

Botanical Campus: A model towards Sustainable University

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Abstract: In the past, the cultivation and development pattern of cultural landscape used to bond very closely with natural environment. However, when the intensity of use becomes high and complex, it demands land use organization to adapt natural resource to fit human modern use, and sometimes, with less consideration of cultural landscape. As in the case of campus planning, contemporary design of Campus Master Plan in Thailand is commonly practiced on the principle of creating suitable land modification to support human needs system, and academic planning rather than prioritizing natural factor. Grounds and roads are paved; alien plants are transferred in, requiring fertilizer and a lot of water for maintenance, leading to very high resources and energy used in construction and operation. As a result, problems such as high cost investment and high maintenance in project scale as well as environment degradation in global scale could arise. The impact of artificial landscape presents a severe treat of biodiversity loss in nature. Today's trend in landscape architecture practices should no longer favor only social and economic values, but rather more on environmental values. This paper illustrates the paradigm shift in campus landscape planning from functional oriented to ecological oriented. The example of KMUTT campus presents possibilities in transforming its outdoor space in to Learning Park by integrating native Botanical garden into its master plan. For long-term expected outcome, in such landscape, the restoration of native ecology would be possible. The achievement of the University will be the visibility of the commitment in sustainability in terms of both environment and lifelong education.

INTRODUCTION

In the past, the cultivation and development pattern of cultural landscape used to bond very closely to the natural environment. However, in contemporary times, when intensity of use is high and complex, it demands land use organization to adapt natural resource to serve modern human usages. Same as in the case of campus planning, most campus master plans in Thailand aims to modify land use followed the academic organizational principles rather than the natural environment of the site. When man-made and natural environment is not well-suited, problems such as high cost investment and maintenance of infrastructure and planting system in single-site scale could arise. The impact of artificial landscape presents a severe treat of biodiversity loss in nature, which affects to climate change on a global scale. This paper argues that the present norm of Campus Master Plan design need to be changed towards environmental model, to restore natural landscape as well as to accommodate the life-long learning environment.

The paper illustrates the case of two campuses of KingMongkut's University of Technology Thonburi (KMUTT), which have different environmental issues. Each campus is facing vulnerable natural factors, one is too wet, and the other is too dry. Therefore, the landscape theme and landscape treat of each site has to be different. The revised master plans, however, share the same landscape principle, which is to integrate native botanical garden into their spatial plan, in order to follow our commitment towards the Sustainable University.

Man and Nature

Over the past decades, forests around the world are under threat from deforestation, which comes in many forms, including fires, agricultural clear-cutting, industrial invasion and urban expansion. Global Forest Resources Assessment (FRA) 2010 concludes that net deforestation at the global level occurred at the rate of 0.14 percent per year between 2005 and 2010 or 5.2 million hectares per year (FOA, 2012). In Southeast Asia, the rate of deforestation of tropical forests has been higher during past 10 year, mainly because of commercial agriculture. Mangroves and swamps throughout Southeast Asia have been cleared for shrimp and pawn hatcheries, resulting in over half of the world's original mangrove forest being lost, or approximately 32 million hectares (app. 80 million acres). In 2007, less than 15 million hectares (37 million acres) of mangroves remain. Once mangrove forests are damaged, recovery can be very slow. Despite replanting program in many Asian countries, over 50% of the world mangroves have been destroyed in the last 50 years (Azlan, 2008).

Forests play an important role in global climate pattern, because they act as a carbon sink function. Deforestation undermines carban sink capacities thereby increasing problems from greenhouse gas emissions and global warming, such as flash flood and extreme drought disaster. Mangrove forests are also a nursery for many small aquatic species and provide habitats for various wildlife species. With its complex root structure, it helps maintain coastal water quality through abiotic and biotic retention that remove pollution and recycle nutrients. The loss of mangroves, causes numerous affects including damaged biological diversity and weakness along shorelines that lead to flooding and land erosion.

