INDIGENOUS FOREST LIVELIHOODS IN THE ANTHROPOCENE: Social-Ecological Assessment of Abacá (*Musa textilis*) and Giant Honey Bee (*Apis dorsata* F.) Indigenous Forest Enterprises through a Transdisciplinary Approach

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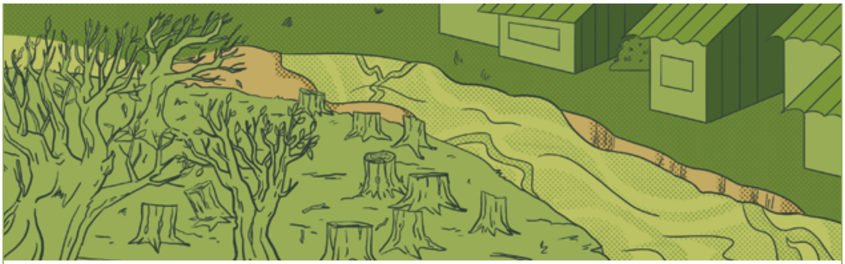
Abstract

Biodiversity, Ecosystem Services, and Traditions (BEST) Forests was a transdisciplinary research study that combined ecological, economic, and sociocultural methods to respectively assess the biodiversity, ecosystem services, and traditions from indigenous forest products in the Bukidnon and Misamis Oriental landscape. Focusing on honey from giant honey bees (*Apis dorsata* F.) and *hinabol* fiber from abacá (*Musa textilis*) plants, BEST Forests assessed how mobile (giant honey bees) and immobile (abacá plants) agents shape both the livelihoods of indigenous peoples and the ecological integrity of a community forest landscape. Through the use of mixed methodology, BEST Forests found that from 2004 to 2019, the Normalized Difference Vegetation Index (NDVI) in the community forests managed by indigenous Higaonon people maintained statistically significant high values. Through gross margin analyses, BEST Forests found that honey and abacá enterprises have positive financial returns, with the seasonal honey enterprise potentially having higher gross margins. These results show that diversified livelihoods contribute to the ethnocompetitiveness of the Higaonon community and could decrease natural resource exploitation pressure on a single forest product. The NDVI analysis of the Higaonon community forest from the past 15 years shows that community forest enterprises could support indigenous livelihoods while maintaining forest cover. In the Anthropocene, it is worth exploring forest livelihood projects that promote multiple forest products and see whether they are more beneficial for forest-dependent peoples and their forest in the long-term than projects that only focus on one forest product.



Introduction

Decreasing forest cover and persistent poverty are two long-standing challenges in Philippine forest communities. Strategies have mostly been adopted in silos, with protected area declaration as a common approach to maintain forest cover while social protection measures or cash-for-work programs were designed for poverty alleviation. Eventually, the protected area approach gained a reputation for being too focused on protecting trees and disregarding people in the process. Alternative approaches have been sought and, in 1989, a study by Peters et al. paved the way for integrated conservation and development in forest communities by concluding that "exploitation of non-wood resources would provide profits while conserving forests." Thereafter, integrated conservation and development projects (ICDPs) focusing on non-wood or non-timber forest products (NTFPs) were implemented by governments and development organizations alike. However, it eventually became apparent that ICDPs such as community forestry enterprises (CFEs) have limited forest conservation and forest livelihood gains; enterprise-based conservation initiatives focused too much on economic returns, with the assumption that profits automatically translate to improved social well-being and increased biodiversity conservation (Lele et al. 2010; Peña 2010). This can be partly attributed to a failure in realizing that conservation will always be undermined unless poverty is alleviated and that poverty and conservation belong to different policy realms, which are difficult to integrate despite its seeming interdependencies: poverty reduction itself depends on the conservation of resources, but conservation must not compromise poverty reduction (Adams et al. 2004; Garnett et al. 2007; Shanley et al. 2015). In rural forest communities, NTFPs are not only important in their livelihoods but also for their health and nutritional needs (Arnold and Perez 2001; FAO 2014a; Shackleton et al. 2015). Globally, NTFPs are also foreseen to have a role in the Sustainable Development Goals (SDGs) such as on poverty eradication (SDG 01), on affordable and clean energy (SDG 07), sustainable communities (SDG 11), responsible production and consumption (SDG 12), climate action (SDG 13), and life on land (SDG 15) (FAO 2014a).

Implicit in the promotion of NTFPs is the concept of forest resource utilization, which revolves around questions of "how" and "by whom." How are the NTFPs used? Who uses the NTFPs? These questions touch upon the long-standing debate within conservation circles whether "sustainable use" of wild plant and animal species drives conservation or further degrades resources. In the Philippines, indigenous forest communities traditionally use NTFPs for subsistence. With the emergence of CFEs, traditional subsistence use of NTFPs eventually evolved to commercial use where harvest amount exceeded personal and/or household use. Often, the focus of research on NTFPs has been on resource sustainability (i.e., whether harvesting levels are sustainable) and overlooks risks and threats to local stakeholders (Bolwig et al. 2008; Hughes and Flintan 2001). This focus also implicitly assumes that local stakeholders and their natural resource management approaches are the drivers of resource degradation (Hughes and Flintan 2001). Species extinction rate due to human activity in tropical rainforests is one of the growths and impacts of human activity that Paul J. Crutzen referred to when he suggested to use the term *Anthropocene* to emphasize the central role of mankind in geology and ecology in the current geological epoch (Crutzen 2006). The concept of Anthropocene is said to facilitate research focus from problem definition to solution formulation (Jahn et al. 2016; Steffen et al. 2011). Drawing from the concept of Anthropocene, this chapter aims to determine how commercializing traditional forest products like honey and *hinabol* (handwoven fabric from abacá or *Musa textilis*) can improve the well-being of indigenous forest peoples and contribute to forest and biodiversity conservation by employing a social-ecological systems (SES) perspective.

