TECHNISCHE UNIVERSITÄT DRESDEN

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ENABLING EFFECTIVE COMMUNITY FORESTRY THROUGH A NATIONAL CO-MANAGEMENT PROGRAM: THE CASE OF THAILAND'S COMMUNITY FORESTRY PROGRAM

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To achieve the academic degree

DOCTOR RERUM SILVATICARUM (DR. RER. SILV.)

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Submitted on: 17 August 2021

Defended on: 7 March 2022

Declaration of Conformity

I hereby confirm the accordance of this copy with the original dissertation on the topic:

“Enabling Effective Community Forestry through a National Co-Management Program: The Case of Thailand’s Community Forestry Program”

Dresden, 03.06.2022

Michael Jenke

ACKNOWLEDGEMENTS

I owe a great deal of gratitude to my supervisor Prof. Jürgen Pretzsch who guided me through this journey over a great geographical distance. I thank my dissertation committee, Prof. Uta Berger and Prof. Yongyut Trisurat, for their valuable comments and suggestions.

Thanks to all the people at Kasetsart University who made me feel welcomed in Bangkok. Thank you to Dr. Surin Onprom for his support. I would like to offer special thanks to Assoc. Prof. Dr. Monton Jamroenprucksa, who, although no longer with us, continues to inspire the scientific pursuit of sustainable development.

I would like to thank my office mates, Tina, Sri, and Tham, who made my time in Tharandt very pleasant. To my fellow investigator of the Thai forestry sector, Marcel, thank you very much for helping me during the last stretch.

I thank the German Academic Exchange Service (DAAD) who helped with a one-year scholarship to conduct my initial fieldwork in Thailand. Thank you to the National Research Council of Thailand (NRCT) for approving my fieldwork and facilitating the visa application process. Thanks to the Royal Forest Department for kindly providing access to their digital maps and database. I am indebted to all respondents from around Thailand who agreed to participate in this study and without whose support this research would not have been possible.

To Aor, my beloved wife, together we can do anything. Thank you for being my partner in everything. To Till, who patiently accompanied me during most of my studies and kept cheering me on to finish my "homework" too. To my parents and grandparents, who enabled me to achieve this and were always there when I needed their help.

SUMMARY

Rural communities have engaged in the governance and management of forest resources by developing institutions that prevent overexploitation of common-pool resources and maintain the basis of their livelihoods. Effective community forestry relies on several conditions, including secure tenure rights, an enabling regulatory framework, strong governance, and sufficient knowledge. Worldwide, customary community forests have gained legal recognition in the wake of tenure reforms with the expectation that this formalization would enhance tenure security. In Thailand, the Royal Forest Department (RFD) began in 2000 to legally recognize community forests and share formal rights and responsibilities with communities through a national co-management program. This program was further expanded to support the development of community forest networks. The RFD could not provide extension services to approximately 10,000 community forests and aimed to improve the information sharing among communities.

The objective of this dissertation was to investigate whether both program elements, i.e. forest tenure formalization and community forest networking, could provide better conditions for community forests. It was of particular interest whether the formalization could enhance the security of tenure rights, which could affect the willingness of communities to invest in forest conservation. The intervention to enhance inter-communal networks is of particular relevance for the international community due to its uniqueness.

A diverse set of methodological approaches was required to address each objective. A quasi-experimental design was used to analyze the effect of community forest management on deforestation and the impact of the subsequent formalization based on statistical matching and panel data analyses. Comparative case studies were investigated subsequently to better understand the relationships between formalization, tenure security, forest-related conflicts, and deforestation. Social network modeling was used to analyze how networking organizations affected the flow of information between communities.

The findings indicated that community in Thailand have effectively protected their forests even before receiving legal recognition. The formalization procedure has improved the relationship between communities and RFD officials but it has not enhanced their ability to prevent forest encroachment as support from the State has been insufficient in the case of tenure conflicts. In the absence of state-led extension services, established networking organizations enabled

communities to provide mutual support as indicated by the enhanced inter-communal flow of information on a provincial level. However, networking organizations still depended on external funding and support during their initial establishment.

The co-sharing of forest tenure rights and responsibilities between communities and the RFD might have helped to build trust and acceptance. This study has, however, confirmed that formalization can only provide limited benefits to forest-managing communities if they remain unprotected from forest encroachment because their formal tenure rights are not being enforced. Thus, communities might become disillusioned if their rights are not protected against more powerful actors. The community forest networks have the potential to increase the political influence of these communities while also enhancing their capacity to share and develop new knowledge. However, communities require more financial resources as their responsibilities increase while their ability to generate financial returns remains legally limited. Thus, the regulatory framework can be changed to balance communal rights and responsibilities or expanded by developing financing mechanisms to fund community-based conservation activities, such as forest patrols and fire prevention measures.

Keywords: Community forestry; Thailand; Tenure formalization; Tenure security; Forest conservation; Inter-organizational networks

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1 ENABLING EFFECTIVE COMMUNITY FORESTRY

Governments have increasingly shared or transferred rights and responsibilities over forestland to local institutions through the process of devolution (White & Martin 2002; Bixler 2014). These forest management systems are known under the general term 'community forestry' but can be also called collaborative forest management or participatory forest management (FAO 2010). Community forestry relies on the involvement of local forest users in decision-making processes concerning land use and their right to access and benefit from forest resources (Baynes et al. 2015). In many areas, community forestry has been a well-established form of customary forest management which has become more tied to state authorities through these recent tenure reforms (Larson et al. 2010). Nowadays, state authorities around the world officially recognize community forest management on approximately 513 million ha (FAO 2010; RRI 2014), with an estimated half a billion people relying on community forests (Agrawal 2007). In this chapter, the potential benefits of community forestry will be outlined to subsequently discuss the factors that are required to enable their effective provision based on three seminal global studies (Pagdee et al. 2006; Baynes et al. 2015; Arts & De Koning 2017).

1.1 Potential outcomes of community forestry

The rapid disappearance and degradation of forests have revealed the limitations of top-down approaches and state-led forest conservation. Evidence has shown that community forestry can be more effective in preventing further deforestation compared to private or state-mandated forest management (Rasolofoson et al. 2015; Santika et al. 2017). The effectiveness of community-based forest conservation is generally portrayed as the result of a stronger sense of ownership among involved and benefiting forest users who are more motivated to contribute to sustainable practices (Lachapelle 2008). Consequently, community forestry is seen by many state authorities as a cost-effective forest conservation strategy given budget cuts and limited resources among state authorities. However, scholars stress that community forestry should be also seen as an approach to alleviate poverty among rural communities and to empower these communities (Maryudi et al. 2012). These outcomes are strongly tied to an intact forest

ecosystem that holds the potential for various ecosystem services, such as forest products, water, and climate regulation, as well as cultural services.

Community forestry permits local forest users the sustainable use of forest resources according to communal rules. Users generally extract edible forest products for subsistence use or to share among their neighbors helping to ensure food security and meet basic needs. This safe-net function can increase their resilience to unexpected shocks and has helped communities especially during the COVID-19 pandemic (RECOFTC 2020). However, a general critique is that rural communities are not permitted to commercialize forest resources and are, thus, barred from economic development opportunities (Sunderlin 2006). The commercialization and marketing of forest products could ensure a small but regular financial income through forest-based livelihoods (Rasolofoson et al. 2017). However, these discussions of economic outcomes generally focus on direct users and overlook the importance of regulative ecosystem services for farmers as the majority of rural communities are dependent on agriculture (Walker 2004). Thus, even if community members extract only small amounts of forest products, their agrarian livelihood can be still considered to be forest-dependent if it is enabled by regulative ecosystem services provided by local forests (Salam et al. 2006).

The devolution of management rights to communities empowers local forest users to have a relevant influence in the management of their surrounding forests (Charnley & Poe 2007). Their greater decision-making power enables community members to align forest management objectives with their livelihood strategies, be it timber production, the processing of non-timber forest products (NTFPs), or farming, by centering their management efforts on protective or provisioning ecosystem services. Communities gain the rights to access and control their forests and, thereby, implement their management objectives. Community forestry is an increasingly important form of forest management and has developed in response to concerns that centralized forest ownership in developing countries has failed to promote sustainable management (Irland 2008).

1.2 Conditions for effective community forestry

Mixed findings from a wide range of case studies have shown that community forestry was not always successful in providing these outcomes effectively (Maryudi et al. 2012). Subsequently, a framework of enabling settings was developed and refined by studying to what extent underlying conditions were associated with positive outcomes (Pagdee et al. 2006; FAO 2011;

Gilmour 2016). Legal and institutional frameworks should aim to create these conditions when implementing community forestry.

1.2.1 Secure tenure rights

Tenure rights, or property rights, are defined as social rules that govern how and to what extent benefits can be attained from a resource (Bromley 1993). Forest tenure is generally referred to as a bundle of rights that govern who is permitted to access, use, manage, exclude other users, and transfer these rights (Schlager & Ostrom 1992). For example, a community might hold the rights to access and extract a forest resource under certain conditions but is not involved in its management. Tenure generally specifies the right holder, the duration of a right, and the conditions that apply (Sunderlin et al. 2008; FAO 2010). These tenure rights can be provided based on customary arrangements at the local level. Tenure arrangements with the State are based on statutory laws and might contradict customary tenure rights (Riggs et al. 2016). The security of tenure rights is essential in ensuring community members that their investments in forest resources and the derived benefits are being acknowledged and protected by society (Arnot et al. 2011). Without secure tenure, communities are less motivated to protect forests for their long-term benefits and more likely to engage in unsustainable extraction practices (Pagdee et al. 2006; Larson et al.2010; Baynes et al. 2015; Cronkelton et al. 2017; Cuenca et al. 2018; Robinson et al. 2018).

1.2.2 Enabling regulatory framework

Community forestry is attractive for governments as they do not lose complete control over forests while permitting local people to participate in forest management (Cronkleton et al. 2012). Communities that engage in a tenure-sharing agreement with forest authorities are also required to fulfill certain responsibilities. Community members are required to prepare detailed management plans and conduct forest inventories (Cronkleton et al. 2012). Thus, the investment required by communities to satisfy regulatory requirements could outweigh the expected benefit streams (Mahanty et al. 2009; Virapongse 2010). Without adequate governmental support, these responsibilities can be bureaucratic hurdles that reduce the effectiveness of community forests and even discourage communities from investing in forest resources.

1.2.3 Supportive government

The sharing of rights and responsibilities with communities also requires a change in organizational culture among forest authorities (Kanel & Acharya 2008). However, government field officials might be reluctant to fully retreat from active forest management and engage in

assisting communal groups to manage forests according to local objectives (Paudel et al. 2008). Thus, the implementation of national community forestry frameworks depends on a supportive bureaucracy on the ground to be successful. The building of equitable relationships between the staff of forest authorities and local communities requires time and trust (Thompson et al. 2005). This process of exchange can help to enhance the compatibility of communal and bureaucratic cultures and institutions. Furthermore, the communal tenure rights remain insecure as long they are not only formalized but also enforced by local police and forest authorities in the face of encroachment.

1.2.4 Strong communal governance and cohesion

Community forestry is only as effective as the institutions that govern the rights and responsibilities of local forest users and regulate the management and use of forest resources (Charnley & Poe 2007). Community forests are frequently managed by executive committees that can be formed by elected representatives or traditional village leaders (Sekher 2001). The recognition of self-initiated forest institutions and organizations has been an effective approach to strengthen community forestry due to their adaptation to local conditions (Ribot 2002; Robinson et al. 2018). In contrast, the replacement of well-established traditional tenure regimes by externally-imposed institutions can reduce the effectiveness of community forestry (Shanmugaratnam 1996). For example, the implementation of a state-approved management plan could change existing customary forest rules (Johnson & Forsyth 2002). Thus, interventions that seek to alter local institutions need to consider the complexity of communal forest institutions and the potential of unintended consequences associated with their change as they can conflict with communal economies and social structures (Fisher 2014).

1.2.5 Technical skills and knowledge

Rural communities have developed local forest management systems based on local ecological knowledge of plant diversity and their respective uses, for example as herbal medicine. These management systems have been well-suited for the extensive extraction of forest products (Steele et al. 2015). However, new responsibilities and management objectives necessitate community members to develop new skills. First, a shift toward commercial forest utilization requires regular inventories and low-impact extraction methods to ensure sustainable use (Cedamon et al. 2017). It will particularly be challenging for communities to develop multifunctional systems that can balance timber production and ecosystem service provision as forest authorities were traditionally only experienced in large-scale industrial forestry (Gilmour

2016). Second, the active restoration and rehabilitation of degraded forests have been planned and managed by state officials and only involving local communities in their implementation (Colchester et al. 2003). Third, satellite-based navigation and detection of deforestation can improve the protection of forests and the effectiveness of patrolling (Niraula et al. 2013). These examples highlight the need for technical and silvicultural capacity-building within communal forest organizations.

1.3 Policy interventions in Asia's community forests

Community forestry has become a central part of forest management in most Asian countries. Although the specific models can range ranging from community groups to household-level forest management, there are commonalities found in Asia that are less prevalent in other regions. Generally, forests are managed or under the formal control of state authority. Community forest programs entail the devolution of management responsibilities to communal organizations. Their rights tend to be limited by the state resulting only in a partial devolution of tenure rights. This also means that communities are restricted from utilizing and marketing forest resources, particularly timber, in contrast to community forestry in Latin American countries (Medina et al. 2009; Cubbage et al. 2015). Moreover, many traditional forms of community forestry have existed before their official recognition through customary arrangements in parallel with statutory forest systems. However, not all community forests existed for generations but were initiated only in the 1970s and 1980s, for example in Nepal, Indonesia, India, and Thailand (Gilmour 2016).

Various policy interventions have been implemented by the central government but also civil society organizations (CSOs) to enhance the effectiveness of community forestry on either a national or local scale. Such interventions could be beneficial if they provide the previously outlined enabling conditions. State-led interventions have focused primarily on devolving or transferring formal tenure rights to rural communities. CSOs seek to empower forest-managing communities, for instance by forming associations and building networks (Barnes et al. 2016). In contrast, the private sector in Asian countries has been involved only to a very limited extent (Wong et al. 2020).

1.3.1 Formalization of tenure rights

Following the emergence of community forestry programs in Nepal, India, and the Philippines in the 1980s, governments in most of Asia have expanded community forestry, so that communities hold statutory tenure rights over 34% of forestland (Poffenberger 1990; Gilmour

2016). These governments generally plan for further allocating formal tenure rights to communities as large forest areas remain under state management. As a consequence, standardized programs and policies concerning community forestry have been formulated and implemented in the region (Wong et al. 2020). Nevertheless, unofficial agreements between communities and state authorities have existed in parallel to statutory laws but tolerating customary rights did not protect communities from legal actions. State-led tenure reforms have sought, among other goals, to formalize community forests on state-owned forestland to provide secure tenure by granting formal rights (RRI 2012; Blackman et al. 2017). A spatial overlapping of conflicting customary and statutory tenure arrangements can reduce the security of tenure rights (Myers et al. 2017). Thus, high tenure security arises from "clear, uncontested and enforced" rights (Larson 2012: 20). However, both the perceived certainty of tenure rights and their enforcement regardless of their formality affect tenure security (Van Gelder 2010). The mapping, recording, and documentation are seen as critical to officially involve local communities in the management of forest resources (Riggs et al. 2016). The legal recognition of customary tenure rights as part of statutory laws can enhance tenure security (Aggrawal et al. 2021).

State authorities in Asia tend to endorse co-management agreements to transfer certain tenure rights for a designated forest area and limited duration (Banjade et al. 2017; Nsita et al. 2017; Larson et al. 2019). This stands in contrast to other regions, such as Latin America, where full and permanent ownership rights were transferred to many indigenous communities by recognizing their customary tenure claims (Larson et al. 2010). Similar policies were only implemented to a limited extent in the Philippines and India (Dahal & Adhikari 2008). Instead, community forestry programs in Asia are built upon the temporary granting of usufruct rights over state-owned forests. In the course of these tenure reforms, state authorities have to shift their responsibilities toward facilitating communities in forest management. Beyond transferring rights, authorities have to protect and enforce communal rights against encroachment by outsiders and mediate in tenure conflicts if necessary.

Governments tend to see community forestry as an effective model for the restoration and conservation of degraded forests. Commercial forest utilization, particularly timber production, has been restricted unlike in Latin America. Concurrently, many Asian countries have implemented a logging ban or moratorium in natural forests (Brown et al. 2001). Nevertheless, the formation of formal communal organization and the preparation of management plans has been mandated as part of community forest programs (Klooster 2009). However, without

granting communities the legal rights for decision-making and an active role in forest management, a formalization of community forests might only lead to passive participation.

1.3.2 Networking among forest communities

Networking has been on the agenda of many community forestry initiatives to improve the communication between forest communities, government agencies, and CSOs, both local and international (Dupuits 2015). Arts & De Koning (2017) conclude that a "Community of Practice" can empower communities through communication, learning, and training relations with external forest professionals and, thereby, build trust-based networks to mitigate potential conflicts. Several inter-organizational networks emerged around the issue of community forestry between 1990 and 2000 but were mainly operating at the interface of national and international levels connecting governmental and non-governmental organizations (Colchester 2003). A critique was that these networks generally failed to establish strong relations with local communities that would enable two-way communication. Although Poffenberger (2006: 67) stated that "the emergence of community forestry networks is apparent in upland areas of Indonesia, Vietnam, Thailand and Cambodia", these networks remain informal, spatially confined, and underreported (Kurniasih et al. 2021).

In Nepal, the Federation of Community Forestry Users of Nepal (FECOFUN) has emerged as a national inter-communal network by joining smaller informal networks to connect approximately 14,500 communal forestry organizations (Ojha et al. 2007; Dahal et al. 2010). These smaller networks do not only help rural communities to address forestry-related issues at the local level but also to organize the marketing of forest products (Springate-Baginski et al. 2003). The FECOFUN was initiated in 1995 to strengthen the tenure rights of the growing number of state-recognized forest user organizations and to enhance their interconnectedness (Gautam et al. 2004). Its establishment was supported by donor organizations and District Forest Offices, who provided funding and support to organize initial meetings (Ojha et al. 2007). The development of this would unlikely be possible without the prior reinstatement of multi-party democracy in 1990 (Timsina 2003).

Community forestry networks have been established in other Asian countries as well but without reaching the level of formality and scale found in Nepal or Thailand. In the Cambodian Province of Kampong Thom, motivated forest users have organized across the Prey Lang Forest to engage in community-based forest monitoring autonomously to stop illegal logging and encroachment without strong external assistance. However, the local network remains small

and limited to highly dedicated members due to the threats and conflicts with loggers and state officials (Turreira-García et al. 2018). Correspondingly, Indonesian community forestry networks might have connected governmental organizations, local and international non-governmental organizations but failed to establish links to communal organizations due to the long history of the suppression of local initiatives (Colchester 2002).

2 JUSTIFICATION AND OBJECTIVES

Community forestry has been a central part of forest politics in Thailand since the 1980s. Forest policies have progressed through pressure from local people and CSOs from restrictive social forestry programs (1970s - 1980s), which focused on eviction and reforestation, toward a community forestry program in which customary practices are more accepted. In 2019, the Community Forest Bill was ratified after 30 years of legal disputes. Despite the absence of a national regulatory framework, the Royal Forest Department (RFD) engaged in an extensive formalization campaign resulting in the registration of 10,000 community forests between 2000 and 2020 (RFD 2021). Similar to other South-East Asian countries, access and management rights over state forestland have been devolved to local communities through a co-management agreement whereas land ownership and alienation rights remained ultimately with the state (Larson et al. 2010). Moreover, communities remain excluded from managing forests within protected areas – a fact which has been strongly criticized by rights activists. In addition to the formalization of community forests, the RFD supported the establishment of formal communal network committees in 2009. These organizations were tasked to engage forest communities and create networks to strengthen inter-communal information sharing.

The main objective of this dissertation was to evaluate to what extent Thailand's Community Forestry Program, specifically the two program elements, that is (1) the formalization of communal tenure rights and (2) the creation of network administrative organizations, could develop more enabling conditions for community forestry (Figure 2-1). The evaluation of each program element can fill a knowledge gap that is relevant for both Thai policy-makers and the international academic community. In the following section, the significance of each pathway for both local stakeholders and the global scientific community is outlined.

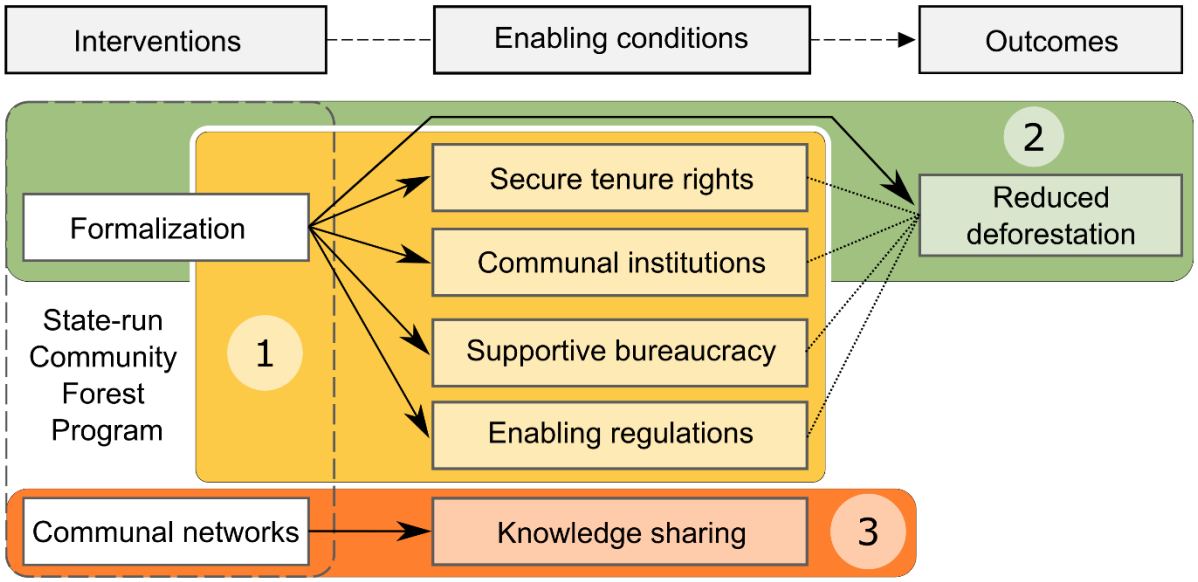


Figure 2-1: Conceptual framework of the dissertation indicating that each research objective aims to investigate whether state-led interventions could enable more effective community forestry

2.1 Impact of formalization on tenure security and local institutions

Community forestry has been governed by local, customary rules, which have not been recognized by state authorities or private investors resulting in tenure conflicts. Thus, their formalization has been promoted partly to increase the tenure security of local communities in the face of growing external pressures. Tenure security is determined by the tenure holder's perception or expectation of losing rights, i.e. 'how secure one feels that their rights will be upheld by those around them' (Kant & Berry 2005; Arnot et al. 2011). Thus, security should not be equated with the number of tenure rights a community holds. Due to its intangible nature, tenure security has remained ill-defined and could not be operationalized in many studies (Arnot et al. 2011). Although tenure security determines the success of community forestry, it remains unknown whether formalization programs can enhance it (Baynes et al. 2015). However, without secure forest tenure, communities would fear losing future benefits resulting in overexploitation and limited re-investment into the conservation and improvement of forest resources.

In Thailand, rural communities have been utilizing and conserving forests for several generations. In addition, other communities developed institutions to protect forests as a reaction to rampant deforestation caused by illegal logging and continued agricultural expansion (Virapongse 2017). Both, indigenous and self-initiated, forms of community forestry

operated under customary rules and were not legally recognized by the state but accepted by local forest officers through unofficial agreement (Sato 2003). Thus, the tenure of these forests remained insecure. Communities began to organize networks in the early 1990s to advocate for the legal recognition of community forests (Poffenberger 2006). Their objective was to strengthen the communities' forest tenure rights through official titles. Although the Community Forest Bill for which these networks advocated was not adopted, many of these community forests have been registered except those located within the boundaries of protected areas (Vandergeest 1996; Zurcher 2005). Each community had to organize a steering committee and develop a forest management plan, which had to be approved by RFD. However, it is unknown whether communities had to change the organization of their community forest following its registration.

Objective 1: To evaluate the contribution of community forest formalization toward the perception of tenure security among communities

2.2 Impact of registration on forest loss

Community forestry has been advocated with the expectation that it could prevent further deforestation by giving local people a greater voice in forest management (Charnley & Poe 2007). Furthermore, there are indications that the formalization of community forests is linked to lower rates of deforestation (Bray et al. 2008; Rasolofoson et al. 2015), likely due to the strengthening of communities' formal exclusion rights (Larson et al. 2010). Their efforts to reduce deforestation is not only of great relevance for the security of their livelihoods but also an important measure to mitigate several global crises, such as climate change (IPCC 2019), biodiversity loss (Alroy 2017), and the spread of novel infectious diseases (FAO 2020). However, establishing a valid causal relationship between the legal recognition of community-based forest management and deforestation is not straightforward. This relationship is potentially confounded by socio-economic and biophysical factors because both the location of community forests and the pattern of their legal recognition are not random (Agrawal & Chhatre 2006; Yin 2016).

In Thailand, many communities conserve watershed forests to maintain a steady water supply and as a source of non-timber forest products (Elliott et al. 2019). In support of a Community Forest Bill, CSOs argued that official recognition would give communities a greater incentive and the legal right to patrol and protect forests, whereas state authorities were accused of being unable to prevent further deforestation (Johnson & Forsyth 2002). In contrast, conservationist

groups opposed the Community Forest Bill as they doubted whether local people were able to manage forests sustainably and feared that the devolution of forest management rights would accelerate deforestation. These opponents of Thailand's community forest movement demanded strict forest conservation under state management through the expansion of existing protected areas and the relocation of residents (Makarabhirom 2000). As a result, community forestry within protected areas and steep watershed areas are not legally recognized and deemed illegal. Thus, empirical evidence about the effect of community forest formalization on deforestation could be of great value for decision-makers (Yin 2016).

Objective 2: To determine the impact of formalization on deforestation rates within community forests

2.3 Impact of network administration organization on information-sharing

The limited capacity of state authorities to fulfill their responsibility of enforcing forest conservation law has been one cause of continuing deforestation (Sodhi et al. 2010). Co-management arrangements enabled authorities to transfer tenure rights and the associated management responsibilities to communities, and thus reducing the public costs of forest conservation while retaining legal ownership (Colchester 1994). Communities might be eager to engage in forest conservation and carry the responsibilities but lack the technical knowledge. Correspondingly, the role of state authorities did shift from forest managers to communal facilitators (Kanel & Acharya 2008). This new role might be even more demanding and costly given the large number of communities, their relatively small forest areas, and the high transaction costs. One approach to solve this dilemma is to further delegate the responsibilities of capacity-building to communities through the establishment of communal networks (Soontornwong 2006). The institutionalized network enables communities to support each other by sharing information and resources, and develop locally adapted forest management systems. State authorities can focus their efforts on engaging with a designated group of communal coordinators who facilitate the formation of a community forest network.

In Thailand, many local community-based forest conservation initiatives were not developed by a single village but through collaborative networks of neighboring villages with shared interests over adjacent forest areas. These watershed management networks crossed village boundaries and connected ethnic groups (Kaosa-ard 2001). As communities began to campaign for their legal recognition, local networks joined to form regional advocacy networks, for example, the Northern Community Forest Network (Roberts 2016). Both local and national

networks were supported by CSOs, such as The Center for People and Forests (RECOFTC). In 2010, RFD's Office of Community Forestry began to support the formal establishment of provincial community forest networks (RFD 2012). Ten years later, institutionalized network organizations exist in most provinces. However, it remains unknown whether these network coordinators were able to facilitate the formation of networks, which go beyond local village clusters and connect distant communities to share information.

Objective 3: To analyze the influence of network administrators on the information exchange within community forest networks

3 THE HISTORY OF COMMUNITY-BASED FOREST MANAGEMENT MODELS IN THAILAND

Since 1967, Thailand's national policy-makers have implemented several social forestry programs with the common goal of preventing the further deforestation of state-owned forestland. These programs varied in their degree of local people's participation in planning and decision-making as well as the extent of tenure rights local people received. In parallel, many communities began to develop their forest management models, which were often based on traditional communal systems, despite the state's centralized control over forest management (Johnson & Forsyth 2002). With increased confidence and supported by a growing number of CSOs, these communities formed advocacy networks to influence the formulation of a new Community Forestry Act drafted in 1990. However, this law was never passed as conflicting views between conservationists and community activists could not be conciliated. Instead, the RFD used existing legislation to register established community forestry and granted limited land-use rights. After the Community Forest Act failed to become legislation, community-rights activists continued to advocate for land tenure reforms to communities located within forestland.

Although Thai forest politics have been reviewed, analyzed, and evaluate, a comprehensive overview of the organizational models employed in each program remains absent. The objective of this chapter is to present the historical development of Thailand's participatory forest policies at the national level. First, the national drivers that shaped Thailand's participatory forest policies since the establishment of RFD in 1896 were reviewed. Second, the organizational model implemented as part of each policy was analyzed.

This chapter sets off with the foundation of the RFD in 1896 as Thailand's first national forest policy and reviews the process of centralization, which occurred subsequently. The first form of participatory forest policy, the Forest Village Program, will be analyzed. Then, the history of state policies and local initiatives leading up to the discourse concerning the Community

Forest Act will be reviewed and RFD's current community forest program will be described in detail. Next, the most recent developments regarding the establishment of communal land titles will be outlined.

3.1 Expansion of state control over forestland

3.1.1 Centralization of forest control

Although Thailand, formerly known as Siam, was never colonized, almost all modern state institutions and legal systems were established under Western influence during the formation of the Thai nation-state (Vandergeest & Peluso 1995). Western concepts of governance were brought in either by members of the royal family, who were often educated abroad, or through the employment of foreign experts. In 1896, the RFD was established to transfer the control over teak forests in northern Thailand from local rulers to the central government (Pragtong & Thomas 1990). RFD's main task was to collect taxes on teak extraction mostly from foreign-based companies. Its first director was Herbert Slade, a British forester who formerly served in Burma. The Forest Act of 1941 formally declared all 'all land that does not belong to any individual by law' (Chapter 4 Section 1) as forest area, which is owned by the state (Sato 2000; Usher 2009). Thus, forests were classified regardless of the actual presence of a closed tree cover. Land under customary ownership, especially forests managed under traditional communal systems, was regarded as public land managed by the state. Moreover, all forms of land-use change were prohibited (Chapter 5 Section 54) making settlements nor the practice of agriculture in these areas illegal.

3.1.2 National Reserved Forest Act and National Park Act

In 1961, two national forest policies, the National Park Act and the National Reserve Forest Act, further cemented RFD's control over designated forestland (Roth 2004b). Forest reserves and protected areas were demarcated based on aerial surveys and, later on, satellite images. The legislation enabled the government to declare any land it deemed valuable to the public as reserved or as protected. Nowadays, 46.4% of Thailand's land cover is situated within the boundaries of national reserve forests (RFD 2020). Moreover, after centuries of expansion, 16.9% have been declared strictly protected areas prohibiting all forms of human presence (Figure 3-1). This extent of strictly protected areas is among the highest in the world and originated from the 'wilderness'-conservation concepts, which Thai policy-makers adopted from the North American national park system in the 1960s (Roth 2004b).

State-owned forestland, both reserved and protected, was expanded regardless of whether people were residing in these areas. Thus, many communities lived in and nearby these forests during the enactment of these laws in 1961. Moreover, the state's claim over forestland was initially not enforced so that farmers continued to migrate into these areas. It has been estimated that approximately 20–25 million people live in or near national forest reserves, and 1.2–2 million people live in and around protected areas (FAO 2009). Other surveys showed that 20% of forest reserves were occupied by people (Hirsch 1990; USAID 2011). As settlement and agriculture were prohibited, people's presence and agricultural livelihood base became illegal (NRF: Chapter 2 Section 14; NP: Chapter 3 Section 16). Thus, both legislations severely restricted the involvement of local communities in forest management and conservation. These people were labeled illegal squatters encroaching into forests and were in accordance with the law evicted by state authorities from their customary lands (NRF: Chapter 2 Section 25; NP: Chapter 2 Section 21 and 22). Consequently, many farmers living on forestland lack secure land tenure rights. Contradicting forest policies (sensu Wataru 2003) have been the underlying cause of tenure conflicts over trees and land within forest reserves (Cleary & Eaton 1996).