In Thailand, the mangroves area was reduced about 50% since 1960 due to shrimp farming, urbanization, agriculture expansion, roadways, and marinas. The forest cover In Thailand decreased from 61% to 34% of the country's land area during 1945-1975 because of logging industries. After that, deforestation caused mostly due to the economic policy that supports single product cultivation, such as rubber plantation and vegetation field. Lately, other intrusive developments and tourist industries play a significant role in destroying the forests as over-built structures encroach beautiful natural areas. Indirectly, developments elsewhere

transport mature-grown plants from forests to fill their projects. Too often that landscapes select the grown plants moved from forests or general plants available in the markets, which requires extra care because they are not adapted to local climate, or worse can be invasive. So man-made landscape could partially responsible for the lost of forests and the climate change we are facing today.

Towards sustainability and learning

King Mongkut's University of Technology Thonburi (KMUTT), Thailand was established in 1960 as a skillful technician institution (Planning Department, KMUTT, 2011), after 50 years, it is now a well-known University in Science and Technology. Today, KMUTT aims to produce graduates in creative Science and technology fields to be change agents in a sustainable society. KMUTT has announced the Sustainable Policy Plan in 2005 (EESH, KMUTT, 2012), along with the policy in "New Approach Learning" to construct the 21st century learning. Its mission is to educate the students and encourage them to learn outside classroom, so it has to transform KMUTT campus space into an ideal environment for developing awareness and knowledge in green. This would, then, lead to the innovative solutions for the better world for current and future generations (Limpaiboon, 2012). The 21st century learning behavior would induce lifelong learning in students, as they develop their intellectual through interactive, observable, curiosity and collaborative in open-learning environments (JISC, 2006). KMUTT has begun to make its policy visible by planning every campus grounds to be a Learning Garden or an Education Park. The KMUTT philosophy to roadmap2020 defines the Learning Garden as, "a beautiful shady place that provides peaceful atmosphere, encouraging enthusiasm for intellectual dialogs and new ideas, that support KMUTT to produce young graduate with greater knowledge and virtue for improving our society . The pleasurable park atmosphere will make users feel fresh and comfortable, thereby ensuring an open mind for new ideas and eagerness to exchange opinions" (KMUTT, 2002). The KMUTT learning garden is a creative environment that responds to users' behavior and interaction while preserving and restoring its natural environment (Limpaiboon, 2012).

BOTANICAL CAMPUS

Botanical Garden, as defined by Botanical Gardens Conservation International (BGCI) is, "*Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education*". This explains the common role of Botanical garden as the place for plants collection, scientific research and plants education, and recent role, as tourist attraction. Landscape architects categorize Botanical Garden as one type of educational theme park; hence, the traditional layout of botanical garden is composed according to organized zoning, required functions and manageable operations.

Recently, some Botanical Gardens have altered its role to be less scientific to serves specific society and ecology. For instance a Native Botanical Garden, in which communities are involved in planting and maintenance, serves natural preservation purpose. The Native Botany requires relatively less investment, low cost for maintenance and no pesticide because the plants are conditioned to the local climate, soil types and animals (CNPS, 2013). Since the garden focuses more on native plant communities in natural setting, it will be able to support the restoration of local ecological systems.

The purpose of a Botanical Garden in Campus normally emphasizes to serve the scientific research and provide education of plants varieties. Most campuses provide specific zone closed to their Natural Science or Horticulture Departments. Only a few campuses claim to integrate Botanical Garden to the whole campus ground, one of which is The University of Chicago (Harms, 2010). Their Botanical Gardens are spread across the entire 215 acres Hyde

Park campus, which beautify the area and educate the visiting public about flora with labeled plant selections. A major negative impact of this holistic garden integration, however, is the uses of many resources in manage and sustain of such landscape. Another campus case is the conservation garden of University of North Carolina at Chapel Hill, which is ranked 5 in the twenty most impressive campus gardens by Online Colleges (Online Colleges , 2011), for its huge collection of native species. The Native Botanical Garden covered over 700 acres which filled with 2500 native North Caralina species. They commit to the environmentally responsible gardening practices to grow healthy plants while simultaneously preserving diversity and the overall balance of nature. It is remarked that alien plants can become aggressive invaders of natural areas and local biological diversity, so alien plants should be avoided or used with care. The Native Botanical Garden allows them to use minimum approach necessary to manage and maintain the garden.

