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Chapter 13
Community monitoring of illegal logging and forest resources using smartphones and the Prey Lang application in Cambodia
Ida Theilade, Søren Brofeldt, Nerea Turreira-García and Dimitris Argyriou

Highlights

• Indigenous and local people are increasingly recognised as playing an important role in the global environmental science policy arena. Participatory environmental monitoring is promoted as a cost-effective approach to collect and report data on environmental trends and support decision making while providing social co-benefits to local people.

• The use of geographic citizen science applications for data collection has opened up new opportunities for communities wishing to engage in environmental monitoring. While geographic citizen science applications assist in data collection and analysis, the use of technology may present a barrier to broad community involvement.

• Using a geographic citizen science tool to collect data on forest crimes and forest resources in Cambodia showed that community members could collect large amounts of geographic data regardless of their gender or age. The documentation facilitated advocacy and awareness-raising on social media and helped petition the government of Cambodia to protect Prey Lang forest officially.
1. Introduction

Tropical forests are home to a large proportion of the global terrestrial biodiversity, act as important carbon sinks helping to regulate the world’s climate and are essential to millions of livelihoods across the tropics. However, tropical forests remain under pressure from alternative land uses and unsustainable resource use (Hansen et al. 2013). Since the United Nations climate change conference (Conference of Parties or COP 14) in Poznan in December 2008, Reduced Emissions from Deforestation and Forest Degradation (REDD+) has been at the heart of the UN Framework Convention on Climate Change (UNFCCC) strategy for mitigating global climate change through the protection and expansion of forests as carbon reservoirs and sinks (UNFCCC 2010, Decision 1/CP.16). REDD+ was adopted by UNFCCC at COP 21 in Paris in 2015 (UNFCCC 2015, Decision 1/CP.17). Simply put, REDD+ provides funding and processes that pay for forest protection in developing countries by acknowledging their carbon capture capacities.

While various types of community-based monitoring of forests have proven effective at informing management decision at local levels ( Danielsen et al. 2010), the inclusion of community-based monitoring in the UNFCCC REDD+ strategy would require data collected by local stakeholders to inform global forest management policies (Boissière et al. 2017). A key question is how to standardise data collection so that it can feed into monitoring at national and international levels.

The Intergovernmental Panel on Climate Change (IPCC) guidelines require the use of activity data (changes in extent of areas affected) and emission factors (changes in carbon stock within areas) to estimate emissions at a national level (Herold et al. 2011). Remote sensing is increasingly used but requires calibration by on-the-ground monitoring of emission activities (IPCC 2006, 4) such as forest inventories. While several types of emission activities from forests are described by the IPCC, such as forest fires and carbon stock changes in dead organic matter and mineral soils, illegal logging and illegal conversion of forest will be the emission activities addressed in this chapter. Local people’s involvement in this monitoring of illegal activities has faced a number of obstacles, including: concerns of impartiality, as local people often rely on harvesting of forest products for their livelihoods (Kanninen et al. 2007); questions about local people’s authority to engage in law enforcement (Klooster 2000; Kaimowitz 2003); and opposition from local regulatory institutions and forestry officials (Glastra 1999; Tacconi, Mahanty and Suich 2013;
Most importantly, individual community members potentially run a personal risk (Global Witness 2016) when monitoring the extraction of contested resources or using monitoring as a tool for advocating local forest rights (Tacconi, Mahanty and Suich 2013). As a result, no coherent body of literature exists on locally based monitoring of emission activities, but a number of studies have included documentation of illegal extraction activities in community-based monitoring of forest resources (Clarke, Reed and Shrestha 1993; McCall, Chutz and Skutsch 2016).

Here, we present a case study of how a local community network use smartphones and a geographic citizen science application to monitor and report illegal logging and illegal conversion of forest in Cambodia.