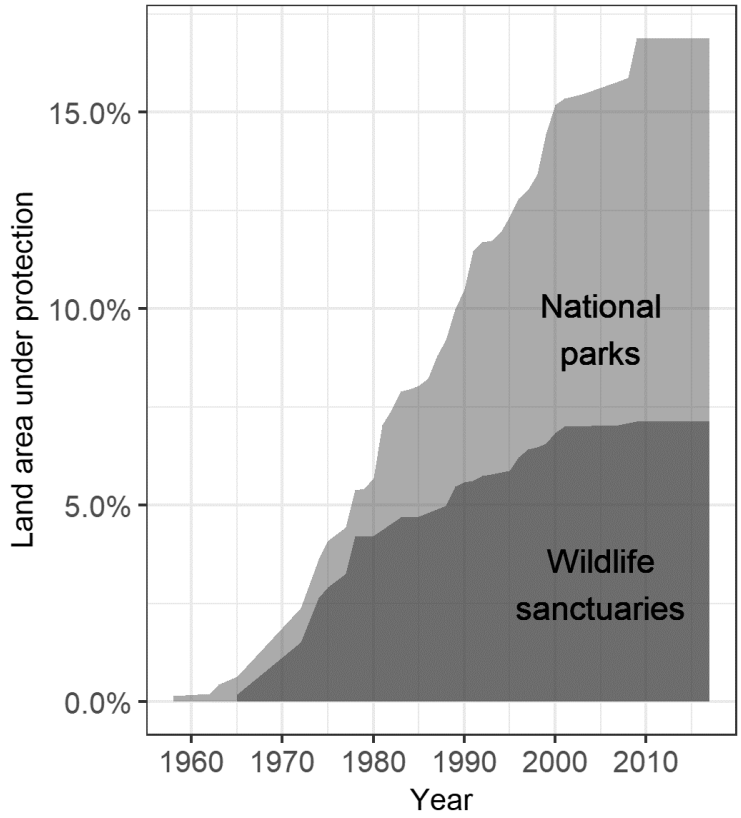


Figure 3-1: Expansion of protected areas since the establishment of the first national park in Thailand in 1958

During the first comprehensive aerial survey of Thailand conducted by the Royal Thai Airforce in 1961, the national forest cover was approximately 53% (Figure 3-2). Since then, RFD has based all forest monitoring on Landsat satellite images (Boonchana & Thongchai 1990). Within 17 years, annual deforestation rates rose to a maximum of 2.3% p.a. or 1.12 million ha/year in 1979 and only fell continuously below 0.5% after 1991 (Figure 3-3). The decline of forest cover was paralleled by an expansion of arable land, i.e. land under regular agricultural use, making Thailand the world's biggest exporter of rice between 1975 and 2011 (FAO 2017). Government incentives also accelerated the conversion of coastal mangrove forests to intensively managed aquaculture ponds (Barbier & Cox 2004). A second deforestation driver was commercial logging, which was administrated through a concession system. During the 1960s, approximately 40% of Thailand's northern forests were granted to concessionaires without monitoring or enforcement of management guidelines (Poffenberger & McGean 1993). Thus, deforestation was either actively supported through subsidies or passively by 'turning a blind eye' to forest destruction. Since 2010, net forest change has been positive despite the expansion of arable land, which can be attributed to the regeneration or restoration of forests on abandoned farmland (Leblond & Pham 2014). In fact, from 2001 to 2012, Thailand gained 499,000 ha of tree cover, equivalent to a 2.8% increase since 2000 and 0.6% of global tree cover gain (Global Forest Watch 2019).

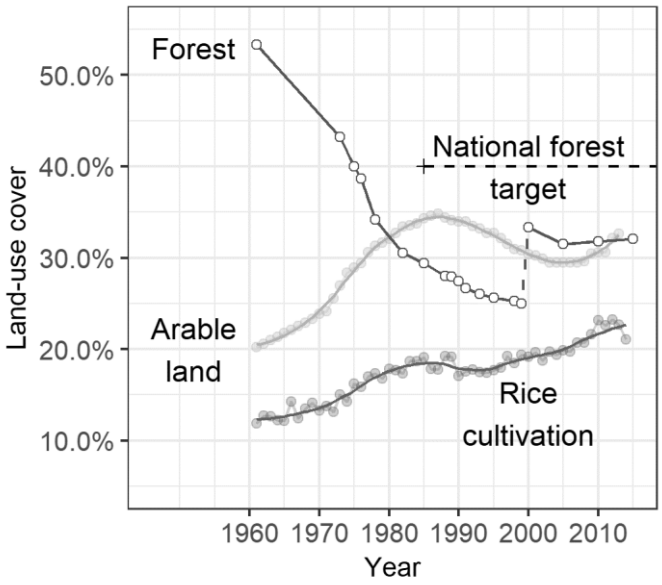


Figure 3-2: Change in land-use cover between 1961 and 2015 for forest cover excluding forest plantations (RFD 2020), arable land, and rice cultivation (FAO 2017). The dashed line highlights 40% forest cover targeted by National Forest Policy of 1985. Agricultural data points were smoothed line to highlight long-term trends. The abrupt change in forest cover between 1999 and 2000 is the result of newly employed survey techniques showing that previous methods tended to underestimate forest cover creating this artifact.

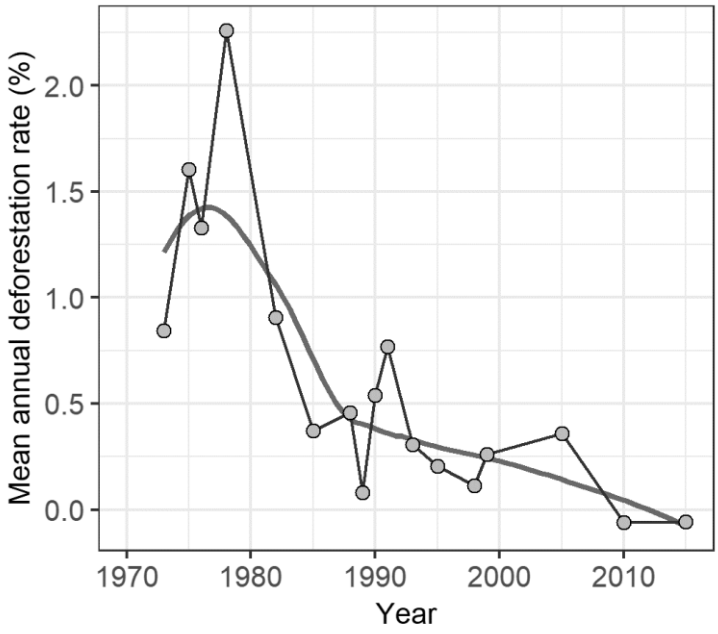


Figure 3-3: Annual deforestation rates calculated based on available forest cover data. A smoothed line has been added to visualize long-term development.

3.1.3 The '40%-goal' forest cover

Although foreign logging companies withdrew from Thailand after the end of the Second World War, Western experts continued to influence forest policies as government advisors. In 1948, the Food and Agriculture Organization of the United Nations (FAO) sent a team of forestry experts, led by a G.N. Danhof. In their report, the FAO team highlighted the lack of well-trained foresters as well as financial resources and marked shifting cultivation as the main driver of deforestation (FAO 1948 cited in RFD 1971 cited in Luangaramsri 2002: 75). Moreover, they recommended keeping 40% of Thailand's land area under forest cover. However, the FAO team did not provide any specific reasons for this seemingly arbitrary number. Despite this fact, the '40%-goal' has remained a major aspect of present Thai forest policy, such as the Twelfth National Economic And Social Development Plan.

In 1985, the National Forest Policy was adopted through a cabinet resolution as a guideline for later forestry policies. The National Forest Policy reiterated the '40%-goal' and specified that 15% of land area were to be designated as conservation forest while 25% should be reserved as production forest. Following the logging ban in 1989, this ratio was reversed to 25% conservation and 15% production. Thus, forest cover became the key performance indicator of the RFD and the single most important goal of Thailand's forest policy. It has been easier to monitor this indicator given the early adoption of satellite-based forest monitoring by RFD in 1973 (Ongsomwang 2002). Although forest policies stated that 40% of Thailand's land area had to remain under forest cover to secure the country's development, this declaration has never been backed by scientific studies of ecosystem services provided as a consequence of a given forest cover (Walker 2004). Moreover, the condition and species composition of forests has been ignored entirely, so that state-run restoration projects often centered on the fast-growing tree plantations consisting of exotic tree species, such as *Eucalyptus spp.* or *Acacia spp.* (Pye 2005). Thus, local communities lost ecosystem services as forests were declared 'degraded' and replaced with monocultures (Onprom 2013).

3.2 Forest Village Programs

3.2.1 Forest Village Program (1967-1989)

The problem of illegal squatters in reserved forestland had to be solved almost immediately after the declaration of National Forest Reserves. However, adjusting the boundaries of demarcated areas was not pursued (Wataru 2003). Instead, the Forest Industry Organization (FIO), a state enterprise managing forest plantations, created the Forest Village Program in

1967 to establish forest plantations on degraded areas using a modified taungya system. The official objectives were (1) to reforest degraded forestland, (2) to persuade shifting cultivators to settle permanently in designated areas as they were seen as the main drivers of deforestation, and (3) to build a stable labor force for forest plantations (Samapuddhi 1974).

In 1975, the RFD's National Forest Land Management Division replicated this village-based afforestation model under the same name, Forest Village Program, but with slightly different objectives reflected in the official title 'Program for the Improvement of National Forest Reserves'. The objectives were also (1) to gather farmers, which were living 'dispersed' in reserve forests, in designated settlements, and (2) to reforest degraded forestland. Further migration into forestland was to be prevented through incentives, such as land-use rights and social services. The ultimate goal was to increase the forest cover around each village and conserve the remaining forest areas. However, the main function of these newly established plantations was not timber production, but the rehabilitation of degraded forests and their conservation. The rehabilitation objective was limited to a quantitative increase in forest cover, i.e. the percentage of state-owned forestland under a forest canopy. Fast-growing tree species were chosen to achieve this goal as fast as possible regardless of the utilization of these trees by local communities. The official documents did not further elaborate on how plantations of fast-growing tree species should provide protective ecosystem services, and which specific services they should provide. Although RFD advertised them as multi-purpose trees providing many ecosystem services to local communities, local communities tended to be restricted from actually using them (Onprom 2013). The RFD received funding from two other actors, the Crown Property Bureau and the Royal Thai Armed Forces, to establish additional forest villages (Table 3-1).

Table 3-1: Overview over projects implemented under the Forest Village Program (based on Preeyagrysorn 1992)

Official program title	Implemented by	Number of villages
Forest Village Program	FIO	53
Program for the Improvement of National Forest Reserves	RFD	115
Royal Development Projects	RFD under directive from Crown Property Bureau	32
Rural Development Projects for National Security	RFD under directive from Armed Forces	22
Green Isan/KYK	RFD under directive from Armed Forces	25

Both FIO- and RFD-administered programs followed similar procedures. Families were invited to move from areas located within forest reserves to settle in a newly established village. There, each household was allocated a 0.16 ha land parcel to build a house and to establish a home garden. Facilities were built to provide drinking water and electricity free of charge. Health, education, electricity, and drinking water facilities were implemented to promote rural development (Boonkird et al. 1984).

In return, each household had to plant trees on a previously cleared area of 1.6 ha annually following the instructions of the administrative staff. Households were given land use rights and were allowed to grow food or cash crops between planted trees during the first three years after tree planting. Thus, one household could cultivate 4.8 ha each year. Teak trees used to be planted at a distance of 4 m × 4 m, which was later modified to 2 m × 8 m to provide more space for agricultural crops. In addition to tending to their crops, villagers would also be employed for weeding, pruning, thinning, fire management, and other tasks. They earned the minimum agricultural wage but could receive bonus payments for high survival rates among planted trees.

In the case of FIO-administered forest villages, tenure rights transferred from the responsible forest authority to village households were limited to temporary cultivating and harvesting agricultural products between plantation trees (Figure 3-4). In villages established by RFD, each household received a small land parcel of 0.16 ha for housing as well as not more than 2.24 ha for farming through a usufruct land certificate and could be employed in the reforestation program.

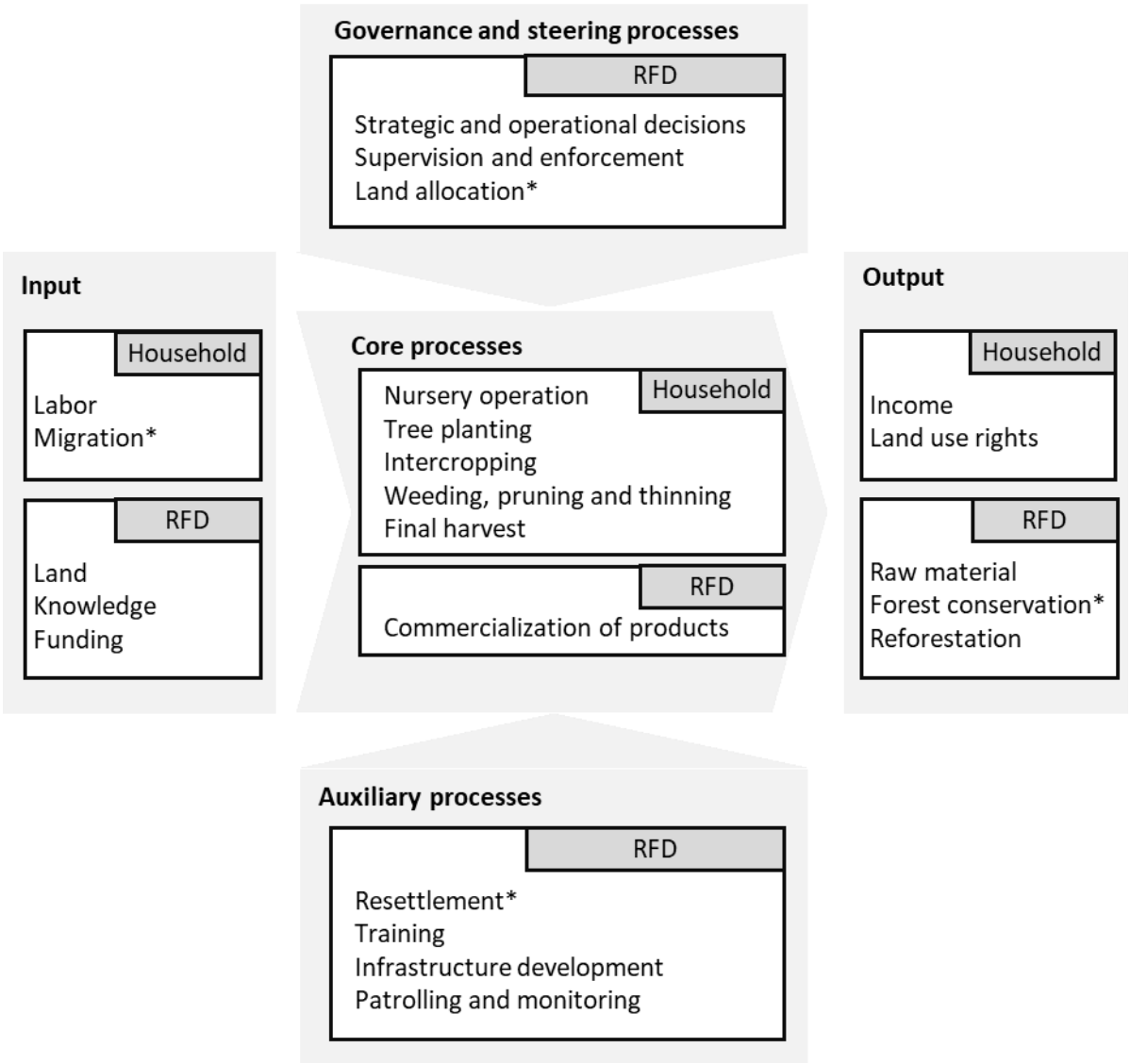


Figure 3-4: Input-process-output model of the Forest Village Program (adapted from Auch et al. 2014), *optional program elements

Both state authorities retained the ownership of both land and standing trees. Although villagers were responsible for tree planting and tending, they had no tenure rights over tree crops but were compensated in cash according to minimum wage (Figure 3-5). All management decisions regarding the forest plantation were made by state officials. The choice of crops was made by villagers as long as the crops did not interfere with tree growth. There were half-hearted plans to encourage farmers to adopt agroforestry practices on their farmland. As many farmers had to cope already with marginal farm productivity, they were reluctant to implement unknown practices. In addition, farmers were often unsure whether they could utilize trees within the agroforest.

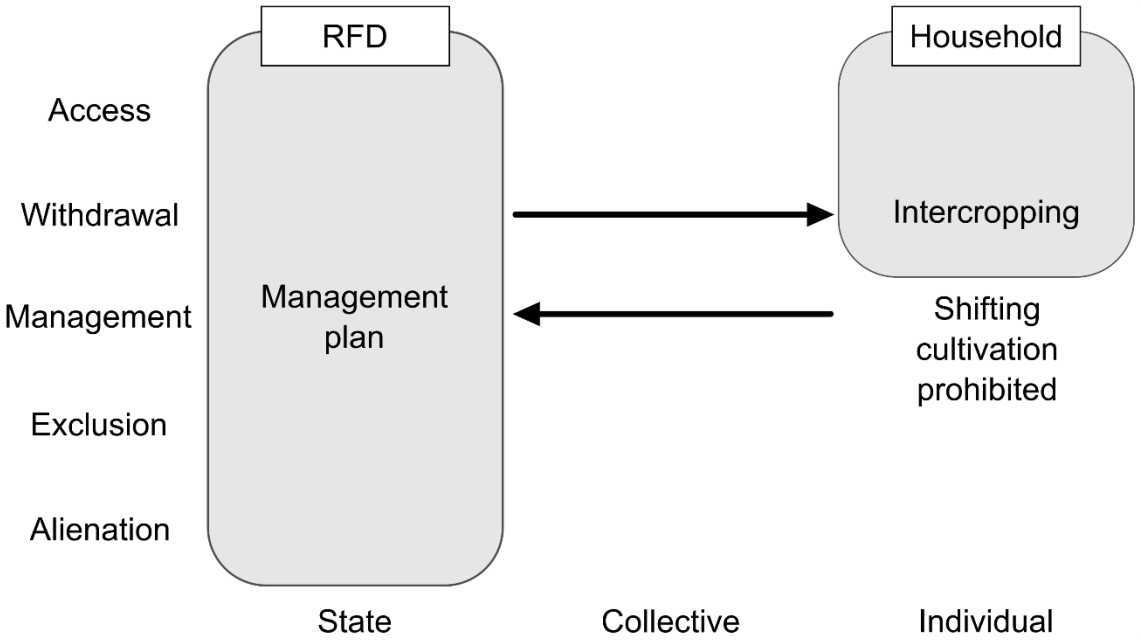


Figure 3-5: Forest tenure rights of the Forest Village Program

Between 1975 and 1993, the RFD set up 169 villages throughout Thailand (Preeyagrysorn 1992) in addition to the 53 villages established under the administration of the FIO (FAO 2009). In 1993, the program was discontinued and the responsibility for the existing forest villages was transferred from the RFD to the newly established Agricultural Land Reform Office.

The RFD-administered Forest Village Program was canceled after budget cuts, which made it impossible to fund infrastructure developments, social services, and the employment of local villagers in the afforestation activities (Hafner & Apichatvullop 1990; Kurashima & Jamroenprucksa 2005). Each village was administered by at least six officials (Pratong 1985). However, there was a shortage of competent managers, who were not only trained in the biophysical aspects of forestry but also qualified in rural extension and communication (Boonkird et al. 1984). Subsequently, a social forestry curriculum was incepted in 1985 at the Faculty of Forestry, Kasetsart University with the assistance of FAO and SIDA to resolve this shortage (Redhead 1986). In 1986, the RFD established a Division for Community Forestry under the Office of Reforestation with the task of developing new participatory programs. Hafner (1995) rated the Forest Village Program as a failure due to its shortcomings in the limited participation of local communities and the lack of necessary institutional reforms of the RFD. Farmers were allocated equally sized land parcels without considering their agricultural productivity, so that earlier participants were able to secure productive parcels while leaving marginal areas to latecomers. Insufficient harvests drove many farmers to leave the forest villages again to settle within forest reserves so that deforestation continued (Hurst 1990).

3.2.2 Forest Village Type IV (*Khor Jor Kor*)

In 1990, the Internal Security Operations Command (ISOC) developed a new type of Forest Village Program, the 'Land Distribution Program for the Poor Living in Degraded National Forest Reserves in the Northeast of Thailand', which became known as *Khor Jor Kor* referring to its abbreviation in the Thai alphabet. The plan proposed to resettle 25,000 households from national forest reserves to allocate a total land area of 14,400 km^2 for the establishment of large-scale fast-growing tree plantations (Pye 2005). Communities were relocated either from newly created national parks (Nepal 2002; Roth 2004a) or from areas designated for the establishment of large-scale forest plantations (Pye 2005). Leblond (2010) argued that the RFD adopted *Khor Jor Kor* to increase their revenue from timber royalties by strengthening the timber plantation sector with the aim of financing other population displacement initiatives.

The *Khor Jor Kor* project was executed through forced evictions, to which villagers reacted by organizing a regional resistance movement (Pye 2005). The 2.4 ha of land allocated to each household was often of marginal agricultural productivity. In 1992, the project was channeled through a successful civil society action and public pressure (Leblond 2010). The resistance against these activities and the widespread tenure insecurity among forest communities gave rise to a strong civil society movement, which demanded more community participation in forest management (Pye 2005; Fey 2007). Consequently, a civil society movement of farmers emerged advocating community forestry as an alternative to large-scale plantations and forced evictions (Brenner et al. 1999). Moreover, the ruling government implemented a temporary moratorium on large-scale private plantations with a size of over eight ha. However, despite the failure of the Forest Village Program, eviction from designated forest reserves and protected areas remained part of Thailand's national forest policy up to the present.

3.3 Community forestry discourse

3.3.1 Growing influence of civil society and the national logging ban

As Thailand's public became more aware of environmental problems, commercial logging under RFD's supervision was seen as highly destructive and a major cause of forest loss. In November 1988, extremely heavy rainfall triggered several catastrophic landslides as well as flooding in southern Thailand. CSOs advocated for forest conservation to prevent landslides supported by the public due to their growing mistrust in the state's ability to manage forests (Onprom 2013). This strong narrative remained, although later studies could show that these events were not caused primarily by commercial logging (Lakanavichian 2001). However, only

2 months later, in January 1989, the Thai Government instituted a national logging ban, which prohibited the extraction of timber from natural forests (Cabinet Resolution 32/2532). The logging ban has been criticized due to its sudden and unprepared implementation, as well as its unintended consequences on forests in neighboring countries (Lakanavichian 2001). Despite this critique, it has been neither revised nor revoked since its implementation.

In addition to its immediate restriction of commercial logging (Figure 3-6), the logging ban had several long-term effects on Thailand's forest policies. The government had to acknowledge publicly that the RFD failed to manage and utilize forests sustainably. Thus, the successful implementation of the logging ban strengthened civil society movements, which also advocated the devolution of forest management rights to local communities. Growing environmental awareness of Thailand's public was paralleled by a stronger involvement of local CSOs. Between 1980 and 1992, approximately 12,500 national and local CSOs were officially registered in Thailand (GoT 1992; OECD 2002).

However, the RFD shifted its mandate toward stricter forest conservation by expanding protected areas in line with the Wildlife Conservation and Protection Act of 1992 (Usher 2009). In addition, the RFD also had lost substantial financial income from timber royalties. In addition to a sharp increase in timber imports from the neighboring countries Laos, Cambodia, and Myanmar, the logging ban was also followed by a rise in illegal logging within Thailand's forests (Lakanavichian 2001).

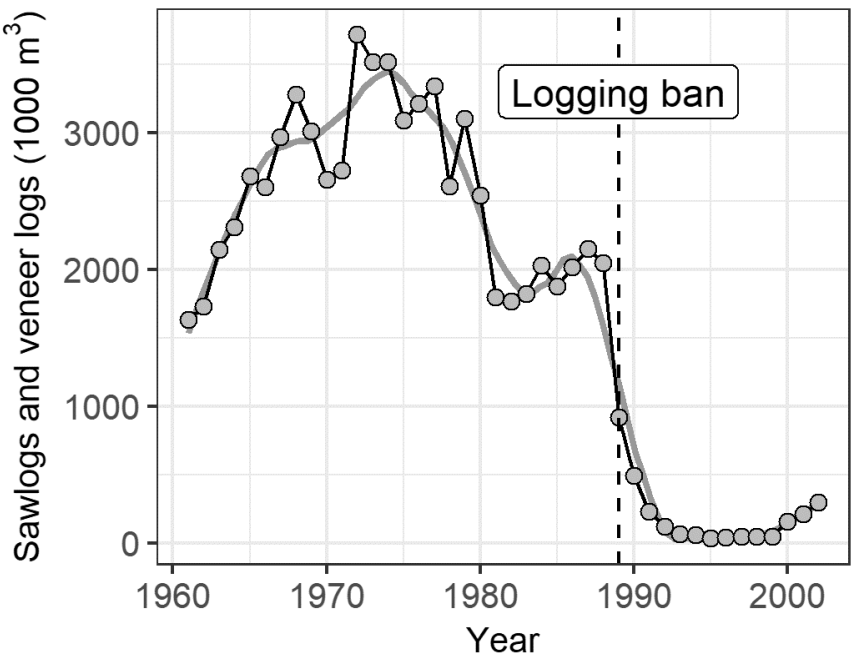


Figure 3-6: Effect of the logging ban on sawlogs and veneer logs production between 1961 and 2002 (source: FAOSTAT). Data points were overlaid with a smoothed trendline to highlight long-term trends.

3.3.2 Community forest initiatives

During the 1980s, local people began to organize groups for the protection and management of their surrounding forests in response to continuing forest degradation (Salam et al. 2006). In northern Thailand, traditional forms of communal irrigation systems (*muang fai*) may have been a starting point for Thailand's contemporary community forestry, in which irrigation groups organized to conserve local watershed forests (Apinyaa 2001; Johnson & Forsyth 2002; Mungsunti & Parton 2017). There, communities began to protect surrounding forests against illegal logging as a response to the state's absence (Johnson & Forsyth 2002). Shalardchai et al. (1993) found 153 community forests in Upper Northern Thailand, while Sukwong & Makarabhirom (2000) reported that the number had risen to 733 in the same area. Community forestry spread through Thailand as local leaders from other regions visited these sites and initiated similar management models at home (Poffenberger & McGean 1993). Following the unsatisfying results of previous social forestry programs and the negative impacts of strictly protected areas on the livelihoods of local communities, community forestry was perceived widely as an effective alternative to centralized forest conservation (Makarabhirom 2000).

Besides setting up community forest organizations, the ordination of trees in a Buddhist-inspired ceremony has been used to demonstrate the presence and effectiveness of community

forest management. In June 1990, the Buddhist monk Phrakhru Pitak organized the first tree ordination in a community forest located in Nan province, Northern Thailand (Darlington 1998). Saffron-colored cloths, which are identical to the robes worn by Buddhist monks, are tied around a tree's stem. Thus, these trees are sanctified to discourage people from felling them and remind them to respect and protect nature (Tannenbaum 2000; Isager & Ivarsson 2002). Tree ordination has been characterized as a modern environmental movement, which re-interpreted traditional religious practices.

The Regional Community Forestry Training Centre for Asia and the Pacific (RECOFTC), now The Center for People and Forests, has become a think-tank and major advocator of community forestry in Thailand. In 1981, it was founded following the regional FAO conference on social forestry in Semarang, Indonesia (Colchester 2002). Among many other activities, RECOFTC trained villagers in forest survey techniques, which enabled communities to conduct forest inventories using standard scientific methods. The objective was to provide evidence for the forest's intactness and highlight the species richness of community forests based on standard inventory techniques.

RECOFTC and other CSOs collaborated with the media to document and publicize success stories of communal forest conservation, which helped community forests to gain legitimacy among the urban middle class and elites. Thus, community forestry has been promoted by local communities and not by the state. Only later did RFD start to collaborate with communities and local government organizations in a small number of pilot projects. For example, in 1989, regional RFD officers encouraged villagers in Dong Yai (Ubon Ratchathani province) to assume responsibility for the protection of a logging compartment whose concession had just been canceled due to the preceding logging ban (Poffenberger & McGean 1993). For the majority of communities, their forest activities remained informal and de jure illegal within forest reserves. However, many local RFD officers tolerated it and had unofficial arrangements with communities regarding forest use. The lack of legal recognition meant that communities could be prosecuted at any time and were unable to develop forest-based community enterprises. Thus, a civil society movement was formed to legalize community forestry (Johnson & Forsyth 2002).

3.3.3 Community Forest Act

In 1990, a committee consisting of forest officials and academics was appointed by the government to prepare the initial draft of a Community Forest Act to formalize the growing

number of community forests (Weatherby & Soonthornwong 2008; Onprom 2013). The stated objective was to reduce tenure conflicts in state-owned forestland, which resulted from the large number of people living in these areas, and to rehabilitate degraded forests. The policy was seen as another way to reach the 40% forest-cover goal set out by the National Forest Policy (1985) through the community-based restoration of degraded forestland. In the first draft, submitted in 1992, the RFD envisioned a program focused on the participatory reforestation of degraded forest and, thus, restricted it to community-based woodlots (Makarabhirom 2000; Onprom 2013). Consequently, community forests could be only designated on forest reserves, which were classified as degraded and intended for reforestation (Weera 1993). This view of community forestry as village-based afforestation corresponds to the National Forest Policy (1985) in which it was defined as the "establishment of forest woodlot for household consumption" (NFP 1985, Article 12).

One year later, a team of Thai academics and activists applied their research findings in local forest management to write an alternative draft. The draft's authors were seeking to include traditional shifting cultivation systems as important livelihood and cultural aspects of ethnic minorities. In 1996, the National Economic and Social Development Board (NESDB) consisting of representatives from government, CSOs, academia, and communities developed a draft intending to conciliate the first and the alternative draft. This compromise was approved by the Cabinet. However, conservationists disagreed strongly with the legalization of community forests within protected areas resulting in more restrictions. On the other hand, communities were now permitted to commercialize their forest products, which had been prohibited in the previous draft.

In 1998, the newly formed CSO Assembly of the Poor publicized in collaboration with other CSOs a new draft in response to these changes called the People's version. This draft was based on the alternative draft of 1993 and drew from the recently passed Thai constitution of 1997 (Zurcher 2005). However, shifting cultivation was not anymore included as a traditional form of forest management. In addition, recognition of community forests now required proof of the community's ability to manage a forest area for over 5 years. In 1999, the Northern Community Forest Network was established to represent over 730 communities and to advocate for the People's version of the Community Forest Act by collecting over 50,000 signatures and submitting it in form of a petition to parliament (Makarabhirom 2000). According to this draft, community forests should be tolerated within protected areas if the community had managed them for at least 10 years before the demarcation of the protected area (Article 25) (Weatherby

& Soonthornwong 2008). The collection of NTFPs would be permitted, whereas the harvest of timber should be prohibited (Article 35).

The debate around the act tended to center around the recognition of communities' rights to protect and extract NTFPs from forests but, apart from the second, alternative draft, neither side talked about agriculture and residence within forest areas and, thus, ignored main aspects of people's livelihoods (Fey 2007). Walker (2004) termed this issue arborealization to underline the strong focus on forests and the ignorance of agriculture as the main source of farmers' livelihoods. Although supporters of community forestry argued that local people can manage forests sustainably, they did not consider management options beyond protection and NTFP use.

In the following years, the drafted act remained in a state of limbo while it moved back and forth between the House of Representatives and the Senate. The main issue remained the legislation of community forests within protected areas. In 2002, the House of Representatives passed the 'People's version', which was rejected subsequently by the Senate. In 2007, a modified version was passed by the National Legislative Assembly, an unelected parliament, but declared illegitimate by the Constitutional Court and lapsed (Weatherby & Soonthornwong 2007; Hares 2008).

The finalization of a Community Forest Act was hindered by the conflicting views among stakeholders over the communities' willingness and capability to manage forests sustainably. Two non-governmental interest groups emerged which supported their version of the proposed law in addition to the state-sponsored legislative draft (Makarabhirom 2000). Forest communities were supported by a "community-centered" group (Makarabhirom 2000) of urban-based CSOs and academics to organize themselves into a social movement consisting of 'community forest networks' at provincial, regional, and national levels (Zurcher 2005). The proposals made by this group were opposed by a coalition of strict conservationists and lowland farmers, which has been termed the "national-centered" group (Makarabhirom 2000).

In Thailand, watershed areas are classified based on the prevailing slope of their terrain and accordingly restricted in their land use. Any form of land use is strictly prohibited in upland forest areas with a slope of more than 35% to guarantee a consistent water supply and prevent flooding of low-lying farmland (Tungittiplakorn 1995). Thus, upland forests are perceived to exist for the benefit of the nation (Kurashima & Jamroenprucksa 2005). Despite the focus of communities to protect these watershed forests, the legislation prohibits community-based

conservation in headwater areas due to a general mistrust in people's ability to protect forests (Virapongse 2017). As ethnic minorities were framed for causing extensive deforestation through the practice of shifting cultivation in upland areas, this conflict became also one centered on ethnicity and Thai nationality (Vandergeest 2003). Moreover, it can be also seen as a conflict between highland and lowland farmers.

3.3.4 Decentralization and engagement with local government

Decision-making regarding natural resource management became more decentralized with the passing of the Tambon Administrative Authority Act of 1994 and the Decentralization Act of 1999. Through the implementation of these two decentralization acts, local government units (Tambon Administrative Organization, TAO) received more responsibilities in the management of forest reserves and the support of forest communities (Dupar & Badenoch 2002). The existing 7,400 *tambon* or sub-district level governments became directly elected bodies with a five-year term. In addition, Thailand's former constitution of 1997 permitted local governments and communities to engage in natural resource conservation and management, although it did not specify how communities could engage in forest management (Birner & Wittmer 2003). This was a significant development, as prior national forest policies, as well as forest management plans, were defined based on directives from the central government. After the legislative standstill of the Community Forest Bill became apparent, CSOs began to utilize increasing decentralization to shift their engagement from the national to the local level of government. Instead of emphasizing their work on national policy advocacy, these organizations began to help local government organizations (TAO) to develop capacities and to implement community-based forest management (RECOFTC). This engagement by CSOs is important, as forest officials tend to continue to promote central directives at the local level instead of decentralizing decision-making (Dupar & Badenoch 2002)

3.3.5 Restructuring of Public Administration

Due to the Public Administration Act of October 2002, the RFD was divided into three departments under the Ministry of Natural Resources. Besides RFD, and Department of National Parks, Wildlife and Plant Conservation (DNP) was mandated with managing national parks and wildlife sanctuaries, whereas the Department of Marine and Coastal Resources (DMCR) is responsible for all mangrove forests. RFD kept control over national forest reserves, which were located outside protected areas. In the course of the structural reform, RFD did not only lose jurisdiction over large forest areas but also received a smaller financial budget, and a

significant share of its staff was transferred to other departments (Figure 3-7). Subsequently, forest offices at the district level had to be closed leaving only RFD officers at the provincial and national level (RFD, personal communication September 2013).

