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Rural Communities' Local Knowledge of Forest Resources
Utilization for their Livelihoods: A case study in the Katha District,
Myanmar

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Contents

စာတမ်းအကျဉ်း	i
Abstract	iii
1 Introduction	1
2 Materials and Methods	2
2.1 Study area	2
2.2. Methods	4
3 Results	5
3.1 Household's livelihood activities	5
3.2 Diversity of forest products collected and used by households	6
3.3 Sharing forest products	7
3.4 Perceptions on forest products	7
3.5 Local knowledge of rural communities	8
3.6 Awareness and application of LK	11
3.7 Influence of household's characteristics on the application of LK	11
3.8 People's perceptions on local knowledge	12
3.9 Influence of household's characteristics on LK	14
3.10 Local knowledge related to forest resource management	15
4. Discussion	16
5. Conclusions	19
6. Acknowledgements	20
References	21

**ဒေသခံကျေးလက်ပြည်သူတို့၏ လူမှုဘဝများအတွက် သစ်တောသယံဇာတများ အသုံးပြုခြင်း
နှင့် ဆက်စပ်လျက်ရှိသည့် မိရိုးဖလာလုပ်ကိုင် ဆောင်ရွက်မှုများ နှင့် အသိပညာအား
လေ့လာခြင်း**

ဒေါက်တာဇာခြည်လှိုင်၊ ဦးစီးအရာရှိ
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သဘာဝသယံဇာတအရင်းအမြစ်များအား ထာဝစဉ်ရေရှည်တည်တံ့စွာစဉ်ဆက်မပြတ် ထုတ်ယူသုံးစွဲနိုင်ရန် ဒေသခံပြည်သူများပါဝင်သည့် စီမံအုပ်ချုပ်ခြင်း၊ ထိန်းသိမ်းခြင်းများ ဆောင်ရွက်ရာတွင် ဒေသခံကျေးလက်ပြည်သူတို့ လိုက်နာကျင့်သုံးလျက်ရှိသည့် မိရိုးဖလာ လုပ်ကိုင်ဆောင်ရွက်မှုများနှင့် အသိပညာအား အသုံးပြုခြင်းဖြင့် အောင်မြင်သော သစ်တော သယံဇာတအရင်းအမြစ်စီမံအုပ်ချုပ်မှုများ ရရှိနိုင်သည်ကိုသိရှိရသော်လည်း လက်တွေ့ နယ်ပယ်၌ ဆောင်ရွက်ရာတွင် စိန်ခေါ်မှုများ များစွာဖြစ်ပေါ်လျက်ရှိပါသည်။ ဤစိန်ခေါ်မှု များကို ကျော်လွှားဖြေရှင်းနိုင်ရာတွင် နေရာဒေသအလိုက် အသုံးပြုလျက်ရှိသည့် သစ်တော သယံဇာတများအပေါ် မှီခိုလျက်ရှိသော ဒေသခံကျေးလက်ပြည်သူများ၏ မိရိုးဖလာ လုပ် ကိုင် ဆောင်ရွက်မှုများနှင့် အသိပညာအား သိရှိထားရန်လိုအပ်လျက်ရှိသည့်အတွက် ၎င်းတို့ သည်သစ်တောသယံဇာတများနှင့် မည်သို့စပ်ဆက်လျက်ရှိသည်ကိုသိရှိရန် နှင့် သစ်တော သယံဇာတများ စီမံအုပ်ချုပ်ရာတွင် ၎င်းမိရိုးဖလာလုပ်ကိုင်ဆောင်ရွက်မှုများ၏ အခန်းကဏ္ဍ ကို သိရှိလေ့လာရန် ဤသုတေသနကို ရည်ရွယ်ဆောင်ရွက်ခြင်းဖြစ်ပါသည်။ ဤသုတေသန လုပ်ငန်းကို မြန်မာနိုင်ငံ၊ စစ်ကိုင်းတိုင်းဒေသကြီး၊ ကသာခရိုင်အတွင်းရှိ ကျေးလက်ဒေသ(၄) နေရာတွင်ဆောင်ရွက်ခဲ့ပါသည်။လေ့လာတွေ့ရှိချက်များအနေဖြင့် လေ့လာခဲ့သည့် ကျေးလက် ဒေသ(၄)နေရာတွင် ၎င်းတို့လိုက်နာကျင့်သုံးလျက်ရှိသည့် မိရိုးဖလာလုပ်ကိုင် ဆောင်ရွက်မှု များနှင့်အသိပညာများကို ရိုးရာဓလေ့အရတားမြစ်မှုများ၊ ရိုးရာဓလေ့ယဉ်ကျေးမှုနှင့်သက် ဆိုင်သည့်လိုက်နာမှုများ၊ လူမျိုးစုအရရိုးရာဓလေ့သတ်မှတ်မှုများနှင့် လူမှုဘဝလုပ်ငန်းများ နှင့် ဆက်စပ်မှုများ စသည့်ဖြင့် အမျိုးအစား(၄)မျိုး လေ့လာမှတ်သားခဲ့ရပြီး မိသားစုအစဉ် အဆက်အရသော်လည်းကောင်း၊ ကျေးလက်ဒေသလူမှုအဖွဲ့အစည်းများမှ သော်လည်း ကောင်း၊ သက်ကြီးဘိုးဘွားများမှ သော်လည်းကောင်း လက်ဆင့်ကမ်းလေ့လာမှတ်သား လိုက်နာ

ကျင့်သုံးခဲ့ကြောင်း သိရှိခဲ့ရပါသည်။ မိရိုးဖလာလုပ်ကိုင်ဆောင်ရွက်မှုများအား လက်တွေ့ လိုက်နာကျင့်သုံးခြင်း (Applying) သည် လေ့လာသိရှိခြင်း (Awareness) ထက် လျော့နည်းနေသည်ကို တွေ့ရှိရပြီး လိုက်နာကျင့်သုံးမှုမှာ အိမ်ထောင်စုများ၏ နေထိုင်မှု ကာလ၊ အိမ်ထောင်ဦးစီးအသက်အရွယ်၊ တိရိစ္ဆာန်များမွေးမြူခြင်းတို့နှင့် တိုက်ရိုက် သက်ဆိုင်နေ သည်ကို တွေ့ရှိရပါသည်။ လိုက်နာကျင့်သုံးမှုနည်းသည်ကို တွေ့ရှိရသော်လည်း ၈၅ ရာခိုင်နှုန်းသော အိမ်ထောင်စုများမှာ ၎င်းတို့၏ မိရိုးဖလာလုပ်ကိုင်ဆောင်ရွက်မှုများ၏ သစ်တော သယံဇာတများအပေါ် အကျိုးသက်ရောက်မှုများအတွက် သဘောတူညီထောက်ခံ ကြောင်း တွေ့ရှိရပါသည်။ ဒေသခံကျေးလက်ပြည်သူများလိုက်နာကျင့်သုံးနေကြသည့် တချို့ သော မိရိုးဖလာလုပ်ကိုင်ဆောင်ရွက်မှုများသည် သဘာဝပတ်ဝန်းကျင်အား ထိခိုက်မှုဖြစ် ပေါ်စေသော်လည်း အများစုသည် သစ်တောသယံဇာတအရင်းအမြစ်များ ထိန်းသိမ်းခြင်း လုပ်ငန်းစဉ်များနှင့် တိုက်ရိုက်ဆက်သွယ်ပတ်သက်မှုများရှိသည့်အပြင် ဒေသခံကျေးလက် ပြည်သူတို့၏ လူမှုစီးပွားဖွံ့ဖြိုးမှုအတွက်ပါ အကျိုးကျေးဇူးဖြစ်ပေါ်လျက်ရှိကြောင်း လေ့လာ သိရှိရပါသည်။ သို့ဖြစ်ပါ၍ သစ်တောသယံဇာတများအား ရေရှည်တည်တံ့စွာ အသုံးပြုနိုင် ရန် စနစ်တကျစီမံအုပ်ချုပ်မှုတွင် ဒေသခံကျေးလက်ပြည်သူများ၏ မိရိုးဖလာလုပ်ကိုင် ဆောင်ရွက်မှုများနှင့် အသိပညာများသည် အရေးကြီးသည့်အခန်းကဏ္ဍတွင် ပါဝင်သည့် အတွက် ဒေသခံကျေးလက်ပြည်သူများ၏ မိရိုးဖလာ လုပ်ကိုင်ဆောင်ရွက်မှုများနှင့် အသိ ပညာအား နေရာဒေသအလိုက်မှတ်တမ်းတင် လေ့လာထားရှိပြီး သစ်တောသယံဇာတများ ထိန်းသိမ်းရေးနှင့် ကျေးလက်ပြည်သူတို့၏ လူမှုဘဝဖွံ့ဖြိုးတိုးတက်ရေးကို ညီညွတ်မျှတစွာ ဆောင်ရွက်နိုင်မည် ဖြစ်ပါသည်။

Rural Communities' Local Knowledge of Forest Resources Utilization for their Livelihoods: A case study in the Katha District, Myanmar

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Abstract

Although the application of local knowledge has received increasing attention and became the important role in environmental conservation, the successes and challenges encountered in the application of local knowledge in managing and governing natural resources. This case study aimed to examine rural communities' applying local knowledge practices related to forest resources for their livelihoods and to understand the role of local knowledge in forest resources management. Data collection was conducted through face-to-face household interview from 218 households and focus group discussions in four rural communities in the Katha District, Myanmar. The study documented four different types of local knowledge practices such as taboos, custom, norms and other local knowledge related to livelihood activities, and they are acquired and transmitted through family custom, social networks and oral communication including learning from elder people. The results showed that a significantly lower proportion of applying local knowledge when compared to the awareness in each studied community. Household characteristics like length of stay (residence years), HHH's age and livestock varieties were found as the influence variables on the awareness and application of local knowledge, and average 85% of local communities showed their agreement on application of local knowledge. Communities' applying knowledge practices are supporting the forest resources conservation activities directly, and helping to address contemporary livelihood (socio-economic) and environmental conditions. But the vice versa effects like beneficial and detrimental, of local knowledge practices are observed as one of the attention factors when local knowledge is utilized in the forest resource management and livelihood improvement activities.

