

# **Phu Chom Ngea Reserved Forest Conservation Model, Xiangngern District, LuangPrabang Province, Lao Peoples's Democratic Republic**

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## **Abstract**

This study aimed to investigate problem conditions, recommendations for problem-solving, and the identification of an appropriate conservation model for the Phu Chom Ngea reserved forest. The locale of the study was at Xiang Ngern district, Luang Prabang province, Lao People's Democratic Republic. Focus group discussion was used for data collection conducted with a sample group of three government officials in the area, five members of village forestry committee, five community leaders, and 13 focus group discussion participants. This study consisted of 3 parts: 1) data collection on problem conditions and opinions of officials and villagers to solve problems in the conservation of Phu Chom Ngea reserved forest (Descriptive data analysis); 2) creating a reserved forest conservation model; and 3) Assessment of Phu Chom Ngea reserved forest conservation Model.

Results of the study revealed that the conservation problems in the Phu Chom Ngea reserved forest are at a high level (3.59). The following were found at a high level: People in the area, the community administrative organization, and the public sector agency, however, found the problem of conservation to be moderate: Context area and Forest conditions. The opinions of officials and villagers identified: 1) The community should realize the importance and necessity of being involved in forest conservation; 2) concerned agencies should promote occupational training; 3) prevention of forest encroachment by clear determination of the forest area; 4) strengthen community leaders; 5) training on knowledge about conservation; 6) continually instill awareness of forest conservation; 7) should have continual plans on projects implemented in the area; 8) government officials must take the regulations comprehensively and seriously.

The Phu Chom Ngae reserved forest conservation model comprised the following: 1) driving force of stakeholders—the government, community administrative organizations and people in the area. 2) operation—3 important sector: The public sector-The former included budgets material equipment support, clear determination of the forest area, issuing regulations and training/education trip; community administrative organization-public relations, campaigning, being a coordinator with people and other agencies. The latter included people in the area-participate in forest conservation. 3) output-increased participate in the forest conservation. The model had been evaluated and approved by experts.

**Keywords:** Model, Conservation, Phu Chom Ngae reserved forest

## Introduction

Lao PDR is a country located in Southeast Asia. It is rich of forest resource which is directly and indirectly valuable / important to livelihoods of people in the country. Since 1986, Laos has adopted the new economic mechanism. There is adjustment of land use following marketing mechanisms and investment (Ministry of Agriculture and Forestry, 2005, p.3). The said transformation results in a decreased forest area. In 2010 the forest area in Lao PDR decreased to 9.55 million hectares or 40.34% compared with that of the year 1960 having 17 million hectares or 70% of the country's area (Forest Inventory and Planning Division, 2012, p.2) Crop rotation, unauthorized logging, infrastructure construction, urbanization, irrigation, and the building of hydroelectric dams are the factors contributing to the decline in forest area. Besides, growth of the timber industry and the country's revenue-generating exports of timber products contributed to the deterioration of the area and quality of natural forests.

According to the tendency of a decrease in forest area, the Lao government held a national forestry conference in 1989 (Ministry of Agriculture and Forestry, 2005, p.4). This emphasized on forest conservation and reforestation. Since then, the Lao government has developed and proclaimed forestry strategy to the year 2020 was endorsed and declared by the Lao government in 2005. It was an important strategy of forestry in Lao PDR which aimed to increase forest area to be 70% of the total area of the country (Ministry of Agriculture and Forestry, 2005). In this respect, the Lao government indicated civil and local administrative organization liberties to play important roles in the management of natural resources and environment of the community. This included people participation in the decision making in the management of forest resource and other natural resources beneficial to livelihoods of the community economic stability, society and politics (Ministry of Agriculture and Forestry, 2005, p.44). Even though Lao government works hard to manage and preserve forests, the forest area cannot expand as intended. This is due to needs for land use for agriculture, urbanization, the development of infrastructure, and a lack of funding for the management of forest resources. (Department of forestry, 2021, p.2).