From an SES perspective, BEST Forests considered the Forest Foundation Philippines grantee Non-Timber Forest Products Exchange Programme Philippines (NTFP-EP Ph) project at the Kimangkil-Kalanawan-Sumagaya-Pamalihi (KKSP) Mountain Range as it is an appropriate case to document and assess CFE impacts on both social (indigenous peoples) and ecological (forest) systems. BEST Forests employed a transdisciplinary approach in assessing the NTFP project in KKSP on academic and praxis levels. On an academic level, BEST Forests aimed to contribute in filling the research gap on species of honey bees other than the European honey bee, *Apis mellifera* L. (Hym.: Apidae). BEST Forests recognizes that there are nine species of honey bees, yet most of the research has been done on the European honey bee. In addition, eight out of the nine species are extant in Asia, making Asia the cradle of honey bee diversity (Koeniger et al. 2010). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) thematic assessment of pollinators, pollination and food production also recognized the lack of wild pollinator data in Africa, Latin America, Asia, and Oceania (IPBES 2016). It is, therefore, important to study the lesser-known species of honey bees to determine whether they are also being affected by similar problems of the European honey bee. On a policy level, this study has implications on both local and international valuation of honey from wild honey bees. Locally, wild honey has the same price as cultured honey from the European honey bee, but there can be a quality difference that can impact people's health. With pests such as Varroa mites hounding the European honey bee, beekeepers have no choice but to use chemical miticides, traces of which can be found in the resulting honey (Koeniger et al. 2010). Wild honey bees are unmanageable bees and cannot be treated with miticides and they usually forage deep into the forest and not in agricultural lands, making their honey "organic by default." This is not recognized in the current market of honey locally. Internationally, the Codex Alimentarius standard for honey is based on only the European honey bee, making it difficult for other honeys to compete since their characteristics are different. On a praxis level, BEST Forests looked at the value chain of wild honey from giant honey bees (*Apis dorsata* F.) and abacá fibers (*Musa textilis*) and compared their profitability for indigenous livelihoods.

To support this chapter's aim, BEST Forests had three objectives:

(a) map geographical coordinates of harvest areas of the indigenous community enterprise products hinabol and wild honey from giant honey bees (*A. dorsata* F.) through global positioning system (GPS);
(b) analyze forest land cover changes through normalized difference vegetation index (NDVI); and
(c) conduct an integrated value chain and gross margin analysis of the community enterprise products hinabol and wild honey through key informant interviews.

The research assessed provisioning and regulating ecosystem services as well as cultural ecosystem services, which are often overlooked in comparison with the previous two (Matias et al. 2017a). The following sections of the chapter addresses each objective of the research, with the next section providing a background on the study area and the research collaborators. It is followed by a third section on methodology and research approach, then a fourth one presenting the spatial mapping of the harvest areas alongside NDVI analysis, corresponding to the first and second objectives of BEST Forests. The fifth section addresses the third objective on value chain and gross margin analysis of the NTFPs, and the sixth concludes with a discussion of how NTFP harvesting in the Anthropocene could improve the well-being of indigenous forest communities while conserving forest biodiversity.

Indigenous Abacá Weavers and Honey Gatherers of the KKSP

The provinces of Bukidnon and Misamis Oriental in Northern Mindanao are two of several focal landscapes of Forest Foundation Philippines due to their relatively high forest cover. Bukidnon is also home to several indigenous groups in the Philippines, with the Higaonon people as the least known of all. The Higaonon are mostly situated in the municipalities of Impasug-ong and Malitbog within their approximately 10,000 ha^2 of ancestral domain. One of these Higaonon communities is the *Agtulawon-Mintapod Higaonon Cumadon*, or AGMIHICU. The AGMIHICU community is led by their tribal chieftain, Amay Mantangkilan Cumatang, who is also the first Asian to be awarded the Darrell Posey Fellowship Award in 2012 (Balane 2012). In turn, each sitio is led by a tribal leader. In 2001, the AGMIHICU community started negotiating with the local government and other organizations to map their ancestral domain claim, which has been successfully delineated in 2003 (Abeto et al. 2004).

Known as "people of the living mountains" and "people of the wilderness," the Higaonon live off activities such as farming; shifting cultivation of crops such as kamote or sweet potato, corn, beans, cassava, yam, tobacco, and peanut; hunting and gathering; and/or abacá weaving, which is their principal economic activity (Cajetas-Saranza 2016; Vidal 2013). As part of traditional Higaonon culture, the practice of weaving abacá to hinabol, a traditional colored hand-woven textile, is passed down from generation to generation among Higaonon women, with the Higaonon men harvesting the abacá fibers. Some Higaonon men also engage in hunting giant honey bees, which is a seasonal activity practiced by a select group of men who could endure the stings of the giant honey bees. The BEST Forests project team carried out eight months (May–December 2019) of ethnographic fieldwork with AGMIHICU.

