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MACROPHYTES AND NUTRIENT DYNAMICS: PROCESS AND FIELD STUDIES IN THE UPPER REACHES OF LOWLAND RIVERS "MANUDYN II"

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Terrestrial Ecosystems

FINAL REPORT PHASE 1
SUMMARY

MACROPHYTES AND NUTRIENT DYNAMICS: PROCESS AND FIELD STUDIES IN THE UPPER REACHES OF LOWLAND RIVERS

"MANUDYN II"

SD/TE/04A

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Introduction

Due to the high urbanisation of Flanders water quality is reduced resulting in turbid system where plant growth is inhibited due to the poor light conditions. This lack of light has resulted in the disappearance of macrophytes. Because efforts have increased to reduced nutrient loadings towards our rivers light conditions have increased with a return of freshwater macrophytes. Because nutrient loading of our rivers is still high macrophyte growth is even stimulated. This high biomass results in reduced drainage during summer with high water levels and possible flooding as result. From the previous MANUDYN I project we know that macrophytes have a crucial role in the nutrient cycle of rivers. They seem to prefer ammonium as nitrogen source instead of nitrate which is available in higher amounts.
The general objective of this project is to develop a numerical tool allowing the quantitative description of the growth and decay of macrophytes, and of their interactions with nutrients from the water column and the sediments. For this purpose we will study in detail the growth, decay, and nutrient uptake, release and allocation processes of macrophytes in response to their various physical, chemical and biological controlling factors. These include light intensity, temperature, water quality, sediment quality, stream velocities and macrophyte or macro-algae species composition. Experiments will be performed at various spatial and temporal scales in order to develop integrated models describing the kinetics of growth and decomposition of river macrophytes.

Methodology

Three work packages were created with an increasing spatial complexity (individual, plant patch and river stretch). WP1 and 2 were all performed ex-situ to keep certain environmental variables constant. A schematic overview of the work packages is given in the following figure.

