Participation patrolling efforts by local people: Case of Nam Tien forest station in Pu Hu Nature Reserve, Vietnam

L. K. Dong1,2, S. Sinutok1,3, P. Manop5 and K. Techato1,4

1Faculty of Environmental Management, Prince of Songkla University, Hat Yai, 90110, Thailand.
2Pu Hu nature reserve, Quan Hoa district 480000, Thanh Hoa province, Vietnam
3Coastal Oceanography and Climate Change Center research, Princes of Songkla University, Hat Yai, Thailand.
4Environmental Assessment and Technogy for Hazardous Waste Management, Faculty of Environmental Management, Prince of Songkla University Hat Yai, 90110 Songkhla, Thailand.
5Faculty of Law, Prince of Songkla University, Hat Yai, 90110 Songkla, Thailand.

E-mail: Ledongthph@gmail.com, uhugua@hotmail.com

Abstract. Protected areas, nature reserves and national parks in Vietnam, has considered foot patrols under traditional law enforcement with local forest guard (LFG). The participant between LFG and rangers in protected areas has been applied as commons way of patro lling on forest protection. However, very few studies have considered the contribution of LFG performance of patrolling activity with GPS-based monitoring system from Nam Tien forest station (FS), Pu Hu nature reserve (NR). Through the contribution of the monthly report was collected and the reliability of patrol data was analyzed in the central office. This study explores that the number of LFG was affected by the distance and patrol hours in the working field (P < 0.01). It could also be reducing the rangers’ law enforcement if the limitation of LHG’s performance was considerably significant. Admittedly, the illegal activity might be declined by ranger’s efforts in term of patrolling activity. This study highlights the importance of LFG performance for protected area management was related to the efficacy of conservation targets.

1. Introduction
The main role of tropical forests in biodiversity and climate change has commanded the world to examination for current ways to reduce deforestation [1]. Furthermore, the protected areas, including national parks and nature reserves in Vietnam, are fundamental for conservation [2]. These areas are habitat for the variety of animal and plant species [4] but also to support human well-being [3]. Location of protected area is perceived as a purely protected “sanctuary of nature” without human’s activity [5]. Because, strictly protected areas, which proscribes most human activities, are popular in the early days of conservation [1] with keeping far the safe from illegal activities[6].

Typically, conservation policy has been keeping out of people from NRs and operate impingement by law enforcement [7]. Fringe people in protected areas keep on extracting forest resources from PAs by boundary encroachment, including illegal logging, firewood, grazing, hunting, settlements and agricultural farms[8,9]. The continuous struggling between the management board and some
immediate inhabitants illustrates some inconsistencies in imposing conservation law because the variety of protected areas are isolated by surrounded settlements and agricultural farms [10].

In order to address threats to conservation, the practiced activity is prohibited illegal activities in tropical forest based on law enforcement efforts that are an essential component of reducing illegal activities [9,11]. Rangers are frontline as the guardians responsible for the management protection [12] in many countries such as Vietnam with often tedious work [13] during patrolling exercise in the huge jungle forest. Forest management recruits local people from the fringe villages as local forest guards [14]. That is a part of community forest management that is a widespread conservation approach in these topics [1].

This main of this study is to understand how the contribution of local people to participate in patrolling with rangers by monitoring at the Nam Tien forest station (FS) in Pu Hu Nature Reserve (NR). The dual objectives of this study were to (i) to quantify patrol efforts (ii) to analyze the fluctuation of LFG during the time given. This study seeks to concretion of local people who could present their efforts for supporting rangers in conservation aspects in the future.

2. Material and methods

2.1. Location and general description
Pu Hu NR is located in Quan Hoa and Muong Lat districts in Thanh Hoa province with composed mountain areas (latitude 20°30’ to 20°40’N and longitude 104°40’ to 105°05’E), in northeast Vietnam was established in 1999 as a special-use forest area by Vietnam government. Nam Tien FS is one of the managements of Pu Hu management board. It is home to various endangered and rare animal and plant species [15]. In the protected buffer zone, around 423 households with about 1,512 people in 12 villages of 2 communities are distributed (Figure 1). However, local living areas in and around NR often impact the ability of the PAs to meet conservation objectives[9]. Nam Tien FS has always implemented the patrol activity for the strict protected area. However, the great management issues include the relative unrestricted extraction of bamboo, thatch, medicine plants, and fuelwood by local residents from the surrounding area [9, 16]. With limited the permanent forest officers, Nam Tien FS has the number of villagers from the Village Forest Guard Group.

