Permaculture Design Consultancy

Nam Khan Eco Farm Foundation
Luang Prabang (Laos)

By Patrick Vibert
Permaculture Institute Asia

Compiled by:
Patrick Vibert
Permaculture Institute Asia

Approved by:
David Spicer
Howard Story

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Context and client brief

On the 28 of january 2017, the *Nam Khan Eco Farm Foundation*, in the name of Xisca Llabres, asked Patrick Vibert, from *Permaculture Institute Asia,* to do a Permaculture Design Consultancy on a 5.5 ha property, situated in Luang Prabang (LAOS PDR).

The owners intend is to build a **sustainable farm project,** which will **include a private area** for the owners on the North West side of the property, a **central area including a botanical garden, water features, a restaurant, accommodations and a natural pool for guests** on one side and a **workshop, packaging, laboratory, admin and bakery area with accommodation for staff and volunteers** on the other side.

The **east side of the property** will be **dedicated to organic farming**, with a **main focus on vegetable production**, which surplus will be sold to local restaurants, and on **medicinal herbs** for elaboration of plant extracts.

9 greenhouses have already been purchased to extend the production over the rainy season and an agricultural expert from Thailand has been hired to oversee the production.

The **main features to be addressed in the design** are **distribution and management options of grey and black waste water in relation to the botanical garden**, in order to **create a water landscape (treatment wetland) both esthetic, sustainable and productive.**

The **already existing master plan**, including potential dam sites, access and infrastructure, **have been revisited**.

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Water storages, features and waste management

In this specific environment of Luang Prabang, **water is the main issue to a sustainable landscape and ecological farm project.** Therefore **a biological matrix** made of a **lush cascade of water features, hydroponic plants, and engineered wetlands** have to be created, all of which are constantly working to **cleanse wastewater** and rainwater for re-use.

The project should embody an **approach** that finds ways to **make essential systems** both **environmentally sustainable** and **aesthetically pleasing,** by working with **leading companies and technologie**s in the field of **ecological wastewater treatmen**t and **permaculture landscape design.**

These systems should be **integrated to the resort's design from the very beginning** and become a **central part of an overall sustainability strategy** that included:

- *Collection of rainwater and recharge*
- *Ecological treatment and reuse of wastewater*
- *Environmental friendly water disinfection*
- *Composting and re-use of organic waste material*
- *Onsite production of food in relation to water*

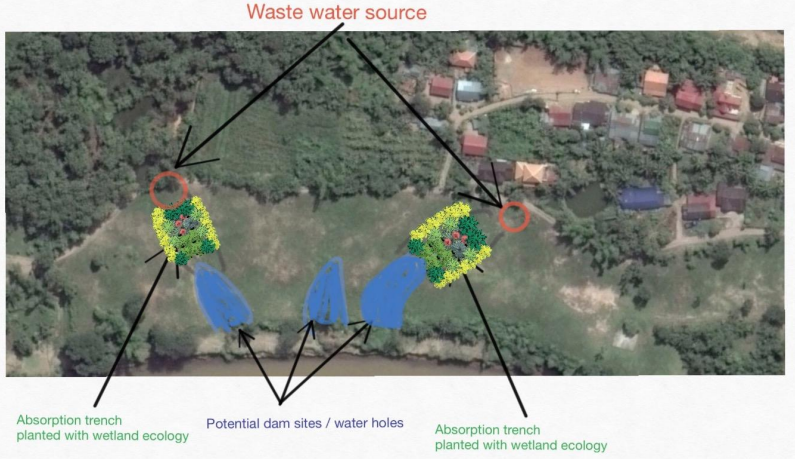
Ecological threats and opportunities

2 sources (outlet pipes) **of waste/stormwater** have been identified, running from the village and landscape above into the property and are a THREAT but also a social (village education towards sustainability) and ecological OPPORTUNITY to the environment and the owners if well managed.

The **quality and the amount of the outflow** are actually **unknown** and **water testings** would be of great use.

However, observations and pictures taken on the ground are evident and indicating a **Nitrates, Phosphites and residential pollution** (See picture) with a **slow sewage infiltration from the TOP to the BOTTOM, damaging for the local ecology.**

These waters can be either seen as a problem and therefore released to the river without treatment or be taken with RESPONSIBILITY and as an OPPORTUNITY to BE **integrated into a holistic, ethical and ecological landscape approach, based on the functioning** of WETLAND ECOLOGIES in relationship with the biological matrix of the BOTANICAL GARDEN.



