Final report HypoTRAIN research project

Hyporheic Zones Processes

A training network for enhancing the understanding of complex physical, chemical and biological process interaction

Coordinator Organization: Forschungsverbund Berlin EV

Start - End: January 2015 - January 2019

1. Introduction

Hyporheic zones (HZs) are key compartments for the functioning of aquatic ecosystems. As dynamic and complex transition regions between rivers and aquifers, they are characterized by the simultaneous occurrence of multiple physical, biological and chemical processes. Turnover and degradation of nutrients and pollutants figure among the prominent ecological services the HZ provides. We are facing a significant knowledge gap in the understanding of how hyporheic processes are linked and how they impact on each other. This can be attributed to a lack of truly supra-disciplinary research and harmonized and innovative investigation methods.

The concept of HypoTRAIN has been tailored to fill this gap. Collaborative research with state-of-the art technologies from multiple disciplines (hydrology, ecology, microbiology, engineering, environmental physics, contaminant science, modelling) will generate new mechanistic insights into the functioning of HZs.

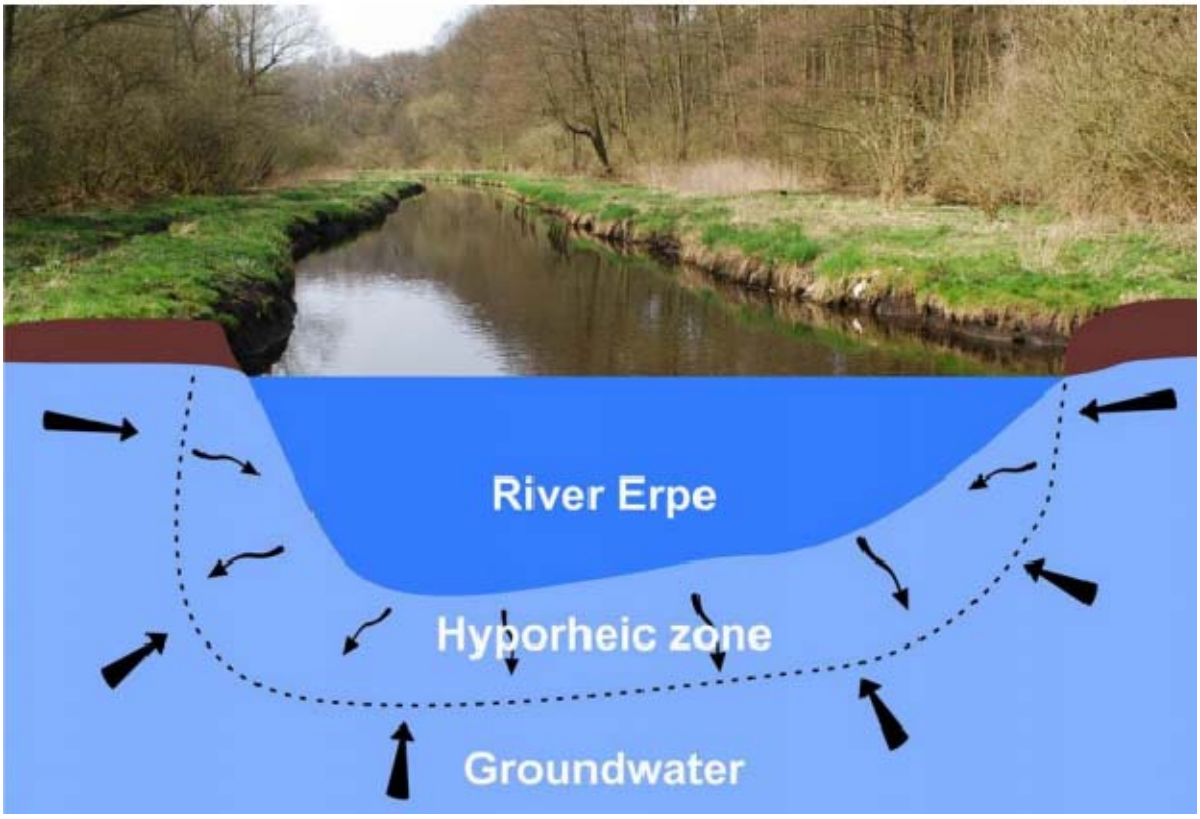

Fig 1: Scheme of the different layers in a River

The project leads by IGB (Leibniz Institute of Freshwater Ecology and Inland Fisheries) from Berlin presents the following 10 partners, all of them universities and research centers except from the company Naturalea

2. Institute Forschungsverbund ·Germany
3. The University of Birmingham · Great Britain
4. KTH Royal Institute of Technology · Sweden
5. Universitaet Bayreuth · Germany
6. EAWAG Swiss Federal Institute of Aquatic Science and Technology · Switzerland
7. IWW-Beratung GMBH · Germany
8. University of Roehampton RU · Great Britain
9. NATURALEA · Catalonia-Spain
10. River Restoration Centre · Great Britain

These partners will receive 12 researchers, who one of them will be working with Naturalea with the scientific supervision of Dr. Francesc Sabater from the Ecology Department of the University of Barcelona (UB).
The project has the support and the active participation from:

1. UNIVIE University of Wien · Austria
2. University of Flinders · Austria.
3. University Beb Gurion · Israel
4. Stockholm Environment Institute · Sweden
5. University de Barcelona · Catalonia - Spain

2. Dissemination of the project

Apart from the research done in the HypoTRAIN project, this project has a line of communication. This communication is internal in order that all the PhD's has common training to learn new concepts and with time to share know-how within them; but also is external to show the importance of rivers in conservation and the paper of research. Naturalea organized a three days training course in Sant Cugat Del Vallès to expose the river restoration work done in Europe and a visit to some jobsites with a detail explanation of the works; this event, in English was open to any technician interested in with more than 30 persons. In those days after the course, we also organize a public conference in Catalan open to all citizens about research and river restoration.