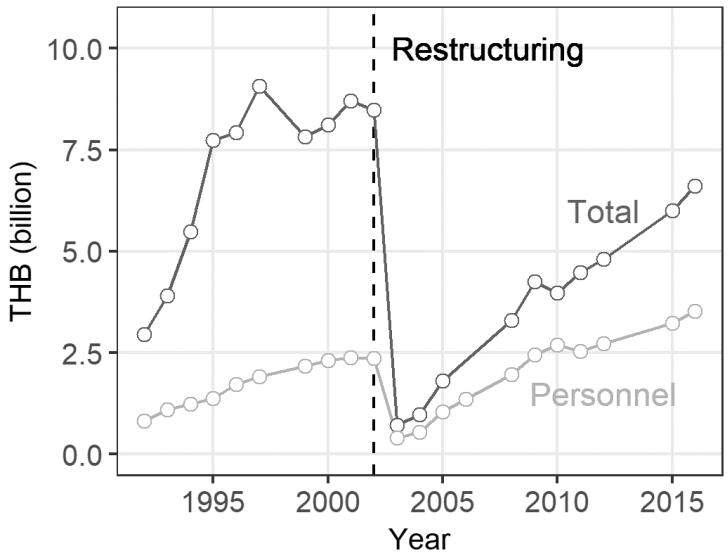


Figure 3-7: Reported inflation-adjusted budget expenses of RFD in total and for personnel between 1992 and 2016 based on RFD's annual financial statements

3.4 Community Forest Program

In 2000, RFD initiated a community forests program to register community forests expecting the implementation of the Community Forest Act (Boonyananta et al. 2012). Due to the absence of national legislation regulating community forestry, the RFD registered community forests based on Chapter 2 Section 19 of the National Reserve Forest Act (Boonyananta et al. 2012). This regulation states that it is at the discretion of the department's Director-General to implement any activity that aids the control and conservation of reserve forests (Onprom 2013). Thus, the registration of each community forest has to be approved by the Director-General of RFD. This regulation remained the legal basis for the community forest program until now as the Community Forest Act was rejected. The RFD's Community Forest Office is responsible for coordinating and facilitating the development of community forestry on the national level, whereas Community Forest Sections support the community forests in each of Thailand's provinces (Boonyananta et al. 2012).

Between 2000 and 2021, RFD recognized and registered the community forests of over 10,000 villages throughout Thailand (RFD 2021). Due to regulatory limitations, only community forests located outside of protected areas can be legally recognized and accepted by RFD. RFD officials consider the community forest program to be very successful and pursue the

registration of more forests where it is legally possible (Virapongse 2017). Community forests have been especially important in the more forested northern region, where communities tend to manage forest areas above the national average (Figure 3-8; Figure 3-9). In 2016, registered community forests covered a total area of 908,268 ha corresponding to 3.8% of national forest reserves (RFD 2020). Most community forests have been registered in northern Thailand.

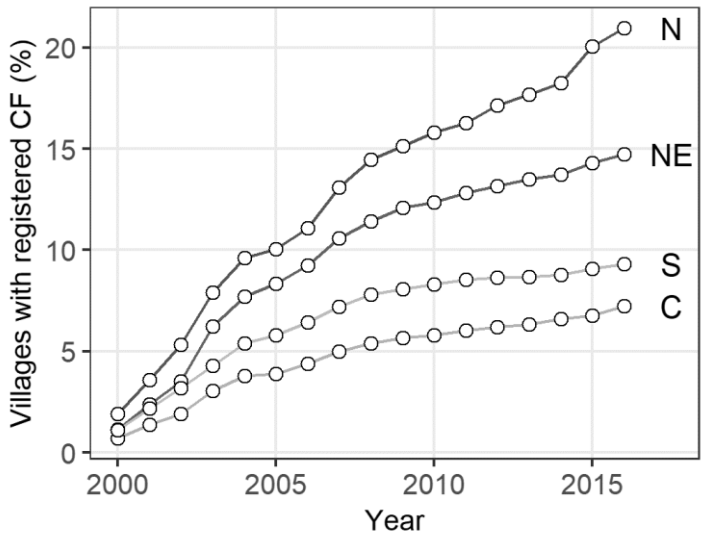


Figure 3-8: Cumulative percentage of villages that have registered a community forest since 2000 grouped based on their regional location (Central, North, Northeast, and South). Data: RFD 2021.

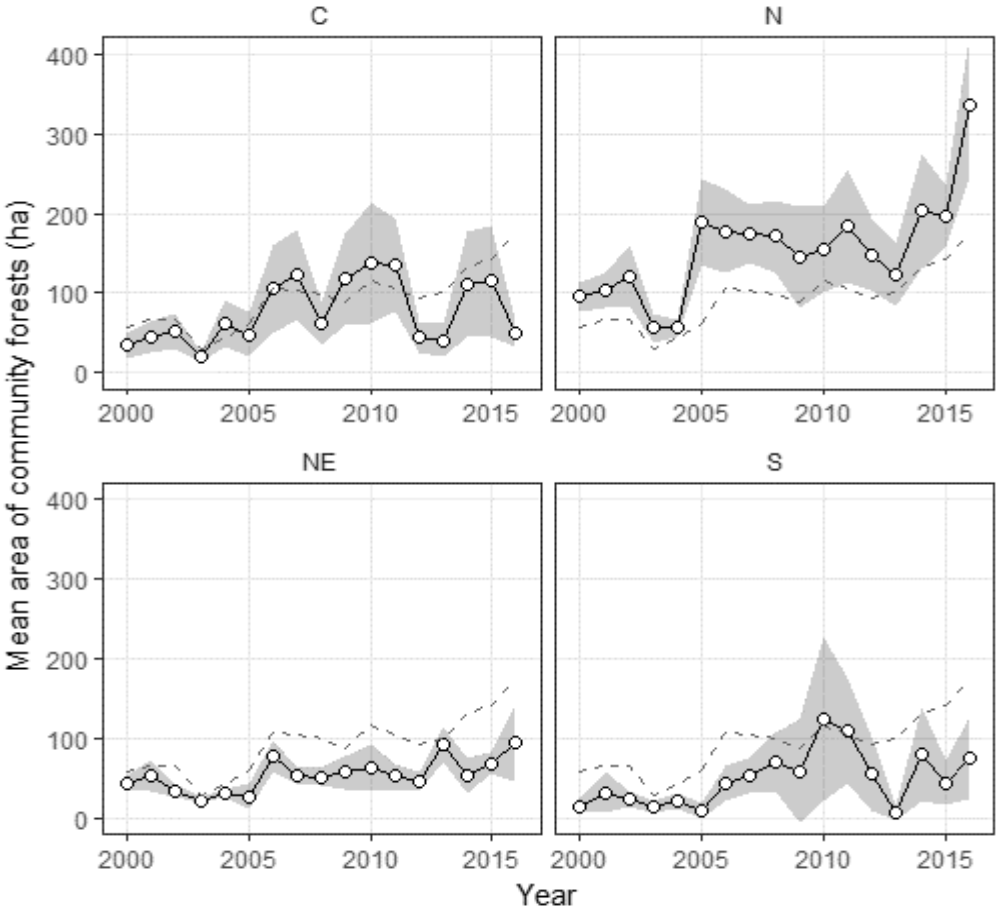


Figure 3-9: Mean area of community forests at the time of their registration grouped by the regions they are located in (Central, North, Northeast, and South). Envelopes show standard deviation around the mean value. Dashed lines indicate the national average. Data: RFD 2021.

3.4.1 Governance and steering processes

Each community formed a steering committee before registration of its community forest for monitoring forests, supervising extraction of forest resources, and organizing management activities. RFD granted extensive tenure rights to community forest organizations and strengthened their ability to manage community forests (Figure 3-10). Transfer of management rights was conditional on registration of a community forest committee as well as the development and approval of a management plan by forest officers. Customary management rules were often in place before registration but became increasingly formalized and were displayed on boards to be visible for all forest users. RFD permits communities to enforce their own self-developed rules to govern forest management as long as rules do not conflict with the law (Salam 2006). Community members received all rights over the withdrawal, management, and exclusion of forest products used for subsistence, such as mushrooms and bamboo.

However, management rights were particularly constrained concerning the marketing of forest products, as villagers are officially not allowed to sell forest products to a larger market outside their community. In return for the transfer of management rights, community organizations are expected to prevent forest encroachment and report illegal logging activities.

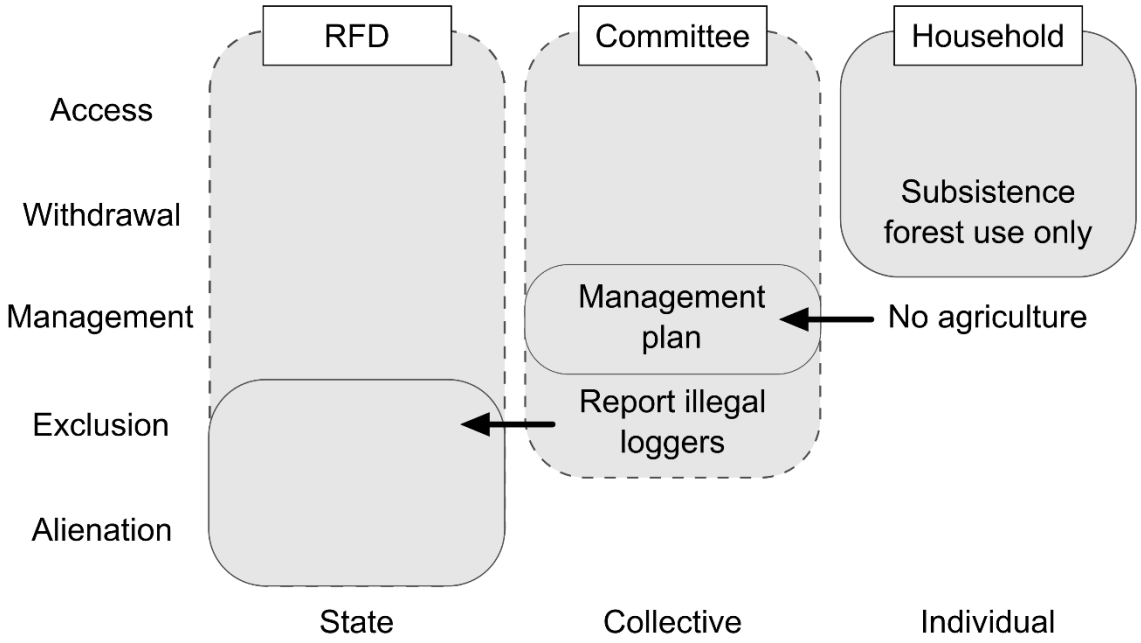


Figure 3-10: Transfer of tenure rights in Thailand's community forestry program. Dashed boxes represent de jure rights, which are de facto not exercised.

Community organizations are permitted to decide how to organize management activities and regulate the harvesting of NTFPs. Although the community has the right and responsibility to exclude community outsiders from logging, village outsiders are generally not restricted from collecting NTFPs. This has led to concerns in some communities about the sustainability of NTFP harvest as a large number of outsiders gathered forest products in community forests, especially if these are very productive forests (Poffenberger & McGean 1993; Pagdee et al. 2008). Government authorities retained alienation rights, as communities were not allowed to convert or sell forestland. All rights are granted for 5 years and have to be renewed continuously. Community committees have to submit three documents to the RFD to register their community forest (Boonyananta et al. 2012). First, a list of community members, who seek to register and are interested in participating in forest activities, has to be compiled. Second, a survey map of the demarcated forest area based on GPS measurements has to be prepared in collaboration with RFD officials. Third, a management plan that describes planned forest activities has to be submitted.

3.4.2 Organizational model

Beyond the recognition of tenure rights, the inputs from RFD are rather limited. Local communities receive for these delegated responsibilities a limited transfer of tenure rights over forest land use. Since 2005, the RFD also provides initial funding to the committee. RFD staff provides technical assistance during the surveying and demarcation of the community forest area, which is a requirement for its official registration. Furthermore, local RFD staff advise committees during the development of their forest management plans, which also submitted to the central RFD office. However, management plans are generally not soundly grounded on systematic forest-related information due to the lack of regular forest inventories. Provincial forest officers do occasionally transfer technical knowledge through training courses in forest fire prevention and management and the construction of check dams. Tree seedlings are provided free of charge from state-run nurseries, however, limited to certain species deemed relevant by the RFD.

Most communities conduct regular forest patrols either by organizing permanent patrol teams or through a rotation system involving all capable community members. Their responsibilities are to patrol the forest perimeter, monitor forest conditions, spot forest fires early, report illegal timber logging, and, if possible, deter forest encroachers. The salary for these patrol teams represents the main, and sometimes only, financial costs of forest management. These costs are carried either by the community or the sub-district administration (Pagdee 2008). In the case of Khoa noi-Napang Community Forest in Khon Kaen province studied by Pagdee (2006) in 2004, annual personnel costs for forest patrolling amounted to 60,000 THB (1,700 EUR) which were covered by the local government organization. Additional but lesser costs fall on forest fire management, including the establishment of firebreaks, tree planting, and community meetings. These activities are conducted through voluntary engagement by members, which contribute their labor.

All inputs required for the collection of forest products, specifically labor and tools, are provided by the individual community member (Figure 3-11). The local knowledge required for the sustainable utilization of forest products is shared among community members and in some cases incorporated in the community's forest rules. For instance, members agree to cut edible bamboo shoots at the soil surface to allow resprouting, which would not be possible if the shoot would be dug out (Abd Razak et al. 2014).

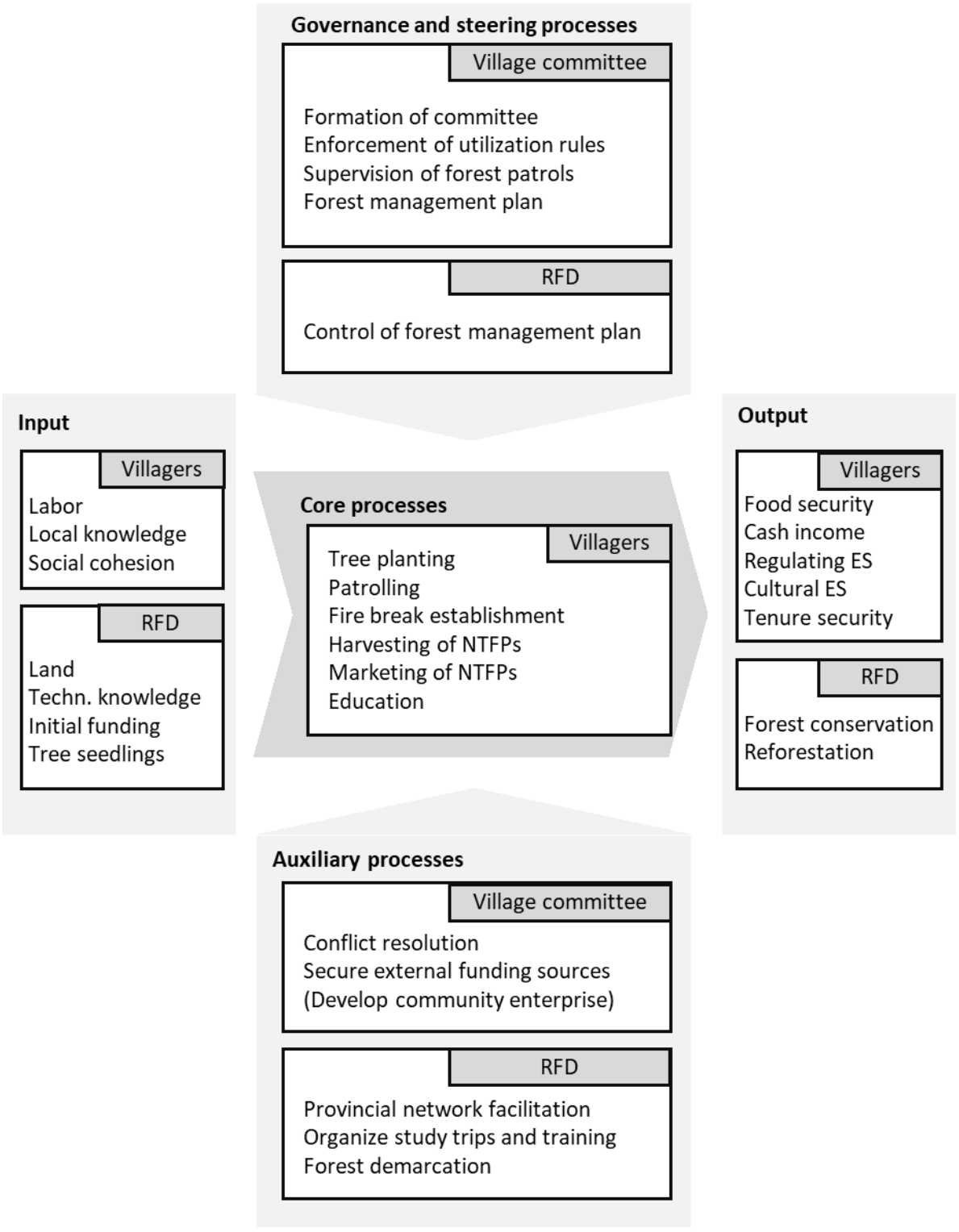


Figure 3-11: Input-process-output model of the Community Forest Program (adapted from Auch et al. 2014), *not obligatory

The management objectives of communities go generally beyond areal-based conservation and focus more on the provision of ecosystem services. Service-oriented forest activities aim at providing NTFPs as well as protective ecosystem services through multi-purpose forestry.

Therefore, the management goals of both RFD and community committees regarding forest conservation are in congruence. However, individual community members may have management goals, which diverge from the goals set out by the management committee. Especially poorer households depend more on the collection of NTFPs for subsistence or cash income and may disagree with harvesting restrictions put in place by management committees (Onprom 2013).

The main provisioning service is the collection of non-timber forest products (NTFPs). Logging of timber trees is officially prohibited by the national logging ban in natural forests. However, many communities established internal rules, which permit villagers to cut trees for house construction permitted the committee and village administration. Hunting of small animals, such as deer, rodents, birds, etc., is allowed in some community forests but completely prohibited in others depending on the community's management rules. In a study of a forest-managing community in Khon Kaen, Thailand, Pagdee (2006) found that 5.3% of a household's average annual income (20,000 THB) was earned through the sale of NTFPs in form of cash income in 2007. Moreover, non-cash benefits from NTFP-collection amounted to 18.4% (3680 THB) of household income. Thus, households in the studied community derived on average almost one-quarter of their annual income from the collection of NTFPs from their community forest.

Regulating ecosystem services are important for most villages, which depend on the regular water supply to irrigate rice paddies. Forests and particularly forest cover is seen as an important ecological requirement for supplying water to upland and lowland farmers. The conventional wisdom that forests act like a sponge that stores water and releases it gradually through the aquifer has been internalized by all stakeholders, both local communities and state officials (Walker 2002). Forest conservation is understood as an important factor for maintaining the hydrological cycle, whereas extreme hydrological events, both floods and droughts, are attributed to deforestation. Cultural ecosystem services play an important role in addition to regulative and productive services. Communities begin to monetize these cultural services through eco-tourism.

Communal forest activities are aimed at maintaining and improving forest conditions, whereas harvesting activities are conducted by each community member individually. Figure 3-12 shows the relative importance of certain communal forest activities based on a survey among

community forest committees conducted in 2017[1]. Over half of all surveyed committees organized tree plantings (78.6%), fire prevention measures, including the establishment of firebreaks (70.3%), forest patrols (66.1%), and the establishment of educational facilities (56.2%). Less than a third conducted weeding (26.0%), built forest roads (24.0%), conducted tree-thinning operations (8.3%) and operated a tree nursery (5.2%).

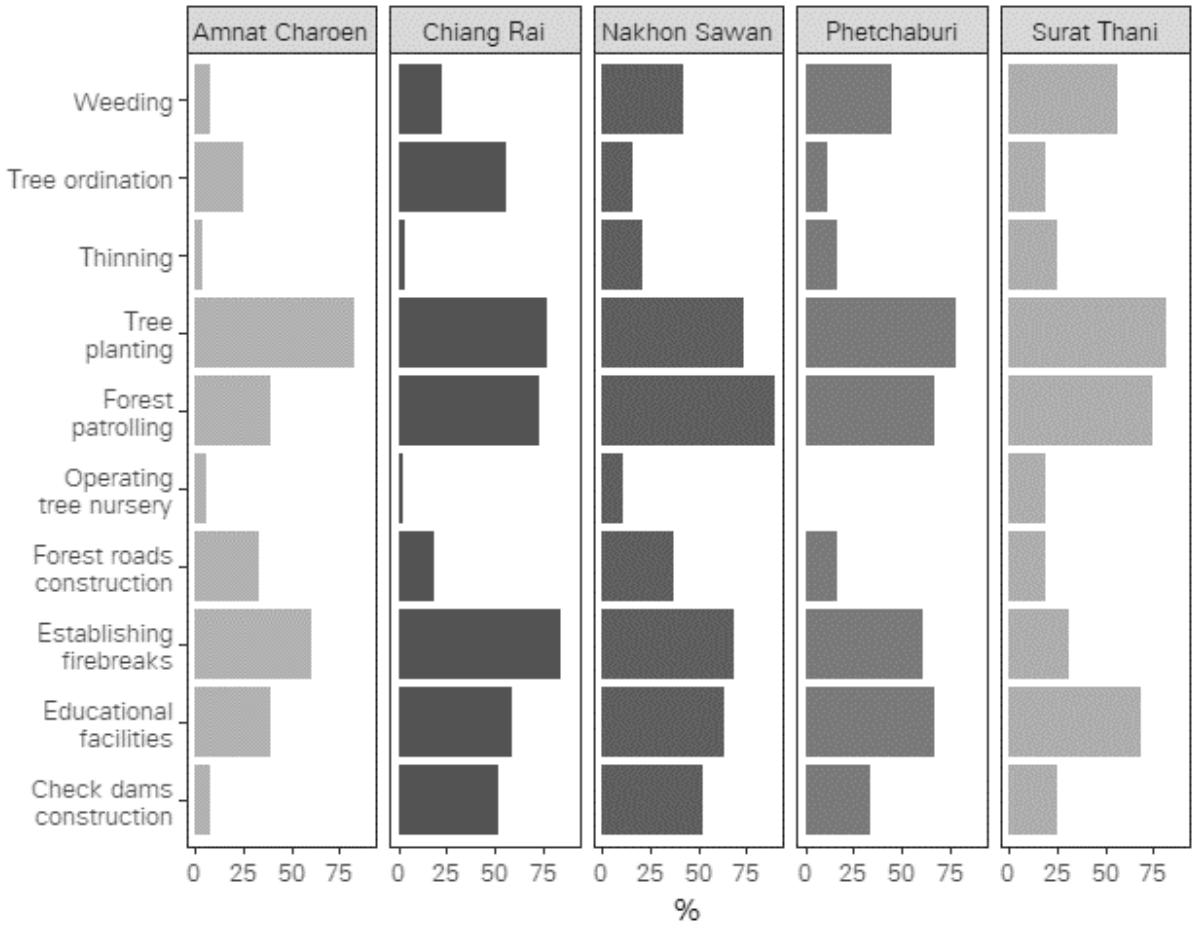


Figure 3-12: Forest activities organized by community forest organizations (N = 192)

Although the initial objective of the RFD in developing community forestry was to restore degraded forestland, many communities established their community forests in intact forests. Many communities rehabilitated degraded forests through strict conservation and fire protection but relied otherwise on natural tree regeneration. Consequently, the tree species composition of restoration-based community forests resembles the initial forest type more than many state-run restoration efforts, which relied on fast-growing tree species (Elliott & Kuaraksa

[1] Postal surveys were conducted by the author among community forest organizations in five randomly sampled provinces (Amnat Charoen, Chiang Rai, Nakhon Sawan, Phetchaburi, and Surat Thani) with response rates ranging from 15-30% resulting in 192 returned questionnaires following 2 reminders.

2008). In community forests, enrichment planting is undertaken either to increase the production of food products or to encourage the regeneration of climax tree species, which did not regenerate naturally due to limited seed availability (own observation). It was found that 56.2% of community forest organizations built educational facilities (Figure 3-12). This can include the construction of information boards, tree labels indicating respective species names, and even observation towers.

3.5 Conclusions

The objective of this chapter was to outline the historical context from which the current community forest program emerged. The foundation of the RFD in 1896 initiated a period of increasingly centralized control over forests. Approximately half of Thailand's land area is currently designated as state-owned forestland although only 30.4% are covered by forests. In 1975, the Forest Village Program was implemented to stop further colonization of state-owned forestland through rural development. State authorities sought to conserve forests by evicting people to designated areas, providing land parcels for agriculture in the hope that farmers would invest in their land and not migrate back. However, a limited budget and a lack of skilled extension workers limited this program to 247 villages, when it was canceled in 1993.

RFD looked for more cost-effective alternatives and engaged in large-scale plantations by resettling people in the Khor Jor Kor program. With the support of the armed forces, RFD engaged in large-scale displacement programs aimed at expanding timber plantations for the pulp-and-paper industry to finance resettlement. This program was stopped amidst strong public protests, which were supported by the growing and well-connected civil society sector. The cancellation of the Forest Village Program marked a shift toward the decentralization of forest management.

During the 1980s, local people began to establish groups for the protection and management of their surrounding forests in response to continuing forest degradation. In the 1990s, these communities began to form networks, first at the local level, later at the regional level. The number of CSOs also increased rapidly, and communities received support in form of scientific knowledge, funding, and fostering legitimacy as examples of sustainable forest management were publicized. In contrast, as the continuing deforestation coincided with floods and landslides, the RFD lost its legitimacy and the public did not trust the state in managing forests.

RFD has been pressured by a limited budget, a result of the logging ban and its administrative restructuring, to lower the financial costs of forest management by transferring responsibilities

to local communities and thereby reducing RFD's direct control over forests. The formal recognition of self-initiated community forests has been a policy, which has been met with greater public support in comparison to earlier forest policies. RFD officials see the community forest program as a great success and work to increase actively the number of registered forests. However, communities receive relatively little support for their efforts due to the limited financial resources of RFD and rely on community networks.

4 DESIGNING IMPACT EVALUATIONS FOR POLICY INTERVENTIONS

The methodological approaches used in this study aimed to determine the causal impacts and contribution of a forest policy intervention to understand whether the observed changes can be attributed to the intervention or are the result of other factors. Causal impact evaluation seeks to contribute to evidence-based policymaking by testing the effectiveness of policy intervention (Sanderson 2002). In this section, methodological approaches for ex-post evaluations are outlined, discussed, and justified according to their applicability concerning each research objective (Table 4-1).

Table 4-1: Overview of units of analysis used in each study

Study	Unit of analysis	Analytical approach
1) Formalization and tenure security	Community forest organizations	Comparative case study
2) Formalization and deforestation reduction	Community-managed forest areas	Panel data analysis
3) Inter-communal network administration	Provincial networks of community forest organizations	Social network modelling

4.1 Quantitative impact evaluation

Randomized controlled trials (RCT) are frequently referred to as the 'gold standard' for scientific research as potential selection biases are eliminated by randomly allocating subjects to treatment or control groups (Rosenbaum 2017). However, RCTs are a rare exception in policy studies as their use may not be feasible or ethically unjustifiable (Barrett & Carter 2010). Quasi-experimental study designs are most commonly used as the next-best method. These studies use the counterfactual effect of an intervention to identify causal links. Counterfactuals are control groups that are similar in all relevant aspects to the treatment group except for their participation in an intervention. Counterfactuals are constructed to reduce the influence of confounding factors and, thereby, the selection bias by using longitudinal observational data

and statistical techniques, such as matching, e.g. Propensity Score Matching, Difference-in-Differences, or instrumental variables (Ferraro 2009; Schleicher et al. 2020).

In the absence of a counterfactual, the effect of an intervention can be also assessed by comparing changes within the treatment group before and after an intervention using panel data analysis, e.g. Fixed-Effects Models (Jones & Lewis 2015). This requires long-term observations of each subject to discern changes following an intervention. The advantage is that time-fixed differences between subjects do not confound the analysis as only changes within the timeline of each subject are analyzed. This is especially useful when subjects are drawn from different locations, which could confound the impact of a specific intervention. In the context of forest policy, forest areas are regularly selected for interventions based on their location and characteristics, such as forest type, size, ownership, accessibility, etc., which are factors that can have a substantial confounding effect on the expected outcomes (Blackman 2013).

Here, quasi-experimental matching was used to determine the effect of community forestry on deforestation, and a longitudinal panel study was used to evaluate the impact of formalization on forest encroachment. Forest cover and deforestation rates were derived from high-resolution maps (Hansen et al. 2013). The boundary maps and the registration time of 680 community forests were obtained from the Office of Community Forest Management (RFD), which could provide accurate and complete maps only for this sample representing 14.3% of all registered community forests. First, propensity score matching was used to control for confounding factors by identifying similar forest areas that only differed in their management status, i.e. being located within or outside of a community forest. Subsequently, deforestation rates were compared within and outside of community forests using only matched samples. Second, fixed-effects models were used to determine the change in deforestation rates within community forests before and after their respective formal recognition. This approach was selected to analyze the within-forest variations over time while controlling for time-invariant confounders.

4.2 Qualitative impact evaluation

Quantitative methods, particularly quasi-experimental studies, can be used to validly estimate the impacts of an intervention. However, these studies tend to be limited to a ‘black box’ approach hindering researchers from investigating the mechanisms behind these findings (Maxwell 2004). In a qualitative study, in-depth case studies are conducted to understand the role of intermediate factors along a causal pathway. This approach might not provide the same statistical rigor as quasi-experimental studies but can provide valuable insights into the

contribution of interventions. A qualitative impact evaluation relies on a comprehensive Theory of Change (ToC) to provide robust causal understandings. A ToC describes how the activities of an intervention are linked to the expected outcomes and impacts along specific causal pathways (Mayne 2015). In addition, a ToC also outlines what assumptions have to be met for each causal link to be realized. The sequence of each causal pathway helps to better understand the behavior of participants and the reasons for their decisions (Mohr 1999). Cases that confirmed and disconfirmed the ToC were compared to understand what factors could explain the divergence from the hypothesized causal linkages and to develop challenging explanations.

The case selection approach greatly influences the validity of causal inferences made (Seawright & Gerring 2008). In this study, a comparative-case design was used to conduct between-case assessments of tenure security. A control group was not available as all communities participated in the formalization program. Instead, cases were deliberately selected to maximize their variance in policy outcomes, specifically the occurrence of tenure-related forest conflicts among the registered communities. The aim was to understand why certain community forests were still being encroached upon despite their formalization. The critical evaluation of apparently disconfirming evidence enhanced the credibility and validity of the qualitative analysis (Booth et al. 2013).

4.3 Social network analysis

The investigation of social networks has gained growing attention within the scientific community as these complex patterns of social relations provide an important structure for the socio-ecological system (Bodin & Prell 2011). The characteristics of social networks can determine the success of collaborative resource management (Pretty 2003). This has been also the case in community forestry where the capability of members to engage in collective action strongly depends on their social cohesion (Gautam & Shivakoti 2005). Social network analysis is an analytical tool that enables researchers to quantify the characteristics of social relations reliably (Lakon et al. 2008). Social network analysis can be also used in community development projects to target influential agents that can enhance an intervention as multipliers (Prell et al. 2009). However, social network analysis has not been widely and its use in the evaluation of interventions targeting network structures has not been consolidated yet. Here, social network modeling was selected as a promising approach to evaluate the impact of the targeted social intervention on the structure of networks.

Although being useful social network analysis has been often used only for descriptive analyses and not as a tool for inferential statistics (Popelier 2018). Consequently, network modeling has been developed to fill this gap (Hunter et al. 2012). These models enable researchers to understand what social processes can explain the establishment of social relations between two actors while simultaneously considering the complex interactions with others (Lubbers & Snijders 2007; Robins 2013). Exponential random graph models (ERGM) are currently the most commonly used techniques. Social processes are conceptualized and tested by determining the probable presence of specific network configurations or statistics. Small network configurations are used to describe a network instead of its overall global network structure (Wasserman & Pattison 1996). Model parameters are fitted according to the frequency distribution of each network configuration within the observed network to determine whether their appearance differs from random network processes (Robins 2013). The model estimates indicate the likelihood of each network configuration indicating whether a hypothesized social relation is not random.

A comparative social network analysis was used to study the role of networking organizations within three communal networks. Besides two cohesive networks, a disconfirming third case was selected through key informants to understand why the intervention, that is the establishment of a networking organization, did not have the desired effect. The study did not have access to baseline information or longitudinal network data and, thus, had to rely on three cross-sectional network datasets. Each dataset was used to develop a viable model to test whether the communal networking organization enabled inter-communal information-sharing. Specifically, ERGMs were used to assess the effect of the network committee on the probability of information sharing between communities in each province.

5 THE IMPACT OF COMMUNITY FOREST FORMALIZATION ON TENURE SECURITY AND FOREST CO-MANAGEMENT IN THAILAND

Jenke, M.; Pretzsch, J. (2021): The impact of community forest formalisation on tenure security and forest co-management in Thailand. International Forestry Review 23(1): 29-40.

5.1 Abstract

The formalization of community forestry through legal registration could enhance the tenure security of local communities, although its effectiveness remains unclear. The issue of whether Thailand's registration program strengthened the tenure security of community forests and altered their customary forest institutions was investigated. The tenure security and forest management of registered community forests with varying levels of tenure disputes were compared across five different localities. The formalization process and its effects on tenure security were discussed with representatives from communal forest committees and forest officials. Findings indicated that neither management organization nor forest rules were altered following registration but remained adapted to local forest uses. Moreover, forest communities were confident in the assurance of their use and management rights. The registration generally enabled communities to prevent further forest encroachment and resolve conflicts if forest officials and police provided support. However, limited financial resources hindered communities to manage and monitor forests effectively.

