

**Reedbeds for the Treatment of Greywater
as an Application of Ecological Sanitation
in rural Costa Rica, Central America**

by

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I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

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Published Papers

1. Dallas S. and Ho G. (2005). Subsurface flow reedbeds using alternative media for the treatment of domestic greywater in Monteverde, Costa Rica, Central America. *Water Science and Technology*, 51 (10). (*in press*).
2. Dallas S., Scheffe B. and Ho G. (2004). Reedbeds for greywater treatment—case study in Santa Elena-Monteverde, Costa Rica, Central America. *Ecological Engineering*, 23, 55-61.

Abstract

The widespread practice in Latin America of separating greywater from blackwater at the domestic level lends itself to the application of Ecological Sanitation, or Ecosan. In this research simple, low-cost subsurface flow wetlands, or reedbeds, were investigated not only for their potential in treating the greywater component but also to evaluate their acceptance as an appropriate Ecosan technology in rural Central America. The hypothesis for this thesis is that Ecological Sanitation, namely via reedbeds for the treatment of greywater can improve sanitation in rural Central America.

The first aim of this research determined that untreated greywater was having a significant negative impact on the water quality of the local streams of Monteverde in Costa Rica (the site of this research) and that the associated public health risks will continue to increase in line with population growth. Local residents expressed strong dissatisfaction with the current situation and were supportive of any means to improve it.

The second aim of this research was to determine if reedbeds designed according to the principles of Ecosan could provide a healthier, affordable and more sustainable sanitation alternative suitable for rural areas. As a result five case study reedbed systems were designed and installed. All these reedbeds made use of locally available materials and incorporated low-maintenance design features, and research with a local plant species determined a robust macrophyte suitable for use in these systems. The ability of low-cost reedbed systems to successfully treat greywater was demonstrated. The Costa Rican guidelines for wastewater reuse were found to be overly restrictive in regards to fecal coliform limits (<1,000cfu/100mL) and may inhibit the wider uptake of reedbed systems if enforced. Despite this the uptake of the reedbed technology was strong and more than ten systems were installed in Costa Rica as a result of this research. An innovative environmental services contract, the first of its kind in Costa Rica, was developed to ensure on going funding for operation and maintenance of a four-household reedbed system.

The third aim was to specifically investigate the use of waste plastic (PET) bottle segments as an alternative media in reedbeds to conventional crushed rock, or gravel. Twelve mini-reedbeds, or cells, incorporating PET media and plants as the two

variables, were monitored through wet and dry seasons. This experiment demonstrated that reedbeds incorporating PET segments were able to achieve comparable removal of fecal coliform and BOD when compared to conventional media reedbeds, and at a significantly reduced cost. The local plant species *Coix lacryma-jobi* enhanced the performance of all reedbeds, most notably in the PET-based reedbeds, which was attributed to the considerably greater root biomass achieved in these systems as compared to conventional media systems.

This research has demonstrated that reedbeds incorporating simple, low-maintenance design features are able to provide an affordable and appropriate technology for the treatment of greywater in rural Latin America.

for Dad

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