The forest area in Luang Prabang province accounts for 65% of the province area. This includes one national reserved forest area (70,788 hectares), one provincial reserved forest

area (1,370 hectares), and 22 district reserved forests (88,661 hectares), Phu Chom Ngae reserved forest covers an area of 3,530 hectares (Forest Resource Management Sub-division, Luang Prabang Province, 2019). It covers 5 villages: Ban Pak Thor, Ban Na kha, Ban Huay Khot, Ban Huay Khong, and Ban Huay Phaeng, of Xiang Ngaern district. In the past, the communities near the Phu Chom Ngae reserved forest used it as a food source and a place to gather wood for personal use and sale. Examples of the utilization are herbal plants, bringing wood to build houses and forest encroachment for cultivation. Unfortunately, because of a lack of awareness on the part of the general public, the Phu Chom Ngae Reserved Forest is deteriorating. In order to reduce the problem of forest deterioration, the Lao government has determined that the aforementioned area is a reserved forest area that people may use sparingly (Upland Agriculture Research Center, 2008). In order to manage the forest resource appropriately, conservation is very important. According to a study, the concept of conservation is existing resource keeping and making use of it as planned.

Finding a suitable model for forest conservation will be helpful in terms of looking for and clearly determining a process of reserved forest conservation of people, according to the problem conditions and development guidelines that have been mentioned. The investigation of problem conditions, recommendations for problem-solving, and the identification of an appropriate conservation model for the Phu Chom Ngae reserved forest the main objectives of this study

## Methodology

### Population and sample group

1) The population was made up of people from five villages around Phu Chom Ngae Reserved Forest. The sample group consisted of 188 people. (Channang et al, 2022).

2) The sample group of three government officials: 1) Staff of Upland Agriculture Research Center, 2) Staff of District of Agriculture and Forestry officer Xiangngern and 3) Staff of District of Natural Resources and Environment Officer Xiangngern, five members of village forestry committee, 2) five community leaders from five villages and 13 participants in focus group discussion and they were obtained by purposive sampling.

3) The inspectors of the Phu Chom Ngae reserved forest conservation model consisted of five experts and concerned personnel in the area: 1) the head of Upland Agriculture Research Center; 2) the head of Forest Unit in the Upland Agriculture Research Center; 3) the head of District of Agriculture and Forestry Officer Xiangngern; 4) the head of District of Natural Resources and Environment Officer Xiangngern; and 5) the head of forest Unit in the District of Agriculture and Forestry Officer Xiangngern.

### Research instruments and Data collection

1) Questionnaire: The researcher used a questionnaire to ask people's opinions about problem conditions. The questionnaire was a five point-rating-scale of Likert, and the obtained data were analyzed for finding the mean and standard deviation. Researchers then took the draft questionnaire created with the assessment form to three experts who had knowledge and

experience in the area, considered a questionnaire to determine the tool's quality by examining the Index of Items (IOC). The value is between 0.60-1.00, and the optimum value is 0.50 (Ongiem, 2018), and the confidence level of the whole questionnaire was 0.89, which is greater than 0.7. It is accepted that the question has sufficient precision (Numsang & Tantrarungroj, 2018).

2) Focus group discussion record forms: It was used in a group meeting to brainstorm problem conditions and recommendations for problem-solving in reserved forest conservation for the purpose of developing a model of reserved forest conservation.

3) Assessment form: The latter was the application of theoretical concepts gained from review of related literature for the preparation of an assessment form. It comprised 4 aspects: 1) appropriateness of the model; 2) possibility of the model application in practice; 3) consistency with the context; and 4) actual utilization of the model (Pengsawat, 2010). The experts evaluated the prepared model using a five point-rating-scale of Likert, and the obtained data were analyzed for finding the mean and standard deviation.

### **Data analyses**

1. Quantitative data: Obtained data were analyzed by using were mean and standard deviation.

2. Qualitative data: Processed according to the information from the document and data gained from the focus group discussion to be knowledge back in the preparation of the reserved forest management model. Finally, the data were analyzed and grouped to form the groups of data that answered the question.

## **Results**

The findings revealed that the conservation problems in the Phu Chom Ngae reserved forest are at a high level (3.59). The following were found at a high level: People in the area, the community administrative organization, and the public sector agency, however, found the problem of conservation to be moderate: Context area and Forest conditions (Table 1).

