Analysis of human and Philippine teak forest interaction in the *lasang-baybay* landscape along Verde Island Passage Marine Corridor, Batangas Province, Philippines

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Abstract

This study determined the local ecological knowledge (LEK) on the uses of plants in the Philippine teak forest (PTF) landscape and proposed a framework for conservation practitioners reconciling anthropogenic change drivers and ecological values of the PTF. Using techniques in participatory resource appraisal (PRA), facilitated focused group discussion (FGD), and key informant interviews (KIIs), the information on LEK on the plant uses were gathered among the villagers in the *lasang* (*satoyama*) and *baybay* (*satoumi*) in Batangas City and the municipality of Lobo, Batangas Province. Results show that the local community in the study site had a good perception of the multiple ecological functions of the Philippine teak (*Tectona philippinensis*) forest. The PTF is integral in the lives of the local community as a component wood source for the construction of their dwellings and shelters of domestic farm animals. Cultivated plants in the agroecosystems were observed as best alternatives to sustain the harvesting of some indigenous plants such as *Vitex parviflora* and *T. philippinensis* for the livelihood and material culture of the local population. Since the old times, molave (*V. parviflora*) trees have been used to build houses of the century-old dwellings in the localities, suggesting that the species had been dwindling its abundance in the wild. This could also explain the reason for the

dominance of *T. philippinensis* in a dry limestone habitat in Lobo, Batangas, where *V. parviflora* is expected naturally to overlap. The PTF is one of the locally valuable resources affected by urbanization, infrastructure development, and agricultural expansion resulting in forest fragmentation. However, there are still locally learned practices that may serve as localized models of harmonious human-forest interaction. In the proposed framework, understanding the local drivers of threats to the PTF will allow the policy, regulatory, and research institutions to address these challenges, invest in conservation networking, and do the restoration for the species as well as the forest ecosystem levels. Conservation approaches can be highly varied but localized, building from local knowledge, stakeholder values, and peculiarities of the PTF environment. As soon as other plant resources in the landscape are exhausted for dwellings, firewood, and boat-making, other locally lesser-used species might be misused by the locals in the future. Hence, to preserve the natural patches of native plants from the ridge to coast, institutional support should be given to the local communities as they integrate these indigenous floras in their farms, homegardens, and safe public sites for posterity use values.

Keywords

dipterocarps, *ex situ, in situ*, local knowledge, molave, *Tectona philippinensis*, *Loboanos*, *Vitex parviflora*, wooden boats

Introduction

Forests are storehouses of numerous plant resources that enhance the existence of local communities. These resources include timber, fuelwood, and non-timber forest products. Forests also provide ecological services such as wildlife habitat, erosion control, and climate regulations (Munasinghe 1995; Panayotou and Ashton 1995; Perrings et al. 1995; FAO 2003, 2005; UNFCC 2005).

Studying the local knowledge of the forest-dependent communities is based on the concept of human-nature interaction (Putri et al. 2014). Since the early civilization, people have cultivated plants for food, fuel, medicine, house construction materials, and traditional implements (Gerique 2006). The study on the local knowledge on plant resource use can improve the understanding of forest management at the local and regional scale (Dalle and Potvin 2004). To understand the dynamic relationship between biodiversity and social and cultural systems, ethno-ecological research has been suggested (Putri et al. 2014).

The Philippine teak forest (PTF) of Batangas Province is an example of *satoyama-satoumi*, a Japanese term which refers to the landscape thriving through human-nature interaction. *Satoyama* is a mosaic landscape composed of various ecosystems with human settlements that provide valuable ecosystem services for human well-being (Duraiappah and Nakamura 2012). The Philippines has its own share of *satoyama* landscapes, each having a local term of its own, such as *muyong* in the Cordilleras (Santiago and Buot 2018), *guba* in Palawan (Sopsop and Buot 2011), and *lasang* in the Visayas and Mindanao regions (Buot 2014).

The PTF is unique among the studied *satoyama* landscapes in the Philippines, as it also has a coastal ecosystem (*satoumi*) extending along the Verde Island Passage Marine Corridor (VIPMC), the center of marine biodiversity in the Philippines. Also known as *baybay* by the locals, *satoumi* as a landscape is intricately linked with humans for several

years (Duraiappah and Nakamura 2012). Throughout this article, the authors will refer *satoyama-satoumi* using local terms: *satoyama* will be addressed as *lasang* (Buot 2014), and *satoumi* will be addressed as *baybay*.

