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Cornell University
Landscape Architecture Graduate, May 2010
OCTOBER 2010

DREER travel award

Monthly Report

I N T R O D U C T I O N

One of the greatest attributes of the Dreer award, is the responsibility that the recipients get of sharing our experiences and findings with other students, professors and friends. It was with excitement that I remember reading the reports of last year's recipient, Stephanie Gautama, who revealed the structural intricacies and benefits of green wall technologies, and with sincerity explained the difficulty of maintaining alive that green blotch that we so easily draw into the designs of buildings and landscapes.

Cool green wall that reminded me of Stephanie's research. Santiago, Chile

Stephanie and I on a trip to Pondicherry, India Spring 2009

Tilapia ponds in Guatemala using Vetiver for filtration (rafts) and slope stabilization (front grass)

Now it is my turn to share with you all the knowledge that I might gain in the six months ahead, researching the use of the Vetiver plant (Chrysopogon *zizanioides*) in constructed wetlands, slope stabilization and as a key component for the Green Infrastructure that landscape architects often embed in the rhetoric of our designs. The original travel plan involved going to a conference in Chile, and from there traveling to Australia and finally to Vietnam. However, the future of my trips is yet to be determined, as the original trip to Vietnam had to be changed, due to safety concerns and also because the great Vetiver expert from Vietnam, Paul Truong, with whom I will be working, has been living in Australia for many years as an internationally renowned consultant for the Vetiver System (VS). Mr. Truong invited me to speak at a Conference in Chile and also found a place for me to stay in Brisbane, a city on the eastern coast of Australia, about 46o miles north of Sydney.

A T T R I B U T E S o f V E T I V E R

The following is a quick list of attributes adapted from *Vetiver System Applications, Technical Reference Manual* which should help you understand how a simple plant can be an answer to a lot of the most prominent environmental problems in tropical and subtropical areas of the world.

Origin:

Southern India

Physical attributes:

Tall grass with varying height from 0.5 to 3.0 m tall
Dense root system without rhizomes, can grow up to 3.6 m deep in a year
Flowers are sterile and plant is therefore non-invasive

Tolerance:

High concentrations of nutrients (N and P), heavy metals; acid, alkaline, saline soils
Herbicides & plagues
Temperatures of -15^{o} to 60^{o}C (5^{o} to 140^{o} F)
Complete saturation or drought
Fires

Intolerance:

Shade
Complete flooding of foliage for an extended period of time
Animal grazing (rabbits)

Uses:

Slope stabilization – Prevents erosion in barren land that is hostile to most plants
Effluent filtration – Absorbs 94% Phosphorus and 90% Nitrogen from water in 4 days
Phytostabilization – prevents heavy metals from moving to groundwater
Land rehabilitation – pioneer plant that helps improve soil and moisture for other plants
Buffer or barrier – prevents spreading of forest fires and pests into crops, slows water flow
Natural Terracing – contour planting accumulates soil behind the constantly emerging roots
Arts and Crafts – Thatched roofing, household products (chairs, hats, baskets etc)
Perfume – Essential Oil extraction from Roots

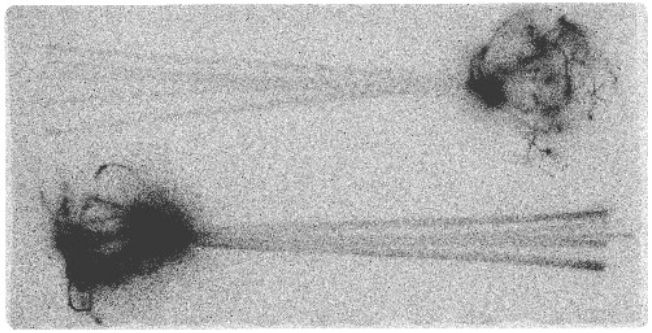
Facts:

