Session L04 – Invited speaker

From monitoring to modelling soil erosion and sediment transport in gullied tropical savanna catchments

Maarten Wynants[1,2], Nic Doriean[2], John Spencer[2], Will Bennett[2], Pascal Boeckx[1], Andrew Brooks[2]

[1] *Isotope Bioscience Laboratory (ISOFYS), Department of Green Chemistry and Technology, Ghent University, 9000 Gent, Belgium*
[2] *Precision Erosion and Sediment Management Research Group (PrESM), School of Environment and Science, Griffith University, Gold Coast Campus, 4222, Australia*

Abstract: Sediment and particulate nutrient loads to the Great Barrier Reef have been observed to increase over the past decades (Guo et al., 2025), a process that started with the onset of European settlement and land use in the region (Bartley et al., 2018). The main cause of the degrading water quality by sediment and nutrients results from accelerated erosion of soil resources, wherein subsurface gully and riverbank erosion on deep tropical and alluvial soils has been shown to be the dominant source of sediment (Brooks et al., 2013). However, these soil loss processes tend to happen in stochastic burst during storms and associated flooding events. Little is known about the impact of these rapid geomorphological changes on fine sediment and particulate nutrient connectivity in tropical savanna catchments. These caveats in our understanding of soil erosion and sediment transport responses to extreme events are a major hindrance for attribution to environmental drivers. These challenges are further compounded by a lack of suitable approaches for quantifying and modelling catchment erosion and sediment transport processes during storm events in these remote and unpredictable environments. Using an hierarchical catchment approach in the Bonnie Doon Creek of the lower Burdekin, Australia, this study assesses fine sediment and phosphorus transport during the 2024/2025 flood season. We introduce a novel sediment tracing tool based on secondary weathered metal species that provides a new pathway for attributing the contribution of different subsurface layers in deep tropical soils. This novel tool is integrated within established techniques, resulting in a dynamic sediment budget to elucidate non-linear geomorphological responses to extreme events. Our results highlight the dominance of alluvial gullies to the sediment losses towards the Great Barrier Reef. We demonstrate shifting importance of source contributions and gully erosion processes throughout and between storm events. Moreover, we provide evidence for the positive feedbacks of gullies on land and water degradation through increased connectivity and the dissolution of P-holding carbonates. Finally, we introduce SWAT+-Gully concept that integrates open-access gully maps as hydrological response units to both model sediment generation by erosion, but also influence water and sediment connectivity. In the future, this gully-inclusive catchment model will allow us to test the impacts of future climate change on sediment and nutrient loads, as well as land management plans to reduce loads to safeguard future reef and freshwater ecosystems.

Keywords: *Gully erosion, sediment connectivity, phosphorus, Great Barrier Reef*

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