In the case of KMUTT, the different role of Botanical Garden has been purposed at both Bangkhuntien and Rajburi campuses. Rather than solely creating a beautiful, well managed “garden” in campus, we purpose a campus of natural woodlands, bogs and meadows which is cheaper in investment, easier and eco-friendlier for maintenance. In which the students and communities can explore by trail and bicycle, can exercise and learn permaculture, postharvest technology and environmental technology. Thus, KMUTT will be Native Botanical Campus housing native plant species in local ecology for outdoor learning. To do so, the understanding of landscape ecology is important to indicate the native botany for the campus landscape theme.

STRESSED AND OPPORTUNITY

KMUTT places its positioning as a pioneer educational institution in the western region of Thailand. Its four campuses are located from west of Bangkok to the western most area of Thailand in Rajburi. The geography is varied from central floodplain area to the mountainous area close to Thai-Burmese border. This paper illustrates two sites with different natural and cultural landscape characteristics, KMUTT at Bangkhuntien and KMUTT at Rajburi.

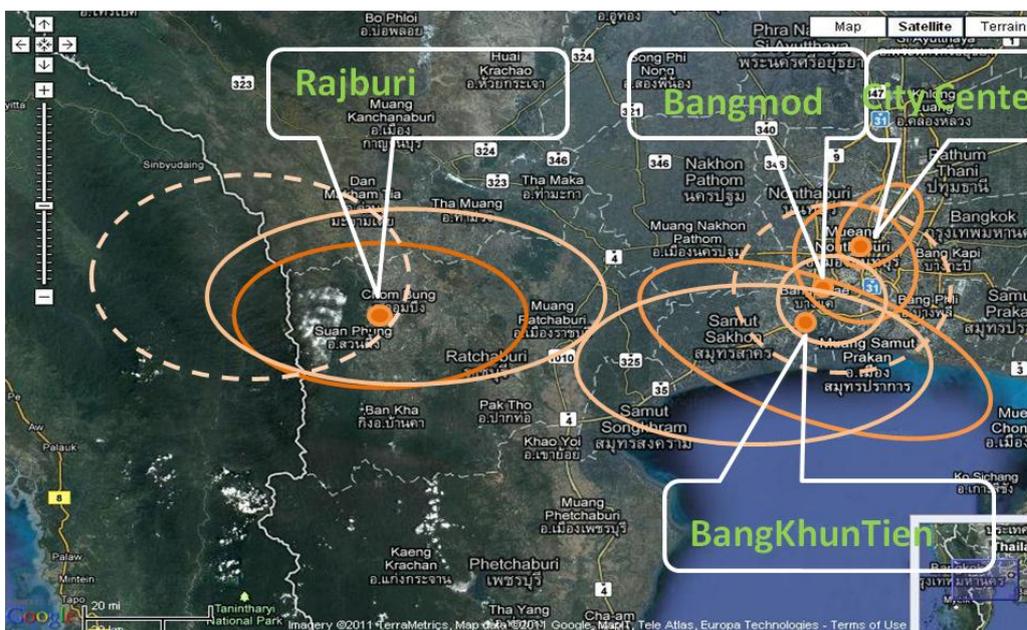


figure 1 King Mongkut’s University of Technology Thomburi on 3 sites the western Thailand with varied geography from Coastal plain to mountain foothill.

Bangkhuntien Landscape Character

Bangkhuntien campus is located in a mixed ecology between tidal wetland and inland wetland. Tidal wetland is where seawater mixes with fresh water to form an environment of varying salinities. The salt water and the fluctuating water levels (due to tidal action) combine to create a rather difficult habitat for most plants, except for Mangroves, with salt-loving shrubs or trees, common in wetlands in tropical climates. Inland wetland is where the groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (EPA: United states Environmental Protection Agency). It is a shallow water ecosystem between terrestrial and aquatic ecosystem, where marsh, and aquatic plants can grow, playing an important role as a habitat for many fishes, birds and mammals. Bangkhuntien area is muddy clay, unstable and high salinity soil, and watertable is at or close to the land surface, causing floods to occur regularly due to high tide and rainfall runoff from the city.