One hectare of planted Vetiver can evaporate 279,000 liters/day
When used in civil works its cost is about 1/20th the cost of the traditional grey infrastructure
"A Living Soil Nail" – Average tensile strength of 1/6 of mild steel

To learn more about the Vetiver System applications, go to http://www.vetiver.org/TVN-Manual_Vf.pdf

CHILE CONFERENCE

Mother, grandmother, Vetiver plant, Paul Truong and I before the start of the conference. To learn more about the conference go to www.conferenciavetiver.cl



Radiographic image of vetiver plant cultured in the yellowcake solution, revealing that more radionuclids accumulate in root part than in shoot part

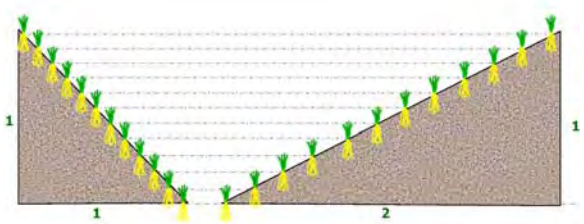
Before leaving home, Guatemala City to go off to Chile's capital Santiago, along with my two proud supporters (my mother and my grandmother), I had to prepare a series of documents for the First Latin American Vetiver Conference, where I presented my thesis *Green Movement Against Green Water* http://hdl.handle.net/1813/17514. In addition to preparing a presentation, an abstract and a summary of my thesis, I was also asked to translate some of the papers written in English into Spanish, which of course, helped me learn a lot of new information about Vetiver which I had not yet heard. The conference took place Oct. 14-16, an exciting time to be in Chile when after 69 days of being buried 700 meters underneath the surface, on Oct. 13th the 33 rescued miners became Chile's new heroes.

A total of 18 speakers presented their research worldwide on Vetiver. One of the speakers was Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand, the patron of the Vetiver grass worldwide who has followed her father's legacy in promoting and teaching people about the beneficial attributes of this plant, which has helped shape and preserve the landscape of her country. At the conference, I finally met Dr. Paul Truong from Brisbane, Australia, probably the most prominent leader in the research and proclamation of the *Vetiver System Applications*.

The panelists openly shared all the knowledge they had about propagation, phytoremediation, filtration, crafts, slope stabilization, land rehabilitation; all of them proclaiming how in their case, this simple plant had enhanced the quality of life of their communities. I will not mention all of the panelist's work, though I would be glad to share the information I obtained with anyone who requests it. I will however, mention some of the reasercher's work whichI had not yet read about in the Vetiver System Technical Reference Manual.

The first was Naulchavee Roongtanakiat, a Thai lady who had conducted painstaking research on the phytoremediation and phytostabilization capabilities of Vetiver in Thailand. This topic is of course very interesting to the eyes of a landscape architect who might want to learn about green solutions for cleaning up a site that is considered uninhabitable due to its fatal soil qualities. Vetiver can play a major role in phytoremediation, a process which according to Roongtanakiat "it

Eco mortar with Vetiver terraces and Pinto Peanut groundcover



Vetiver terraces are planted with a vertical interval of 0.5 to 1 m

cost $100-$400 per cubic meter". Because of its intense foliage and tolerance to toxic elements, one vetiver eco-type called Surat Thani might be good for retaining pollutants within their roots so that they don't spread and contaminate aquifers, while another ecotype Ratchaburi might be better for absorbing these elements into its foliage, a process that is accelerated when pruning the foliage all the way to the bottom every so often, forcing the leaves to absorb the contaminants.

Another presentation which provided me with some brand new information was that of Mr. Jorge Londoño, from Colombia, who had been planting Vetiver for stabilization and combining it with a legume called Pinto Peanut (*arachis pintoi*) in order to aid in the replenishing of nitrogen to the depleted soil. The latter plant also prevents weeding from occurring and gives the Vetiver roots a better chance to grow without being overcast by the shade of the towering weeds. Mr. Londoño also uses an eco-mortar for the initial stabilization of the slope, which is flexible and will allow the plants as well as the wet earth to expand without much cracking.

