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Reforestation in Limestone Forest in Central Thailand: A Case of Baan Lam Nam Kaew Community Forestry in Lopburi Province

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Abstract

The conflict over the necessary use of limestone mountains for supporting economic growth activities has been protested from environmentalists owing to the rich biodiversity and habitats to endemic flora and fauna of the limestone mountains. The Baan Lam Nam Keaw village in Lopburi Province is an example of the newly setup but quite a while practically managed community forestry, and shares the common characteristics of the limestone forests in the Central Thailand areas. The success story proclaims the over two decades of individual-led reforestation and afforestation prior to the setup of community forestry on the Khao Sap Kaeng Kai limestone forest that resulted to the improving ecosystem services especially ground water wells, and rehabilitating local and endemic flora and fauna in the village areas. Local plants Kratin Yak tree *Leucaena leucocephala* (Lam.) and Chan Pha (*Dracaena loureiri* Gagnep) have been used for forest fire prevention and the forest cover increasing respectively. The key success was the efficient local spiritual leader, Phra Prinya Suprinyo, with his strong professional background, and good connection with the forestry office and local administrative office. Furthermore, the participation in the Royal Forest Department community forestry project in 2010 had brought the villagers into the new learning process of community involvement in the forest management, and consequently created the sense of village ownership. The Khao Sap Kaeng Kai forest management is symbolic for the villager's cooperation, and now being used as a platform for further sustainable development in forestry community in the future.

Keywords: Reforestation; Limestone ecosystem; Community forestry; Limestone forest

1. Introduction

Geographically, the central region of Thailand is significant on a wide alluvial plain, which dedicates mainly to paddy rice fields. From the high quality and productivity of the grain, the central region has been recognized as a 'rice bowl' in Asia. It leaves the karstic rolling hills with low plateau on the east side bordering to northeastern region marginalized. The patches of forests on the hills in the central region are cumulated to 11.7 per cent of the whole country forest areas or five times smaller than the evergreen mountainous ranges and rain forests in the northern region (RFD, 2012). Most of the mountains in the central region, especially Saraburi and Lopburi provinces, are limestone mountains with the great composition of Calcium carbonate ($CaCO_3$) substances, as known as limestone. For construction industry, these limestone mountains are the premium raw material for cement, lime, and hardcore industry. For ecology, they are the habitats of rich but fragile flora and fauna, surviving endemically in the limestone ecosystem (Latinne *et al.*, 2011; Panitawong, 2011). For forestry conservation and management, after having tracked the footprints of the northern watershed green forests for long, the limestone forests and communities have become one of the interesting and challenging study areas for researchers and practitioners.

Because of the living on field cultivation and the lower intensive forest products extraction, the forestry communities in the central region have less degree on forest dependency in comparison with the northern forest people, representing the majority of forestry communities in Thailand, who live in the forest, and manage the forest for their livings. The low awareness of the forest benefits allows the alarmingly rate of deteriorated deforestation and limestone quarries in the region. Like other types of forests, the steep, rugged, and rocky terrains of limestone forests provide ecosystem services to all lives and communities nearby. The severe deteriorated forest cover and ecosystem services from illegal logging, land clearing for cash crop agriculture, and limestone quarries tremendously damaged the biodiversity of the limestone ecosystem and made changes on the topography in the central region of Thailand, as seen that the whole mountains with all living creators including their endemic habitats had been erased from the map. The degraded ecosystem services gradually impacted to the resilience of the community livelihoods, and consequently raised awareness of the community for forest

conservation to improve and sustain the ecosystem services. Besides the case of Baan Lam Nam Kaew community forestry, the community forestry of Khao Phra Buddhapath Noi in Saraburi Province, to be discussed in section 3, is an example of the communities impacted from the deteriorated ecosystem services resulted from the limestone quarries, and later outreached and gained collaboration from four villages for forest conservation.

