Overview

Uthai Forest is a project to transform an environmentally degraded, former agricultural land into a native forest. It was started with the conviction that in this time of planetary crisis, it is not too late to take action. The most impactful work we can do now is to help nature regenerate. Since 2019, we have been working to convert this piece of land into a natural, self-sustaining ecosystem. We are a family and team based in Khao Yai, Thailand working around the causes of environmental protection, health, and wellness.
The Past Two Years – At a Glance

May 2019

February 2019

June 2020

May 2020

March 2021
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Introduction

Over the past two years, the Uthai Forest project has experimented with various methods of large-scale ecosystem restoration methods on a former paddy field, or degraded agricultural land. The goal has been to introduce native forest trees to the landscape as efficiently as possible while ensuring a high survival rate, in order to create a natural ecosystem. We have also tried various methods of engaging with the local and international community in order to make ecosystem restoration both accessible and equitable. This report will elaborate on the restoration methods used at Uthai Forest, their advantages and disadvantages as observed so far, and lessons that can be gleaned from our experience for anyone looking to embark on a similar project.

This work was initiated by All Green Learning Center in Khao Yai, Thailand. Through the support of the directors and team, we have been able to make a small impact through the restoration work at Uthai Forest.

We are deeply grateful to Goh Foundation for the invaluable support that has enabled necessary infrastructural work at Uthai Forest. The creation of common spaces, roads, solar energy systems, and land preparation, all crucial to the overall effort of ecosystem restoration, would not have been possible without Goh Foundation.

We are also grateful for the partnership of the Ecosystem Restoration Camps Foundation and its community around the world working to restore our environment. Solidarity and a strong network have been crucial to sustain the spirit of our work.

Thank you also to our local patron, Jard Foundation (จาดมูลนิธิ), for supporting on-site work and other matters within Uthai Thani province.

Finally, we wish to thank our individual patrons: Liau Tian Der and Lim Swee Meng; Angela Tan; Shirley Chung; Kork Hoe Soon; Yip Chee Seng; and Poh Toon Xuan for supporting the project. Your involvement in transforming the land has been invaluable.

Objectives

(1) Plant a diverse native forest on 19 hectares of land
   • Increase local biodiversity; create habitat and food sources for native fauna and migratory birds
   • Food production in an agroforestry system

(2) Create a space for a wider community to take action on environmental problems through getting involved in ecosystem restoration
   • Demonstration space for use of solar energy; resource-efficient design to support ecosystem restoration
   • Demonstration space for different experimental techniques for large-scale landscape restoration in the tropics

*Images and diagrams in this report are attributed to Toh Hui Ran, Aleithia Low, Andy Leong, and Saksipon Lawong.
Restoration Strategy

(1) **Landscape modification** to create the right conditions for tree growth
(2) **Water management** – to enable water to move through the site, infiltrate soil, irrigate trees, prevent flooding
(3) Grow **native forest trees** and other plants that help rehabilitate the ecosystem

**Uthai Forest – At a Glance**

- 4000 trees planted
- 85% success rate
- 200 volunteers
- 6 camps & events

**Site Map**

- Total area: 18.8 ha / 188,000 m²
- 117.5 rai

**LEGEND**
- **Pond**
- **Nursery**
- **Shelter**
- **Road**
- **Gate**
- **Zone 1**
- **Zone 2**
- **Zone 3**
- **Zone 4**
- **Common Area**
- **Toilet & Shower**
Terrain modification to optimize the land for ecosystem restoration was the first priority at Uthai Forest, besides water management. Often, landscape and water design come hand in hand; with a key objective of landscape modification being the collection and distribution of water in the site. This section will cover the landscape design strategies used on site.

We observed the original terrain of the land as being shaped like a basin, around 1 meter below ground level. As a former rice paddy, this was created to facilitate flooding of the rice plantation during rainy season. The soil type and quality was also of note – hard clay soil with very low water penetration ability.

These are not beneficial conditions for ecosystem restoration and had to be overcome while preparing the landscape at Uthai Forest for afforestation. Since 2019, we have implemented two main methods of large-scale landscape modification methods. Their effectiveness in ensuring tree survival and improving soil water retention of time, has been monitored closely over the past two years.

**Methods:**

1. ‘Ditch and Mound’ – Implemented 2019
2. ‘Cluster’ Planting – Implemented 2020
Ditch and Mound

Above: Zone where ditch and mound method has been implemented.