2. Collective action and self-governance in the protection of Cambodia’s forests

This case study is based on the initiative of the Prey Lang Community Network (PLCN) – a network of villagers, mainly farmers with little or no formal education, who patrol their ancestral forests in the Central Plains of Cambodia. Formed in the early 2000s, as a response to rampant illegal logging, the PLCN was part of a wider network of community groups across the country coined the natural resources protection groups. The PLCN conducted regular forest patrols to protect Prey Lang from illegal logging and poaching. It worked successfully until 2012 when the founder and leader of the natural resources protection groups, Chut Wutty, was murdered while on a trip to document illegal logging. Hereafter, most villages worked in isolation, reports on illegal activities were often lost and the patrols had limited impact.

In 2014, an innovative partnership was formed between an international non-governmental organisation (NGO), Danmission, the University of Copenhagen, a local IT company, the PLCN and two local NGOs, namely Peacebridges Organisation (PBO) and the Community Peace-Building Network (CPN). The project was named ‘It’s Our Forest Too’ after the Prey Lang, which means ‘our forest’ in the local language. The aim of the project was to engage vulnerable communities in peaceful dialogue for forest protection in Cambodia. One of the unique features of the project was to develop a specially designed geographic citizen science application for smartphones for communities to collect documentation about resources and illegal logging in Prey Lang forest. In February 2015, a PhD student taught more than 100 villagers from the PLCN how to use the Prey Lang application.
The forest patrols remain a central feature of the project. The patrols consist of 15–20 people on motorbikes, covering various sections of the Prey Lang forest. Illegally cut timber is seized and often burned on the site. Logging equipment is confiscated and turned over to the authorities upon completion of the patrol. Offenders are questioned, and reports, including fingerprints of the offenders, are filed and sent to authorities. As part of the ‘It’s Our Forest Too’ project, all patrol members have been trained in non-violence, peaceful methods and conflict resolution following the theory and methods of Galtung (1996). Usually, the PLCN invite apprehended offenders to share a meal. Only after befriending the loggers, many of whom are poor villagers paid off to harvest timber, will the PLCN question the offenders and try to establish links to the kingpins behind the logging. Finally, PLCN members ask the offenders to sign a statement not to return to Prey Lang.

Currently, the PLCN is not formally recognised by the Cambodian government and has no official rule enforcement or sanctioning power. In May 2016, after the PLCN had petitioned the government to protect Prey Lang for 10 years, 432,000 ha of Prey Lang was declared a Wildlife Sanctuary (Figure 13.1). At the same time, the government started to draft a new national environmental legislation, the environmental code, which allows for greater participation of local and indigenous peoples in the management of the country’s protected areas.

2.1 Forest-dependent communities in Prey Lang

Cambodia has one of the world’s highest national deforestation rates (Hansen et al. 2013), mainly driven by large-scale acquisitions of land for agro-industrial purposes, primarily in the form of economic land concessions and mining concessions (Jiao, Smith-Hall and Theilade 2015; Work and Thuon 2017). These have led to large-scale agricultural conversion of forest land and extensive illegal logging operations outside the borders of the officially granted concession areas, which are in conflict with the land law, forestry law and the law on protected areas. Prey Lang forest holds great ecological (Theilade et al. 2011), economic (Jiao, Smith-Hall and Theilade 2015; Hüls-Dyrmose et al. 2017) and cultural (Turreirea-Garcia et al. 2017) value. Roughly 250,000 people live within the vicinity of Prey Lang, most of whom rely directly on the forest for their livelihoods. Hence, resin extraction from dipterocarp trees is the main source of cash income for many (Hüls-Dyrmose et al. 2017). Prey Lang is also a source of medicines, food, building materials and firewood. Access to natural resources is customary and without official property rights.
The predominant ethnic groups are Kuy (indigenous) and Khmer. In Prey Lang, both ethnic groups practice animism and are culturally and spiritually linked to their forests (Turreira-García et al. 2018).