Forest conservation and management has often recognized people as a key to sustainability. Although the legal acknowledgement of community forestry management in Thailand has lost on the track, the attempt to advocate local capacity and participation has not wasted, as about seven thousands of local communities (RFD, 2013) practice their indigenous ways of forest conservation and management and buy in some technical and financial supports from government agencies and other private sectors under the corporate social responsibility (CSR) schemes. With the commended reforestation and wildlife rehabilitation in a unique landscape, and a few studies done in the Central limestone forests, the study site has been determined at the village of Baan Lam Nam Keaw in Lopburi province, located in the fragile biodiversity and ecosystem services of limestone hilly areas in the central Thailand. This paper will discuss the intensive forest management and restoration practices, as well as the historical changes in the development of the Baan Lam Nam Keaw community forestry as a case study of the Central limestone forestry community.

2. Central Thailand's Limestone Ecosystem Characteristics

Limestone karsts are sedimentary rock outcrops consisting of calcium carbonate created millions of years ago by calcium-secreting marine organisms, and subsequently lifted above sea level by tectonic movement (Clements *et al.*, 2006). Limestone mountains in central Thailand are cluster on the Permian age of Indochina block (Chitnarin *et al.,* 2012; Fontaine, 2002) and are exposed as a chain of hills, ridges, and occasionally as mounds which create classic 'tower karst' sceneries. The karst plateaus and mountain landscape usually consists of springs, caves, and dry stream beds. The central Thailand receives annual rainfall ranging between 1,500 – 2,000 mm. The dry season begins in October and ends in May, followed by a monsoon season from June to September. Temperature ranges between 20°C and 40.7°C. The rainforests, excessive rainfall and widely variable climatic conditions caused a karst landscape and cave forming environment to develop, with streams draining into the limestone from mountain catchments (Ponta *et al.*, n.d.). Limestone landscape has special characters on caves and limestone layers. Rain water can easily carve through limestone and it is a rock which dissolves and drains readily. Therefore, ground water under the limestone layers and springs play significant roles for all livings in the areas and nearby. Limestone-based soils tend to be drier than other soils and support a unique flora and fauna.

Taking the geographical disadvantages on failure to hold water of limestone soil into account, the characteristics of the limestone ecosystem support an intriguing flora and fauna which has adapted to its conditions. The vegetation has evolved the ability to withstand long periods of droughts and almost complete lack of soil. Plants acquire a tenacious foothold in small crevices where moisture and small quantities of nutrients from decomposing leaves are available. As the roots and stems grow so they often sheer off parts of the rock face. Among the many plant species that grow on limestone are primitive cycads, slipper orchids, begonias, and fan palms. Thailand's endemic limestone flora includes 34 species of ferns, and 28 species of flowering plants (World Bank, 2004). Among the endemic animals found in or on limestone hills are two rats (Neill's rat *Leopoldamys neilli* and Limestone rat *Niviventer hinpoon*), and at least seven cave fish. These exhibit different degrees of extreme adaptation to the pitch blackness in the caves such as no eyes, no pigment, and long appendages. The richest, most diverse animals with the highest rates of endemism are the snails. Recently nearly 100 species were reported from a number of Thai caves, and half of them were new to the science (World Bank, 2004).

3. Community Forestry in Central Thailand

Community forest in Thailand means land and/or forestland, which is legally permitted for the community together with forestry officer to participate in continuously managing forestry activities under the relevant laws and regulations. The community people can set up their own policies which may be concerned with culture, beliefs, religious, and other traditions (Wichawutipong, n.d.). Conceptualized local community as the key player and stakeholder in the forest management and conservation, together with the provision of the current constitutional law and the relevant Ministry of National Resources and Environment's regulations, the Royal Forest Department (RFD) permits local people to locally manage the community forestry project with the objectives on conservation, development, and utilization of their own forest resources.

Community forestry is easily referred to the communities in the northern and western evergreen forests where