Right: Planting trees on the mounds; before and after (1 year in between)

The Method
Long straight ditches are dug through the land, 1.5 meters wide and deep. The displaced soil is piled onto adjacent rows of width 6 meters. This creates elevated mounds with a loose layer of topsoil on which trees are planted. The ditches serve as rainwater catchments, which help to prevent flooding while providing a constant source of water that trees can absorb through their roots. During the dry season, biomass from the ditches is used to mulch trees.

Observations and Lessons Learned
This method is neat, easy to commission with an excavator, and makes subsequent planting work systematic and straightforward. The area where trees were planted with this method has so far yielded an 80% survival rate over the past 18 months.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>- Passive, gradual irrigation – especially useful during dry season when water is scarce</td>
<td>- Less accessible for people and vehicles; due to mounds not being connected to each other except at the end.</td>
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<tr>
<td>- Gradually replaces underground water as water leaches into the ground slowly</td>
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<tr>
<td>- High flood mitigation potential due to large volume of water collected by ditches, and ponds dug to catch runoff</td>
<td></td>
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<tr>
<td>- Companion planting is easy and straightforward; a lot of space for intercropping</td>
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**Cluster Planting**

_Above:_ Zone where the cluster method has been implemented

_Right:_ Trees being planted with the cluster method; what clusters look like from above.

_Above:_ Drawing showing the design and dimensions of clusters, cross section (left) and top view (right)

_Left:_ Drawings are given to the contractor and viability of the design is tested and modified on site before land works commence
The Method
Small mounds of 2x2 meters are created with a shallow pit on two parallel edges. Soil dug from the pits is used to create a mound in between. Clusters are spaced 4 meters apart from each other. Two trees of the same species are planted on opposite corners. This is to promote symbiosis and competition, as is observed in the way trees grow a natural forest. The trees both compete for, and share nutrients and sunlight, thus accelerating their growth.

Observations and Lessons Learned
The success rate of this method cannot yet be measured conclusively because of the short time frame between implementation (May 2020) and this report.

However, from initial observations of the process and results over the past year, we are not likely to recommend it to other practitioners.

Firstly, compared to the previous ‘ditch and mound’ method, the ‘clusters’ are more complex and expensive to create with machinery. An excavator must do more precise work to dig small pits and then create a flat, evenly-shaped mound between them. One advantage is the soil that makes up these small mounds is soft and relatively fertile, and ideal for young trees. However, whether this method can prevent them from being damaged by flooding remains to be seen.

Additionally, the clusters at this size (2x2m) are too small, and the pits dug parallel to them on both sides are not deep enough to contain water for long, especially during dry season. This makes them an inefficient passive water source as water evaporates before it can be absorbed into the soil. Without the ability of soil to ‘hold’ moisture, the method loses much of its initially intended advantages.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>- Enables and encourages the planting of more trees (natural competition doesn't hamper their growth)</td>
<td>- Companion planting is harder</td>
</tr>
<tr>
<td>- Less disruption to original soil structure</td>
<td>- Flood mitigation potential not as high as the ‘clusters’ are not too elevated above the ground</td>
</tr>
<tr>
<td>- Easier for people and vehicles to move around between clusters</td>
<td>- Hard to create with machinery</td>
</tr>
<tr>
<td></td>
<td>- Not an efficient passive water source</td>
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Water Management

Water was initially, and continues to be a key concern at Uthai Forest. Water can both sustain and destroy life; the difference lies in how it is managed.

In the rainy season (May – November), the province of Uthai Thani where Uthai Forest is located experiences flooding. The other half of the year (December – April) is constantly hot and dry, often akin to drought. With worsening climate change and increasingly unpredictable rainfall, the challenge of retaining, conserving, and managing water will only become more pressing.

A range of water storage and distribution infrastructures have been put in place at Uthai Forest. We continue to monitor their effectiveness and make improvements to existing systems.

Methods:
1. Ponds, ditches, and culverts
2. Solar-powered groundwater wells
3. Gravity-flow water tower systems
Ponds, Ditches, and Culverts

Ponds and ditches are created for the purpose of water catchment and irrigation. They also prevent flooding as water can be diverted to fill ponds during heavy rains; provide a passive source of water for trees; and help to replenish groundwater. During times of little to no rain, water is also pumped from the ponds to irrigate trees.

