Environment and Natural Resources Journal

Volume 22
Issue 4
2024

Landscape Ecological Structures and Patterns for Green Space Conservation in Forest Monasteries in Northeast Thailand

Prat Kongsombut[1, 2], Sura Pattanakiat[3*], Wee Rawang[1], Pattranit Srijuntrapun[1], Uthaiwan Phewphan[2], Thamarat Phutthai[3], Sirasit Vongvassana[3], and Jirapatch Jumpasingha[3]

[1]Faculty of Social Sciences and Humanities, Mahidol University, Nakhon Pathom 73170, Thailand
[2]Innovation for Social and Environmental Management, Mahidol University, Amnatcharoen Campus, 37000, Thailand
[3]Faculty of Environment and Resource Studies, Mahidol University, Nakhon Pathom 73170, Thailand

ARTICLE INFO

Received: 27 Jan 2024
Received in revised: 3 July 2024
Accepted: 8 July 2024
Published online: 23 Jul 2024
DOI: 10.32526/ennrj/22/20240016

Keywords:
Forest monastery/ Landscape ecology/ Geo-informatics/ Greenspace conservation

*** Corresponding author:**
E-mail: sura.pat@mahidol.ac.th

ABSTRACT

The green spaces in Wat Pah play an important role in forest conservation in Thailand. This study identified and analyzed the structures and patterns of landscape ecology in Wat Pah Nanachart, Ubon Ratchathani Province, to guide a conceptual framework for green space conservation in forest monasteries. Spatial analysis and modeling using geoinformatics technology were employed to recognize and characterize these landscapes. Information on the green space conservation and management of Wat Pah was also obtained using an in-depth interview and site observation. The results revealed that most of the green space in Wat Pah is forest, characterized by an ecological matrix and a dry evergreen forest. The forest structure can be divided into three canopies, dominated by the Dipterocarpaceae family, which has regenerated into upper and lower canopies. It is an edge matrix and ecological corridor connected to the internal and external green spaces of Wat Pah. It plays an important role in supporting cultural, religious, and aesthetic activities for ordained monks and Buddhists . The spatial landscape model can be divided into three main zones: Thoranisangha, Buddhawas, Sanghawas. Thoranisangha is an open space covered with traditional and artificially planted tree species. It is located in front of the temple and designed for public utilities in the context of managing and conserving the remaining trees. Buddhawas is a semi-open space mostly covered with traditional tree species. It represents Buddhism's identity and uniqueness and is used for religious ceremonies and dissemination—listening to sermons, meditating, and praying. Meanwhile, Sanghawas is covered with natural forest and contains residences for monks that are designed to be in harmony with the forest ecosystem.

1. INTRODUCTION

The forest deterioration situation in Thailand is critical. Formerly, the forest area covered more than 70% of the country (Baimai, 2007). Unfortunately, it has significantly declined owing to rapid population growth and economic expansion. Deforestation and forest degradation are mainly caused by utilization activities that exceed the capacity of the forest ecosystem. They include, for instance, forest encroachment for the construction of resorts and golf courses; slash and burn agriculture; and dam and road construction (UN-REDD, 2013). The forest area has gradually reduced from 33.15% in 2000 to 31.57% in 2022 (Royal Forest Department, 2022). The national forest policy proposes that the forest area in Thailand must cover at least 40% of the country, with 25% for conservation forest and 15% for economic and community forest (Royal Forest Department, 2020). In addition, before the 20-Year National Strategy (2018-2037) can be achieved, the green area in Thailand must

Citation: Kongsombut P, Pattanakiat S, Rawang W, Srijuntrapun P, Phewphan U, Phutthai T, Vongvassana S, Jumpasingha J. Landscape ecological structures and patterns for green space conservation in forest monasteries in Northeast Thailand. Environ. Nat. Resour. J. 2024;22(4):366-377. (https://doi.org/10.32526/ennrj/22/20240016)

consist of natural forest, economic forest, and urban/recreation exploitation at 35%, 15%, and 15%, respectively (NESDC, 2023). Therefore, increasing the forest area to meet these targets is very important. Since the forest area is a scattered patch pattern, especially outside protected areas, it needs particular attention regarding conservation. Wat Pah, or forest monasteries, play an important role in this matter.

Buddhism is the predominant religion in Thai society, and temples are Buddhist organizations. Buddhists comprise more than 90% of the population, and the country is home to 43,562 temples (Kanyalak et al., 2015). The northeast is the region with the most temples. In Ubon Ratchathani Province alone, there are as many as 1,848 temples (The National Office of Buddhism, 2021). There are 936 forest monasteries spread over the natural landscape, rural areas, and urban areas, 375 of which are recognized as legitimate (Sornsakda et al., 2013). Numerous forest monasteries preserve a wide range of vegetation and enormous trees, and this conservation was partly influenced by Buddhism (Jirathasanakul, 2001). Monks are tied to the forest, and many role-model noble monks use the forest to practice Dhamma, such as Luang Pu Sao Kantasilo, Luang Pu Man Phurithatto, and Luang Pu Cha Suphattho. Thus, even though there is not much remaining forest, a few places, like Wat Pah Nanachart, Wat Nong Pa Pong, Wat Pah Phrom Thitanusorn, Wat Pah Hua Don, Wat Pah Non Sawan, Wat Pah Nam Bun, and Wat Pah Nong Bua Hi, have status as forest monasteries, which are best suited to preserving the forest conditions, guaranteed by the Species Diversity Index and Importance Value Index. *Aquilaria crassna*, *Dipterocarpus turbinatus*, and *Dalbergia cochinchinensis* are among the critically endangered and endangered plants found in these monasteries (Jumpasingha et al., 2018). This demonstrates that forest monasteries are places where the traditional forest's green spaces have been conserved. Functionally, these monasteries have lush forests that maintain an ecological balance; thus, they can be used as peaceful locations for Dhamma practice and serve as green spaces that support environmental sustainability within a province's landscape system.

