Potential Applications of the Vetiver System in the Lake Amatitlan Watershed, Guatemala

King of Thailand Vetiver Award
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Abstract:

This research focuses on the possible hydrological, infrastructural and social applications of the Vetiver System - an affordable bioengineering technology – in the watershed of a highly polluted lake near Guatemala City, and how the construction of a wetland park displaying the different uses of Vetiver Grass could teach people how to participate in a movement to clean the lake. Interviews, research and data collection were conducted in Guatemala, Chile, Australia and Indonesia.

I. Existing Problem:

Lake Amatitlan, a 15km^2 body of water near Guatemala City, is the most polluted natural resource of its kind in Central America, receiving its water from a largely urbanized watershed extending 381 Km^2. Its main influent, the Villalobos River, deposits about 500,000 tons of sediment per year into the lake due to the erosion in gullies that drain the watershed. This deposition is causing the lake to slowly loose its depth, while the daily inflow of 437,500 m^3 of water contaminated by industrial waste, fertilizers and untreated sewage has triggered the proliferation of a green microcystin algae that is inhospitable to humans and the ecology of the lake (figure 1). Although there have been efforts by a government agency to help clean the lake, their “end of pipe solutions” have been addressing issues at the end of the river and within the lake, and lack of funding has prevented them from pushing their pilot projects and awareness campaigns through.

Figure 1: Microcystin Bacteria thrives in Lake Amatitlan due to high contamination ratings, causing eutrophication.

II. Objective:

The lack of funding and little knowledge of affordable green technologies prevents the local government administration from making meaningful changes in the population’s attitude towards the lake. By providing feasible examples displayed in a public park for reducing their impact within the watershed, people will begin to collaborate in a green movement that will restore Lake Amatitlan to make it once again a culturally valuable natural resource. The controlled use of a non-invasive but extremely hardy wetland grass called *Chrysopogon zizanioides*, or Vetiver, can be the solution to many of the erosion and water pollution problems that are currently affecting the lake. This research focuses on some of the worldwide applications of Vetiver Grass which can be applied in this watershed.

III. Relationships investigated and methodology

The first step was to investigate the government programs implemented to try clean the lake. I then looked at how other countries have dealt with similar water pollution issues using the Vetiver System. Finally, I combined my studies in landscape architecture to design solutions and concepts that could help improve the health of Lake Amatitlan. These tasks are summarized below:

a. The current practices being used by the Administration for the Sustainable Management of Lake Amatitlan and its watershed (AMSA) were investigated through interviews with the staff members of this government agency, visiting projects, reading published material and diagramming projects they have built (figure 3). The current AMSA administration includes educators, engineers, biologists, chemists, aquaculturalitsts and more than 120 people who have been by hired to try to improve the health of the lake and create awareness about the destruction occurring throughout the watershed. However, over the past seven years of operation, a lot of the effort that AMSA has put in has had dwindling results. Graphs of the water quality in the Villalobos river showed an increase in the chemical oxygen demands (an indicator of the amount of bacteria in water) raising from 40 mg/L in 2005, to 98 mg/L in 2007. Only one of three waste water treatment plants constructed to treat the water in the river is still operating today, while the rest were ineffective, abandoned, destroyed, and unheard of by most people. In 2008, a sedimentation pond was built in order to hold some of the sediments coming out from the river which would later be dredged. However, in 2010, it was destroyed during a flood, and sediments have since continued to fill in the lake. A series of energy intensive aerators scattered throughout the lake have replenished some of the stagnant flow within the lake but are energy intensive, hard to maintain and have had parts stolen. Many of the projects that AMSA has taken on have been only partially successful, mainly because people in the watershed do not know how what feasible changes they can make in order reduce their impact.