Besides the ponds shown on the map above, several more are currently planned for areas that have been observed to flood. The size of ponds is designed according to the expected rainfall volume in the area. Vetiver grass is planted along the banks of ponds and ditches to prevent erosion and remediate the soil, as they have extremely deep roots.

**Above:** Vetiver grass planted along the banks of all the ponds at Uthai Forest

**Right:** Ducks and chickens (chicken house pictured) are reared, for their droppings to fertilize the soil and to provide eggs for the caretaker and surrounding community.
Right: All zones are connected by culverts. They help to drain water away from low-lying areas prone to flooding, into ponds, ditches, and a common ditch outside of the site.
Gravity-Flow Water Tower Systems

**Left:** Map showing location of the gravity-flow water tower system in Zone 1

**Center:** Water tank which groundwater is pumped into and subsequently distributed through the system of water towers. **Right:** Eight water towers, each slightly lower than the previous, through which water can be distributed via gravity and released via two taps.

The gravity-flow water tower system is a means of distributing water over a large area using as little energy as possible, relying instead on gravity. This was designed to enable trees to be watered individually and preferred over a sprinkler system which might also promote a proliferation of weeds which could impede the trees’ growth. It was intended to optimize water-efficiency in a place that can occasionally be very dry. This system is able to supply water to an area spanning 200m (length) by 150m (width). Water is pumped into the main water tank and distributed via gravity to pipes suspended on towers with cascading heights. Each tower has two taps, one on each side, from which water can be released.

The original design (*above*) was successful in enabling the entire vertical length of the area (200m) to have access to water. However, without a more automated means of distributing water latitudinally, it was observed to still be labor-intensive. Additional pipes and taps were later installed along the horizontal of each water tower (*right*). This will help to reduce the labor needed to irrigate this area.
Solar-Powered Groundwater Wells

*Left:* Solar panels used to power the groundwater pump
*Right:* Structured upon which solar panels are mounted

Groundwater is used as a backup source of water. There are two wells, both powered by solar energy. Each well reaches an underground aquifer of around 100m below the surface. Groundwater is constantly being replenished through ponds and ditches. However during the dry season when there is no other water available, it is occasionally pumped above ground to irrigate trees.

*Left:* Underground pump and control panel
Native Species Reforestation

Uthai Forest uses a method of reforestation that is unconventional but currently gaining popularity in Thailand. It is taught and popularized by a local non-profit, the Native Species Reforestation Foundation (มูลนิธิฟื้นฟูป่าพื้นถิ่น). We also adapted from agricultural strategies introduced to Thailand by the late King Rama IX.

This is a strategy for the large-scale reforestation of native species. Instead of starting the restoration work with pioneer and fast-growing species before successionaly introducing forest trees to the landscape, it starts with forest trees as the ‘foundation’. The reason is to optimize the growth of trees that will ultimately become a native primary forest. Additionally, many fast-growing leguminous species can be invasive without proper and meticulous management. The use of pioneer species or solely natural regeneration can be detrimental instead of helpful to the ecosystem restoration effort as a whole. So far, this method has proven effective with the average tree survival rate over 80%.

Methods:
1. Planting native trees and shrubs, and vetiver grass
   a. Planting trees in a configuration designed to mimic a natural forest
   b. Vetiver grass to prevent erosion and increase soil water retention
2. Strategy to create a native forest and maximize tree survival
Native Trees, Shrubs, and Vetiver Grass

Above (L-R): Phyllanthus emblica, Afzelia xylocarpus; Tectona grandis; Hopea odorata; Dipterocarpus alatus. Some of the native forest species established so far.

Tree Species
Only native trees, or tree species that have been cultivated in Thailand for a long time, are planted at Uthai Forest. These species have been acclimatized to the local conditions and climate, and are able to grow in many soil types found across Thailand. Before being planted into the ground, some trees are inoculated with soil mycorrhiza, which has a symbiotic relationship with their root nodules. This helps to facilitate the creation of a soil fungal network.

