Marie Skłodowska-Curie

Innovative Training Network

"HypoTRAIN"

Hyporheic Zone Processes – A training network for enhancing the understanding of complex physical, chemical and biological process interactions

Grant Agreement No. 641939

Deliverable D1.1

Validation of integrated HPS and DTS method

Dissemination Level of Deliverable:

PU	Public	**X**
CO	Confidential, only for the members of the consortium (including the Commission Services)	
CI	Classified, as referred to in Commission Decision 2001/844/EC	

Contents

1. Heat Pulse Sensor development

The Heat Pulse Sensor (HPS) method was improved and extended by ESR 04 (IGB). The analysis routine was improved to allow the HPS to be deployed in new configurations (2D as well as 3D) and to allow calculation of error.

The HPS was used during the first joint field experiment (JFE 1) in the River Erpe, Germany, to provide crucial supporting data to ESR 14 in the development of a novel method for non-target passive sampling of micropollutants in surface water and the hyporheic zone.

Further trails of the HPS are currently being conducted at the Colorado School of Mines through at collaboration with Skuyler Herzog (external participant in JFE 1). Future trials will be conducted during at second JFE which will take place in June 2017 in Birmingham and also under laboratory conditions at the IGB in Q3/4 of 2017.

A publication on the improved HPS routine is currently in preparation and is expected to be submitted to a journal in Q4 2017.

2. Further achievements

In March 2017 Stefan Krause (UoB) gave a talk in the Water Resources Discipline Research Seminar at the United States Geological Survey (USGS). The presentation was titled "*The Good, the Bad, and the Ugly - Interacting Physical, Biogeochemical and Biological Controls of Nutrient Cycling at Ecohydrological Interfaces*". It provided a detailed overview on the research done in the working group of Stefan Krause to understand the complex processes driving and controlling the functioning of the ecohydrological interface (i. e., the hyporheic zone) regarding nutrient cycling.

Organizational principles ("*The Good*") driving hyporheic exchange flux were highlighted by the results of various empirical studies using distributed temperature sensing (DTS), combined with several approaches using heat as a tracer. Modelling studies by Tanu Singh (ESR 2) and Liwen Wu (ESR 5) from HypoTRAIN illustrate the role of hydrodynamic forcing through flood events on HEF.

In the following parts of the talk the perception of the role of HEF on biogeochemical cycling ("*The Bad*") and community structure and ecological activity ("*The Ugly*") was reviewed. Stefan concludes that the traditional perception of top-down-controlling does not reflect the complexity of the processes in hyporheic zones (Fig. 1). The abstract and the presentation can be found in the annex of this document.

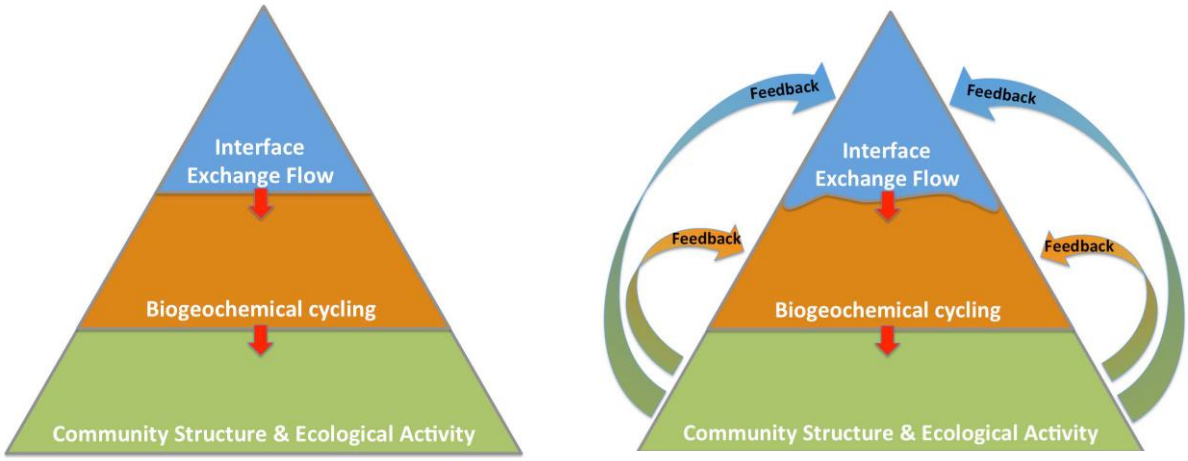

Figure 1. Drawings of the interactions of physical, biogeochemical and biological drivers of nutrient spiraling with the top-down controlling concept (a) and the reviewed concept including feedback mechanisms in (b).

Annex

"The Good, the Bad and the Ugly" (Abstract of presentation by Stefan Krause)

USGS
Water Resources Discipline
Research Seminar

Dr. Stefan Krause
University of Birmingham

The Good, the Bad and the Ugly

New Concepts for Integrating the Analyses of Physical, Biogeochemical and Biological Controls of Nutrient Cycling at Ecohydrological Interfaces

10 AM on Thursday March 30, 2017
Building 15, Rm 3245

Dr. Stefan Krause
University of Birmingham

The Good, the Bad and the Ugly
New Concepts for Integrating the Analyses of Physical, Biogeochemical and Biolological Controls of Nutrient Cycling at Ecohydrological Interfaces

The interfaces between streams, lakes and their bed sediments have for a long time been in the research focus of ecohydrologists, aquatic ecologists and biogeochemists. While over the past decades, critical understanding has been gained of the spatial patterns and temporal dynamics in nutrient cycling at sediment-freshwater interfaces, important question remain as to the actual drivers (physical, biogeochemical and biological) of the often observed hot spots and hot moments of nutrient cycling at these highly reactive systems. This presentation critically reviews current concepts of the interactions of physical, biogeochemical and biological drivers of nutrient spiraling under the impact of global environmental change. It therefore combines laboratory manipulation, artificial stream and field experiments from reach to river network scales and numerical models to investigate how physical, biogeochemical and biological drivers of nutrient cycling at ecohydrological interfaces interact, causing non-linear hotspot and hot moment behaviour. Our results indicate that biogeochemical hotspots at sediment-freshwater interfaces are not only controlled by reactant mixing ratios and bulk residence time in hyporheic or riparian mixing zones, but strongly affected by the patterns in streambed physical properties and bioavailability of organic carbon. Lab incubation experiments revealed how substrate properties, and in particular organic matter content controlled the magnitude of nutrient spiraling and enhanced streambed greenhouse gas production caused by increasing water temperatures. While these findings help to improve our understanding of overlapping physical and biogeochemical controls on nutrient cycling, we only start to understand to what degree biological factors can enhance these processes even further. Incubation studies revealed that for instance chironomid larvae or brittle star facilitated bioturbation has the potential to substantially enhance freshwater or marine sediment pore-water flow and respiration efficiency. Our results highlight that continued ignorance of these important biologically controls on physical exchange fluxes can lead to critical underestimation of whole system respiration and its increase under global environmental change.