On site wastewater treatment train

From source to sink

In the example shown in Figure 1, **wastewater is discharged into a collection tank (grey water or septic tank)** that acts as a primary treatment chamber for the settling of solids, flotation of oils and greases, and the **anaerobic breakdown of pollutants.**

All collection tanks (grey water or septic) must be fitted with **effluent filters** to improve the quality of the effluent leaving the tank.

Wastewater from the collection tank is **treated to a secondary level** before being **discharged to the land** (disposal area) where it will be **absorbed by a WETLAND ECOLOGY, integrated into the botanical garden** (refer to MASTERPLAN for details of placement)

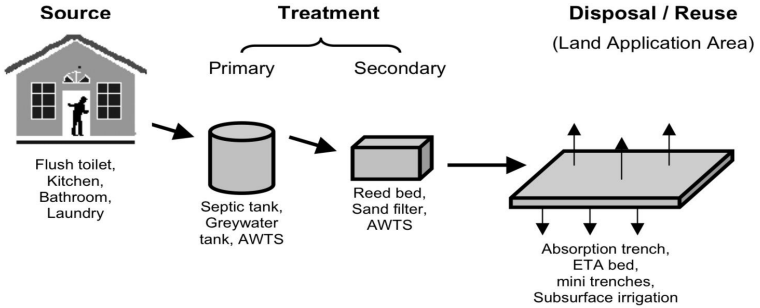
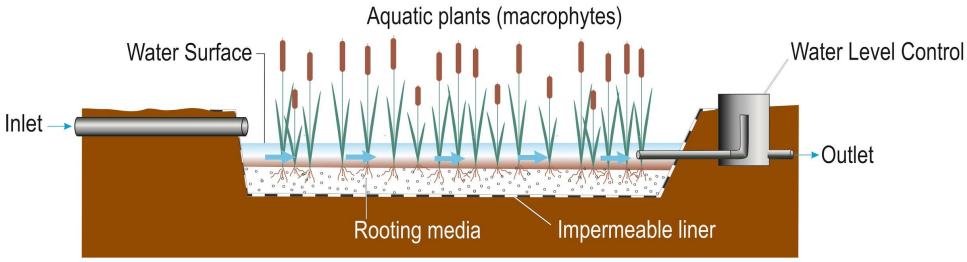


Figure 1: The On-site Wastewater Treatment Train
(AWTS = Aerated Wastewater Treatment System; ETA = Evapotranspiration-Absorption)



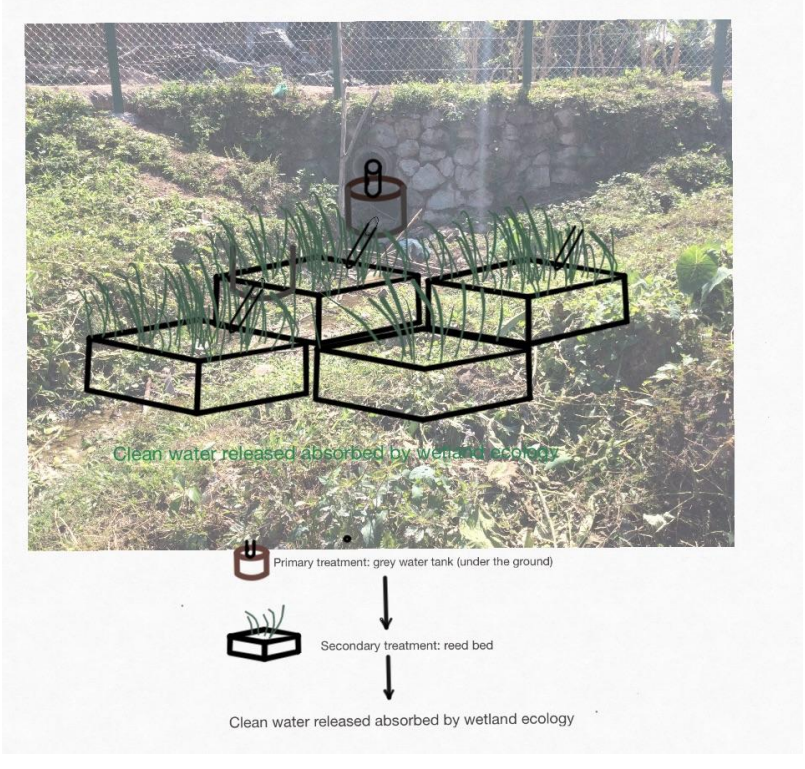
Reedbeds & ecological Wastewater treatment