Keywords: Royal Forest Department; exclusion rights; forest encroachment; illegal logging; forest tenure conflict

5.2 Introduction

Tenure security is an important prerequisite for the success of community forestry (Baynes et al. 2015; Pagdee et al. 2006). Communities are more likely to invest in the conservation and silvicultural improvement of forest resources if they are confident that their rights to reap future benefits remain protected even when being contested (Cuenca et al. 2018; Robinson et al. 2018). Without secure tenure, communities could fear the potential loss of those benefits resulting in unsustainable management decisions, overexploitation, and limited re-investment in the improvement of forest resources (Dahal & Capistrano 2006; Finley-Brook 2007). Worldwide, communities have sustainably managed public forestland based on customary tenure but usually without legal recognition and, thus, in violation of national forest laws. State-led tenure reforms have sought, among other goals, to formalize community forests on state-owned forestland to provide secure tenure by granting formal rights (Blackman et al. 2017; RRI 2012).

Tenure rights, often interchangeably used with property rights, are defined as social rules that govern how and to what extent benefits can be attained from a resource (Bromley 1993). Sjaastad & Bromley (2000) highlighted that tenure rights can provide benefits, which they term "substance", but these remain insecure without assurance. Accordingly, Arnot et al. (2011) defined tenure security as a tenure holder's expectation of losing these tenure rights, i.e. how secure one feels that their rights will be upheld by those around them. Van Gelder (2010) proposed a wider view of tenure security to consider both the perceived certainty of tenure rights and the actual (de facto) tenure security, i.e. its enforcement regardless of the legal tenure status. High tenure security arises from "clear, uncontested and enforced" rights (Larson 2012: 20).

Effective cases of common-pool resource management have shown that shared tenure rights can be secure (Gibson et al. 2000). In these cases, state authorities have endorsed co-management agreements to share certain tenure rights as well as responsibilities over a designated forest area (Banjade et al. 2017; Nsita et al. 2017; Chankrajang 2019; Larson et al. 2019). Thus, each formalization program determines which forest tenure rights from the bundle of rights are held legally by communities (Cronkleton & Larson 2015). The access to, and the withdrawal of, certain resources enables community members to use the forest. In addition to these operational rights, communities require management and exclusion rights to make long-term forest management decisions and to adapt to changing circumstances (Cronkleton et al. 2012). Management rights enable the communal right holders to decide how to invest in, use,

and allocate forest resources (Agrawal & Ostrom 2001; Schlager & Ostrom 1992). These decisions can be made for a forest area or a particular resource, e.g. the planting and utilization of a certain tree species. Furthermore, the right to design rules, monitor their compliance, and mediate disputes are also considered management rights (Agrawal & Ostrom 2008).

Exclusion rights enable communities to protect forest resources from overexploitation by restricting the access or withdrawal rights of other forest users. Lastly, alienation rights control the sale or transfer of tenure rights. However, the transfer of tenure rights is constrained in community forest arrangements either by customary institutions, formal restrictions by the state, or both (FAO 2002). In co-management arrangements, tenure rights are formally held jointly by a community forest committee and a state agency, except for the right of alienation (Carlsson & Berkes 2005).

Co-management could secure communal tenure if the state could make local forest users feel more confident in keeping their rights (Saito-Jensen et al. 2015). Furthermore, mapping, recording, and documentation of forest tenure are seen as critical to officially involving local communities in the management of forest resources (Riggs et al. 2016). This process can strengthen the exclusion rights of a community, i.e. their capacity to prevent others from accessing their forest area and withdrawing forest resources without their consent (Buntaine et al. 2015). The official recognition and legal documentation of a community's tenure claims can facilitate its access to the state's legal enforcement capabilities. In such cases, a community can enforce the boundaries of its forest and exclude competing tenure claimants more easily to increase their tenure security (Dahal et al. 2010). Thus, formalization can be a defense mechanism against illegal deforestation. However, if the state does not enforce the community's formal rights, official registration remains ineffective and does not strengthen the community's tenure security (Cronkleton et al. 2010; Cronkleton et al. 2017; Larson et al. 2010). Similarly, granting a more complete bundle of tenure rights would not necessarily improve tenure security if community members anticipated losing those rights or were unable to enforce them (Arnot et al. 2011).

Replacing well-established traditional tenure regimes with standardized rules can affect forest conditions negatively (Shanmugaratnam 1996). Following state-led formalization, customary rules, management practices, and decision-making procedures can either be legally recognized or replaced by state-mandated institutions and management practices (Ribot 2002; Robinson et al. 2018). The implementation of these policies has been criticized as cumbersome while putting

an unnecessary burden on communities (Virapongse 2017). Thus, the investment required by communities to formalize tenure rights and improve forest resources could outweigh the expected benefit streams (Mahanty et al. 2009).

In Thailand, communities began to organize networks in the early 1990s in order to advocate for the legal recognition of community forests aiming to strengthen communities' forest tenure rights through official titles that operated under customary rules (Poffenberger & McGean 1993). In 2000, Thailand's forest state authorities started to officially recognize community forests. This formalization program built upon a co-management approach in which use rights, management rights, and exclusion rights are co-shared between the community and the state through the Royal Forest Department, or RFD (Chankrajang 2019).

This study aimed to analyze how the formalization of community forests affected the security of different tenure rights and whether it resulted in an institutional change within the community. Specifically, it was assessed how registered community forests perceived their tenure security in case of tenure-related conflicts. Communities from five different provinces were included to determine whether the outcomes of registration differed between localities.

5.3 Background

In Thailand, community forestry began during the 1980s as local people began to organize groups for the protection and management of their surrounding forests in response to continuing forest degradation (Pagdee et al. 2006, Salam et al. 2006). Particularly in northern Thailand, traditional forms of communal irrigation systems may have been a starting point for Thailand's contemporary community forestry, in which irrigation groups were organized to conserve local watershed forests (Johnson & Forsyth 2002). Communities began to protect surrounding forests against illegal logging as a response to the state's absence (Ibid.). Community forestry spread through Thailand as local leaders from other regions visited these sites and initiated similar management models in their home regions (Poffenberger & McGean 1993).

In 1990, a committee consisting of forest officials and academics was appointed by the government to draft a Community Forest Act to formalize the growing number of community forests (Weatherby & Soonthornwong 2008). The stated objective was to reduce tenure conflicts in state-owned forestland, which resulted from the large number of people living in these areas, and to rehabilitate degraded forests. However, the Community Forest Act was only passed in May 2019 after ensuing disagreements over the legalization of community forests within strictly protected areas (Vandergeest 1996). Regardless of the progress of the

Community Forest Act, the RFD implemented a procedure to register community forests in 2000 (Sharp & Nakagoshi 2006; Wichawutipong 2005), which was administered based on Section 19 of the National Reserve Forest Act (Onprom 2013) and, since May 2019, by Section 4 of the Community Forest Act.

Between 2000 and 2020, over 10,000 villages registered their forests with the Royal Forest Department (RFD) to formalize their customary tenure rights (Boonyananta et al. 2012; RFD 2021). Although many communities had already managed local forests over several generations, the majority of community forests have been established during the beginnings of Thailand's community forest movement in the 1980s (Wittayapak & Dearden 1999; Sukwong & Makarabhirom 2000). Inspired by the example of other communities, villagers developed their own forest institutions and governance (Salam et al. 2006; Soontornwong 2006).

Local state officials tend to tolerate customary community forestry as long as it does not conflict with the state's forest management objectives (Onprom 2013; Soontornwong 2006). However, communities without formal tenure rights remain at risk of losing access to their forest or face prosecution for illegal forest activities (Hirsch 1990). Moreover, the enforcement of statutory laws can reduce or eliminate forest benefits enjoyed by communities based on their customary rights. For instance, the establishment of new protected areas is associated with stricter law enforcement resulting in the eviction of local communities or the restriction of their access to forestland (Roberts 2016).

The Community Forest Act (2019) stipulates the following procedure for the registration of community forests: (1) The village head or a sub-district official applies to register the community forest on behalf of the community's residents. (2) The required documents include the signed approval of 50 community members, a map of the community forest area, and a formal management plan. (3) All documents have to be approved by an RFD official and the provincial administrative organization. (4) Upon registration, communities receive a certificate granting certain use and management rights. (5) The communal forest committee has to revise its management plan every 5 years. If the community is unable to conserve their forest, the registration is withdrawn.

5.4 Methodology

5.4.1 Research approach

A case-control study design was used to assess perceived tenure security among communities with and without tenure conflicts. Community forests were selected through a stratified

purposive sampling procedure based on the presence, both in the past and present, or absence of tenure conflicts. Tenure-related conflicts included illegal logging, forest encroachment, and the alienation of tenure rights. Using random sampling would have been infeasible due to the regionally-varying occurrence of tenure conflicts.

Forests were sampled from five different provinces to identify location-dependent factors that could potentially confound the relationship between registration and tenure security. A database containing registered community forests has been made publicly-available by the RFD from which a district in Phitsanulok province was selected for a pilot survey. In each of four additional provinces, one district was randomly selected. Subsequently, four communities were sampled in each district. The aim was to increase the variance of cultural, ecological, economic, and administrative factors within each stratum but to reduce the variance between strata.

5.4.2 Study sites

The study sites differed greatly in the condition of their forest cover, population density, and average income (Figure 5-1). Three sampled provinces, Lampang, Phitsalunok, and Uttaradit, were located in Thailand's northern region, which is densely forested and, consequently, contains a large number of community forests. Nakhon Phanom is located in north-eastern Thailand, in which natural forests remain only in smaller areas, rarely forming connected forest areas. Rayong is located on Thailand's industrialized eastern seaboard with very little remaining forest cover.

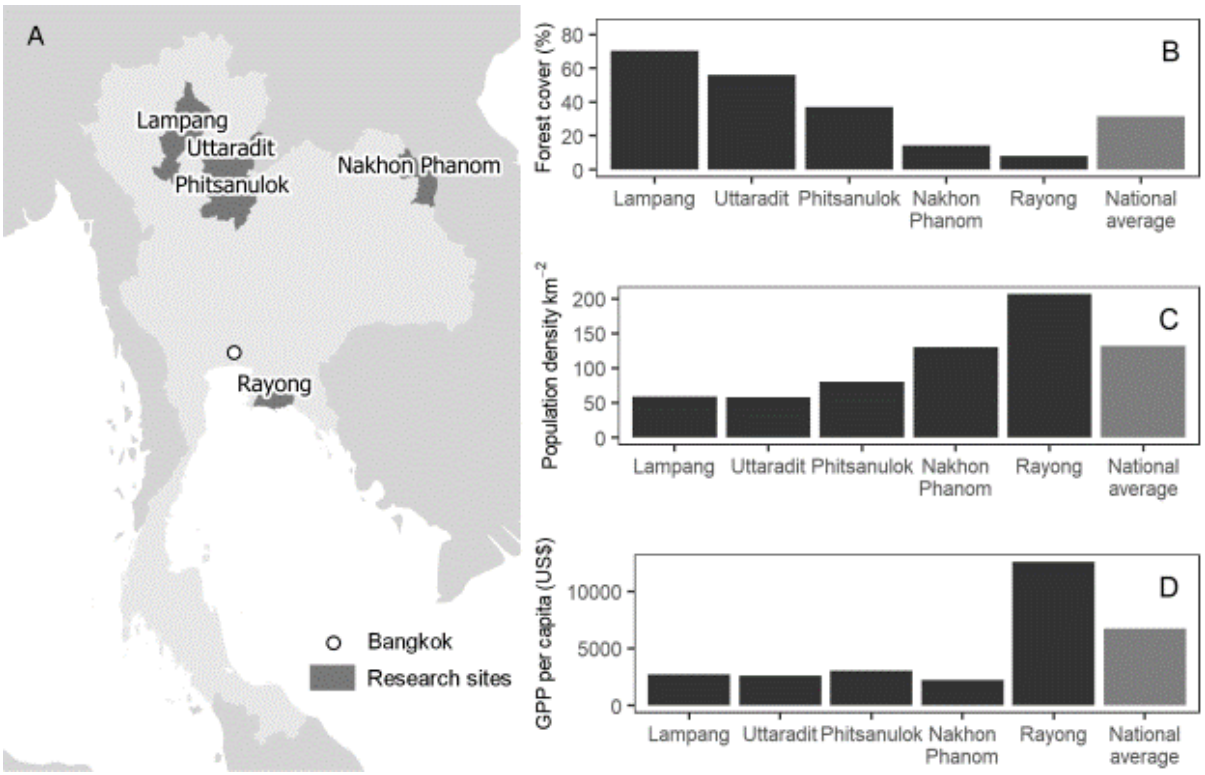


Figure 5-1: Location of the sampled provinces (A) and comparison of sampled provinces with the national level of forest cover in 2019 (B), population density (C), and gross provincial product (D). Data sources: RFD (2020); NESDC (2019)

5.4.3 Assessment of tenure security

Semi-structured interviews were conducted with one key informant from each community forest organization. Each respondent was asked to retrospectively assess the outcomes of their registration. Interview questions were organized into three parts to assess the tenure security of use, management, and exclusion rights. In the first part, the questions explored the history of their community forest and its registration process, the perceived benefits and challenges that arose before, during, and after the registration process. In the second part, questions discussed the effects of registration on use and management rights through an assessment of their economic and forest management activities before and after the registration. In the third part, questions particularly focused on how committees dealt with tenure conflicts before and/or after their registration in order to understand the security of their exclusion rights.

Tenure security is partially determined by the tenure holder's perception of security, i.e. the perceived probability of losing tenure rights. Thus, respondents were asked to rate how confident they were that each tenure right was upheld and enforced in their future security. Representatives from 20 communities were interviewed (Table 5-1).

Table 5-1: Location and code of interviews with community representatives

Province	*Communities with tenure conflicts*	*Communities without tenure conflicts*
Lampang	L1, L3	L2, L4
Nakhon Phanom	N1, N2	N3, N4
Phitsanulok	P1, P4	P2, P3
Rayong	R1, R4	R2, R3
Uttaradit	U1, U4	U2, U3

In addition to community representatives, six RFD officials (O1-O6) from the headquarters and provincial offices were interviewed, first, about the forest co-management with communities, and second, about the occurrence and resolution of tenure conflicts in community forests. If encroachment into the community forest occurred, the role of the RFD in assisting the community in preventing destruction was discussed further. All interviews were conducted by telephone with a Thai researcher over a duration of 30-60 min, audio-recorded, and transcribed. All respondents were assured of their anonymity. Interviews were conducted December 2020 - January 2021 during the COVID-19 pandemic.

5.5 Results

5.5.1 Registration process

The attitude among communities toward the registration program shifted over time from cautious observation to confident engagement with local RFD officials. A community representative whose community was among the first to register their forest in 2004 stated that villagers were cautious in the beginning. "*There was fear because it [the consequences of registration] was unknown. But then there was no fear because the [RFD] officials explained to the villagers that they could continue their activities as before*" (L3). Under the pressure of continuing forest encroachment, these early-registered communities decided to formalize their tenure claims to protect their rights, as explained by another respondent: "*We wanted to prevent from being further encroached*" (R1). A community in Rayong was afraid that their urban forest could be cleared for new residential development projects, "*Land here is very expensive, and we registered the forest before someone would clear it*" (R3). Another factor that spurred registrations was the mutual support among communities: "*When the government announced that we can take care of the forest around our village, all nearby communities went to register.*

So we went together" (L4). No interviewed community was engaged with a non-governmental organization before or during its registration.

All respondents received support from the RFD to prepare registration documents, who also provided technical assistance by surveying and demarcating the community forest area. This made communities confident about the registration process, "*It was not difficult, the staff helped us to prepare all documents*" (N3). The establishment of a forest management committee was also required. Most communities already had a forest management group, which had often less than five members. These groups had to seek additional members and formalize their committee in a membership list. However, unresolved tenure conflicts did delay the registration process, "*Before the registration, some community members were hired by an investor to clear the forest and plant rubber trees*" (P4). Both overlapping claims could not be supported by formal documentation making it more difficult for the community to secure their tenure rights. "*Only after they abandoned the rubber plantation did the forest officials register our community forest*", according to the same respondent (P4).

5.5.2 Security of use rights

All respondents stated that they were never seriously concerned about being restricted from their community forest by RFD officials even without formal registration documents. When asked whether communal forest users were afraid of coming into conflict with RFD officials, most respondents stated that they were not afraid even before their registration. One representative stated that "*We used to have fear, but now we are not afraid*" (L4). Consequently, villagers could collect forest products without fearing a confrontation with the state.

Community representatives stated that forest use did not change after their registration. All respondents were fully confident that villagers would be able to collect forest products and continue their management in the future as they did in the past and, therefore, perceived their use rights as secured. Moreover, no community abandoned activities related to forest use.

The provision of NTFPs, such as mushrooms, bamboo shoots, and medicinal plants, was an important management objective of all communities in addition to preserving the forest's protective ecosystem services. Thus, community forestry was practiced through multiple-use forest management that has been integrated into the community.

There is a general agreement among community members that rules regarding forest use should be adapted to local conditions, as summarized by one committee representative "*Community forestry has a different context in each area; some might have problems with illegal logging*

and others with livestock [grazing]; each needs their own rules" (N1). Similarly, RFD officials stated, "*We let communities develop their own rules*" (O2). This adaptation to local conditions is also indicated by the wide range of different forest uses across regions, which also include livestock grazing and resin tapping in north-eastern Thailand, in this study Nakhon Phanom province.

The extraction of timber for both subsistence and commercial use remains illegal under Thailand's national logging ban in natural forests imposed in 1989. However, committees in seven communities have implemented parallel local rules to regulate the selective cutting of smaller-sized trees by members. Timber extraction by community members is highly-regulated and requires approval from the management committee. As a result, timber extraction is approved in cases of emergencies, "*We allow villagers to cut trees [for timber] if they have lost their home after a fire and are too poor to rebuild it*" (L1). The same respondent stated that the committee was aware of cases where logging permits have been misused to sell timber outside the village. As a consequence, committees closely inspect the housing conditions of each applicant. These communities are located in both northern and north-eastern Thailand and, thus, the practice is not limited to a particular area. All RFD officials are aware of the local use of timber but do not report it as a violation of the logging ban and let communities decide instead, a view that was exemplified by the quote of one local official: "W*e know that it is not allowed [prohibited by the national logging ban] but some villagers rely on timber, we try to find a compromise [by making informal exceptions]*" (O4). Local RFD officials were more inclined to tolerate communal forest use as long as it was practiced on a limited scale and communities continued to conserve and restore forest areas.

5.5.3 Security of management rights

All villages in the study had managed a forest area for at least 30 years under customary rules. Communities organized and conducted planting, patrolling, and fire suppression in their forest before its registration and did not abandon management activities afterwards. Instead, all activities were formalized and scheduled through a management plan, which was jointly-drafted with RFD officials, *"What changed after the registration was [the implementation of] our formal management plan. We also divided the forest into a strict conservation zone and a use zone"* (L2). Two other communities used management zoning to implement different objectives as well. In 2019, the designation of management and use zones had also been included in the national legal framework through the Community Forest Act. Forest fire management and

suppression has become a major focus in the RFD's support of community forests as particle pollution from forest fires has become a national problem. In the case of larger forest fires, the local network of communities and the RFD coordinate activities, "*RFD officials organize people from other villages if our village cannot handle it*" (U2).

Communities conducted restoration activities, although these were limited to the planting of nursery-raised seedlings to restore open sites or to enrich the diversity or value of forest stands. One community used natural regeneration instead of artificial regeneration in order to maintain a successional forest ecosystem (P2). Although tree seedlings are provided free of charge from state-run nurseries the diversity of available tree species is limited as most local tree nurseries offer only commercially-relevant species. This led to problems in one community whose representative stated "*We wanted to plant a local tree species but were unable find seeds or seedlings*" (P2). These villagers planned to rehabilitate their community forest by planting *Sandoricum koetjape* (Burm.f.) Merr., which had grown in this forest area naturally in the past. Their management goal was to provide a habitat for birds and wildlife which inhabited the forest area before its deforestation.

All communities received a one-time payment ranging between 40,000 and 150,000 THB ($1 = 30 THB) during their registration to create border markings and signage at forest entrances. The amount differed significantly between provinces and years. Moreover, funding was not adjusted to the area of the community forest, which made it more difficult to fund the protection of larger forest areas. Although community members provide valuable services through voluntary work, in some cases this was not enough and several respondents of communities with larger forests complained that the RFD did not provide enough funding to patrol and monitor their entire forest. Limited funds meant that communities organized forest patrols only when issues with illegal logging existed. Other committees relied on community members to report illegal activities.

5.5.4 Security of exclusion rights

Community representatives were 'fully confident' concerning their capacity to exclude encroachers or gatherers if they had previously dealt successfully with tenure conflicts, suggesting a high level of perceived tenure security. Communities try to resolve violations of local rules through awareness-raising and graduated sanctions. More severe acts can be punished through a fine, as outlined by one respondent, "*If one tree is smuggled, we fine [the smuggler] 10,000 THB ($1 = 30 THB) and contact the police, otherwise our forest would*

become degraded" (L2). Generally, the forest committee would file a report of the forest-related crime with the local police either alone or together with a local RFD official. If possible, a local RFD official would attempt to mediate the dispute. Communities did not have access to additional legal aid but relied on support from the RFD.

The causes of forest encroachment differed between regions. In Nakhon Phanom, the forest cover is low and encroachment is less likely as remaining forests are located on sites that are unsuitable for agricultural use. In contrast, forests in the northern region (Lampang and Uttaradit province) are being cleared for farming. Similarly, the high land values in and around urban forests put them under high pressure from residential encroachment. Despite these differences, registration hindered the appropriation of forestland within community forests. One community member assumed that "*Investors would try to use their contacts in the Land Department to get a chanote [full private land ownership deed] in a forest, this is more difficult in a registered community forest*" (R3).

Two communities were unable to resolve tenure conflicts and lost de jure or de facto tenure rights over parts of their forest after its successful registration and demarcation. In the first case, the community in Uttaradit (U2) had to give up legal use and management rights over a smaller forest area to the Agricultural Land Reform Office (ALRO) due to conflicting land use maps. The tenure rights could not be defended by the RFD in this inter-agency dispute. In the second case, a community's forest committee reported to the local police office that areas of their community forest had been cleared for the cultivation of cashew trees one year after its registration. However, efforts to exclude encroaching farmers were not supported by local police or RFD officials due to the apparent political influence of the new landowner. As a consequence, the community lost de facto tenure rights over the cleared forest area. The respective community representative was desperate as the conflict could not be resolved, "*Nobody is helping me*" (P1). When asked about such tenure conflicts, RFD officials try to avoid further questions: "*It's difficult to explain, I don't want to have a problem*" (O5).

5.6 Discussion

In Thailand, local communities manage approximately 0.97 million ha of public forestland (Chankrajang 2019) and have been able to formalize their forest tenure through a co-management scheme with the RFD since 2000. Although registration represents a considerable investment for communities (Gray et al. 2015) the legal formalization of community forests is thought to strengthen the security of the community's tenure rights if a community forest has

been established under customary rights (Saito-Jensen et al. 2015). However, it is unknown to what extent Thailand's registration program replaces local institutions and management systems with external state-initiated rules and how effectively it ensures the tenure security of communities. In this study, representatives from community forests were interviewed to identify possible effects of formal registration on actual and perceived tenure insecurities.

Registration of the co-management scheme has increased tenure security of communities in two ways. First, communities could use their registration to protect their forest against encroachment by farmers, plantation owners, or real estate developers. The formal registration of co-managed forests has made it more difficult for outside investors to secure titles to claim land ownership within public forestland; a problem has been occurring throughout Thailand since the 1980s (Ganjanapan 1994; Peluso et al. 2012; Wittayapak & Dearden 1999; Wittayapak & Baird 2018). Interestingly, the perceived tenure security of communities was very similar across different regions suggesting a similar outcome. Second, the registration strengthened the sense of responsibility within communities to prevent illegal logging. Their legal exclusion rights did not change with regards to logging as it remains illegal in all natural forests regardless of their status as a community forest, and, thus, could be reported to the RFD. However, members were more confident in reporting and prosecuting activities that defied 'their' forest rules. Illegal loggers were increasingly challenged and, if necessary, reported to the local police. Thus, the communities' de facto exclusion rights became stronger as communities organized regular patrols or checkpoints, and communities were more willing to invest in forest protection.

Despite these advantages to registration, the successful resolution of tenure disputes and, thus, the actual security of communal exclusion rights depends on the support from government agencies, most importantly the local police and the RFD (Chankrajang 2019). In a possibly exceptional case, a politically-influential businessperson was able to discourage state authorities from providing legal aid for a community that *de facto* lost co-shared tenure rights as a result. It is, thus, a concern that the failure of state authorities to enforce formal tenure rights could significantly affect the risk perception of other communities. However, it should be highlighted that, in this case, encroachers did not expand further into the community forest after being reported. These findings show that the formalization of customary tenure rights, especially exclusion rights, can strengthen tenure security if they are legally enforced by the state.

Registration requires the formal sharing of management rights and responsibilities with the RFD, equivalent to a co-management approach (Carlsson & Berkes 2005). As such, communities were able to develop a wide range of locally-adapted rules for the shared use of forest products. During the registration, communities formalized each set of rules by displaying them on signs for community members and visitors from other areas. The sets of customary management rules could be similar within districts but varied across regions depending on the local management objectives. However, they were not altered as a consequence of the registration. Similarly, forest committees were formalized but their organizational structure was not altered. The bureaucratic process of registration was facilitated by state officials, so that communities were not unnecessarily burdened. These findings contrast with earlier studies and showed that community forestry was less developed in Thailand, and that customary institutions were more likely to be disregarded by forest officials (Johnson & Forsyth 2002). The community forest program provided an important platform to build trust between communities and the RFD. Thus, it could be suggested that communities in Thailand have gained more autonomy in the management of their forests, a process that has been recommended by many scholars (Ribot 2002; Cronkleton et al. 2012).

The RFD have co-shared rights but transferred most responsibilities to communities as their capacity is too limited to engage in active collaborative forest management. Local communities received limited *de jure* tenure rights over their forest. However, beyond the recognition of tenure rights, the inputs from the RFD were limited. Committees found it difficult to finance management activities as revenues were not be generated from the utilization of forest resources. Some possible revenue-generating options that could be considered are ecotourism (Laverack & Thangphet 2009) or the processing and marketing of NTFPs (Thammanu et al. 2020). Furthermore, regular forest inventories, which would be necessary to evaluate the effect of management practices on forest conditions, were neither planned nor implemented by the RFD. A similar issue has been documented by De Royer et al. (2018) in Indonesian community forests.

The locally-regulated use of timber resources by some communities suggested that communities developed of a mix of customary and formal forest institutions following their registration. Communities were confident that the selective harvesting of timber for local use would not be prohibited by RFD officials despite its ban by national law. These communities could rely on *de facto* tenure security based on their agreements with local RFD officials who recognized their use informally. Moreover, the Community Forest Act (2019) permits the

harvest of low-quality timber species by community forest members but prohibits the extraction of commercially-valuable timber species, which are listed as reserved in the Forest Act. This would not legalize all timber harvest currently conducted within community forests according to state laws yet but it would enhance the alignment of local rules and state laws and provide a higher level of legality for communities.

Districts from southern Thailand were included in the study but not selected through the random sampling process. The social, economic, and ecological conditions in the southern region can differ from the sampled research sites located in central, north, and north-eastern Thailand. But the findings amongst the provinces included in the study were similar suggesting that communities across the country can be more confident of securing their tenure rights through a formal registration process regardless of varying local conditions, such as encroachment pressure or the value of forest products.

This study was limited to the investigation of external relations between communities and extra-communal actors. Thus, interviews were only conducted with community representatives that understood the tenure security of their community forest and could assess how the registration affected it. However, internal interactions among community members, specifically between the forest management committee and forest users, were not investigated. It is possible that some forest users could lose their rights to withdraw certain forest products, such as timber or bamboo, or use forests for grazing due to restrictions implemented by a committee to prevent overuse by community members or establish a conservation zone within the community forest. Thus, the security of use rights can differ between community members. These differences can ultimately result in internal conflicts if the community lacks sufficient social cohesion. Thus, future studies should investigate the potential for communal conflicts over forest resources and approaches to adapt local institutions to changing ecological and social conditions.

5.7 Conclusion

Although the formalization of customary forest tenure rights has been promoted to enhance the tenure security of communities in Thailand, its effectiveness to date has been unclear. This study found that while registration enhanced the ability of communities to prevent further forest encroachment and to deter illegal loggers indicating secure exclusion rights communities depended on the local law enforcement agencies and forest authorities to enforce their rights. Furthermore, communities were not required to alter forest rules during their registration resulting in the formalization of locally-adapted forest co-management systems. The required

registration procedures did not put excessive burden on communities as the process was facilitated by local RFD officials. These findings suggest that the formalization of community forests can enhance tenure security while preserving customary forest uses.

6 COMMUNITY-BASED FOREST MANAGEMENT MODERATES IMPACT OF DEFORESTATION PRESSURE REGARDLESS OF FORMALIZATION IN THAILAND

Jenke, M. (Under Review): Community-based forest management moderates impact of deforestation pressure regardless of formalization in Thailand. Land Use Policy.

6.1 Abstract

Governments are legally formalizing an increasing number of community forests by sharing and transferring tenure rights over state-owned forestland in an effort to reduce deforestation. However, there has been little evidence on whether their conservation effectiveness could be further strengthened through formalization. In Thailand, the Royal Forest Department began to register community forests in 2000. The objective of this study was to assess the effectiveness of community forests in moderating the impact of deforestation pressures and the effect of a legal formalization.

In a spatial evaluation approach, statistical matching and fixed-effects models were used to analyze the effect of community-based forest conservation and its formalization on deforestation rates. Each analysis was conducted in provincial areas sampled from northern, north-eastern, and southern Thailand (n = 680) to compare the impact of varying levels of deforestation pressure over 14 years.

The large majority (82%) of sampled communities effectively protected their forests against deforestation regardless of their formalization status. Moreover, the likelihood of forest loss in regions of high deforestation pressure could be reduced from approximately 40% to almost zero. In contrast, the threat of deforestation did not significantly change after a formal registration. These findings were similar across different regions despite their biophysical and socio-economic differences.

These findings suggest that formalization itself is currently ineffective in strengthening communal forest conservation and that its implementation in Thailand is likely still lacking behind its potential. Registered community forests are still affected by forest encroachment despite their successful conservation efforts. Thus, communities require stronger support from forest officials and local law enforcement agencies in both legal and technical capacities.

Keywords: avoided deforestation; forest cover change; deforestation pressure; spatial impact evaluation; propensity score matching; panel regression

6.2 Introduction

Forest-dependent communities are immediately affected by deforestation and forest degradation as they rely on intact forests for a wide range of provisioning, regulating, and cultural ecosystem services (Ferraro et al. 2011). Many of these communities initiated new local forest institutions or strengthened existing ones in an effort to conserve forests, sustain the provision of ecosystem services, and secure their livelihoods (Oldekop et al. 2019; Rana & Miller 2019). There is growing evidence that self-initiated community forest are an effective forest conservation strategy (Klooster & Masera 2000; Porter-Bolland et al. 2012; Santika et al. 2017). However, customary community forests often lack full tenure security and are, thus, vulnerable to encroachment by powerful outsiders, which could reduce their effectiveness in avoiding deforestation (Robinson et al. 2018). Only recently have governments started to provide communities with formal tenure rights over their forests (Blackman et al. 2017). Official recognition, or formalization, can provide communities with legal means to prevent forest encroachment by outsiders further lowering deforestation rates (Bray et al. 2008; Larson et al. 2010; Robinson et al. 2014).

Community forestry can promote forest conservation and sustainable use through direct forest-safeguard measures and the establishment of common property resource institutions. First, organized communities patrol forest areas to deter forest encroachers and can report offences to local law enforcement (Pinyopusarerk et al. 2014). Second, locally recognized institutions, such as sets of use rules and norms, can discourage forest users from using destructive utilization practices (Cox et al. 2010). Moreover, strong institutions also make community members more likely to organize and engage in collective action to support protective measures (Ellis & Porter-Bolland 2008). Community members are more likely to adhere to forest conservation if rules are part of locally accepted institutions (Larson et al. 2010; Andersson & Agrawal 2011). However, a community that is weakened by dysfunctional local institutions is

unlikely to maintain common tenure rights over forests, which would potentially diverge into open access accelerating encroachment (Osei-Tutu et al. 2015).

State authorities around the world have officially recognized community forest management on more than 513 million ha (FAO 2010; RRI 2014). There have been differences in national formalization policies but also similarities within regions, specifically in the range of tenure rights that are officially transferred to local communities (Larson et al. 2010). Most national policies in South-East Asia outline a sharing of tenure rights between local communities and state authorities, who retain alienation rights (Sunderlin 2011). The formalization of communal tenure rights could strengthen tenure security as communities can gain access to financial, technical, and legal support from state authorities (Wright et al. 2016). Sustained funding can ensure that villagers can organize and conduct regular forest patrols (Pagdee 2006). Technical support often entails a survey and the demarcation of forest boundaries (Cox et al. 2010). However, community forestry will only benefit from formalization if the community's perceived level of tenure security can be increased (Stickler et al. 2017; Robinson et al. 2018). In particular, assured backing from law enforcement agencies is essential in enforcing the communities' rights of exclusion against illegal forest encroachers (Larson et al. 2010). A formalization that does not ensure legal support will not secure formal tenure rights and, thus, not be effective. On the other hand, secured tenure rights might reinforce a community's motivation to engage in collective action (Pagdee et al. 2006).

Community-based forest management, including conservation, do not only differ in terms of their governance but also in the conditions of their forest resource. Community forests vary greatly in size, forest conditions, and accessibility ranging from small communal woodlots to vast forest reserves, which are either part of a fragmented forest mosaic or embedded within a primary forest landscape (Nagendra 2002; Putraditama et al. 2019). Consequently, their exposure to deforestation threats is likely to differ depending on their accessibility (Trisurat et al. 2010; Trisurat et al. 2019). Thus, their effectiveness in forest conservation will not only depend on their protection measures but also on the level of deforestation pressure in the surrounding area, which has been already shown for protected areas (Nolte et al. 2013; Cuenca et al. 2018). More exposed community forests likely require greater protection efforts and could benefit more from secure tenure rights compared to less-threatened communities. The underlying threat of forest conversion to other land uses, or deforestation pressure, should be considered when evaluating their effectiveness as, otherwise, the potential benefits in high-risk areas would be underestimated.

