measurements and associated time series maps, Ionita et al. discuss chronosequences of gully development in eastern Romania. Here, gully systems have been mainly initiated by human activities and often subsequently trigger landslides. The paper by Kociuba et al. provides information on landscape dynamics and associated hazards, by using terrestrial laser scanning (TLS) and conventional survey approaches in the loess area of south-east Poland. Perhaps surprisingly, Zgłobicki et al. illustrate that these gullies also provide interesting opportunities for educational purposes, as forested gully systems form attractive geo-touristic sites. Su et al. examine the effects of land cover on gully morphodynamics in a dry-hot region of Yunnan Province, south-west China. They manipulated conditions in a controlled in situ field experiment and quantified erosion processes and rates that are hard to observe in nature. The paper by Moeyersons et al. sheds new light on hydrological processes controlling the development of mega-gullies from urbanized areas in the rapidly growing cities of developing countries in tropical climates. Maerker et al. assess gully erosion dynamics in northern Tanzania using improved digital elevation models (DEMs) and demonstrate the utility of publically accessible data (i.e. Google Earth) in scientific research for areas where there are no other available data or where the amount of data is limited. Jurchescu and Grecu show that spatial scale dependence represents an open research topic and this is important for both the scientific community working on models of gully erosion susceptibility assessment and for decision-makers. Gómez-Gutiérrez et al. make a methodological contribution to gully studies by focusing on cause–effect relationships between the considered variables. Unfortunately, due to an involuntary error, the paper by Guerra et al. has already been published in another NHAZ volume of 2015. However, it is considered as being part of this Special Issue as mentioned in the Erratum and investigates gully control using biological geotextiles in Maranhão State, north-east Brazil.

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significant contribution to the field of gully erosion and become an important scientific volume for those dealing with gully erosion and its consequences.

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