A reed bed is essentially a **basin that is lined with an impermeable membrane**, **filled with gravel** and planted with **macrophytes such as reeds and rushes.** It can be **managed individually to each household or collectively for a small settlement (refer to MASTERPLAN)**

Wastewater (black or grey) passes through the root zone of the reeds where it undergoes treatment via physical, chemical and biological **interactions between the wastewater, plants, micro-organisms, gravel and atmosphere**.

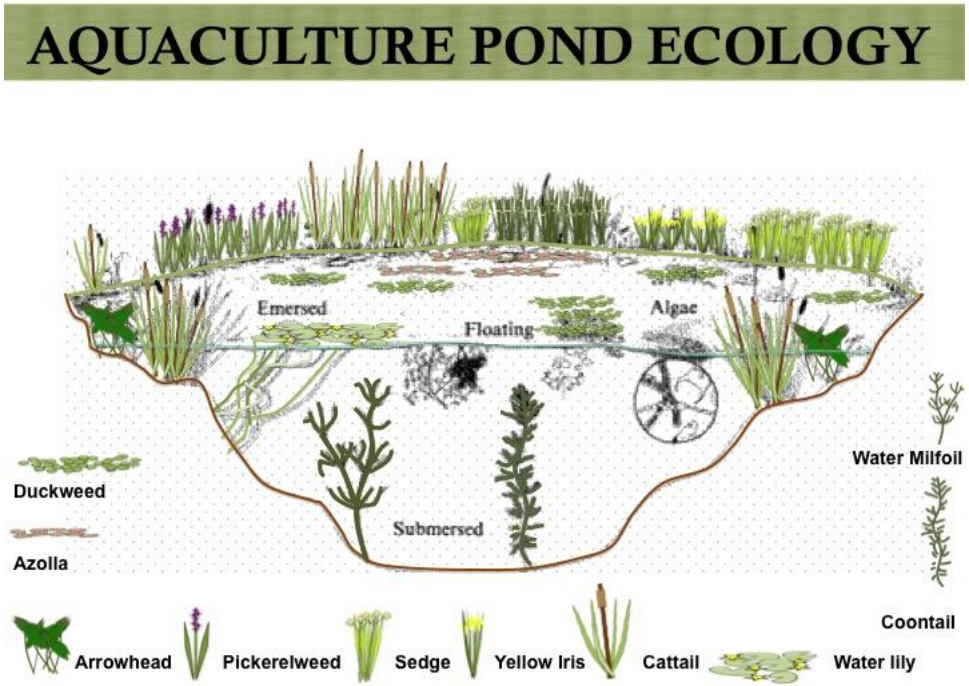
Inlet and outlet pipes are positioned below the gravel surface, so that the **water always remains below the surface, thus minimising the risk of human exposure to the wastewater, mosquito breeding and unpleasant smell.**

Reed beds for the treatment of wastewater



Species suitable for reed beds and wetland ecologies

Plant type	Species name	Common name	Range of depths (m)
Emergent	*Typha* spp.	Cattail	> 0.1 to < 1
	Scirpus spp.	Bulrush	> 0.1 to < 1
	Juncus spp.	Rushes	> 0.1 to < 0.3
	Carex spp.	Sedges	> 0.1 to < 0.3
	Phragmites spp.	Reeds	> 0.1 to < 1
Submerged	*Potamogeton* spp.	Pond weeds	> 0.5
	Vallisneria spp.	Tapegrass, wild celery	> 0.5
	Ruppia spp.	Widgeongrass	> 0.5
	Nuphar spp.	Spatterdock	> 0.5
	Elodea spp.	Waterweed	> 0.5
Floating	*Lemna* spp.	Duckweed	Flooded
	Eichhornia crassipes	Water hyacinth	Flooded
	Hydrocotlye umbellata	Water pennywort	Flooded
	Azolla spp.	Water fern	Flooded
	Wolffia spp.	Watermeal	Flooded



Select species suitable to the local ecology and for multiple functions: animal forage, mulch or building material, aesthetics, type of pollutants to treat...