Keywords: Local knowledge, Awareness, Application, Livelihood activities, Katha, Myanmar

Rural Communities' Local Knowledge of Forest Resources Utilization for their Livelihoods: A case study in the Katha District, Myanmar

1. Introduction

The global degradation and reduction in biodiversity and ecosystem services are appeared by various causes, especially human's activities, and also impact on people's livelihood that depends on the ecosystem services. The tackled issue gained much momentum recently because of its relevance for management [1], [2], conservation [3], [4] and ecosystem modeling [5], and also parallel, the people's knowledge of forests resources and utilization has received increasing attention [6], [7]. Several studies [8]–[12] have provided empirical evidence of past and present success and challenges encountered in the application of local knowledge in managing and governing natural resources in different ecosystems, and the relationships among livelihood variables and natural resources. The usage of local knowledge in management of environmental resources has received increasing attention and became the important role in environmental conservation and rural livelihood improvement program [13]–[15]. Moreover, on a multilateral level, Article 8 (j) of the United Nations Convention on Biological Diversity explicitly states the needs to respect, preserve, and maintain knowledge practices of local and indigenous communities related to biological diversity [16]. The Millennium Ecosystem Assessment (MA) report also identified the traditional ecological knowledge as relevant in addressing the current unsustainable utilization of different categories of ecosystem services [17]. The has created opportunities for the inclusion of indigenous and local communities and their traditional ecological knowledge in ecosystem Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and biodiversity assessment by making it a key component in its established conceptual framework [18].

The integrated approach to the link conservation and development with the traditional ecological knowledge, have been implemented to generate the benefits of local communities and policy intervention. Here local knowledge is not confined to tribal groups or the original inhabitants of an area, and all communities possess local knowledge – rural and urban, settled and nomadic, original inhabitants and migrants [19]. Moreover, the socio-cultural, i.e., social needs, belief and perceptions, knowledge, practices and preferences towards ecosystem services, are context-dependent variables and related to the type of knowledge the people hold, their place and the way in which they interact with their natural surroundings [20]. The traditional ecological knowledge or the local knowledge of the people who depend on the ecosystem services (forest resources) for their livelihood is important to realize – it is related to the people household characteristics, socioeconomic status, experience, environment, history, etc. [21]. Although local knowledge is not static; is dynamic, local knowledge evolves exploring the human-environmental interaction including ecosystem services [22]. Several studies [23]–[25] emphasize the advantages of local knowledge as the resources uses and dependency that involve in the management of forest resources and conservation biodiversity.

Most of the studies that related with rural people's LK on forest resources described the LK play an important role in the conservation of local biodiversity and their landscape [26]–[29], in the changing of socio-economic and cultural conditions including external environmental change [30]–[32]. There is still a limited information on the applying LK and the communities' perception on applying LK on forest conservation [14], [33]–[35]. Challenges have arisen about how to integrate with forest resources conservation activities and the local communities' dependence on forest resources through their local knowledge in local community level.

Since 1856, Myanmar, one of the developing countries, has been applied sustainable forest management to conserve the forest resources. The Forest Department of Myanmar (FD), in 1990s, implement community-based natural resource management (CBNRM) approach to achieve sustainable forest management, and Community Forestry Instructions 1995 has been issued. According to Forest Resource Assessment [36], Myanmar lost 19% of forest cover between 1990 and 2010. It shows that CBNRM in Myanmar is not seemed to be effectively approach, and suffers from setbacks due to lack of professional attitudes among the forest staffs, and communities' empowerment and property rights to get their participation (Ref.). Moreover, the local knowledge practices of the long-lived rural communities and the existing people–forest interaction have not been adequately appreciated, and considered into the policies/ development plans and management activities. This has been largely limited to descriptive of people role places of applying in CBNRM. The understanding of community's local knowledge practices can fulfill this gap in ensuring sustainable forest management through CBNRM in Myanmar.

In this context, the objective of this study is to understand community's applying local knowledge practices for their livelihoods by conducting assessments of their perceptions regarding the application and the effectiveness of LK. LK is a part of people's life, especially the poor/ rural people, almost entirely, for their livelihoods and their survival. It can be whether positive or negative effects on either resources or local community's livelihood and both. In the face of these uncertainties, it has become necessary to examine how the local people apply their local knowledge in integrating of forest resources conservation and livelihood improvement as the sustainable way. In this study, LK refers to any knowledge/ practice which is a collection of facts and relates to their belief, custom, perceptions and their daily activities and experiences that people hold about the world around them. It is the main asset they invest in the struggle for survival, to produce food, provide for shelter or achieve control of their own life [21], [37]. To achieve the objective of the study, we focus the following questions; What are the main HH's livelihood activities? What are the existing LK practices for their livelihood activities and to what extent of the communities' awareness and applying LK? Which HH's characteristics have the most influence on the applying LK? How do the communities' perceptions show on the applying LK and their effects on HH's livelihood activities?

2. Materials and Methods

2.1 Study area

The study was conducted in the Katha District, located between 23° 31' and 24° 57' N, and 95° 14' and 96° 17' E. Data collection were conducted in rural communities from four townships—Banmauk (BM), Kawlin (KL), Pinlebu (PLB), and Wuntho (WT) (**Figure 1**) of the Katha District. More than 89% of the total district population comprises rural communities living in rural area of these four townships [38]. On an average, 81% of the studied townships' area is covered with the moist upper mixed deciduous forests, and these forest areas are Protected Public Forest (PPF) under the management of the FD [39]. The studied communities have a settlement history for over 100 years in these PPF areas. Shan, Kadu, Kanan tribes are found in BM, and Shan and Burma tribes are found in KL, PLB and WT communities. All studied communities' tribes are Buddhist. Their main livelihood depends on forest resources and agriculture which is subsistence agriculture with the shifting cultivation. The studied communities locate between 11 km and 72 km away from the nearest towns and the accessibility/ transportation to the studied communities is only road route and it is more difficult in rainy season.

The studied communities were selected with purposive sampling on the basis of the following factors: high rural population area in the district, the proximity of the rural settlements to forested areas and urban area, and village size (number of households (HH) in the village).

Table 1 describes the information of studied communities.

Table 1. The general information of studied communities

Studied communities	Estimated settlement locating year (length of stay)	Estimated total household	Average household size	Average distance to surrounding forest area from settlement (km)
Kawlin	+ 100 years	559	5.5 (±1.8)	2.2
Pinlebu	+ 100 years	495	5.5 (±1.5)	1.3
Banmauk	+ 160 years	534	6.0 (±1.9)	1.1
Wuntho	+ 160 years	284	6.0 (±2.3)	2.3

Source: *The 2014 Myanmar Population and Housing Census, Sagaing Region, Census report Volume 3-E, Department of Population, Ministry of Immigration and Population, May 2015*

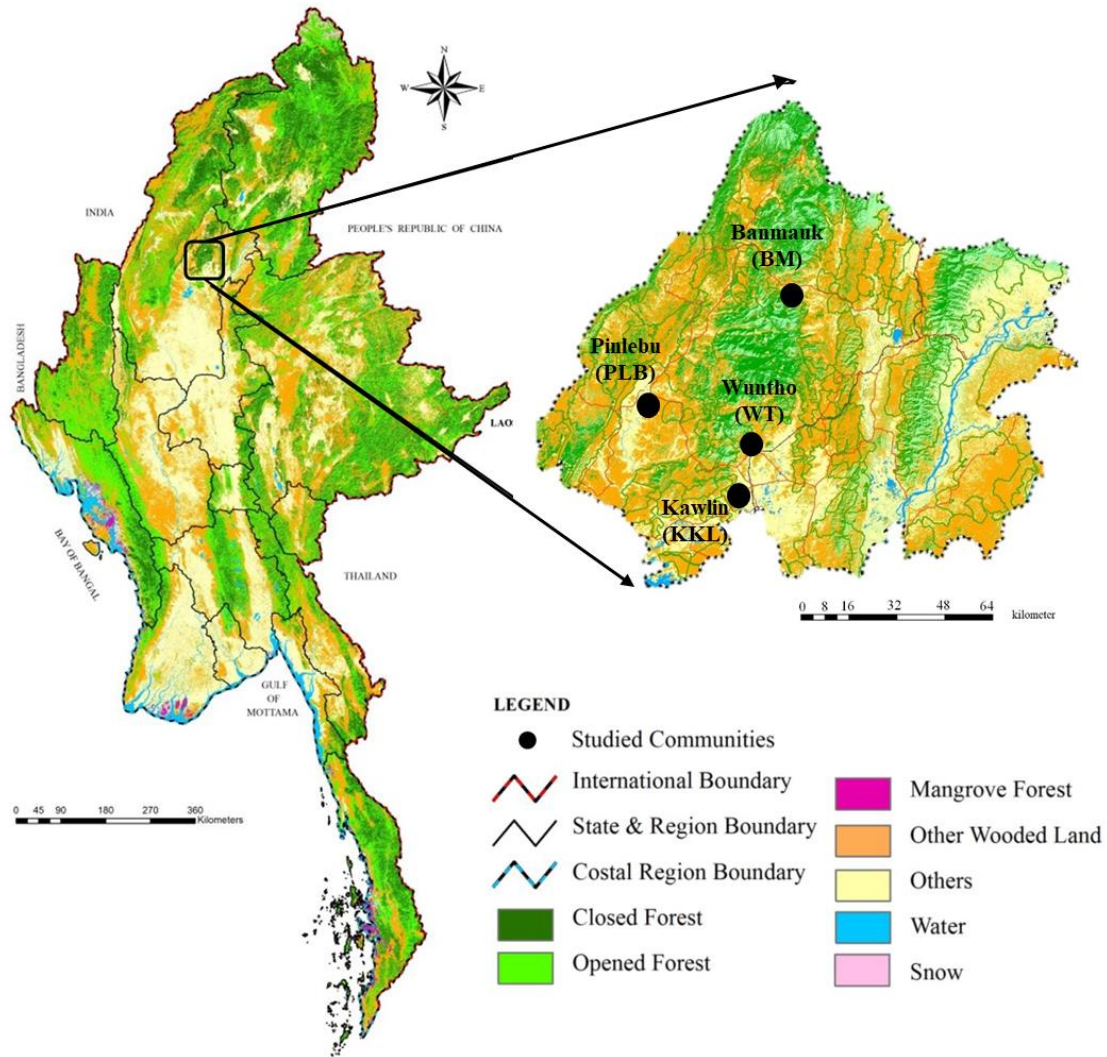


Figure 1. Location of study area

Source: Katha District Forest Department, 2015[39]

2.2. Methods

Field-based quantitative and qualitative data collection was carried out in November 2015 and April 2016. The participatory action research (PAR) approach was used to achieve study objectives. PAR is collective and self-reflective process which is directly linked to action, influenced by understanding of history, culture and local context and embedded in social relationships in which researchers and participants undertake [40]. Field data collection process was shown in **Figure 2**. Firstly, the community entry meetings were started with the 10 – 20 people including village heads, village elders, and few villagers to obtain a general overview about the villages. Then, snowball sampling was used to identify and get more information about the local knowledge practices (LK) that the communities apply for their livelihoods. Key informants were identified for a series of in-depth interviews using snowball sampling technique. The target people for key informants' interview included village head, elder people, monk, community groups' leaders, traditional medicine healer and carpenter. After that, observations

with villagers were conducted as the visits to the villages including monastery, school, water sources, farm land, and the surrounding forest area. During these observations, information related to LK were collected as field notes and photographs.