2.2. Data collection
In Pu Hu, Nam Tien FS applied for conventional law enforcement in the method of foot patrols that commonly emanate by ranger from scattered forest stations [15]. The patrol routes were presented on the map (Figure 1) and recorded the using GPS device by rangers or local people. All the patrol tracks were collected from January to December 2017 in central office with collecting monthly reports. The typical patrol track was carried out by one or two village guards with rangers patrolling depend on a head of forest station decision. During the patrolling routes, village guards were supporter rangers to patrol protected areas such as rangers had recorded the patrol day from each member of LFG.

2.3. Participant in patrol operation
Due to using conventional patrol on foot by Global POSiting System (GPS)-based monitoring, we analyze patrol data from this area to consider on illegal activity encounters and patrol ranger efforts in the short-term law enforcement intervention [9]. The current patrol tracks and the member of LFG group were decided by the head of the forest station for the specify of sub-area forest [10]. The LFG group could advise the patrol plan due to lesson learn or new information from the village [9]. During the patrolling time, the leader of a team had a decision to make about whether to use an ‘arrow head’ or a ‘single file’ formation for his officers, depending on previous information obtained from the earlier patrol [10]. Local guards had the discussion the new information with rangers and it could focus on this area. After patrolling each time, the name of patroller in LFG group was recorded by rangers or leader in the forest station. It helped rangers to organize the shifting local guard efficiency.
2.4. Data analysis

Kilometers (km) per Effort index (P/E), the percentage of the distance in kilometers (km) and man-days per unit was patrolled [10]. All the data were analyzed and presented in Microsoft Excel software for descriptive statistics and using the Statistical Package Social Sciences (SPSS, version 20.0) for determine any significant difference among various variables by testing function (p = 0.05) and mean values were presented as mean ± S.D (Standard deviation) [9]. Particularly, descriptive statistics were used to summarize the illegal activity found on data set. The data presented not normal distributed, thus, the correlation and compare means were analyzed during non-parametric statistics (Spearman rank correlation and Kruskal-Wallis test if more than two events and Man-Whitney test with two variables, \( \alpha = 0.05 \)).

3. Results and discussion

Generally, the description of possible patrol routes illustrated in Figure 1 and of basic geography of each forest plot presented in Table 1. Most of the patrol routes was established by rangers and local guards based on the available paths and the sensitive biodiversity loss and the density of illegal activity. These tracks are divided into different priorities, like the size of areas, patrol distance, and absolute height.

![The available patrol routes](image)

**Figure 1.** The location of case study area

| Name of sub-areas | Name of communities | Size of sub-areas (ha) | Patrol distance (km) | Absolute height (m) |
|-------------------|---------------------|------------------------|----------------------|---------------------|
| 102               | Nam Tien            | 1240.21                | 9 - 10               | 1,200 - 1,320       |
| 120               | Nam Tien            | 1081.03                | 7 - 9                | 926 - 1,025        |
| 121               | Nam Tien            | 754.46                 | 7 - 8                | 650 - 730         |
| 124               | Nam Tien            | 574.09                 | 5 - 6                | 541 - 635        |
| 132               | Nam Tien            | 658.82                 | 4 - 5                | 230 - 335       |
3.1. Fluctuation of distance and patrol-hours

The patrol performance is, regarding patrolling days or hours and distance, the most important part is presented of adaptive management attempt to work [9]. The quarterly average patrol-distances in 2017 were as follows: 10.52 (SD = 5.44), 11.24 (SD = 8.33), 11.00 (SD = 8.08) and 11.73 (SD = 8.87) respectively. And patrol-hours (man-days) from the first quarter to fourth quarter altered in 2017, i.e., from 6.37 (4.48) to 7.23 (SD = 5.65). Particularly, there was no significantly different distances among these quarters (H = 3.9, p > 0.05). The patrol efforts might be insufficient due to fitting local guard to the payment of low allowance per patrol day. By contrast, quarterly patrol-hours walked varied significantly across this year (H = 8.4, p < 0.05). Quite surprisingly, monthly distance and patrol hours by LFG group covered 2017 that did not differ. Different findings have been presented in Ghana [12] who found the significant index of distance and patrol hours, however, another supported to current findings in Vietnam [17, 18]. However, the changing of distance and patrol hour during this year was clearly observed (Figure 2).