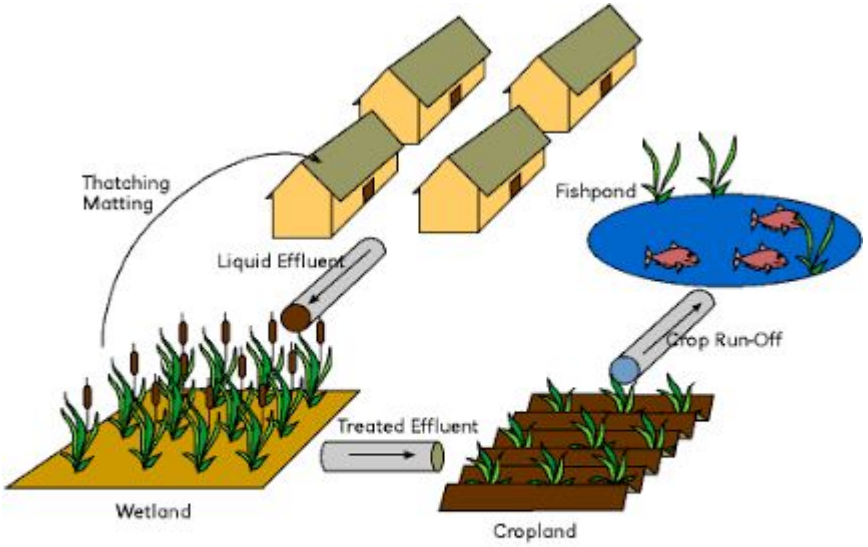
Wetlands Integrated within a Village Food Production Cycle

The constructed wetlands should form an **integrated part of the food production system (**see Figure),

In a hot climate with a continuous growing season, that means also that the **wetland biomass can also be harvested (for crop mulch, animal forage or construction material).**

Example: , the annual production of **papyrus** in tropical conditions can be in excess of **100 tonnes/ha/year.** The foliage can be sustainably cropped, while the papyrus stems can be used for matting and thatching roofs.

Water that has **passed through the wetland** can be **used to irrigate crops** and/or **introduced to a fishpond.** In this **final stage, remaining nitrates and phosphates stimulate the growth of phytoplankton and single cell algaes-** the **favorite foods of the Tilapia** (Oriochromis niloticus L.).



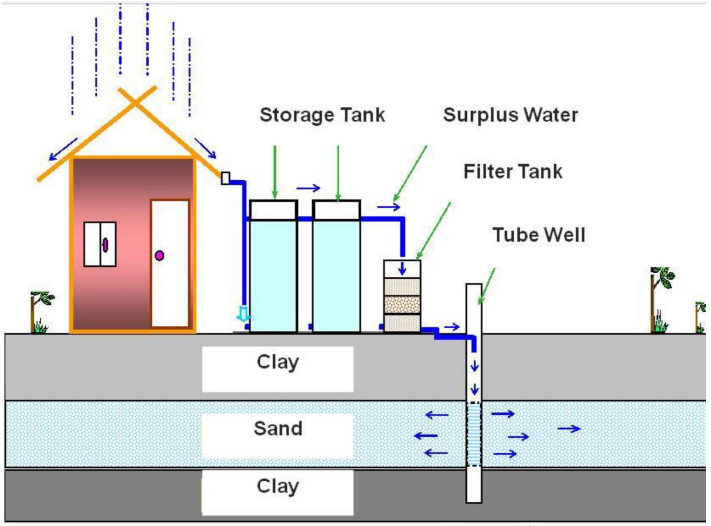
Roof water catchment and Artificial Recharge

3R Process: Reuse, reduce, recycle

For **sustainability and back up purposes** , **water storage and filter tanks** should be installed (as shown in the diagram) **around the main infrastructures** and **artificial recharge** can be done with the **roof water catchment.**

Multiple **wells** have been installed **on the property. However water scarcity** have to be taken into consideration and the **resource** should be **used wisely and recharged.**

Diagram of Artificial Recharge using rainwater (in Thailand)



The botanical garden

The *Tropical botanical garden of Louang Prabang* is a Key component of the ecological farm project initiated by the Nam Khan Eco Farm foundation.