Wat Pah monasteries are categorized as elements of the landscape's ecosystem that provide ecosystem services in terms of their ecological value, use for Buddhist religious purposes, beauty, and green spaces (Wonglangka and Han, 2018). These functions are like lungs that purify the air and create a pleasant surrounding environment. Furthermore, there are sporadic communities of forest monasteries in urban, suburban, rural, and natural settings. Even though most forest monasteries today have been disturbed by surrounding land use activities, an abundance of plants is still maintained within certain ones (Wongsanao and Krutasean, 2022), such as Wat Pah Nanachart, owing to their emphasis on environmental preservation and protection. As part of the initiative to improve green space and environmental management in monasteries, Wat Pah Nanachart was certified by the Department of Environmental Quality Promotion in 2019 and given the Excellent Environmental Management Temple Award (Wat Pah Nanachart, 2022a), indicating that this monastery has conserved green spaces to preserve the health of a productive forest. This study aimed to research the principles of landscape ecology, which are crucial for understanding the ecological and cultural significance of these green spaces, recognizing the ecological landscape structure and patterns, as well as the conservation and management strategies at Wat Pah Nanachat, which serves as a representative Buddhist forest conservation site. It successfully maintains forest habitats. Understanding these elements will guide conservation and management efforts, help foster a unique identity, and promote the expansion of green spaces in monasteries. Therefore, this research aims 1) to analyze the ecological structures and patterns of Wat Pah Nanachart to understand the physical, biological, and functional components integrated into the forest monastery landscape system, and 2) to create a landscape ecological model for conserving the green spaces of forest monasteries based on the principles of landscape ecology to establish conservation and management concepts based on the lessons learned and the needs of the monks. This will help us create a framework and present this model as it relates to Ubon Ratchathani Province.

2. METHODOLOGY

2.1 Study area

Situated in Ban Bung Wai, Warin Chamrap District, Ubon Ratchathani Province, Wat Pah Nanachart is one of the temples of the Wat Nong Pa Pong. Originally an abandoned monastery called Wat Nong Pla Keng, it is located in the old Bung Wai cemetery. Owing to the community's faith, monks were invited to practice Dhamma, and this place became a monastery. Vihara was built in the old Sima area (in 1985), consisting of Kuti, buildings, and a chapel for monks to use for chanting and performing

various religious rituals. This forest monastery received the Wisungkhamsima in 1998. The monastery's territory has an area of 365 rai (Wat Pah Nanachart, 2022b) (Figure 1), and is surrounded by community and agricultural areas. The structure of the facilities and transportation routes have been developed, and the community surrounding the monastery has expanded. In both the past and present, forest monasteries conserve and preserve the forest and allow monks to practice their beliefs.

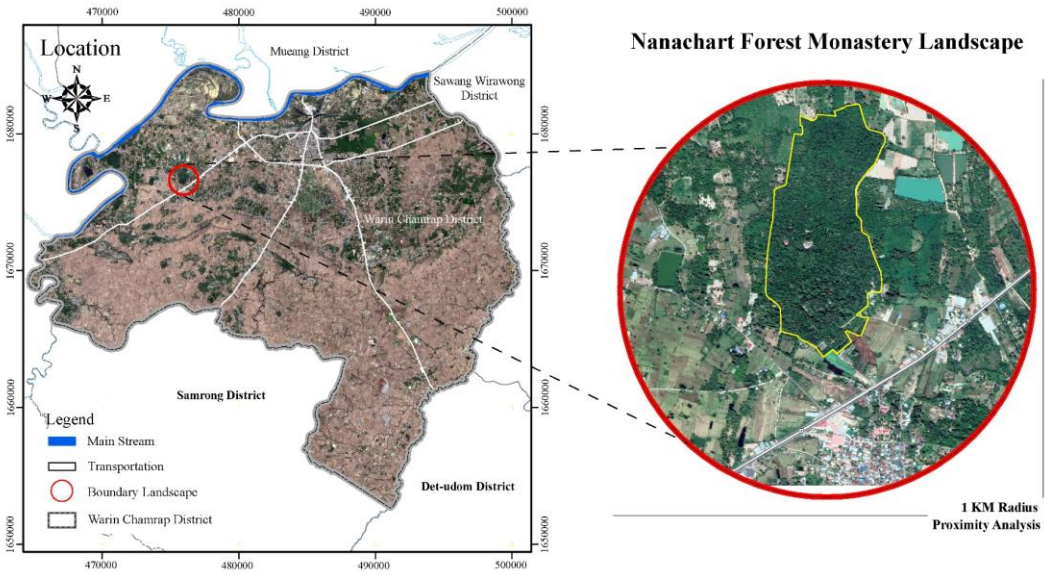

Figure 1. Position and location of Wat Pah, Ban Bung Wai, Warin Chamrap District, Ubon Ratchathani Province

2.2 Methodology

This study was conducted based on landscape design approaches (Ahmadi et al., 2018; Suppakittpaisarn, 2021). These approaches served as a foundation for presenting conservation and management guidelines for the ecological landscape of forest monasteries. This study consisted of the following steps.

2.2.1 Site inventories and user requirements

To create a base plan for surveying, analyzing, and designing, basic data regarding the physical structure and components of the forest monasteries were gathered (Limthongkul, 2019). A survey was conducted with intensive in-field data collection from April to August 2022. The site inventory gathered landscape elements such as locations, morphology, soil, drainage, circulation, plants, and forest habitats. Simple random sampling was used, along with one temporary plot (20×50 meters) in a representative forest habitat selected through purposive sampling, based on a monastery zone identified from aerial photographs taken in 2002 and 2022. Additionally, user needs were explored through in-depth interviews using purposive sampling, which included an abbot and 2 monks. These semi-structured interviews focused on the history, management, use, and concepts of forest conservation. Interviews were also conducted with 2 urban planners to discuss green development concepts and observe activities within the context of the Wat Pah.

2.2.2 Landscape structure analysis

The landscape composition of forest communities was assessed using geo-information techniques, which involved visually interpreting aerial photographs from 2002 and 2022 and worldview satellite imagery from 2022 (Esri, Maxar, USDA, USGS, GeoEye, Getmapping, AeroGRID, IGN, IGP, UPR-EGP, and the GIS user community). This analysis aimed to evaluate forest cover (Pattanakiat, 2018). The forest cover was classified into three categories based on the main green space development concepts (ONEP, 2005), forest, open space, and imperviousness/buildings, followed by the delineation of the dominant land cover type and delineation based on the most extensive and well-connected land cover type, referred to as the matrix (Aminzadeh and Khansefid, 2009; Forman and Godron, 1986; Tangkitngamwong, 2012). Meanwhile, the path and corridor of the dominant landcover were identified by visually interpreting aerial photographs, and a site inventory was used for intensive in-field data collection across the three landscape zones of the forest monastery based on suggestions from the abbot. All tree species

within these zones were identified and recorded. Individual tree characteristics, tree positions, and tree canopies were measured using diameter tape, a hypsometer, and a GPS receiver, respectively.