Secondly, face-to-face household interview with a total of 218 randomly sampled households (10% of the total households in the studied communities) was conducted to investigate HH's applying LK practices for their livelihood activities [KL: n=69, PLB: n=58, BM: n=52 and WT: n=39]. It was done with household heads, and where unavailable, the suggested person was interviewed. The household survey questionnaire was developed using a semi-structured format with both closed and open-ended questions to obtain information about household characteristics such as demographic factors, household income conditions and livelihood activities, and LK practices related with HH's livelihood activities. Finally, to identify the already-recorded LK during HH interview, four group discussion/ meetings were conducted (one meeting per one studied community). Totally 241 community's people [KL: n= 60, PLB: n=68, BM: n=56 and WT: n=57] participated in the meetings. Meeting lasted around one and half hours.

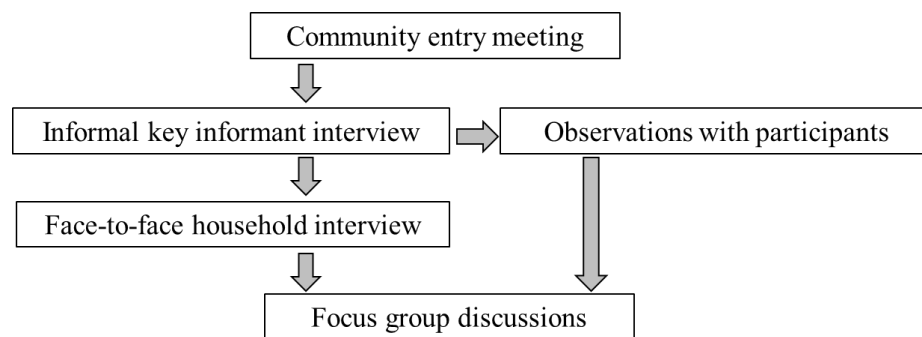


Figure 2. Field data collection processes

To examine the communities' perceptions on their applying LK, the communities' awareness and application of LK, the levels of importance (with Likert-type scale: 0 = not importance, 1= just importance, 2 = low importance, 3 = moderate importance and 4= high importance), the agreement (like/ dislike), and the attitudes (positive/ negative effects) were recorded. The regression linear model was run to observe the influence variables of household's characteristics on LK. Household's socio-economic variables such as HH members (HH sizes), number of working people (15 – 75 years old), household head's age, HH member age groups (young people: 15 - 30 years, mature people: 31 - 60 years, Elderly: ≥ 61 years), the length of stay, and cultivating land area and livestock varieties were considered as independent variables of household's characteristics.

3. Results

3.1 Household's livelihood activities

Table 2 shows household's main activities which were HH's income flows as well as stocks for contributing to household consumption and cash generation. HH's activities included agricultural activities, forest related activities, livestock activities, and others such as small scale gold mining (household level), small stalls at home, daily wages activities and government services including teachers, government officers. Among those income activities, agricultural crops especially rice is found as the main income source in all studied communities. Overall, although 88% of total household are agricultural (especially rice) households, above 63 % of these households cannot earn from rice production and is mainly used for own consumption. Therefore, they earn cash from animal husbandry especially pig (piglet), and in addition, from non-timber forest products (NTFPs) collection, and other cash income activities. HH's activities are mostly related to their surrounding forest resources and forested area.

Table 2. Percentage of household which engage in different household activities for their livelihoods

	Household's livelihood activities related to			
	Forest	Agriculture	Livestock	Others
Kawlin (n=69)	66 (96%)	63 (91%)	61 (88%)	31 (45%)
Pinlebu (n=58)	53 (91%)	47 (81%)	48 (83%)	30 (51%)
Banmauk (n=52)	51 (98%)	49 (94%)	48 (92%)	28 (54%)
Wuntho (n=39)	37 (95%)	35 (90%)	31 (79%)	31 (79%)

3.2 Diversity of forest products collected and used by households

Food, building materials, energy, medicine, and income are found to be the main uses. Below, we explore how these basic needs are derived from each of the forest products on the basis of interviews with HHHs, field observations, and key informants.

Food: All types of foods collected and consumed in each studied HH were observed and their quantities were recorded as long as the HH could recall. HHs collect forest products to use as vegetables such as edible leaves from trees, shrubs, flowers and seasonal fruits, mushrooms, bamboo shoots, honey, bush meat, and fodder for their livestock. These were used for both consumption and cash generation. Food products were mostly collected during the rainy season (from May to October).

Table 3 describes the collected forest product varieties and the average quantities used for consumption and cash generation. In general, 13 forest products are found to be most frequently collected products by the people in the studied communities. NTFPs incur the main contribution to cash generation from forest products, but TFPs are only for their consumption. We observed that people depended more than four times on forest products for their non-cash consumption than for the cash value of the products, based on the monetary values of forest

products. The main NTFPs collected for consumption and cash generation are food stocks such as leaves and fruits, mushrooms, bamboo shoots, fodder, honey, and bush meat. In the household interviews, we were able to record that NTFPs collection such as mushrooms, bamboo shoots, vegetables, and medicinal plants is done mostly during the rainy season (May to October). *Tinospora cordifolia* (Sin-ton-ma-new), *Millettia extensa* (Win-u), and *Costus speciosus* (Phanlan-taung-hmwe) are generally collected for their medicinal value. Although the local communities rely on the traditional medicines for their health care, low intensity of collection of forest products with medicinal purposes such as honey, orchid and medicinal plants is observed. It can be attributed to the fact that medicinal plants collection is usually undertaken by people with special knowledge and expertise (traditional healers). Among the four communities, Pinlebu and Banmauk shows higher collected forest product varieties than Kawlin and Wuntho (Table 3). Pinlebu and Banmauk also have higher collected quantity of some forest products especially for food purpose such as bamboo shoot, mushroom, honey, vegetables and thatch than that of Kawlin and Wuntho. The higher distance of Pinlebu and Banmauk communities from urban area can be the reason behind more utilization of forest products for food consumption (Table 1).

Table 3. Types of collected forest products in all studied communities

No.	Collected forest products	Kawlin	Pinlebu	Banmauk	Wuntho	Direct contribution to daily basic needs
1.	Timber	✓	✓	✓	✓	Building materials, Energy
2.	Fuel-wood	✓	✓	✓	✓	Energy
3.	Fodder	✓	✓	✓	✓	Livestock feed
4.	Bamboo	✓	✓	✓	✓	Building materials, Income
5.	Bamboo shoot	✓	✓	✓	✓	Food, Income
6.	Mushroom	✓	✓	✓	✓	Food, Income
7.	Small Wood (Tools)	✓	✓	✓	✓	Tools, Building materials
8.	Food (Vegetables)	✓	✓	✓	✓	Food
9.	Thatch	✓	✓	✓	✓	Medicine, Income
10.	Medicine	✓	✓	✓	✓	Building materials
11.	Food (bush meat)	✓	✓	✓	✓	Food, Income
12.	Honey	✓	✓	✓	✓	Medicine, Food, Income
13.	Orchid	✓	✓	✓	✓	Medicine, Income
14.	Resin			✓		Income
15.	Cicada		✓			Food, Income

Source: Data collection November 2015 and April 2016

3.3 Sharing forest products

Sharing of forest products is one of the main social activities of communities. Of the 13 recorded forest products that are commonly collected, 10 forest products are found to be shared with neighbors (Table 4). Generally, bamboo (56%) is the most shared products among households while orchid (5%) is the least shared product. Bamboo shoot (49%), fodder (37%), mushroom (33%) and small wood (34%) are also highly shared among the studied communities.

Table 4. Shared forest products with neighbors and percentage of households which described their sharing forest products

Shared forest products to the neighbor household	Kawlin (n=69)	Pinlebu (n=58)	Banmauk (n=52)	Wuntho (n=39)
Bamboo	45 (65%)	25 (43%)	30 (58%)	22 (56%)
Bamboo shoot	32 (46%)	34 (59%)	22 (42%)	19 (49%)
Mushroom	24 (35%)	18 (31%)	16 (31%)	14 (36%)
Honey	9 (13%)	6 (10%)	11 (21%)	1 (3%)
Orchid	1 (1%)	6 (10%)	-	1 (3%)
Vegetables	10 (14%)	17 (29%)	23 (44%)	9 (23%)
Bush meat	1 (1%)	6 (10%)	13 (25%)	6 (15%)
Medicinal plants	15 (22%)	13 (22%)	12 (23%)	3 (8%)
Fodder	17 (25%)	23 (40%)	31 (60%)	9 (23%)
Small wood	27 (39%)	15 (26%)	20 (38%)	-

3.4 Perceptions on forest products

To know the priority of forest benefits for their livelihood, the households were asked to list their priority of forest benefits that they described during the HH interview. **Figure 3** shows the priority level of forest benefits for their livelihood in the studied communities. The communities recognized multiple benefits from their surrounding forest area as provisioning, regulating and cultural services. Generally, there were different perception on the forest benefits, but the provisioning services are the most important for their livelihood, followed by regulating and cultural services.