3. Participatory design and development of the Prey Lang application

In August 2014, a five-day initiation workshop was held with partner organisations including 34 participants, selected by the PLCN, from all four Cambodian provinces in which the PLCN operates. The overall aim of the smartphone-based monitoring programme was discussed in a series of focus group discussions. Participatory mapping on printed land use maps was employed to identify forest areas perceived as important and frequently used by communities. Participants were then asked to list the resources and activities they wanted to monitor and to rank these using
cardboard cards. Finally, resources and activities were grouped into categories to guide the design of the geographic citizen science application. It was agreed that the PLCN would have ownership of all produced geographic data, and that no data could be shared without their permission.

A smartphone app based on the Sapelli platform (Stevens et al. 2014) was chosen, as it was developed specifically for use by local people with limited experience in interacting with technology. The backend of the application was modified by a local IT company based on the PLCN’s input during the workshop and its feedback on a first prototype decision tree, which was presented on the last day of the workshop (Brofeldt et al. 2018).

The Prey Lang application compiled three types of information: (1) reference data: as soon as a new data point was created, metadata, including time and date, Global Positioning System coordinates and phone ID, were automatically attached to the observation; (2) primary documentation: upon establishment of a new data point, the patroller documented the observation with a photo and an optional audio recording using the smartphone’s built-in camera and recorder; and (3) thematic tag: the patroller tagged the observation using a decision tree with three main categories: resources, illegal activities and reporting to authorities (Brofeldt et al. 2018). Each main category had a limited number of preset subcategories such as trees, animals, forest products and sacred places for the resources category; and logging, conversion of forest for plantations and mines, illegal hunting and illegal fishing for the category on illegal activities.

After the registration of new geographic observations in the field, the data points were automatically uploaded to an online database via the cell phone network. Next, the data were cleaned manually by a database manager in order to remove incomplete, irrelevant and duplicate entries. When the reference data, primary documentation (photo and optional audio recording) and the thematic tag were uploaded correctly, the entry was validated. Additionally, data points that were clearly tagged incorrectly were corrected if possible (e.g. an animal tagged as a plant), and the entry was post-validated. Entries could be excluded due to human and technical errors or lack of relevance.

The first version of the Prey Lang application (Version 1) initially had the possibility of recording: activities such as different kinds of illegal logging, illegal mining, illegal hunting and so on; resources that were considered valuable to the end users such as resin trees, other luxury trees, non-timber forest products and animals; and interactions with government officials at the local and national level and company officials. It was designed to collect quantitative information on a limited number of
activities, resources and interactions to minimise complexity and to encourage systematic use during patrolling. Categories in the decision tree were all illustrated by drawings to allow participants with low literacy to navigate the application more easily (Figure 13.2).

Version 1 of the Prey Lang application was tested by a group of 40 PLCN members using 20 Samsung Galaxy devices during a seven-day field trial in December 2014. The participants agreed that Version 1 was too limited in scope, and there was a strong wish to be able to document more categories of forest resources and illegal activities and to be able to give qualitative descriptions of interactions with illegal loggers and authorities. This input was used to inform the design of an updated version (Version 2) of the Prey Lang application, developed in January 2015. The following functionality was added: one-push audio recording option (for documentation using qualitative description); multiple photo recording option (for documentation using more photos for one event); drop-down menus (for decision tree navigation); and free writing (for decision tree navigation).