2.2.3 Recognition and identification of landscape ecology structures and patterns

The "Morphological Spatial Pattern Analysis" (MSPA) model, developed by Soille and Vogt (2009), was employed during this step. This model is a crucial tool in landscape ecology assessment, focused on understanding the spatial configurations of landscape elements. It aids in analyzing the spatial patterns of habitat connectivity and fragmentation, which are essential for identifying and prioritizing areas for conservation and management planning, particularly in the context of Wat Pah monasteries. The MSPA model is a binary segmentation technique that measures the foreground and background. The foreground refers to the forest landscape, while the remaining landscape types are set as the background. Using the Guidos Toolbox software for 8-neighborhood analysis, the edge width was set to 1 pixel (10 meters). The shape, connectivity, and arrangement of the forest areas were used to form 8-connected neighborhoods automatically classified into seven landscape patterns: core, edge, perforation, bridge, loop, branch, and islet. This classification focused on key habitats and corridors that require conservation. Subsequently, post-classification data were analyzed. The results were then presented through a data layout.

2.2.4 Landscape ecology design

Conceptualization was created from site programming based on user needs and analysis of structural space characteristics, patterns, and landscape ecology. The synthesis phase involved three tasks and decision-making steps aimed at site planning for conservation and management. These tasks included: 1) development of the Preliminary Greenspace Concept, 2) establishment of conservation strategies for protecting, preserving, and zoning greenspace, and 3) presentation in Perspective and Isometric Patterns.

3. RESULTS

3.1 Assessment of the landscape's ecological features

Wat Pah Nanachat is on a low terrace along the Mun River, facing southward. The area has an elongated shape extending from south to north, covering approximately 0.55 square kilometers and surrounded by a dry evergreen forest. Aerial photographs in 2002 visually indicate that the Wat Pah area was previously covered by dry evergreen forest (forest cemetery) at the frontal and eastern sections, followed by disturbed forest and agricultural and barren areas. The Wat Pah has a strategic plan for reforestation, restoring the area to one predominantly covered by forest. By 2022, the forested regions were surrounded and predominantly characterized by dry evergreen forest and secondary dry evergreen forest. The land use around the monastery consists of agriculture. The fence and a wall of large trees provide the monastery with privacy; the morphology is slightly undulating, with slopes ranging from 0 to 2% at an elevation of 130 to 149 meters above sea level. The soil conditions are sandy loam with moderate permeability, affecting surface runoff and drainage in both the surface and subsurface soil. These influence the impact on the forest ecosystem and create a local climate that reduces temperatures and is supported by shade from trees, resulting in an optimal environment. The direction of the Sun's path, particularly in the morning, creates an ideal environment for Buddhist activities. Although the temple area receives some sunlight throughout the day in open areas, large trees provide ongoing shade, cover sunlight angles, and create shade from the west and south directions. The planning area is divided using a combination of fences and walls made of trees to separate the zones. This division can be identified by the components and activities in each section with circulation patterns within these areas. The main pathways, accessible to the public, are concrete or paved, providing access to public and interior areas, with some exceptions. Natural dirt pathways, serving as semi-public access, are intended for walking and meditative practices in the central area. The monks' walking pathways, which serve as private access, are designated as living quarters. The forest monastery is divided into three zones: 1) the Public Zone: Known as the Thoranisangha, this area surrounds the monastery and serves as an open space for public benefit activities. 2) the Semi-Public Zone: Referred to as the Buddhawas, this area is located within the interior front part of the monastery and is designated for activities associated with propagating Buddhism. 3) the Private Zone: Known as the Sanghawas, this is the largest area of the monastery used for the monks'activities and living quarters (Figure 2).