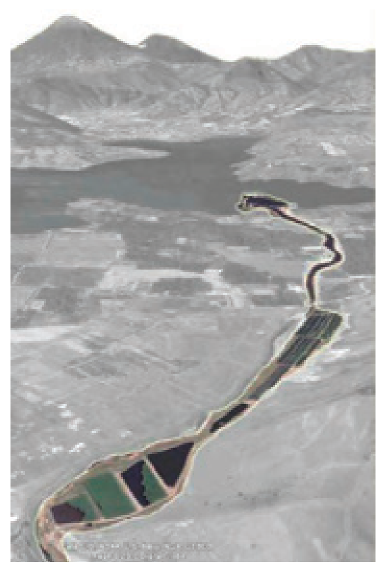

Figure 2: AMSA water treatment plant- anaerobic ponds and biofilters use native species to extract nutrients from water. The sedimentation pond at the end collapsed in 2010.

b. By evaluating the progress and effectiveness of sites around the world that use the Vetiver System for Water Treatment, Slope Stabilization, and low income applications I was able to determine which of these applications could be feasible in the Lake Amatitlan watershed. Travels to visit projects in Chile, Australia and Indonesia were partially funded by the Dreer Travel Award from the Cornell University Horticulture Department. I got to visit many existing Vetiver projects in Brisbane and Bali to verify their long term resilience based on the conversations and photographs taken by the director of the Vetiver Network International for Asia and the Pacific, Paul Truong. This archival of information was summarized and written in monthly reports that were sent out to the Landscape Architecture and Horticulture Departments at Cornell University (found at imariacalderon.blogspot.com). Additionally, I received hands-on training on how to propagate the plant, separate its shoots, prepare the terrain and plant it. I also participated in research projects funded by the Australian companies Gelita Pty. Ltd, Veticon Consulting, and the Organic Force. These projects all used the affordable green technology of the Vetiver System for green infrastructure projects in the tropics and subtropics.

Constructed wetlands using the Vetiver system have proven to be successful in Australia for removing nutrients from water (Truong et al. 50) and are being used for treating different components of wastewater. Some of the applications for constructed wetlands in Brisbane included floating pontoons at a fertilizer and explosives factory, a subsurface flow wetland in Toogoolawa with Vetiver planted on contours that helped absorb secondary treated wastewater, bioswales at a housing development for beatification as well as transporting and filtering stormwater, and channels plated with Vetiver on contours for flood and erosion control. During my time in Australia, I was involved in a research project that studiend macrophytes for aiding in the humification and breakdown of septic sludge, an inevitable solid/humid byproduct of wastewater which needs to be composted. I helped an organic composting company construct a series of 56 small scale Macrophyte (reeds and tall grasses) Sludge Drying Beds (MSDB) built inside wheelie bins with an outlet pipe in the bottom (figure 3). The goal of the experiment was to understand which of the six species tested would best survive the rising sludge levels.