The final presentation that truly helped understand the basics of vetiver planting was given by a Venezuelan who used a series of simple diagrams to explain the how erosion occurs and exactly how Vetiver should be planted in order to achieve its full potential. He also showed a stunning series of pictures of a roadside hill improvement where the severe erosion problems were completely stabilized with a combination of careful contour planting of Vetiver and a series of check dams. This most ambitious bioengineering project really gave Vetiver plants a chance to prove themselves!

Ambitious vetiver project, vertical stabilization

Contour planting and dikes

Completely restored slope once vetiver is established

I was the last to present my research (I'd like to think it was because they left the best for last :) which dealt with sustainable strategies for the remediation of a eutrophic lake near Guatemala City that has been severely affected by the most heavily impacted watershed in Central America. One of those strategies was of course using the Vetiver plant as a form of green infrastructure to help stabilize riparian zones and filter water pollutants. This presentation ended up being significantly different to the technical and hands-on experiences of most speakers, and was, for the most part, a study of precedents which could be applicable to Guatemala, a watershed management plan and a pilot park that applied various Vetiver strategies into the landscape. Despite the fact that this was a purely conceptual presentation, people in the audience found a new vision for how we can bring this green infrastructure technology to the next level of landscape architecture design. (Poster next page. Sorry if you don't speak spanish)

CHILE SITE VISITS

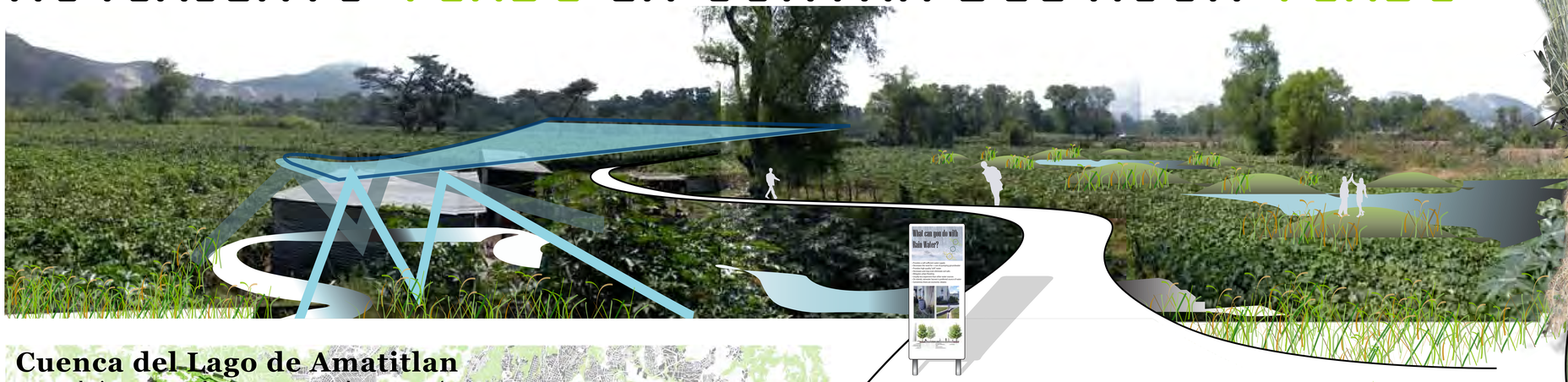
Another site visit to a pig farm, where Vetiver was irrigated with highly saline effluent waters. The combination of a cold winter and the increased salinity caused the plant's foliage to turn brown. Plants on higher ground made it better than those on lower ground.

My trip in Chile also involved visiting some of the few sites where Vetiver had been installed. Contrary to all the wonders we had been hearing about Vetiver, the wilting plants did not seem to agree with the weather so far south of the equator. The freezing temperatures of the winter season (which in October had just come to an end) had caused the foliage to turn brown, but new shoots starting to emerge indicated that the roots were still alive. This is where I learned another lesson about Vetiver: as long as the crown of the roots does not freeze, the plant will regenerate year after year.