There have been few studies on the local knowledge of plant resources in southern Batangas, such as the studies on timber and non-timber products in Mts. Lobo and Banoy (Caringal and Generoso 2002; Caringal and Bañados 2008), plant diversity in swidden patches (Caringal and Panganiban 2008), life cycle of *Macrophysis luzona* in timber wood *Heritiera sylvatica* (Briones 2005), underutilized edible fruits in the agroecosystem landscape of Lobo, Batangas (Cueto et al. 2015) and the pioneering account on native plants built by *Loboanos* for their swidden harvests (Boongaling and Macatangay 2014; Caringal et al. 2017).

The local knowledge on the Critically Endangered Philippine teak (*Tectona philippinensis* Benth. & Hook.f.) has never been the subject of ethnobotanical inquiry. Ethnobotany probes the local knowledge on the use of plants, which is equally valuable as the modern scientific knowledge on plant sciences. These complementary knowledge systems can be used in formulating policies and strategies in the conservation of the species and the forest ecosystem on a larger scale (Pei et al. 2009).

This research investigated the extent to which the Philippine teak is utilized in relation to other plant resources in the PTF landscape of Batangas, Philippines. This study aimed to determine the local knowledge of villagers on the uses of plants in the PTF landscape. From the information on the local knowledge, a framework for a harmonious interaction between the local community and the Philippine teak forest was established in this study.

Study Area and Methods

Study Area

The study area is located at the Philippine teak forest (PTF) in the agroscape of Batangas (Fig. 1). Forest fragmentation is visible across the landscape where the Philippine teak populations were sampled (Plot 1-24). The map shows that 2,078.39ha of forest cover was converted to farming and settlement lands from 2000-2015. The habitats of *T. philippinensis* were affected by this landscape process (forest cover lost in red patches) due to human disturbances. In Lobo, Batangas (Fig. 2), the Philippine teak forest fragments were in agricultural and built-up zones, mostly in the coastal hilly lands while the agroforest zone is in the interior upland villages dissecting the remaining intact forest zone at higher elevation of Mt. Lobo.

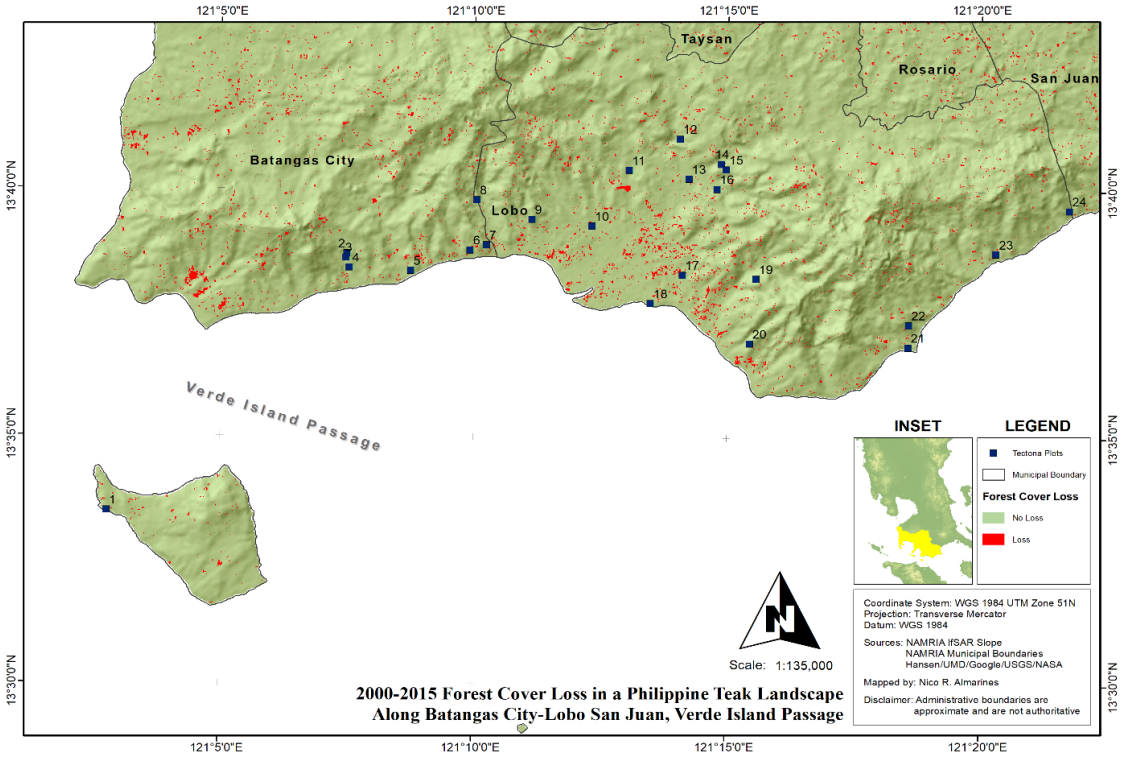

Fig 1. Forest cover lost (*red fragments*) in the Philippine Teak landscape (2000–2015).

