倉田奨励金研究報告書 第 52 集
2020 年度（第 52 回）助成



奨励金No. 1440

# マルチセンサー地理空間データを用いて森林の回復力を強化するコミュニティ林業プロジェクトの有効性の評価：カンボジアから学んだ経験

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# Evaluating the Effectiveness of Community Forestry Projects Using Multi-Sensor Geospatial Data to Enhance Forest Resilience: Lessons Learned from Cambodia

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開発途上国の 10 億人以上の地域住民が、コミュニティ林業プロジェクトに参加する機会が増えています。森林管理の実践を通じて、森林減少の削減、炭素排出量の相殺、地域住民の生活向上に重要な役割を担っています。現在、コミュニティ林業が森林減少の抑制や生物多様性の保全に有効であることを裏付ける証拠は限られています。これまで、コミュニティ林業プロジェクトが、開発途上国の森林状況や地域住民の生活の改善にどのように役立つのか、国レベルで明確な知識ギャップがありました。本研究では、カンボジアにおいて、マルチセンサーリモートセンシング、参加型マッピング、地上調査の相乗的アプローチにより、コミュニティ林業プロジェクトの有効性を評価しました。本研究は、カンボジアにおけるコミュニティ林業プロジェクトの成否の評価に貢献するものである。カンボジアは REDD＋のもとでコミュニティ林業プロジェクトの拡大を計画しており、本研究が今後のコミュニティ林業プロジェクトの実施に役立つことが期待されます。

Over a billion local people in developing countries are increasingly participating in community forestry projects. They play an important role in reducing deforestation, offsetting carbon emissions, and improving the livelihood of local people through local forest management practices. Currently, there is limited evidence supporting the effectiveness of community forestry in reducing deforestation and conserving biodiversity. Hitherto, there is a clear knowledge gap in how community forestry projects are useful in improving forest conditions and the livelihoods of local people in developing countries at the national level. In this study, the effectiveness of community forestry projects was evaluated using a synergistic approach of multi-sensor remote sensing, participatory mapping, and ground-based survey in Cambodia. This research contributes to evaluating the success or failure of community forestry projects in Cambodia. As Cambodia is planning to expand community forestry projects under REDD＋, it is expected that this study will help in the implementation of future community forestry projects.

## 1. 研究内容

Community forestry is a progressively important form of forest management and has developed in response to concerns towards centralized forest ownership in developing countries (Schusser, 2013;). It is also one of the strategies for REDD＋ implementation by reducing GHGs emissions (Pelletiet et al., 2016). The underlying principle is

that communities are in the best position to manage and protect forest resources, provided they see that it is in their best interests to do so (Robinson et al., 2014). Recent research has supported the view that community-managed forests have lower and less variable rates of deforestation than protected forests (Porter-Bolland et al., 2012; Baynes et al., 2015). Small-scale and localized research has been done to evaluate the effects of community forestry on biodiversity and forest biomass (Singh et al., 2018). However, large-scale and national-level research is still very limited (Luintel et al., 2018).

Evaluating the impact of community forestry to counter forest cover change is important because previous studies acknowledged the need of community forestry to understand the factors responsible for the success of the project (Nathan et al., 2017). This study utilizes geospatial data as a vital role to monitor the efficiency of community forestry by comparing the temporal variation in forest biophysical parameters at a national scale. Different remote sensing and community-level data can help to monitor forest dynamics and improve our understanding.

**Results and summary:**

Community forestry programs are essential for reducing deforestation, maintaining bio-diversity and improving the livelihood of people through forest management practices. We have done our analysis of 337 community forestry areas in Cambodia. Out of these boundaries, 16 were considered to have gone through major

**Table 1. List of community forest areas facing high deforestation across Cambodia**

| Name | Forest Lost % | Forest Lost average year | Area in ha | commune | district |
|---|---|---|---|---|---|
| Orot Kikiri Prey Sabong | 75 | 2016 | 6,344 | Lumtong | Anlong Veng |
| Khum sochit | 54 | 2016 | 4,572 | Sochit | Sandan |
| Sammakie Song Kros Prey Cheur | 67 | 2017 | 4,151 | Anlong Veng | Anlong Veng |
| Stoeng Tror | 96 | 2012 | 2,392 | Ta Mau | Prek Prasab |
| Phnom Krem Morodok | 60 | 2013 | 2,313 | Rotanak | Rovieng |
| Prey Kabl Ta Kong | 75 | 2017 | 2,207 | Dong Kambet | Sandan |
| Kok Thlorkler | 54 | 2013 | 2,086 | Kouk Thlok Leu | Chi Kreng |
| Dong Beng | 49 | 2018 | 1,843 | Beng | Banteay Ampil |
| O meas | 90 | 2013 | 1,356 | Tomring | Sandan |
| Phnom Luk | 77 | 2010 | 1,334 | Preaek Prasab | Prek Prasab |
| Prey Tralach | 66 | 2012 | 1,332 | Prey Tralach | Rukhak Kiri |
| Prey Nak Tala | 83 | 2013 | 1,301 | Tomring | Sandan |
| Prey O Phum | 93 | 2013 | 1,120 | Tomring | Sandan |
| Prey O thmor | 94 | 2016 | 1,065 | Tomring | Sandan |
| Prek Thnaot | 49 | 2018 | 1,007 | Preaek Tnaot | Tuek Chhou |
| Sala Chpor | 72 | 2014 | 1,006 | Sala Visai | Prasat Ballang |