<table>
<thead>
<tr>
<th>Uthai Forest Tree Species (As of 2021)</th>
<th>Romanized Thai name (Scientific name)</th>
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<tbody>
<tr>
<td>Sak (Tectona grandis)</td>
<td>Khee Lek (Senna siamea)</td>
</tr>
<tr>
<td>Yang Na (Dipterocarpus alatus)</td>
<td>Hu Guang (Terminalia catappa)</td>
</tr>
<tr>
<td>Yang Hiang (Dipterocarpus obtusifolius)</td>
<td>Fang (Caesalpinia sappan)</td>
</tr>
<tr>
<td>Takhianthong (Hopea odorata)</td>
<td>Payom (Shorea roxburghii)</td>
</tr>
<tr>
<td>Mahogany (Swietenia macrophylla)</td>
<td>Samrong (Sterculia foetida)</td>
</tr>
<tr>
<td>Makha (Afzelia xylocarpa)</td>
<td>Chamuang (Garcinia cowa)</td>
</tr>
<tr>
<td>Moringa (Moringa oleifera)</td>
<td>Philung Gasa (Ardisia pendulifera)</td>
</tr>
<tr>
<td>Samo Phi Phek (Terminalia bellirica)</td>
<td>Kalapruek (Cassia grandis)</td>
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</tbody>
</table>

The above is a non-exhaustive list of the tree species currently grown at Uthai Forest. While monitoring the project progress, we also track the growth and success rates of different tree species and their ability to establish in clay soil.
Vetiver Grass

Vetiver grass (*left*) is planted extensively, both near the trees as well as along the banks of ponds and ditches. They help to improve soil water penetration ability, thus increasing availability of water to the roots of tree saplings. As a perennial grass with very deep roots, vetiver also helps to prevent erosion. The use of vetiver in agriculture was introduced to Thailand by the late King, Rama IX (Chomchalow, 2011¹). Today it is used extensively across the country as a companion plant in both agriculture and ecosystem restoration. It is very fast-growing and thus can also act as a consistent source of mulch when cut down and allowed to regrow every few months.

Planting Method to Create a Native Forest

Spacing and Configuration
During the first stage of restoration at Uthai Forest, we primarily planted trees that make up the canopy and understory, the two highest levels of a natural forest. These function as the ‘foundation’ of the forest, which are later intercropped with other trees that occupy lower levels in the forest strata. Due to their height, canopy and understory trees need a lot of underground space for their roots to establish as fully and extensively as possible. Using the ‘ditch and mound’ method of plantation, canopy trees are given at least 8 meters, and understory trees 4 meters on either side between each other (below). The ‘cluster’ method of plantation follows the same spacing, except that two trees of the same species are planted on each ‘cluster’ to promote competition and faster growth.

This is called a ‘neat’ forest plantation. Employing a method like this has allowed us to plan the restoration of a large area in a systematic way. It also maximizes the potential of forest trees to reach their full size. With most saplings having been established for 1-2 years already at Uthai Forest, we will subsequently be intercropping them with fruit trees and other fast-growing, leguminous species that can be used for chop and drop mulching.

The relative effectiveness of the different spacing methods is still being monitored.
Individual Tree-Planting Method

The method of planting each tree is also designed to maximize their chances of survival, especially when faced with the hard, nutrient-poor, and (for half the year) very dry conditions at Uthai Forest. The step-by-step method is illustrated below.

This method can be used in other projects of similar conditions. From our experience, several points are worth noting:

- **Size of hole**: Must be significantly wider and deeper than the existing container holding the sapling. This creates space for it to establish roots further, especially in hard soil.

- **Organic fertilizer**: Dry cow manure is used here, as it is relatively inexpensive and in abundant supply in Thailand. Any other organic fertilizer or compost can be used in replacement.

- **Agricultural hydrogel**: This is potassium-based, biodegradable starch that can break down within 3-5 years. It is used to retain water and release it to tree roots when the soil is dry. While it is a less common product, the use of hydrogels has helped to reduce the frequency of watering trees individually.

- **Soil compaction**: After soil has been filled back around the tree, it should be piled up and compacted such that eventually the soil tree forms a slight mound. It should not be a depression such that water pools in the loose soil around the tree itself. This ensures that in times of flooding, the roots will not be drowned and rot. This is an irreversible cause of damage and death for most young trees. In instances where soil was not filled back into the hole sufficiently, trees have died as a result of flooding and heavy rains.
Social Engagement

Planting trees and ecosystem restoration is a form of collective action that tangibly helps to repair the destruction done to our planet Earth. While it may seem like a small effort relative to the scale of environmental degradation, it makes a big difference to the individual, who feels empowered and inspired just by doing something.