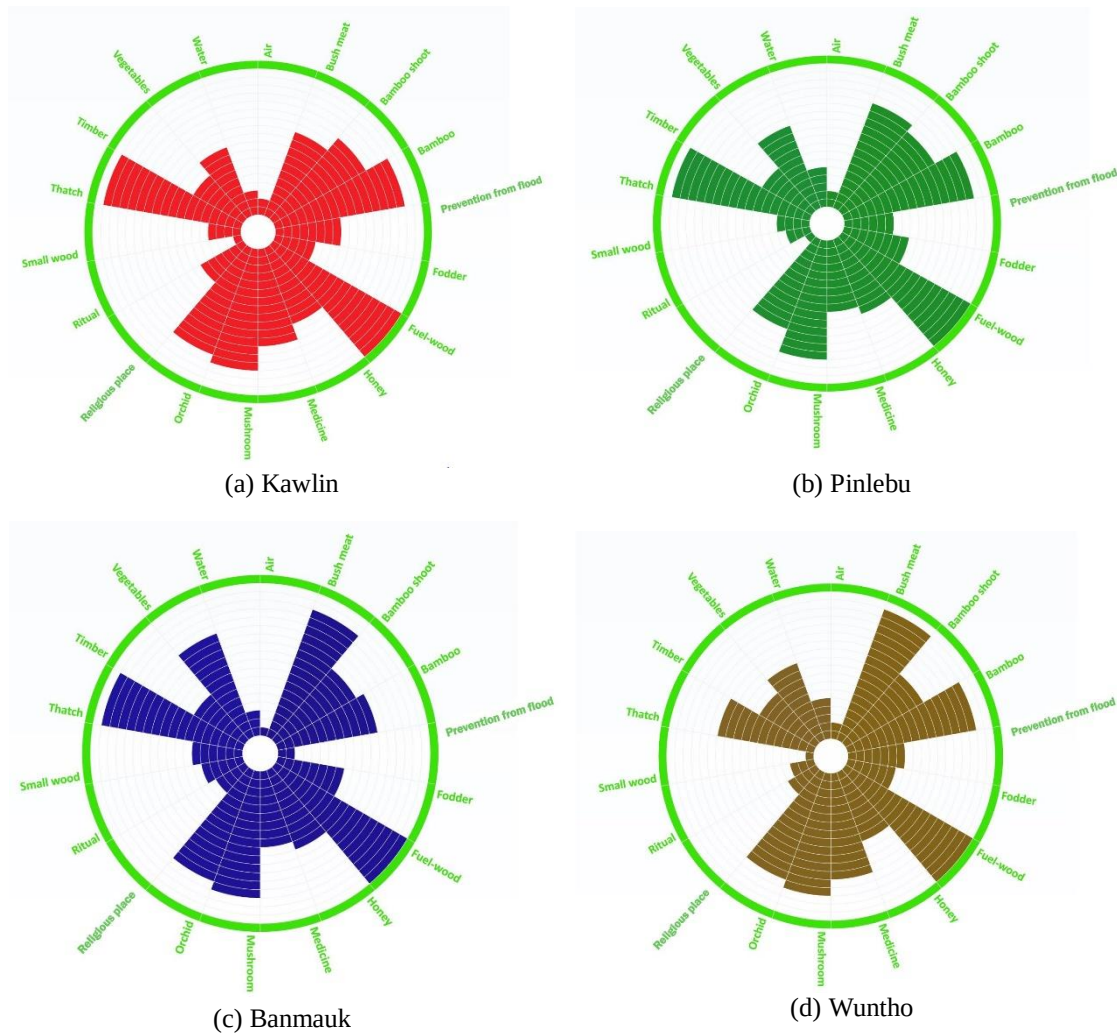


Figure 3. Priority of forest products for the livelihoods in the studied communities

3.5 Local knowledge of rural communities

The communities' LK was acquired base on their experiential knowledge and daily activities for their livelihoods. LK practices were associated with especially forest related and agricultural activities. The transition of LK was through observation and information passed on from oral tradition. Table 5 shows recorded LK and the usages of LK in the studied communities. Across the studied communities, the recorded LK was observed as common and different LK. There were 27, 29, 31 and 26 LK practices in KL, PLB, BM and WT, respectively. Based on the recorded existing LK, four types of LK were identified such as (a) related to local belief (taboos), (b) related to local custom (custom/ ritual), (c) related to local norms (rules and regulations), and (d) related to individual or community's household activities/ practices.

(a) LK related to local belief (Taboos)

The LK related to local belief was identified as the communities' restrictions and prohibitions. Totally 5 LK related with local belief were recorded across the studied communities. These LK were based on communities' belief in religion (all of the rural communities in the study area are Buddhist). In the focus group discussion, the elderly people mentioned that these LK (taboos) have been existed and applied in their communities since their ancestors. It causes the good consequences of social bond among their communities and enhances their belief in religion. The usages of these LK are related with the forest resources, especially bamboo, bamboo shoot and fuel-wood collection.

(b) Related to local custom (Customs/ ritual)

The form of customs/ ritual was recognized as the communities' social norms, custom and culture activities. Overall, 6 LK of local custom were recorded. Among the recorded LK, 5 LK were found in all studied communities as common LK. One LK "building the specific (house) building style" that was only found in BM community, and it was directly related with Kanan ethnic of BM community. They apply and regard as a responsibility of their ethnics. These recorded LK in the studied communities, were directly used for the utilization and conservation of forest resources for the communities.

(c) Related to local norms (Rules and regulations)

The LK of rules and regulations was based on their local/ community norms that were directly related to social bond and safety of communities. Totally 7 LK were recorded across the studied communities. The respondent household said that these local norms were unwritten rules and the villagers and village head discussed and announced that kind of local norms in the community. Local norms were not very strict on the people but the communities regard and follow them. However, "the keeping the woodlot, patches for the water sources" was found the highly restricted norm among other LK. We noticed that these LK were also used for as forest resources management in their surrounding forest area.

(d) Related to individual or community's household activities/ practices

LK related with individual or community's household activities/ practices was based on household's experiments and experiences on their daily or seasonal or annual activities. These LK were associated with other three types of LK, and mainly related with household's activities such as agriculture, livestock, forest resources and other household's activity (gold mining). Totally 13 common LK were recorded in all studied communities. They were mainly used for household's income and food supplement.

Table 5. The local knowledge based on the communities' taboos, customs/ ritual, taboo, rules & regulations and others in the studied communities

No.	LK practices	Usage	KL	PLB	BM	WT
	Related to local belief (Taboo)					
1	No allowing to cut/ collect all culms / bamboo shoot from one clump	Bamboo, bamboo shoot	+	+	+	-

2	No allowing to collect the extra fuel-wood	Fuel-wood	-	-	+	-
3	No allowing to cut trees in the scared places (the area where is donated or allotted for religious purposes - monastery, pagoda, cemetery)	Timber, fuel-wood	+	+	+	+
4	No allowing to slaughter livestock (cow, buffalo) for meat	Subsistence livestock	+	+	+	+
5	No allowing to kill the snake	Food supplement	+	+	+	+
Related to local custom (Customs/ Ritual)						
6	Celebrating ritual (related with agriculture and generally celebrated twice a year– at the beginning of crop cultivating and harvesting season)	Crops production	+	+	+	+
7	No cutting the big trees (Bayan – Ficus spp., and other trees – mostly DBH> 50 cm or 0.5 m)	Timber, fuel-wood	+	+	+	+
8	No hunting (bush meat) at the specific days/ period (Full moon day, New moon day, Sabbath day, Waso to Tawthalin (July to September), Tabaung (March) – bird hatching season, not shooting the wildlife with baby/ies)	Food supplement	+	+	+	+
9	Sharing the collected forest products (especially food) to neighbor	Food supplement	+	+	+	+
10	No selling/ taking money for traditional medicines (healer)	Traditional healing	+	+	+	+
11	Building the specific (house) building style	House construction	-	-	+	-
Related to local norms (Rules and Regulations)						
12	Recognizing and following the (community) forest boundary (it is defined by local people between the villages and is not acknowledged by government/ FD)	Forest resources managing	-	+	+	-
13	No allowing to harvest the timber/ collect the fuel-wood/ make the grazing land where is near the water sources (Keeping woodlot for water sources)	Water resources managing	+	+	+	+
14	Letting people (neighbor or 10 HHs leader) know where the farm land (shifting cultivation land in the forest)	Forest resources managing	-	+	+	-
15	Informing village head or 10 HHs leaders for harvesting timber	Forest resources managing	+	+	+	+
16	Seeking permission for pasture (at private pasture)	Food supplement for livestock	+	+	+	+
17	Sharing (bamboo, thatch, fuel-wood) to the HH which has weeding, donation, funeral	Forest products utilization	+	+	+	+
18	Informing village head or 10 HHs leaders for new (house) building (Seeking permission for building/ house within/ outside the settlement)	Land/ forest resource management	+	+	+	+
Related to individual or community practices						
19	Making (private) pasture (grazing land)	Fodder	+	+	+	+

20	Doing gold mining (small scale HH level)	HH's income	+	+	+	+
21	Doing shifting cultivation	HH's income and food supplement	+	+	+	+
22	Ways of selection sites for shifting cultivating land (soil color, the lee side, sunlight)	Cultivating land	+	+	+	+
23	Cultivating method (one crop vs. successive crops)	Cultivating crops' method	+	+	+	+
24	Doing home husbandry (pig, chicken)	HH's income and food supplement	+	+	+	+
25	Changing livestock (cow, buffalo) for agriculture	HH's income and agricultural activity	+	+	+	+
26	Collecting medicinal plants	HH's income and Traditional healing	+	+	+	+
27	Recognizing/ familiar with their surrounding environment (forest resources)	HH's income, forest products utilization	+	+	+	+
28	Noticing bamboo flowering (past and current conditions)	HH's income	+	+	+	+
29	Following the collecting period for forest products (bamboo harvesting – January to February, mushroom – before 2 to 3 days of full moon day, gathering honey – April to May)	HH's income, forest products utilization	+	+	+	+
30	Using the specific tree (leave) for gathering honey	HH's income	+	+	+	+
31	Doing home garden (vegetables)	HH's income and food supplement	+	+	+	+
Total			27	29	31	26

KL = Kawlin, PLB = Pinlebu, BM = Banmauk, WT = Wuntho, + = applicable in community, - = not applicable in community

Among the recorded LK with four types, 58 % of local knowledge is related with forest related activities which is followed by 19% of livestock, 16% of agricultural and 6% of other household livelihood activities.