The stability mangroves along the coastal line and waterway could help protect the coastal erosion from violent wave with their complexity root system, but the forests must be thick enough. The dominant plant in mangroves is Rhizophora species, still requiring flushing with freshwater and a fluctuating water level, even as they are able to grow in salt or brackish water. Along the Gulf of Thailand coast, the thickness at mangroves strip was reduced to only 150 metres wide in 2012 because of the strong wind and the gulf water current (DMCR, 2013) of the sea. In addition, man-made activity which is the expansion of shrimp farm is the most harmful activity to inland mangroves. Bangkhuntien campus has an opportunity to encourage mangroves planting inland and along the stream corridor further from the coast. The seasonal marshland will be able to grow along the pond edge and retention area in our campus.

Rajburi Landscape Character

Rajburi campus is located in the foothill with lateritic soil structure and have an average rainfall of less than 100 ml. per month. The soil is mainly composed of coarse gravel and sand with low moisture, particularly during the dry season, low nutrients and high rate of soil erosion. Plants communities found here are dry deciduous dipterocarp forests with 5 dominant deciduous plants. The campus area used to be an abandoned deforested site caused by forest fire. Presently, existing trees are secondary succession of dipterocarps, which form open canopy woodland with a grassy under storey but because of the poor soil, they cannot grow further to become a mature forest. Refer to Thongvichit's article on Assisted Natural Regeneration(ANR) in Thailand, many studies have shown that in deforested sites formerly covered by evergreen forests, very few of the original species can be restored through natural regeneration. Trees that regenerated naturally were pioneer species common to secondary forests. Through the process of ANR, which involves community to grow and maintain the forest, recovery rate would be twice as fast (Boriphan Thongvichit, Sermoyot Sommun, 2003).

Soil and ecological improvement opportunities in Rajburi campus including assisting the secondary succession to grow better, as it will enhance natural processes and promote the regeneration of native species. In some areas, a wetter patch in the dry forest must be provided to recover soil conditions, so that other evergreen and mixed deciduous plants will be able to grow. The semi-evergreen forest patches or corridors could be seasonally soakage swale eco-regions that are key resources to many species during dry season.



figure 2 Rajburi Site environment



figure 3 Rajburi site is connected to the Wildlife Suncetry on the west

DESIGN WITH NATURE

Landscape Theme specified by water

The review of landscape character of both cases shows that in the tropical region, water is the essential component in the restoration of each type of ecology. In creating a Botanical Garden in campus, native botany is the scheme that best fits the former and surrounding ecosystem. It would require relatively less maintenance and man-made infrastructure such as drainage and irrigation piping for its sustenance. The limitation of the built area is significant to support ecological restoration. Hard surface usable area, such as circulation, parking and large plazas should be limited in compact arrangement to provide as much permeable ground as possible for ground water recharge. Outdoor research in natural science and environmental technology in outdoor area that responds to the correlated type of ecology should be widely encouraged. Post harvest technology and knowledge such as Bee Laboratory and Mushroom Farm Study, could also be beneficial in following the idea of Permaculture.