It should create and demonstrate an **aesthetically pleasing and functional multi-purpose facility** that will **serve as a tropical fruit and food production facility** combined with **multi-purpose recreational use** that will **easily invite members of the community/village/city** to **spend time in this space.**

Establishing a botanical garden is a process including:

- **Documenting all plant species indigenous to the property**
- **Accession of all plant material introduced to the property**
- **Maintaining a collections policy which conforms to the standards of international bodies.**

Species selection and guilds for the botanical garden

In order to **attract a variety of wildlife** you **need to provide a habitat with structural diversity** as well as **plant diversity**.

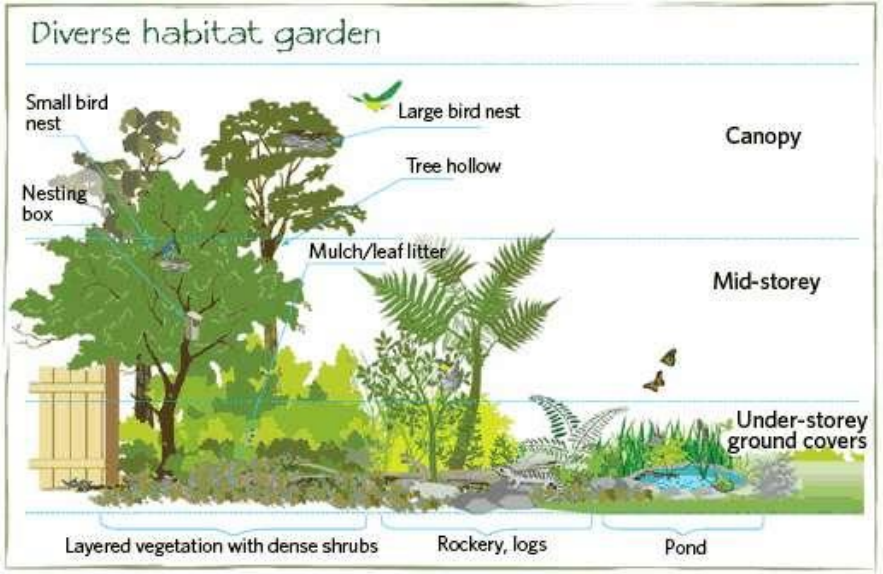
That means to **provide a wet landscape and a botanical garden** with a **canopy, shrub and ground cover.**

A canopy layer of trees with **hollows provides habitat for insects, larger birds, possums and bats.**

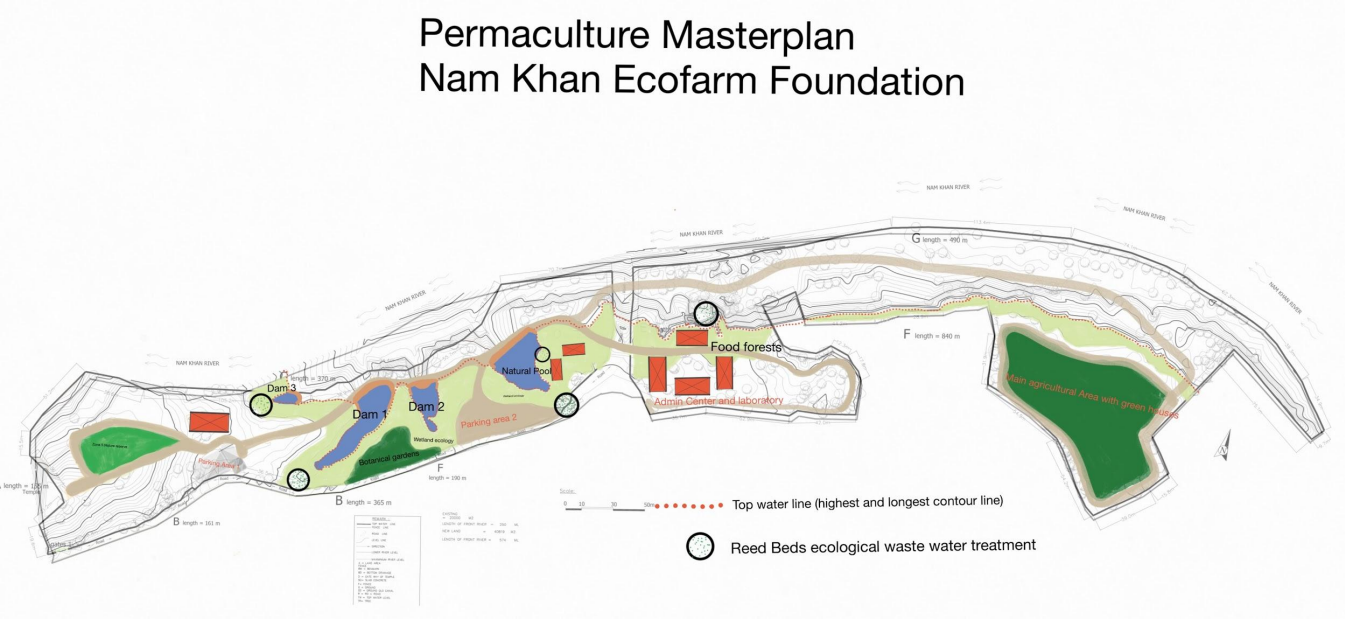
A shrub layer includes **small trees, large shrubs and tree-ferns.** These plants provide **habitat for insects, birds, possums and tree-frogs.**