Another problem we encountered in a site visit where the plant was being used for slope stabilization, was that the small brown rows of wilted vetiver leaves would barely be visible amidst the dense weeds that had started to colonize the ground. On one hand, these weeds were good because they indicated that Vetiver had successfully created the right conditions for plant life to begin growing there again, but on the other hand, the weeds, being adapted to the climate, were thriving in the early spring, competing too much with the Vetiver saplings emerging from the crown. Paul Truong, who was called to assess the success of these projects, concluded that perhaps they should help the newly planted Vetiver by removing weeds with a pesticide or manually just this year, so that the plant would have a chance to establish a better root system. They also concluded that it would make sense to plant in the spring, around September and not right before the winter season, which was the main reason for failure in this project.

MOVIMIENTO VERDE EN CONTRA DEL AGUA VERDE

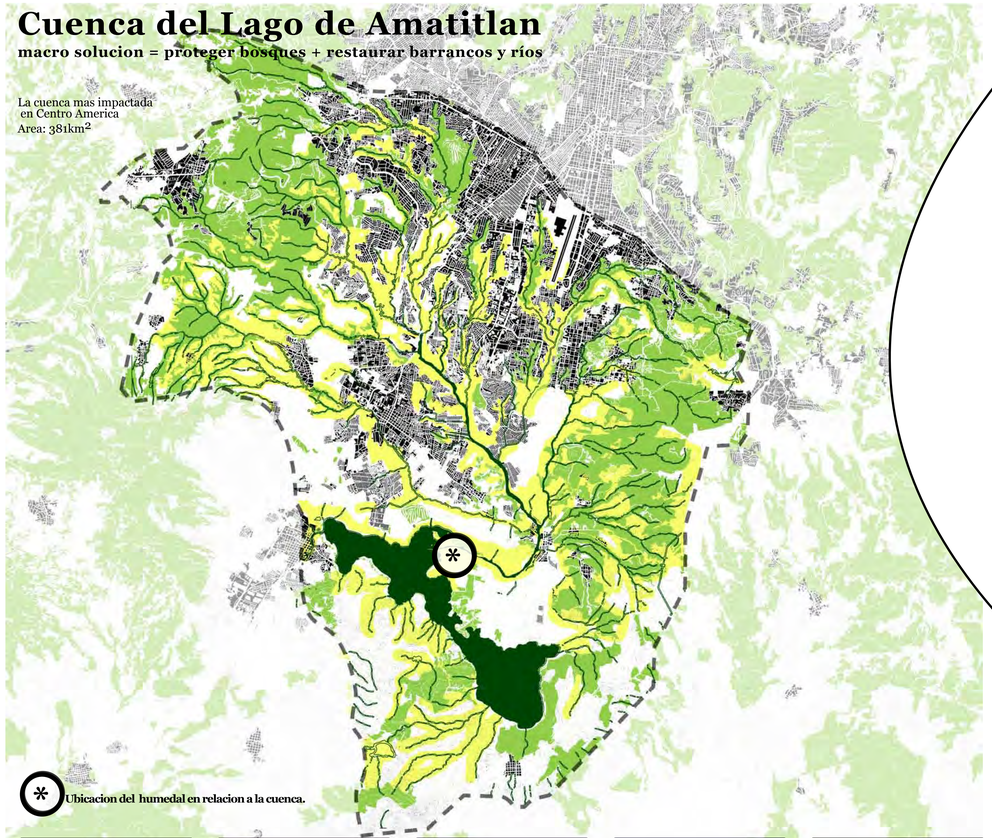
GUATEMALA - LAGO DE AMATITLAN



Cuenca del Lago de Amatitlan

macro solucion = proteger bosques + restaurar barrancos y ríos

La cuenca mas impactada en Centro America
Area: 381km^2



* Ubicacion del humedal en relacion a la cuenca.