Water Sensitive Design

1. **KMUTT at Bangkhuntien “Natural Energy Park”.** Landscape Theme of KMUTT at Bangkhuntien is set to be Mangroves and Marsh Wetlands. The regional landscape is flat with ground water level approximately at the surface. It was once in mangrove wetlands and salt marshes, but has since been destroyed by shrimp farm and infrastructure construction. As the site is located between Bangkok’s urban floodway and the sea, it regularly faces flood problems both from urban floods and raised sea water level. The master plan concept started from the shift in thinking about water management and flood treat, to allow natural water to run through the site with the seasoning fluctuation, resulting to be an ideal place for mangroves. The open water creates natural succession from marsh vegetation to swamp forest vegetation.



figure 4 Bangkhuntien Masterplan



figure 5 detail of the edge



figure 6 Boardwalk on marshland and Mangroves

The water edge is extended to provide dampness area, which is naturally treated for the continuity of hydro-biodiversity and marsh-biodiversity linkage. Here provides the habitat for many wetland-species i.e. birds, water monitors, fish. A vast area is prohibited to be built on in order to avoid hard surface and compact soil, and is reserved as retention area that accommodates marsh wetland ecology. Blue green infrastructure, continuous bio-corridor and permeable ground are provided as much as possible within the landscapes, without borders, fences and obstructions. Most walkway should be boardwalks above ground which do not obstruct the ecological flow.

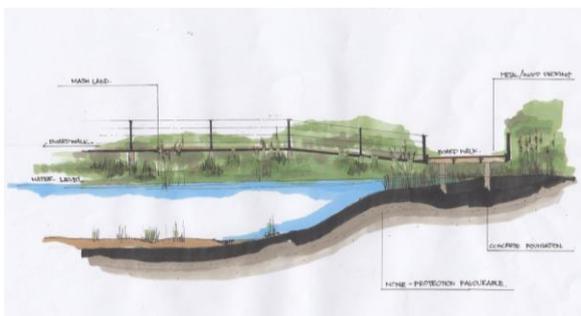


figure 7 Boardwalk and bridge

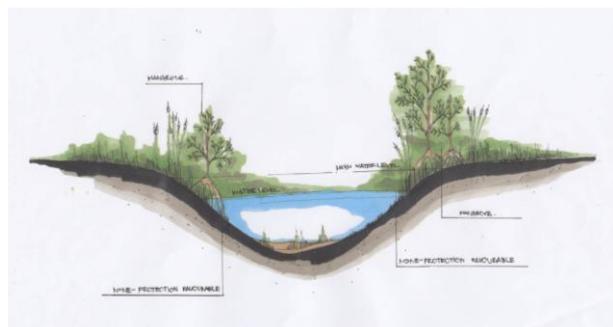


figure 8 smooth gradient edge

2. KMUTT at Rajburi “Residential Campus in a Wood”. Landscape Theme of KMUTT at Rajburi is dipterocarp and seasonal swale wetlands. The site’s natural context is different from KMUTT at Bangkhuntien, especially in terms of hydrological factor. While BangKhuntien have to deal with excess water, Rajburi is faced with too little water body and low moisture. The master plan concept utilizes the water receptions parallel to site’s existing contour variations, with the landform in evenly slope down across the site. We have to harvest rainwater as much as possible and store in the site. There is no water source on site and ground water level is very deep (150M.in depth). The series of water channels and water bodies are proposed to harvest rainwater runoff by conducting, collecting, retaining and discharging water into the soil. We implement two techniques to manage water on site, water storing, and water harvesting.



figure 9 Rajburi Master Plan showing its water networks

The former is to build a water source by capturing runoff water through an open channel, which conduct water to the series of ponds in different levels. The ponds retain water at the desired level and release the excess to be absorbed into the soil. These ponds must have a smooth gradient edge to provide biodiversity linkage between water and land.

The latter involves harvesting water from everywhere on site, then infiltrating and collecting water in the swale. It requires land grading with a gentle, blurred gradient bank that creates sloping swale to drain runoff water in. The series of drainage channels along the contour lines will capture water and drain into the central spine “swale”, called blue green fingers. The drainage swale will be a soakage area with pioneer species that can be in wet condition and still can stand the drought for some periods, so it could keep hold of water and then slowly absorb into the soil to improve soil structure and, and create natural wetland swale in the long run. Water collected from roof and road runoff, along with the treated brown water from sewage system will be directed into natural channel drains, infiltration area, and finally to bio-retention swales.