On the whole, across the 12 months of patrol between rangers and VFG group, the number of man-day per month was positively correlated with the number of distance in those months (rs = 0.89, p < 0.001) as the similar consider in Ghana [12]. Furthermore, the number of local patrollers was positively correlated with number of distance and time-patrol (rs = 0.27, p < 0.001; rs = 0.3, p < 0.001). It was possible that the higher the number of patrollers on the walk in the larger protected areas explored. Thus, the number of patrollers rises they enabled to cover extended distance and patrol time walked as the similar in Ghana [10] and Vietnam [9].

|   |   |   |   |
|---|---|---|---|
| 142 | Nam Tien | 100.35 | 2 - 4 | 353 - 430 |
| 146 | Nam Tien | 678.08 | 1 - 3 | 454 - 540 |
| 147B | Nam Tien | 36.06 | 5 - 6 | 600 - 752 |
| 142 | Thien Phu | 545.2 | 7 - 8 | 720 - 820 |

Source: [15]

3.2. Relative altitude and speeds of patrolling

The quarterly relative altitude of patrolling was not significant across all the sub-forest plots (H = 13.92, p >0.01). It was no doubt that the patrol routes were significantly stable in topography during
those months even though patrol movement was unpredictable and subject to adaptation based on lessons learned or natural occurrences[10]. The relative altitude was excessively correlated with the distance and patrol-hours (rs = 0.29, p < 0.01 and rs = 0.32, p < 0.01, respectively). Admittedly, the most difficult local guards walked, the highest relative altitude local guards was disappointed. As shown in Figure3, the average relative altitude was merely changed.

Conversely, the quarterly speed of patrolling was not significant (H = 10.12, p <0.01). Depend on the current situation, it required local guards to patrol in the given time with different speeds. Further, the speed of patrolling was the negative correlation with relative altitude (rs = -0.25, p < 0.01) that was undoubtedly that level of the topography on conventional patrolling was mainly the factor of discouraging local guard to patrol on the field. However, the increase in patrol speed was significant during the month (Figure4). Interestingly, there was no a significant correlation with the speed of patrolling related to the distance and patrol-hours (rs = 0.09, p > 0.05 and rs = 0.19, p > 0.05, respectively). More importantly, the relationship between the number of local guards given by rangers and relative altitude and speeds of patrolling was not significant (rs = 0.03, p > 0.05 rs = 0.27, p < 0.05 respectively).

Figure 3. The difference in average relative altitude

Figure 4. The difference in average speed of patrolling
4. Conclusion
This benefit of the paper presents the strategy of a forest activity provides planning being enhanced for the sustainable forest protection at the local level. The objective of community forest management is involved the number of people to participate in patrolling as law enforcement efforts (Figure 5). In spite of the limited staffs, with often no more financial operation flowing to the patrolling fields, the patrol officers is one important factor to continues illegal activities off-take would be reduced drastically. Effective management of LFG group is also dependent on information on the illegal activity found, thus, it is a seemly significant strategy of conservation protection efficiently. Furthermore, research is therefore needed to ascertain the effect of social factors and education can be influenced patrol performance as well as patrol efforts. And, a comparison of patrol efforts of rangers and LFG should consider.

5. References
[1] R. A. Rasolofoson, P. J. Ferraro, C. N. Jenkins, and J. P. Ge. of C. F. M. at reducing deforestation in M. Jones, “Effectiveness of Community Forest Management at reducing deforestation in Madagascar,” Biol. Conserv., vol. 184, pp. 271–277, 2015.
[2] A. Erlewein, “Disappearing rivers — The limits of environmental assessment for hydropower in India,” Environ. Impact Assess. Rev., vol. 43, pp. 135–143, 2013.
[3] U. C. Berkeley and A. Cole, “Electronic Thesis and Dissertations Wildlife Monitoring and Conservation in a West African Protected Area By Andrew Cole Burton A dissertation submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Environmental Sc,” Univ. Calif., 2010.
[4] T. Patarkalashvili, “Some problems of forest management of Georgia,” Ann. Agrar. Sci., vol. 14, no. 2, pp. 108–113, 2016.
[5] K. Niedzialkowski, M. Blicharska, G. Mikusiński, and B. Jedrzejewska, “Why is it difficult to enlarge a protected area? Ecosystem services perspective on the conflict around the extension of the Bialowieza National Park in Poland,” Land use policy, vol. 38, pp. 314–329, 2014.
[6] K. E. Jenks, J. Howard, and P. Leimgruber, “Do Ranger Stations Deter Poaching Activity in National Parks in Thailand?,” *Biotropica*, vol. 44, no. 6, pp. 826–833, 2012.