Ciudad de Guatemala

El desarrollo urbano ocupa un 50%. de la cuenca del Lago de Amatitlan. 900 idustrias.

Cuerpos de Agua

Lago de Amatitlan: 4%
Influente: Rio Villalobos - Alimentado por 14 Tributarios

Desechos domesticos tratados: 25% (el resto es depositado en el los rios, incrementando los niveles de nitrogeno)

Bosques existentes

6 % bosques predominan en los barrancos

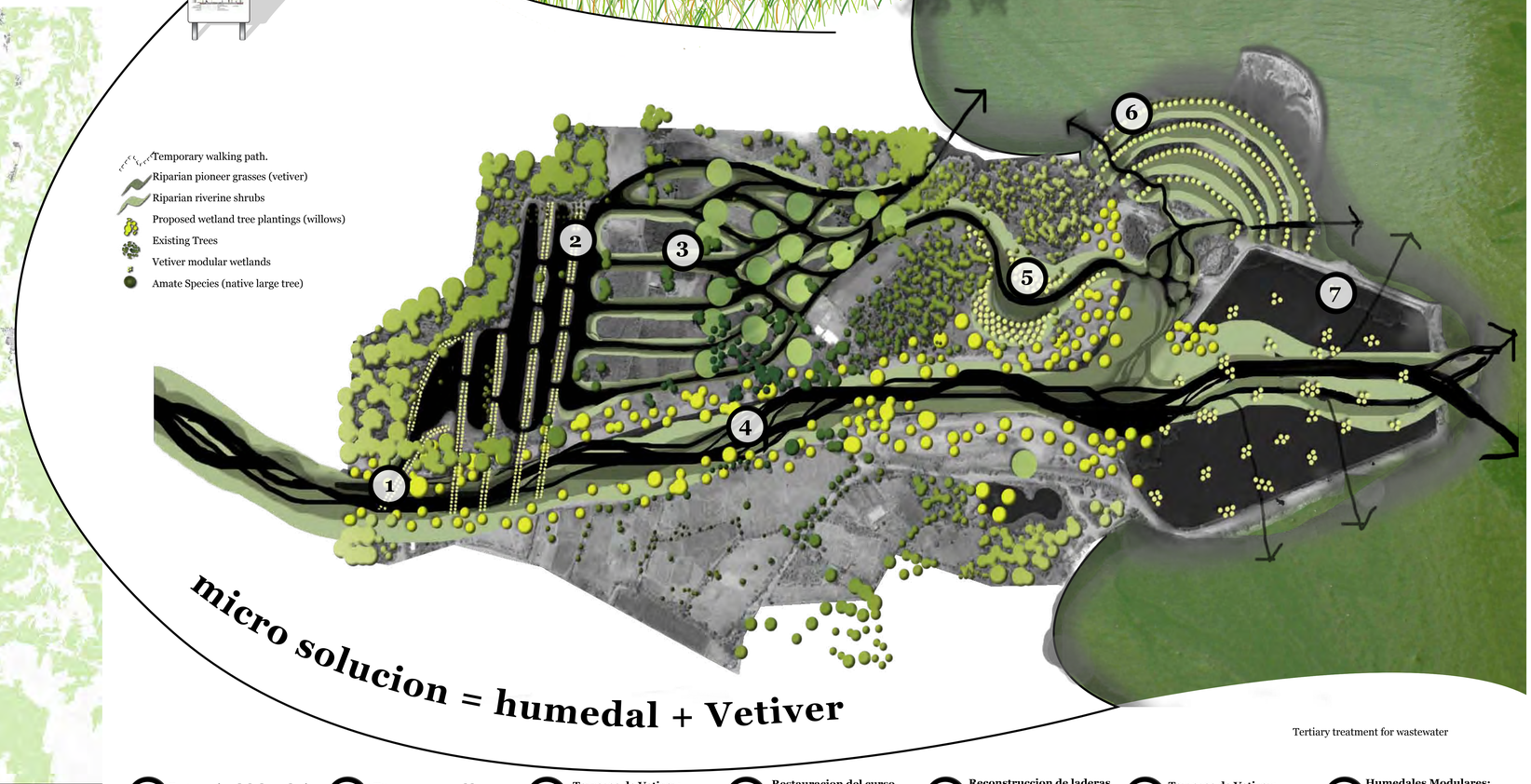
Deforestacion en los barrancos ha causado inestabilizacion de cuestas