**Table 1** Mean, Standard Deviation, and Problem on conservation of Phu Chom Ngea Reserved Forest

(n=188)			
Issue	Mean	SD	Problem level
Context area	3.25	1.20	moderate
1. Topography	3.82	1.42	high
2. social and cultural conditions	2.04	0.78	Low
3. economy	3.88	1.40	high
People in the area	3.75	1.39	high
1. knowledge of conservation	3.76	1.48	high
2. Public participation in conservation	3.73	1.51	high
The community administrative organization	3.94	1.12	high
1. Roles of community leaders	4.10	1.30	high
2. Surveillance patrolling the area	3.81	1.41	high
Forest conditions	3.35	1.18	moderate
1. forest encroachment	3.31	1.62	moderate
2. illegal deforestation	3.38	1.44	moderate
Public sector agency	3.64	1.34	high
1. Budget and equipment support	4.13	1.25	high
2. Implementation of rules	3.15	1.43	moderate
<b>Total</b>	<b>3.59</b>	<b>1.25</b>	<b>high</b>

Focus group discussion related to recommendations for the management of problems for the conservations of Phu Chom Ngae reserved forest included the following: 1) area context; 2) forest condition and situation; 3) people in the area; 4) the community local administrative organization; and 5) public sector agencies. (Table 2)

**Table 2** Problem Condition and opinions of Officials and Villagers for solving problems in the Phu Chom Ngae reserved forest conservation

Issue	Current problem conditions	opinions of Officials and Villagers for solving problems
1. Context area		
1.1 Topography	The area had limited potential such as most of area was mountainous, little flat area, many creeks were dry, less fertility was mostly the agricultural society, and depend nature for sustain sustenance.	It should put the importance on reserved forest caretaking.
1.2 Social and cultural conditions	Most people in the communities around Phu Chom Ngae reserved forest were traditional local people comprising 3 ethnic groups and their way of life must rely on the forest products.	It should have people participate in the reserved forest conservation and continual reserved forest management
1.3 Economy	The community economy mostly relied on agricultural occupation and the agricultural	Concerned agencies should promote agricultural occupation and training such as used of technology to increase in agricultural yields
2. Forest conditions		
2.1 Forest encroachment	The problems in the reserved forest encroachment for occupying farm land, unclear forest areas, and forest burning for farming.	Prevention of the reserved forest encroachment by clearly determining of the reserved forest area.
2.2 Illegal deforestation	Problems in violation of logging and deforestation by people inside and outside the area.	Strengthening of community leaders, the village committee and the community to realize impacts of forest destruction
3. People in the area		
3.1 Knowledge of conservation	People in the area lacked of knowledge about forest law and consciousness of natural resource conservation	Training on knowledge about conservation and concerned law as well as continual holding activities to instill forest consolation.

Issue	Current problem conditions	opinions of Officials and Villagers for solving problems
3.2 Public participation in conservation	People participation and consciousness of conservation were at a low level. For example, some groups of people acted against rules & regulations eg. illegally cutting down trees, clearing the forest and wild hunting.	Extension of knowledge about the importance and usefulness of the forest and avoidance of illegally cut down trees, forest burning, forest encroachment, resource destruction, etc.
4. The community administrative organization		
4.1 Roles of community leaders	Capacity strength of the village committee and it had few roles.	Strengthening community leaders and the village Committee by the
	They would perform their tasks when there were allocated budgets or project implementation in the area	Extension of knowledge about conservation and finding budget sources
4.2 Surveillance patrolling the area	Lack of surveillance to patrol forest areas	Preparing the prevention of forest encroachment and destruction project
5. Public sector agency		
5.1 Budget and equipment support	The public sector lacked of budgets used for forest conservation. It must rely on budgets for various aid organizations and the budget to operate in the area was not continually thorough.	It should have continual through roadmaps and project implementation
5.2 Implementation of rules	Lack of strictness and rigor in applying the rules	Government officials must implement the regulations comprehensively and seriously.