One of the members of AGMIHICU is a group of Higaonon weavers named Kalandang Weavers (*kalandang* meaning "peace"), which is one of the three groups of weavers found in Bukidnon (the others being Sunflower Weavers and Pauhangan Weavers). As hinabol weaving transitioned from a subsistence to a commercial livelihood strategy of the Higaonon community, different organizations such as NTFP-EP Ph and a local marketing arm called Lindungawan helped the weavers in selling their products to the mainstream market. NTFP-EP Ph is a collaborative network of non-governmental organizations (NGOs) and community-based organizations (CBOs) working with forest-based communities in strengthening their capacity to sustainably manage natural resources. The Mindanao office of NTFP-EP Ph is based in Malaybalay City in Bukidnon and it closely cooperates with Lindungawan as one of NTFP-EP Ph's green intermediaries in Mindanao.

Lindungawan offers cultural and environmental products of high quality and standard to its target market and is a trading partner of NTFP-EP Ph's national marketing arm Custom-Made Crafts Center (CMCC). The marketing mechanism of Lindungawan is designed to support the livelihood activities and products of forest-dependent communities and other cottage industries, particularly in Bukidnon and Misamis Oriental. Since 2004, NTFP-EP Ph has been helping the Higaonon in developing and promoting their hinabol products both locally and internationally. Through the years, they were able to develop a checklist for harvesters and weavers to be used during harvesting and weaving abacá. This checklist, called Good Hinabi Practice (GHP), was collaboratively developed by the abacá weavers and harvesters and staff of NTFP-EP Ph and Lindungawan and contains a series of questions that the community needs to answer before they can start weaving. Most of the questions were based on Fair Trade principles as well as on policies and standards developed through the Sustainable Hand Woven Eco Textile (SHWET) project supported by the Hivos Foundation Southeast Asia to ensure the welfare of all weavers with regard to weaving being a source of livelihood. The GHP revolves around five aspects: Authenticity, Environmental Accountability, Social Responsibility, and Quality. As of the year 2018, there is a total of 18 active Kalandang Weavers. The GHP highlights Sustainable Consumption and Production (SCP) to ensure that the harvest of natural materials used for weaving is still within the carrying capacity of the environment.

Despite being a seasonal occupation, honey hunting is also an important activity for the Higaonon. However, unlike abacá harvesting, honey hunting is believed to "run in the blood" of a select few as not all have the ability to go deep in the forest, hunt wild honey bees, and climb tall trees. Wild honey hunters of the Higaonon community belong to a group named Higaonon Amamag Malandang Olandok Gagaw (HAMOG), which has 25 active members that gather wild honey in their community forests. Aside from hunting giant honey bees and gathering wild honey, HAMOG also promotes cultural preservation for their indigenous community by employing cultural learning programs to the youth. They have also appointed leaders and officials to manage their CFE products such as wild honey, cassava chips, and others.

The forest enterprises of the Higaonon community show a labor-sharing structure that capitalizes on different gender roles.

Transdisciplinary Research on Social-Ecological Systems

Working with the Higaonon requires social science expertise. From an anthropocentric perspective, they are also part of the natural environment, which falls within the purview of the natural sciences. The traditional disciplinary division in academia has caused the separate study of social and natural systems instead of jointly looking at their linkages and feedbacks (Berkes and Folke 2002). The concept of SES underscores the integrated nature of social and ecological systems, which are also captured in other terms such as coupled human-environment systems or coupled human and natural systems (Fischer 2015). The relatively new field of sustainability science is one of the new analytical approaches and types of science that emerged in response to the need to study the interaction between human and natural systems (Kates et al. 2001). Despite a lack of a common glossary or commonly shared research framework in transdisciplinary research, sustainability science commonly includes multiple disciplines aiming at solving societal and scientific problems through active engagement of stakeholders, practitioners, and researchers (Hirsch-Hadorn et al. 2006; Lang et al. 2012; Angelstam et al. 2013; Brandt et al. 2013). To achieve its goals of promoting sustainable development and understanding the fundamental character of interactions between nature and society, sustainability science requires a transdisciplinary approach (Angelstam et al. 2013). Transdisciplinarity is not only about the integration between different disciplines in interdisciplinarity, but also about the integration at the interface of scientific questions and societal problems (Jahn et al. 2012). A transdisciplinary approach can facilitate adequate problem orientation and can ensure integrative results (Campennì 2016). This was the approach employed in BEST Forests. With an aspiration to help shape social realities in indigenous forest communities, BEST Forests used joint learning processes between science and society (ISOE 2020).

BEST Forests implemented the transdisciplinary approach from conception until the end of the project. Prior to the drafting of the project proposal, the project director of BEST Forests consulted NTFP-EP Ph on their Forest Foundation grant with the Higaonon in the KKSP Mountain Range for common problem framing. After initial agreement with NTFP-EP Ph, the project director of BEST Forests drafted its project proposal and designed the project with societal challenges in indigenous community forestry in mind. Upon approval of the project proposal, BEST Forests formed an interdisciplinary project team consisting of research assistants with academic training in either the natural or social sciences. NTFP-EP Ph also provided contact persons from their office in Bukidnon for closer collaboration.