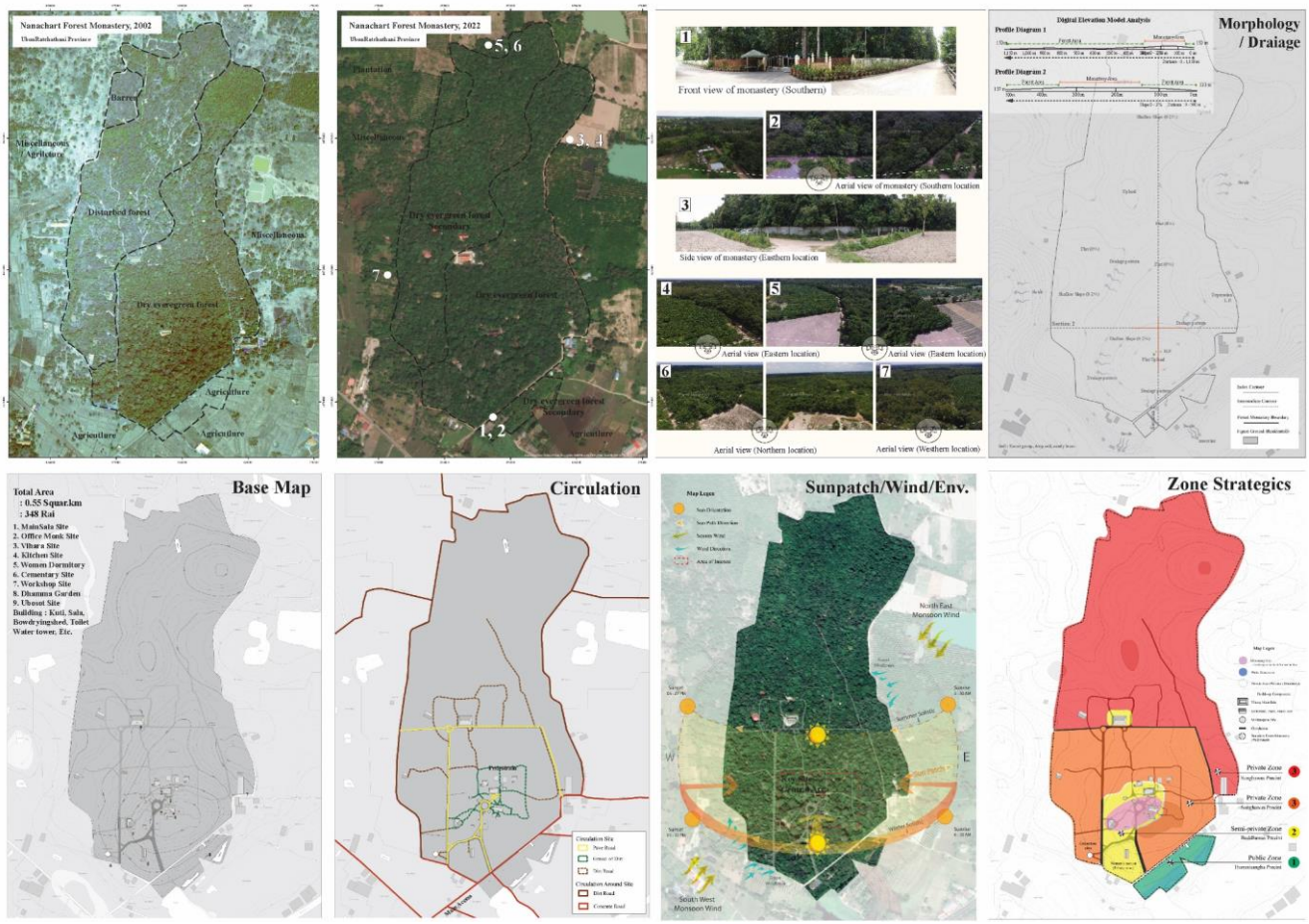

Figure 2. Analysis of spatial data to identify landscape ecological structures and patterns

3.2 Classification and identification of landscape ecological structures

The board structure of the Wat Pah was delineated by interpreting landscape ecology based on aerial photographs and field surveys. Two major dominant cover types were identified: dry evergreen forest, constituting approximately 54.49% of the area, located centrally near the monastery entrance, surrounding the Buddhawas Zone and extending eastward to the Sunghawas zone; reforestation dry evergreen forest, covering about 45.51% of the area, situated in the western part of the monastery, around the outer boundaries and near the Thoranisangha Zone entrance. The forest matrix status was studied using forest community structure analysis in three zones: Sunghawat, Buddhawat, and Thoranisangha. The details are as follows (Figure 3).

1) The Sunghawas area comprises dry evergreen and restored dry evergreen forests characterized by a dense canopy. A survey indicated 84 trees and 24 species, prominent trees are in the Dipterocarpaceae family, resulting in a Shannon-Wiener diversity index of 2.63 and a Richness Index of 3.18. Prominent species include *Aglaia cucullata* (Roxb.) Pellegr. *Dialium cochinchinense* Pierre and *Streblus asper*. The forest structure is stratified into three canopy levels: 1) an upper canopy, reaching heights of 25 meters, with some areas reaching up to 30 meters in height; 2) a middle canopy layer, ranging from 15 to 20 meters; and 3) a lower canopy layer and ground cover consisting of regenerating species. Additionally, introduced patches, including offices, a hospital, a sewing area, a bow-drying shed, Thera, Mahathera, Kuti, and a cemetery, serve specific monastic purposes. These areas are interconnected by semi-natural corridors like dirt and gravel paths, as well as human-made corridors, including paved roads for accessing the ordination hall (Ubosot) and other significant sites within the Sunghawas area.

2) The Buddawas area comprises dry evergreen forest characterized by a dense canopy and a seamlessly interwoven ecotone with the Sanghawas Zone. This area is demarcated by concrete walls and wooden fences and has transitioned from a dense forest structure into a semi-natural state owing to increased Buddhist activities in designated areas, such

as the shrine precinct, the pavilion, the kitchen, and recreational spaces. A survey indicated a total of 76 trees and 21 species, identifying seven species. Prominent trees are in the Dipterocarpaceae, family, contributing to a Shannon-Wiener diversity index of 2.65 and a Richness Index of 3.00. Prominent species include *Hopea odorata* Roxb., *Dipterocarpus alatus* Roxb. ex G. Don., and *Baccaurea ramiflora* Lour. The forest structure is stratified into two canopy levels: 1) an upper canopy reaching heights of 25 meters, with some areas reaching up to 30 meters, and 2) a middle canopy layer ranging from 5 to 15 meters. The ground cover is cleared and managed to enhance recreational activities under the forest canopy, preserve scenic views, and preserve landscape aesthetics. Containers with auspicious trees further enhance the landscape. Additionally, introduced patches such as the pavilion site, the shrine precinct site, the kitchen, and infrastructure buildings serve specific functional purposes and support visits by Buddhist devotees. These patches are interconnected by semi-natural corridors such as gravel paths and human-made corridors, including paved roads leading directly to the Buddhawas Area.

3) The Thoranisangha Area is a restored dry evergreen forest characterized by secondary growth. It interfaces with the Buddhawas and Sanghawas Zones, featuring edge patches along riverbanks and water bodies connected to the agricultural matrix. A survey identified a total of 93 trees and 12 species, including seven species. Prominent trees are in the Fabaceae and Dipterocarpaceae family, contributing to a Shannon-Wiener diversity index of 2.40 and a Richness Index of 2.48. Prominent species include *Sindora siamensis* Teijsm. ex Miq. var. *siamensis*., *Hopea odorata* Roxb., and *Dipterocarpus alatus* Roxb. ex G. Don. The forest structure is stratified into two canopy levels: 1) upper canopy trees, reaching heights of 10-20 meters, and 2) lower canopy trees, reaching 5 meters. The ground cover consists of regenerating species integrated into the primary forest structure. Additionally, introduced patches such as parking areas, public utility spaces, recreational open areas, and the Dhammajukkra Garden support visits by Buddhist devotees. These patches are interconnected internally within the monastery by human-made corridors, including paved roads, and connected to urban areas via concrete roads.

