

Land Use Changes and Si Transport through the Scheldt River Basin. (LUSi)

Duration of the project: 01/01/2007 – 31/07/2009

Budget: 453.782 €

Keywords: Land use changes, Si transport, weathering, eutrophication, Scheldt basin

Context

This project refers directly to the objective of the domain 'Terrestrial and marine ecosystems of the North Sea', and to the European Water Framework Directive 2000/60/EU. The study includes an integrated approach combining a process study of Si-release and transfer to the North Sea with the construction of a policy supporting framework to quantify the effect of land use towards eutrophication remediation.

Several national and internationally funded research projects and networks focus on the risks of eutrophication posed by excess N and/or P input into freshwater ecosystems. However, there is until now, no integrated research project focusing on the potential role of changes in Si fluxes in the dynamics of freshwater ecosystems. It is precisely this gap that this research project, integrating the know-how of three Belgian research groups, attempts to fill.

Project description

Objectives

This project aims to answer the question if Si fluxes through a river basin, and ultimately towards the sea, can change because of land use changes. These changes will be budgeted for the Scheldt basin, taking into account surface runoff, subsurface drainage and storage and cycling through vegetation. The results will be used to evaluate the effect of land use changes over historical times on Si fluxes. Moreover, it is the aim to formulate recommendations towards land planning with respect to the reduction of eutrophication, working from the viewpoint of Si in the nutrient ratios. As such, this study of Si can provide a mirror image for the N and P side of the eutrophication problem, and provide invaluable, new insights in our evolving concept of eutrophication.

Habitat scale research towards surface erosion and subsurface transport of dissolved Si (DSi), and biogenic Si (BSi) and sediments (as an indicator for transport of mineral Si) will be conducted in different landscape types. On a Scheldt basin scale, rivers draining sub-basins, will be sampled on a regular basis for all BSi and DSi. The sampled sub-basins will represent a gradient from still largely forested to largely covered by cropland and grassland. The integration of results from both site-specific experiments and basin scale sampling will for the first time allow an estimate, based on both historical and recent land use maps, of the extent to which Si fluxes towards the coastal zone have been altered by human land use, and how this change has been triggered by changes in erosion processes, changes in vegetation type and cover, and hydrology.

Methodology

Habitat scale research towards surface erosion and subsurface transport of dissolved Si (DSi), biogenic Si (BSi) and sediments (as an indicator for transport of mineral Si) will be conducted in different landscape types. On a larger scale, rivers draining individual sub-basins within the

Scheldt watershed will be sampled on a regular basis for both BSi and DSi. The sampled sub-basins will represent a gradient from still largely forested to largely cultivated farmland. The integration of results from both site-specific experiments and basin scale sampling will allow to estimate, based on both historical and recent land use maps, the extent to which Si fluxes towards the coastal zone have been altered by human land use, and how this change has been triggered by changes in erosion processes, vegetation and hydrology.

Through the coupling of experimental results with existing models for sediment transport and subsurface hydrology, the results will be extrapolated to the scale of individual catchments. The model is then validated by data from a detailed survey of Si and sediment transport in individual river basins throughout the whole Scheldt basin. The results will show if Si release can enhance resilience against N and P enrichment of the river continuum, and as such, counter this threat of riverine, estuarine and coastal diversity. The sustainable management of the Scheldt basin requires a thorough understanding of interactions between ecosystems (both freshwater and marine) functioning, basin-wide biogeochemical nutrient fluxes, and land use, which are directly studied in this project for the unknown Si component.

Interaction between the different partners

All silica analyses will be performed at University of Antwerp, where also a large expertise is present on silica biogeochemistry. KUL and UCL have long-standing experience in sampling, studying and modelling basin-wide fluxes of water and sediments, both surface and subsurface. The interaction between geologists and ecologists provides a unique opportunity to map basin-wide silica fluxes in an integrated way.

Expected results

- Normally, around 4 manuscripts will be prepared or be in preparation for international peer-reviewed journals

Possible (preliminary) titles:

- Local Si retention and remobilization processes in agricultural and afforested areas
- Riverine DSi and BSi fluxes vs. watershed land use: Is Si flux really undisturbed?
- Modelling BSi and DSi fluxes on a watershed scale
- Land use and Si mobilization towards the coastal zone: new insights in the eutrophication problem
- Enhanced transport of BSi as a result of human land use

- A regularly updated website is available: www.ua.ac.be/LUSi

- A model for both subsurface and surface mobilization of Si on a basin scale should be available or in preparation

Partners

Activities

Coordinator: University of Antwerp, Ecosystem Management Research Group (ECOBÉ, Department of Biology)

The ecosystem management research group is involved in fundamental and applied research on ecological processes in watercourses and wetlands, as well as in research at the integrative level of management of ecosystems and river basins. These studies, both descriptive and experimental in nature, are integrated to predict the impact of different management options on the functioning and the biodiversity of the system.

Catholic University of Leuven (K.U. Leuven), Physical and Regional Geography Research Group (Department of Geography and Geology)

The Physical and Regional Geography Research group concentrates its research on the following research themes: Geomorphic processes including soil degradation and soil conservation, integrated spatial analysis, terrestrial ecosystems and environmental change and regional climate studies. Recently, the unit has broadened its research focus by studying the interactions between geomorphic processes and bio-geochemical cycles. The end products of the unit are newly developed tools and research concepts which are of relevance for policy makers and/or the broad environmental research community.

Université Catholique de Louvain (UCL), Department of Geography

The Department of Geography at the Université Catholique de Louvain has an international reputation in research in land-use/land-cover change within the rural sector, both in Europe and tropical regions. The laboratory of physical geography focuses on the dynamics of soil properties at the landscape and regional scale. Recently, the geographical and historical scale have been expanded to better include the effects of land use change on soil erosion and hydrology.

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