BEST Forests started with a preparatory phase, which involved both formal and informal processes. For the formal process, the research assistants were mandated to undergo a cultural sensitivity session with NTFP-EP Ph, ethical research and health and security training with the project director, a basic mountaineering course with Viajero Outdoor Centre, and to complete an ethical clearance and health and security check. With the assistance of the NTFP-EP Ph project team in Bukidnon, BEST Forests sought free, prior, and informed consent (FPIC) from the Higaonon community through several meetings in the area. These consisted of (1) introductory meetings, (2) BEST Forests immersions, and (3) Higaonon ritual meetings, all of which served to build trust between the BEST Forests team and the Higaonon community represented by AGMIHICU. This period corresponds to the first phase of an "ideal" transdisciplinary research process (see Figure 1), where the aim is to combine social and scientific problems to create a common object of research (ISOE 2020).

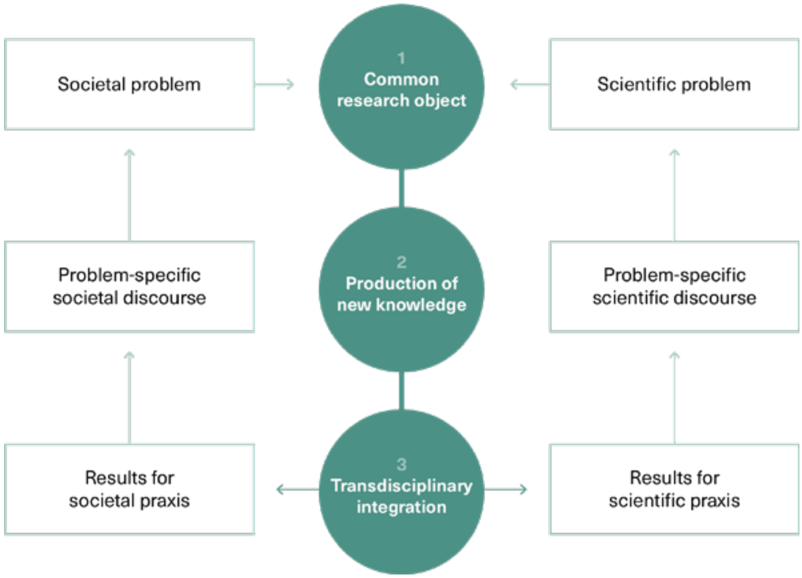


FIGURE 1. Transdisciplinary research process (ISOE 2020).

The second phase of a transdisciplinary research process focuses on the coproduction of new knowledge through collaborative data collection, which also involved skills building of the BEST Forests project team and AGMIHICU community members. The transdisciplinary approach of BEST Forests required a mixed methods approach that used both quantitative and qualitative methodologies. The research assistants were trained with the use of the global positioning system (GPS) equipment Garmin eTrex 20, which were used to collect geographical data in line with the first and second objectives of BEST Forests. In turn, the research assistants assisted a GPS trainer who was tasked to train community members who volunteered to gather geographical coordinates of giant honey bee nests and abacá plants. To address the third objective, the research assistants were also taught how to conduct participant observation, focus group discussions, key informant interviews, and questionnaire surveys in line with ethical research practices. All raw data were kept in a file sharing service with restricted access to uphold confidentiality and protect privacy and security of personal data.

FIGURE 2. GPS and digital camera training in the community.

Transdisciplinary integration, which corresponds to the third phase of a transdisciplinary research process, was done through data analysis and results diffusion with relevant actors throughout the duration of the project. The BEST Forests project team regularly communicated with NTFP-EP Ph and AGMIHICU and activity logs were regularly posted on the website of BEST Forests. The BEST Forests project team also presented the project and its preliminary results in two international workshops through talks and poster presentations. These international workshops had diverse participants coming from the academe, indigenous communities, NGOs, etc. and provided an opportunity for transdisciplinary discussion. Specifically, the BEST Forests project team was able to have an exchange with NTFP-EP Ph and give an update on the project's progress as well as discuss challenges that arose during project implementation (e.g., ambuscade during field work, field inexperience leading to poor decision-making in the field, etc.).

The scientific and praxis results of BEST Forests will be disseminated through this book chapter and in communications materials developed by the BEST Forests project team. Posters, infographics, and equipment instructional guides written in both English and in Visayan languages were given to the Higaonon community through NTFP-EP Ph and AGMIHICU. Equipment instructional guides were developed during the skills training for the use of GPS in geographical coordinates mapping and for the use of solar home systems, which were distributed as energy source of the abacá and honey CFEs of the community. An exit interview and final equipment turnover with the assistance of NTFP-EP Ph was conducted in July 2020, after having the initial turnover on March 2020 postponed due to the COVID-19 situation in the Philippines. As the BEST Forests project gained insight on the difficulties of indigenous forest livelihoods, this knowledge was also used by the project director of BEST Forests to raise funds through NTFP-EP Ph's Suporta para sa mga Katutubo Kontra COVID-19 for the Higaonon and other indigenous communities whose livelihoods were affected by the lockdown brought about by the COVID-19 pandemic. This exemplifies how a transdisciplinary approach could facilitate an integration of scientific and praxis results and how these could be used in finding solutions to societal problems.

Spatial Mapping of Abacá Plants and Giant Honey Bee Nests

To address the first objective of BEST Forests, the local honey hunters and gatherers were trained to handle GPS and digital camera units. Following the framework of Matias et al. (2017b) on baseline mapping of a community forest through GPS, representative hunters from the different *gaop* or sitios from the indigenous community participated in the GPS and digital camera training held in July 2019 in the AGMIHICU tribal hall. A local trainer from Cagayan de Oro demonstrated the use and basic functions of the GPS equipment. After the three-day training, the local community harvesters were thoroughly trained to use and handle the GPS and camera units, as well as transcribe GPS coordinates and other important data on a data sheet.