deforestation (Table 1). The global Forest Change map provided by UMD (University of Maryland) was used to determine forest change area and year of loss (figure 1). Table 1 lists down 16 most affected areas by deforestation by their total area cover. All mentioned community forest areas are above 1,000 ha. Their forest area loss ranges from 49% to 96%, which is quite high. Whereas, Table 2 shows 5 areas with the highest increase in forest cover. Most of them are small community forest areas with gain percentages ranging from 14% to 33%.

Four of the 16 community forest areas, 'O meas', 'Prey Nak Tala', 'Prey O Phum', and 'Prey O thmor' all belonging to 'Tomring' commune, show high deforestation (Table 1). Figure 2(a) shows the temporal variation of deforestation occurred in Tomring commune from 2001 till 2021. Figure 2(b) illustrates ALOS PALSAR RGB composite image (HH, HV, HH/HV) of the year 2020. PALSAR images have been helpful and used in the past for mapping forest cover and estimation of biomass. In

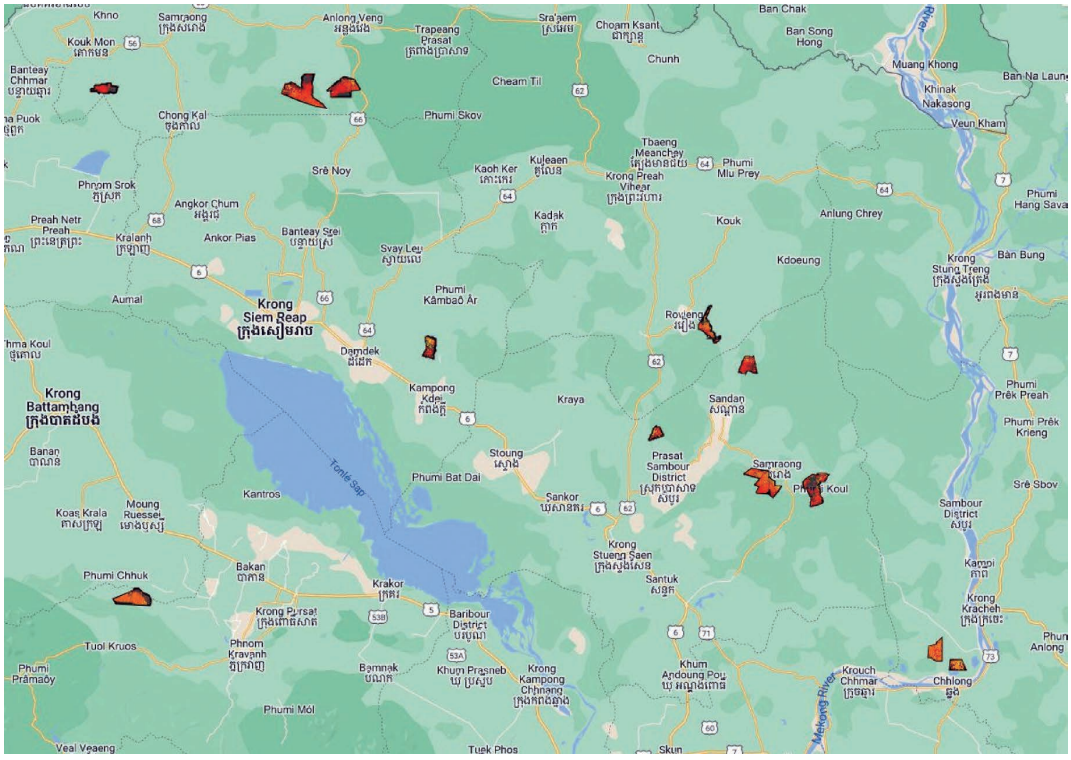
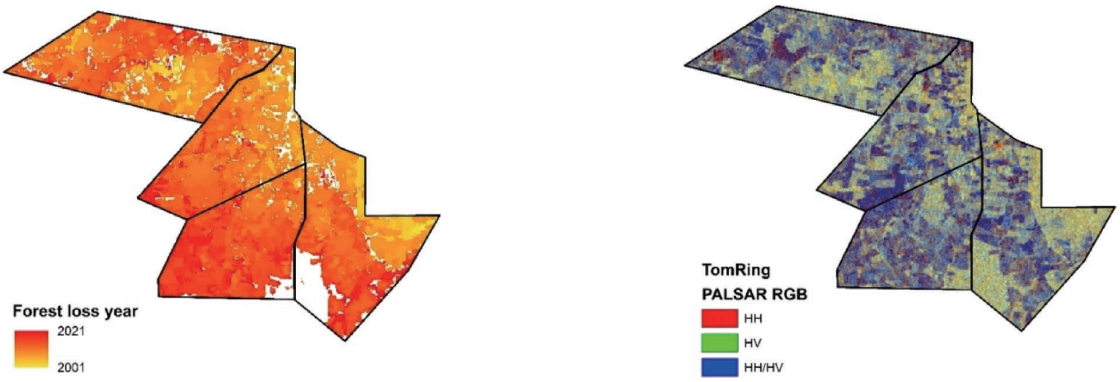