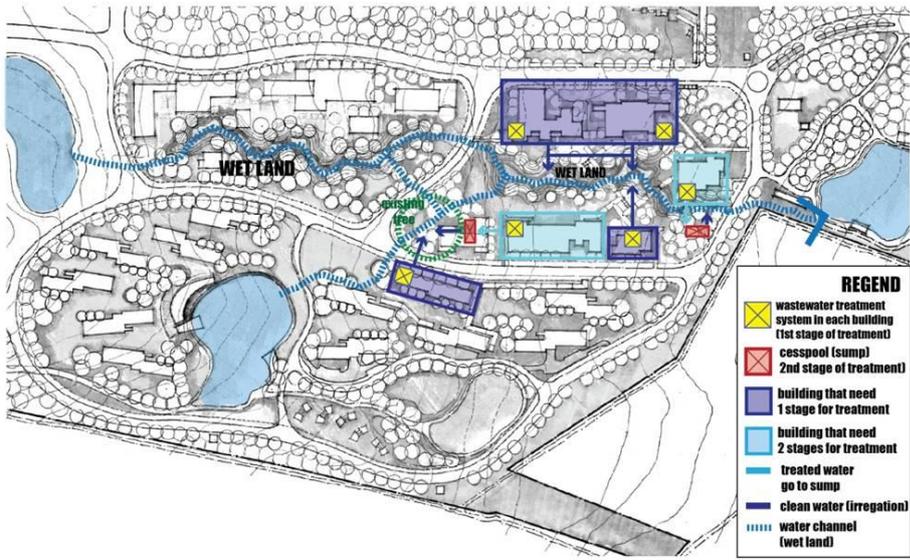


figure 10 KMUTT Rajburi water management plan

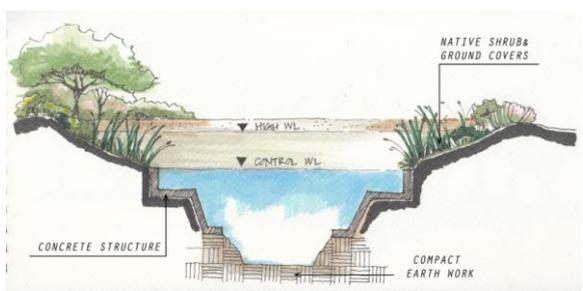


figure 11 section showing the sloping pond's edge

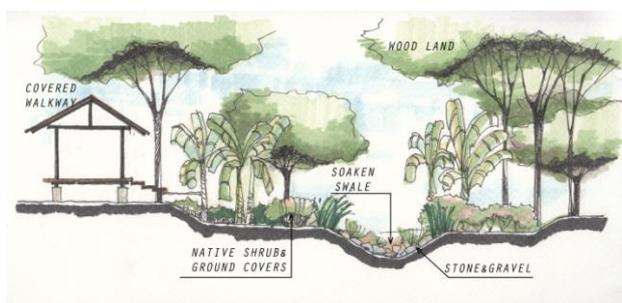


figure 12 section showing soakage swale planted with pioneer plant species

CONCLUSION

The illustration of each KMUTT campus master plan case shows different theme in landscape appearance according to each site's natural context. Both cases, however, demonstrate the same landscape planning principle towards sustainability by integrating the Native Botanical Park with the spatial treatment of academic land use. They are both based on the same paradigm, which is the ecological approach that started from thinking about the water containment, water chain and water footprint in the project. Natural water in both locations is specific and sensitive in quantity and quality, therefore, the use of native plant species is the most appropriate. As water is the critical factor in biodiversity regeneration and conservation, the hope is to be able to restore the native landscape in and around the site. In terms of learning, the new landscape acts as outdoor classroom and experimental site that provides a large and dynamic natural learning space for learners and researchers to explore.

In conclusion, this paper defines KMUTT Botanical campus as “a place that integrates native botany into campus space in order to create outdoor learning environment, which will implant the habit of lifelong learning in environmental energy, science and technology in students and members”. The achievement of the University will be the visibility of the commitment in sustainability in terms of both environment and lifelong education.

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