### **Preparation of the Phu Chom Ngae reserved forest conservation model**

The team of researchers used factors/conditions, problems encountered, and methods of improvement in the area as a basis for the model preparation. This was in order to have ideas or concepts in the model preparation. In fact, the team of researchers employed the concepts of participation, model construction and development and Phu Chom Ngae reserved forest model drafting. Importantly, this study chose to employ Semantic model using language communication for the explanation of phenomenon studied by language, chart or picture to understand. This was in order to perceive structure of thought, components and relationships of the components of the phenomenon. Besides, there was use of the text to explain to make it clear like the Phu Chom Ngae reserved forest conservation model (Figure 1)

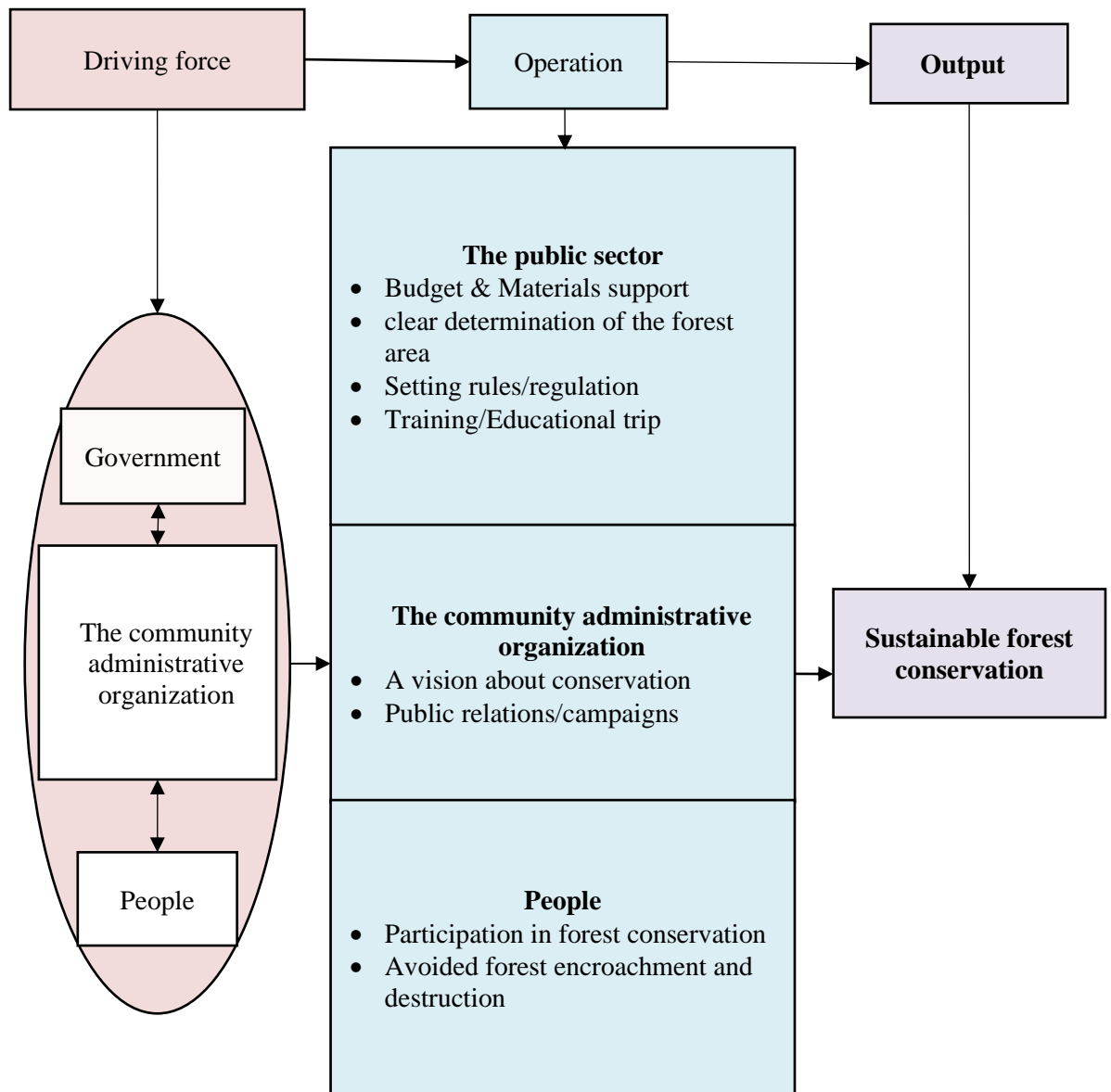
The Phu Chom Ngae reserved forest conservation model can be a formal form of development, starting from

**Driving force of stakeholders:** 1) government-policy setting and budget support. 2) The community administrative organization took part in the forest management in terms of setting rules & regulations as a mechanism or tool for managerial administration. 3) People - People in the area provide cooperation to support labor and jointly decide to solve problems that arise together.