Data collection using Version 2, running on 36 Samsung Galaxy devices, began in February 2015. Version 2 of the Prey Lang application was in service for 11 months, during which the PLCN continually discussed needs and operational challenges between themselves during patrols and at the quarterly PLCN committee meetings. The feedback was delivered to the project holders by a project officer who took part in patrols and the committee meetings. Requests included the addition of new secondary thematic tags (categories) to allow documentation of activities that did not fit the primary thematic tags, such as whether illegal timber was recorded as planks or stumps. The users also requested that some of the tiers of thematic tags were extended in order to include more information. Finally, they felt that the categories of plants and animals were too broad, and stated that they wished to record species names. The feedback was used to develop Version 3 of the Prey Lang application, which became operational in December 2015. This version featured a significantly extended decision tree as well as some bug fixes. A number of thematic tags were extended to include more tiers. For example, the thematic tag ‘NTFPs’ (non-timber forest products) was extended to include types of NTFPs (edible wild plants, construction and medicine). Likewise, the thematic tag ‘transport’ was extended to include information on how illegal timber was transported. Optional scroll-down menus with vernacular names of plant and animal resources were added. This was the first interface where literacy was required to operate the application.
Fig. 13.2 Interface of the Prey Lang app, showing the opening page, interface for taking photos, interface for recording an audio and the visual representations of the three main categories documented by the app (upper row). The red squares indicate selection of a category (here illegal activities). The lower row of interfaces shows a sequence of the next four points in the decision tree: illegal logging, logging of single tree/stump, offender was a foreigner and patrol member interacted with offender. Credit: Prey Lang data-collection app by Prey Lang Community Network (PLCN).
Version 3 operated for seven months until the release of Version 4 in August 2016. Version 4 did not change the geographic citizen science application itself, but rather added extra functionality requested by PLCN members to enhance their experience. It provided end users with the ability to see their own records, the justification if some of their entries were excluded and an overview of the total number of records in their province. Due to budget restraints, it was not possible to introduce these improvements in the geographic citizen science mobile app. Instead, the options were offered in a browser mode. Unfortunately, lack of technological experience and illiteracy made the new function difficult for PLCN members to use. The guiding principle for all Prey Lang application updates was to fit the design of the application more closely to the needs of the PLCN (documentation of their most valuable forest resources and illegal activities). On the release of every new version, one- to two-day refresher training was conducted in each province to familiarise PLCN patrollers with added functionality.

4. Use of the Prey Lang application to document illegal logging and forest resources

A total of 30 male and 6 female PLCN patrol members, ranging from 18 to 61 years of age, used the application in the two-year period from 2015 to 2017. They were selected by the PLCN based on volunteerism and experience with either patrolling or using smartphones. The PLCN members collected the data with the Prey Lang application during existing patrolling activities. These included regular and ad hoc local forest patrols in response to rumours of illegal activities, multiple times every month, and large-scale patrols, covering the Prey Lang core area, three to four times per year.

The primary objective of patrols was to discourage illegal logging by confiscating logging equipment and turning it over to the authorities, along with reports of recorded incidents (Figure 13.3).

Members of the PLCN made 10,842 entries of data on forest resources and illegal logging over the 24-month period. A total of 4,560 entries (42 per cent) were successfully validated by the external data managers, whereas 4,979 entries (46 per cent) were excluded due to technical errors and 1,303 entries (12 per cent) were excluded due to human error. Lack of mobile coverage leading to missing geographic coordinates or photo documentation was by far the biggest obstacle.
Data recorded with the Prey Lang application during patrols were compiled in biannual monitoring reports by a data manager and students from the University of Copenhagen. The data were published in both English and Khmer, and presented to the general public by PLCN members at press conferences held in Phnom Penh supporting the PLCN’s overall advocacy strategy for the protection of Prey Lang.

In January 2017, 24 Prey Lang application users attended a two-day evaluation of the application, and provided input for the development of Version 5 (released in August 2017). The evaluation was conducted using individual questionnaires featuring open-ended questions on experiences that users had in working with the Prey Lang application and participating in the monitoring programme. This was followed by a mediated plenum discussion of the questionnaire results and formulation of recommendations for the Version 5 design (Brofeldt et al. 2018).

Most patrollers (80 per cent) felt that they understood the Prey Lang application and that they were able to use it correctly. Patrollers mentioned
challenges associated with learning how to use new functionality added in Versions 3 and 4 in a plenum discussion. About half of the patrollers said that it took them a few failed attempts to navigate the updated decision tree and to use the drop-down menus with local names of trees, animals and resources added in Version 3. They concluded that the new application versions probably led to them uploading some erroneous entries in the first months following release, but all except two users felt that they learned how to use the updated version after that.

