Source and effects of sediments
in medium to large scale catchments across three continents

1. Summary of the research plan

Recent research on soil erosion demonstrates that ultimately land use and management in combination with climate change, especially expected climate extremes will drive soil redistribution and thus sediment input to rivers, streams and oceans in a changing world. To stabilise soils to support future sustainable land use and to minimise detrimental high sediment loadings to rivers requires tools to attribute sediment production to specific land use and management effects in catchments. This proposed project aims at testing the suitability and application of compound specific stable isotopes (CSSI) as tracers for sediment source attribution to specific land use and land management in small to large scale catchments (70 – 35 000 km^2; WP1). Simultaneously, modelling sediment delivery (WP2) and assessment of sediment transfer using a geochemical tracer with the example of phosphorus loads to rivers (WP3) will support and complement sediment tracking with CSSI. Here, our main aim is not the determination and modelling of absolute rates of sediment delivery and P loads to freshwaters, but rather assess the relative contribution of different land uses in differing climate and vegetation settings from small to larger scales. As test sites we chose two European catchments (River Dee and a sub catchment of River Rhine), one North American (Delaware River) and one Chinese catchment (sub catchment of the Yellow River). Selection of tests sites was based on (i) established monitoring programs, (ii) catchment specifics deepening our understanding of method application and process understanding as well as guaranteeing feasibility of the project and, last but not least, (iii) inspiring and reliable collaboration partners adding scientific and local knowledge and data to the project. Each of the sites have specific sub aims and challenges. We will rigorously evaluate the challenges of upscaling sediment source attribution with CSSI as well as modelling sediment and P transport from small (70 km^2) to large scale (2100 km^2) in the Scottish River Dee and the sub catchment of the Swiss/German Rhine. The Rhine sub catchment will also be our specific test site to investigate the influence of particle size and concentration effects on CSSI based sediment source attribution as well as the influence of source soil heterogeneity. Due to the wealth of data and previous work done, the Delaware catchment will be the ideal site to investigate the role of riversides/ riparian strips: can they be considered as intermittent sinks for eroded sediments from nearby hillslopes or do we need to include them as independent endmembers? The approaches will also partly be applied to the challenging situation of one sub catchment of the Chinese Yellow River, where we can already build upon a basic but successful modelling application in the Luoyugou catchment (Scheper et al., 2023) with a high complexity of land use (e.g., secondary forests of multiple ages, diverse cropland use with C3 and C4 plants, the effect of terracing on sediment production) coupled to extremely high sedimentation rates. As such, this project will not only gain substantial knowledge from combining CSSI with modelling approaches to evaluate the influence of land use on sediment and P transfer from soils to freshwaters, but will also test these approaches from small to large scale under different climate and land use regimes.

Landnutzung und Landnutzungsänderungen sind hauptverantwortlich für Bodenerosion und damit den Sedimenteintrag in Flüsse, Bäche und Ozeane. Um nachhaltige Landnutzung zu unterstützen und schädliche hohe Sedimentbelastungen zu minimieren, muss die Sedimentproduktion spezifischen Landnutzungs- und Bewirtschaftungseffekten zugeordnet werden. Wir werden die Eignung und Anwendung von Biomarkern (insbesondere Komponentenspezifische stabile Isotopen (CSSI)) als Tracer für die Zuordnung von Sedimentquellen zu spezifischer Landnutzung von kleiner bis großer Skala (Einzugsgebieten von 70 – 35.000 km²; WP1) testen. Gleichzeitig wird die Modellierung des Sedimenteintrages (WP2) und die Bewertung des Sedimenttransfers unter Verwendung eines geochemischen Tracers am Beispiel der Phosphorbelastungen in Flüssen (WP3) die Interpretation der Ergebnisse der Biomarker – Tracer unterstützen und ergänzen. Unser Hauptziel ist hier nicht die Bestimmung und Modellierung absoluter Raten der Sedimenteinträge und P-Belastungen für Gewässer, sondern vielmehr die Bewertung des relativen Beitrags unterschiedlicher Landnutzungen in unterschiedlichen Klima- und Vegetationsbedingungen von kleinen bis größeren Skalen. Als Testgebiete haben wir zwei europäische Einzugsgebiete (Fluss Dee und ein Teileinzugsgebiet des Rheins), ein nordamerikanisches (Delaware River) und ein chinesisches Einzugsgebiet (Teileinzugsgebiet des Yellow Rivers) ausgewählt.