3.6 Awareness and application of LK

Figure 4 shows the comparison between the household's awareness and applying of four types of LK across the studied communities. The result revealed a significantly lower proportion of applying LK when compared to the awareness in each studied community. Overall, among the four types of LK, LK related to local norms was found the highest awareness (91%) and applying (86%), followed by taboos (87% and 84%), customs/ ritual (76% and 70%) and household's activities/ practices (73% and 65%). The household's awareness and applying LK for the studied communities were analyzed separately (Figure 3). Among the studied communities, the highest applying all types of LK was observed in BM community (69%), followed by PLB (59%), KL (57%) and WT (52%). Although the awareness of LK ($X^2=4.40$, $df=3$, $p=0.22$) was not difference across the studied communities, the applying LK ($X^2=10.62$, $df=3$, $p=0.01$) was significantly difference.

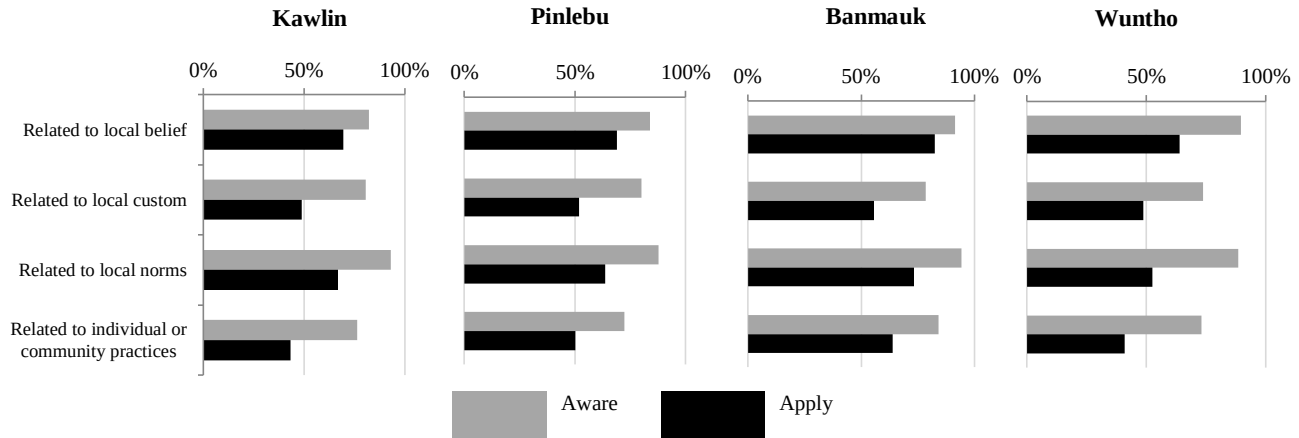


Figure 4. Communities' awareness and applying LK practices across the studied communities

3.7 Influence of household's characteristics on the application of LK

Linear regression model was run to examine the influence of household characteristics on the applying LK. Table 6 shows the influence of household's characteristics on the applying LK. The similar HH's influence variables on LK's awareness and application were found in the studied communities **Error! Reference source not found..** Overall, length of stay ($p<0.05$), number of working people per household ($p<0.05$), HHH's age ($p<0.05$) and HH's husbandry (livestock varieties) ($p<0.01$) were found as the influence variables on the awareness and applying LK. In the applying LK related to local belief (Taboo) and individual or community's household activities/ practices, women ($p<0.05$) were more applied LK than men, and elderly people ($p<0.05$) more applied than young-age people in KL, PLB and WT communities. But generally, the more elderly people showed the less applying LK related to local norms, for instance in PLB and BM communities.

Table 6. Influent HH's characteristics (linear regression model analysis) on LK application in the studied area

HH characteristics	LK awareness	LK application
Length of stay (year)	0.000*	0.001*
HH sex (male compared with female)	0.046	-0.021
HH's average education level	0.007	0.009
HH's working people	0.008*	0.029***
Mature adult people (compared with elderly)	0.033	-0.024
Young adult people (compared with elderly)	0.014	-0.036*
HHH's age	0.004***	0.002**
HHH's sex	0.010	0.030

HHH's education level	0.000	0.002**
Cultivating land area (ha)	0.009***	-0.000
Livestock varies	0.031***	0.041***
Constant	0.334***	0.220***

* $P < 0.05$, ** $P < 0.01$, *** $p < 0.0001$

Table 7. Influent HH's characteristics (linear regression model analysis) on LK application in the studied communities

HH characteristics	LK awareness				LK application			
	Kawlin	Pinlebu	Banmauk	Wuntho	Kawlin	Pinlebu	Banmauk	Wuntho
Length of stay (year)	0.002*	0.000	0.001	0.003*	0.002	0.001	0.000	0.001
HH sex (male compared with female)	0.001	0.036	-0.022	0.003	-0.068	0.026	-0.067	0.097
HH's average education level	-0.017	-0.004	-0.007	0.027	0.015	0.022	0.006	0.021
HH's working people	-0.003	0.015	0.003	0.009	0.035***	0.026**	0.010	0.018
Mature adult people (compared with elderly)	0.006	0.004	-0.017	0.029	-0.007	-0.016	-0.121*	-0.020
Young adult people (compared with elderly)	-0.005	-0.017	0.002	0.030	-0.051*	-0.029	-0.023	0.021
HHH's age	0.007***	0.003*	0.004*	0.000	0.001	0.000	0.003*	0.003*
HHH's sex	-0.018	0.037	-0.021	0.003	0.054	0.052*	0.033	0.010
HHH's education level	0.008	-0.015	0.020	-0.025	0.013	-0.029	0.011	0.025
Cultivating land area (ha)	0.005*	0.008	0.002	0.003	0.002	0.008*	0.002	-0.000
Livestock varies	0.043***	0.031*	0.042**	0.059**	0.025**	0.033***	0.029*	0.031*
Constant	0.345**	0.346**	0.418**	0.397**	0.200*	0.228**	0.424***	0.039

* $P < 0.05$, ** $P < 0.01$, *** $p < 0.0001$

3.8 People's perceptions on local knowledge

(a) Levels of importance on applying LK

Four points Likert-type scale was applied to observe the importance levels of applying LK such as just importance, low importance, moderate importance and high importance. Figure 5 shows the respondent household percentage which described the important levels of applying LK. The highest HH percentage was found in the moderate important level which was followed by high and low important levels (Figure 5). The respondent HH percentages were significantly different ($p < 0.05$) in each community of the levels of importance, and overall, the statistically

difference across the levels of importance ($X^2=30.27$, $df=3$, $p=0.00$) was observed in the study area.

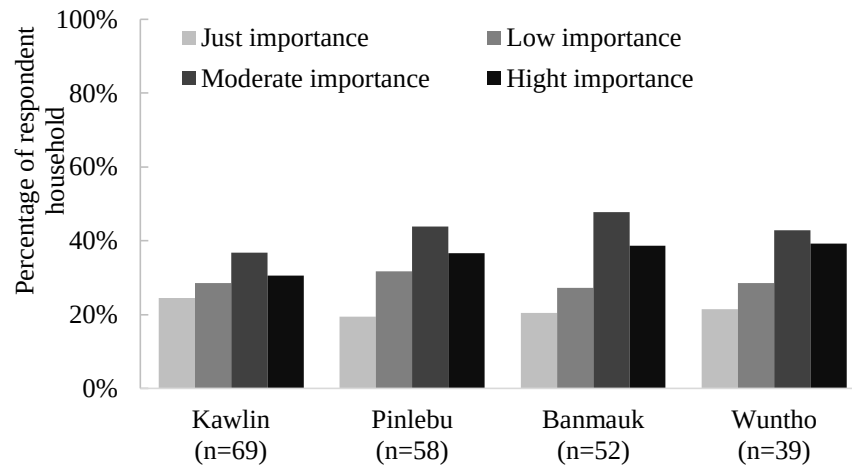


Figure 5. Percentage of respondent households which described the levels of importance on applying LK

(b) Agreement on applying LK

The communities' agreement (like and dislike) on applying LK was examined to know their willingness on applying LK. Figure 6 shows the percentage of respondent households which described their agreement on applying LK. Regarding the agreement on applying LK of all communities, average of 83% of respondent HH showed their acknowledging (like), 3% showed dislike on applying LK, and 14% did not give any response (Figure 6). One of the respondents during the face-to-face household interview in PLB community mentioned: *"the reason why I apply LKs is these LK have been applied by our ancestors and all the people in this community. These LK are our culture and custom, and we have to follow and regard them to protect and transmit our culture and custom to our generation"*. During the group discussion after household interview in BM community, one elderly people said: *"the community head discussed about their community norms with community members, and agreed to apply. These norms were not strict to community, and there was no force to apply them and no penalty, because we all believe each other and are just one big household through our same ancestors. This relation builds mutual trust and respect among community members, but also between other communities."* These explanations point out their higher agreement (like) on applying LK.