indigenous communities have lived in the forests for generations, enjoyed the benefits of forest products and ecological services for common livelihoods, and intensively practiced the forest management and conservation since long period of time. Contrary to the mainstream community forestry, the ones in the central region, where they are located on the limestone chain hills and high land, relatively have distance relation with the local forests. They may extract the forests from time to time for fuel, fodder, and subsistence such as bamboo shoots, wild star gooseberry, snails, honey, and wild herbs, but they rarely live in the forests, because the full of stones forests and infertile soil are not attractive for cultivation. The less dependency creates distance and unfortunately does not strengthen the awareness for forest conservation of the community. Prior to the national logging ban in 1989, like other forests in the country, limestone forests had been severely extracted for timbers, left behind the non-forest covered karstic limestone mountains. Besides, limestone ecosystem and habitats have been completely washed away by the quarry for cement, lime and hard core industry. The statistics from the Department of Mineral Resources showed that about 20 per cent of limestone mountains in Thailand had been quarried (World Bank, 2004). However, the environmental impact assessments from the limestone quarry have been done unsystematically. Regardless what the official assessment reports have been written, the community livelihoods near the limestone quarry sites have been impacted significantly by imbalance of ecosystem services resulting to shortage of groundwater, poor soil for agriculture, extinction of endemic limestone flora and fauna, dust and polluted air, and so on.

The community forestry management in Central Thailand tends to begin with individual start-up. The local leaders, either administrative or spiritual leaders, play the important role on initiating the collaboration within the community on forest conservation and management with and without the financial and technical support from the government and the forest department. Forest management activities here focus on cancellation of new limestone quarries, restoration of forest and wildlife rehabilitation, prevention of forest fire and land clearing for agriculture, and prevention of illegal extraction of wildlife and vegetation. Example of Central community forestry is given by the community forestry of Khao Phra Bhuddapath Noi in Saraburi province, being granted the best community forestry award from the Green Globe Award organized by PTT Public Company Limited in year 2003, followed by Sipanont Ketutad - 5 Years of Sustainability Award in 2009. The Khao Phra Bhuddapath Noi community forestry started from the mayor's leadership to protect the limestone mountain from limestone quarry concession and illegal extraction of forest products. The late mayor could extend the cooperation to the four villages nearby covering 9.6 square kilometers through the connection with communities, temples, and schools. Consequently, the Khao Phra Bhuddapath Noi limestone mountains have been protected from the quarry, the forests and endemic flora and fauna have been saved, and the ground water has been improved for household consumption and agriculture. Importantly, the environmental conservation awareness has been strengthened fruitfully, and Khao Phra Bhuddapath Noi community forestry has become a model on forest conservation in the limestone mountains in Central Thailand.

Owing to the case of Khao Phra Bhuddapath Noi community forestry the characteristics of the Central Thailand community forestry have been seen different than the mainstream community forestry in the Northern Thailand. The special characteristic is less dependency, reflecting from the way community people use the forest through its ecosystem services, less direct forest extraction. Considering less dependency on the forest and still in good condition of ecosystem services, the forests were not carefully managed, but severely degraded during the logging and quarry concessions. The awareness of forest conservation and management started from the acknowledgement of ecosystem degradation by the leading figures in the local community, with the support from administrative office and the forest department. The collaborative forest management has fruitfully brought back the balance in ecosystem services and saved the habitats of endemic flora and fauna.

4. Study Site and Methodology

The study has been conducted in the village of Baan Lam Nam Keaw in Khao Noi Sub-District, Lam Sonthi District, Lopburi Province, located in the central region of Thailand. Apart from literature reviews, surveys of the village households and in the limestone forest of 'Khao Sap Kaeng Kai mountain' during May 4 – 31, 2013 including the interviews with key informants from the forestry office and local administrative office were conducted for data collection.

The village is located on a mountainous plateau, bordered with three provinces, namely Baan Hew Ta Bua Village, Lam Sonthi District, Lopburi Province to the north and the west; Baan Tha Plu Village, Lam Sompung Sub-district, Muaklek District, Saraburi Province to the south; Don Muang Sub-district, Si Kew District, Nakorn Ratchasima Province to the east. The village is about 100 kilometers in the northeast far from Khao Phra Buddhapath Noi in Saraburi Province. The Baan Lam Nam Keaw village has total area of 11.15 square