From August to September 2019, the BEST Forests team went with the HAMOG honey hunters and employed participant observation of traditional honey hunting and gathering in the AGMIHICU community forests. During this time, the spatial distribution of the giant honey bee nests was documented through geographical mapping using the GPS units and the digital cameras. According to the honey hunters, the flowers in the community forests start to bloom in March or April. During honey hunting, hunters usually start early in the morning and walk for a couple of hours to reach the location of a beehive. Hunters then start to prepare the necessary tools used for harvesting the hive. As they harvest, hunters prepare ropes called *uway* which come from a bamboo-like plant to wrap around their body as a harness as they climb the tree, and to place on tree branches to serve as a ladder as they climb the main tree. Hunters also gather *namu* leaves prior to harvesting and light these leaves until smoke is created in order to smoke out the honey bees from the hive. As they start to collect the honeycomb from the tree, they say a prayer and perform chants as they climb the main tree and smoke out the beehive. Usually, two to three honey hunters climb the tree to collect the honeycomb and they use a *balde* or bucket lined with sterile plastic to store the harvested beehive.

FIGURE 3. A honey hunter lights up *namu* leaves for smoking out bees.

On the other hand, abacá harvesters live in another sitio, and most of them are husbands of abacá weavers. Based on interviews conducted by the BEST Forests team, community respondents consider abacá harvesting as the second main source of income after farming. Abacá harvesting is typically learned during one's teenage years. During harvest, abacá harvesters use a bolo and two different kinds of tools called the lagitan and toksi. *Lagitan* is a tool used to obtain the fiber in an abacá plant, while *toksi* is a type of dagger used to pull or comb the strands of the fiber. The Higaonon people believe that the best time to harvest abacá fibers and to weave them is during a full moon, as they believe the fibers are of good quality during this time. Abacá harvesters gather the fibers so that their wives could weave them into hinabol handicrafts to be delivered to Lindungawan. However, there are also instances that harvesters directly sell the abacá they have gathered to the nearest market in Kalabugao. Similar to the honey hunters, the abacá harvesters also conduct a ritual of thanks before and after harvesting.

FIGURE 4. Abacá harvester mapping geographical coordinates of abacá plants.

Spatial Analysis of Abacá Plant and Giant Honey Bee Nest Locations

Volunteer honey hunters and abacá harvesters conducted the mapping of abacá plant and giant honey bee locations, which resulted in eight honey bee hives and 14 abacá harvest areas mapped. Spatial analysis was conducted on the GPS coordinates gathered through a normalized difference vegetation index (NDVI) of the community area. Satellite images from of the vegetation of the community area were downloaded for the years 2004, 2016, 2017, 2018, and 2019. The year 2004 represents the baseline year when the community's abacá CFE began, while the year 2016 represents the start of the wild honey CFE intervention in the community. The researchers used freely accessible satellite images from Sentinel-2 except for the year 2004, which used images from the Landsat satellite. Through the use of the Point Sampling Tool of QGIS version 2.16, the NDVI values for the abacá plants and giant honey bee nests were extracted for comparison.

Weier and Herring (2000) of the NASA Earth Observatory classify NDVI as follows: very low NDVI values correspond to barren areas of rock, sand, or snow (≤0.1); moderate values represent shrub and grassland (0.2 to 0.3); and high values indicate temperate and tropical rainforests (0.6 to 0.8). The range of NDVI values for Bukidnon are as follows, which show that maximum values correspond to high values that indicate rainforests:

TABLE 1. Minimum and maximum NDVI values for the whole community area in Bukidnon. The maximum values show high NDVI values consistent with tropical rainforests.

NDVI	2004	2016	2017	2018	2019
Minimum	-0.1	0.0936073	-0.117241	-0.0254958	-0.285448
Maximum	0.6	0.839036	0.832883	0.807531	0.854158

Through numerical and visual inspection (see Figure 5) of the NDVI for the past years, it can be seen that the community area has retained high NDVI values consistent with the characteristic high vegetation of tropical rainforests. This may be an indication that abacá harvesting and/or wild honey hunting do not negatively harm the community forests and are sustainable practices. Further analyses through mixed effects regression and repeated measures analysis of variance (ANOVA) (see Tables 2 to 4) using Stata 14.2 show that the high NDVI values in the Higaonon community forests as shown in Table 1 are statistically significant. This is highly relevant to forest conservation, showing that indigenous community-conserved areas such as those managed by AGMIHICU in Bukidnon could keep the forest cover high even with community forestry enterprises.

Mapping the Value Chain of Abacá and Wild Honey CFEs

The value chains of the abacá and wild honey CFEs were mapped through key informant interviews and survey questionnaires. Looking at the two value chains (Figures 2 and 3), both enterprises have similar downstream actors and downstream value addition while having different upstream actors. In the abacá CFE, the upstream actors consist of the abacá harvesters and the abacá weavers and dyers. The abacá harvesters are responsible for gathering abacá plants in the forest and are usually the husbands of the abacá weavers. Due to abacá diseases such as bunchy top, there are instances when abacá plants are in short supply and abacá harvesters need to buy abacá plants from other harvesters. Abacá fibers that are gathered or bought are either given to the harvesters' wives, the Kalandang Weavers, for weaving or sometimes sold directly as fibers in the town market.