Debe protegerse!

Asientamientos informales ocupan barrancos peligrosos.

Carece sombra

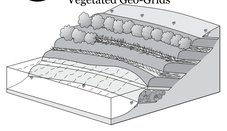
Areas sin utilidad: 13%
Agricultura: 27 %
Agricultores utilizan de abonos cargados con fosfatos



micro solucion = humedal + Vetiver

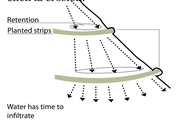
Tertiary treatment for wastewater

1 Restauracion de laderas de rios: Bastago de plantas entreecembrado en niveles de tierra. Ingles: "Vegetated Geo-Grids"

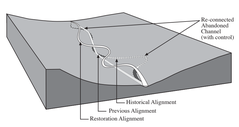


2 Terrazas permeables permiten al agua pasar a travez de ellas, dejando que las raices del vetiver sembrado la limpie.

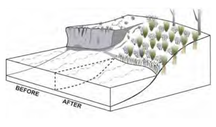
3 Terrazas de Vetiver: Raices emergen del suelo creando barreras naturales que previenen la erosion.



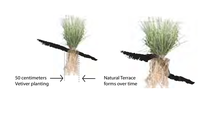
4 Restauracion del curso natural del Rio. La sinuosidad original alenta el agua y previene erosion



5 Reconstruccion de laderas inestables utilizando vetiver le da rigidez a los suelos humedos



6 Terrazas de Vetiver: Raices emergen del suelo creando barreras naturales que previenen la erosion.



7 Humedales Modulares: Balsas de materiales reciclados exponen a las raices del vetiver al agua para filtar sus contaminantes.

El lago más contaminado de América Central recibe sus efluentes de la ciudad de Guatemala, localizada sobre una cuenca hidrografica que se extiende 381 km^2. La mayoria de las aguas residuales e industriales son depositadas directamente en los rios sin tratamient previo, y luego fluyen hasta desembocar en el lago Amatitlán, causando que este se convierta en un cuerpo de agua muerto y eutrofizado. La ciudad de tres millones de habitantes está formada por densos desarrollos urbanos, asentamientos informales, enormes condominios, granjas agrícolas, y 30% de la industria del país. La falta de regulacion y planeaje urbano y ecologico ha sido la mayor causa de la muerte del lago.

Las estrategias actuales de remediación que se han utilizado para en el lago y sus afluentes han tenido poco exito a pesar de haber utilizado tantos recursos monetarios y esfuerzo humano. La infraestructura actual para controlar la hidrologia de la cuenca no ha logrado prevenir las catástrofes que frecuentemente debilitan a esta ciudad tropical.

"Green Movement Against Green Water" es una tesis que estudia casos de estrategias efectivas y diseños ecologicos basados en la "infraestructura verde", en cuanto a la filtración, rehabilitación, y administracion de recursos naturales. Estas prácticas contemporáneas informaron el diseño de un **humedal ecologico construido como parque** en la desembocadura de un rio que utiliza el Sistema Vetiver y otros principios de la arquitectura paisajista para filtrar los efluentes contaminados que son depositados en el lago por este rio. Los efluentes del rio son desviados para entrar en una serie de canales y monticulos sembrados con Vetiver y plantas nativas que oxigenan y ayudan a reducir la velocidad del caudal. Simultaneamente, el humedal se convierte en un area protegida donde existe fauna y flora subrepresentada, que atraerá visitantes que quieran aprender sobre este sistema y la infraestructura verde para eventualmente implementarlo en sus casas.