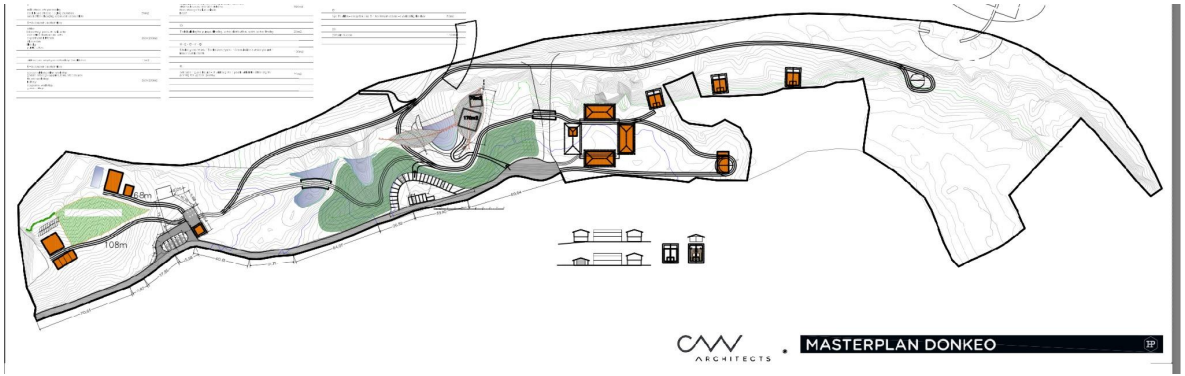
A ground cover layer can consist of **small shrubs, climbers, scramblers, ferns, herbs and grasses**. This layer provides **habitat for insects, frogs, lizards, small marsupials, and small birds.**

Logs, rocks and crevices provide food and protection for insects, frogs and lizards. A **pond provides habitat for fish, frogs, lizards** and also **drinking water for birds and other fauna.**



Master Plan revisited: Water, Access, Infrastructure





Conclusion

The **master plan** provided by the owner have been **revisited**, following observations.. Therefore the **dams have been placed in relation to the high water line,** which is the **highest and longest contour line in the landscape** of this property.

So, the **main access have been modified**, **passing over the dam walls** (instead of the 2 previous roads), connecting the parking area 1 & 2. The road splits then in two; one leading to the admin center, the other one to the agricultural area.

Reed bed wastewater systems have been proposed as the easiest way to recycle and clean the wastewater coming into and going out of the property. But **more complex systems (***Living machine, helox flow reactor***)** could be taken into consideration for a more "closed loop system".

Taking into consideration the **complexity of the landscap**e and the **long term sustainability outreac**h of the project, I advice to get in touch and to **work closely with an ecological/ permaculture landscape designer and/or project manage**r and a **water engineer or wastewater engineering company** to put in the **earthworks** and the **wetland ecology.**

I can **propose myself for the permaculture project management aspect,** as this is a **project I'm very interested in, which needs a global understanding of the processes**. However, the **implementation** should be done **in close relation with a water engineer and permaculture expert.** Different ecological wastewater companies have also been contacted in order to price the installation and the cost of such systems.

I stay at your disposal for any further information concerning this consultancy.

Patrick Vibert