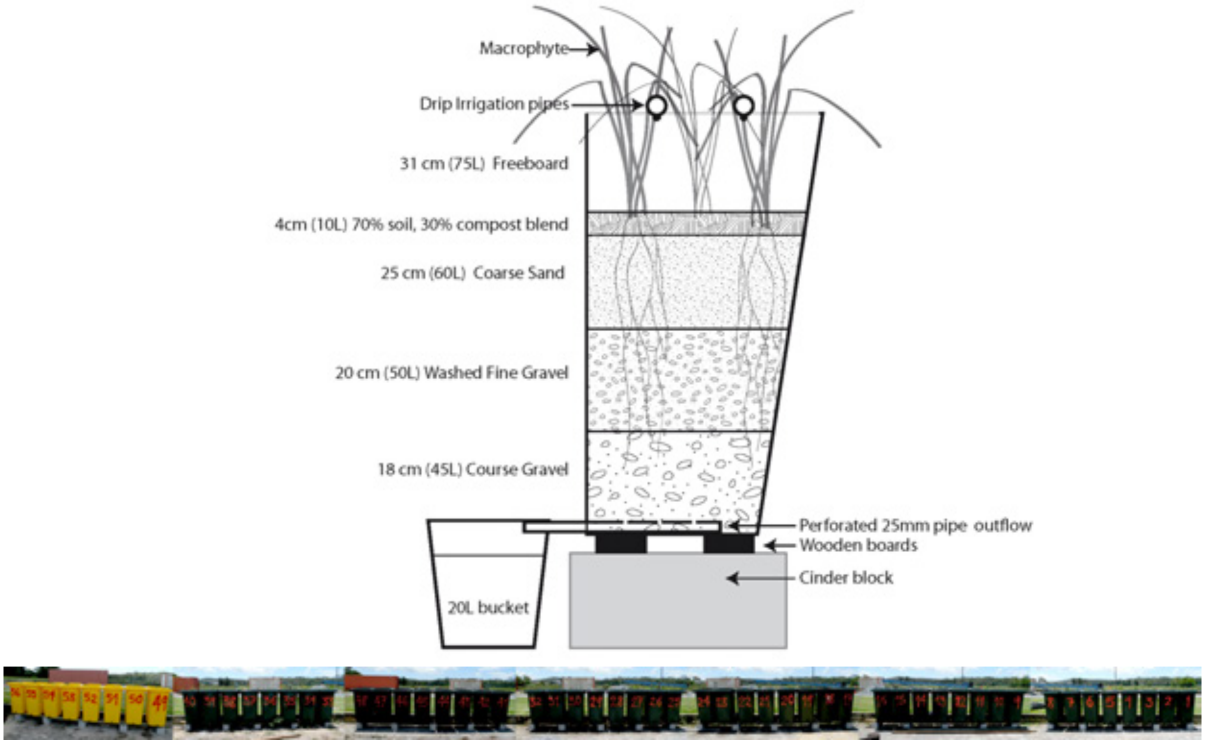

Figure 3: 56 Pilot sized constructed wetlands testing the effectiveness of 6 species in drying and humifying sludge, Brisbane Australia. Species tested were Chrysopogon zizanioides (2 sets), Phragmites Australis, Lepironia articulata, Philydrum lanuginosum, Schoenoplectus mucronatus, Bolboschoenus fluviatilis.

Due to time limitations and because the plants were still in the establishment phase, I was only involved in the construction and in monitoring the growth of the plants (no conclusive data has been obtained yet). This information however, can be very important because so far, no research has been done using Vetiver in MSDB, and the results of this trial will help understand whether the Vetiver root structure would help create useful compost and dry up the sludge in the quickest amount of time. Such knowledge would be extremely valuable in Guatemala because many households choose no to deal with septic tanks due to maintenance issues and difficulty of getting pumping services, and consequently many end up depositing their wastewater untreated into the rivers.

In order to understand the Vetiver System for wastewater polishing and slope stabilization in the third world, I traveled to Bali and Java in Indonesia to visit the East Bali Poverty Project. In the Citarum River Basin of Java, a pilot project meant to reduce erosion at an agricultural site. It used Vetiver hedges planted on the contours and with vertical intervals of 0.5-1.5 meters to hold back fine sediments, reduce erosion and improve the vitality of barren slopes or agricultural fields (figure 4).

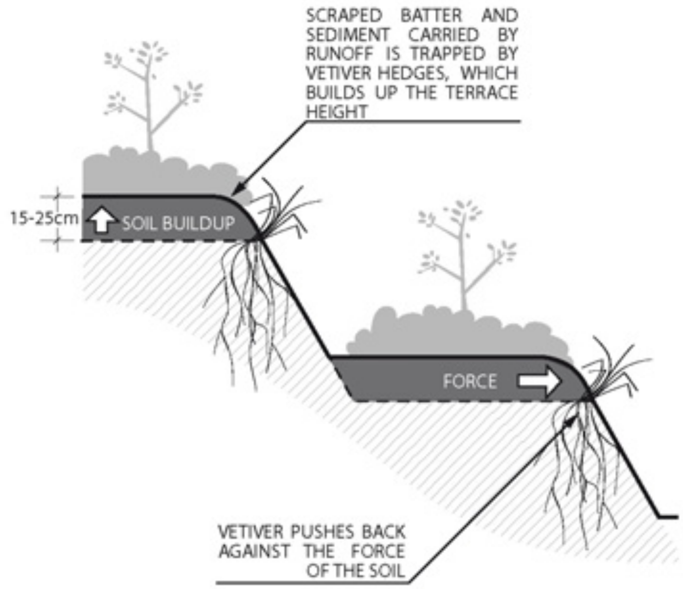

Figure 4: Vetiver hedges planted on terrace edges hold back sediment loaded runoff and increase agricultural productivity. Example taken from a site visit in the Citarum River Basin, Java, Indonesia.