kilometers (6,969 rai). On the west side of the village sits a single limestone mountain covering almost half area of the small village. The limestone mountain is called Khao Sap Kaeng Kai Mountain, 693 meters high above sea level, and having area of 4.84 square kilometer (3,027 rai) in total. On the east and the north of the village is slope plateau between rolling hills for housing, agricultural fields, and livestock. Encircling the village are three canals, namely the Huay Luk, the Lam Phaya Klang, and the Huay Haeng. The Lam Phaya Klang canal, the longest among three canals, runs from the southeast passing on the east side of the village. The water in the Lam Phaya Klang canal is available for the whole year, so it becomes the main water resource for agriculture after the rain water. The Huay Luek canal, the second main water resource for agriculture, runs from the southwest towards the northwest then turns across to the northeast. The Huay Haeng canal runs from the southwest towards the southeast, and connects to the Lam Phaya Klang canal. Supplementing to rain water and water from canals, the village has three manmade ground water wells and local pipe water system covering 75 per cent of the whole village. Inadequate water for agriculture, however, is the village's chronic problem until now.

In 2013, there were 105 registered households in the village, but less than 70 households presently lived in. Registered 379 populations in the village consist of 194 men and 185 women. The average gross domestic product (GDP) of the villagers was above THB 55,000 (about USD 1,833) in 2011. The villagers' main occupations are seasonal agriculture and livestock, with a few households manage small trade, and laborers in agricultural sector and industrial factories.

The background of the Baan Lam Nam Kaew village started in the previous three to six decades when most of the villagers migrated from other areas. They seized the land and settled down by clearing the forest land and started cultivating field crops for instance maize, tapioca, and vegetables. The land clearing and illegal logging are the main reasons of deforestation in this area. The interviewed villagers reported about the decreasing numbers of wild animals and forest products, as well as the deteriorated of ecosystem services especially the dry out of ground water wells. The villagers experienced droughts, delayed rain, slightly changes in rainy pattern, and higher temperature than before. They believed that the droughts and other poor weather condition resulted from chronic deforestation in the Khao Sap Kaeng Kai mountain and the nearby forests. The conservation of forest and anti-illegal logging has been conducted privately by the urban-born Buddhist forest monk, Phra Prinya Suprinyo. Using the Buddhist virtue combatting against illegal logging and hunting, and using personal connection reaching for the assistance from villagers and local administration offices, for more than two decades Phra Prinya has gradually reforested and conserved the forest in Khao Sap Kaeng Kai mountain and nearby limestone mountains. Started from 2010, the village has officially participated in the forestry community project with the RFD, and in 2012 the forest and wildlife rehabilitation in Khao Sap Kaeng Kai mountain has been accepted as one of the Royal Initiative Projects.

5. Forest Management and Restoration Practices in Baan Lam Nam Kaew Village

5.1 Individual-led Reforestation Practices at the Start-up

Severely degraded for many decades, the forest on Khao Sap Kaeng Kai limestone mountain has been restored and the surrounding areas of the mountain afforested. Prior to the establishment of community forestry, the attempt on reforestation had been done individually, and some were funded through small projects from governmental forestry office. The key individual, who has played a crucial role on the reforestation for decades, is the forest monk Phra Prinya Suprinyo. With his professional background as former forest officer in Saraburi province and the nearby areas prior to entering into the monkhood, Phra Prinya could gain cooperation from villagers and easily reach out to the RFD for forestry related supports. The commended reforestation and forest management under his endeavor are mainly the forest fire prevention, the reforestation by using local plants, and the support for setup of the community forestry. He, together with villagers, established the forest fire break on the mountain by planting rows of *Leucaena leucocephala (Lam.)* or locally known as Kratin Yak, functioning as natural fences preventing the spread out of fire and bulks. Kratin Yak has tiny leaves, branches in bushes shape, and grows easily from seeds. Kratin Yak has been planted in four to five rolls in the areas that used to affect from forest fires. The dense, tiny, and bush-shape leaves of Kratin Yak helps suppress forest fires efficiently, Phra Prinya confirmed. Kratin Yak, in addition, serves as subsistence for the cultivated goats, which is the main livestock in the village. The goats eat only the leaves and bark of the tree branches and trunks. The core stem of tree branches and trunks left over from goat's subsistence is usually used as fuel wood, or being processed to add value by making charcoal. In parallel to the natural fire break in the forest, a non-asphalt road has been constructed around the mountain to be a clear demarcation between forest lands and villager's lands, and functions also as a break from fire running from the harvest fields close to the forest. Up to the present, the Khao Sap Kaeng Kai forest is safe from the forest fire and increasing the forest cover owing to the characteristics of

Kratin Yak especially fast-growing, tolerant to draughts, and production (Sukkasem *et al.*, 1994).