[7] C. No 24/10/2010/ND-CP, *Administration and management of special-use forest*. Hanoi, Vietnam: http://moj.gov.vn/vbq/lists/vn%20bn%20php%20lut/view_detail.aspx?itemid=26113, 2010.

[8] F. J. Venter, R. J. Naiman, H. C. Biggs, and D. J. Pienaar, “The evolution of conservation management philosophy: Science, environmental change and social adjustments in Kruger National Park,” *Ecosystems*, vol. 11, no. 2, pp. 173–192, 2008.

[9] K. T. Dong. K. L, Sutinee. S, Hoa. A. X, Dong. N. P, Ali. A, Mano. P, “A quick comparison of patrol efforts for supportive protection: a case study of two stations in Vietnam,” *Appl. Ecol. Environ. Res.*, vol. 16, no. 2, pp. 1767–1781, 2018.

[10] C. Wiafe, “Wildlife laws monitoring as an adaptive management tool in protected area management in Ghana: a case of Kakum Conservation Area,” *Springerplus*, vol. 5, no. 1, p. 1440, 2016.

[11] H. Jachmann, “Illegal wildlife use and protected area management in Ghana,” *Biol. Conserv.*, vol. 141, no. 7, pp. 1906–1918, 2008.

[12] W. D. Moreto, “Occupational stress among law enforcement rangers: insights from Uganda,” *Oryx*, vol. 50, no. 04, pp. 646–654, 2016.

[13] N. J. Dominy and B. Duncan, “GPS and GIS Methods in an African Rain Forest: Applications to Tropical Ecology and Conservation,” *Conserv. Ecol.*, vol. 5, no. 2, pp. 1–9, 2001.

[14] S. Humphries, T. Holmes, D. F. C. de Andrade, D. McGrath, and J. B. Dantas, “Searching for win-win forest outcomes: Learning-by-doing, financial viability, and income growth for a community-based forest management cooperative in the Brazilian Amazon,” *World Dev.*, 2018.

[15] K. T. Dong. K. L, Sutinee. S, Hoa. A. X, Anh. N. T, Thin. N. V, Hai. L. V, Mano. P, “Overview of improving patrolling efforts: a case study of forest station in Pu Hu nature reserve,” *Appl. Ecol. Environ. Res.*, vol. 16, no. 3, pp. 2845–2859, 2018.

[16] H. A. X. Dong Le Khac, Sutinee Sinutok and K. T. Manop Promchana, “Potential of Approached Ecotourism Consideration as Part of Patrolling Efforts Responsibility in Pu Hu Nature Reserve, Vietnam,” *EnvironmentAsia*, vol. 7, no. 1, pp. 104–111, 2018.

[17] H. Jachmann, “Monitoring law-enforcement performance in nine protected areas in Ghana,” *Biol. Conserv.*, vol. 141, no. 1, pp. 89–99, 2008.

[18] H. Jachmann, “Illegal wildlife use and protected area management in Ghana,” *Biol. Conserv.*, vol. 141, no. 7, pp. 1906–1918, 2008.

Acknowledgements
The authors would like to say thanks to Thailand’s Education Hub for Southern Region of ASEAN Countries (TEH-AC), Graduate School of Sustainable Energy Management, faculty of Environmental Management of Princes of Songkla University – Thailand for supporting my research. I would like to appreciate the protected area authorities of the Pu Hu nature reserve and Nam Tien Forest Station where a ranger-based monitoring system have been established. And, I am thankful Department of Law Enforcement-Pu Hu for providing all technical processing of data analysis, their knowledge, and their services as well.