The main goal for bringing this knowledge about the Vetiver System to Guatemala is to stabilize the extremely erodable and precarious gullies in the watershed of Lake Amatitlan that end up depositing tons of sediments into the river and destroying the Lake's ecosystem.

c. Combining this research on the Vetiver System and my studies in Landscape Architecture I designed a constructed wetland park open to the public which can be used to teach people about the different methods for applying the Vetiver System in their own homes, industries and agricultural sites. This constructed wetland or ecopark would divert about a third of the water, or 145,800 m^3, from the Villalobos River and absorb the nutrients and heavy metal loads prevailing in the water while at the same time trap many of the sediments that would otherwise get deposited into the lake (figure 5). Although such a park would only take care of part of the flow from the river, the remaining water would not get filtered unless all gullies in the watershed are stabilized and revegetated. This park would serve as an educational venue for people from the watershed to come to the visitor centre, where information about the Vetiver System and other Best Management Practices would be disseminated. For example, people living illegally in the gullies throughout the watershed could plant Vetiver on the banks of the river and use that green infrastructure for the dual purpose of stabilization and depositing their wastewater for the vetiver hedges to absorb the nutrients in the effluent (figure 6). Various programming aspects of the ecopark relating to Vetiver would be used in the park and access would be provided to them through the boardwalk circulating the constructed wetland. Rest spots and information boards would be spread throughout the boardwalk and would reveal the various Vetiver applications people can include in their homes, industries, or agriculture sites.

Figure 5: Ecopark uses Vetiver to detain and absorb contaminants

1. Information/visitor's center 2. Building's stand alone biological treatment plant 3. Water from river diverted into vetiver reedbeds 4. Recreation and rest area. 5. Vetiver planted in hedges holds back sediments carried by water and forms natural terraces 6. Floating pontoons directly absorb nutrients from water. 7. Horizontal Flow Constructed wetland planted with vetiver absorbs water moving subsurface 8. Vetiver planted along the bank of the river and on contour holds back erosion

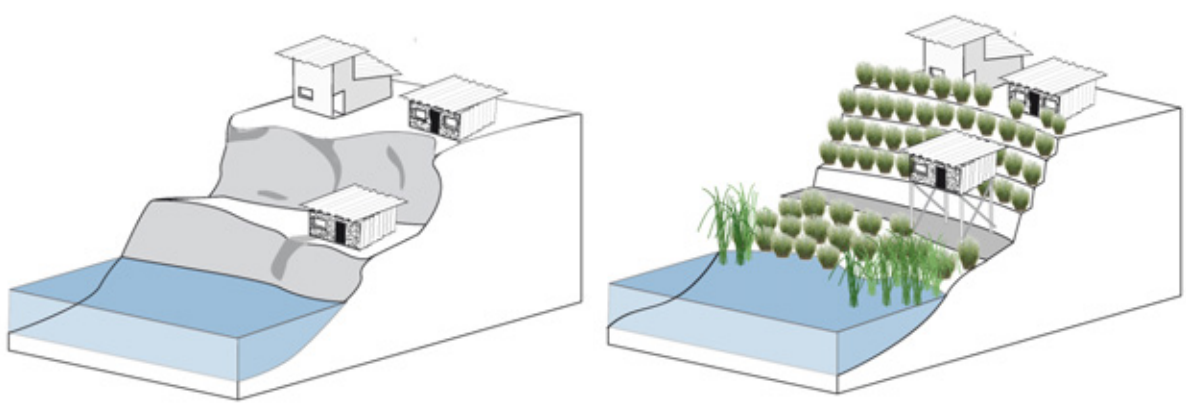

Figure 6: Vetiver is used to revegetate deforested riverbanks occupied by illegal settlements.
This system will reduce erosion and absorb nutrients from the wastewater of the illegal housing settlements.

<u>*Conclusion:*</u>

Unfortunately, several lakes in Guatemala and other third world countries are suffering the same fate as Lake Amatitlan. The successful clean-up of this lake using the Vetiver system could make this an exemplary project for other third world countries in need of simple bioengineering solutions. The next steps for this project therefore involve fundraising money for building pilot scale constructed wetlands, starting a nursery in Guatemala, and getting in touch with local municipalities to explain the function of the Vetiver system and how it could be applied in Guatemala.

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