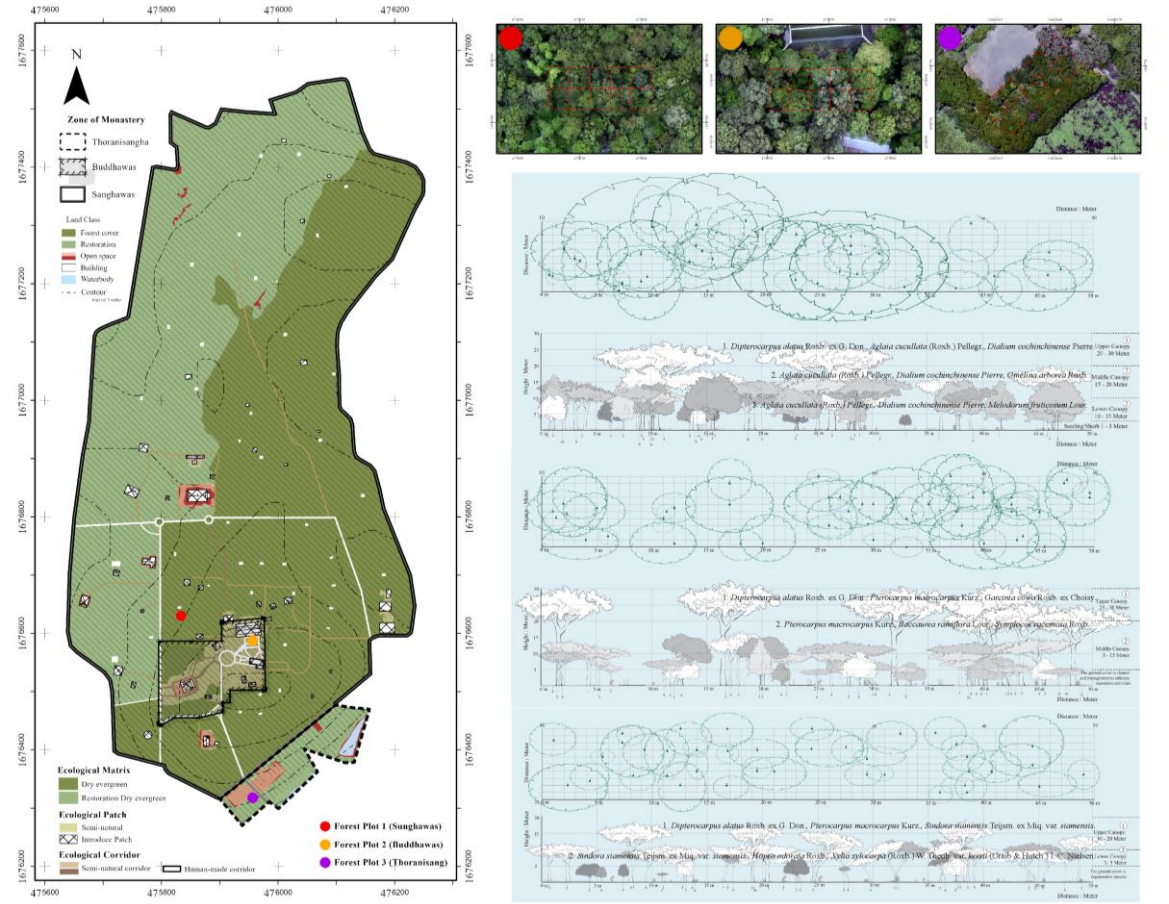

Figure 3. Landscape ecological structure and canopy structure of the Wat Pah

3.3 Recognition and identification of landscape ecology pattern

Figure 4 shows the landscape pattern types generated by the MSPA calculation, overlaid on the Wat Pah zone, divided into three major areas: 1) The Sunghawas area, encompassing 91.97% of the Wat Pah, primarily serves as the main forest matrix landscape. It consists of 96.59% foreground and 3.41% background, with core landscapes comprising the majority at 72.62%. Additionally, edge landscapes cover 19.47%, while the remaining patterns are loop (1.71%), perforation (1.55%), bridge (0.72%), islet (0.47%), and branch (0.06%). 2) The Buddhawas Area accounts for 4.47% of the area and functions as a forest patch adjacent to Buddhist activities within the matrix landscape. It features 75.31% foreground and 24.69% background, predominantly characterized by edge landscapes (26.42%). The area also includes core (20.74%), islet (12.66%), bridge (6.97%), loop (6.48%), and branch (2.03%) patterns. Lastly, 3) the Thoranisangha Area comprises 3.56% of the total area and is a forest remnant patch surrounded by agriculture. It exhibits 71.39% foreground and 28.61% background, with core landscapes covering the largest portion at 25.58%. This area also includes edge (23.29%), loop (19.71%), islet (1.31%), branch (1.27%), and bridge (0.24%) patterns.

The results indicate that the Sunghawas area is a crucial natural forest matrix within the landscape ecosystem, providing continuous habitats for biotic communities and maintaining ecosystem balance. This forest primarily consists of core and edge patterns (72.62% and 19.47%, respectively), emphasizing the need for preservation. In contrast, the Buddhawas Area is a forest patch embedded within the forest matrix, contain significant religious buildings and Buddhist activities. This area exhibits various patterns, including edge, background, core, islet, and loop (26.42%, 24.69%, 20.74%, 12.66%, and 6.48%, respectively). Conservation strategies should focus on minimize impacts on the edge and core areas that connect to the surrounding Sunghawas zone. Meanwhile, the Thoranisangha Area, located on the periphery of the forest monastery, serves as a remnant patch buffering the monastery from adjacent agricultural areas; it also displays diverse landscape patterns, such as background, core, edge, and loop (28.61%, 25.58%, 23.29%, and 19.71%, respectively). Strategies should be developed to increase forest patches and enhance their role as a buffer against the agricultural matrix.