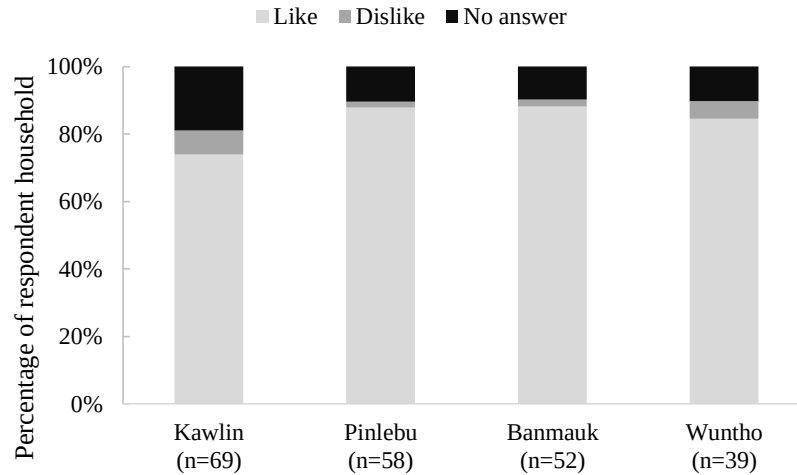


Figure 6. Percentage of respondent household which described their agreement on applying LK

(c) Attitudes to applying LK

The communities do appreciate their applying LK which are affected by their agreement on applying LK. They describe their attitudes not only positive (beneficial effect) but also negative (detrimental effect) of applying LK. Figure 7 describes the respondent HHs which mentioned their attitudes to applying LK across the communities. Although people describe the positive attitude on applying LK, they do not mention only negative attitude. But LK with both positive and negative attitudes are found in the studied area. Generally, in the studied communities, 74% and 16% of respondent HHs mentioned the positive, and both positive and negative attitude to applying LK, respectively. Their attitudes on LK were depended on the important levels of LK and the positive attitude was significantly related with importance level ($p < 0.05$) of applying LK. The important levels were also significantly different across their attitudes ($p < 0.01$).

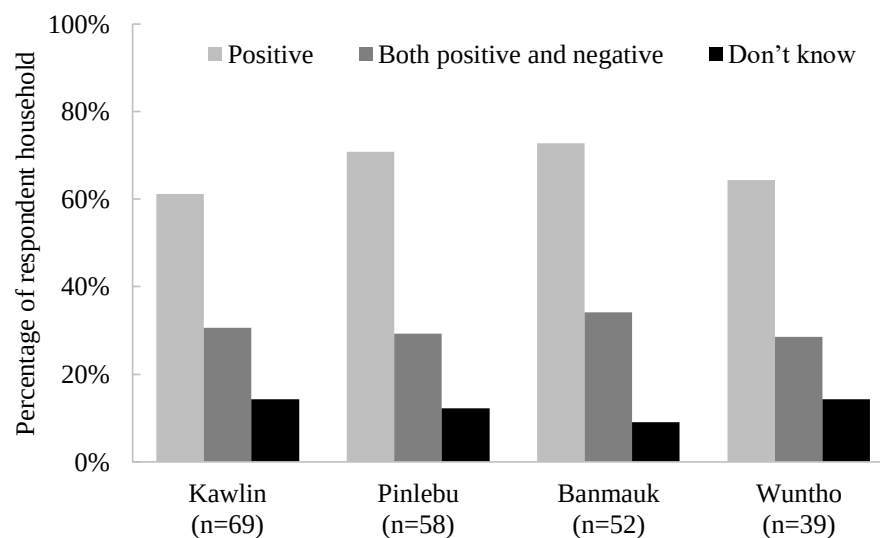


Figure 7. Percentage of respondent households which described their attitudes on applying LK

3.9 Influence of household's characteristics on LK

Linear regression model was run to examine the influence of HH characteristics on the awareness and applying LK. Table 8 shows the influence of household's characteristics. Length of stay, number of working people, HHH's age and HH's husbandry (livestock varieties) were found as the significantly influencing variables on both awareness and applying LK (Table 8). Moreover, length of stay, cultivating land area and livestock varieties were statistically influent on communities' attitudes to their applying LK. Elderly people ($p<0.05$) more aware and apply LK than younger generation.

Table 8. Influent HH's characteristics (linear regression model analysis) on LK awareness, application, and communities' attitudes

HH characteristics	LK awareness				LK application			
	Kawlin	Pinlebu	Banmauk	Wuntho	Kawlin	Pinlebu	Banmauk	Wuntho
HH total members	2.83**	-0.38	0.09	-0.74	1.48	-0.26	0.04	-0.91
Number of working people	-2.56*	1.48	-0.19	1.33	0.81	1.37	0.22	0.93
Length of stay (residence year)	2.75*	-0.08	1.25	3.18**	1.93	1.09	0.29	4.10***
HHH's age	7.30***	2.42*	2.31*	0.19	2.33*	0.91	2.57*	0.97
Mature people (compared with elderly people)	-1.09	-1.24	-0.44	0.71	-1.18	-1.53	-2.12*	0.89
Young people (compared with elderly people)	-0.89*	-0.92	0.62	0.15	-0.67*	-0.53	-1.06	-0.03*
Young people (compared with mature people)	-1.35	-1.70	-0.78	0.52	-1.92	-1.72	-1.76	0.76
Cultivating land area	1.72	1.73	0.56	0.54	2.19*	2.37*	1.15	0.02
Livestock varies	2.85**	1.84	1.97	3.00**	2.09*	3.88***	2.13*	1.25
Constant	3.79***	4.10***	4.93***	3.10**	2.95**	2.82**	3.60**	0.15

	Positive Attitude				Both positive and negative Attitudes			
	Kawlin	Pinlebu	Banmauk	Wuntho	Kawlin	Pinlebu	Banmauk	Wuntho
HH total members	0.99	-0.11	-0.11	0.51	-0.38	0.28	0.44	-1.52
Number of working people	-0.39	-0.03	-0.19	0.24	-0.41	2.02	0.32	1.52
Length of stay (residence year)	1.58	0.61	1.34	2.89**	-0.93	-1.09	-0.74	0.97
HHH's age	0.73	1.18	0.89	0.14	1.68	-0.01	1.99	-0.07
Mature people (compared with elderly people)	-1.06	-0.02	-0.48	-0.01	-1.66	-0.85	-1.77	0.63
Young people	0.31	-0.42*	0.58	-0.54	1.92	-0.47	0.70	-0.14*

(compared with elderly people)								
Young people	-1.45	-0.35	-1.42	0.46	-1.25	-0.68	-0.89	0.77
(compared with mature people)								
Cultivating land area	1.08	0.97	2.08*	-2.02	0.89	0.83	0.69	2.31*
Livestock varies	1.26	2.84*	0.94	2.06*	-0.15	1.11	1.17*	-0.96
Constant	1.91	1.97*	3.07**	0.31	1.45	1.56	0.61	0.56

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

3.10 Local knowledge related to forest resource management

Application of LK is not only used for forest resource collection including utilization but also for resources management. On the other hand, LK related to gold mining, making pasture and shifting cultivation in the studied communities are found to cause forest resources depletion. But some LK are found to be directly related to forest resource management activities, and they are mostly related to community's custom, rules and regulation. Table 9 describes the LK which are directly related to the forest resources management activities implemented by the government (Forest Department of Myanmar). These LK are supporting the forest resources conservation activities directly, and helping to address contemporary livelihood (socio-economic) and environmental conditions.

Table 9. Local knowledge that related to the forest resources management activities that are being conducted by the government

Local knowledge	Related activities and legislations that are being conducted by the forest department for forest resource management*
Supporting to conservation activities - No allowing to cut all of bamboo and collect all of bamboo shoot from a clump of bamboo - No allowing to cut the trees and hunt bush meat in the scared places - No allowing to hunt bush meat at the specific days and periods - Keeping the woodlot for water source - Informing village head or (10) HHs leaders to harvest timber - Following the collecting period for the forest product (bamboo, bamboo shoot, mushroom, honey)	- Bamboo cutting method for bamboo management - Forest rehabilitation activities (natural regeneration, enrichment plantations) - Seasonally protected wildlife (June 15 to Sep 30) and birds (march 15 to Sep 30) by list of endangered wildlife (fauna) species, FD 1994 - Watershed management (environmental conservation plantations) - Protection forest resources (combating illegal logging) and Working plan activities and Township's FD activities - Bamboo harvesting period for bamboo management
Contradicting to conservation activities - Doing shifting cultivation - Making (private) pasture	- Target activity of district forest working plan (2016/17 – 2025/26) - Forest Law 1992, Chapter XII, Paragraph 40:

- Doing gold mining

sub-paragraph (a) to (f); the local communities are not allowed to have trespassing and encroaching rights, pasturing, breaking up, clearing, digging, or causing damage to the original condition of the forest land without a permit from the government

**Forest Department's District forest working plan (2016/17 to 2025/26) and Township's forest department activities, Forest Law (1992), and The protection of wildlife and protected areas legislations (1994)*

Among these LK, 6 LK are supporting the forest resources conservation activities directly, and helping to address contemporary livelihood (socio-economic) and environmental conditions. Generally, a higher percentage of applied LK are found to support forest resource management activities and a lower percentage of household found LK to contradict forest resource management activities. A local knowledge practice can have more beneficial effect on forest resources which in turn it can have a detrimental impact on communities' livelihoods and vice versa (**Figure 8**). Based on communities' perceptions, it shows that the beneficial effect of local knowledge practices can be a critical step in encouraging communities for forest resource management through their local knowledge practices.

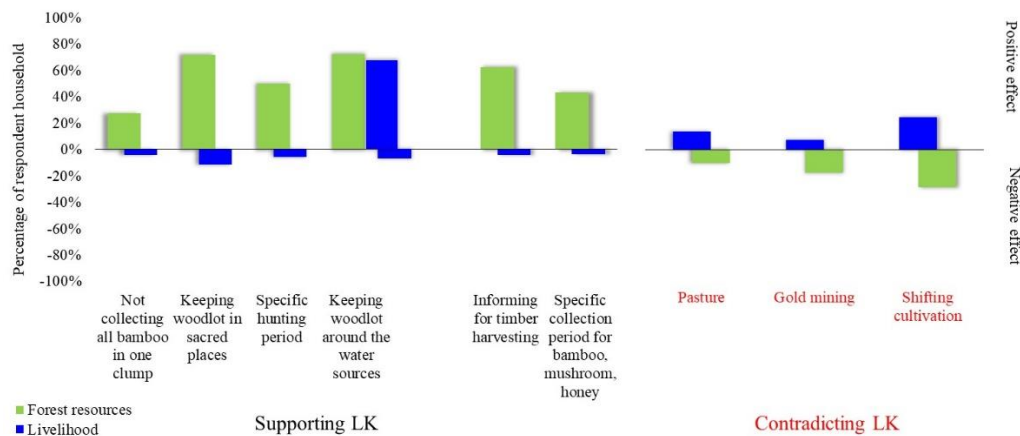


Figure 8. Percentage of respondent household which perceived their attitudes on LK that related to forest resources

4. Discussion

Geographical conditions, and socio-economic and cultural conditions are same among the studied communities, but the slightly different LK practices are observed. Among recorded 26 LK, 21 LK are found to be common across the studied communities. The 51% of LK is mostly embedded in communities' forest-related activity including forest resources utilization and management (Table 5). Although the rest of LK are related to other livelihood activities, these LK are also linked to forest resources. As the communities are found forest-dependent livelihoods, and their household main activities are mostly related to forest and forest products. Moreover, the LK were mostly embedded in local communities' forest resources collection and utilization which were directly and indirectly linked with household's social activities and

livelihood activities. There are slight differences on the existing LK, people's awareness and application of LK and are mostly similar across the communities (Figure 4**Error! Reference source not found.**). Among the four different types of LK, application of LK related to local beliefs, custom and norms (rules and regulations) are found to be higher.

