SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Physical Geography

has the honor to invite you to the public defense of the PhD thesis of

Liuelsegad Belayneh Bunare

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Gully erosion in the Southern Main Ethiopian Rift: characteristics, spatial-temporal distribution, and sediment yield

Promotors:
Prof. dr. Matthieu Kervyn (VUB)
Dr. Olivier Dewitte
(Royal Museum for Central Africa)
Dr. Guchie Gulie (Arba Minch University)
Prof. dr. em. Jean Poesen (KULeuven)

The defense will take place on
Tuesday, June 27, 2023 at 10h in auditorium D2.01

Members of the jury

Prof. dr. Frank Canters (VUB, chair)
Prof. dr. Margaret Chen (VUB, secretary)
Prof. dr. Benoît Smets (VUB)
Prof. dr. Matthias Vanmaercke (KULeuven)
Prof. dr. Ann Verdoodt (UGent)

Curriculum vitae

Liuelsegad Belayneh holds a bachelor of science degree in Agricultural Resource Economics and Management, and an MSc degree in Soil and Water Conservation Engineering, from Hawassa University, Ethiopia. He has benefited from a VLIR-UOS PhD scholarship for his research in the framework of the Inter-University Cooperation program with Arba Minch University. He has published one scientific article from his PhD research. He has supervised several bachelor's and master's students theses. His research interest is in soil (gully) erosion and soil and water conservation measures.

Abstract of the PhD research

Land degradation is a well-known environmental threat in sub-Saharan Africa. Gully erosion - one of the key land degradation processes – has been attributed to recent human-induced environmental degradation as well as the long-term topographical evolution of the landscape. In the Southern Main Ethiopian Rift, gully erosion is identified as an important land degradation process, but, until now, it has remained understudied. In this research, we investigate gully erosion processes in four river catchments of lakes Abaya and Chamo, in the Southern Main Ethiopian Rift, with the aim to (i) characterize the type of gullies and their interaction with landslides and rift formation; (ii) understand the susceptibility patterns associated with the gully life cycle, and (iii) assess the contribution of gullies to the total catchment sediment budget.

Through Google Earth imagery and field surveys, we mapped a total of 7336 gullies across the four catchments. The presence of a large proportion of active gullies highlights that gully erosion is a widespread erosion process in the region. Large old and inactive landslides, with a potential seismo-tectonic origin, contribute to the landscape dynamics by favouring the occurrence of gullies. We find that large percentages of severe to extremely degraded areas are located in rejuvenated landscapes - a landscape actively incised due to the upward migration of tectonic knickpoints.

Assessing the life cycle of gullies helps to understand the environmental conditions under which gullies initiate, expand, and stabilize. Here, the life cycle of gullies was modelled using both gully initiation points and active or inactive gully heads. Highly susceptible areas for gully initiation are mainly located in rejuvenated landscapes downslope of rifting-associated knickpoints. On the other hand, convex slopes with a more diffusive characteristic favor stabilization of gullies.

Combining historical reconstruction of gully geometry with elderly people, aerial photographs, and drone mapping we quantify gully volume and erosion rate; establish a volume-length relationship; and estimate the total volume of sediment contributed by gullies. Gully erosion rates observed between the years 1965 and 2020 is much higher than between the 1940s and 1965. The large proportion of soil loss contributed by gullying suggests that gully erosion is an important source of sediment production. The results of this thesis highlight the need to implement mitigation measures to reduce gully sediment production affecting the downslope ecosystems of lakes Abaya and Chamo.