**Figure 1. Community forest areas with boundary and deforested areas highlighted in red.**

**Table 2. Forest gain in community forestry sites**

| Name | Forest Gain % | Area in ha | commune | district |
|---|---|---|---|---|
| Sala Chpor | 14 | 1,006 | Sala Visai | Prasat Ballang |
| Prey O Ta Kros | 20 | 569 | Tipor | Santuk |
| Tropang Prey | 28 | 162 | Chhok | Prasat Sambor |
| Prey Bos Srey Pouv | 33 | 128 | Tipor | Santuk |
| Bos Yeay Nheb | 24 | 111 | Sala Visai | Brasath Ballang |




(a) Forest lost year　　(b) ALOS PALSAR false color composite

**Figure 2. Tomring commune with (a) Hansen Global Forest Cover map showing temporal changes in forest area, and (b) ALOS PALSAR RGB composite of HH, HV and HH/HV polarization band composite.**

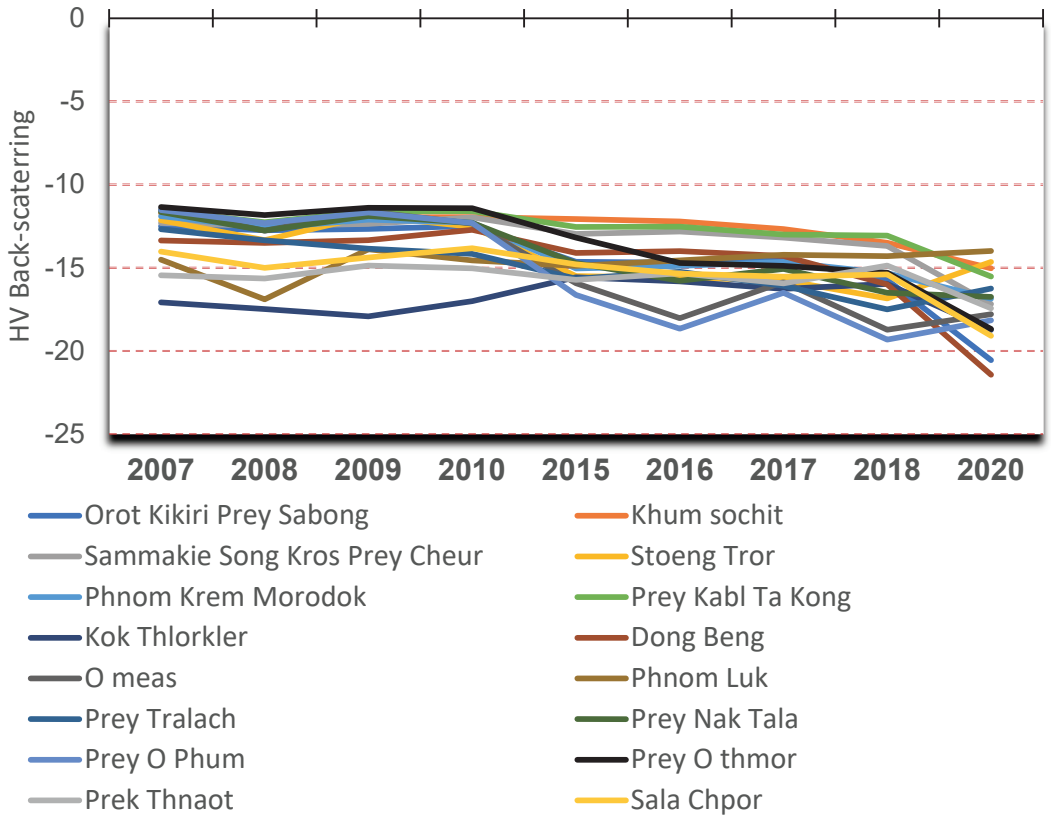



**Figure 3. Temporal changes in average HV polarization band values of 16 affected deforested areas.**

this study, we used yearly PALSAR HV polarization data to detect any change in backscattering values. Figure 3 is the mean HV backscattering of 16 community forest areas in this study. All show a gradual drop in values since 2007. This supports the Hansen Global Forest Cover data on deforestation in Cambodian forests.

We also retrieved 3 m spatial resolution PlanetScope images of 2017 and 2022 to validate the results (figure 4). From these images, the forest cover change is clearly noticeable and it matches with Hansen GFC data and ALOS PALSAR

(a) TomRing in 2017　　(b) TomRing in 2022

**Figure 4. High resolution (3 m) PlanetScope data of Tomring, captured on (a) 8th January 2017 and (b) 2nd January 2022.**

**Figure 5. Community survey data collected during the field trip to Kach Pka commune.**

RGB (HH, HV, HH/HV polarization) images.

From the above analysis, it is understood that Cambodian community forests have likely gone through continuous deforestation in the last 2 decades. The mentioned 16 areas (Table 1 and Figure 1) have shown the highest forest cover change, while only a few (Table 2) have shown positive growth which was expected. The likely reason for deforestation is agricultural land expansion. Many areas were seen with agricultural activities taking over forest areas, eventually causing deforestation. Tomring commune's southern part is one of the regions which underwent such changes and it is evident through analyzed data. Stricter measures are expected to be implemented for meeting the targets of the REDD＋program.