This study aims to evaluate (1) whether community forestry would moderate the impact of regional deforestation pressure and (2) whether their formalization affected deforestation rates. These effects were analyzed based on the spatial variations of deforestation patterns relative to community forest boundaries (Blackman 2013). The study focused on community forests in Thailand, where communities could register their forests with the Royal Forest Department (RFD) since 2000 (Salam et al. 2006). Two analytical approaches were used to control for potentially confounding biophysical and administrative factors, propensity score matching and fixed effects models (Jones & Lewis 2015). First, propensity score matching was used to identify similar forest patches within and outside of community forests and compare the impact of deforestation pressure. Second, fixed effects models were used to analyze deforestation rates within community forests before and after their official registration. A longitudinal panel dataset was created by joining publicly available maps of community forests in 10 Thai provinces with a high-resolution forest cover dataset (Hansen et al. 2013) to determine each forest's annual deforestation rates from 2001 to 2012. It has to be acknowledged that the maintenance of forest cover is only one conservation-oriented objective, which can be can be associated with marginalization of poor community members (Chomba et al. 2015) but also improve well-being through the secured provision of ecosystem services (Agrawal & Chhatre 2006).

6.3 Methodology

6.3.1 Study area

Thailand's rapid economic development was paralleled by continuous deforestation following the expansion of agricultural production, particularly corn, as well as mining and infrastructure development (Delang 2002; Zeng et al. 2018). Consequently, national forest policies emphasized less on timber utilization and focused on forest conservation. In 1985, a National Forest Policy was issued to stop deforestation by reserving 15% of land area as production forest and 25% as conservation forest (Zurcher 2005), in addition to the already established protected areas (Sims 2014). After devastating floods and landslides in 1988, a nationwide ban on logging in all natural forests was declared (Lakanavichian 2001). However, new forest legislation failed to stop deforestation, and as a consequence, national forest cover reached a minimum of 25.3% in 1998 but slowly increased subsequently (RFD 2020).

Self-initiated community forestry has been traditionally widespread in Thailand and even conducted on state forestland. Its numbers have increased rapidly since the 1980s (Poffenberger

& McGean 1993). Since 2000, Thailand's Royal Forest Department (RFD) has officially recognized over 10,000 self-initiated community forests representing 15% of all village administrations (Chankrajang 2019). In order to register their forest formally, communities were required to organize a committee responsible for planning and implementing forest management activities and to demarcate their forest area. Registered communities are legally permitted to collectively manage and use state-owned forestland outside of protected areas (Boonyananta et al. 2012). Forest use is restricted to the collection of non-timber forest products for subsistence use whereas large-scale commercialization is prohibited for all forest products. Many villages are dependent on a steady water supply for the irrigation of rice paddies and intensified their efforts to protect watershed forests after experiencing declining harvests following the deforestation of surrounding forests (Poffenberger & McGean 1993; Wittayapak & Dearden 1999; Apinyaa 2001; Johnson & Forsyth 2002; Salam et al. 2006). Hence, a community's incentive to manage forests stems from its stronger dependence on regulative ecosystem services instead of marketable forest products. This conservation-oriented management is also enforced through the national logging ban, which prohibits logging and forest conversion of natural forests located within conservation reserve forests (RFD 2011).

6.3.2 Data and samples

Forest cover in 2000 and deforestation for the years 2001 - 2012 were retrieved from high-resolution raster maps compiled by Hansen et al. (2013; version 1.0). Later years were not included in this analysis to ensure data consistency as recommended by Hansen et al. (2013). The dataset has a spatial resolution of 1 arc-second per pixel cell ranging from approximately 29 m to 30.7 m in Thailand. Forest cover is a continuous variable that ranges from 0% to 100% in each raster cell in 2000. Deforestation is a continuous variable indicating the year of a subsequent stand-replacing event ranging from 2001 to 2012. In this study, only areas with a canopy cover of ≥ 10% in 2000, the beginning of the observation period, were regarded as forest according to FAO (2001) and included in the subsequent analysis. However, this forest map did not provide detailed information about forest types and did not distinguish between tree plantations, secondary or primary forests (Wichawutipong 2006; Johnson 2015). The land-use status of each forested cell was determined based on the national forest land use map for 2000 provided by the RFD. This dataset did not provide information about a decline in forest cover indicating forest degradation but its high spatial resolution made it possible to detect the appearance of small forest clearings with a size of approximately 0.09 ha.

The boundaries and registration time of community forests were obtained from the Office of Community Forest Management, RFD, which is in the process of digitizing the boundaries of all registered community forests. Accurate and complete maps were available for 10 provinces located in three regions: Ubon Ratchathani (north-eastern region), Chumphon, Krabi, Phang-Nga, Phuket, Ranong, and Surat Thani (southern region), and Chiang Rai, Phrae, Lampang, and Tak (northern region). Forest areas smaller than 1 ha were excluded as the spatial resolution of forest cover change maps was too low to determine whether deforestation occurred within or outside their boundary. Thirty community forests had a forest cover < 10% and were excluded from the analysis. The final sample contained, in total, 773 community forests representing 14.3% of all forests registered nationally by 2012, i.e. at the end of the observation period.

The boundaries of National Reserve Forests were provided by the Royal Forestry Department, whereas the boundaries of protected areas were obtained from the World Database on Protected Areas (UNEP-WCMC & IUCN 2020). The boundaries of sub-districts were made available by the Thai National Statistical Organization (Global Administrative Areas 2012). The distance to the nearest rural population cluster with a population density of at least 300 inhabitants per km^2 was calculated using the Global Human Settlement Layer for 2000 (Pesaresi & Freire 2016; Florczyk et al. 2019). The annual mean temperature and the precipitation of the wettest month were retrieved from WorldClim (Fick et al. 2017) and extracted for the study area. The underlying soil type of each forest cell was extracted from the FAO-UNESCO Digitized Soil Map of the World (FAO 2007).

6.3.3 Data analysis

6.3.3.1 Deforestation pressure

Deforestation pressure was defined as a significant clustering of forest loss within a radius of 50 km, which was calculated using the Getis–Ord G_i^* statistic (Ord & Getis 1995; Harris et al. 2017). The use of the G_i* statistic in the spatial analysis of local deforestation rates, as shown by Harris et al. (2017), was expanded by applying the spatio-temporal G_i^* statistic developed by Tang et al. (2019). This modified statistic measures the degree of spatial clustering of deforestation events and also enables the identification of annually recurring hotspots. Deforestation rates (ha km^{-2}) within natural forest areas as classified by the national forest land use map were calculated and aggregated to the sub-district level. Note that all logging within natural forests is illegal due to the nationwide logging ban. Deforestation hotspots are indicated

by G_i^* values that are significantly higher than the expected mean value for a specific area and year and calculated as:

$$G_i^*(d,t) = \frac{\sum_{t=0}^{l}\sum_{j\in\partial \mathrm{i}} w_{ij}(d,t)\cdot x_{jt} - \bar{x}\sum_{t=0}^{l}\sum_{j\in\partial \mathrm{i}} w_{ij}(d,t)}{S\sqrt{\frac{n\sum_{t=0}^{l}\sum_{j\in\partial \mathrm{i}} w_{ij}^2(d,t) - \left(\sum_{t=0}^{l}\sum_{j\in\partial \mathrm{i}} w_{ij}(d,t)\right)^2}{n-1}}}$$

Where x_{jt} is the deforestation rate in sub-district j, ∂_i represents the neighboring sub-districts, l is the time lag in years, n the number of spatio-temporal observations from neighboring sub-district, w_{ij} is spatio-temporal weight function, which declines with increases spatial distance and larger time lags, and $\bar{x}$ and S represent the mean deforestation rate and the standard deviation of spatio-temporal neighboring sub-districts (Tang et al. 2019).

6.3.3.2 Propensity score matching and autoregressive logistic regression

The effectiveness of community forests, regardless of their registration status, in avoiding deforestation was assessed by matching community forest areas (treatment) with areas outside of community management (counterfactual). Propensity score matching was used to identify forest cells under community management that were very similar, if not identical, to raster cells located outside to control for confounding factors that would influence both the likelihood of deforestation and the presence of a community forest.

The analysis was conducted at the cell level as boundary maps were only available for community forest areas and not the control sites. Furthermore, the large forest areas suggest a high variance of confounding factors, such as topography, within their boundaries, which could introduce a bias when being aggregated.

Treatment cells were extracted from all community forests. Within each province, control cells were randomly selected from a subset of forested cells (cover ≥ 10%) that were located outside of all community forests that were registered by 2019 and protected areas with a minimum distance of 0.5 km between control cells. Conservation forests that overlap with protected areas, such as national parks or wildlife sanctuaries, were excluded because community forests located within protected areas cannot be registered and legally recognized by state authorities. Additionally, control cells were also removed from a 1-km buffer zone around community forests to control for potential short-range spillover effects. It was, however, not possible to apply a wider buffer zone, e.g. 10-km as suggested by Blackman et al. (2013), due to the close proximity of community forests within provincial areas.

Propensity score matching was implemented using one-to-one nearest neighbor matching (caliper width: 0.25) with replacement. Table 6-1 lists all covariates, which were considered relevant confounders. These covariates were either fixed or measured at the beginning of the observation period in 2000. Matching was implemented using the R-package MatchIt (Ho et al. 2007; Ho et al. 2011; R Core Team 2020). The similarity of control and treatment cells was determined through a balance test of the respective covariates before and after the matching procedure (Zhang et al. 2019). Rosenbaum bounds were used to assess the sensitivity of the matching estimates to unobserved covariates (Rosenbaum 2002) and implemented in the R-package rbounds (Keele 2014). The sensitivity parameter Γ indicates to what extent unobserved covariates influence the presence of community forests. Generally, a value of the threshold Γ_C close to 1 suggests that matching results are highly sensitive to unobserved covariates, whereas larger values of Γ_C indicate robust results.

A logistic regression model was used to analyze the treatment effect of community forest management on forest loss. This binary response variable indicated whether a cell was deforested from 2001 to 2012. An interaction term between the binary treatment variable, community forest management, and the deforestation pressure G_i* averaged over the observation period was included to determine whether communal management moderated the impact of regional deforestation pressure on deforestation rates. The deforestation of a cell was likely influenced by the deforestation dynamics of its neighboring cells (Hargrave & Kis-Katos 2013). Hence, a distance-weighted autocovariate was included in the model to remove the potential bias of parameter estimates caused by spatial autocorrelation (Augustin et al. 1996). This autocovariate captured the forest loss, i.e. the response variable, in all neighboring cells within a radius of 0.1 km around the focal cell using an inverse-square weighting scheme.

Table 6-1: List of matching covariates

Variable	Description	Source
Accessibility		
LDCdist	Distance to nearest rural low-density population center in 2000	Florczyk et al. (2019)
ELEV	Elevation	Jarvis et al. (2008)
SLOPE	Slope	Jarvis et al. (2008)
FRAGMENT	Number of forested cells around focal raster cell in 2000 as indicator of exposure	Created using Hansen et al. (2013)
Administration		
PROVINCE	Provincial boundary	Global Administrative Areas (2012)
Forest tenure regime		
NRF	Pre-existing forest tenure (National Forest Reserve)	RFD
Forest conditions		
TYPE	Forest type in 2000	RFD (2001)
COVER	Tree canopy cover in 2000	Hansen et al. (2013)
GAIN	Forest cover gain 2001–2012	Hansen et al. (2013)
NB_COVER	Mean tree cover of surrounding raster cells in 2000	Created using Hansen et al. (2013)
Biophysical		
SOIL	Dominant soil type	FAO (2007)
TEMP	Annual mean temperature	Fick et al. (2017)
PREC	Precipitation of Wettest Month	Fick et al. (2017)
Deforestation pressure		
G_i*	Hotspot of deforestation in 2000	Own elaboration
DIST_PA	Distance to boundary of nearest protected area	Created using UNEP-WCMC & IUCN (2020)

6.3.3.3 Fixed effects model

One-way fixed effects models were used to determine how deforestation changed within each community forest after its registration. Two one-way models, which fixed either forest or year, were used instead of a two-ways model that includes both year and forest fixed effects to clarify their interpretation (Kropko & Kubinec 2020). The within-forest variation over time was analyzed by means of longitudinal panel data. Forest cells were aggregated to the administrative unit of the community forest. Year fixed effects were included in the one-way model to control

for time-invariant confounders which vary in all forests similarly over time, such as national policy or economic changes. Forest fixed effects control for time-invariant factors, which are distinctive for each forest area, such as socio-economic and biophysical factors.

The fixed effects models were estimated as

$$y_{it} = \alpha_i + \beta_1 y_{it-1} + \beta X_{it} + \varepsilon_{it}$$

$$y_{it} = \gamma_t + \beta_1 y_{it-1} + \beta X_{it} + \varepsilon_{it}$$

where y_{it} is the deforested area in community forest i in year t, α_i are time-invariant forest fixed effects, γ_t are annual time fixed effects, X_{it} are the time-varying explanatory variables, β are vectors of parameters to be estimated and ε is the error component. A binary indicator variable was used to describe the official status of the community forest for each year, namely unregistered (0) or registered (1). Annual deforestation pressure (G_i*) was included as a time-varying control variable. In a second model, an interaction term of the registration status and a dummy variable of a deforestation event before registration was included to assess whether the effect of registration was influenced by previous experiences of forest encroachment. Only communities that registered after 2002 and before 2010 were analyzed to provide at least 2 years of observations before and after the treatment. Cluster robust confidence intervals were applied to account for serial correlation and heteroscedasticity. Fixed effect models were estimated using the plm-package in R (Croissant et al. 2008; R Core Team 2020). Moran's I test was used to assess whether model residuals were spatially autocorrelated and implemented using the R-package spdep (Bivand et al. 2013).

6.4 Results

6.4.1 Deforestation pressure

Figure 6-1 displays the spatial distribution of deforestation pressure throughout Thailand as well as its temporal changes in the three sampled regions. Persistent deforestation hotspots were located along Thailand's north-eastern border to Laos and in the southern provinces (Figure 6-1A). Deforestation increased in all three regions over the observation period but declined around 2012 (Figure 6-1B). The sampled regions in the North-East and the South covered hotspot areas, whereas Northern provinces showed distinct low deforestation rates. Deforestation rates were generally similar in sampled provinces and entire regions. In the

North-East, the sampled province of Ubon Ratchathani exhibited higher deforestation rates compared to other forest areas of the region.

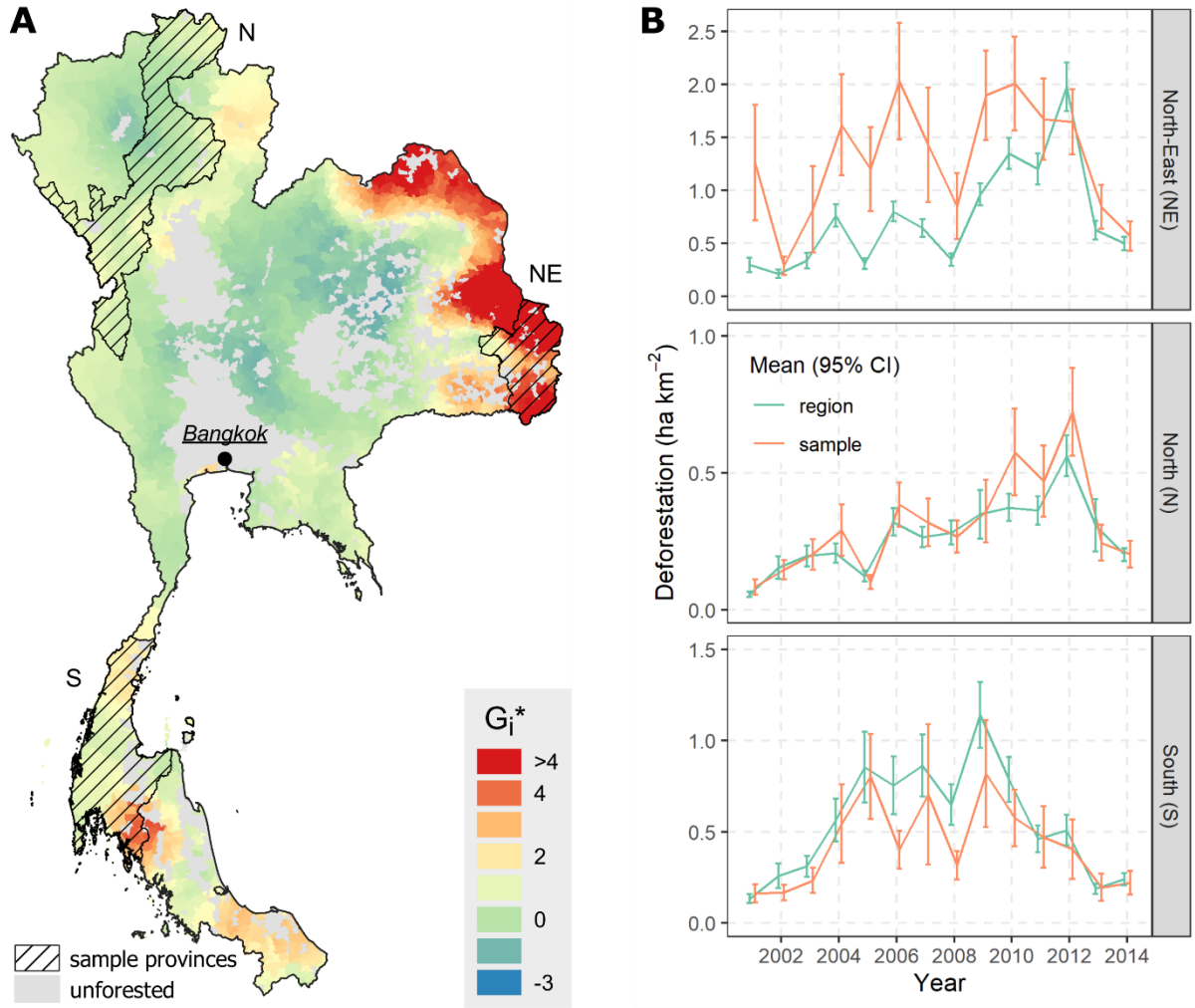


Figure 6-1: Spatio-temporal distribution of deforestation hotspots (mean G_i* with a neighborhood distance of 50 km) from 2000 until 2012 (A). Mean deforestation rates with 95% confidence intervals were compared among sampled provinces and entire regions (B).

6.4.2 Regional comparison

Table 6-2 shows the regional differences among community forests. Communities in Northern provinces tended to manage significantly larger forest areas, on average, approximately 5-times larger than in the North-Eastern region. However, many northern communities gained official registration significantly later. Community forests in the southern provinces are more densely forested and less accessible compared to other regions. Yet despite being located in areas of lower deforestation pressure, community forests in the South showed high deforestation rates. The majority of all sampled community forests (82.1%) did never experience deforestation of

> 1 ha, before or after registration. Approximately half (52.8%) of those that were affected by deforestation before their registration could stop any forest encroachment afterward.

Table 6-2: Characteristics of sampled community forest areas in three regions. Values indicate mean [95% CI]. Positive values of G_i^* indicate regional deforestation hotspot. Regions were compared using the Kruskal-Wallis rank sum test.

	North	**North-East**	**South**	***p***
Area (ha)	172.6 [148.8,196.4]	33.4 [27.9,38.9]	58.7 [41.8,75.6]	< 0.001
Years to registration	8.2 [7.9,8.6]	5.6 [5.2,6]	6.7 [6.1,7.3]	< 0.001
Distance to LDC (km)	7.84 [7.41,8.26]	7.51 [7.07,7.95]	8.02 [7.2,8.84]	> 0.05
Elevation (m)	416.1 [403.48,428.8]	148.2 [145.6,150.8]	108.6 [94.5,122.7]	<0.001
Slope (°)	7.9 [7.5,8.2]	1.6 [1.5,1.7]	9.6 [8.6,10.7]	< 0.001
Mean G_i^*	-3.16 [-3.22,-3.09]	4.87 [3.9,5.84]	-2.39 [-2.48,-2.3]	< 0.001
Forest cover in 2000 (%)	96.1 [95.4,96.8]	91.9 [90.5,93.3]	99.31 [98.9,99.7]	< 0.001
Forest loss (%)	1.4 [1.09,1.71]	3.25 [2.44,4.07]	6.08 [4.6,7.56]	< 0.001

Note. Years to registration, time between program initiation (2000) and registration of community forest. Distance to LDC, shortest geographical distance between community forest boundary and nearest low-density settlement. Elevation, elevation above mean sea level. Slope, slope of forest terrain. Mean G_i^*, mean deforestation pressure from 2000 until 2012. Forest cover in 2000, relative tree cover of forest cells. Forest loss, relative area of community forest lost from 2000 until 2012.

6.4.3 Effectiveness of community forestry

The matching procedure ensured that cells within community forests (treatment) and outside (control) were sufficiently similar after matching as the standardized mean differences of covariates were close to 0 (Figure 10-2, see supplementary material). The majority of control cells could not be matched and, consequently, the number of control cells was lower than the number of control cells. However, the Rosenbaum sensitivity analysis indicated that matchings were robust to hidden bias as Γ_C (p-value = 0.05) was consistently larger than 2 (Figure 10-3, see supplementary material).

Figure 6-2 shows the interactive effect of community forest management and deforestation pressure on the probability of deforestation based on an autologistic regression of the matched datasets. In high-pressure locations, forests under community management were 38.4% (North-East) and 28.3% (South) less likely to be deforested between 2000 and 2012. Hence, the impact

of deforestation pressures was moderated and reduced by local conservation initiatives including forest rules and patrolling (Table 10-1, see supplementary material). Otherwise, the risk of deforestation strongly increased in regional deforestation hotspots.

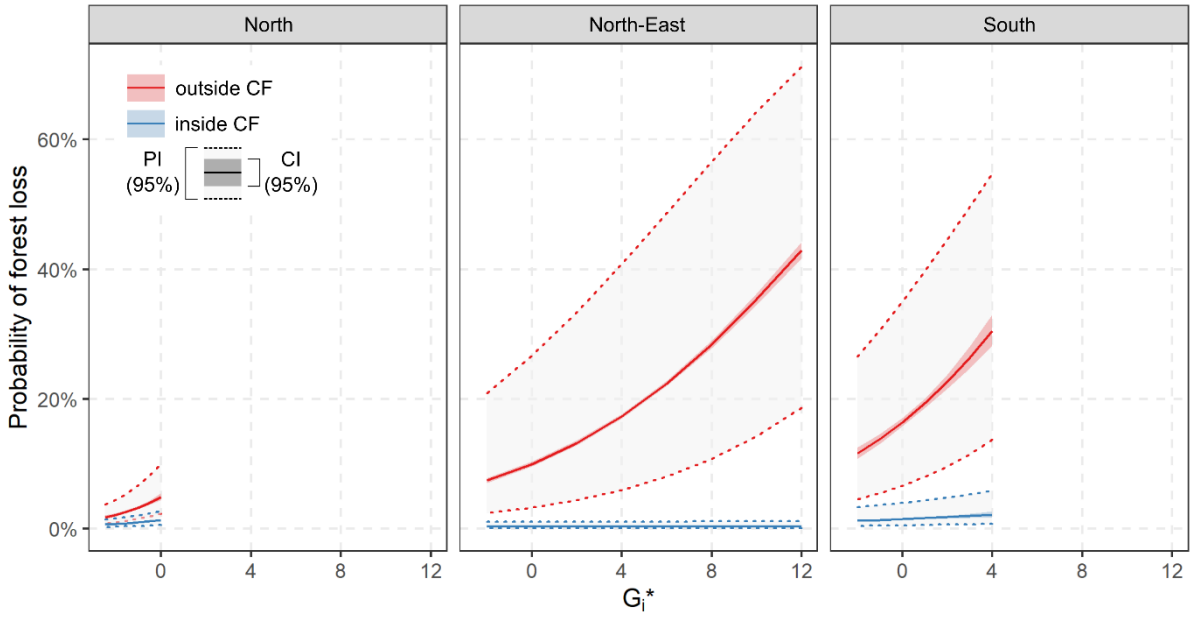


Figure 6-2: Community forests (CF) had a lower probability of forest loss moderating the impact of deforestation pressure (G_i*) in each region. Autologistic regression lines with G_i* × CF confidence intervals (95% CI) and prediction intervals (95% PI). Areas outside of community forests were matched to areas under community management using propensity score matching.

6.4.4 Effect of registration on deforestation

The encroachment into community forests significantly delayed their registration by, on average, 2 years ($p < 0.001$, Mann-Whitney U test) suggesting that tenure contestations had to be resolved before a registration could be completed (Figure 6-3). Figure 6-4 shows the estimated effects of registration on deforestation within community forests based on one-way fixed effects models (Model 1). The full models are shown in tabular form in Table 10-2 (see supplementary material). All coefficients are not significantly different from 0 suggesting that registration neither increased nor decreased deforestation significantly. Specifically, the time fixed-effects model indicates that a successful registration was not associated with a change in deforestation rates. Furthermore, the forest fixed-effects model shows that unregistered relative to registered community forests did not display significantly different deforestation rates within the same year. Mirroring the previous results, deforestation pressure did not affect deforestation

within community forests. Spatial autocorrelation was negligible as Moran's I remained below < 0.1 and insignificant during most years (Figure 10-4).

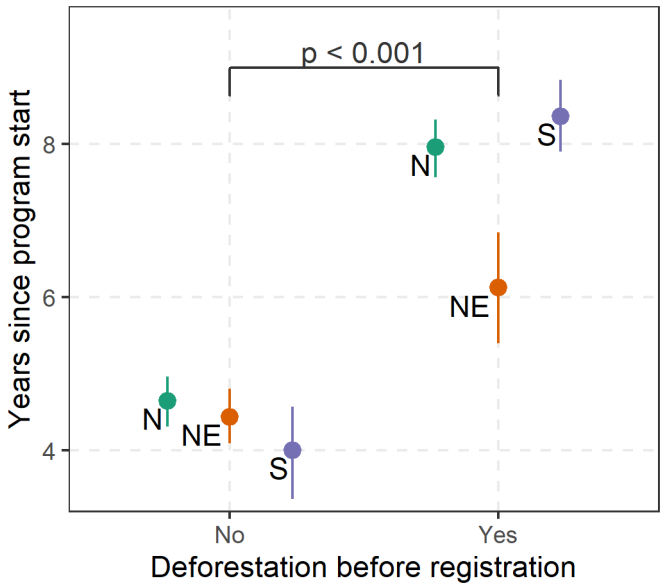


Figure 6-3: Deforestation within a community forest (registered 2000-2012) is associated with a delay of its official registration by ~2 years. Mean [95% CI] registration time of communities after program initiation in 2000 without and with at least one deforestation event prior to registration. Mann-Whitney test indicated a significant difference in all regions. Regions: North (N), North-East (NE) and South (S).

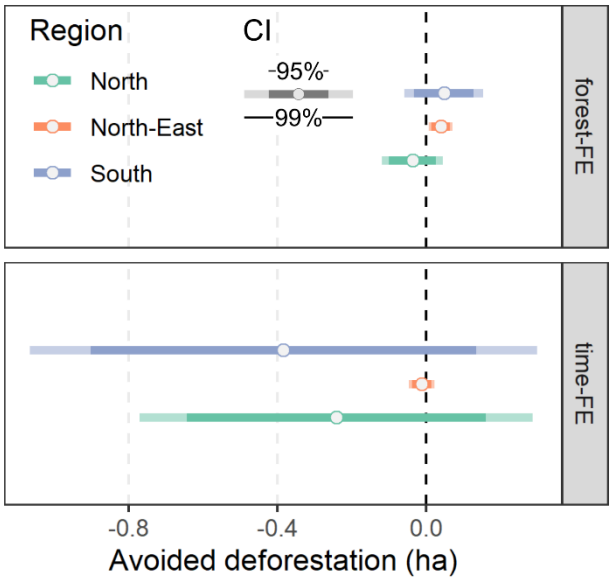


Figure 6-4: Registration was not associated with a significant change in annual deforestation rates within community forests. Fixed effects estimates with 95% and 99% confidence intervals (CI) based on one-way fixed-effects model. Only communities that

registered from 2002 until 2010 were included providing a minimum 2-yr pre-/post-registration period.

6.5 Discussion

In Thailand, local communities manage approximately 0.97 million ha of public forestland or 5.9% of remaining forests (Chankrajang 2019) and can formalize their forest tenure through a co-management scheme with the Royal Forest Department since 2000. The registration represents a considerable investment for communities that are required to organize and initiate the registration process with support from forest officials (Gray et al. 2015). Moreover, the growing number of registered community forests entails a greater workload for state officials, who are responsible for facilitating the registration process and the community's forest management activities. Current evidence suggests that communities can safeguard forests against encroachment and reduce deforestation, which could be further strengthened through formal recognition by the state. However, there is still no sufficient empirical evidence that the registration of community forests reduced deforestation in Thailand. A better understanding of the effectiveness of community-based forest conservation and the actual benefit of tenure formalization could indicate how this program could be further improved (Bowler et al. 2011). This study assessed the avoided deforestation within community forests under different levels of deforestation pressure and the impact of Thailand's registration policy. The analysis could draw upon a large nationwide sample of community forests observed over 14 years.

The findings suggest that community forests were (1) effectively protected against encroachment but were (2) not further secured because of their official registration. The first result substantiates previous matching studies conducted in South-East Asia where deforestation was significantly lower in community forests compared to forest areas located outside of community management or strict conservation (Santika et al. 2017; Putraditama et al. 2019; Ota et al. 2020). Moreover, all community forests located outside of protected areas are restricted from commercial logging which could also explain the high rate of avoided deforestation, similar to the findings of Rasolofoson et al. (2015) in Madagascar. However, these studies did not assess the impact of formalization. Several studies found that the legal recognition of collective land ownership in Latin America reduced deforestation significantly (Blackman et al. 2017; Holland et al. 2017; Vélez et al. 2020), whereas Buntaine et al. (2015) could not confirm these findings. Thailand's community forest program does not involve the transfer of land ownership rights but is limited to the legal recognition of communal forest use

and exclusion rights. A similar increase in avoided deforestation would likely have been observed if formalization could strengthen exclusion rights. The absence of such an effect implies that exclusion rights were relatively strong even in unregistered community forests suggesting that assurance is provided to customary institutions by local users and neighboring communities. Local institutions are in some cases also supported by the state although not officially as suggested by reports of informal assistance provided by RFD staff to non-registered communities (Sato 2003). An absence of additional capacity or legal support as part of the formalization process could explain the remaining, although small-scale, occurrence of deforestation (De Royer et al. 2018). This indicates that formalization does not routinely result in a higher level of tenure security (Robinson et al. 2014). Although deforestation could generally be reduced within community forest, the average rates of avoided deforestation differed significantly between regions suggesting the influence of several socio-ecological factors (Pagdee et al. 2006).

Despite the higher forest cover, greater slope, remoteness, and overall lower accessibility of community forests in the southern region due to, deforestation rates were significantly higher compared to the North-East (Table 6-2) indicating a lower conservation effectiveness. Lower accessibility could also increase the costs of patrolling, which becomes more difficult in denser forest areas. In contrast, northeastern forests are small remnants located within a highly fragmented forest mosaic that could be monitored easier (Cropper 1999; Behera 2009). Several other factors could explain these regional differences, such as the level of local autonomy in decision-making, the practice of monitoring and sanctioning (Gibson et al. 2005), the social capital to engage in collective action (Pretty & Ward 2001), and the demand for and scarcity of conserved resources (Gibson et al. 2007). In Thailand, modern communal forestry and its institutional design have been developed in northern and northeastern Thailand (Wittayapak & Dearden 1999) and practiced for a shorter period in the South. Furthermore, southern communities might be less dependent on forests or have not faced a scarcity of forest services and products, or both, as their livelihoods depend more on perennial oil-palm and para-rubber smallholder plantations (FAO 2017). In contrast, rice-cultivating communities in northern and north-eastern Thailand have been more dependent on a steady water supply, an important regulative ecosystem services provided by forests, as well as the extraction of NTFPs (Wittayapak & Dearden 1999). Less severe scarcity of forest resources could reduce the motivation of communities to engage in collective conservation measures (Behera 2009; Okumu & Muchapondwa 2020).

Spillover, or leakage, of deforestation as a result of successful conservation measures has been observed around protected areas (Oliveira et al. 2007; Engel et al. 2008; Ewers & Rodrigues 2008; Fuller et al. 2019) and across national borders (Gan & McCarl 2007). Thus, the observed difference between community and non-community forest areas could be partially caused by a shift of clearing activities (Blackman 2013). For instance, protective measures in a community forest could deter encroachers, which would then find later another, unprotected, site. Communal conservation could create positive spillovers by discouraging encroachment in adjacent forests through an increase in awareness and enforcement of forest protection regulations on a larger scale. Unfortunately, I was unable to control for potential spillover effects as their spatial and temporal range could not be determined accurately. Despite this limitation, it is unlikely that community forests alone could be the entire source of spillover as forests outside community management remain much larger than community forests.

In the Northern provinces, 25.6% of the combined provincial land areas are part of an extensive system of protected areas, specifically national parks and wildlife sanctuaries, and, thus, under strict conservation. The current national legislation permits only the formalization of community forests that are not located within the boundaries of protected areas (Trisurat et al. 2010). Many of these forest-dependent communities were evicted following the establishment of protected areas while other communities maintain their traditional management (Vandergeest 1996). The findings showed that, within Thailand's National Forest Reserves, community forestry and formalized co-management are more effective than a conservation strategy that only relies on state authorities. Further research is necessary to determine whether a co-management model would bring similar benefits in protected areas. Such a study would require accurate boundary maps of still unregistered community forests but would have the potential to provide clear evidence to decision-makers.