Until the COVID-19 pandemic hit, we were actively engaging a wider community to be involved in Uthai Forest through volunteer camps, and events with the local community. Since 2020, we have focused on growing our local network and connecting with peers within Thailand passionate about ecosystem restoration.

Volunteer Events

Volunteers are involved in the whole spectrum of work at Uthai Forest, from planting trees to clearing weeds; building and decorating common areas; creating fire breaks; and other activities. It is a communal experience; everyone pitches tents in the common area, cooking and eating together, and looking out for one another.

Above (L-R): Harvesting a watermelon that grew from a volunteer plant; Painting the common shelter; removing weeds from the fence to prevent fires from the neighboring lands from spreading; collectively planting a tree.

The experience was quite impactful for some and feedback and testimonials were collated to make the experience better for subsequent volunteers.

Right, below: Social media posts by past volunteers about their experience
Local Community Engagement

Most of the community around Uthai Forest are comprised of small farmers, growing rice commercially and for subsistence. Many use conventional, chemical-intensive methods of planting; burning and tilling their fields after each harvest. Thailand is one of the world’s biggest producers and exporters of rice.

Changes in the economic situation and local policy over the years have left low-income rice farmers in Thailand at a disadvantage. With a glut of production relative to Thailand’s consumption and export amount and constantly fluctuating prices, farmers often lose money year after year, instead of earning a profit from their harvest. Besides research that suggests this, we have learned as much from interactions with people in the community. Often, they spend more on pesticides, seeds, machinery, and other costs than they earn from the harvest. Compounded over time, this has left many in debt, having to sell their land or mortgage it to the bank. However, most people still persist in rice-growing and agrarian livelihoods. To some extent, this is because of the lack of other options available.

When engaging with the community, we are conscious of the need to be equitable. We provide payment or compensation for any opportunities offered, usually above market rates. The main caretaker at Uthai Forest, Uncle Noont, used to be a rice farmer in the area. He and his wife are now employed full-time and part-time at Uthai Forest.

In 2020, due to COVID-19 and the restrictions on global travel, we turned to hiring within the local community to plant trees instead. Villagers were paid for every tree planted. For us, like many around the world, the pandemic gave us the opportunity to go local, and focus on galvanizing our neighbors and the immediate community in the work that we are doing.

Above (L-R): Students from a nearby school at a tree-planting event; locals learning how to make charcoal for free.

Below (L-R): Local villagers at a week-long event where they planted 2000 trees and were paid for each tree. This was also an opportunity to get acquainted with them as neighbors.

Upcoming in 2021

The priority moving forward will be expanding the water system through various means: installing an irrigation system; creating more means of rainwater harvesting and water storage; and implementing passive watering systems.

Besides this, the restoration of the remaining areas through planting native trees has also been planned. The method of land preparation will be modified from the ones currently used, based on feedback and observations of their effectiveness.

Drip Irrigation

Drip irrigation systems will be installed at the areas where trees have already been planted. This is to reduce the labor involved in watering as well as to increase water efficiency as the drip system will be operated by an automatic timer, and turned off during the rainy season or times with sufficient water.

Water System Expansion

Improvements are continuously being made to improve the water efficiency at Uthai Forest.

Water tanks of 4500 l capacity have been installed to serve as storage for rainwater from the ponds. When pumped up to the tanks, installed on towers of height 3m, water from the tanks can be released and used to irrigate the area via gravity.

Deep Pipe Watering
‘Deep pipe’ watering is a method of getting water to the roots of trees by installing a pipe with small holes below ground. It has been tested offsite for its effectiveness in promoting tree survival, and observed for any detrimental effects.

Generally, trees where the deep pipes were installed fared well even in the dry season and were seen to be putting out new leaves even when others were not. Given no adverse effects, this method will be trialed at Uthai Forest also with the intention of improving water efficiency and getting as much water to the tree roots as possible.

**Funding Needs and Objectives**

Funds for large-scale infrastructural needs, compost, equipment, as well as trees, seeds, and other plants is consistently needed. Uthai Forest is currently supported through a combination of overseas and local foundation-based funding and its Adopt-a-Plot programme. Due to the effects of COVID-19 on overseas travel, many existing funding channels have been restricted.

All funds have and will be used solely to support ecosystem restoration work at Uthai Forest.

To explore possibilities of collaboration, please contact huiran.toh@gmail.com.