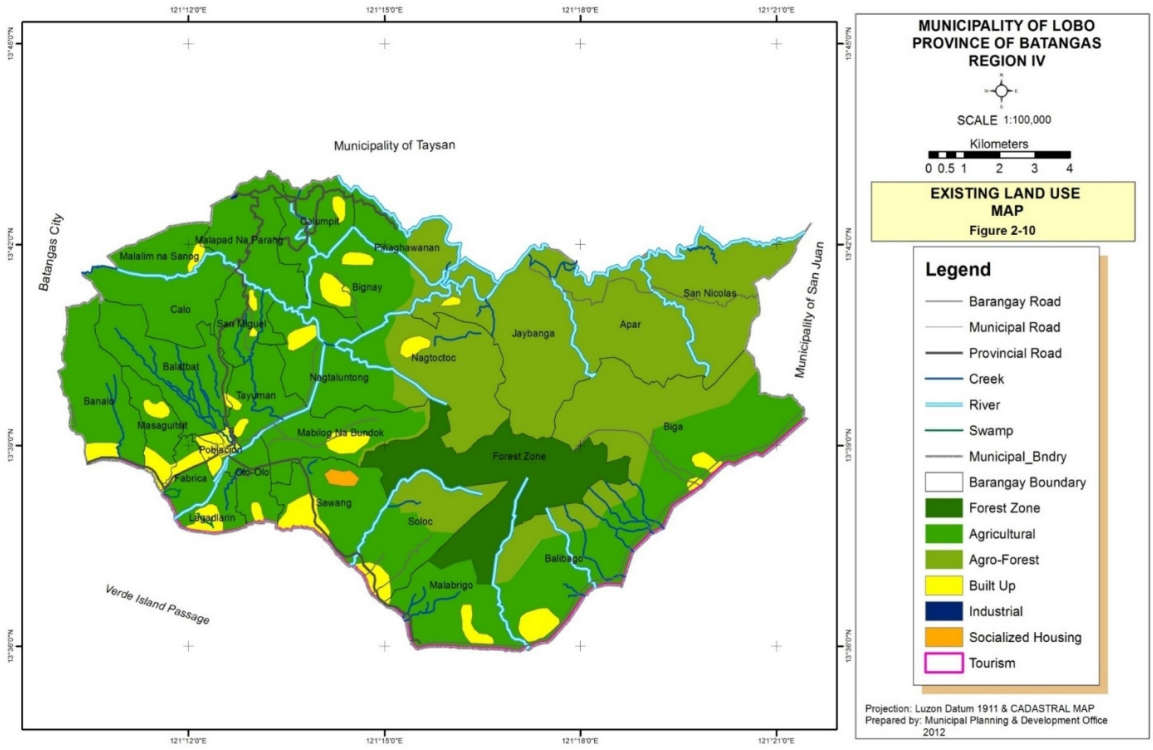

Fig 2. Existing land use map of Lobo, Batangas (CLUP-Lobo Batangas, 2012–2022. Used with permission).

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Methods

Determining local knowledge on the use of plants in the Philippine teak forest

To gather information on the knowledge on plant uses, the researchers used the Participatory Resource Appraisal (PRA). PRA is a data collection method that involves sharing of local ecological knowledge (LEK) by the local community with the researcher or facilitated by outsiders from different sectors or disciplines. The outsiders help the local community in identifying and analyzing information, practicing critical awareness, taking responsibility, and sharing their knowledge and condition to plan and act (Bhandari 2003; Macandog et al. 2014). Local ecological knowledge refers to "knowledge, practices, and beliefs regarding ecological relationships that are gained through extensive personal observation of and interaction with local ecosystems and shared among users of biodiversity resources (Charney et al. 2008; Macandog et al. 2014)."