6.6 Conclusion

This study aimed to contribute further robust evidence showing the effectiveness of community-based forest conservation by further studying the effects of formalization and deforestation pressure in Thailand. The significant reduction of forest loss within community forests, even in high-pressure locations, further confirms previous studies. These findings do not show that formalization itself is ineffective in strengthening communal forest conservation but that its implementation in Thailand is still lacking behind its potential. Registered community forests are still affected by forest encroachment, so that communities require strong support from forest

officials and local law enforcement agencies in both legal and technical capacities. Future studies should investigate the effectiveness of community forestry located within protected areas that are under current legislation not able to formalize their tenure rights.

7 NETWORK ADMINISTRATORS FACILITATE INFORMATION SHARING AMONG COMMUNAL FOREST ORGANIZATIONS IN THAILAND

Jenke, M.; Pretzsch, J. (2021): Network administrators facilitate information sharing among communal forest organizations in Thailand. Forest Policy and Economics 126: 102436.

7.1 Abstract

The exchange of information among communal forest organizations is potentially beneficial for the creation and transfer of knowledge, but the establishment and maintenance of links between distant communities can be challenging. Network facilitators can help to establish and strengthen ties or collect and relay information among organizations. For this purpose, communal forest organizations in Thailand organized provincial network committees in collaboration with the Royal Forest Department (RFD). This policy represents a unique example of inter-organizational network administration in the context of natural resource management. The objective of this study was to determine how these network committees influenced information sharing among communal forest organizations.

A network survey was conducted to gain information about the flow of information between community forest organizations in three Thai provinces, Chumphon, Kanchanaburi, and Trat, which differed in network maturity and activity. Exponential random graph modelling was used to compare the influence of network committees on the information flow among geographically dispersed community organizations while accounting for structural network processes.

Results indicated that trust-generating network structures, specifically network triangles and strong ties, facilitated information flow. However, geographical distances significantly impeded direct information transmission between communities. Network committees played an important role in connecting local clusters beyond geographical limits. The structural position of committee presidents showed that they coordinate the provincial network by bridging gaps between distant organizations or concentrating all information flow in a centralized position.

Presidents increased the efficiency and resilience of information networks by acting as a central information hub. The findings suggest that a cohesive network committee can help to establish a strong network among all communal organizations. Network committees have the potential to facilitate the development of a cohesive inter-communal network given sufficient skills and resources.

Keywords: community forestry; social network analysis; network governance; exponential random graph modeling (ERGM)

7.2 Introduction

Co-management has become a widespread approach to legally recognize the relevance of local communities in the conservation and sustainable use of natural resources by sharing rights and responsibilities with state authorities (Armitage et al. 2008; Cronkleton et al. 2012). Although co-management arrangements tend to be officially limited to the dyadic relationship between state and community, in reality, a web of formal and informal social relations connecting communities surround them (Carlsson & Berkes 2005). Inter-communal relations can be an important source of support for communal organizations in face of limited resources and capabilities of state agencies (Newig & Fritsch 2009; Reed & Bruyneel 2010). These horizontal relations can be conduits for information, resources, and ties for collaboration (Owen-Smith & Powell 2004). Due to these benefits, social networks have been recognized as important factors for enhancing the adaptability and resilience of natural resource management (Adger 2009; Folke et al. 2005).

Conceptualizing co-management arrangements and inter-communal relations as patterns of social relations connecting organizations, i.e. social networks, allows us to evaluate the impact of social structures on resource governance (Bodin et al. 2006). Especially the efficient transmission of information between geographically and administratively dispersed actors is a key function of networks and beneficial for the creation and transfer of knowledge as well as collaboration (Duit & Galaz 2008; Lubell et al. 2002). This collaborative advantage (sensu Vangen & Huxham 2003) enables organizations to achieve goals that could not be achieved on their own, such as securing additional resources, gaining access to information, and addressing complex issues (Provan & Kenis 2007). However, the establishment and maintenance of inter-organizational relationships requires time and resources resulting in high transaction costs, especially when these relations span great distances and do not connect immediate neighbors

(Knoben & Oerlemans 2006). Consequently, inter-communal networks could be limited to small groups of participants.

Studies in the healthcare and education sector have indicated that the goal-directed coordination of inter-organizational networks can enhance the delivery of public services (Akkerman et al. 2012; Hoflund 2013). Thus, the effectiveness of service delivery is influenced by their mode of network governance, i.e. the mechanisms of network-level coordination and resource allocation (Provan & Kenis 2007). Members of a small inter-organizational network with a high level of trust could engage equally in the management of their network through shared governance (Provan & Kenis 2007). However, this completely decentralized form of network management can become challenging as the network grows beyond six members (Provan & Lemaire 2012), which has been shown in the coordination of diverse and extensive education networks (Russell et al. 2015). Studies of social service networks have shown that a shared form of governance can also be associated with an increased integration over time, even in larger networks (Raeymaeckers 2013). However, if the self-development of an inter-organizational network has been impeded, designated network managers can lower the participants' costs and risks of networking as well as highlight common interests and, thus, help to establish a foundation for long-term relations among participants (Agranoff & McGuire 2001; Provan & Huang 2012; Giest & Howlett 2014).

Network managers can mobilize new and valuable participants as well as create communication channels between otherwise unconnected actors, similar to organizational managers (Angst et al. 2018). Provan & Kenis (2007) identified two additional modes of network governance that are built upon a designated network manager. (1) A key network member could be promoted as a lead organization resulting in a more centralized structure. (2) Alternatively, a network administrative organization (NAO) could be established and equipped with adequate resources and skills to act as a network manager. In a crime prevention network, the presence of an NAO could enhance the provision of positive outcomes for its members (Raab et al. 2015). Particularly recently formed organizations, which are still establishing their internal institutions, benefit from a network manager, who highlights the utility of relationships with other organizations and facilitates the establishment of these relations (Giest & Howlett 2013). These networking strategies, linking unconnected actors and strengthening cooperation, shape the strength of emerging ties through the combined effect of time, trust, and reciprocity of interaction (Marsden & Campbell 1984). However, it has been shown that implementing these strategies can be a very demanding task for network managers (Milward et al. 2009). Network

managers have to know which connections and network structures increase the network's overall effectiveness as simply establishing more connections and a denser network can be inefficient (Newman & Dale 2005; Bodin et al. 2006). Facilitating information flows within a network can be challenging, as the right balance between tight and sparse network structures has to be found.

Information exchange is costly for all parties involved because it includes the costs of searching for partners, establishing and maintaining network relations as well as examining the reliability of the exchanged information (Lee et al. 2012). Due to the complexity and large amounts of uncertain information, actors require trust in their partners to accept the information they receive (Henry & Dietz 2011; Yang & Maxwell 2011; Berardo 2014). Actors evaluate the trustworthiness of other actors, or alters, not only through their direct interaction but also based on the alters' network position and their attributes (Newig et al. 2010). Actors who share common partners with their alters are in a position of investigating and testing the credibility of information provided by others (Echols & Tsai 2005; Lazer & Friedman 2007). Granovetter's concept of structural embeddedness stipulates that triangulated network configurations are the central building blocks of cohesive social networks, which are characterized by higher levels of interconnectedness, transitivity, and redundancy of ties (Granovetter 1985). These cohesive network structures facilitate embedded information flows through social mechanisms, such as sustained reputational and mutual social monitoring of partners minimizing uncertainty, and building trust (Coleman 1988; Isett & Provan 2005). The high interconnectedness and redundancy of channels enable information to reach all network members quickly and reliably (Schilling & Phelps 2007). In addition to embedded network structures, specific attributes of actors increase their reputation as competent and reliable sources of information.

Members of extremely cohesive networks are at risk of becoming isolated by preventing new partners to join, which lowers their access to new information and knowledge (Lazer & Friedman 2007) and stifles innovation (Uzzi et al. 2007). Therefore, bridging organizations, which connect cohesive subnetworks across structural holes, are crucial in disseminating new knowledge (Burt 2004; Agranoff & McGuire 2001). Moreover, actors in centralized networks are contrary to cohesive networks only connected through a few actors, which results in low information redundancy. For instance, a star-structured network around a central actor is the most efficient configuration for connecting actors. Thus, central and bridging organizations in such network structures are assumed to provide efficient information flows by enhancing access to novel information and reducing redundancy (Bodin & Crona 2009).

In Thailand, network committees coordinate activities and disseminate information among community forest organizations (CFOs). These committees were created at the provincial level by the Royal Forest Department (RFD) in 2010 to manage a growing network of community forest organizations, which is comprised of over 10,000 registered CFOs nationwide (RFD 2012). Each network committee has approximately 10 members including one chairperson, two vice-chairpersons, one secretary, and one accountant in addition to regular members. Committee members were selected based on the geographical location of their community to ensure that CFOs from each district (amphoe) were represented by at least one committee member. They have a mandate to facilitate the networking among CFOs, to organize meetings, seminars, training courses, as well as excursions, to secure funding from external organizations and local government, and to represent provincial CFOs. These committees can be understood as network managers as they conduct management activities from within a network targeting other communal organizations (Giest & Howlett 2014). In May 2019, the establishment of provincial networks was stipulated in Section 3 (Articles 23-31) of the Community Forest Act. According to the network governance concept of Provan & Kenis (2007), Thailand's network committees for community forestry resemble a mixture of the lead agency and the network administrative organization mode of network governance, in which a group of network members forms a distinct entity to coordinate network-level activities.

Using comparative social network analysis, the influence of network committees on information sharing between CFOs was investigated in three Thai provinces. Inter-communal information networks were analyzed and compared in each province using exponential random graph modeling (ERGM). ERGM was used to make statistical inferences about how interacting social processes shape the emergence of complex network structures (Robins 2013).

7.3 Methodology

7.3.1 Study site

The selection of study sites was limited to provinces with a sufficient but relatively small number of community forests, between 10 and 150 in total, to ensure that a high percentage of community forest organizations (CFO) from each province could participate during the survey. With the support of key informants, three provinces with different levels of inter-communal network activity were selected subsequently. Key informants were representatives from Kasetsart University, RFD's Bureau of Community Forest Management, and RECOFTC, an

international non-governmental organization strongly involved in the development of Thailand's community forestry.

The first province, Kanchanaburi, was used as a pilot site for the development of a community forest network since 2001 and strongly supported by the provincial RFD office. In 2001, 17 community forest leaders from Kanchanaburi visited community forests in northeastern Thailand during a study trip funded by Thailand's Social Innovations Fund (SIF). After returning, they began to organize a network committee with the leader of Huay Sapan Samakee community as the committee's president.

The second province, Trat, established a community forest network more recently in 2009. However, it has been the site of well-established local forest protection initiatives, best represented by the mangrove forest managed by the community of Pred Nai. Communities in this province maintained strong partnerships with national and international non-governmental organizations, such as RECOFTC and UNDP, which supported the development of local inter-communal networks.

The third province, Chumphon, has not been the site of any long-term networking initiatives from governmental or non-governmental organizations. Only in 2011, a provincial network committee has been initiated as requested by the RFD.

7.3.2 Data collection

Each president of the three provincial network committees was interviewed to ascertain their activities, meeting frequency, and relationship with RFD. In a semi-structured interview, respondents were asked whether the committee (1) helped to establish relations among CFOs, (2) organized meetings among CFOs, (3) helped to establish relations between CFOs and other organizations, (4) helped CFOs to organize their activities, and (5) would mediate conflicts among CFOs as well as (6) mediate conflicts between CFOs and other organizations if they would arise.

Network data was collected via a survey among CFOs from September until October 2015. Survey respondents were representatives of each CFO who usually maintain organizational relationships, such as spokespersons or presidents. It was assumed that representatives share information with other board members, thus all members possess similar information regarding community forest management. Survey respondents were asked about their interactions with other CFOs using a structured questionnaire consisting of close-ended questions. Presented with two exhaustive rosters of CFOs in the respective province respondents were asked to

nominate all alters they communicated with during the last year. In a subsequent question, information-sharing relationships were elicited by asking respondents from whom they received information, which was useful for the work of their CFO. In total 150 CFO-representatives responded, resulting in a response rate of 59% in Chumphon, 68% in Kanchanaburi, and 82% in Trat.

A name roster of all registered community forests was compiled for each province based on a database provided by the Royal Forest Department and was used to collect all network data (Lin 1999; Van der Gaag & Webber 2008). The roster improved data reliability as respondents could remember relationships with other organizations easier (Marsden 1990). The RFD database also contained detailed information about each community forest including name, location, the date of registration, and total forest area. In addition to the presence, or absence, of information flows between actors, the direction of flows was considered as well. Network data of directed information transmissions was compiled in form of a square matrix *Y* in which the number of rows and columns corresponds to the number of network actors. Information sharing was recorded as directed relationships to distinguish between information transfer from actor A to actor B and from actor B to actor A. If B received information from A, the information link was recorded as $Y_{AB} = 1$, otherwise $Y_{AB} = 0$.

7.3.3 Exponential random graph modelling

After inspecting descriptive network measures (see supplementary text), statistical network modeling was used to assess the effect of the network committee on the probability of information transmission among CFOs in each province. Social selection models, such as the exponential random graph models (ERGM), are most suitable to explain the establishment of social ties between actors because of their capacity to deal with the complex dependencies within networks (Lubbers & Snijders 2007; Robins 2013). The presence of a tie is modeled dependent on the actors' attributes, the character of their relationship, and the structure of the overall network (Robins et al. 2007). Thus, the tie between two actors is the unit of analysis instead of the individual actor.

The core principle of ERGM is that underlying social processes shape the observable structural properties of a social network. The influence of hypothesized social processes on the observed network structures are described through network configurations or statistics. Thus, a network is not described in terms of its overall global network structure, but as an accumulation of local network configurations representing the network's building blocks (Wasserman & Pattison

1996). The frequency distributions of these network configurations are fitted as model parameters to the observed network and indicate whether their frequency differs from a randomly generated network with the same number of nodes (Robins 2013). Therefore, the estimated probability of each parameterized network configurations describes the likelihood that a hypothesized process shapes network interactions (Ibid.). The model estimates are reported as conditional log-odds indicating the probability of a tie conditional on the associated network configuration. Due to the wide range of possible network configurations, models can incorporate the effects of network self-organization, actor attributes, dyad attributes as well as exogenous effects on tie formation.

7.3.3.1 Structural Network-Level Configurations

The first structural parameter, the edges term, controls for the network's density corresponding to an intercept term, which measures the baseline probability of an information exchange tie between two organizations.

A term for degree distribution was included to model the tendency of a network toward centralization indicated by the skewed distribution of ties. The degree of a node in a network is the number of links to other nodes. Both geometrically weighted in-degree and out-degree were used to reflect the directionality of information transmission. In-degree of an actor is the number of alters an organization received information from, whereas out-degree is the number of alters an organization provided information to. These terms captured the tendency for organizations with higher in-degree respectively out-degree to exchange information with additional alters. A negative term would suggest that the network relied on a small number of active organizations for disseminating and receiving information and, thus, acting as hubs. In contrast, a positive value would imply a homogenous network without central hubs. Both terms were included with the value of the decay parameter fixed to 0.5.

The geometrically weighted edgewise-shared partner statistic (GWESP) was used to capture an actors' tendency toward generalized reciprocity, or network transitivity (Snijders et al. 2006; Hunter et al. 2008). This statistic captures the transitivity by counting the occurrence of triangles. A positive GWESP statistic would suggest that information transmission is more likely between actors, who share the same partners, to validate the information. The geometrically weighted dyad-shared partner statistic (GWDSP) was included to model path-shortening (Snijders et al. 2006). The GWDSP statistic is based on the number of indirect paths between actors, who are not directly connected. A positive GWDSP statistic would indicate that

actors, who already share partners, are less likely to share information to avoid information redundancy.

The geographical distance between two CFOs was modeled to investigate whether physical distance negatively affects the likelihood of information sharing (Boschma 2005; Butts & Acton 2011; Mok et al. 2007). A dyadic covariate of inter-village distances was constructed by determining the distance between every pair of CFOs based on the location of the village managing the community forest. To test whether the information is shared along strong or weak relationships, a second dyadic covariate was included indicating whether mutually reported communication links exist between two CFOs. Following Granovetter (1973), the mutual report of a communication link was considered as an indicator of a strong relationship, whereas the one-sided report was considered as a sign of a weak relationship. Including a term for the reciprocity of information exchange instead prevented the model to converge due to the collinearity with other structural parameters.

7.3.3.2 Committee Dyad-Level Configurations

In addition to structural network effects, the probability that an actor provides information could be also influenced by the actor's individual attributes. In each province, some CFOs are members of the provincial network committee with one acting as president. The network committee is embedded within the provincial network of CFOs as each committee member also represents a CFO (Figure 7-1). Each CFO was classified according its involvement and position within the network committee as CFO, committee member or committee president. Consequently, following dyadic covariate were created to model the influence of the embedded committee on the information network: (1) the internal cohesion among committee members (committee member - committee member), (2) the role of the committee's president within the committee (president – committee member), (3) the level of outreach achieved by committee representatives (committee member - CFO), (4) the level of outreach achieved of the committee president among CFOs (president - CFO), and (5) the inter-communal relations among CFOs that are not members of the network committee (CFO - CFO).

Furthermore, links between organizations of different types were differentiated according to the direction of information flows into information reception and provision. In total, seven dyadic covariates were included to determine the likelihood of the committee president, members, and other CFOs to provide to and to receive information from each other.

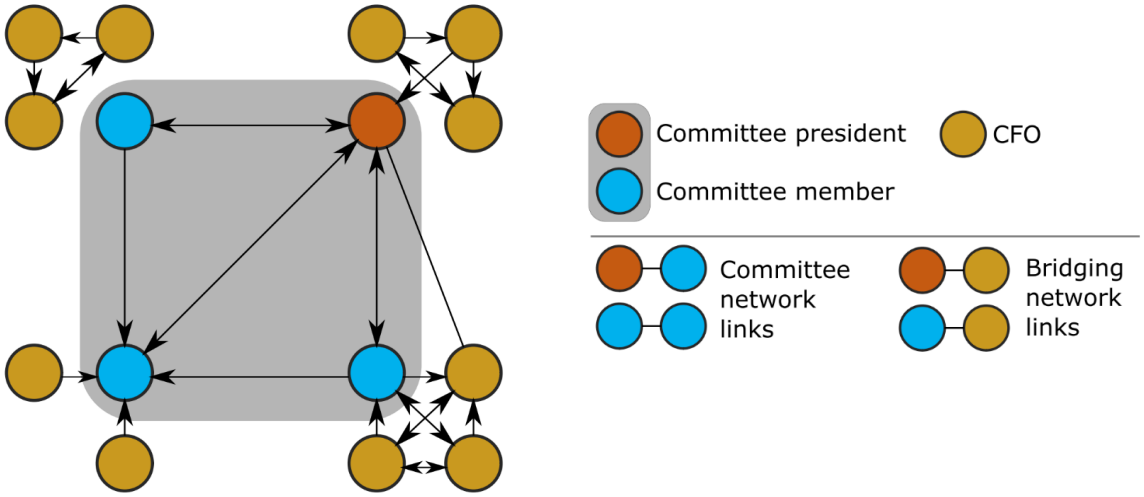


Figure 7-1: Graphical conceptualization of the network committee's embeddedness in the larger provincial network of community forest organizations (CFO) and the resulting differences in inter-organizational linkages

7.3.3.3 Missing data

All network datasets contained missing actors representing committee representatives, which were unable to participate in the survey. The non-response of actors resulted in missing ingoing ties. These non-respondents were not removed but included in the network model (Robins et al. 2004; Levy & Lubell 2018). Hence, information about network structures was maintained, especially when two respondents would be linked through the same non-respondent. Multiple imputation was used to deal with missing ties by estimating an initial ERGM containing missing data, simulating the values of missing ingoing ties (250 simulations), and, subsequently, re-estimating the ERGM by including simulated values from non-respondent ties (Wang et al. 2016; Krause et al. 2020).

7.3.3.4 Model convergence

For each province, (1) a basic ERGM was fitted by including only network-level configurations, and (2) a full ERGM was fitted based on both network-level and dyad-level configurations around the network committee. ERGMs were fitted using Markov chain Monte Carlo (MCMC) maximum likelihood estimation (Snijders 2002; Snijders et al. 2006; Hunter & Handcock 2006). Through 10,000 iterations, approximations of each model term are refined by comparing the observed network to 1,000 randomly generated networks. During these iterations, parameter estimates have to stabilize, so that the model can converge, is stable, and does not degenerate. With one exception, all models were stable without signs of degeneracy and converged as

parameter traces are distributed horizontally throughout the sample space and empirical estimates are centered within simulated estimates. The full model of the Chumphon network failed to converge, and could not be further investigated.

7.3.3.5 Goodness-of-fit

First, the best-fitting model for each network was selected based on the lowest Akaike Information Criterion (AIC). Second, the goodness-of-fit of each model was assessed by comparing observed network statistics with network statistics generated by 1,000 network simulations based on the model estimates. This procedure indicates whether the model can create network structures that are similar to the observed network based on the distribution of indegree as well as outdegree, the distribution of edgewise shared partners, and a triad census. All selected models correspond adequately to the distribution of simulated network statistics and provided a sufficient fit to the observed networks. All analyses were conducted in the R software version 3.0.1 (R Core Team 2020). The exploratory network analysis was conducted using the R package sna (Krivitsky 2014); the ergm package was used for network modeling (Handcock et al. 2014).

7.4 Results

7.4.1 Networking activities

Each provincial committee organized networking activities (Table 7-1). The establishment of each network committee was promoted by the provincial RFD office. The interviews conducted with each network committee revealed that all committees understand that their main tasks are to facilitate the establishment of new relations among community forest organizations (CFO) and between CFOs and other organizations. A common organization mentioned by each respondent was Ratchaburi Electricity Generating Holding, which engaged with CFOs as part of their corporate social responsibility program and approached the network committee as intermediaries. Moreover, the committee also seeks to mediate conflicts where necessary. In the case of conflicts over the demarcation of forest borders, RFD officials were invited to settle legal issues. The committee of Chumphon was unaware of any conflicts but willing to help to mediate if necessary.

Only the committee in Kanchanaburi was able to organize meetings among CFOs, as it was able to secure funding for these events from the Ministry of Natural Resources and Environment. Other committees did not have the financial resources to hold such meetings. A noteworthy difference between the interviewed committees was the frequency with which

committee members meet to discuss network activities. The committee of Chumphon meets only irregular and, if possible, once a year. The committees of Kanchanaburi and Trat hold regular meetings at three- and six-month intervals, respectively. According to all respondents, committees exchanged information with RFD and forwarded suggestions.

Table 7-1: Network activities conducted by each provincial network committee

Network activity	Chumphon	Kanchanaburi	Trat
Connect CFOs	yes	yes	yes
Organize meetings among CFOs	no	yes	no
Connect CFOs with other organizations	yes	yes	yes
Help CFOs to organize their own projects	no	yes	yes
Mediate conflicts among CFOs	yes	yes	yes
Mediate between CFOs and other stakeholders	yes	yes	yes
Meeting frequency	Annual	Every 3 months	Every 6 months

Network graphs were compiled to visualize the structure of information-sharing networks in each province (Figure 7-2). These highlighted the spatial clustering of connected CFOs and the central location of committee presidents, both geographically and socially, in Kanchanaburi and Trat. It also suggests that Chumphon's network development could have been impaired by the marginal location of its president along the northern provincial border.

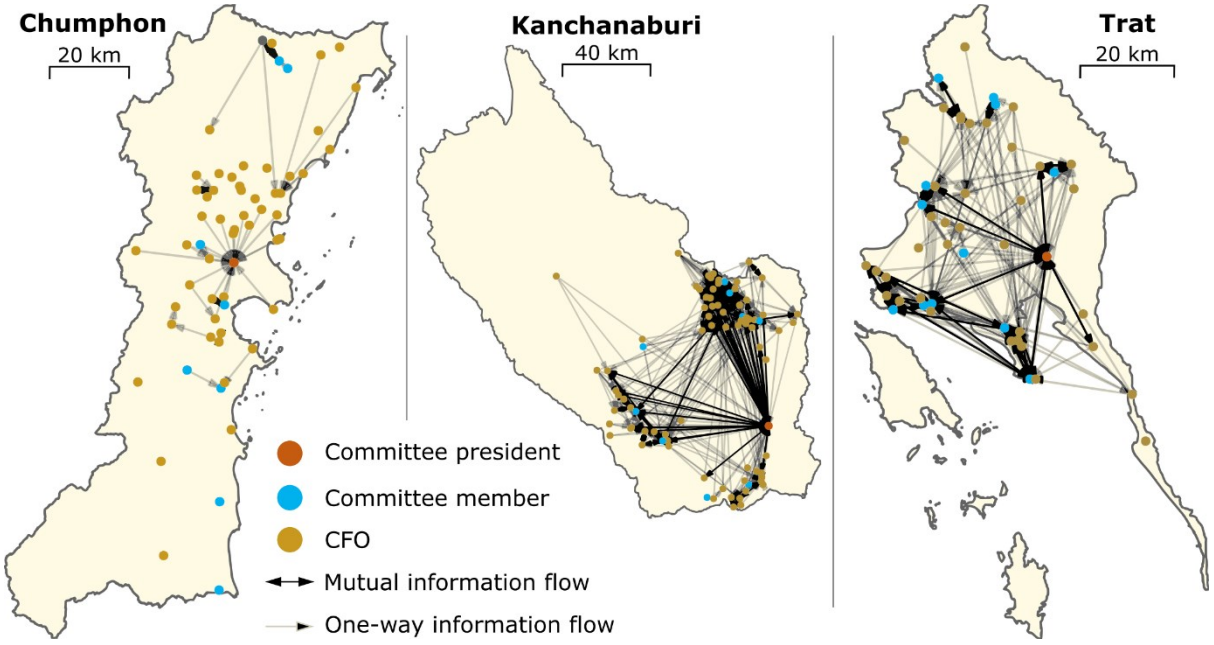


Figure 7-2: Map of information flows among community forest organizations in three provinces

7.4.2 Modeling of inter-organizational information sharing

Statistical network modeling was used to test statistically the influence of provincial network committees on inter-communal information flows. Two models were analyzed for each provincial network, only the second model included the dyadic covariates with the network committee. The model without these dyadic covariates resulted in a better fit of the Chumphon network, whereas the full model was better fitting in the other provinces. The best-fitting models are presented (Figure 7-3). The full models are shown in table form in Table 10-4.

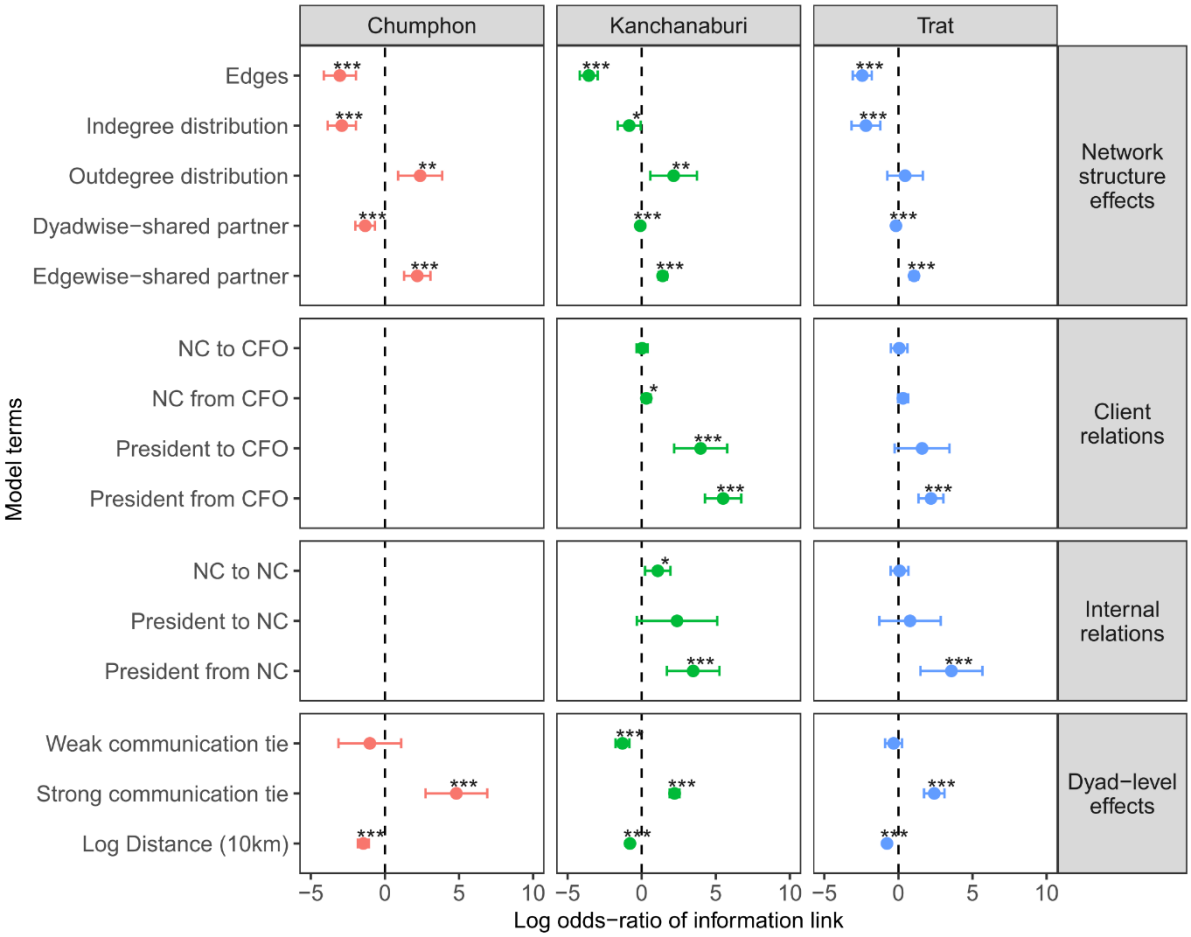


Figure 7-3: Estimates of information exchange among communal organizations (CFO), network committee members (NC) and the committee president in three provinces. Each point represents the estimated model coefficient; whiskers indicate 95% confidence intervals. Significant terms are indicated next to their estimates (*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$).

7.4.2.1 Degree distribution

Network structures of information reception (in-degree distribution) and information provision (out-degree distribution) differed. The negative in-degree distribution terms of all networks indicate that information reception was centralized in a small number of hub organizations. These popular and more connected organizations were more likely to establish additional receiving links than less-connected organizations. Thus, a large number of CFOs preferred to provide information to a few, popular partners. It further indicates that some CFOs did not receive information from any other organization. The network structure of information reception resembled a core-periphery structure with a few popular organizations as central information sinks. In contrast, the positive odds-ratio of the out-degree distribution terms was significant in Chumphon and Kanchanaburi, but insignificant in Trat, indicating that CFOs provided information through a similar number of links. These findings suggest that a small number of popular CFOs received information from a disproportionally large number of CFOs, but all CFOs provided information to an equal number of alters. The Trat network was more centralized (negative in-degree term and positive but not significant out-degree term) than the Kanchanaburi network (negative but not significant in-degree term and positive out-degree term).

7.4.2.2 Edge- and Dyad-wise shared partners

In all networks, the statistic for dyadwise-shared partners (GWDSP) was significantly negative, whereas the statistic for edgewise-shared partners (GWESP) was significantly positive. The positive GWESP indicated that directly linked CFOs were more likely to be connected through multiple shared partners. Thus, CFOs had a strong incentive to transmit information within cohesive groups. The negative GWDSP suggests that a pair of not directly linked CFOs were unlikely to be linked indirectly through a third CFO. These findings indicate that information transmission in the studied networks was not hierarchical. The comparison of these statistics between provincial networks revealed that information transmission in Chumphon (GWESP 2.7; GWDSP -1.9) occurred only in tightly-knit groups, whereas transmission in Trat was least dependent on cohesive network groups (GWESP 1.1; GWDSP -0.17). In Kanchanaburi, network clustering was of intermediate level (GWESP 1.9; GWDSP -0.03). Due to the strong triadic closure, information transmission in these networks would be harder to disrupt entirely as participants were connected through multiple ties.

7.4.2.3 Network committee

In all provinces, information links were significantly less likely to occur among CFOs, if neither of them was a member of the network committee (CFO – CFO). Seven dyadic covariates of committee relations were included to model the committee's influence on the establishment of information links. Only concerning the network of Chumphon were these statistics useful in explaining the structure of the network as indicated by the model's inferior goodness-of-fit. In this province, relations maintained by members of the network committee did not differ from relations among other CFOs. Thus, the membership of a CFO in the provincial network committee did not affect its information transmissions neither information provision nor reception in Chumphon. However, in the other provinces, the president and the other member of the network committees enhanced information transmission with CFOs significantly. Especially the presidents of network committees held a central position as information sink within the committee and among all other CFOs. Other committee members were also actively gathering information from CFOs although to a lesser extent.

7.4.2.4 Dyad-level effects

The network model confirmed that CFOs, who were separated by greater geographical distance, were less likely to exchange information as indicated by the significant negative coefficient. Especially in Chumphon, information transmission was hampered by geographical distance. Thus, a pair of CFOs separated by the same spatial distance was less likely to establish a link in Chumphon compared to the other studied provinces. CFOs with strong communication links, which were reported by both partners mutually, were significantly more likely to share information as well. Weak communication links, which were not mutual and only reported by one partner, were either not associated with information transmission (Chumphon and Trat) or significantly hampered information flow (Kanchanaburi).

A comparison of established inter-communal network links and unrealized links revealed the strong influence of geographical distances on information flow (Figure 7-4). In general, CFOs maintained more links with nearby neighbors. However, committee members in Kanchanaburi were able to maintain links over significantly greater distances compared to links among CFOs, which are not committee members (Wilcoxon test, p-value < 0.001). Here, geographical subgroups of CFOs were connected through members of the network committee. In Trat, both committee members and non-members were connected over similar distances (Wilcoxon test, p-value > 0.05). The network committee of Chumphon province was not separated by greater

distances and was unable to reach distant committee members. As a result, inter-communal network links in Chumphon were limited to shorter distances compared to the other provinces.