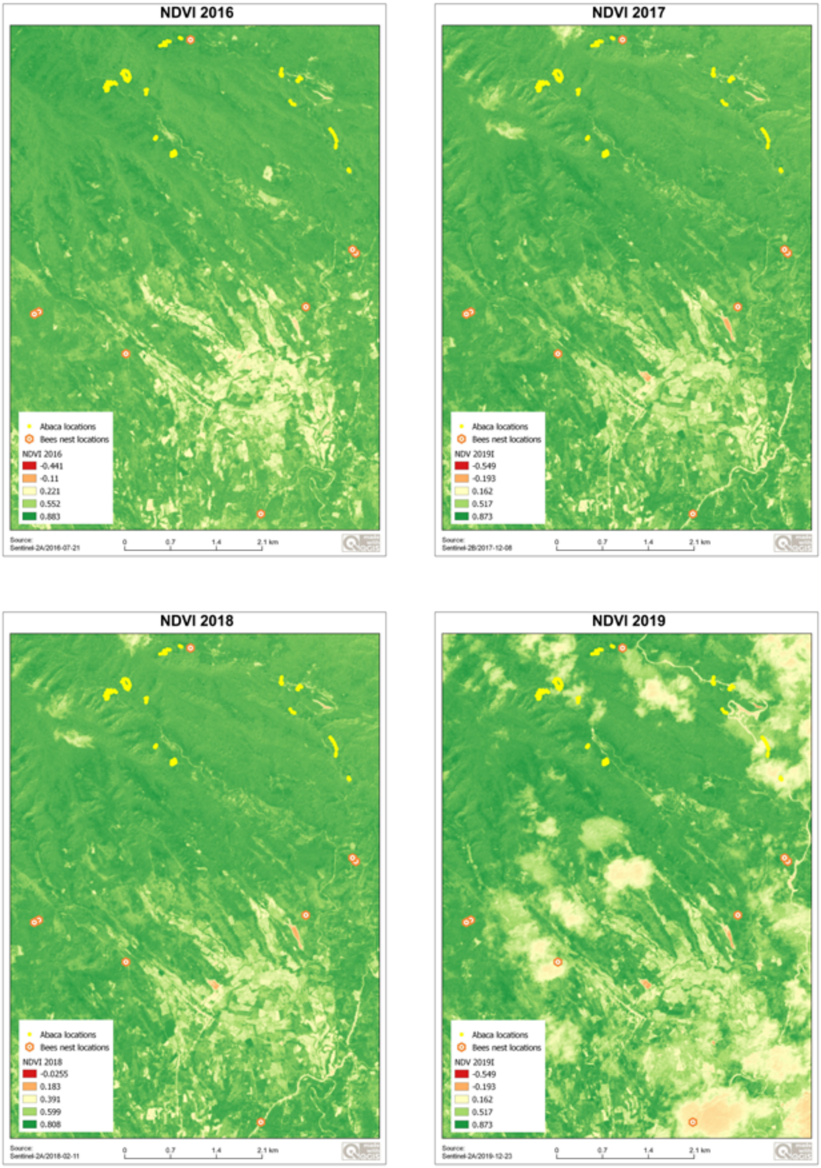


FIGURE 5. NDVI images of the area during the years 2016, 2017, 2018, and 2019. The year 2004 was not included due to a scan line corrector (SLC) failure of the satellite and the satellite image for 2019 includes cloud cover.

TABLE 2. Mixed effects regression analysis for honey

Mixed effects ML regression		Number of obs	40
Group variable: id		Number of groups	8
		Obs per group	
		min	5
		avg	5.0
		max	5
		Wald chi2(4)	117.32
Log likelihood	63.173783	Prob > chi2	0.0000

NDVI	COEF.	STD. ERR.	Z	P>|Z|	[95% CONF. INTERVAL]	
Year						
2016	.3820791	.0445463	8.58	0.000	.2947699	.4693883
2017	.3991212	.0528643	7.55	0.000	.2955091	.5027333
2018	.3725509	.0578537	6.44	0.000	.2591597	.4859421
2019	.2938173	.100241	2.93	0.003	.0973484	.4902861
_cons	.3128423	.0433953	7.21	0.000	.2277891	.3978955

TABLE 3. Repeated measures ANOVA for honey

Number of obs		40	R-squared		0.7160
Root MSE		.125119	Adj R-squared		0.6044

SOURCE	PARTIAL SS	DF	MS	F	PROB>F
MODEL	1.1051623	11	.1004693	6.42	0.0000
ID	.21464996	7	.03066428	1.96	0.0974
YEAR	.89051231	4	0.22262808	14.22	0.0000
RESIDUAL	.43833618	28	.01565486		
TOTAL	**1.5434984**	**39**	**.03957688**		

TABLE 3 (CONT'D)

Between-subjects error term	id	
Levels	8	(7 df)
Lowest b.s.e. variable	id	
Repeated variable	year	

Huynh-Feldt epsilon	=	0.4647
Greenhouse-Geisser epsilon	=	0.3806
Box's conservative epsilon	=	0.2500

			PROB > F			
SOURCE	**DF**	**F**	**REGULAR**	**H-F**	**G-G**	**BOX**
Year	4	14.22	0.0000	0.0006	0.0016	0.0070
Residual	28					

TABLE 4. Mixed effects regression analysis for abacá

Mixed-effects ML regression		Number of obs	500
Group variable: id		Number of groups	100
		Obs per group	
		min	5
		avg	5.0
		max	5
		Wald chi2(4)	787.72
Log likelihood	606.5049	Prob > chi2	0.0000