In this study, 30 PRA participants were engaged in a half-day focused-group discussion (FGD). The researchers determined the participants based on the demographic information provided by the Municipal Agriculture and Natural Resource Office (MA/MENRO) of Lobo, Batangas. The demographic features of the participants were registered prior to the actual FGD. From this, the following outputs were generated: (1) timeline which captures the local information on significant events (biophysical and socio-economic changes) that happened in the PTF landscape and (2) resource flow of locally-important plants from the forests and agroscape into to the households or community level.

The output of PRA was supported by conducting face-to-face interviews with the key informants (KI) using a semi-structured questionnaire. The conduct of the KII was performed within a month to determine local knowledge about the ecological services of *malabayabas* (local name of Philippine teak) and the diverse uses of other plant resources from the Philippine teak forest landscape. Upon consent, only those persons possessing knowledge (in habitation and in practice) regarding forest plants use were interviewed purposively. Direct accounting or ocular observations were also done following the approach by Weerd et al. (2003) and by identifying the different main use categories of local plant resources (Balangcod 2010). Three main plant use categories were prioritized: (1) dwellings, especially native houses built from plant materials; (2) fuelwood; and (3) boats. House (shelter) is a primary necessity for any human beings; fuelwood for daily cooking and the boats that were built from forest plants connect the lives of the people to the sea through fishing livelihood.

Evaluating the use value index of plant resources

The use value (UV) index indicating the use reliability and relative importance of locally known plants was calculated based on the formula of Trotter and Logan (1986) and Kaval et al. (2015), and was modified as follows:

$$UV = \frac{U}{N}$$

where UV refers to the use value of a species; U to the number of local citations and observed used per species; and N to the number of informants.

Establishing framework for harmonious interaction between humans and the Philippine teak forest

Based on the information gathered and synthesized from FGD and KIIs, the framework was constructed by identifying the threats and opportunities happening in the PTF landscape. Relevant conservation initiatives were done by the local community despite some drivers of change as well as institutional and political challenges in the landscape. The key actors of change in the Philippine teak forest landscape were also identified. Through systems thinking, a proposed framework relevant to the identified opportunities and challenges was proposed. This was visualized as interacting systems aiming to solve conservation challenges in the Philippine teak forest landscape.

Results

The local knowledge on the ecological services of *malabayabas* (Philippine teak forest), as well as the diverse plant resources utilized for building native houses and fishing boats, and fuelwood were learned from various key informants in the local community. These key informants were composed of the residents of rural upland and coastal villages of Batangas City and Lobo Batangas (Table 1).

Table 1. Demographic profile of key informants on ecological services and major plant use categories in the Philippine teak forest landscape.

Ecological Services and Major Plant Use Categories	Socio-Economic Profile of Key Informants				
	Male (N)	Female (N)	Age Range (Years)	Total	Socioeconomic Niches
Ecological Services of *Malabayabas* (Philippine teak forest)	55	2	19-76	57	Coastal and inland dwellers in Lobo and Batangas City; upland-lowland farmers; fishermen and members of Bantay Dagat (Baywatch); barangay officials and community elders
Plants used to build native houses/shelters	63	29	18-90	97	
Plants used as fuelwood	15	7	33-73	22	
Plants used for building boats	72	None	22-72	72	Fishermen in Lobo Batangas including one skilled resident boat builder from Oriental Mindoro

Local Knowledge on the Ecological Services of Philippine Teak Forest

The Philippine teak, known as *malabayabas* or *malapangit* by the *Loboanos* (term used to identify the local people of Lobo, Batangas), was perceived well by the mountain farmers of Batangas City for its multiple ecological functions, in direct consumptive as well as indirect non-extractive values. Based on the information gathered from the interview of 57 key informants, the Philippine teak provides important wood used for building houses in the form of post or pile, lumber for roof flooring and partitions giving an overall use value index of 0.72 (Table 2). The woods of Philippine teak were also designed into furniture such as tables, chairs and tool handles; boats and propeller of galleon ships; or converted into charcoal or used as firewood. Trees were used as living peg and fence and manually trimmed lumber are used to build shed of farm animals.

Malabayabas were also grown as backyard and farm trees, as bonsai, and seedlings for planting. From the knowledge of the local people, it was revealed that Philippine teak trees enhanced microclimate and covered the hilly landscape preventing potential soil degradation. Likewise, the forest with Philippine teak provides habitat for wildlife. Taken together (Table 2), the consumptive use value of Philippine teak forest was 1.02 while all the non-consumptive use value was 0.36. This showed that the local knowledge about the multiple uses of Philippine teak and the forest in general had taken roots from the perception of community. *Malabayabas* is integral in the lives of local community as component wood in their dwellings and shelter for domestic farm animals (Fig. 3).