Fig 2: Meeting in Sant Cugat Del Vallès and visit to the Cànoves river project

Moreover, we have contributed to different conferences and workshops within the project. In the conferences, we give dissemination for what we were doing in this project and we participated in a river restoration conference about the investigation conditions of rhizosphere in macrophytic and non-macrophytic habitats in a lotic system in response to WWTP effluent unloading in the University of Roehampton (Nottingham, UK). In 2015, we contributed in a workshop in the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (Berlin, Germany) to give a talk about the bioengineering and a brief presentation on outcomes of the project of our PhD.

Fig 3: Workshop in Berlin, Germany

3. Studies

Within these 4 years project, our PhD has been working on four papers to understand the conditions that macrophytes create in relation to their bioremediation capacity. The study sites has been in the River Erpe (Berlin, Germany) and in the URL (Urban River Lab) in Montornès Del Vallès, Barcelona.

Paper 1: Biochemical cycling and pharmaceutical attenuation in an urban lowland river

In a joint field experiments with others PhD researchers in Berlin, the main objective was to analyze the impact of macrophytes on pollutant degradation. Pore-water was extracted from sediments in the rhizosphere of native macrophytes in River Erpe (*Sparginum emersum* and *Potamegeton pectinus*). As a control, pore-water was also sampled from non-macrophyte river sediments. Samples were taken along a reach of approximate 2 km, with two sampling points upstream of the WWTP discharge and at the confluence and three downstream of the confluence.

To understand better the rhizosphere conditions, it is important to know that the rhizosphere is the environment where interactions between plants roots, soil and microbes alter significantly soil physical and chemical properties.

First results imply that interactions between plants roots and soil significantly alter soil physical and chemical properties.

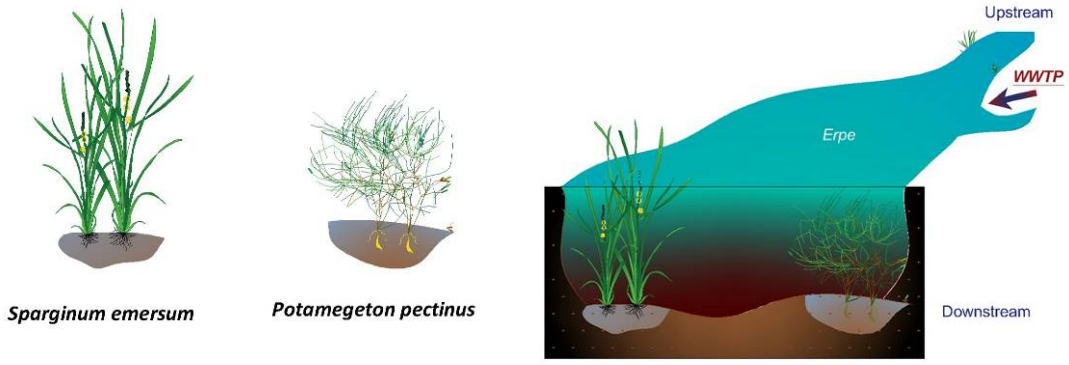

Fig 4: Species selected for the experiment and scenario for the study in River Erpe

Paper 2: The impact of floating islands in greenhouse effects

The focus of this paper is compiling the potential adverse effects, if any, commonly cause by gases of the aquatic vegetation that is used in floating island. Comparison of methods, floating island design and implementation of this approach is carried out to identify the best way forward in implementation of artificial treatment islands as one of bioengineering optimal solution for pollution control.

Paper 3: Effects of Pharmaceuticals on Nutrient cycling of Macrophytes

A sterile root-exudate system extraction in mesocosm was constructed to isolate the rhizosphere from gas exchange, and with these three macrophytes (*Phragmites australis, Scirpus lacustris, Iris pseudacorus)* commonly used for bioengineering purposes were selected. Root-exudates are substances released from plant root system in drops or small quantities of carbohydrates, organic acids, vitamins and many other substances essential for life of soil microorganisms.

These species were then grown in a regulated environment (nutrient conditions, light intensity, temperature) prior to the injection of a cocktail of pharmaceutical compounds. Nutrient and pharmaceutical concentrations in the root-exudates were collected periodically throughout the experiment. The result from this system could elucidate the effect of root exudates fostering the pharmaceutical degradation (representative of the rhizosphere chemical and physical condition).

Paper 4: Diurnal effects on nutrient cycling of macrophytes

High-frequency sampling were also conducted in URL (Urban River Lab) flumes in Montornès del Vallès, Barcelona where canals with and without macrophytes were compared in terms of pharmaceutical degradations and nutrient turnover. In addition to this, we have collaborated with researchers in CEAB-CSIC to help compliment this study with their research in biomass and biofilm

4. Conclusions and first results

Pharmaceuticals are present in clean water in our rivers (most of them more 50% with threated water) like diffuse pollution. In wetland areas and in green sewage treatment plants is a fact that pharmaceuticals are degraded, “disappear”. Is clear that macrophytes have and important paper specially because create a favorable condition. In the project we studied natural, artificial and laboratory conditions to try to understand what happen and if its possible to design a wetland natural treatment plant to be more efficient in this subject

In order to bridge the missing gap in understanding the importance of macrophytes to rectify pollution of rivers, we aimed to show how effective are the current implementation of the bioengineering techniques.

Our Phd researcher is working on the first results of their experiments in order to see the effectiveness of macrophytes to degraded pharmaceuticals and reduce them in clean water in rivers.

KEY CONCEPTS: hyporheic zone, root-exudates, macrophytes