**Operation:** 1) The public sector: the Ministry of Agriculture and Forestry and the Provincial Department of Agriculture and Forestry-played crucial roles in providing budget and material support under various roadmaps/projects. Upland Agriculture Research Center, District of Agriculture and Forestry Officer Xiangngern, and District of Natural Resources and Environment Officer Xiangngern support operations to prevent the encroachment of the reserved forest by clearly determining the reserved forest area, setting rules, restoring the forest, and providing rewards and wages for workers to participate in activities as appropriate. A learning process must be created for local people to be aware of importance and value of forests. The leveraging process creation by training and educational trip focused on direct knowledge transfer to people in the area by experts. 2) The community administrative organization - public relations campaigns for local people to be aware of the importance and value of forests. In fact, the community administrative organization was coordinator with people and organizations both local and non-local for the conservations of Phu Chom Ngae reserved forest conservation. 3) People - People in the area participating in the forest conservation had a common consciousness and perceived the importance and benefits of forests. They avoided forest encroachment and destruction. They participate in forest utilization as necessary. Besides, people in the area were given an opportunity to rehabilitate natural conditions. That was, they participated in the determination of village rules & regulations

**Output:** Increased participate in the forest conservation.





**Figure 1** Phu Chom Ngae reserved forest conservation model at Xiang Ngerm district

### Assessment of the Phu Chom Ngae reserved forest conservation model

Five experts evaluated the prepared Phu Chom Ngae Reserved Forest Conservation Model in terms of appropriateness, practicability, context coherence, and model application. There were five levels in the system used to determine score weight. The results of the assessment in every area showed a value greater than 3.60, indicating that the model was actually usable (Table 3)

**Table 3** Results of the assessment of Phu Chom Ngea reserved forest conservation model

Issue	Mean	S.D	Description
Appropriateness of the model	4.13	0.49	High
Possibility to be used	4.03	0.38	High
Consistency with the context	4.07	0.45	High
The model is truly utilized	3.97	0.30	High

### Discussions

According to study findings, Luang Prabang province's Phu Chom Ngea Reserved Forest conservation issues are primarily the result of low levels of locals' participation in forest conservation. Inadequate budget support resulted in forest destruction rather than forest utilization. This is perhaps consistent with research by Sangchanthavong & Sitthi (2016) which found that the forest conservation problems were due to: 1) local people lack of knowledge and 2) most local people did not put the importance on forest conservation. Vannabuathang & Khamjatpai (2017), conducted a study and found that problems in forest conservation included people lacked of knowledge and understanding about forest conservation. Besides, Pengvansavan et al. (2018) found that problems the conservation and rehabilitation of Dong Hua Sao National Reserved forest resource included the following: 1) inadequate budgets, 2) people lacked of knowledge about conservation; 3) people did not perceive the importance of conservation; 4) Some groups of people violated reserved forest regulations such as collecting forest products, and clearing the forest for farming, illegally cut down trees, wild hunting, etc.

The Phu Chom Ngea reserved forest conservation model was a study which aimed to encourage all parties to express their opinions in an analysis of forest conservation problems and solving the problems. Results of the study comprised to aspects: a) driving force of stakeholders—the government, community administrative organizations and people in the area. b) operation—3 important sector: The public sector—played crucial roles in providing budget and material support; community administrative organization-public relations, campaigning, being a coordinator with people and other agencies. The latter included people in the area-participate in forest conservation. c) output-increased participate in the forest conservation. This is perhaps consistent with research by Wichaiwong et al. (2018) which proposed guidelines for developing watershed forest conservation which cultivation area allocation and training villagers on environment were included. Sungkaew et al. (2021) claimed that community participation in sustainable management of forest must be supported by the government in terms of budgets and technology. Channang et al. (2022) found that people's training in forest conservation would result in their participation in forest conservation as well. Besides, Kantaros & Sodamark (2022) revealed that the procedural form of co-development of