Table 2. Local knowledge on the ecological services of the Philippine Teak.

Ecological Services Mentioned	Frequency of Citation (KIs=57)	Use Value Index
Direct consumptive uses		
Plants for Dwellings / House Construction:		
• Pole, post or pillars	28	0.49
• Roof lumber	2	0.03
• Floor lumber	2	0.03
• Other parts of the house: walls	10	0.17
Furniture: chairs, tables	4	0.07
Plants for firewood and charcoal	8	0.14
Wood for tool handles: bolo, hammer, axe	1	0.02
Biopeg, lumber for shed and fence for domestic animals: cattle, goat, swine	3	0.05
Wood for boats and propeller of galleon ship	1	0.02
Indirect non-extractive uses		
"Malabayabas" cultivated in homegardens:		
• grown in backyard	1	0.02
• grown with other farm plants	2	0.03
• grown as bonsai	2	0.03
• grown as seedlings	1	0.02
Gives favorable microclimate:		
shade trees in the landscape	1	0.02
Protects hills from soil erosion and landslide	3	0.05
Habitat of wildlife: monkey, monitor lizard, birds, bats, snakes	11	0.19

Fig 3. The Philippine teak woods integral to material culture of *Loboanos* in Batangas: (A) house partition; (B) chair furniture; (C) flooring; (D) pole fences for goats over a hill tamarind tree and (E) biopeg sapling for tethering cattle in a grazing patch.

Plants Used for Native Houses

Forty-two (42) plants were known by the community as important materials for building their traditional dwellings (Table 3). The 20 most commonly used (UVIs: 0.06-1.32) species for this purpose are *mulauin* (*Vitex parviflora*), *niog* (*Cocos nucifera*), *malunggayain* (*Melia azedarach*), *buri* (*Corypha utan*), *dungon* (*Heritiera sylvatica*), *dungon-pula* (*Planchonella obovata*), *guijo* (*Shorea guiso*), *amugis* (*Koordersiodendron pinnatum*), *lauan* (*Shorea spp.*), *nipa* (*Nypa fruticans*), *kogon* (*Imperata cylindrica*), *akasya* (*Samanea saman*), *manga* (*Mangifera indica*), *malaruhat-bundok* (*Syzygium subcaudatum*), *malabayabas* (*T. philippinensis*), *baguiraua* (*Terminalia polyantha*), *santol* (*Sandoricum koetjape*), *kauayan-tinik* (*Bambusa blumeana*), *malibayo* (*Berrya cordifolia*), and *yakal* (*Shorea stylosa*).

Some non-native plants from the Philippine teak forest or other *lasang* ridge forests were also used by the community for building houses, such as *Cocos nucifera, Mangifera indica, Gliricidia sepium, Chrysophyllum cainito, Leucaena leucocephala*, and *Tamarindus indica*. These are cultivated plants in the agroscape from Batangas City to Lobo Batangas (Fig. 4). *Samanea saman* is common along the riparian zone and alluvial plain while *Avicennia marina, Nauclea orientalis*, *Nypha fruticans*, *Terminalia catappa* and *Wrightia pubescens* are coming from *baybay* (beach and mangrove) forests in Lobo.

The wood of molave tree, known locally as *mulauin*, was used primarily as pillars, flooring, stairways, tables and furniture in old houses (80 to 100 years old, Fig. 5) due to its proven hardness. Hence, the hardwood is known to be expensive as it is highly resistant to deterioration. The price of *mulauin* furniture ranged between PhP 30,000-50,000 in Lobo. *Tectona philippinensis* and *Terminalia polyantha* are the two most dominant hardwoods in the Philippine teak forest landscape, but these are not the primary alternative woods preferred (with UVI: 0.08) due to diminishing number of molave trees in the wild. The local community revealed other important hardwoods for building houses such as *lauan*, *yakal* and *guijo* (trees belonging to genus *Shorea*) which are harvested from Mt. Lobo, the highest *lasang* summit in Batangas. This mountain has its last remaining dipterocarp forests from 700-900m altitude (Caringal and Generoso, 2002; Caringal, 2008).

Table 3. Use Value Index (UVI) of locally important plant resources in the Philippine Teak Forest landscape, as classified into three major plant use categories.