Users were asked to free-list challenges encountered and priorities for future Prey Lang application development. Half of the patrollers specifically mentioned problems with uploading data as a key concern. The problems with uploading photos and coordinates were partly fixed in Version 4 by lowering file sizes. Yet, patrollers all mentioned the scarcity of areas with stable mobile phone connection in the provinces as a major cause of this, with one stating, ‘It is not possible to get a signal in my village and I have to travel to Thala Barivat in Stung Treng Province to get a signal strong enough to upload my data. Therefore, my phone memory is often full’. Lack of mobile coverage leading to missing geographic coordinates or photo documentation remains the single largest problem for the efficiency of the Prey Lang application to date.

4.1 Patrollers’ ability to use the smartphone app

In a response to the users’ wishes, the complexity of the Prey Lang application, measured as the number of unique end points in the decision tree, became greater with each new version. However, the proportion of submitted entries that were successfully validated increased over time as well, probably due to the introduction of the thematic tags that guided users making an entry. The number of entries that were excluded because of technical errors decreased with the smaller size of photo files in Version 3. However, technical errors remained high at around 40 per cent in Versions 3 and 4, mainly due to problems with mobile coverage in remote areas of Prey Lang that led to missing coordinates and photos.

One third of the patrollers expressed a wish to have access to more functions, including the ability to take videos (in addition to photos and audio recordings), availability of maps to see areas of previous patrols and satellite imagery to see areas of recent forest loss. A few patrollers also requested more species to be added to the drop-down menus to allow for more precision in monitoring of plants and animals. However, the drop-down menus require the user to type first letters of a species and then select the right species from the list provided in writing. This fea-
ture was challenging for less literate users and users with poor eyesight. Hence, two patrollers mentioned that ‘the app (Version 4) had become too complex and the introduction of drop-down menus to add specific names for trees, animals and resources was the function that was most difficult to use’.

4.2 Age and sex

Older people tended to submit more entries than younger people, and men generally submitted more entries than women. We found no significant differences in the proportion of validated entries produced between sex and age groups. A few patrollers in the 36–51 years age group had particularly high validation percentages, but the age group as a whole did not perform significantly better than the 19–24 years reference age group.

4.3 Cost

The cost of developing and maintaining the Prey Lang application, including database management and reporting for the first two years of monitoring, was about US$136,500. This is equal to US$0.26/ha monitored/year and about US$30 per validated entry. Approximately one third of the total cost was spent by the PLCN and local partners on patrols and meetings (c. US$51,000), one third by the University of Copenhagen on training, data management and reporting (c. US$45,000) and one-third by the IT company that developed the software (c. US$40,000). Many of the costs of operating the monitoring programme were borne by the PLCN members who volunteered their time on patrols, at meetings and for coordination of activities. These costs are not included in the cost calculations.

4.4 Obstacles

During the commune election period in 2017, the government instituted new regulations to control civil society. The result of the commune elections was a major blow to the ruling party. Three months later, the government initiated a crackdown on the opposition, civil society and independent media.

The shrinking civil space has affected the PLCN in a number of ways. The PLCN is now required to seek permits from the Ministry of Environment (MoE) before undertaking patrols, and the new regulations stipulate that rangers from the MoE must be part of the patrols. The permit
system has made the organisation of patrols more difficult, and there is a
general feeling among PLCN members that the MoE tips off loggers ahead
of planned patrols.

The PLCN has responded by seeking permits and collaborating with
MoE rangers in the hope that a dialogue and common patrols would fur-
ther encourage authorities to enforce the forest law. At the same time,
the PLCN has continued ‘surprise’ patrols without contacting the MoE
ahead of the patrols or only contacting rangers with short notice. Gener-
ally, more illegal logging operations were found when authorities were
not forewarned. In some parts of Prey Lang, the PLCN has good coopera-
tion with the forest rangers, while in other parts, cooperation is limited,
as rangers are directly or indirectly involved in illegal logging.