NDVI	COEF.	STD. ERR.	Z	P>|Z|	[95% CONF. INTERVAL]	
Year						
2016	.544449	.0217575	25.02	0.000	.5018051	.5870929
2017	.5162163	.0231488	22.30	0.000	.4708453	.5615872
2018	.500334	.0231793	21.59	0.000	.4549034	.5457646
2019	.4149599	.0287325	14.44	0.000	.3586452	.4712745
_cons	.2194147	.0218722	10.03	0.000	.176546	.2622834

TABLE 5. Repeated-measures ANOVA for abacá

Number of obs		500	R-squared		0.7724
Root MSE		.128785	Adj R-squared		0.7132
SOURCE	**PARTIAL SS**	**DF**	**MS**	**F**	**PROB>F**
MODEL	22.285654	103	.21636557	13.05	0.0000
ID	1.8309696	99	.01849464	1.12	0.2345
YEAR	20.454684	4	5.113671	308.32	0.0000
RESIDUAL	6.5678566	396	.0165855		
TOTAL	**28.85351**	**499**	**.05782267**		

Between-subjects error term	id	
Levels	100	(99 df)
Lowest b.s.e. variable	id	
Repeated variable	year	

Huynh-Feldt epsilon	=	0.4627
Greenhouse-Geisser epsilon	=	0.4547
Box's conservative epsilon	=	0.2500

				PROB > F		
SOURCE	**DF**	**F**	**REGULAR**	**H-F**	**G-G**	**BOX**
year	4	308.32	0.0000	0.0000	0.0000	0.0000
Residual	396					

Abacá fibers given to the Kalandang Weavers are processed and woven to make hinabol products such as earrings, bags, and table mats, which are then delivered to Lindungawan's showroom in Malaybalay City, Bukidnon. Lindungawan is responsible for selling the hinabol products in Mindanao and delivering them to CMCC in Luzon.

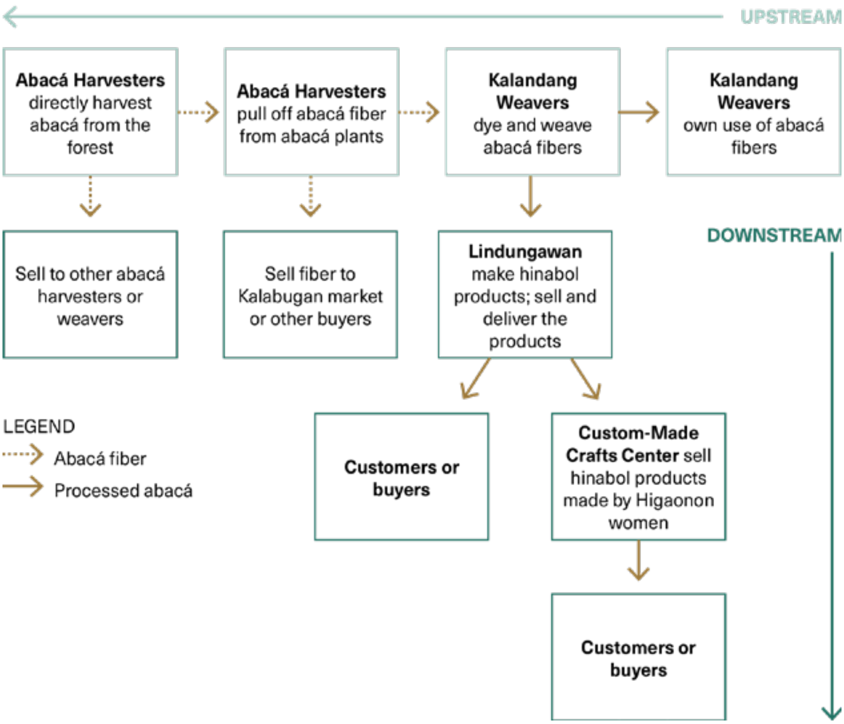


FIGURE 6. Value chain map of abacá (*Musa textilis*). Abacá harvesters (upstream actors) sell raw materials to Kalandang weavers, who process the abacá and sell to downstream actors such as a local Bukidnon marketing initiative called Lindungawan, other retail buyers or direct customers.

In the wild honey CFE, the value chain is shorter than that of the abacá CFE. This, however, does not mean that there is less effort required in the wild honey CFE. Honey hunting and gathering also involves going to the forest and searching for giant honey bee hives and then climbing the trees to gather the honeycombs. As mentioned previously, only a select few have the skill and courage to do hunt giant honey bees and gather their honeycombs. Afterwards, the honey hunters and gatherers bring the honeycomb to the honey processors who are usually the wives of honey hunters. The honey processors drip filter the honeycomb in their tribal hall and then transfer the processed honey to a one-gallon container. The processed wild honey must first be blessed through a ritual before getting transferred to 250ml bottles provided by Lindungawan for retail selling.