Native Houses	UVI (N=97)	Fuelwood	UVI (N=66)	Boats	UVI (N=72)
mulauin (*Vitex parviflora*)	1.32	ipil-ipil (*Leucaeana leucocephala*)	0.62	lauan (*Shorea spp.*)	2.22
niog (*Cocos nucifera*)	0.35	sampalok (*Tamarindus indica*)	0.39	kauayan-tinik (*B. blumeana*)	0.92
malunggayin (*Melia azedarach*)	0.32	niog (*Cocos nucifera*)	0.27	himbabao (*Broussonetia luzonica*)	0.77
buri (*Corypha utan*)	0.24	madre-cacao (*Gliricidia sepium*)	0.24	yemane (*Gmelina arborea*)	0.54
dungon (*Heritiera sylvatica*)	0.23	kauayan-tinik (*Bambusa blumeana*)	0.18	mulauin (*Vitex parviflora*)	0.20
dungon-pula (*Planchonella obovata*)	0.21	aromang dagat (*Acacia farnesiana*)	0.15	bayok (*Pterospermum diversifolium*)	0.18
guijo (*Shorea guiso*)	0.20	mulauin (*Vitex parviflora*)	0.15	guijo (*Shorea guiso*)	0.16
amugis (*Koordersiodendron pinnatum*)	0.19	suyak-daga (*Canthium horridum*)	0.14	palosapis (*Anisoptera thurifera*)	0.13
lauans (*Shorea spp.*)	0.17	aromang bundok (*Acacia juliflora*)	0.09	santol (*Sandoricum koetjape*)	0.13
nipa, sasa (*Nypa fruticans*)	0.12	Indian mango (*Mangifera indica*)	0.07	anonang (*Cordia dichotoma*)	0.11
kogon (*Imperata cylindrica*)	0.11	malunggayin (*Melia azedarach*)	0.06	kamatsile (*Pithecelobium dulce*)	0.09
akasya (*Samanea saman*)	0.11	batungol (*Flacourtia sp.*)	0.06	malibayo (*Berrya cordifolia*)	0.08
manga (*Mangifera indica*)	0.10	ates (*Annona squamosa*)	0.04	dungon (*Heritiera sylvatica*)	0.08
malaruhat-bundok (*Syzygium sp.*)	0.08	bayabas (*Psidium guajava*)	0.04	mahogany (*Sweitenia macrophylla*)	0.05
malabayabas (*T. philippinensis*)	0.08	yemane (*Gmelina arborea*)	0.03	dita (*Alstonia scholaris*)	0.04
baguiraua (*Terminalia polyantha*)	0.08	tan-ag (*Kleinhovia hospita*)	0.03	antipolo (*Artocarpus blancoi*)	0.04
santol (*Sandoricum koetjape*)	0.07	mahogany (*Sweitenia macrophylla*)	0.03	nangka (*A. heterophyllus*)	0.04
kauayan-tinik (*Bambusa blumeana*)	0.06	malabayabas (*T. philippinensis*)	0.03	talisai (*Terminalia catappa*)	0.04
malibayo (*Berrya cordifolia*)	0.06	ayangaw (*Albizia procera*)	0.01	akasya (*Samanea saman*)	0.04
yakal (*Shorea stylosa*)	0.06	kapistula (*Cassia javanica*)	0.01	lanete (*Wrightia pubescens*)	0.04
madre-cacao (*Gliricidia sepium*)	0.04	kalamansi (*Citrus microcarpa*)	0.01	malabunga (*Alseodaphne malabonga*)	0.03
himbabao (*Broussonetia luzonica*)	0.03	parbakale (*Dehasia triandra*)	0.01	santol-tamar (*Crateva religiosa*)	0.03
bogo (*Garuga floribunda* var. *floribunda*)	0.03	binunga (*Macaranga tanarius*)	0.01	manga (*Mangifera indica*)	0.03
binunga (*Macaranga tanarius*)	0.03	kulasi (*Melicope monophylla*)	0.01	malunggayin (*Melia azedarach*)	0.03
caimito (*Chrysophyllum cainito*)	0.03	narra (Pterocarpus indicus)	0.01	kamagong (*Diospyros discolor*)	0.01
akleng-parang (*Albizia procera)*	0.02	bilit (*Tristira triptera*)	0.01	batikuling (*Litsea leytensis*)	0.01
bangkal (*Nauclea orientalis*)	0.02	kulombyo (*Samanea saman*)	0.01	tangile (*Shorea polysperma*)	0.01
dulitan (*Palaquium merrillii*)	0.02				
kulatingan (*Pterospermum obliquum*)	0.02				
balayong (*Afzelia rhomboidea*)	0.01				