Para salvar el lago, la cuenca primero debe adoptar prácticas de manejo sostenible e infraestructura verde (ejemplos arriba) incluyendo:

a) Construccion de areas de infiltración y retención de lluvias, especialmente cerca de parqueos y terrenos impermeables.

b) Separar aguas pluviales y el alcantarillado para prevenir frecuentes inundaciones

c) Establecer un plan de zonificación unbano que protega los bosques y barrancos e impida a que personas vivan en ellos.

d). Promover el uso de fosas sépticas como tratamiento primario y piletas de escurrimiento (leach ponds) para proporcionar un sistema de filtracion al alcance de los pobres.

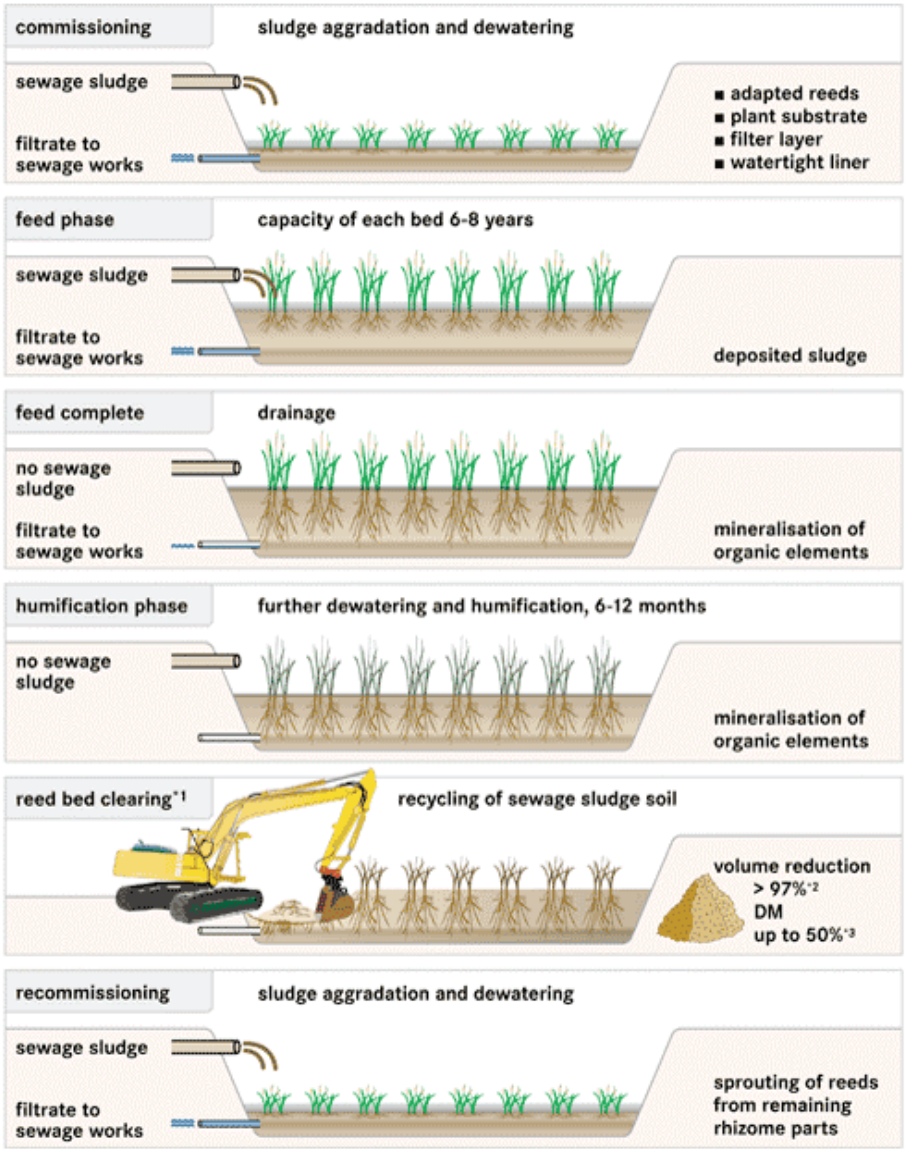
Honors Thesis presented by Maria Calderon Landscape Architecture Student graduating May 2010