At the same time of preventing the threat from forest fire, Phra Prinya, with priority to expanding the forest cover, has reforested in many ways: extending new branches to the logged trees; growing local vegetation from seedlings; and importantly planting Chan Pha (*Dracaena loureiri* Gagnep). Chan Pha is a kind of dragon trees, and a local vegetation in the limestone areas. It was tested and chosen as the key seedlings to grow in the spaces between big trees to protect the moister in the soil, because of its characteristics that tolerate droughts in the limestone forest. Fast growing, small and tiny roots, and fewer leaves makes the trees survive in the dazzling sunshine, dry weather, and less soil in the cracks of stone layers under the ground surface. Planting Chan Pha is very easy by dipping its branches into the soil to growing roots and leaves. Interestingly, both fast growing trees of Chan Pha and Kratin Yak are chosen for reforestation because of the priority to maximize forest cover to the forest in the short time, and the both trees have accomplished the expected priority.

For decades, the forest lands around the Khao Sap Kaeng Kai mountain were continuously encroached by the expansion of field crop agriculture. Phra Prinya realized the threat, so he requested the land owners for purchasing the lands next to the forest for afforestation. With the Buddhist virtue and the good aspiration of the abbot, some owners sold the land in the very low price; some even granted the land for free for afforestation purpose. However, there are some villagers misunderstood that Phra Prinya wanted them to move out from their occupied lands. This conflict was gradually resolved by evidences from the fruitful reforestation in many years after. With respect of the reforestation of the Khao Sap Kaeng Kai forest, the individual start-up by the abbot Phra Prinya, prior to the cooperation from the local community, was another noticeable case for the community forestry management in the Central Thailand. The virtue of Buddhism in forestry management since the Buddha's time (Laosuksri, 2013), and the monkhood status of Phra Prinya are the key support to gain cooperation from the villagers for local forest management and conservation, and outside parties for financial and technical supports. The villagers agreed that Phra Prinya was the strength of the village's community forestry management due to his forestry background and knowledge, previous professional relation, leadership, and the respectful religious status.

5.2 Limestone Flora and Fauna Rehabilitation

Having studied the prominent characteristics of the flora and fauna in the limestone forests in Central Thailand for many years, an interviewed RFD officer described that the weather in the limestone forest is generally drier than other types of forest, because of the geological development of limestone mountain. Fewer big trees growing on the mountain cannot shade the strong sunshine or reduce the heat, cannot fade the wind power, and cannot hold much water due to less soil. Vulnerable climate and the shortage of soil and water make the vegetation in the limestone ecosystem adapted to have small and thick leaves, bended trunks or branches, and many tiny roots. The roots of some vegetation may grow above the soil surface for moister extraction from the air. Sharing the similar characteristics as other Central Thailand's limestone forests, the Khao Sap Kaeng Kai forest provides habitats for perennial, bushes, vegetables, herbal plants, and mushrooms. The local vegetation popularly found is Chan Pha, Chan Daeng, Chan Nuu, Prong Saraburi, Saladdai, and so on. The four-meter high giant Chan Pha tree (*Dracaena loureiri* Gagnep) in Khao Sap Kaeng Kai forests, has graciously grown and survived through the cluster of limestone layers. It has bended and curled trunks to get the sunshine; and small - thick leaves to reduce transpiration; small roots for sheering off the stone layers and finding limited soil nutrition available under the ground. These adaptive characteristics pursue the struggling photosynthetic process given the harsh climate and geological restriction in the Central Thailand.