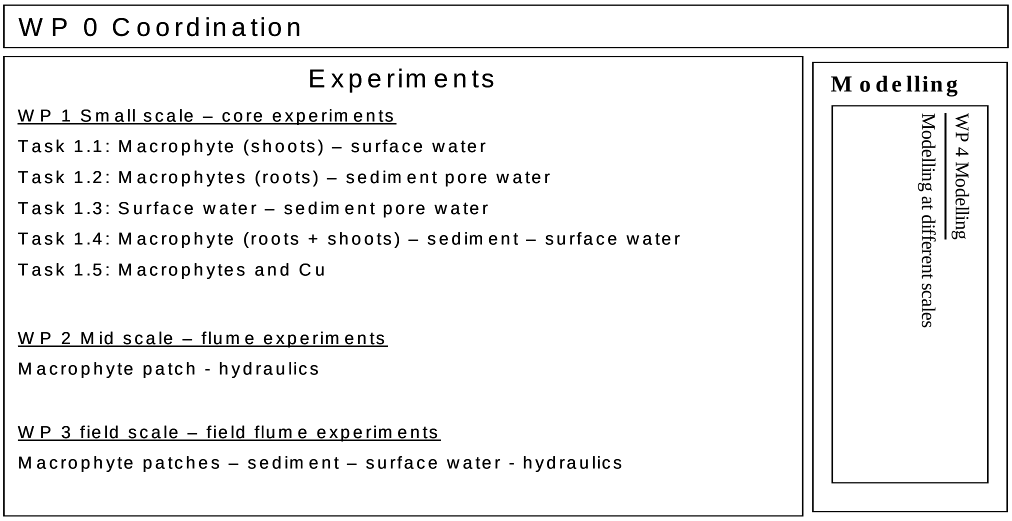


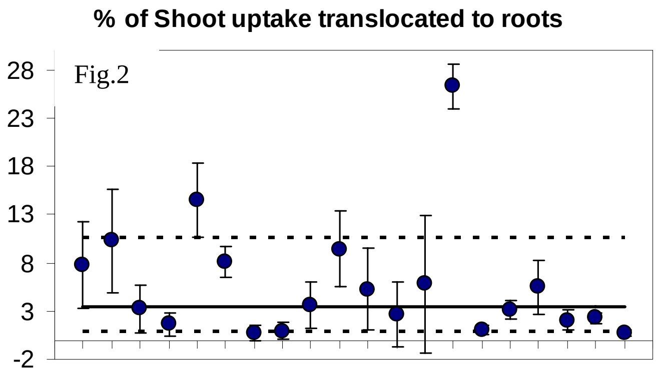
Fig. 1: General overview of the Manudyn II project structure

This project has started with the work package dedicated to small scale experiments at the level of a single individual of a macrophyte (WP1). The uptake mechanisms of *P natans*, *C platycarpa* and *R fluitans* were quantified under a range of variable conditions of light intensity, temperature, water quality, sediment quality and stream velocities. In the other packages a spatial up scaling was performed. In this report the the results of WP1 and 2 will be summarized.

Results

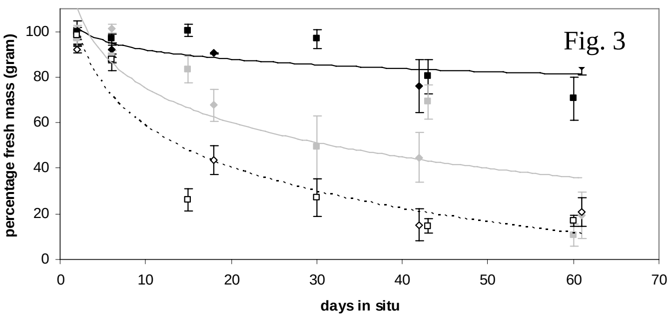
Nutrient uptake and release

On individual plant scale and during short time periods P natans and C platycarpa were not able to satisfy the nitrogen need trough the uptake of nitrate. Their nitrogen need had to be completed by ammonium uptake. From our results it is clear that ammonium is taken up in excess and stored in their biomass allowing them to fixate dissolved inorganic carbon (DIC) in the absence of ammonium and nitrate. From the same experiments was clear that nitrogen and carbon uptake took place through the stems. Between 1 and 10 % of the ammonium uptake of the roots was explained by translocation from the stem (Fig 2). The uptake of dissolved inorganic nitrogen (DIN) for *C platycarpa* was strongly dependent on the ammonium concentration and temperature but for *P natans* only dependent of temperature. Light did influence the DIC uptake but had no effect on the DIN uptake.



In general we therefore can say that, with the exception of temperature, both macrophytes have similar DIC and DIN uptake.

However, at longer exposure times (several weeks) ammonium became toxic for the plants with a reduction in biomass. As suggested by Li et al (2007) this could be the result of consumption of plant carbon to store the ammonium as protein in the plant. On the mid long term (days) plants rather preferred nitrate as a nitrogen source but were able to use ammonium after an adaptation period. The storage of nutrients in the plant was also species dependent.



black = 6 °C diamond = C platycarpa
grey = 15 °C square = R fluitans
white = 20 °C

Temperature was not only an important parameter during the accumulation of nutrients but also during decay of plant material (Fig below). With increasing temperature plant decay was much faster and primarily the result of bacterial decomposition. The contribution of fungi in this decomposition process was negligible.

Hydraulic influence

Because nutrient uptake is strongly determined by the existing hydraulic conditions the effect of macrophyte resistance is investigated. From these experiments it was clear that friction was generated (60%) primarily by the leaves. For the tested species a clear trade-off was seen between the ratio photosynthetic surface/ total friction and stream velocity.

Optimalization of in-situ macrophyte measuring

Because estimation of macrophyte growth at river scale is a time consuming activity three different (manual transect method, DGPS method and aerial photography) methods of macrophyte mapping were compared. All three methods gave comparable results allowing us to choose the most efficient method for the measurements of macrophyte patches. This aerial photography method will therefore be used in the second phase of this project.