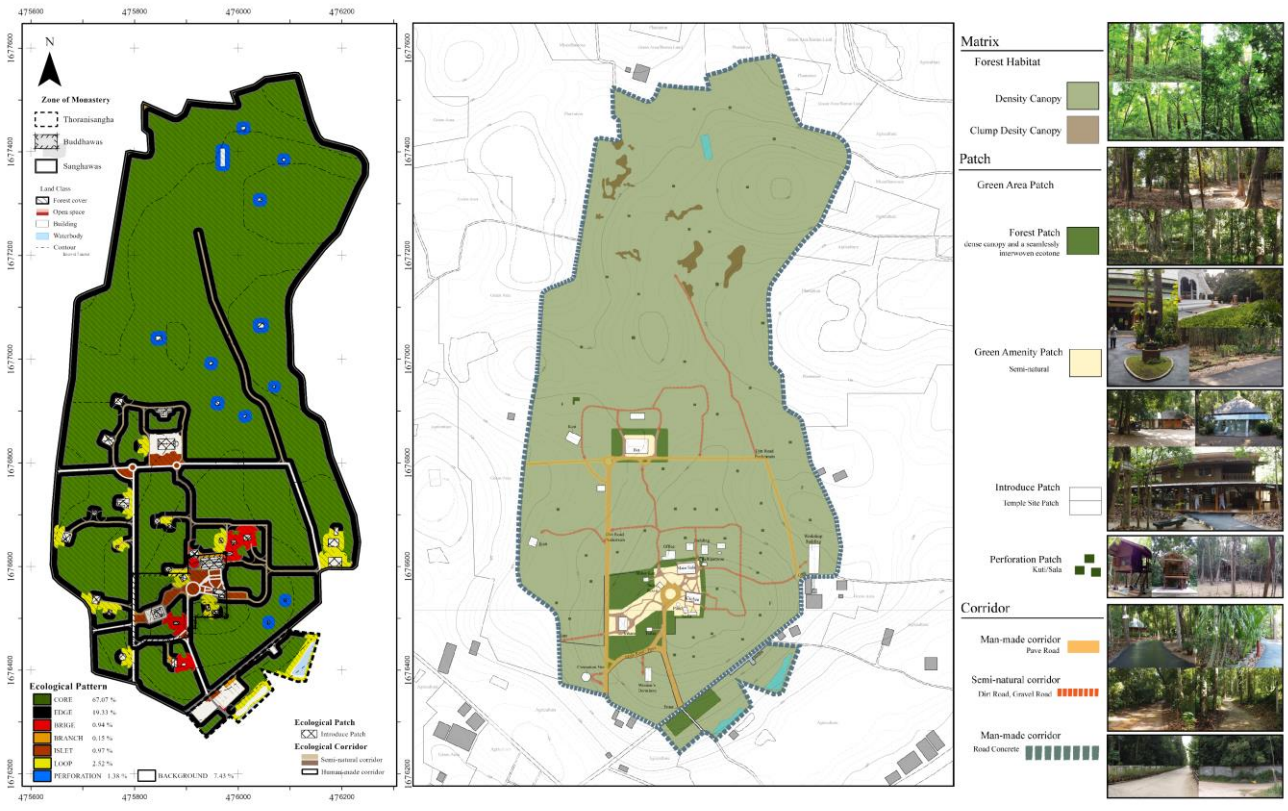

Figure 4. Landscape ecological structures and patterns of the Wat Pah

3.4 Presentation of guidelines for conservation and management

Based on our study of structures, patterns, Buddhist space-planning concepts (Jirathasanakul, 2001; Piromkeat, 2002; Wonglangka and Han, 2018), green space development concepts (Ahmadi et al., 2018; Bentrup, 2008; ONEP, 2005; Tangkitngamwong, 2012), and lessons learned from the concept of conservation and management at forest monasteries (Saardiam, 2020), a framework for site programming can be summarized as follows (Figure 5 and Figure 6).

3.4.1 Forest patch conservation and management in the Thoranisangha Area

Conserving and managing forest patches within the Thoranisangha Area means prioritizing green utility spaces to enhance the environmental quality surrounding the forest monastery and the community. This approach involves expanding forested areas as a buffer before entering the Wat Pah, focusing on native tree species and ornamental plants to preserve biodiversity and enhance the landscape, as illustrated in Diagram A. Located at the entrance of the Wat Pah, adjacent to the main road and the community's land use area, this open space is adorned with native and naturally planted trees. It serves as a distinct boundary for convenience, catering to Buddhists visiting the Wat Pah. Additionally, a garden symbolizing the Buddhist religion enhances the environmental quality and improves the community's quality of life.

3.4.2 Forest patch conservation and management in the Buddhawas Area

In forest patches within the Buddhawas Area, we should prioritize designing buildings that harmonize with the natural environment, emphasizing using native or local plant species as primary shade trees and maintaining local flora. Management should concentrate on undergrowth and utilization areas, integrating auspicious plant species to enhance the landscape and spiritual ambiance on-site. Restoring forest edges along the boundary between the Buddhawas and Sanghawas Areas serves to harmonize these zones and protect core habitats within the Sanghawas Area while also raising awareness of the privacy of the monastic domain. As depicted in Diagram B, the functional green area serves structural purposes and facilitates Buddhist activities at the entrance garden of the temple site. It encompasses buildings, public amenities, meeting areas, and seating spots nestled under original trees, with a line of tree barriers delineating the space. Similarly, Diagram C shows that the landscape amenity green area provides spaces for sitting and listening to Dharma teachings. It integrates pedestrian zones with managed spaces featuring potted plants and preserved trees to create clearings beneath them, guiding viewers toward landmark buildings adorned with plants. This area is demarcated by the forested and temple private zones.

3.4.3 Forest matrix conservation and management in the Sunghawas Area

Forest matrix should serve as a prominent landscape feature, with a strong emphasis on conserving native species and biodiversity. Green conservation areas should be designated to protect various species habitats, surrounded by buffer zones that allow for limited, low-impact activities. As depicted in Diagram D, a temple site within the matrix for performing Buddhist rituals and sangha activities, should be designed to blend seamlessly with the natural environment. An Ubosot area on the monastery land is envisioned as a green space to enhance the landscape; we should incorporate landscape amenities and plant auspicious species to elevate its aesthetic appeal. This area will support activities such as Dharma practices and meditation walks, with natural corridors near forest edges facilitating seamless transitions between spaces. Similarly, Diagram E depicts kuti patches in the green conservation area that will serve as animal habitats and private areas for the monks' Dharma practices. These patches should be integrated into the matrix landscape or constructed without disturbing the natural area, avoiding vegetation clearing and protecting critical habitats. Enclosed with trees to create privacy, the corridors connecting them will be narrow yet functional, effectively mitigating matrix fragmentation.