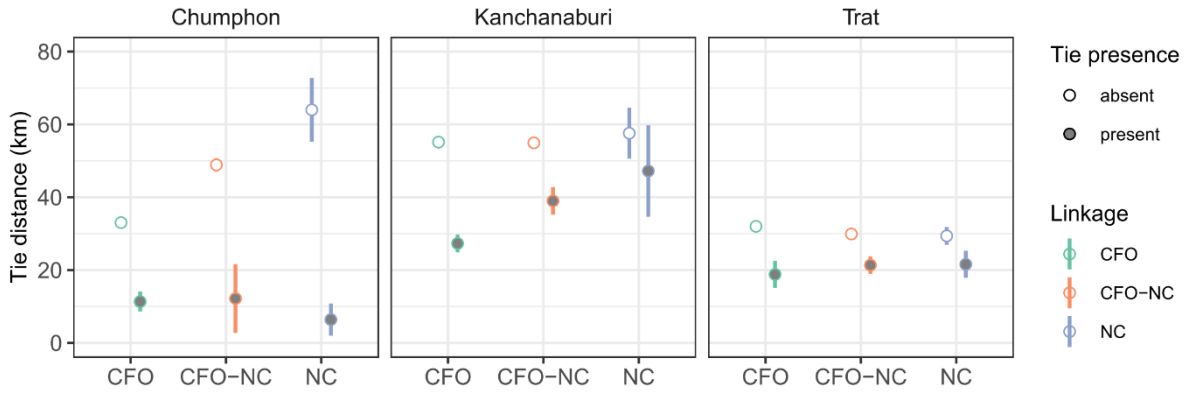


Figure 7-4: Inter-communal spatial distances (mean ± 95% confidence intervals) classified into links among network committee members (NC), links between committee members and other community forest organizations (NC-CFO) and links between CFOs. For each relationship type, the spatial distances of realized (grey) and unrealized (white) information links are shown.

7.4.2.5 Survey respondent

The ingoing ties of non-respondents were estimated based on simulations. The estimated isolation rate of non-respondents was high, ranging from 84% (Chumphon) to 88.9% (Trat), indicating that the majority of non-respondents were peripheral actors.

7.5 Discussion

Information sharing is the most basic function required in social networks to achieve common goals (Watts & Strogatz 1998). However, the self-development of large or spatially dispersed networks is possibly not sufficient to ensure efficient and reliable transmission of information (Provan & Lemaire 2012). In the case of larger inter-organizational networks, active network management has been advocated to facilitate the development of desirable network outcomes (Provan & Kenis 2007). The influence of network-level committees on inter-organizational information flow was investigated in the context of community-based forest management in Thailand by comparing networks of community forest organizations (CFOs) in three provinces, Chumphon, Kanchanaburi, and Trat. Here, a group of key network members formed a committee for the management of the network. With the application of a network modeling approach, the hypothesized influence of committees could be tested statistically. Moreover, the

use of spatial-explicit network data provided important insights into the effect of geographical distances on inter-communal information sharing.

The results indicate that network committees, especially their presidents, act as hubs between local groups of CFOs, which tend to form local clusters of limited geographical extent. This particular spatial network structure could develop as committees recruited members based on their location to ensure that each district was represented by at least one committee member. The sub-network of committee members provided a frame to which other CFOs could connect through their local committee members. The committees not only bridge spatial clusters of CFOs but also provide a link between communities and the provincial RFD office. The networks of Kanchanaburi and Trat formed a single weak component, except for a few isolated CFOs, whereas the Chumphon network was highly fragmented.

7.5.1 How did inter-communal spatial distances affect information sharing?

The results confirmed that greater geographical distances can impede the direct transmission of information between CFOs significantly. On average, CFOs were able to transmit information across a distance of 10 km (Chumphon) to 35 km (Kanchanaburi) leaving more distant CFOs unconnected. This confirms the great impact of spatial proximity on the establishment of inter-communal relationships (Provan & Lemaire 2012), and shows that distance is not irrelevant yet (Cairncross 2002) even as more than half of Thailand's population is using social media regularly (Leesa-Nguansuk 2018). It could be also suggested that CFOs deliberately refrained from maintaining relations with more distant partners and instead engaged with local neighbors to focus on local forest management issues. However, this limitation could also limit their adaptive capacity to changing legal and environmental conditions.

The network analysis showed, moreover, that the establishment of inter-communal ties in Chumphon is stronger impaired by distances compared to the other provinces. The network committee in Kanchanaburi was able to bridge larger distances when exchanging information among committee members as well as engaging with other CFOs. Thus, the network committee could connect local sub-groups, which would otherwise be isolated. The network structures of Kanchanaburi and Trat resembled the network design recommendations of Provan & Lemaire (2012) in that organizations of a particular geographic area form dense clusters (Bell & Zaheer 2007), which are connected through connections between CFOs and the committee president or the committee network. Although spatial distances also impaired information flow in Trat, its network structure was less affected due to the smaller area of this province. Thus, the

network committee was less relevant in bridging distant CFOs. However, the network committee was incohesive and unable to connect dispersed CFOs.

These findings also confirmed the important role of spatial dimensions in the formation of inter-organizational networks (Ter Wal & Boschma 2009). Therefore, future studies of inter-organizational networks at the local, regional, or national scale should consider geographical distances between organizations using spatially explicit network data.

7.5.2 Which underlying social processes shaped information sharing?

Information exchange is costly for both partners as it includes the costs of searching for partners, establishing and maintaining network relations as well as examining the reliability of the exchanged information (Lee et al. 2012). Due to the complexity and large amounts of uncertain information, actors require trust in their partners to accept and apply received information (Henry & Dietz 2011; Yang & Maxwell 2011; Berardo 2014). Information-sharing among CFOs depended on the presence of trust-generating network structures, specifically transitive triangles and strong mutual communication ties, in which members were tightly-knit, knew each other, and could trust the credibility of received information (Carpenter et al. 2004; Lubell et al. 2014). Triangulation and strong personal relations helped information receivers to confirm the information provider's credibility facilitating information exchange, which appeared to be more important than fast and efficient information flow. Likely, information was not transferred through weaker network structures, as they would require greater monitoring efforts by the information receiver resulting in higher transaction costs.

Information sharing does not result in the immediate and successful transfer of knowledge among organizations but is an essential requirement. Cohesive network structures can facilitate the transfer of tacit knowledge among CFOs (Hartley & Benington 2006). Tacit knowledge requires demonstration to be transferred successfully, opposed to explicit knowledge, which can be transferred through verbal or written communication (Reagans & McEvily 2003).

Although trust-generating network structures were a requirement for information transfer in all provinces, inter-communal information sharing in Chumphon was more restricted to strong ties and triads compared to the other networks. Considering that Chumphon is the least developed and most fragmented network, it could be suggested that the network's slower development coincided with a less general prevalence of trust among CFOs. The inability of Chumphon's network committee to organize regular meetings among CFOs is a likely cause of this relatively low level of general trust.

7.5.3 How did the network committee affect the inter-communal networks?

The formally designated committee presidents were among the most popular providers and receivers of information. They bundled information from CFOs, which would be otherwise disconnected, as indicated by the presidents' high levels of degree and betweenness centrality. The presidents' central network positions originated out of the CFOs' need for credible information from a popular information provider through preferential attachment (Snijders et al. 2006; Hunter 2007). It is likely that the committee presidents in Kanchanaburi and Trat already occupied a central network position before being promoted to their formal position. In Kanchanaburi, the network committee is being led by the well-known CFO of Baan Huay Sapan Samakkee. In contrast, the president of Chumphon's committee could not establish himself as a central network coordinator yet.

Comparing each province, the network structure of each committee's sub-network corresponded to the structure of the whole network, for instance, the social network of both the committee and all CFOs was highly fragmented in Chumphon. The small number of members in each network committee enabled members to sustain a social network, which was denser and more cohesive compared to the provincial CFO network. Network modeling furthermore confirmed that joint membership in the network committee was associated with a greater likelihood of information exchange compared to exchanges among non-members. The position of the president within each committee was less central as well, indicating a flatter hierarchy among committee members. Because the committee aimed for equal representation across each province, members were able to maintain information links across greater distances.

Local representatives of the provincial network committees engaged other CFOs to a greater extent compared to interaction among non-members. Thus, committee members devoted additional effort to establish information-sharing ties with local CFOs. Moreover, CFOs did not refrain from interacting with them as they were represented although network committees have been established in collaboration with RFD (Giest & Howlett 2014).

These findings suggest a division of tasks within the committee. Each committee member represented local CFOs, whereas the committee president acted as a provincial representative maintaining ties across district boundaries. Therefore, network committees connected local CFO groups across structural holes providing a crucial role in disseminating new knowledge and providing access to external resources (Agranoff & McGuire 2001; Cristofoli et al. 2014). Compared to a fully connected network, this network structure is more efficient while providing

sufficient cohesion. Moreover, it can be suggested that information provided by committee representatives to CFOs gained additional credibility when the committee president maintain relations to both partners and thus forms a transitive triad. However, a network's reliance on the committee also entails potential downsides as better-connected committee members might misuse their influence as gatekeepers to direct information flows for their benefit (Scott & Thomas 2015; Kellogg & Samanta 2017).

7.5.4 Why were community organizations in Chumphon connected less?

Based on the comparative analysis of the three provincial networks, it can be suggested that both the provincial networks and network committees in Kanchanaburi and Trat are more advanced in their development compared to Chumphon. Despite the presence of a network committee, the network structure resembles more a form of shared governance without a central leadership (Provan & Kenis 2007). According to the presented network analysis, several factors potentially delayed its development apparent due to its high fragmentation and lack of cohesion. CFOs in Chumphon were separated by greater distances with the committee president being located not in a central area but at the northern border of the province. Moreover, CFOs in Chumphon tended to be less spatially clustered compared to Kanchanaburi and, thus, geographically more isolated. Thus, local committee representatives would have to invest more effort in maintaining ties to bridge these distances.

Network committees need to develop skills to conduct network activities, which is a resource- and time-consuming task (Vangen & Huxhum 2006), and remains challenging under funding constraints (Provan & Kenis 2007). The studied network committees differed in the level of financial support they received during their inception. The committee in Kanchanaburi collaborated strongly with the provincial RFD office, whereas in Trat, non-governmental actors, such as RECOFTC and UNDP, were more prominent. This initial support was necessary to help each committee to form its internal social network before engaging in provincial network-level activities. Regular and frequent meetings, at least every 6 months, among committee members were an important requirement. As soon as the network committee was well connected, such as in Kanchanaburi, members could secure funding through their initiative. Here, sufficient resources enabled the committee to organize meetings more frequently giving both committee and other CFOs more opportunities to connect. Funding to conduct regular meetings among committee members as well as all CFOs was insufficient in Chumphon hindering the development of a cohesive social network within the committee.

Chumphon's committee members did not have a long-standing experience of network administration before the establishment of their committee, contrary to the other provinces. The establishment of new ties among CFOs and, consequently, the development of a cohesive network will require time. However, this cross-sectional study cannot provide sufficient evidence regarding how much time is required for the development of a cohesive network; instead, a longitudinal study would be required.

7.5.5 Transferability

The studied communal networks were homogenous in terms of their social, cultural, or linguistic background and were disconnected due to their geography. A heterogeneous network could be well connected if network committee members would be able to form strong ties across socio-cultural as well as geographical boundaries. Thus, the presented approach to inter-communal network governance can potentially be transferred to other areas under certain conditions. However, further research is needed to test this approach in different levels of network heterogeneity. The findings also showed that the exact composition of actors within each network was not relevant for the network's structure. Initial support in building up a network was provided by the state as well as civil society organizations.

7.5.6 Limitations

Several limitations affect this study: cross-sectional design, the binary response variable, and missing data. Robust conclusions on the long-term impact of a network committee within a specific province could not be made due to the study's cross-sectional design. This shortcoming was partially compensated by investigating and comparing multiple networks at different development stages. Furthermore, it should be highlighted that this study focused only on the flow of information as one possible level on a wider scale of social interactions (Friedkin 1990). Lastly, all network studies rely on a complete sample of all social relations among actors within a delineated context. Missing responses represent a serious problem as disregarding certain network ties can present a network structure that differs significantly from the real network. Network analysis is especially sensitive to the absence of central network actors (Robins et al. 2004; Borgatti et al. 2006). Thus, the descriptive network measures (Table 10-3, see supplementary material) need to be interpreted with caution. The study's findings were derived from network models (ERGM), which were complemented with a model-based multiple imputation procedure to estimate the missing values of ingoing ties (Wang et al. 2016; Krause et al. 2020). These estimations suggested that non-respondents were peripheral actors that had

a limited impact on the structure of each network. Thus, incomplete survey responses did not threaten the validity of the study's main conclusions.

7.6 Conclusion

Knowledge sharing among community members can determine the success of community forestry. In addition, communal forest organizations have to exchange knowledge with other communities to learn and develop adaptive forest management given rapid environmental, socio-economic, and legal changes. Public forest authorities, as well as non-governmental organizations, lack the resources or skills to provide the required extension services to all communities, especially to a growing number of new and less experienced community forest initiatives. The findings of this study suggest that a group of motivated and skilled community representatives can facilitate the formation of a dense and resilient social network to share information among all other communities. External support was seemingly necessary to coach network administrators and to provide initial funding. The studied self-organizing network, whose network administration was less actively steering, was unable to connect communities beyond their immediate neighbors and bridge larger geographical distances. Further research is needed to investigate whether these findings can potentially be transferred to other areas, where an inter-communal exchange is not only hampered by geographical but also social, cultural, or linguistic boundaries.

8 SYNTHESIS, IMPLICATIONS AND OUTLOOK

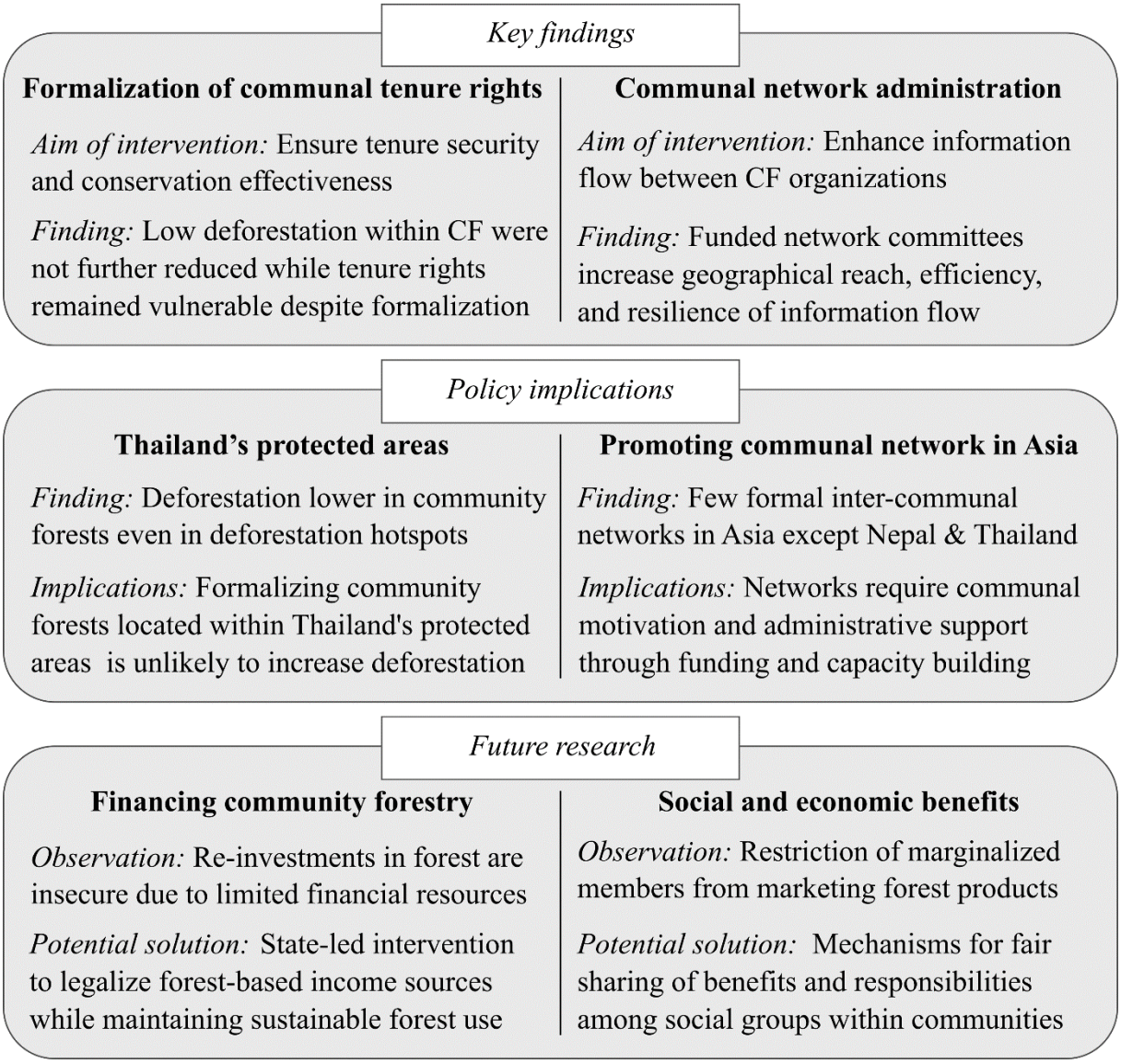
Forest policy in Thailand has moved from a highly centralized management system toward more decentralization, which has largely been implemented through the increased formalization of traditional community forests. In Thailand, around 10,000 rural villages formalized their customary forest tenure rights with the Royal Forest Department (RFD) and gained legal recognition through the community forest program. This program has enabled communities on a national scale to obtain management permits over state-owned forestland. The program also encouraged these communities to form cohesive inter-communal networks to share information and knowledge.

The main objective of this thesis was to evaluate whether the program could provide enabling conditions through two program elements, tenure formalization, and communal networking. In the concluding chapter, the main findings are recapitulated, their implications discussed, and avenues for future research outlined. The historical perspective of Thailand's community forests (p. 6 ff.) has shown that it has never been static and a permanent work-in-progress as the influence of different stakeholders is shifting. Hence, this study can only provide a snapshot of the current situation and suggest future developments after discussing the impact of each intervention.

Although this study has investigated several enabling conditions for community forestry and their most immediate ecological outcomes, specifically the reduction of deforestation rates, some factors and outcomes could not be covered. First, the role of forest utilization and marketing could not be investigated as it remains officially prohibited. However, interviews with community members have revealed that their forest activities are not sufficiently funded as rural communities become more tied into a monetary economy. Thus, in this chapter, several options for ensuring the financial security of these community forests are outlined for future research. Second, community forestry is not only a tool for forest conservation but can provide an avenue for development both economically and socially. Secure tenure rights do not only boost the motivation of communities to conserve and improve forest resources but can also

promote good governance, human rights, and gender equality. Therefore, mechanisms to promote the social effectiveness associated with community forestry are described.

Figure 8-1: Overview of key findings concerning two program elements, resulting policy implications, and directions for future research based on the study of community forests (CF) in Thailand



8.1 Synthesis of key results

8.1.1 Ensuring tenure security and conservation effectiveness of community forests

The community forest program officially recognizes the use and management rights of local communities over public forestland while the government retains ownership over the land and is permitted to withdraw the community's rights if certain conditions are not met. This form of community forestry has become a common forest governance mechanism throughout Asia (RRI

2012). The assumption is that this legal basis for communal participation provides secure tenure rights and, consequently, an incentive to sustainably manage and protect forest resources (Lachapelle 2008). Thus, it was hypothesized that strengthening collective tenure rights reduces deforestation (Dahal et al. 2010; Larson et al. 2010).

The first study indicated that the formalization of communal tenure rights helped to improve the relations with local RFD officials and increased the perceived security among communities. Although communities were more motivated to protect their forests against illegal logging and encroachment, they could not always rely on full support from the RFD officials in case of tenure conflicts. The second study showed that forests under community management were less likely to be destroyed compared to nearby forests under state management. However, the formalization of these community forests had no significant effect on the rate of forest loss. The effectiveness of community forestry in Thailand was confirmed by Chankrajang (2019) and mirrored by similar studies in other countries (Rasolofoson et al. 2015; Santika et al. 2017). There are several conclusions that can be derived from the apparently low contribution of formalization toward forest conservation.

Seeing that the State was unable to effectively protect public forestland, communities were willing to protect their forests despite relying on customary management rights (Dahal et al. 2011). The motivation of rural communities to conserve forests rooted in the traditional understanding that agricultural production is impossible without an intact forest ecosystem that protects against landslides and sustains water resources (Kaosa-ard 2001). These benefits were not accrued within the forest but in the irrigation systems on farmland, which tended to be more secure. As long as the State did not plan to change the land use of these forests, both actors had similar management objectives, i.e. forest conservation. Under these conditions, customary tenure rights were relatively secure and communities were not discouraged from engaging in forest conservation. The formalization did not change this arrangement apart from officially recognizing its existence.

Use rights governed only the extraction of forest products, timber, and non-timber. These traditional rights were not recognized by the RFD although local officials tended not to prosecute local forest users. Nevertheless, the formalization of these use rights decriminalized the extraction of non-timber forest products (NTFPs), reduced the anxieties among communities, and improved the relationship between forest users and the RFD. Thus, the formalization enhanced the security of their right to extract and use NTFPs. The extraction of

timber resources has not changed and is still officially prohibited but simultaneously regulated through customary institutions. Apart from the now legal extraction of NTFPs, the institutions and activities within community forests did not change after their formalization. The perceived benefit of the formalization procedure for the communities was a lower potential for conflict with the RFD as their rights and responsibilities over forest resources were clarified and put in writing.

The vast majority of communities have fulfilled their responsibility to protect forests from illegal logging and encroachment through frequent patrols and vigilant controls along forest roads. The co-management arrangement helped to build trust with local RFD officials. However, encroachment still occurred in some community forests despite their registration and could not be prevented by law enforcement agencies. Even reporting encroachers to local law enforcement has been largely the responsibility of communities and done by forest officials. Moreover, if powerful external encroachers ignored local institutions, RFD officials tended to be reluctant to oversee legal actions leaving communities without access to justice (Aggarwal et al. 2021). Thus, formalization did not substantially enhance the enforcement of communal rights against outsiders.

8.1.2 Effective and resilient communal forest networks

Traditionally, communities in Northern Thailand have not managed forests in isolation but through close collaboration with their neighbors. These community forest networks usually operated at the watershed level helping communities to share knowledge and protect their customary tenure rights (Kaosa-ard 2001). The Northern Community Forest Network was established in 1999 as a regional coalition of individual forest communities and smaller networks that could build a critical mass to advocate for the legal recognition of community forests while and attracting support from non-governmental organizations and donors (Makarabhirom 2000; Zurcher 2005). Following the registration of community forests and the development of co-management arrangements with the RFD, community network organizations were initiated at the provincial level to enhance the flow of information. The third objective was to assess whether the networking element of the Community Forestry Program could provide enabling conditions for community forest organizations by enhancing information exchange.

The findings of this study indicate that the communal network organizations facilitated the development of a well-structured network that helped to disseminated information even among

geographically dispersed communities. The network committee required initial support and time to establish a dedicated and well-connected core within the provincial networks. During the COVID-19 pandemic, network activities could be maintained although to a lesser extent despite the restrictions on face-to-face meetings (RECOFTC 2020). This was, of course, more challenging in areas where the communication infrastructure is not as extensive as in Thailand's more populated areas.

Forest-managing communities will face continuous, and sometimes rapid, environmental, socio-economic, or political changes. Thus, continuous learning will be required among forest communities to adapt to new situations. However, the RFD and local CSOs do not have the required resources or skills to provide extension services to the growing number of registered communities. The horizontal flow of information within community forest networks offer an alternative approach to the top-down transfer of knowledge (Nightingale 2005). Communities have already organized exchange visits to 'good practice' community forests, which enable participants to exchange tacit knowledge through peer-to-peer interactions (Bruns 2002). Thus, the long-term impact of cohesive inter-community networks could be an increase in adaptability among all forest-managing communities and not only of the well-connected ones. Although the official tasks of the state-initiated network organizations are to disseminate information and coordinate forest activities (RFD 2012), these networks still represent communities in national advocacy as they become less dependent on state funding.

8.1.3 General conclusions

At the beginning of this dissertation (page 2), factors enabling effective community forestry were outlined, including secure tenure rights, strong local governance, an enabling regulatory framework, a supportive bureaucracy, and technical skills and knowledge. The general objective of this thesis was to determine whether Thailand's community forest program can provide these enabling settings. The formalization of tenure rights helped to improve relations with the RFD who became more supportive while maintaining tenure security, local institutions, and, consequently, strong local governance. While the regulatory framework did not put an excessive burden on communities, it did also not provide substantial support. Particularly the reluctance of some local RFD officials to enforce tenure rights in face of powerful encroachers can substantially reduce tenure security. Given the limited capacity of the RFD to provide technical support, the community forest networks facilitate the sharing of information and knowledge among numerous communities. The community forest program should be further

expanded to find suitable financing mechanisms for communities as current regulations prohibit the marketing of forest products. Thus, the national co-management program represents a step toward more effective community forestry.

8.2 Policy implications

8.2.1 Formalization of community forests in Thailand's protected areas

This study's second objective, i.e. to investigate the effect of Thailand's community forests on deforestation rates, was partly motivated by the long-standing disagreement within Thai forest politics over the formalization of community forestry in protected areas which is still prohibited (see page 11). Thus, the findings of this study are also relevant for policy makers with regards to the question whether community forestry should be permitted within protected areas.

A national legal framework for community forestry, the Community Forest Bill, was first drafted in 1991 but was ratified almost 30 years later in 2019. This delay was mainly caused by a disagreement over the authorization of community forestry within protected areas (Hares 2009). Thailand hosts a large network of national parks and wildlife sanctuaries that prohibit any form of human activity (Sims 2010). However, many communities of ethnic minorities settle within these forest areas before these protected areas were established and faced evictions (Nepal 2002). Strict conservationists were reluctant to alter these restrictions for forest-dwelling communities and instead of seeking to further expand protected areas (Vandergeest 1996). Consequently, the RFD already began to register community forests outside of protected areas in 2000. This decision was later ratified through the Community Forest Bill.

The comparison of deforestation rates within community forests and similar forest areas without communal management revealed that communal conservation efforts significantly reduced encroachment. This was especially apparent in regions of high deforestation pressure. Thus, there is no evidence for increased deforestation within community forests either before or after their registration. As Thailand's forest-managing communities are formally restricted from engaging in commercializing their management approach is more akin to a mixed-use conservation approach. Although the conservation effectiveness of community forestry was not compared with protected areas in this study, other investigations have indicated that both approaches do not differ significantly in terms of their ecological outcomes (Hayes 2006; Porter-Bolland et al. 2012).

Several recommendations can be formulated regarding the support of community forestry within protected areas. Most importantly, strictly protected areas should not be expanded into

registered community forests (Wittayapak & Baird 2018). The loss of formal tenure rights could exacerbate mistrust and reignite conflicts between communities and state authorities. Moreover, other forest communities adjacent to protected areas might lose their confidence in the security of their tenure rights and, consequently, their willingness to invest in conservation efforts. Thus, the replacement of formal community forests with state-managed protected areas can cause an increase in forest encroachment if locally effective institutions are removed (Mannigel 2008). Instead of bringing well-managed community forests back under exclusive state control, state authorities and rural communities could benefit from formalizing community forests within buffer zones (protected area co-management) especially if communities can rely on robust local institutions (Pokharel et al. 2015). This will require an inter-agency collaboration between the RFD, who is administering all community forests, and the DNP, who is managing all protected areas.

8.2.2 Promoting community forest networks in other Asian countries

Networks among national and international CSOs generally failed to establish strong relations with local communities to create reliable two-way communication channels and stable inter-communal networks (Colchester et al. 2003). The Nepalese Federation of Community Forestry Users of Nepal (FECOFUN) has been one influential example of a large-scale inter-communal network that connects approximately 14,500 communal forestry organizations (Ojha et al. 2007; Dahal et al. 2010). Its multi-tiered organizational structure enables FECOFUN to connect individual communities at the district level as well as engage with policy-makers and donor organizations at the national level. In this study, a second perspective was offered from Thailand, where community forestry networks remain bounded to the respective provinces and, in contrast to Nepal, are not formally connected through an umbrella organization that operates also at the national level. Here, additional financial resources would be necessary to develop a multi-level network structure that connects community forest networks across provincial borders. Thus, external funding organizations are not only an important aspect of community forestry at the local level but are also necessary to initiate and expand inter-communal networks (Friedman et al. 2020).

Community forestry networks have been established in other Asian countries as well but without reaching the level of formality and scale found in Nepal or Thailand. Several recommendations can be provided based on these examples to promote their development. The limited awareness of local administration concerning community forests has likely further

limited the reach of community forest networks (Colchester et al. 2003). In contrast, local administrative organizations in Thailand were found in this study to be well-aware and often strongly connected to community forest organizations. Moreover, network initiatives in Thailand were developed in collaboration with provincial state authorities which relied on community leaders for support. Communities in countries with more state-centered political systems, for instance, China or Vietnam, might not have the capacity or authorization to form networks from the bottom-up. Here, central governments will have to permit and support the communal networks.

Many forest-dependent communities are still demanding tenure security. Network-level organizations can enable communities to negotiate from a more influential position as also seen in Thailand (Zurcher 2005). These grassroots social movements have been accommodating in securing communal tenure rights. With the increasing collaboration of state and communities in forest management, this network model was replicated in all provinces with the support of the RFD. Thus, the development of an inclusive network depends on the resolution of conflicts with the State as communities might be otherwise afraid to join the network. The legal recognition of community forestry is consequently a requirement.

Several factors determine the potential success of community forest networks. This study has shown that the networking organization has to rely on strong internal governance but also requires initial support for networking. The remoteness of each network member is likely to determine the amount of necessary financial support. Communities that are in close spatial proximity, connected through a reliable transportation and communication infrastructure will find it easier to organize regular meetings. Political support might be needed if inter-communal gatherings are suppressed by certain actors to prevent the formation of social movements. In conclusion, self-initiated networks of neighboring communities can be highly effective but still need external support from either state or non-governmental organizations to initiate networks that can connect communities beyond the local level.

8.3 Future research

8.3.1 Ensuring the financial security of community forestry in Thailand

Similar to other communal forest users in Asia, Thailand's forest-managing communities are formally restricted from using forest resources commercially and limited to subsistence uses (Cronkleton et al. 2012). Thus, community members, particularly poor ones, benefit from the important safety net provided by community forests but are restrained from utilizing forest

resources for economic development and poverty alleviation (Sunderlin et al. 2005). Moreover, this restriction does not only limit the income of forest users but also reduces the financial resources that can be reinvested into conserving forest resources (Bhandari et al. 2019). This problem has been brought up frequently during interviews with communal forest committees as they still require funding to protect their forests effectively. The RFD only provides an initial one-time contribution but is unable to provide continuous financial support (RFD 2012). Therefore, communities have to stem the majority of the costs associated with regular patrols that are necessary to curb illegal logging and forest fires. The limited technical and financial support for communities seems to be a common shortcoming of tenure reforms endangering the continuity of community forestry (De Royer et al. 2018). Several options to finance community forestry will be outlined but recommendations cannot be provided as this was not investigated sufficiently in the course of this study (Hernández-Aguilar et al. 2017). The RFD could develop an additional third program element to enable communities to secure funds through a variety of forest-based income sources, including the marketing of NTFPs, payment for environmental services (PES), ecotourism, or commercial timber production.

Some communities involved in this study request formal tenure rights over abandoned farmland and initiated restoration measures. Communities are generally able to acquire tree seedlings from local nurseries free of charge, lowering the costs of artificial forest establishment. Other communities opt to rely on the natural regeneration of forests either to reduce overall costs or due to the limited availability of tree species in state-run nurseries (Elliott & Kuaraksa 2008). The general focus of nurseries on commercially important tree species, particularly fast-growing exotic species, indicates that some forest officials might not have realized yet that species-diverse forests can provide a wider range of ecosystem services (Bowler et al. 2012; Brockerhoff et al. 2017). Regulating ecosystem services, such as a steady water supply, secure livelihoods in rural communities whose members are nowadays mainly engaged in small-scale commercial farming (Pagdee & Kawasaki 2021).

Payments for Ecosystem Services (PES) has been proposed as one market-based approach to finance community forestry. Forest-managing communities are compensated by ecosystem services beneficiaries, for instance, for their efforts to conserve watershed forests (Daniels et al. 2010). However, the number of PES projects in Thailand is limited and many remain in the pilot phase (Jarungrattanapong et al. 2016; Pagdee & Kawasaki 2021). It is, furthermore, likely that only well-established communities benefit as they can attract donors and have an

outstanding track record, whereas other communities are unable to secure external funding (Thompson 2018).

NTFPs are the only forest products extracted and sold by forest users within their community contributing to approximately 10% of annual household income as estimated by Pagdee & Kawasaki (2021). NTFPs offer a pathway for forest-based income and should not be dismissed as low-value forest products (Anderson et al. 2015). There are already a few initiatives that enable selected communities to expand the commercialization of their forest products. A change in national legislation might enable more communities to gain an income from community forestry. Given the changing attitudes toward commercial forest use and local forest management, the support from state authorities could help to increase the number of forest-based community enterprises in the coming years. However, several preconditions have to be met before community forestry can provide an equitable income for Thailand's rural communities. First, regular forest inventories are necessary to prevent the overexploitation of NTFPs (Shackleton & Pandey 2014; Thammanu et al. 2021). Technical support from state authorities would help communities in determining their resource base. Second, communities require extensive knowledge of the general demand and prices of products to develop products that can be marketed to customers (Gilmour 2016). Refined forest products and local specialties could be marketed under the well-known label of 'One District, One Product" that promotes local products (Natsuda et al. 2012). Lastly, the quality and quantity of sustainably harvestable NTFPs and their value chain should be investigated to assess the potential financial returns and the required investments (Belcher & Schreckenberg 2007).