The steep, rugged, rocky terrain landscape of limestone forests in the central Thailand especially in Saraburi and Lopburi provinces are the habitats for serows (*Capriconis sumatraensis*) or locally known as Liang-pha. Serows look similarly to goats, but have harder and longer hair than goats, and having a pair of four - eight inches long horns for both male and female. Harsh environment of limestone habitat is naturally difficult to survive for some fauna, but it suits well with serow's behavior. Serows live in the limestone caves. During the day, they drink little water and not often. In the scarce of water, the roots and bark of Chan Pha is a source of food and water for serows. For chasing tiny insects or mosquitoes on the body, serows like jumping up on the rocky terrains, where they can freely run and jump upon, to let the strong wind blow against the body. This natural gift prevents them from being hunted, however nowadays their enemy is not the common wild hunters, but the limestone quarries which completely destroy their home and sources of food. Serow is one of the fifteen threatened and reserved wild animals according to the Preservation and Protection of Wildlife Act 1960 (amended 1992). Since serows are endemic wild life in the limestone forests only, their habitats should be considered protected legally, because the degradation of limestone forests, by any means, will endanger the serows' livelihood to extinction. At present

about 20 – 30 serows live in the Khao Sap Kaeng Kai forest, after the last serow had been seen twenty years ago.

The reforestation of Khao Sap Kaeng Kai mountain has improved the balance in the limestone ecosystem resulting to the increasing number of wildlife. Besides the serows, there are black bears (*Selenarctos thibetanus*), wild boars (S*us scrofa*), porcupines (*Hystrix brachyura*), monkeys, musk, squirrels, chipmunks, jungle fowls, snakes, birds, insects and other reptiles. In the time of severe deterioration, these hungry animals came down the mountain to find food in the villager's crop fields, which caused damages to the harvesting, as well as, danger to the animals from being hunted or killed. The forest management under the community with respect of wild life included planting fruit trees for being wild life's subsistence, and building small ponds in the mountain forest for being water resources for wild animals. The ponds help extend the water available days in the dry season. These two tasks aimed at the wild animals to live harmoniously in the forest, so that they do not need to take risks coming down the mountain to damage the crop fields, and it secures safety of the wild animals from hunting, as well as to get rid of threat from wild life attack to the crop products of the villagers.

Although the rich biodiversity in the limestone forests, lack of good number and systematic researches and studies have been conducted. With the conservation trend, the more studies have been spotlighted in the limestone ecosystem, the more new species of flora and fauna have been found. Late 2013, Chan Nuu (*Dracaena kaweesakii)* has been discovered as a new species of dragon tree (Chan) family; an underground water cave fauna *Stenasellus mongnatei* was discovered at the Khao Phra Bhuddapath Noi in Saraburi province in 2005; limestone rat *(Niviventer hinpoon)* in 1976; limestone wren babblers (*Napothera crispifrons calcicola*) in 1939, and so on. All parties should support, either broad or specific, researches and studies in the limestone forest and ecosystem for better knowledge and proper management and conservation in the future.

5.3 Ecosystem Services Improvement

The rain water agriculture for sugar cane, maize, and tapioca is the main activity in the Baan Lam Nam Kaew village. The villagers use pipe water and canal water as supplemental sources. However, using pipe water added cost on agricultural investment, on the other hand, the canal water is available to the crop fields that are close to the canals, and there is risk of dry canal. The reforestation of the Khao Sap Kaeng Kai forest has been improving the ground water condition, and consequently the moister in the soil and air. The special characteristic of limestone mountain is the stone layers, which with the other factors create caves in the mountain, and wells under the ground. When it rains, the limited soil can hold only little rain water, and let the rain water go quickly into the ground and further through the cracks of limestone layers. The water cumulatively stores in the cracks of the stone layers in the mountain and some part of the water breaks out of the ground. The well, therefore, serves as ground water bank for villagers to use for agriculture and consumption. In the past 20 years, the ground water through the wells in Baan Lam Nam Kaew village was available for the whole year, giving supplemental water supply to out-of-rainy season cultivation. The ground water was slightly seeping through the cracks of limestone layers gave moister to the soil and consequently reduced the evaporation. Resulting from the severe logging and forest degradation, the wells were gradually dry out, and the agriculture needed to rely on only precipitation, which has become unpredictable on the timing and amount of rain water. The ground water out breaking through the wells was also the water resource for the wild life in the forest. As the wells on the mountain dried out, it was seen that wild animals came down the mountain to villager's field for water. After many years of intensive reforestation and afforestation, the Khao Sap Kaeng Kai forest has improved overall, including the ground water condition. The well, its function, and relationship in the limestone ecosystem have been studied technically in the later years for utmost benefits and conservation.