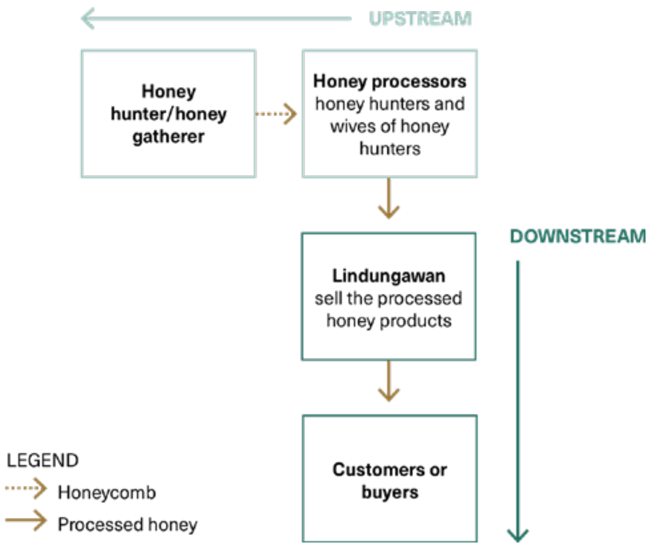


FIGURE 7. Value chain map of wild forest honey gathered from giant honey bees (*Apis dorsata* F.)

Through key informant interviews, we were able to obtain production cost data of Class A abacá and honey, which include information on costs per value addition, labor, and other operating costs (Table 6). Class A hinabol are intricately woven, soft, and smooth with no sharp edges and bumps, and are of superior quality as they are thoroughly cleaned and ironed well. Class A honey has low moisture content, although this standard has been appropriated from the cavity-nesting bees (whose honeycombs are enclosed) such as the European honey bee and adjusted for open-nesting bees like the giant honey bees. Secondary data analysis of the farm gate prices of the two NTFPs show that raw abacá fiber and unprocessed honeycombs fetch the same price per kilo. Further along the value chain, there are marked differences between the production costs and the off-farm price, which is the farm gate price including transportation costs but excluding administrative costs.

Representation of giant honey bee, *Apis dorsata* F.

Looking at the off-farm price, wild honey considerably has a higher price than abacá. When calculating the profit margin, wild honey also has a higher profit with production costs and raw materials around 16 percent of the off-farm price compared to abacá, which has 33 percent of its off-farm price as production and raw material costs. From this rough approximation,

TABLE 6. Comparison of prices (in PHP) between abacá and honey NTFPs. To uphold confidentiality, the absolute figures given below are artificial numbers but provide close approximations of margins.

	ABACÁ	HONEY
Raw material per kilo (Class A)	50.00	50.00
Total production costs (Class A)	128.00 (traditional design)	60.00
Processing	114.00	45.00
Operating cost	14.50	8.50
Resource management and cultural preservation fund	2.00	0.00
Off-farm price	386.00 (per meter)	696.00 (per kilo)

which does not include administrative or fixed personnel costs, it seems that there is more profit to be had from gathering wild honey. However, as noted earlier, wild honey hunting is a seasonal occupation in its early stages within the AGMIHICU community compared to abacá harvesting. As an additional source of livelihood, wild honey hunting could be further explored given its potentials for bigger profit margins. Livelihood diversification through seasonal occupation like wild honey hunting could generate additional income and can spread environmental risk especially since abacá plants within the community are being affected by diseases (Hussein and Nelson 1998). In addition, having more forest products as source of livelihood could hold off land use change from agriculture (Delacote 2010). Given that wild honey hunting is in its early stages of enterprise development, this could also be an opportunity to develop into a sustainable and fair NTFP practice. Labor costs of the gatherers could be factored in gross margin analysis and prices recalculated to include these. Moreover, the wild honey enterprise so far has no allocation for the resource management and cultural preservation fund, unlike the abacá enterprise. With proper financial and technical support, the seasonal hunting of giant honey bees for wild honey could be further developed to contribute to increasing both the ethnocompetitiveness and livelihood security of the Higaonon people (Lugo-Morin 2017). When taken together, abacá and giant honey bees could constitute a diverse livelihood portfolio that could help in forest conservation.

Concluding Remarks

As a social-ecological research endeavor, BEST Forests found that indigenous livelihoods in CFEs have complex and interconnected factors. The practices of abacá harvesting and wild honey hunting are derived from traditional livelihoods of the Higaonon community and have transitioned from subsistence to commercial livelihoods of the community. Both abacá and giant honey bees provide provisioning ecosystem services that support indigenous livelihoods, but the giant honey bee provides an additional regulating ecosystem service through its pollinating activity. However, having abacá and giant honey bees as sources of livelihood are better than having agricultural activities that stem from converting forests to agricultural areas.

There have been apprehensions about the harvesting and gathering of NTFPs and whether this may not contribute to deforestation per se, but instead to forest degradation. Spatial analysis conducted by BEST Forests show that the community forests of the Higaonon people maintained a high NDVI characteristic of tropical rainforests and may be an indication of sustainable harvesting of abacá and wild honey NTFPs. In terms of rural development, having diversified livelihoods may contribute to the ethnocompetitiveness of the Higaonon community and further developing the wild honey CFE may be a key factor.

Findings of BEST Forests show that despite the seasonality of the wild honey CFE, its profit margins are potentially bigger than that of abacá weaving. However, since there is no separate labor payment to the harvesters, it is difficult to assess whether the level of effort on abacá stripping and honey harvesting are commensurate to the gross margins. Once labor costs are factored in, there is a possibility that the gross margins could be smaller. One area where existing projects could further improve is ensuring that harvesters are also paid for their labor and not only for the products they harvest.

These results were made possible through a transdisciplinary research approach, which enabled close coordination throughout and continuous discourse after the project. BEST Forests shows how a transdisciplinary research approach is important in forest conservation research that involves forest-dependent peoples. The transdisciplinary approach ensured that the research goes beyond being a purely academic exercise and contributes to producing new integrated knowledge that could be a basis for future management actions in community forests.

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