a community constitution should be defined as a covenant on common agreement arising from people in a sub-district. Singkham (2006) claimed that an appropriate model for the area where the community on the community administrative organization was not strong comprised 3 parts: 1) communities in the area, 2) concerned government agencies in the area, and 3) local administrative organization. Jirapong & Rojanatrakul (2021) claimed that it was mutual use of the community forest under a common process from many sectors, including the government sector the people's sector, the community forest committee, and the Village committee.

The assessment of the Phu Chom Ngae reserved forest conservation was on the basis of 4 aspects and each reserved gained an average mean score higher than 3.60 which implied that the model was appropriate. This is perhaps consistent with research by Suebsing (2021) which revealed 4 aspects of assessment: 1) benefits, 2) possibility, 3) appropriateness, and 4) correctness. Vannabuathong & Khamjatphai (2017) assessed strategies on the development of understanding, awareness, and participation in forest conservation by using five-point rating scale. It was found that the developed strategies were appropriate at a high level (Total average score > 3.51).

### **Conclusion and suggestions**

According to results of the study it could be concluded that sustainable development of natural resources must be under the coordination of all parties. This included the necessity of the extension of knowledge in the conservation and maintenance of natural resources. This would be beneficial to the community in various aspects. Importantly, truly support from the public sector could make people in the area perceive the importance of conservation and participate in the conservation to prevent deterioration.

### **Recommendations**

Concerning the lack of budgets to conserve the reserved forest, concerned agencies should support the budgets on a need-to-basis. Furthermore, it should emphasize knowledge transfer, public relations on forest conservation, and raising awareness among local residents about the importance of reforestation. Furthermore, research on the roles and awareness of community leaders in the management of the Phu Chom Ngae reserved forest in Luang Prabang province should be conducted. The study's findings can be applied to forest conservation in other areas that have similar socioeconomic characteristics.

### **New knowledge and the effects on society and communities**

In this study, a model for developing forest conservation that is consistent at the local level is obtained. It may be used as a tool to address issues with the management of forest resources. This will contribute to raising awareness of the significance of forest conservation. It will result in the community as a whole becoming stronger for the sustainable management of forest resources.

## References

- Channang, B., Sakkatat, P., Fongmul, S., & Rungkawat, N. (2022). Factors Affecting Conservation of the Phuchomngea Forest Reserve by People in Xiangngern District Luang Prabang Province, Lao People's Democratic Republic Province. *Rajabhat Chiang Mai Research Journal*, 23(2), 50-64. <https://so05.tci-thaijo.org/index.php/cmruresearch/article/view/252662> (In Thai)
- Department of Forestry. (2021). *Five-year Summary of forest management (2016-2020) and plan (2021-2025)*. Vientiane: Department of Forestry (Unpublished Manuscript).
- Forest Inventory and Planning Division. (2012). *The results of the survey of forest cover all the country*. Vientiane: Department of forestry (Unpublished Manuscript).
- Forest Resource Management Sub-Division. (2019). *The Forest reserved area in LuangPrabang Province*. LuangPrabang Province: Division of Agriculture and Forestry (Unpublished Manuscript).
- Jirapong, S., & Rojanatrakul, T. (2021). The participation of the public in the conservation of forest resources in the area of Wang NokAen sub-district Wang Thong district Phitsanulok province. *Journal of Roi Kaensarn Academi*, 6(10), 441-458. <https://so02.tci-thaijo.org/index.php/JRKSA/article/view/250449> (In Thai)
- Kantaros, N., & Sodamark, K. (2022). Guidelines of community charter formation for mutual land utilization in community forest at Sermkhwa sub-district, Sermngam district, Lampang Province. *Rajabhat Chiang Mai Research Journal*, 23(1), 159-174. <https://so05.tci-thaijo.org/index.php/cmruresearch/article/view/249174> (In Thai)
- Ministry of Agriculture and Forestry. (2005). *Forest strategy of the Lao PDR to the year 2020*. Retrieved from [https://data.opendevlopmentmekong.net/dataset/c15c5cb1-dd12-4b8e-a09e-7db879efa588/resource/35ff73d8-fc68-49e6-ad2d-6a93634cd2b5/download/rpaf\\_012-2020-lao.pdf](https://data.opendevlopmentmekong.net/dataset/c15c5cb1-dd12-4b8e-a09e-7db879efa588/resource/35ff73d8-fc68-49e6-ad2d-6a93634cd2b5/download/rpaf_012-2020-lao.pdf)
- Numsang, T., & Tantrarungroj, T. (2018). Validity and Reliability of the Brief COPE Inventory: Thai version. *Journal of the Psychiatric Association of Thailand*, 63(2), 189-198. <https://he01.tci-thaijo.org/index.php/JPAT/article/view/131529> (In Thai)
- Ongiem, A. (2018). Validation of the Tests. *Thai Journal of Anesthesiology*, 44(1), 36-42. <https://he02.tci-thaijo.org/index.php/anesthai/article/view/116944> (In Thai)
- Pengsawat, W. (2010). Model development research. *Rajabhat Sakon Nakhon University Journal*, 2(4), 2-15. [https://www.tci-thaijo.org/index.php/snru\\_journal/article/download/10014/9048](https://www.tci-thaijo.org/index.php/snru_journal/article/download/10014/9048) (In Thai)
- Pengvansavan, K., Sopha, N., & Koddok, A. (2018). Strategies for forest resource conservation and habilitation of Dong Hua Sao national forest, Pathumporn district, Champasak province, Lao PDR. *Journal of Innovation Technology Management Rajabhat Maha Sarakham University*, 5(special), 32-40. <http://it.rmu.ac.th/itm-journal/downloads/entry/439> (In Thai)