4. DISCUSSION

Landscape ecology is the study of structures and patterns in landscape systems. It has the potential to help us understand how to use a holistic approach that can create sustainability. In other words, it is a design that considers aspects of the environment, culture, and aesthetics (Makhzoumi, 2000). Integrating landscape design with planning for the Wat Pah Area facilitates the presentation of research findings that can improve our understanding of the spatial links between the monastery's culture and the surrounding environment. This is because this approach integrates landscape

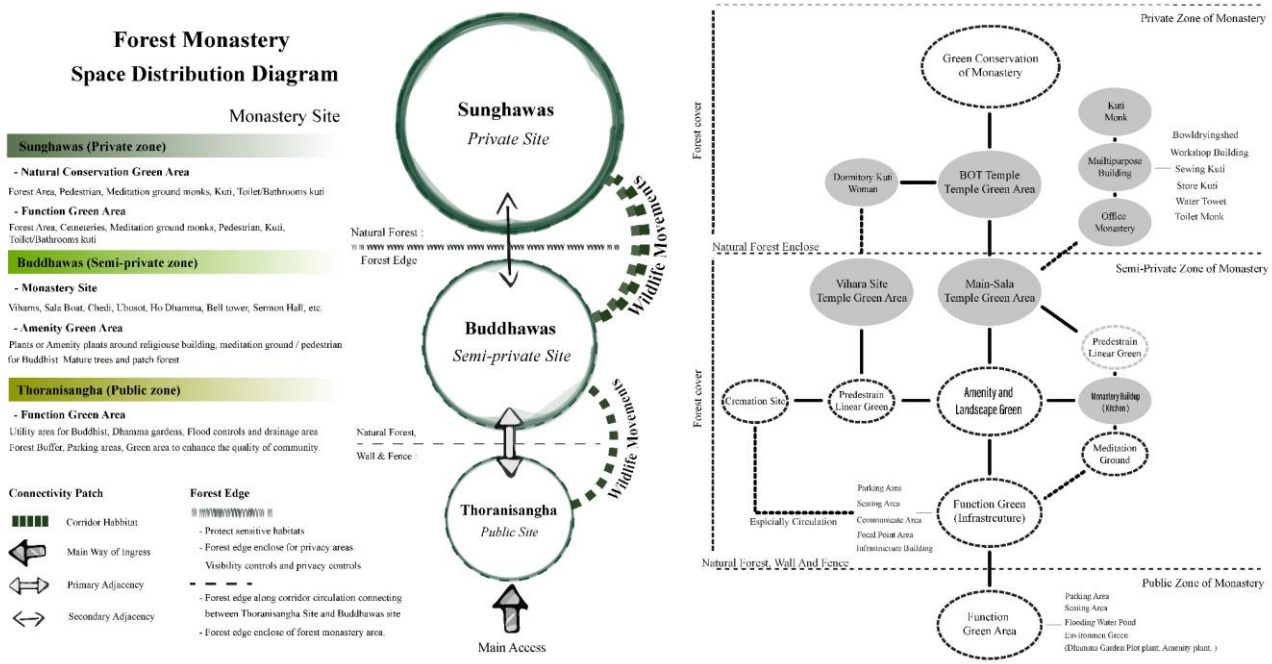

Figure 5. Area planning for ecological landscape conservation management of the Wat Pah

Figure 6. Design and presentation of guidelines for conservation management at the Wat Pah

design with local resources within the framework of the Wat Pah (Chen et al., 2019). For example, native plants are utilized for ecological functions such as barriers, physical control, perspective creation, territorial division, community buffers, and wood replacement in plant community rehabilitation Examples include using native plants as an integral part of the ecological structure (Sittipong and Tongtuam, 2018): as barriers, for physical control, to create perspective, to divide territories, as a buffer between communities, and to serve as replacement wood for plant community rehabilitation. The building's landscaping combines decorative and auspicious trees in strategic locations throughout the monastery with environmentally friendly designs that do not harm the nearby forest. This method places a strong emphasis on preserving natural and cultural capital to raise the value of the environment, establish new ecosystems (Ahmadi et al., 2018), and aid in the understanding the structural components that underpin the categorization and planning of green spaces, such as conservation areas, functional areas, and spaces within Buddhist buildings. This involves using a type of green space that consists of a forest, traditional trees, plants, a hardscape-softscape, and a building area that does not absorb water from different spatial activities; it also involves using the area layouts of the forest monastery. This enables the forest monastery's designer to understand the landscape in every area layout with clarity. To create an aesthetic that strengthens the Buddhist faith, we must establish a conceptual framework to develop the forest monastery's green spaces and enhance its unique traditional value in terms of its surroundings and locations and supporting religious activities (Techaamnuaywit, 2013). This framework also highlights the forest area within a one-kilometer radius of the monastery, which is one of the characteristics of a forest monastery (Chaisuwan and Charoonseang, 2018).

In landscape ecology studies for the conservation and management of green spaces in Buddhist areas, forest monasteries are classified as functional green areas (ONEP, 2005). The ecological landscape in a forest monastery landscape's indicate distinct use in terms of green spaces. For instance, the Sangkawas Area accommodates the monks and their living quarters. The Buddhawas Area promoting both the natural beauty and the distinctive value of Buddhism. The Thoranisangha Area enhance space usage for public benefits, maintain environmental quality, and act as a buffer. Consequently, Wat Pah's green space may be divided into three groups: green utility areas, green amenity areas, and green conservation areas, all under the functional green area category. The guidelines for designing and planning a forest monastery's green space are derived from the lessons that can be ascertained from the conservation and management practices used by the monks there and can be used as information for decision-making when planning the management of urban green spaces in the future. Managing cultural monastic areas is crucial to the growth of green areas improving community's quality of life, and providing additional benefits (Wonglangka and Han, 2018).

Aside from understanding the structures, patterns, and ecological roles of landscapes, it is important to study the selection of plants for a landscape's architecture, as well as to manage forest monastery ecosystems in terms of the structure of each area's layout. Emphasis should be placed on suitable applications for the forest monastery area based on practical uses, such as covering traditional and large trees as integral parts of the landscape (Suteethorn, 2018), the basics of Thai monastery landscape architecture (Kantatian, 2017), and the area's green spaces. This ensures that all dimensions of green spaces are accounted for, including waste, bathrooms, power, the environment, food and water, and sanitation management (Department of Health, 2019). However, Buddhist sites are a delicate matter because of a few limitations. Some of the forest monastery's activities fall outside the monks' purview, and there is a deficiency of detailed information on this subject. Therefore, future studies should clarify their purposes to potential participants to encourage them to engage with the research. This can be achieved by promoting knowledge and understanding regarding forest monastery green spaces in accordance with Thailand's policy and plans to increase its green spaces.

5. CONCLUSION

The plan and guidelines for managing and conserving the green spaces of forest monasteries are based on the structures, patterns, and concepts of conservation and management. Specifically, a space should be designed with Buddhist concepts and teachings at its core, accounting for the organizational management of forest monasteries. In other words, focus should be placed on living in the forest and relying on natural areas, for example, with respect to Vipassana meditation and Buddhist teachings, providing good living strategies for Buddhists who visit the forest monastery. Additionally, there should be guidelines for developing and managing green spaces to promote natural sustainability. As a result, protecting a forest monastery's green spaces involves viewing it as a forest ecology that serves as a habitat for living creatures, provides an environment for Vipassana meditation based on the monk's religious practices, and promotes Buddhism using large trees and/or forest surroundings.