During the focus group discussion, linkages between the communities and their LK are explored through their collected forest products in the surrounding forest area, the purposes of LK application, and related livelihood activities. Although communities' purposes of collecting forest products are to provide food and generate income, the findings on LK application reveal that communities are not only dependent on forest products for that reason, but also for development of their social relations with other communities' through culture and mutual aid. The transmission of LK is also through family custom, social networks, and oral communication including learning from elder people, neighboring households and among the communities. This indicates the sharing and application knowledge between individuals, communities, and generations. Elderly people are found to be the most influential factor in application of local knowledge which could be the low communications or relations between the young and elderly people. One elderly man (around 76 years old) in one of the focus group discussions of the studied communities explained: *"We have noticed and been aware of local knowledge and applied them since ancestral time. Nowadays, especially young people cannot follow the local knowledge which focusses on social bond. Because they said that the needs of their households' (family) for daily livelihood are higher and have higher priority level than social bond"*. But the application of LK is more related to their culture and social norms which show that the communities' social bond is the dominant position in the LK.

The findings from Table 7 shows that the household's length of stay in the community and age-groups have a statistically significant relation to the awareness of all types of LK. It shows older people are more aware and apply LK related to their livelihood [19], [41], [42]. The application of LK practices depends on not only HH's socio-demographic factors but also HH's property and activities for their livelihood [43]. But HH's financial conditions are not directly related to application of LK. The considerable amount of recorded LK has adapted in poorly industrialized landscape (rural area) [44] and LK related to different habitats, the usages and the history of landscape in which LK practices are held by the elderly people. The local people have a deep and thorough LK of the forest and forest resources.

Communities' LK on usages of forest products and identification of tree species provides an avenue for dealing with forest resources management and local knowledge can play a more prominent role in guiding forest resource management decision-making processes in the local level. Communities as knowledge holders, have not only knowledge but also wisdom about the utilization and management of forest resources [44]–[46]. The results of this study provide the evidence to justify the inclusion of local people and their knowledge regarding to conservation and development policy interventions [47] and implementation of local-level policies [26].

Results from the study showed that the studied communities do aware, understand and appreciate their applying LK for their livelihoods. They said although they noticed some their

applying LK have the detrimental effect on their livelihood, for instance, no allowing killing the snake, celebrating ritual, they apply them because of the importance of LK for their social norms or local culture. This finding reveals that the lower applying LK in the communities than awareness (Figure 4). While high level of importance is evidently related to high application on LK, some LK with high level of importance have low application. But the level of importance significantly strikes the attitudes on LK, and their preference about LK is positively related to their beneficial effects. It shows that LK is more emphasized on the effects of LK for their livelihood than importance of LK [48], [49]. The people in the studied communities recognized not only beneficial but also detrimental effects of applying LK (Figure 7).

During the household interview, the respondent households said that some LK practices, for instance, doing shifting cultivation and gold mining, could drive both beneficial effect as they generate household income and consumption, and detrimental effect on forest resources depletion which loss of certain type of provisioning services (timber, fuel-wood, bamboo, eatable vegetables, etc.) for local people's basic needs, and fragmentation of forest which impact habitat of wildlife (bush meat). It shows that communities' perceptions on local knowledge is related to their livelihoods [50], [51]. The communities described their positive attitude based on the social, cultural and environmental impacts such as encouraging their religion and custom, strengthening their social cohesiveness, enhancing the activities/ practices of forest resources utilization for their livelihood activities including household healthcare. Moreover, they mentioned the detrimental effects such as poisonous snake bite, territorial dispute and inordinate greed among and within communities, reducing income and decreasing forest resources in their surrounding forest area. These findings show that local knowledge could have not only positive but also negative effects on the communities' livelihoods based on local context.

A higher percentage of applied LK are found to support forest resource management activities and a lower percentage of household found LK to contradict forest resource management activities (Figure 8). The effects of these forest resource management related local knowledge practices are shown in **Error! Reference source not found..** Both beneficial and detrimental effects of local knowledge exist in all forest resource management practices. A local knowledge practice can have more beneficial effect on forest resources which in turn it can have a detrimental impact on communities' livelihoods and vice versa (Figure 8). Based on communities' perceptions, it shows that the beneficial effect of local knowledge practices can be a critical step in encouraging communities for forest resource management through their local knowledge practices.

These findings (Table 9 and Figure 8) show the role of the local knowledge on forest resources and livelihoods, and the communities' understanding and appreciation of LK. The applications of local knowledge have played a role in the supply of direct and indirect forest resources. Although there are slight differences in the application and existence of local knowledge between communities, the results of this study provide evidence to justify the inclusion of local communities and their knowledge into conservation and development policy interventions [47] and inclusion in national and local-level policies [41].

This study findings, especially the documenting local communities' knowledge, the communities' perceptions on their applying local knowledge practices, and the effects of local knowledge practices, have proved to be one of the important factors for the sustainable forest management under CBNRM approach. And these empirical findings support the policy-makers to consider local communities and their local knowledge as one of the priorities in the conservation and development program. Appreciation of communities' local knowledge and collaborating with them to development and conservation program – such actions will empower local communities to protect, preserve and apply their practices that encourage their livelihood development through sustainable use of forest resources. The identification of influencing variables affecting different forms of local knowledge should be carried out at the local level because the specific knowledge practice could be related to the specific type of effect on the livelihood and also forest resources.

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The communities' applying LK practices and their perceptions on the forest resources showed the links between the local people and their surrounding forest resources. These applying LK practices have proved to be one of the importance factors in the forest management activities in local level. The results of this study provide the evidence to justify the inclusion of local people and their knowledge regarding into conservation and development policy interventions [47] and implementation of local-level policies [26] in the context of Myanmar community-based forest management (CBFM) program. Furthermore, the policy-makers should make efforts to incorporate local knowledge in the development and conservation programs of relevant national and local institutions, such as Forest Department, Environmental Conservation Department, Agricultural Department, and Department of rural development, researchers, non-governmental organizations and other community-based groups.

5. Conclusions

The study documented the existing rural communities' local knowledge as four different forms of knowledge practices – taboos, customs/ ritual, rules and regulations and other local knowledge which are related with their livelihood activities. The application of each form of local knowledge was found significantly correlated with and lower than the awareness.

Households with more elderly people were found to be more applying in all forms of local knowledge than the younger age groups' people households. Household's socio-economic characteristics such as length of stay, total household members, the male working people, cultivating land area, livestock varieties, and forest product varieties were observed as the significant influence variables on the application of overall local knowledge in the study area. The main reasons for the applying local knowledge were found as their belief, custom, culture, social bond and their livelihood activities that were acquired and transmitted through family custom, social networks and oral communication including learning from elder among the communities. Most of documented local knowledge is directly relevant to the development and conservation activities as helping to address contemporary livelihood (socio-economic) and environmental conditions. The link between the communities' cultural (diversity) knowledge practices and biodiversity was recognized and this link provides an opportunity for conservation. The findings in this study are empirically based evidence that the government including formal program, institutions, non-governmental organizations and other community-based groups should identify and implement the conservation and development/ management activities that are in line with (do not conflict) the existing local knowledge maintained and applied by the communities. By appreciation of communities' local knowledge and collaborating with them to development and conservation program, the formal existing (management) plan can be revised and updated at national and local level. Moreover, recognition on influence variables of different forms of local knowledge should be given at the local level because the specific knowledge practice could be related to the specific type of effect on the livelihood and also forest resources. In the context of rural communities, who are living in the forest area and mainly depend on subsistence agriculture with shifting cultivation and forest resources for their livelihoods, and their local knowledge related with their livelihood activities, can help to achieve the formal development and conservation activities/ strategies of the policymakers. In this regard, incorporation with rural communities by applying their existing knowledge practices in forest resource management activities can be useful and viable strategy under the CBNRM approach.