Native Houses	UVI (N=97)	Fuelwood	UVI (N=66)	Boats	UVI (N=72)
bungalon (*Avicennia marina*)	0.01				
toog (*Bischofia javanica*)	0.01				
balihud (*Buchanania insignis*)	0.01				
ipil-ipil (*Leucaeana leucocephala*)	0.01				
binuang (*Octomeles sumatrana*)	0.01				
mulauin-aso (*Premna nauseosa*)	0.01				
bayok (*Pterospermum diversifolium*)	0.01				
tangile (*Shorea polysperma*)	0.01				
sampalok (*Tamarindus indica*)	0.01				
talisai (*Terminalia catappa*)	0.01				
kalumpit (*T. microcarpa*)	0.01				
lanete (*Wrightia pubescens*)	0.01				

Fig 4. Contributing plant resources from the *lasang-baybay* forests and agroscape for building traditional native house (a photo of an old native house used was representation from the rural upland village of Batangas City, Batangas).

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Fig 5. A century old house in Barangay Pulot-Itaas — a remote ridge rural village in Batangas City with abundant Philippine teak trees. The house was built primarily from native hardwoods such as *mulauin*, *lauan* and *dungon*.

Plants for Firewood

According to the informants, 13 species can be used as sources of firewood. These species have use value indices ranging from 0.09 to 1.5 (Table 3). Five of those species are cultivated in lands primarily for this purpose, such as *ipil-ipil* (*Leucaeana leucocephala*), *niog* (*Cocos nucifera*), *madre-cacao* (*Gliricidia sepium*), *ates* (*Annona squamosa*), and *sampalok* (*Tamarindus indica*). *Sampalok* is an abundant naturalized tree growing as evergreen grove along the hills adjoining active and abandoned swiddens, *ates* plantation, and patches of Philippine teak trees.

Aroma (*Acacia farnesiana*) is a component shrub of sandy beach forest near mangroves and is identified as an excellent source of fuelwood due to its intense flammability. It is used by coastal residents as a cheaper alternative to liquefied petroleum gas (LPG). There are other incidental fuelwood species recorded from the informants, such as *kauayan-tinik* (*Bambusa blumeana*), *suyak-daga* (*Canthium horridum*), *batungol* (*Flacourtia sp.*), *tan-ag* (*Kleinhovia hospita*), and *bilit* (*Tristira triptera*).

Mulauin (*Vitex parviflora*) and *malabayabas* (*T. philippinensis*) are preferred less by the community to be utilized as alternative fuelwood since these woods are good materials for lumber and furniture. Meanwhile, *tood* (drift stump) and trimmings of *mulauin*, *madre-cacao* (Fig. 6), *aroma*, and dried *kauayan-tinik* (*Bambusa blumeana*) are collected by the locals from stream bank forest are often reserved as fuelwood in cooking bulk foods during social gatherings such as birthdays, family reunions, *fiestas*, weddings, and Christmas celebrations.

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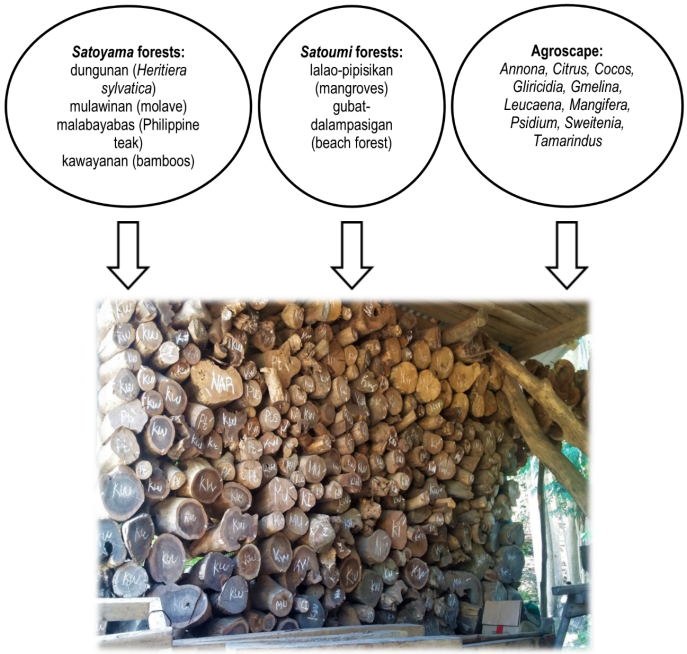

Fig 6. Contributing plant resources for firewood in Lobo, Batangas. In this pile, the cross section of each wood was chalk-marked with letters, e.g. Pt (Philippine teak), Kw (*kakawati*), Mu (*mulawin*), Nar (*Narra*), Pus (*puso-puso*).

