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# Potential for water quality improvement by stimulating ecosystem services provided by aquatic macrophytes

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## Background and aim

Aquatic macrophytes are one of the key drivers providing ecosystem services in aquatic ecosystems (MEA, 2005). Ecosystem services are defined as 'the goods and services provided by ecosystems for the benefits of human beings' (MEA, 2005). Ecosystem services are often taken for granted, undervalued and poorly quantified (Stehle et al., 2011). The aim of this poster is:

1. to highlight and quantify an example of such ecosystem services which is the capacity provided by aquatic macrophytes to purify the water;
2. to recommend how, and under which conditions this specific ecosystem service can be optimized.

## Ecosystem services provided by aquatic macrophytes

Macrophytes provide a range of ecosystem services, like production of oxygen, food and clean water and provision of habitats and shelter for other species. In addition to these production functions submerged macrophytes influence the aquatic ecosystems both physically and chemically thereby potentially reducing levels of toxic compounds. Macrophytes can also produce organic matter, both solid as well as dissolved organic carbon (DOC), to which hydrophobic contaminants can adsorb thereby lowering their bioavailability. Here we quantify such chemical effects on concentrations and speciation of contaminants caused by changed processes mediated by aquatic macrophytes.

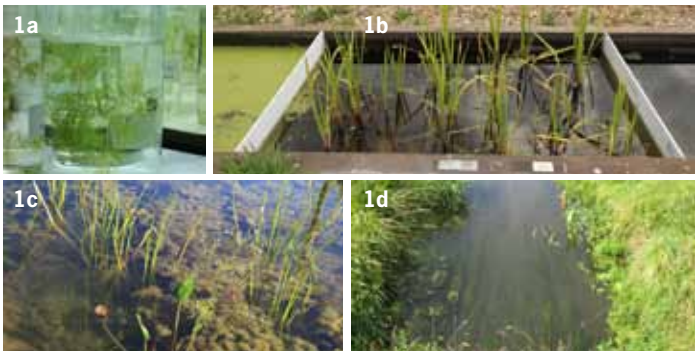


*Figure 1. Macrophyte-dominated experimental systems at different scales. 1a. Laboratory test-vessel. 1b. Mesocosm. 1c. Experimental ditch. 1d. Field.*

## Quantification of water quality improvement by aquatic macrophytes in experimental systems

- Experimental systems: artificially contaminated model-ecosystems at different scales (laboratory to field).
- Toxicants: pesticides, heavy metals and a pharmaceutical.
- Biological level: experiments at species, population and ecosystem level.
- Ecosystem service: improved water quality by aquatic macrophytes and their associated micro-organisms and algae (periphyton).

*For detailed background information see Römkens et al., 2012.*

## Results

*Table 1. Water quality improvement mediated by aquatic macrophytes and their associated micro-organisms and algae (periphyton) in artificially contaminated test systems.*

| Process influenced by aquatic macrophytes | Effects on contaminants | Final service | Quantitative measure for water quality improvement | Experimental scale |
|---|---|---|---|---|
| pH-shift | Increased degradation | Water purification | 70 % reduction in dimethoate concentrations at high macrophyte biomass of 378 g/m$^2$ ; 34 % reduction at low biomass of 96 g/m$^2$ | experimental ditches |
| pH-shift + increased DOC | Decreased availability | Water purification | decrease in free ion concentrations of Cu and Zn (to be quantified) | laboratory and mesocosm |
| Adsorption, uptake and biotransformation | Decrease of water concentrations | Water purification | 50–90 % of Cu and Zn binding to macrophyte biomass | laboratory and mesocosm |
| Retention | Decrease of water concentrations | Water purification | 90–96 % retention for strong adsorbing pesticide (λ-cyhalothrin) | experimental ditches |
| Light interception | Decreased degradation and increased concentrations | No ecosystem service provided | 60–90 % less decreased concentrations for metribuzin below a floating *Lemna* layer | laboratory and mesocosm |
| Increased Production of DOC (Dissolved Organic Carbon) | Adsorption of hydrophobic contaminants and resulting decrease of bioavailability | Water purification | decrease in bioavailability (to be quantified) | laboratory and mesocosm |
| Altered DOC composition | Adsorption of hydrophobic contaminants and resulting decrease of bioavailability | Water purification | decrease in bioavailability (to be quantified) | laboratory and mesocosm |

## Recommendations

Field level testing shows that improvement of surface water quality mediated by aquatic macrophytes and their associated micro-organisms and algae requires conditions where residence time and therefore contact time between aquatic macrophytes and contaminants are increased by reduced flow conditions. These conditions will stimulate processes described in Table 1. Such reduced flow conditions can be realized and optimized in (constructed) wetlands or aquatic macrophyte filters. Here, the combination of submerged, floating ànd emergent macrophytes enhances water quality where emission reduction measures failed to do so. In conclusion, optimizing ecosystem services provided by aquatic macrophytes will contribute to approaching the standards of the Water Framework Directive, the Pesticide Regulation and Dutch and EU criteria for metals.

## References

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