Playing important role on rain and moister regulating, the nurtured forest of the Khao Sap Kaeng Kai mountain has brought the freshness and fair temperature to the village communities. In the drought of the recent years, the Baan Lam Nam Kaew village was the only area within the Khao Noi sub-district that had some slight rain fall. The less evaporating moisture in the soil results to soft and easier to prepare the soil, and less water for agriculture. Moreover, the Khao Sap Kaeng Kai forest is one of the huge pieces of forests that contribute water to the Pa Sak River, and the Pa Sak Jolasid Dam respectively, which is greatly used for agriculture in the Central Thailand. The villagers have received a lot of benefits from the improving ecosystem services, but one important advantage is educational process. The village community systematically studied the ground water wells together with the relation with the limestone ecosystem, involving indigenous knowledge, and exchanged and transferred the knowledge and experiences among the limestone community forestry. The villagers have enjoyed the aesthetical scenery of the reforested Khao Sap Kaeng Kai mountain. They have implemented the ecological tourism sites and educational tourism route for limestone mountain and forest. The cooperation on reforestation and community forestry project of the Khao Sap Kaeng Kai mountain has brought up the sense of involvement

and natural resource sharing and the sense of forest conservation to most of villagers.

6. Historical Changes on Institutional Development in Baan Lam Nam Kaew Village

The forest management of the community of the Baan Lam Nam Kaew village, for the past three decades, has gone through collaborations leading from different parties. Starting from the spheres of Buddhism, Phra Prinya convinced the villagers not to cut down timbers and hunt wild animals, but to participate in the forest management focusing on forest fire prevention, and reforestation by using local plants. In parallel with the reforestation, the lands surrounding to the Khao Sap Kaeng Kai mountain were afforested. The private endeavor of Phra Prinya had been done for almost twenty years. It has brought back the greens to the village, increased the forest cover, rehabilitated wildlife, and improved the ecosystem services. In parallel, there were some small projects related to forest management and conservation supported from the RFD, as the official responsible party of the reserved forest of the Khao Sap Kaeng Kai mountain. Moreover, the village received some financial support under the corporate social responsibility (CSR) project from private corporates, which promote the environmental concerns and the community appraisal awareness. However, the corporate support happened occasionally, and sometimes in the form of competition awards. Until 2010, the village entered into the five year community forestry project with the RFD. Phra Prinya was the key person to bridge the village community with the forestry office, but the participation has rooted the awareness and responsibility on forest conservation and management to the villagers overall. Next two years after, the forest and wildlife conservation and rehabilitation project of the Khao Sap Kaeng Kai mountain has been accepted to be the project under the royal initiation. The benefit of the project under the royal initiation is, it integrates various responsible offices to work on the same project, and ensures the transparent procedures to benefit the villagers as a whole.

Gone through different collaboration on forest management and conservation, the participation in the community forestry project with RFD was the most developed step of the Baan Lam Nam Keaw village in terms of local participatory forest management. The project required village assembly to brainstorm and give consensus on the community forest objectives, rules and regulations, forest management programs and activities, and so on. This was a floor for different background villagers to work together on sharing forest resource utilization and responsibility to conservation. However, the project weakness on only the first year financial support made the 'just begun' local forest management participation run slowly. Fortunately, the gap has been filled by the forest and wildlife conservation and rehabilitation project of the Khao Sap Kaeng Kai mountain under the royal initiation. It reiterated and echoed the importance of forest management and conservation in the village. The royal initiative project provides financial support, takes care of the community forestry setting, and works together with the villagers to elaborate the community and the forest to the highest level that the village can reach.

The Khao Sap Kaeng Kai mountain is the symbol of the village and the center for the villager's cooperation. The limestone forest has attracted visitors for tourism, education, conservation, and so on. The villagers feel the sense of village identity through the Khao Sap Kaeng Kai mountain that makes them different from other limestone forestry community. Interestingly, the village invested in eco-tourism industry in form of community welfare project administrating home stay and recreation center. The project will create jobs to the unemployed villagers, so that they do not migrate to be laborers in other areas. Moreover, the profit from the project will partly support the forest conservation project.

