Hybrid constructed wetland for treatment of domestic wastewater from a tourist site in the alps

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Abstract: The scope of the project was to test the purification efficiency of a hybrid constructed wetland in Italian mountains, with fluctuating hydraulic and organic loads and snow covering the system for most of the year. The constructed wetland is designed for 66 p.e. and is made up of a subsurface horizontal flow (HF) and a free water surface (FWS) in succession, preceded by a septic tank. Four cycles of monthly chemical-physical and bacterial analysis were carried out between June and September in 2005, 2006, 2007 and 2009, with a total of 11 samples. Analysis of the plants showed that the system correctly fulfilled its role in terms of purification, ensuring extremely interesting abatement of the main pollutants: removal was more than 99% for ammonia (N-NH4+), total nitrogen (N), total Phosphorus (P), *Escherichia coli* and 97% for COD.
Key words constructed wetland; domestic wastewater; cold – climate; snow; Italian Alps; tourist site; effluent; removal; nitrogen; phosphorus

INTRODUCTION

Realised in 2004 in the municipality of Carisolo (TN) in the Adamello Brenta Nature Park at an altitude of 900 m a.s.l., the system is used to purify domestic wastewater coming from the Ponte Verde picnic area in Val Genova in the summer months. Ii is made up of a 216 m² subsurface horizontal flow (HF) and a free water surface (FWS) of 225 m² in succession, preceded by a septic tank. The HF system provides for the continuous passage of effluent through a basin waterproofed with EPDM, filled with gravel of different grain sizes (8-16 mm at the centre and 100-120 mm on entry and exit). The purified effluent is then discharged into the River Sarca, which falls within Class I in terms of biological parameters and fluvial functionality. Aquatic plants are bedded out in the basins. In particular, the HF system uses *Phragmites Australis.* The free water system uses both spontaneous species found locally (*Carex spp, Scirpus spp)* and species from nurseries: *Alisma Plantago Acquatica, Iris Pseudocorus, Mentha Acquatica, Nuphar Iutea, Typha Latifolia, Hydrocaris Morsus-ranae.* The system is evolving naturally, accepting and selecting the most suitable species.

MATERIALS AND METHODS

The parameters used for the sizing of the system are given below:

- Maximum equivalent population treated daily: **66** p.e.
- Per capita water supply: **80** l*/a.e. a day*
- Organic load: **60** *grBOD$_5$/a.e. a day*
- QMN (mean daily flow): **5.3** *m^3/d*
- Depth of horizontal flow bed (HF): **0.80** *m*
- Average depth of free water surface bed (FWS): **0.60** *m*
- Slope of beds: **1**%

RESULTS

Four cycles of chemical-physical and bacteriological tests were carried out between June and September in 2005, 2006, 2007 and 2009, with a total of 11 samples.
In order to highlight the purification performance of individual sectors, samples were taken at three different places: downstream of the Imhoff ditch (P1), downstream of the subsurface horizontal flow system (P2) and downstream of the free water surface (P3), in specially constructed collection basins.
The parameters examined, analysed using the official methods, were as follows: colour, smell, temperature at time of sampling, pH, conductivity, COD, ammoniacal nitrogen, nitrous hydrogen, nitric nitrogen, total nitrogen, total phosphorus, fluorides, chlorides, sulphates, total coliforms, fecal coliforms, *Escherichia coli*, fecal streptococcus.
The table below (Table 1) shows the average concentrations of the most representative parameters reported downstream of the individual stages and the percentage reduction.

Parameter	u.m.	P1	P2	% reduction	P3	% reduction
Ammoniac ($N\_NH_4^+$)	mg/L	90.81	0.08	>99%	0.01	>99%
Total hydrogen (N)	mg/L	88.59	0.99	>99%	0.88	>99%
COD	mg/L	136.23	6.30	96%	19.55	87%
Total phosphorus (P)	mg/L	4.90	0.02	>99%	0.01	>99%
Escherichia coli	u.f.c./100 ml	941850	72.20	>99%	133.20	>99%

Table 1 – Purifying performance (average values) of HF and FWS systems in the period 2005-2009

CONCLUSIONS

Analysis of the data shows that the system successfully fulfils its purifying role, ensuring a considerable reduction in the main pollutants. It is above all the effectiveness of the HF basin that emerges, as this on its own deals with the complete purification of the incoming waste. The FWS was indeed included for ecological purposes, considering the impact on the landscape in one of the most attractive valleys in the Adamello Brenta Nature park: here the intention was to create the typical environment of an oxbow bend in a river. It would be interesting to start up a study of the flora and fauna which have colonised this environment over the years.

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