Twenty years ago, Lakanavichian (2001) has proposed community-based timber production has one option to remedy the reliance on timber imports following the ban on logging within natural forests. So far, the prospect of communal timber production has never materialized as there are currently no initiatives to lift the ban. However, both communal management committees and forest officials would require intense silvicultural training if the logging ban would be lifted after almost one generation. It would be difficult for the RFD, who used to supervise commercial logging, to retain the necessary institutional knowledge over this long time (Pragtong 2000). Thus, logging operations in natural forests could cause severe damage within the stand and jeopardize the ecological sustainability of community forestry (Rockwell et al. 2007; Putz et al. 2012). In conclusion, timber remains an unlikely source of income for forest communities soon due to legal constraints and limited capacities making NTFPs

commercialization a more viable and, maybe, more profitable avenue to finance communal activities (Mahapatra & Tewari 2005).

Some communities sought formal tenure rights over degraded areas or abandoned farmland that they wanted to restore. Currently, these communities generally do not decide to establish timber plantations or woodlots as they are currently not allowed to harvest due to the land use classification. Past initiatives have focused on the production of fuelwood for rural communities (Gamser 1980). However, the introduction of liquefied gas and electricity in rural areas has reduced the demand (Pradhan & Limmeechokchai 2017; Tanner & Johnston 2017). Moreover, state-run plantation projects focused heavily on fast-growing exotic tree species, particularly *Eucalyptus*. These exotic species were opposed by rural communities as they could not harvest fodder or fuelwood and feared damages to the soil and groundwater (Lohmann 1991). Nowadays, the Thai Government has increasingly promoted smallholder plantation forestry by simplifying rules and regulations concerning commercial harvesting of timber on private land (Intongkaew & Junchang 2017). For communities, the developing tree bank system could offer a financial tool to secure low-interest loans (Starfinger & Jenke 2021).

Forest co-management arrangements are commonly implemented through the establishment of community forest committees, which organize users in conducting collective forestry activities, enforce management rules, and represent members (Sekher 2001). Thus, communal forest organizations have been the main focus of study as they are the main forest management body and represent the community in interactions with external actors. The findings from this study suggest that the formalization process has not put excessive burdens on communities. However, the development of additional external pressures might increase management costs. The growing risk of droughts will likely increase the frequency of forest fires (Corlett 2016). Thus, communities will require additional resources and skills to combat these threats. The additional pressure of forest encroachment remains high, and illegal logging will likely increase if communities have to decrease their patrolling efforts. It should be also considered that the commercialization of community forests following their successful protection and species enrichment might encourage forest authorities, who still hold full ownership over the forestland, to regain control over forest resources (Basnyat et al. 2020). Thus, strong tenure rights remain of paramount importance for communities.

8.3.2 Providing social benefits jointly with ecological outcomes

In many Asian countries, including Thailand, the growing participation of rural communities in formal forest management has been associated with the democratization of political systems and the emergence of CSOs (Charnley & Poe 2007). These coalitions enabled communities to assert their rights over forests. Subsequently, the participation of these communities, secure tenure rights, and effective local institutions could improve the governance of forest resources. Without an equitable role of communities in decision-making in forest management, positive ecological outcomes might be provided but local livelihoods could be harmed (Thoms 2008).

A commercial orientation of community forests could provide employment in the forest sector and, thus, new sources of income for rural communities increasing well-being as observed in Madagascar (Rasolofoson et al. 2017). However, fair benefit-sharing has to be ensured in community forestry (Sunderlin 2006). Several measures can be implemented to ensure positive social outcomes for all community members. The displacement of poor households due to the restrictive rules on forest utilization should be avoided (Pollini & Lassoie 2011). Similarly, restrictions on the harvesting of certain forest products might affect poorer households more severely as their livelihood depends more on their extraction. Thus, the positive ecological outcomes of community forests should not result in negative social outcomes. Moreover, all social groups should be able to participate in the decision-making process concerning forest management. This would ensure that all community members remain motivated to protect forest resources. This also concerns the inclusion of women in communal decision-making procedures to advance gender equality. Observations by Benjamin (2010) as well as the author indicated that in Thailand women are actively involved in many forest management committees in both supporting and leading positions but still not to the same extent as men. In conclusion, suitable measures should be further studied to avoid the marginalization and exploitation of certain community members and prevent elite capture (Pokharel & Tiwari 2013).

8.4 Critical reflections on research methodology

8.4.1 Comparative case studies

The case selection approach greatly influences the validity of causal inferences made (Seawright & Gerring 2008). In this study, a comparative-case design was used to conduct between-case assessments of tenure security. A control group was not available as all communities participated in the formalization program. Instead, cases were deliberately selected to maximize their variance in policy outcomes, specifically the occurrence of tenure-

related forest conflicts among the registered communities. The aim was to understand why certain community forests were still being encroached upon despite their formalization. The critical evaluation of apparently disconfirming evidence enhanced the credibility and validity of the qualitative analysis (Booth et al. 2013).

The community forest program is a national forest policy that has been implemented under a wide range of varying ecological and socio-economic conditions. Thus, replicated cases were selected from different regions to avoid focusing on localities with outlying cases and increasing the representativeness on a national scale. This selection process enhanced the study's external validity and, thereby, ensured that findings could be generalized to other situations and regions within Thailand analytically (Yin 2018).

The outcome among each respondent, i.e. the presence of tenure-related forest conflicts, was already known at the beginning of the study. Thus, the task of the researcher was to determine the temporal relationship between the intervention, here registration, and effect, the perception of tenure security among respondents. This retrospective approach can make the findings more prone to recall bias as baseline conditions at the start of the intervention have to be reconstructed. The internal validity can be ensured with the support from multiple respondents, key informants, and triangulation of each source (Yin 2018). This might fail if respondents do not perceive the intervention as very relevant and not memorable.

8.4.2 Spatio-temporal measure of deforestation pressure

The Getis–Ord Gi* statistic has been proposed as an indicator of deforestation hotspots by Harris et al. (2017). However, this measure of spatial clustering is not suitable to analyze temporal changes in clustering as to, for instance, identify emerging hotspots. Tang et al. (2019) developed a spatio-temporal Gi*statistic for epidemiological research of an infectious disease by normalizing it over the observation period. Here, it could be shown here that this measure can be also very useful in the study of forest landscape dynamics. The analyst should be aware that the observation radius can be adapted to the region of interest to provide a local (10 km), a regional (50 km), or a global perspective (200 km; Harris et al. 2017).

8.4.3 Quasi-experimental research design

Two quasi-experimental research methods, namely propensity score matching and fixed-effects modeling, were used to determine the effect of community forestry and its formalization on deforestation rates. Both methods have provided robust findings in earlier studies (Rasolofoson et al. 2015; Santika et al. 2017). In this study, a nationwide analysis of community forests was

conducted using boundary maps provided by the RFD. However, the responsible agencies are still in the process of digitizing all maps and were able to provide only a sample covering approximately 14% of all registered community forests. Thus, the sampling procedure was not determined by the researcher but a consequence of the working procedures at RFD. However, it is unlikely that the findings were biased due to this sample as forest maps were available for each region and not limited to one particular area. In conclusion, findings can be generalized to other community forests in Thailand.

An important limitation of this study was the inability to account for deforestation spillovers from community forests to other, less protected forests. If such a shift in illegal activities occurred, the observed effects of community forestry could be overestimated. Unfortunately, the currently available data was insufficient to develop a spatial panel model to determine the presence of spillover effects (Elhorst 2014). Such a study could be conducted as soon as boundary maps from all community forests are available.

8.4.4 Social network analysis and modeling

The modeling of social networks has fully matured in recent years enabling researchers to test hypotheses about social interactions beyond mere descriptions. Exponential random graph models (ERGM) have been used in this study to analyze the effect of network committees on inter-communal information sharing.

Social network analysis generally relies on a complete sample of all relations within a network. Missing data, particularly missing responses from network actors, can alter the result of an analysis and, thus, lowering its internal validity. However, the wide geographical distribution of respondents in this study complicated the collection of network information among all members. Recently developed model-based measures were used to account for the presence of missing ties within a studied network (Wang et al. 2016; Krause et al. 2020). Moreover, it was found that the missing respondents were not central but peripheral actors, which did not affect the overall network structure, and did not threaten the validity of the study's main conclusions.

The effect of the network committee could be analyzed using network modeling. Furthermore, the comparative network approach was used to compare networks at contrasting stages of development. Both measures were chosen to overcome the study's cross-sectional design and the absence of baseline data that showed the status of the provincial inter-communal network before the inception of network committees. The disconfirming case of Chumphon province

showed that a less developed network committee is unable to facilitate the creation of a cohesive inter-communal network.

8.4.5 Evaluating social network interventions ex-ante

The validity of impact evaluations generally benefits from longitudinal data. However, in the case of social network interventions, repeated surveys require substantial efforts and cannot make use of sampling as the analyses of whole networks require complete datasets (Carrington et al. 2005). Moreover, investigators might encounter survey fatigue among respondents who have to answer the same questions repeatedly (Pustejovsky & Spillane 2009). Thus, this study had a static perspective of network administration using only cross-sectional network data. Despite this limitation, important conclusions could be made by comparing multiple networks at different development stages and using statistical network models to test competing hypotheses. However, the developed network models open an additional avenue for future research as they could be also used to predict the impact of network interventions.

This study has identified one highly fragmented inter-communal network in Chumphon province. There are several networking strategies that the network committee in this province could implement to improve the connectedness of the whole provincial network. These actor-level networking measures include (1) bonding among network committee members, (2) reaching out to other communities, or (3) an outreach by the committee's president to communities. Using the trained and validated network model, the impact of each intervention can be simulated by altering the estimated likelihood of tie formations (Hunter et al. 2008). The counterfactual analysis could be combined with an ex-ante scenario simulation of realistic networks approach to provide evaluators with quantitative information about possible outcomes (Mellon et al. 2016). Based on these simulations, the network committee could be advised, for instance, to establish and maintain frequent exchanges with a specified number of communities. This would enable each committee member to use their resources more strategically and optimally strengthen the entire network (Mellon et al. 2016).

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10 SUPPLEMENTARY MATERIAL

10.1 Supplementary material for Chapter 6

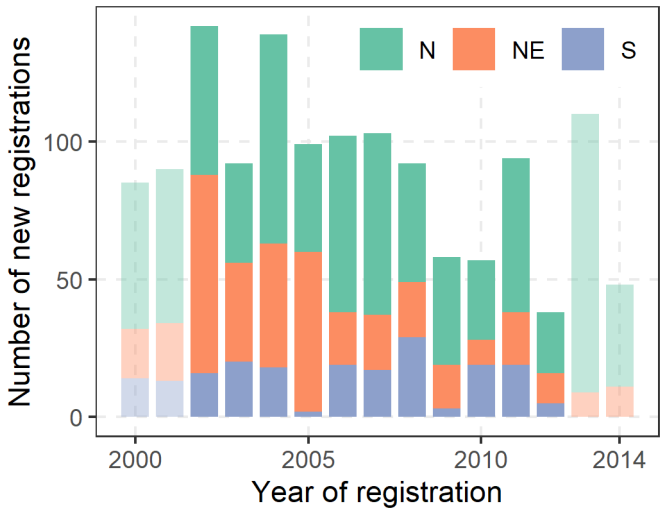

Figure 10-1: Distribution of registration year among sampled community forests in each region from 2000-2014. Highlighted registrations that occurred from 2002 and 2014 were investigated.

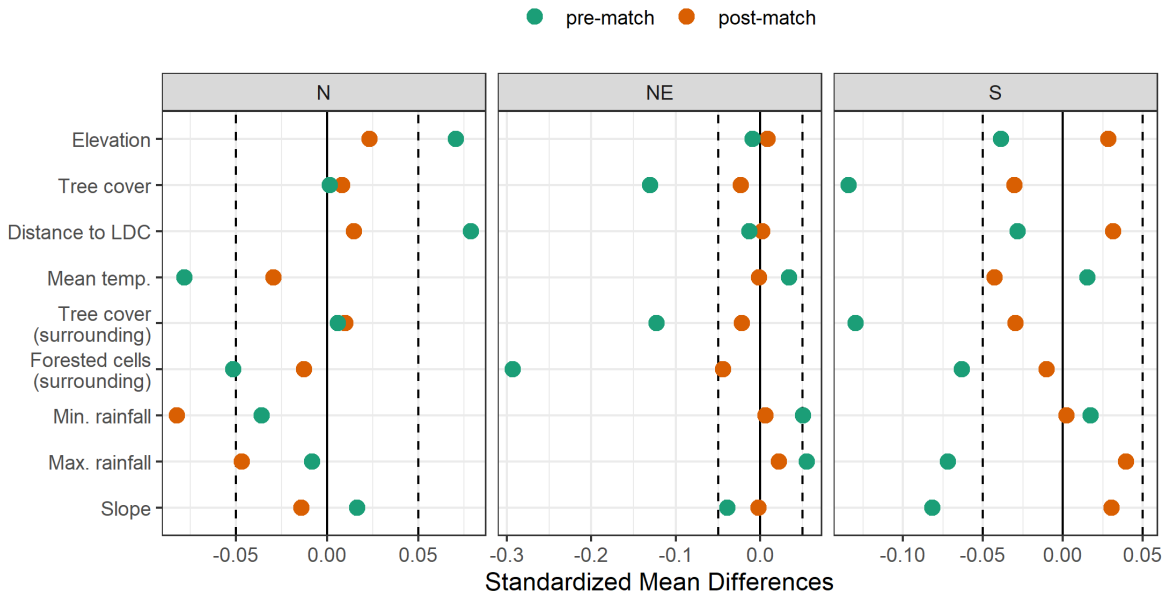

Figure 10-2: Balance of matching variables before and after propensity score matching for all continuous variables. Dashed lines highlight the 0.1 caliper around 0.

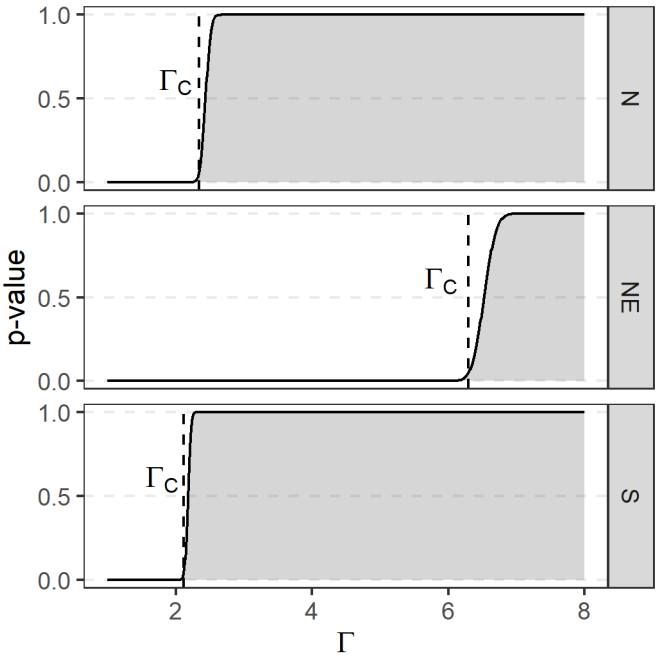

Figure 10-3: Rosenbaum bounds sensitivity analysis for each regional matching with Γ_C indicating the value of the upper bounds of Γ at $p = 0.05$. Values of $\Gamma_C > 2$ indicate robust results.

Table 10-1: Parameter estimates with 95% CI of autologistic regression models for each region. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Variable	North	North-East	South
Intercept	-3.07*** [-3.19,-2.95]	-2.57*** [-2.61,-2.53]	-2.1*** [-2.15,-2.06]
CF	-1.37*** [-1.53,-1.21]	-3.5*** [-3.64,-3.37]	-2.56*** [-2.64,-2.49]
G_i^*	0.43*** [0.32,0.54]	0.16*** [0.15,0.17]	0.2*** [0.17,0.23]
G_i^* × CF	-0.15* [-0.3,0]	-0.15*** [-0.18,-0.13]	-0.1*** [-0.16,-0.05]
Autocovariate	842.33*** [796.6,887.62]	1648.03*** [1615.03,1681.5]	869.7*** [854.34,885.26]
Control cells	41,960	65,382	21,514
Treatment cells	191,143	102,115	111,828

Note. CF, community forest. Mean G_i^*, mean deforestation pressure from 2000 to 2012. Autocovariate, deforestation in surrounding cells.

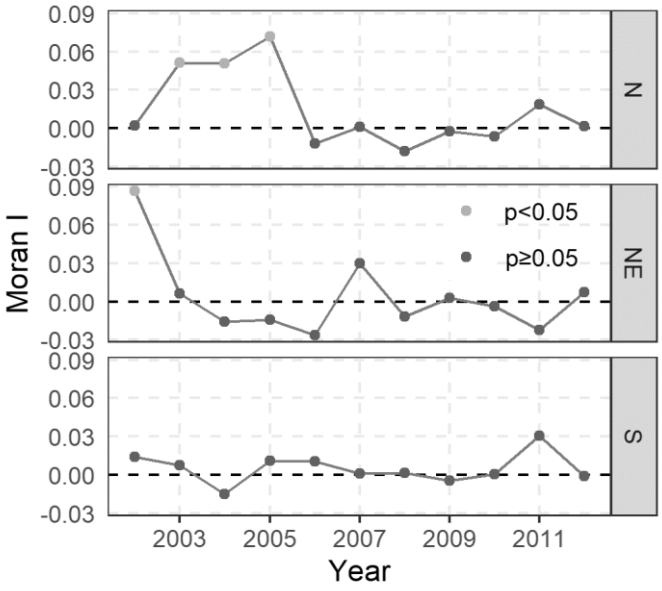

Figure 10-4: Moran's I of fixed-effects model residuals in each region from 2002 to 2012. Small but significant spatial autocorrelation was detected from 2003 to 2005 in the northern region and in 2002 in the north-eastern region.

Table 10-2: Parameter estimates with 95% CI of fixed-effects models for each region, which contain a time- or a forest-fixed effect. Only communities that registered from 2002 until 2010 were included.

Term	Model 1		Model 2	
North (*n* = 373)				
Registered	-0.24 [-0.64,0.16]	-0.07 [-0.17,0.04]	-0.15 [-0.45,0.14]	-0.09 [-0.18,0.01]
G_i^*	-0.01 [-0.04,0.02]	0.05* [0.01,0.09]	-0.01 [-0.04,0.01]	0.05* [0.01,0.09]
$loss_{before}$			0.34* [0.05,0.62]	
Registered × $loss_{before}$			-0.09 [-0.38,0.2]	0.06 [-0.09,0.2]
Fixed-effects	time	forest	time	forest
North-East (*n* = 185)				
Registered	-0.02 [-0.04,0.01]	0.04* [0.01,0.06]	-0.01 [-0.03,0.01]	0.02* [0,0.04]
G_i^*	0* [0,0.01]	0 [0,0]	0 [0,0.01]	0 [0,0]
$loss_{before}$			0.12*** [0.05,0.18]	
Registered × $loss_{before}$			0.05 [-0.05,0.15]	0.06 [-0.04,0.15]
Fixed-effects	time	forest	time	forest
South (*n* = 122)				
Registered	-0.39 [-0.91,0.13]	0.01 [-0.08,0.1]	-0.1 [-0.36,0.16]	-0.01 [-0.09,0.07]
G_i^*	-0.03 [-0.1,0.05]	0.03 [0,0.06]	-0.03 [-0.11,0.05]	0.03 [-0.01,0.07]
$loss_{before}$			0.54* [0.05,1.02]	
Registered × $loss_{before}$			-0.17 [-0.57,0.24]	0.04 [-0.2,0.28]
Fixed-effects	time	forest	time	forest

Note. Registered, Registration status of community forest (unregistered / registered). G_i^*, deforestation pressure. $loss_{before}$, occurrence of a deforestation event before registration (no / yes). *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

10.2 Supplementary material for Chapter 7

10.2.1 1. Descriptive network data analysis

Social network analysis is a quantitative approach to the study of a set of actors, their attributes and relationships (Wasserman and Faust 1994). Networks among CFOs as well as network committee members were examined using both descriptive network measures at the actor-level and the network-level as well as statistical modeling. However, these descriptive network measures need to be interpreted with caution due to the presence of non-respondents.

10.2.1.1 1.1 Actor-level indices

The centrality of each actor within the network was determined based on both the number of receiving (indegree centrality) as well as providing information links (outdegree centrality). Indegree and outdegree centrality of each actor were calculated by counting the number of links that are incoming and outgoing, respectively (Freeman 1978). Thus, indegree centrality was determined by the number of other actors from whom a focal organization receives information. Outdegree centrality shows how much each organization is acting as a source of information for others, and their importance as reference to the entire network (Figure 10-5). Local transitivity measures the extent to which partners of an organization are interacting among themselves, and can indicate tendencies of generalized reciprocity. It was determined based on the local clustering coefficient, which is calculated by

$$cl(v) = \frac{\tau_{\Delta}(v)}{\tau_{3}(v)}$$

Where $\tau_{\Delta}(v)$ is the number of transitive (closed) triangles which contains actor v, and $\tau_{3}(v)$ is the total number of connected triples, i.e. subgraph of three actors connected by two ties, in which both edges are connected to v.

Betweeness centrality was determined based on the number of shortest paths required by a focal organization to reach any other network actors and was calculated as

$$c_B(v) = \sum \frac{\sigma(s,t|v)}{\sigma(s,t)}$$

Where $\sigma(s, t|v)$ is the number of shortest paths, also called geodesics, between actor s and t going through actor v, and $\sigma(s, t)$ is the total number of geodesics between s and t (Freeman 1978). Organizations with a high betweeness centrality are considered influential actors as they control the information flow between pairs of unconnected actors and are able to reach others more easily

(Borgatti and Everett 1992). Networks would be more likely to fragment without these organizations.

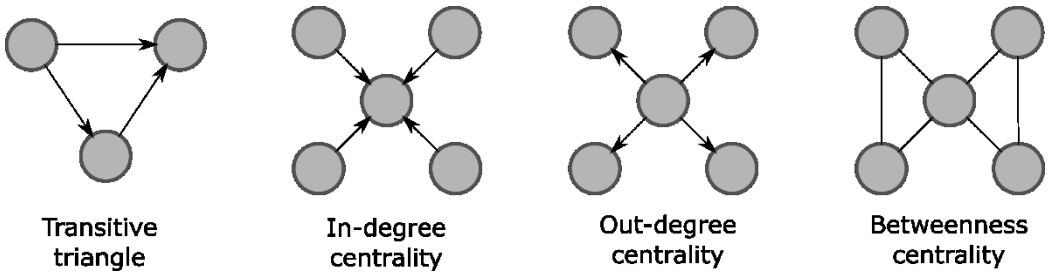

Figure 10-5: Network structures

10.2.1.2 1.2 Network-level indices

The global structure of the whole network was described through its density, level of centralization, and its transitivity or level of clustering. Network density quantifies the ratio between existing ties and the total number of possible ties among all actors. But it has to be considered, that larger networks tend to be less dense compared to small ones as the number of maximum relationships one actor can maintain is limited. Network centralization was calculated to assess whether information flow was concentrated on certain actors or distributed equally among organizations (Freeman 1978). This metric was standardized and rescaled to values ranging from 0 to 1 with 0 indicating a network in which interactions among all actors is equal and 1 indicating a highly-centralized network in which one actors receives information from all other actors but no information-sharing occurs among them. The mean clustering coefficient of a network G was calculated similarly to the actor-level clustering coefficient as the ratio of transitive triples to connected but intransitive triples to assess the network's transitivity (Kolaczyk and Csárdi 2014)

$$cl_T(G) = \frac{3\tau_\Delta(G)}{\tau_3(G)}.$$

10.2.2 2. Network description

Network metrics describe the structure of inter-communal provincial networks and the networks of committee members by quantifying apparent differences in network cohesion, density, and centralization among provinces (Table 2). The most remarkable difference between the studied networks is the low density of the Chumphon network in which only 1% of all possible ties were realized while 17 isolated CFOs did not share any information. The network of Trat province is the smallest (51 members) and densest (11% of all possible ties realized) of the three studied networks. However, the network in Kanchanaburi was not notably different as a lower network

density (0.09) could be expected given the greater number of CFOs. In Kanchanaburi, CFOs maintained on average more relationships (8.2) than in the other networks.

Considering the other indices, networks of Kanchanaburi and Trat displayed similar structure. The high centralization of Kanchanaburi's network (0.54) suggests that the number of ties was distributed disproportional among members with fewer actors involved in more interactions. Transitivity indicated that approximately half of all connected triples were closed to form triangles in all provinces. In contrast, Chumphon displayed a network of lower density, less centralization and greater cohesion. Considering the reciprocity of information flows, only 12% of ties were reciprocated in Chumphon, whereas more than one-third of ties were reciprocated in Kanchanaburi (40%) and Trat (35%). In Kanchanaburi and Trat, networks were comprised of a single large component in which each member was connected to all others through direct and indirect relationships due to the small number of isolated actors. Community forests in Kanchanaburi tended to be much larger, on average 133.4 ha, compared to Trat (45.9 ha) and Chumphon (23.5 ha).

The network committees of the three studied provinces had a similar number of members. However, the density of their shared social network differed greatly between Chumphon, on the one hand, and Kanchanaburi and Trat, on the other hand. In Chumphon, only 5 out of 9 members were connected through information-sharing relations, whereas only one member was isolated in Kanchanaburi and, in Trat, all members were connected at least indirectly. In Chumphon, only 5% of all possible links were actually realized, whereas in the other provinces 21% (Kanchanaburi) and 24% (Trat) of all ties were realized. The social networks connecting committee members in Kanchanaburi and Trat were similar in structure, regarding density, centralization, cohesion, and reciprocity. Moreover, both committees appeared to be cohesive as indicated by the high level of transitivity.

Table 10-3: Descriptive network statistics of information-sharing networks within the network committee (NC) and among all community forest organizations (CFO) in each province. Asterisks (*) indicate values that were normalized to the range [0, 1].

Province	Chumphon		Kanchanaburi		Trat	
Sub-network	NC	All CFOs	NC	All CFOs	NC	All CFOs
Number of CFOs	9	61	10	91	13	51
Indicators of network cohesiveness						
Isolates	4	17	1	1	0	2
Ties (mean ± sd)	0.4 ± 0.7	0.8 ± 2.7	1.9 ± 2.9	8.2 ± 12.5	3 ± 3.8	5.4 ± 8
Network density*	0.06	0.01	0.21	0.09	0.25	0.11
Transitivity*	0	0.45	0.66	0.47	0.65	0.51
Mean network distance	1.2	1.19	1.47	2.23	1.89	2.13
Reciprocity*	0.94	0.98	0.76	0.89	0.71	0.86
In-degree centralization*	0.22	0.33	0.63	0.81	0.72	0.64
Out-degree centralization*	0.08	0.04	0.14	0.26	0.27	0.2
Weak components	8	57	7	30	6	24
Strong components	6	23	2	2	1	3
Largest k-core	2	2	4	18	6	9
Number in largest k-core	2	14	4	10	6	19
Proportion ≥ 2-core*	0.22	0.23	0.7	0.97	0.92	0.92
Proportion ≥ 3-core*	0	0	0.5	0.93	0.69	0.86
Indicators of structural holes						
Number of cut-points	0	0	1	4	2	3
Proportion of cut-points	0	0	0.1	0.04	0.15	0.06
Area of community forests						
Mean forest area (ha)	33.5	23.4	268	133.4	45.5	45.9
Total forest area (ha)	301.6	1430.2	2680.1	12003.2	591.9	2339.5

The network positions of network committee presidents, committee members and other CFOs were further investigated by comparing their actor-level network metrics (Figure 10-6). It could be confirmed that the committee presidents of Kanchanaburi and Trat were the most connected actors in their respective networks and acted as important information brokers as indicated by their high level of betweenness centrality. Moreover, their low network transitivity compared to other actors indicated that they facilitated information flow by maintaining indirect ties between unconnected CFOs. For instance, the transitivity or local clustering of Kanchanaburi's committee president (0.1364) was only 28% that of the clustering for the whole network (0.47). Committee presidents

acted more as information sinks than sources of information, receiving information from more CFOs than they were providing to. Popular information providers with outstanding outdegree centrality were not present. Other members of the network committee were, on average, similar in their network position to other CFOs.

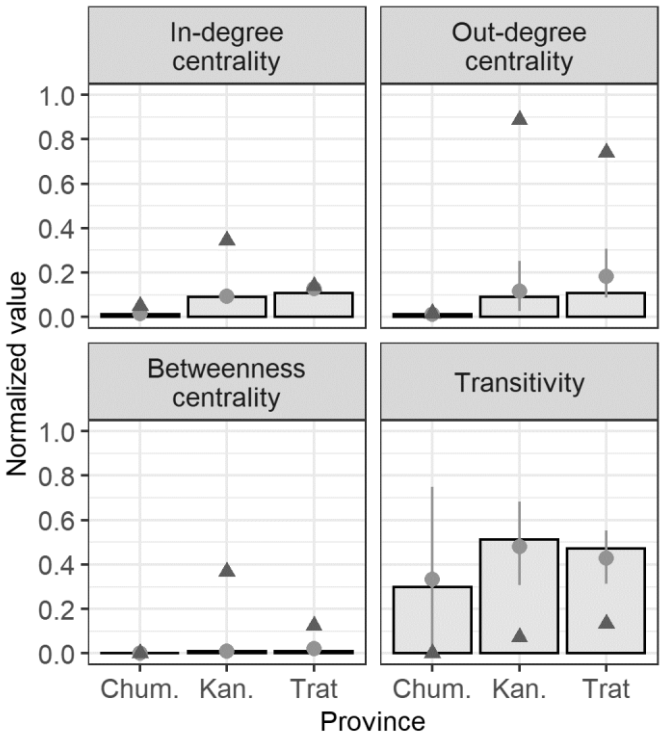

Figure 10-6: Network metrics (mean value with 95% confidence intervals) of all community organizations, members of each network committee (circles) and their president (triangles).

10.2.3 References

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Kolaczyk, E. D., & Csárdi, G. (2014). Statistical analysis of network data with R (Vol. 65). Springer New York. https://doi.org/10.1007/978-1-4939-0983-4

Wasserman, S., & Faust, K. (1994). Social network analysis: Methods and applications. Cambridge University Press.

Table 10-4: Estimates (mean [95% CI]) of information exchange among communal organizations (CFO), network committee members (NC) and the committee president in three provinces. Model II did not converge for Chumphon. Significant terms are indicated next to their estimates (*** p < 0.001; ** p < 0.01; * p < 0.05).

Province	Chumphon	Kanchanaburi		Trat	
Model	I	I	II	I	II
Network structure effects					
Edges	-3.043*** [-4.13;-1.96]	-3.569*** [-4.18;-2.96]	-5.128*** [-5.68;-4.58]	-2.439*** [-3.08;-1.8]	-2.326*** [-2.89;-1.76]
Indegree distribution*	-2.91*** [-3.86;-1.96]	-0.841* [-1.62;-0.07]	-1.091** [-1.91;-0.28]	-2.193*** [-3.16;-1.22]	-2.351*** [-3.23;-1.48]
Outdegree distribution*	2.377** [0.89;3.87]	2.157** [0.58;3.73]	4.474*** [2.41;6.54]	0.452 [-0.75;1.65]	1.022 [-0.03;2.07]
Dyadwise-shared partner*	-1.333*** [-2;-0.67]	-0.093*** [-0.12;-0.06]	-0.031*** [-0.02;-0.04]	-0.164*** [-0.22;-0.11]	-0.167*** [-0.21;-0.12]
Edgewise-shared partner*	2.184*** [1.29;3.07]	1.418*** [1.14;1.69]	1.884*** [1.61;2.16]	1.057*** [0.8;1.32]	1.09*** [0.88;1.31]
Dyad-level effect					
Weak communication tie	-1.017 [-3.13;1.1]	-1.296*** [-1.76;-0.83]	-1.25*** [-1.68;-0.82]	-0.323 [-0.9;0.25]	-0.419 [-0.9;0.07]
Strong communication tie	4.822*** [2.74;6.9]	2.218*** [1.88;2.55]	2.194*** [1.89;2.5]	2.419*** [1.73;3.11]	2.469*** [1.91;3.03]
Log Distance (10km)	-1.454*** [-1.82;-1.09]	-0.79*** [-0.91;-0.67]	-0.756*** [-0.87;-0.64]	-0.771*** [-0.95;-0.6]	-0.654*** [-0.81;-0.5]
Client relations					
NC to CFO			0.029 [-0.34;0.4]		0.054 [-0.51;0.61]
NC from CFO			0.316* [0.04;0.6]		0.314 [-0.03;0.66]
President to NC			2.388 [-0.32;5.1]		0.785 [-1.29;2.86]
President from NC			3.476*** [1.7;5.26]		3.579*** [1.49;5.67]
Internal relations					
NC to NC			1.088* [0.23;1.95]		0.077 [-0.52;0.67]
President to CFO			3.979*** [2.19;5.77]		1.598 [-0.25;3.45]
President from CFO			5.497*** [4.27;6.72]		2.199*** [1.36;3.04]
AIC	316.97	2157	2270.31	893.66	952.64

*decay parameter fixed at 0.5

Note on the commencement of the doctoral procedure

(1) I hereby assure that I have produced the present work without inadmissible help from third parties and without aids other than those stated, ideas taken directly from external sources are identified as such.

(2) When selecting and evaluating the material and also when producing the manuscript, I have received support from the following persons: Prof. Dr. Jürgen Pretzsch and Prof. Dr. Yongyut Trisurat.

(3) No further persons were involved in the intellectual production of the present work. In particular, I have not received help from a commercial doctor adviser. No third parties have received monetary benefits from me, either directly or indirectly, for work relating to the content of the presented dissertation.

(4) The work has not previously been presented in the same or a similar format to another examination body in Germany or abroad, nor has it – unless it is a cumulative dissertation – been published.

(5) If this concerns a cumulative dissertation in accordance with Section 10 Para. 2, I assure compliance with the conditions laid down therein.

(6) I confirm that I acknowledge the doctoral regulations of the Faculty of Environmental Sciences of the Technische Universität Dresden.

Dresden, 03.06.2022

Michael Jenke