- Sangchanthavong, S., & Sitthi, P. (2016). Strategy to manage effective participation in protection of Hinnamnor nation area, protected area, Khammouane province, Lao PDR. *Journal of graduate school Sakon Nakhon Rajabhat University*, 13(63), 37-47. <https://so02.tci-thaijo.org/index.php/SNGSJ/article/view/81818> (In Thai)
- Singkham, W. (2006). A model of sustainable development of villagers' participation on management of community forest: A case study of Dongmao-Dongkhamklang community forest in Amphoe Nathom, Changwat Nakhon Phanom. (Master's thesis, Sakon nakhon University). <https://alist.snru.ac.th/BibDetail.aspx?bibno=40370> (In Thai)
- Suebsing, S. (2021) The development of community solid waste management model by environmental education: A case study of ThaMuang subdistric, Selaphum district, Roi Et Province. *Rajabhat Chiang Mai Research Journal*, 22(1), 235-252. <https://so05.tci-thaijo.org/index.php/cmrruresearch/article/view/240548> (In Thai)
- Sungkaew, B., Phookpan, P., & Rattana, U. (2021). The development of a sustainable forest management model by community participation in national park: A case study of Mae Yom national park in Song district, Phrae province. *Journal of Social Development*, 23(1), 1-29. <https://so04.tci-thaijo.org/index.php/jsd/article/view/245590> (In Thai)
- Upland Agriculture Research Center. (2008). *The results of the survey in Phuchomngea Forest Reserve*. Xiangngern: Upland Agriculture Research Center (Unpublished Manuscript).
- Vannabuathong, B., & Khamjatphai, S. (2017) Strategy of developing create the understanding awareness of participation in conservation of the protected forest: A case study in Ban Kabud-Chingwaen, Thakhek district, Khammouane province, Lao PDR. *Journal of graduate school Sakon Nakhon Rajabhat University*, 14(64), 123-131. <https://so02.tci-thaijo.org/index.php/SNGSJ/article/view/92786> (In Thai)
- Wichaiwong, M., Nobnor, S., & Putrjari, K. (2018). The development of watershed forest conservation model in Chiangdao district by using the social processes and Buddhist principles. *Saint John's journal*, 21(29), 185-197. [https://sju.ac.th/pap\\_file/7f180bd2f0c56c9c150c915293b755e9.pdf](https://sju.ac.th/pap_file/7f180bd2f0c56c9c150c915293b755e9.pdf) (In Thai)