AUSTRALIA

I was picked up from the Brisbane airport by a German couple, Johannes and Ingrid, whom Paul Truong knew via working with them in a Vetiver project at a company called Gelita which produces gelatin. Johannes, the creator and owner of a consulting company called "The Organic Force" has done work with reedbeds using Vetiver to help aid in the dewatering of sludge (see diagram of reedbeds on right). In addition, this German couple is going to provide me with housing during my time in Australia. Both of them have been very kind in including me in a lot of their daily activities, where I had the opportunity to go to a very interesting forum titled 'Adopting Organic Waste – to – Energy Technologies in the Food Processing Industry', which was organized by the Queensland Department of Employment, Economic Development and Innovation.

After stopping by the gold coast and going for a swim in the chilly waters, they took me to the Gelita factory, which had been producing 13,009 m^3 of sludge in 2009 and about 1.3 megaliters of wastewater with high loads of Ammonium, Calcium, Sodium and Chloride per day. The company invests a lot of money in trying to filter this water but still has a big problem disposing of the sludge, and they were therefore looking for more affordable and environmentally friendly alternatives. Johannes then was hired to

Process flow, sewage sludge humification



*1 immediate recycling or further storage – *2 dependent on DM content of wet sludge – *3 dry matter with optional storage

design and build three 40' by 4' reedbeds with a depth of 1.5' as a pilot project. Although the trials ended up working OK for a while, they became poorly managed making the sludge and Vetiver unmanageable.

In addition to the reedbeds, Gelita had a large field planted with Vetiver which was being irrigated with the factory's effluent in order to increase the evapotranspiration rate. Although the Vetiver at the moment might not seem very promising on this field due to the recent passing of winter, it is the only plant that is surviving Gelita's highly contaminated effluents. According to Johannes, most of the Vetiver trials at Gelita are too large in scale for being pilot projects, making them hard to manage and hard to compare with the more conventional filtration methods. Therefore, my task during my stay will involve working on a brand new project, at a sewage treatment plant where we are going test the effectiveness of Vetiver, Phragmites and a few native Australian plants in containerized reedbeds (more to come next report).

In the meanwhile, as I wait for the hard work to start, I have started educating myself on the basics of water health, the different types of conventional water treatment technologies such as sand drying filter beds and effluent irrigation fields, and more "green" technologies, such as constructed wetlands and subsurface reedbeds. Every day the pile of books to read on my desk grows, and every day my brain gets filled with ideas for how I might be able to apply these technologies in the field of landscape architecture.

And while I'm at it, why not enjoy some gelato at surfer's paradise with Ingrid?

C O N C L U S I O N

Why I appreciate this experience: As landscape architectural students, in college we learn to think through the clicking of our fingers to design macro-level spaces without really comprehending the chemical, biological and physical changes that might take place. We develop a concept that is supposed to adapt, morph, grow and improve the world throughout time, but as students we really aren't confronted with *how* these designs might fail, or how much understanding, diligence and patience it really takes to make them work. Even some of the books we read on Sustainable Urban design, that talk about the need for creating a closed-loop, regenerative system, have very few specifics for how we can make these ideas work.

What I hope to acquire from the Dreer travel award is the actual experience of seeing, feeling and smelling the impacts that people have had on a landscape and understanding how much work it actually takes to reestablish the land to a condition vaguely similar to what they used to be before.