

FATA Project

Phytoremediation of water to remove nitrogen

FINAL SUMMARY

OBJECTIVES

The objective of the three-year FATA project, which started in 2013, was to compare the nitrogen removal performance of different types of free surface flow phytoremediation areas, with the goal of delineating guidelines that can be applied to other farms in the Venice Lagoon Drainage Basin.

With this purpose in mind, phytoremediation areas having different design and management characteristics were created:

- a retention basin for inflowing water for sedimentation of suspended solids;
- basins having different types of vegetation that act as biological filters, with varying ratios of planted surfaces to open water;
- a drainage channel with floating phytoremediation platforms.

The water flowing into and out of the system was monitored, taking samples to determine the nitrogen concentration and monitor any decreases. In addition, initial and final analyses of soil characteristics were performed and the vegetation was surveyed periodically.

PROJECT DESCRIPTION

A system composed of several inter-connected phytoremediation areas was designed enabling evaluation of the phytoremediation efficiency of each individual area and the entire system. The basins receive water from drainage channels and

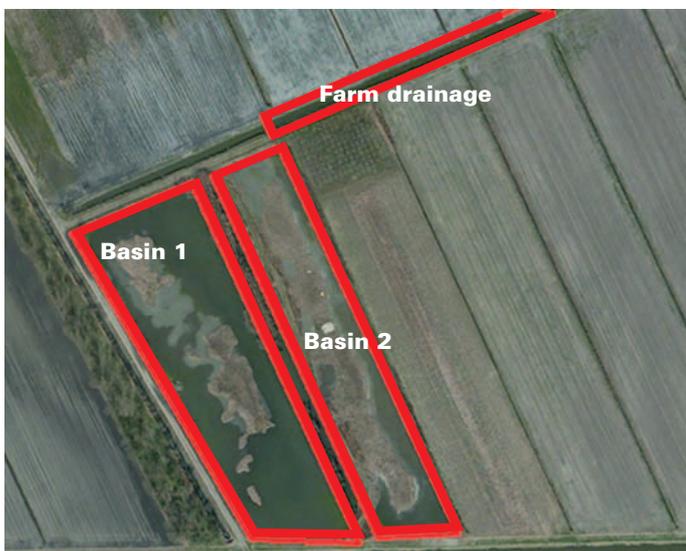


Figure 1 – The basins and channel before construction of the phytoremediation system.



Figure 2 – The basins and channel after construction of the phytoremediation system.

have a relatively modest depth (Figures 1 and 2). In addition to having the primary function of reducing the nitrogen load, the areas are designed and managed to attract bird communities. Furthermore, the basins can also act as retention basins in the event of flooding. The system was designed to offer flexible management, enabling all or only some of the phytoremediation areas to be flooded, depending on experimental or maintenance needs and water availability. The drainage water can be used as is, or nutrient loads can be added to determine the maximum remediation capacity. The performance of the systems was regularly monitored, beginning immediately after construction and following the evolution of the remediation capacity over the course of the first few years, which is normally the most critical period.

PARTNERS

The project was carried out with the Department of Agriculture, Animals, Food, Natural Resources and the Environment (DAFNAE) at the University of Padua, which was responsible for scientific coordination. Project activities were conducted at Tenuta Civrana Farm, located in Cona (VE). The Agricultural Research Department of Veneto Agricoltura was responsible for the general coordination of activities.

PROJECT ACTIONS

The study was conducted at Tenuta Civrana, in Pegolotte di Cona (VE). This agricultural area was created through reclamation of the Cavarzere marshes and is part of the Adige Euganeo Reclamation Consortium area. Water for the farm is diverted from the Canale dei Cuori, which borders the south side of the property. The farm contained two trapezoidal basins (total surface area of approximately 2.5 ha) and internal drainage channels with characteristics suitable for the planned project activities.

In October 2013, a *Global Navigation Satellite System* (GNSS) survey of the site was conducted to calculate the altitude of the basins and a soil analysis was performed. In March 2014, the flora was analyzed to study the hydrophytic vegetation present in the basin areas and the channels with the objective of identifying native species that could independently colonize the channels and guide the choice of species suitable for use on the groups of floating platforms. The platforms are composed of "TECHIA" (a system patented by PAN - *Piante Acqua Natura srl*) floating structures, designed to create vegetated phytoremediation islands in free surface flow basins. Construction of the system took place in May 2014 and involved the area containing the basins and installation of the groups of floating platforms (Figure 3).



Figure 3 – Anchoring the floating platforms to the bank of the drainage channel with cables.

After construction was complete, certain points in the basins were monitored every fortnight, at the basin inlets and sub-basin outlets, before and after each group of floating platforms was installed. Monitoring involved the collection of water samples to analyse nitrogen and phosphorus forms in the laboratory. In addition, the water was tested in the field with a multi-parameter probe, which analyzed the temperature, pH, electrical conductivity and dissolved oxygen, and a turbidity meter, which analyzed the turbidity. In June 2016, a test with an added nutrient load was performed in a portion of the phytoremediation basin. In addition, the transplanted

vegetation on the floating platforms was monitored to determine the survival rate, biometric measurements of emerged and submersed portions, and nutrient content of the biomass produced (Figure 4).



Figure 4 – Close-up of root development in the floating system.

RESULTS

Qualitative analysis of the nutrients demonstrated that the quality of the water entering and exiting the system was considered good, with very low concentrations of both nitrogen and phosphorus in general. Despite these values, the average total value of nitrogen in the water was observed to decrease between entering and exiting the system. These positive results were also found in the load test, in which an average decrease of approximately 6% was observed in a single sub-basin (B4). Vegetation monitoring in the floating systems highlighted the significant ability of *Carex* species to adapt to these unique living conditions, as shown by the survival rate and biometric survey results (Figure 5). The purple loosestrife (*Lythrum salicaria*) is also among the most promising species for growing on floating platforms in the climate conditions of Veneto's lower plain.



Figure 5 – Development and colonization of *Phragmites australis* and *Carex* spp. in the basins.

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