**Community survey**

We conducted a community survey in Kach Pka community forestry (Figure 5). It is located in Battambang province, Cambodia, covers Rung, Chumnab Korki, Chumnab Sbov Plaing, and Prorlay-18 villages, Sdock Proveuk commune, and Rukkiri district. Established in 2005 by an NGO, it involves around 1000 households, protecting approximately 1000 hectares out of a total area of 1300 hectares. However, 300 hectares of forest

have been lost due to poor protection. Illegal activities like deforestation, land invasion, and rock excavation have been observed. A community committee of 16 members, including a chief, deputy chiefs, and a financier, manages the area and restricts access. Despite resource and budget limitations, the committee receives support from local government and NGOs through training and aid. The study highlights the benefits of community forestry, including forest conservation, climate change mitigation, and livelihood improvement. It contributes to understanding the success of community forestry projects, enhancing forest resilience, and achieving Sustainable Development Goals (SDGs) and REDD＋.

## 2. 発表（研究成果の発表）

1. Louw, A. S., Fu, J., Raut, A., Zulhilmi, A., Yao, S., McAlinn, M., ... & **Avtar, R.** (2022). The role of remote sensing during a global disaster: COVID-19 pandemic as case study. *Remote Sensing Applications: Society and Environment*, 100789.
2. **Avtar, R.**, Rinamalo, A. V., Umarhadi, D. A., Gupta, A., Khedher, K. M., Yunus, A. P., ... & Sakti, A. D. (2022). Land Use Change and Prediction for Valuating Carbon Sequestration in Viti Levu Island, Fiji. *Land*, *11*(8), 1274.
3. Islam, J., Sarkar, P. P., Rahman, A., & **Avtar, R.** (2022). Forest Resource Scenario in Industrial Town: A Study of Asansol-Durgapur Region. In *Conservation, Management and Monitoring of Forest Resources in India* (pp. 163–190). Springer, Cham.
4. Nabin Bhattarai, Bhaskar Karky, Saurva Pradhananga, Rajesh Bahadur Thapa, Ranjit Singh Rawat, Teiji Watanabe, **Ram Avtar** (2022) Are countries ready for REDD＋ payments? Armoring REDD＋readiness in Bhutan, India, Myanmar, and Nepal. Sustainable Mountain Development Conference, Chandragiri Hills, Kathmandu, Nepal, December 1–3, 2022.
5. **Ram Avtar**, Chen Xinyu, Ankita Gupta, Fu jinjin, Ali Kharrazi (2022) Using multi-seasonal UAV data and machine learning algorithms to identify tree species. Sustainable Mountain Development Conference, Chandragiri Hills, Kathmandu, Nepal, December 1–3, 2022.