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Case study: green filters - low cost wastewater treatment

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Green filters are a low cost wastewater treatment based on macrophytes species.

These filters are specially designed to maximize performance by providing the optimum conditions for emergent macrophyte growth. The key features of this treatment are:
1.- Rhizomes and roots of the vegetation grow vertically and horizontally in the soil or gravel bed, opening up 'hydraulic pathways'.
2.- Wastewater BOD and nitrogen are removed by bacterial activity; aerobic treatment takes place in the rhizosphere, with anoxic and anaerobic treatment taking place in the surrounding soil.
3.- Oxygen passes from the atmosphere to the rhizosphere via the leaves and stems through the hollow rhizomes and out through the roots.
4.- Suspended solids in the sewage are aerobically composted in the above-ground layer of vegetation formed from dead leaves and stems.
5.- Nutrients and heavy metals are removed by plant uptake.

1) The FMF system - artificially floating macrophyte filters: this wastewater treatment system, developed by the School of Agricultural Engineering of Madrid, is based on emergent macrophytes that naturally root to the soil, but in this case are converted into artificially floating macrophytes.

Fundación Global Nature has managed a LIFE-Environment project financed by the European Commission and the municipality of Lorca to demonstrate the effectiveness of a wastewater treatment system using floating macrophyte filters (FMF) - 7 prototypes (3 filters in 3 isolated population centers located more than 20 km from the central urban area of Lorca: (150-500 inhabitants), three filters in three single family homes or Education Centres, one filter in a pig farm as a prototype for purine treatment).

· Easy installation and minimum energy demand
· Greater effectiveness: the entire volume if wastewater circulates through the treatment mesh (annual absorption rate 180 g N/ m2 and 27 g P/ m2) (Typha latifolia)
· Harvesting does not destroy the system
· Production of a large amount of biomass. 13 kg/m2 year of dry matter (Typha latifolia)
· It absorbs hydraulic peaks. The filter volume acts as a laminator
· Little noise and low visual impact

Commissioning the 7 pilot prototypes has demonstrated the filtering system's technical and economic viability under different waste conditions, but especially for population centres of between 150 and 1,000 inhabitants. Given their size and location, these residential or business centres are unlikely to have access to conventional waste water treatment facilities at a similar cost.

In the case of urban waste waters, the system is capable of eliminating approximately 90% of their organic biodegradable contamination (based on the reduction of BOD5). The system is less efficient at purifying total nitrogen and phosphorus content than organic biodegradable matter, and the reduction values are between 30% and 50%.

In the case of purifying organic animal waste (purines) from pig farms, laboratory testing has shown that after a pre-treatment of the raw waste based on a physical-chemical precipitation with lime and iron chloride, solids in suspension can be reduced by 70-80%, BOD by 50-60%, COD by 37-58%, and phosphorus by 67-73%.

The system is less appropriate for detached houses because of the risk of waste water containing chemical products (such as bleach used for cleaning bathrooms), which could damage the filter's

plants. Implementing the system under such conditions would require instilling knowledge and awareness among houses' residents to minimise the risk of this type of waste water. Therefore, the small-scale filter used at the Fundación Global Nature Centre has been kept in correct operation, unlike the two detached houses' systems.

2) Floating Aquatic Macrophyte Systems

- Experiences in Dominican Republic, Sri Lanka, Paraguay and Senegal.

Several genera are used, including *Salvinia, Spirodella, Lemna and Eichornia* (water hyacinth) In tropical regions, water hyacinth can produce more than 250 kg/ha d (dry weight). Floating macrophyte species can be easily collected. In colder regions, these floating species do not reach a large size, and their production of biomass is limited, which reduces their absolute water treatment value.
In tropical regions, water hyacinth doubles in mass about 6-14 days. Nitrogen and phosphorus reductions up to 80% and 50% have been achieved. Water hyacinth was found to reach a standing crop level of 30 tonnes (dry weight)/ha in Florida, resulting in a maximum storage of 900 kg N/ha and 180 kg P/ha (Reddy and Debusk 1987)

Lessons learned: adaptation to local conditions / building materials and floating macrophytes species.
Better working without cold winters: the lack of plant hibernation in winter means that purification can continue throughout the year. It is not necessary to install a greenhouse.
The tertiary treatment of effluents allows water to be recycled in very dry areas.
The efficiency in purifying organic animal waste resolves one of the main environmental problems in areas such as Lorca, with a large number of isolated pig farms.
Macrophyte filters do not require economies of scale as in the case of large water treatment installations.
They can be applied to small population centres isolated from

key factor: Running pilot experiences.