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References

- [1] E. P. Farrel, E. Fuhrer, D. Ryan, F. Andersson, R. Hutt, and P. Piussi, "European forest ecosystems: building the future on the legacy of the past," *For Ecol Manage*, vol. 132, 2000.
- [2] T. Wohlgemuth, M. Burgi, C. Scheidegger, and M. Schutz, "Dominance reduction of species through disturbance - A proposed management principle for central European forests," *For Ecol Manage*, vol. 166, no. 1–3, pp. 1–15, 2002.
- [3] D. Foster *et al.*, "The Importance of Land-Use Legacies to Ecology and Conservation," *Bioscience*, vol. 53, no. 77, pp. 77–88, 2003.
- [4] P. Szabó and R. Hédl, "Advancing the integration of history and ecology for conservation.," *Conserv Biol*, vol. 25, no. 4, pp. 680–7, Aug. 2011.
- [5] P. Weber, A. Rigling, and H. Bugmann, "Sensitivity of stand dynamics to grazing in mixed *Pinus sylvestris* and *Quercus pubescens* forests: A modelling study," *Ecol Modell*, vol. 210, no. 3, pp. 301–311, 2008.
- [6] J. A. Parrotta and M. Agnoletti, "Traditional forest knowledge: Challenges and opportunities," *For Ecol Manage*, vol. 249, no. 1–2, pp. 1–4, 2007.
- [7] R. L. Trosper and J. A. Parrotta, "Introduction: The growing importance of traditional forest-related knowledge," in *Traditional forest-related knowledge*, J. A. Parrotta and R. L. Trosper, Eds. Springer, 2012, pp. 1–36.
- [8] W. Neil Adger, P. M. Kelly, A. Winkels, L. Q. Huy, and C. Locke, "Migration, Remittances, Livelihoods trajectory, and Social Resilience," *J Hum Environ*, vol. 31, no. 4, pp. 358–366, 2002.
- [9] B. Agarwal, "Participatory Exclusions, Community Forestry, and Gender: An Analysis for South Asia and a Conceptual Framework: Erratum," *World Dev*, vol. 29, no. 12, pp. 1623–1648, 2001.
- [10] A. de Sherbinin *et al.*, "Rural household demographics, livelihoods and the environment," *Glob Environ Chang*, vol. 18, no. 1, pp. 38–53, 2008.
- [11] B. Entwistle and P. C. Stern, *Population, land use, and environment: Research directions*. 2005.
- [12] J. McGinlay, D. J. G. Gowing, and J. Budds, "Conserving socio-ecological landscapes: An analysis of traditional and responsive management practices for floodplain meadows in England," *Environ Sci Policy*, vol. 66, pp. 234–241, 2016.
- [13] J. S. Gruber, "Key principles of community-based natural resource management: A synthesis and interpretation of identified effective approaches for managing the commons," *Environ Manage*, vol. 45, no. 1, pp. 52–66, 2010.
- [14] E. Gomez-Baggethun, S. Mingorria, V. Reyes-Garcia, L. Calvet, and C. Montes, "Traditional ecological knowledge trends in the transition to a market economy: empirical study in the Donana Natural Areas," *Conserv Biol*, p. 9 pp, 2010.
- [15] L. D. Camacho, D. T. Gevaña, †Antonio P. Carandang, and S. C. Camacho, "Indigenous knowledge and practices for the sustainable management of Ifugao forests in Cordillera, Philippines," *Int J Biodivers Sci Ecosyst Serv Manag*, vol. 12, no. 1–2, pp. 5–13, 2016.
- [16] United Nations, *Convention on biological diversity*. 1992.
- [17] M. . Millennium ecosystem assessment, "Ecosystems and human well-being: Synthesis," 2005.
- [18] S. Diaz *et al.*, "The IPBES Conceptual Framework - connecting nature and people," *Curr*

- Opin Environ Sustain*, vol. 14, pp. 1–16, 2015.
- [19] I. J. Davidson-Hunt and F. Berkes, “Nature and society through the lens of resilience: toward a human-in-ecosystem perspective,” in *Navigating Social - Ecological Systems: Building Resilience for Complexity and Change*, F. Berkes, J. Colding, and C. Folke, Eds. Cambridge University Press, 2003, pp. 53–82.
 - [20] I. Iniesta-Arandia, M. García-Llorente, P. A. Aguilera, C. Montes, and B. Martín-López, “Socio-cultural valuation of ecosystem services: Uncovering the links between values, drivers of change, and human well-being,” *Ecol Econ*, vol. 108, pp. 36–48, 2014.
 - [21] FAO, “Assessing forest degradation: Towards the developemnt of globally applicable guidelines,” 2011.
 - [22] C. M. Raymond, I. Fazey, M. S. Reed, L. C. Stringer, G. M. Robinson, and A. C. Evely, “Integrating local and scientific knowledge for environmental management,” *J Environ Manage*, vol. 91, no. 8, pp. 1766–1777, 2010.
 - [23] N. L. Etkin, “Indigenous patterns of conserving biodiversity: Pharmacologic implications,” *J Ethnopharmacol*, vol. 63, no. 3, pp. 233–245, 1998.
 - [24] N. L. Etkin, “Local knowledge of biotic diversity and its conservation in rural Hausaland, northern Nigeria,” *Econ Bot*, vol. 56, no. 1, pp. 73–88, 2002.
 - [25] S. Charnley, A. P. Fischer, and E. T. Jones, “Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest,” *For Ecol Manage*, vol. 246, no. 1 SPEC. ISS., pp. 14–28, 2007.
 - [26] Y. Jiao *et al.*, “Indigenous Ecological Knowledge and Natural Resource Management in the Cultural Landscape of China’s Hani Terraces,” *Ecol Res*, vol. 27, no. 2, pp. 247–263, 2012.
 - [27] G. N. Njoroge, I. M. Kaibui, P. K. Njenga, and P. O. Odhiambo, “Utilisation of priority traditional medicinal plants and local people’s knowledge on their conservation status in arid lands of Kenya (Mwingi District).,” *J Ethnobiol Ethnomed*, vol. 6, no. 1, p. 22, 2010.
 - [28] J. Helfenstein and F. Kienast, “Ecosystem service state and trends at the regional to national level: A rapid assessment,” *Ecol Indic*, vol. 36, pp. 11–18, 2014.
 - [29] R. Vignola, T. L. McDaniels, and R. W. Scholz, “Governance structures for ecosystem-based adaptation: Using policy-network analysis to identify key organizations for bridging information across scales and policy areas,” *Environ Sci Policy*, vol. 31, pp. 71–84, 2013.
 - [30] C. M. Raymond *et al.*, “Mapping community values for natural capital and ecosystem services,” *Ecol Econ*, vol. 68, no. 5, pp. 1301–1315, 2009.
 - [31] B. A. Bryan, C. M. Raymond, N. D. Crossman, and D. H. Macdonald, “Targeting the management of ecosystem services based on social values: Where, what, and how?,” *Landsc Urban Plan*, vol. 97, no. 2, pp. 111–122, 2010.
 - [32] H. F. Smith and C. A. Sullivan, “Ecosystem services within agricultural landscapes-Farmers’ perceptions,” *Ecol Econ*, vol. 98, pp. 72–80, 2014.
 - [33] B. F. Benz, J. Cevallos E., F. Santana M., J. Rosales A., and S. Graf M., “Losing knowledge about plant use in the sierra de manantlan biosphere reserve, Mexico,” *Econ Bot*, vol. 54, no. 2, pp. 183–191, 2000.
 - [34] F. Berkes, “Rethinking community-based conservation,” *Conserv Biol*, vol. 18, no. 3, pp. 621–630, 2004.
 - [35] A. Chhatre and A. Agrawal, “Trade-offs and synergies between carbon storage and livelihood benefits from forest commons,” *Proc Natl Acad Sci*, vol. 106, no. 42, pp. 17667–17670, 2009.

- [36] Forest Department of Myanmar, “Global Forest Resources Assessment 2010 Country Report: Myanmar,” in *Global Forest Resources Assessment 2010*, FAO, 2010, p. 52.
- [37] S. T. Asah, A. D. Guerry, D. J. Blahna, and J. J. Lawler, “Perception, acquisition and use of ecosystem services: Human behavior, and ecosystem management and policy implications,” *Ecosyst Serv*, vol. 10, pp. 180–186, 2014.
- [38] Population Department of Myanmar, “The 2014 Myanmar Population and Housing Census Sagaing Region Census Report Volume 3-E,” Myanmar, 2015.
- [39] Forest Department of Myanmar, “Sagaing Region Forest Working Plan (2010-16),” Myanmar, 2010.
- [40] F. Baum, C. MacDougall, and D. Smith, “Participatory action research,” *J Epidemiol Community Heal*, vol. 60, no. 10, pp. 854–857, 2006.
- [41] Y. A. Bofo, O. Saito, S. Kato, C. Kamiyama, K. Takeuchi, and M. Nakahara, “The role of traditional ecological knowledge in ecosystem services management: the case of four rural communities in Northern Ghana,” *Int J Biodivers Sci Ecosyst Serv Manag*, vol. 12, no. 1–2, pp. 24–38, 2016.
- [42] S. Sophat, P. Chandara, and S. Vibol, “Importance of Forest Ecosystem Services for the Livelihood Activities of a Rural Community in O’Som Commune, Pursat Province, Cambodia,” *Nat Resour Gov Cambodia*, vol. 1, pp. 5–22, 2013.
- [43] WWF, UNESCO, and the R. B. G. Kew, “Biodiversity and Traditional Knowledge: Equitable partnerships in practice,” Earthscan Publication, 2002.
- [44] La. Demeter, “Biodiversity and ecosystem services of hardwood floodplain forests: Past, present and future from the perspective of local communities in West Ukraine,” in *Knowing our lands and resources: Indigenous and local knowledge of biodiversity and ecosystem services in Europe and Central Asia*, 2016, pp. 6–19.
- [45] P. Angelstam, M. Elbakidze, R. Axelsson, M. Dixelius, and J. Tornblom, “Knowledge production and learning for sustainable landscapes: Seven steps using social-ecological systems as laboratories,” *Ambio*, vol. 42, no. 2, pp. 116–128, 2013.
- [46] N. Stryamets, M. Elbakidze, and P. Angelstam, “Role of non-wood forest products for local livelihoods in countries with transition and market economies: case studies in Ukraine and Sweden,” *Scand J For Res*, vol. 27, no. 1, pp. 1–14, 2011.
- [47] T. O. McShane and M. P. Wells, *Getting biodiversity projects to work: towards better conservation and development*. New York, USA: Columbia University Press, 2004.
- [48] M. M. Stickler, H. Huntington, A. Ha, S. Petrova, and I. Bouvier, “Does de facto forest tenure affect forest condition? Community perceptions from Zambia,” *For Policy Econ*, vol. 85, no. 1, pp. 32–45, 2017.
- [49] D. Maphane, B. N. Ngwenya, M. R. Motsholapheko, O. D. Kolawole, and L. Magole, “Rural Livelihoods and Community Local Knowledge of Risk of Malaria Transmission in the Okavango Delta, Botswana,” *Botswana Notes Rec*, vol. 49, pp. 136–152, 2017.
- [50] E. Meijaard *et al.*, “People’s Perceptions about the Importance of Forests on Borneo,” *PLoS One*, vol. 8, no. 9, 2013.
- [51] S. Hommes, S. J. M. H. Hulscher, J. P. M. Mulder, H. S. Otter, and H. T. A. Bressers, “Role of perceptions and knowledge in the impact assessment for the extension of Mainport Rotterdam,” *Mar Policy*, vol. 33, no. 1, pp. 146–155, 2009.