Hence, the full potential of ICT in forest monitoring is primarily
restricted due to the government failing to provide an enabling environ-
ment. Second, mobile coverage was a problem in some of the more remote
areas of Prey Lang, which led to many incomplete entries. Other errors
were due to bugs in the software of the Prey Lang application, mainly
relating to problems of uploading photos and missing coordinates. Finally,
a relatively small amount of entries had to be excluded due to human
error.

5. Conclusion

We found that local communities were able to produce large amounts of
data on forest crimes and important forest resources using a
smartphone app. They did this at a cost that was only slightly higher than
costs in previous community monitoring programmes that did not use
any technology. Over the course of the two-year period, the complexity
of the smartphone app increased considerably, but this did not negatively
impact the quality of data produced. Instead, the data quality increased,
as the patrol members gained more experience in using the Prey Lang
application. Moreover, it emerged that women and elders were at least as
capable of using the application as young men.

We believe that the success of the Prey Lang application is to a large
extent due to profound local involvement in the design of the geographic
citizen science application, as well as in the planning and execution of
the monitoring activities. Other studies have also shown that it is funda-
mentally important to incorporate local knowledge alongside objectives
and priorities stemming from experience with the existing forest patrol-
ling into the design of the monitoring system (Berkes, Colding and Folke 2000; Ens 2012).

The use of a geographic citizen science application increased the reliance on external support for development and maintenance of the application and provision of smartphones, which over time may compromise the sustainability of the community-based monitoring programme. However, if the PLCN become formally recognised by the government of Cambodia as co-managers of the Prey Lang Wildlife Sanctuary, the Prey Lang application would be an important asset helping communities and the MoE to collect and analyse large amounts of forest data that can help inform management decisions.

In 2018, new functionality was added to the Prey Lang application, in collaboration with the international NGO Article 19, which allowed patrol members to report threats, harassment and criminalisation of the users. This is part of an international effort to protect environmental defenders, often indigenous peoples, who are increasingly targeted by governments and agro-businesses when defending their land. A female patroller explained, ‘Before I used to receive threats from authorities and loggers after every patrol. The Prey Lang application has improved our safety as offenders know that we may document their threats and report them’.

PLCN members have also expressed a wish to be able to download satellite imagery showing forest loss and added functionality that would allow them to navigate to coordinates of recent tree loss. The ability to download near real-time maps may be populated with GLAD Alerts provided by the Global Forest Watch or near real-time maps generated by the Joint Research Centre of the European Commission and automatically pushed to the patrollers’ smartphones. Such new functionality may improve the efficiency of the patrols to intercept illegal logging and mining operations in order to protect Prey Lang forest from further degradation.

6. Lessons learned

• Local forest networks have the capacity to collect information on illegal logging and forest resources using geographic citizen science applications.
• It is essential to incorporate local knowledge, objectives and priorities into the design of the geographic citizen science applications used to monitor the environment.
• Simple visual interface is key. Thematic tags should be used to structure data collection and make navigation easy throughout the geographic citizen science application.

• Clear ownership of the data and the geographic citizen science application was critical to the communities that collected the data and in turn increased the sense of responsibility and the quality of the data produced.

• The complexity of the geographic citizen science application did not affect the ability of community patrollers to use the tool.

• The use of a geographic citizen science application in monitoring did not preclude the participation of women and elders. Further, sex and age did not affect users’ capabilities in collecting quality data.

• The costs of development and implementation of a geographic citizen science application for monitoring of forest crimes was significantly less than monitoring by professional forest rangers.

• Data collection using a geographic citizen science application facilitated use of results in advocacy, on social media and to petition relevant authorities in the government.

• Community-led monitoring programmes using smartphones may be highly valuable for environmental protection across the tropics and for global conservation and climate-change mitigation efforts.

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Geographic Citizen Science Design

No one left behind

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