7. Conclusion

In the central region of Thailand, the patches of limestone mountains and forests on the rolling hills have been severely degraded and threatened by limestone quarries, slash and burn for crops agriculture, and illegal poaching and hunting. The limestone mountains, with the typical karstic geological formation, are known as one of biodiversity hotspots, because of the rich but fragile condition of flora and fauna. The forestry communities in Central Thailand have been directly impacted from the deteriorated ecosystem services, and they have put lots of efforts towards resolutions. After experiencing individual-led reforestation for decades, the Baan Lam Nam Kaew village as the study site in this paper, located in the limestone ecosystem of Lopburi province, joined in the community forestry project in 2010, has successfully restored the forest cover by using the local dragon tree or Chan Pha (*Dracaena loureiri* Gagnep), and prevented forest fires using Kratin Yak tree *Leucaena leucocephala* (Lam.). The intensive forest management and restoration, adapted to the harsh climate and typical limestone ecosystem, has improved the ecosystem services significantly and increased numbers of local and endemic flora and fauna. The successful reforestation and rehabilitation from the studied community forestry plays an

important role on scaling up the limestone forests management and the community forestry development in the Central Thailand. The village itself uses the Khao Sap Kaeng Kai forest management project as the floor to gain the further cooperation, since the forestry project has grown the sense of belonging to the village to the different background villagers, and the project has been used to extend to other forms of community cooperative projects.

References

Clements, R., Sodhi, N.S., Schilthuizen, M. & Ng, P.K.L., 2006. Limestone karsts of Southeast Asia: Imperiled arks of biodiversity. *Bioscience*, 56: 733 – 742.

Chitnarin, A., Crasquin, S, Charoentitirat, T., Tepnarong, P. & Thanee, N., 2012. Ostracods (Crustacea) of the Early-Middle Permian from Central Thailand (Indochina block). Part I. Order Palaeocopida. *Geodiversitas* 34 (4): 801-835.

Fontaine, Henry, 2002. Permain of Southeast Asia: an overview. *Journal of Asian Earth Sciences*, 20 (2002): 567-588.

Laosuksri, Walaiporn, 2013. Engaging Buddhism in Forest Management in Thailand. *Research on Humanities and Social Science*, 3(21): 15-22.

Latinne, A., Waengsothorn, S., Herbreteau, V. & Michaux, J.R., 2011. Thai limestone karst: an impending biodiversity crisis. The 1st EnvironmentAsia International Conference on Environmental Supporting in Food and Energy Security: Crisis and Opportunity. IV(O)_001; pp.176-187.

Panitawong, Non, 2011. Limestone Mountains and Biodiversity in Thailand. *Green Line*. January – April 2011, pp.73-75. Available at http://www.deqp.go.th/website/25/images/stories/EE/GR-29/29-73-75.pdf

Ponta, G., Memon, B., LaMoreaus, J., Julawong, J. & Wongsawat, S., n.d. Karst Landforms in the Saraburi Group Limestones, Thailand. 13th Sinkhole Conference. NCKRI Symposium 2; pp. 299-310. Available at http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1140&context=sinkhole_2013

Sukkasem, C., Chalothorn, C., Manajuti, D., & Aoungsawad, K., 1994. Growth and production of *Acacia* and *Leucaena* in Chiang Mai. *Journal of Agriculture*, 10(3): 226 - 234.

World Bank, 2004. Limestone Ecosystem. *Thailand Environment Monitor 2004 – Biodiversity*. *World Bank Report*, pp.12-14. Available at http://go.worldbank.org/VPRE208MZ0. Accessed on November 26, 2013.

Wichawutipong, Janesak, n.d. Community Forest Management in Thailand. Booklet. Royal Forestry Department, Bangkok.

Royal Forest Department, 2012. Table of Thailand's forest areas from 1973 - 2008. *Forestry Statistics Data 1973-2008*. ISBN: 978-616-316-210-8. Available at http://forestinfo.forest.go.th/55/Content.aspx?id=10047

Royal Forest Department, 2013. Table of Thailand's community forest registration 1999 – 2013. Available at http://forestinfo.forest.go.th/55/fCom_Year.aspx. Accessed on February 11, 2014.

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