ACKNOWLEDGEMENTS

This publication is based on thesis research and information support for academic works under the following project: Conservation of Green Area in Wat Pah: A Case Study of Ubon Ratchathani Province 2017: Geo-informatics in Resource and Environment Research and Training Center, Mahidol University.

REFERENCES

Ahmadi F, Bemanian M, Ansari M. An introduction to natural landscape restoration method based on landscape ecology approach. The Scientific Journal of NAZAR Research Center For Art, Architecture and Urbanism 2018;14(56):4-14.

Aminzadeh B, Khansefid M. A case study of urban ecological networks and a sustainable city: Tehran's metropolitan area. Urban Ecosystems 2009;13(1):23-36.

Baimai W. Biodiversity Situation in Thailand. Bangkok: The Thailand Research Fund; 2007. p. 79 (in Thai).

Bentrup G. Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways (General Technical Report SRS-109). United states: United States Department of Agriculture and Forest Service, Southern Research Station; 2008. p. 3-9.

Chaisuwan P, Charoonseang P. The forest monastery and environment preservation. Inthaninthaksin Journal 2018; 13(2):165-75 (in Thai).

Chen X, Xu D, Fadeleseed S, Li L. Analysis on landscape ecological design in landscape architecture. Research in Ecology 2019;1(1):31-4.

Department of Health. Guide to Environmental Health Management in Monasteries. 1st ed. Bangkok: Samcharoen Panich (Bangkok) co. ltd.; 2019 (in Thai).

Forman RTT, Godron M. Landscape Ecology. New York: John Wiley and Sons; 1986.

Jirathasanakul S. Wat: Buddha of Thai Architecture. 1st ed. Bangkok: Thammasat Printing House; 2001 (in Thai).

Jumpasingha J, Phutthai T, Pattanakiat S. Plants community structure and diversity of flora in forest monastery. Thai Forest Ecological Research Journal 2018;2(1):26-36 (in Thai).

Kantatian W. Landscape architecture of Thai temples, and Buddhist intergrated learning and health promotion.Journal of Graduate Studies Review 2017;13(2):137-49 (in Thai).

Kanyalak Y, Chunchlee M, Suwichai T. The forest monasteries roles on human and social development process. Journal of Education and Social Development 2015;11(2):141-53 (in Thai).

Limthongkul S. Site Analysis: Project Site Analysis. 1st ed. Bangkok: Boonsiri Printing co. ltd; 2019. p. 5 (in Thai).

Makhzoumi JM. Landscape ecology as a foundation for landscape architecture: Application in Malta. Landscape and Urban Planning 2000;50(1-3):167-77.

Office of Natural Resources and Environmental Policy and Planning (ONEP). Water Sensitive Urban Design. 1st ed. Chiangmai: Tone Color Chiangmai Printing; 2005 (in Thai).

Office of the National Economics and Social Development Council (NESDC). National strategy 2018- 2037 [Internet]. 2023 [cited 2023 Jan 17]. Available from: http://nscr.nesdc.go.th/master-plans.

Pattanakiat S. Aerial Photograph: Application in Forestry. 1st ed. Bangkok: S.P. Com Interprint Limited Partnership; 2018. p. 128-85 (in Thai).

Piromkeat S. The Lay-Out of Buddhist Architecture in the Sukhothai Period at the Old Sukhothai City [dissertation]. Nakhon Pathom, Silpakorn University; 2002 (in Thai).

Royal Forest Department. National Forest Policy. Bangkok, Thailand: Planning and Information Office, Royal Forest Department; 2020. p. 34.

Royal Forest Department. National Forest Policy. Bangkok, Thailand: Planning and Information Office, Royal Forest Department; 2022: p. 8.

Saardiam T. Wat Nong Pah Pong: The model of organization administration according to the buddhist way. Journal of MCU Modern Education Studies 2020;1(1):17-21 (in Thai).

Sittipong Y, Tongtuam Y. Lanna cultural landscape ecology and the landscape Architecture Integration to Reducing Hydrological Surface Runoff Impact of Land Cover Change: A case study of Chiangmai-Lamphun Basin. Built Environment Inquiry Journal 2018;18(1):19-35.

Sornsakda S, PhrakruDhammathornSiriwat S, PhraSawai C. Patterns and processes of buddhist community forest conservation in Ubonratchathani. Journal of MCU Peace Studies 2013;1(2):11-28 (in Thai).

Suppakittpaisarn P. Research and Design in Landscape Architecture. 1st ed. Bangkok: O. S. Printing House co. ltd; 2021. p. 131 (in Thai).

Suteethorn K. Urban Forests in Temple Landscapes, The Cultural Services of an Urban Forest within a Temple Garden: The Bangkok Experience [dissertation]. Berkeley, University of California; 2018.

Tangkitngamwong O. Landscape ecology: The application to landscape planning for natural area conservation and management in Thailand. NAJUA: Architecture, Design and Built Environment 2012;25:263-87 (in Thai).

Techaamnuaywit P. The study of architectural design which support the acquixition of Sappaya in order to design Wat Pa Vimuttayalaya. Academic Journal Faculty of Architecture Khonkean University 2013;12(1):15-26 (in Thai).

The National Office of Buddhism. Report the number of temples in Thailand [Internet]. 2021 [cited 2021 Aug 8]. Available from: https://www.onab.go.th/th/content/category/index/id/805.

The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD). Readiness Preparation Proposal (R-PP) for Country: Thailand. Bangkok: Forest Carbon Partnership Facility; 2013. p. 62.

Wat Pah Nanachart. Wat Pah Nanachart. 1st ed. Ubonratchathani: Siritham Offset Printing House; 2022a (in Thai).

Wat Pah Nanachart. Wat Pah Nanachat Ubosatha Hall. 1st ed. Ubonratchathani: Siritham Offset Printing House; 2022b (in Thai).

Wonglangka W, Han F. Lanna buddhist temple: The cultural landscape as urban green space. Journal of Environmental Design 2018;5(1):106-29 (in Thai).

Wongsanao K, Krutasaen W. The study of spatial identity of forests temples and temple development standards of buddhist monastery department, National office of buddhism. Journal of MCU Peace Studies 2022;11(3):1219-33 (in Thai).