Plants for Wooden Boats

The long coastline from Batangas City to Lobo to San Juan, Batangas along the Verde Island Passage Marine Corridor (VIPMC) is a well-known fishing ground. In Lobo alone, there were 730 registered bancas; 592 of which were motorized and 137 are small non-motorized used for fishing (MA-LGU Boat-R List, 2016). The *Loboano* fisherfolks (among the FGD/KIIs participants) revealed some 11 plant names that are locally harvested from the ridge to coastal woodlands in Lobo. These plants, popularly used as poles, are purchased from landowners and then brought to a lone local boatbuilder in *lagadlarin* (meaning: *lagarian* or lumberyard — a village near Lobo River where during the Spanish conquest of Batangas, the forest logs harvested from the mountains were rafted and sawn before rafting again to the other side of the river — in a modern-day village; *Fabrica* — a small port in Lobo where boats were built).

The most commonly used plants (UVI: 0.08-2.27) for building small wooden boats (Table 3 & Fig. 7) were the *lauans* (*Shorea spp*.), *kauayan-tinik* (*B. blumeana*), *himbabao* (*Broussonetia luzonica*), *yemane* (*Gmelina arborea*), *guijo* (*Shorea guiso*), *mulauin*(*Vitex parviflora*), *santol* (*Sandoricum koetjape*), *anonang* (*Cordia dichotoma*), *kamatsile* (*Pithecelobium dulce*), *malibayo*(*Berrya cordifolia*), *dungon* (*Heritiera sylvatica*).

Except for *guijo* and the *lauan* (*lauan pula* and *puti* — red and white lauan as revealed by the community) — the rest of the mentioned plants are still abundant in Lobo. Raw materials such as *kauayan-tinik* were used as *katig* (balancer or floater pole) for all boats, which can be shared by landowners at a very affordable price of Php 100-150. The *guijo* and the *lauan* are imported and rafted to Lobo by big motorboats from Mayagao, Baco, Oriental Mindoro. These dipterocarps woods — light, floaters, and easy to uplift — are used in certain parts of the boat called *batiula*, *kasko*, and *roda*. Accordingly, the woods of *dungon*, *malabayabas* and *mulauin* should not be used in large proportion due to their inherent heaviness,

hence the boat will sink during fishing. Specifically, the inner woods of *T. philippinensis* can easily absorb water and this will not become heavy-duty for long time fishing.

Fig 7. Contributing plant resources for building fishing boat in Lobo Batangas.

Based on the local ecological knowledge of *Loboanos*, the Philippine teak forest (or *malabayabas*) is one of their important forest resources (Fig. 8). From the 1940s to the latter part of the 1990s, the landscape used to contain abundant forest resources — a mosaic of different natural vegetation matrixes (NVMs) such as beach, mangroves, bamboos, dipterocarps, *dungon*, *mulauin*, peat, century palm, and *kalumpit*. All these resources are becoming moderate to minimal and diminishing in the present time (Fig. 8).

Loboanos also learned that the diminishing forest resources are caused by increasing population, road infrastructure, and conversion of forest lands into farming ates, coconuts, bananas, vegetables and root crops (Fig. 9). During the 1940s to early 1980s, where the human population in the area were few, the forests were their source of woods for housing and fuel. There were also abundant foods caught from the river, stream and the sea. Flooding events were uncommon. The river was known to be clear with a deep channel. Today, they experience extreme flooding as their waters are silted. By then, the dry and wet season comes normally. In recent times, shorter but extreme wet seasons and longer dry seasons can be observed, resulting in moderate to minimal harvests in their farms. Moreover, in the Batangas City side, it was reported that land use has changed remarkably. From 1946 to 1981, the former agricultural land rapidly developed into major urban centers. From 1981 up to the present time, the land has been transforming into major urban commercial and industrial centers. The area allocated for ecological development comprised only 389.86ha (1.41%) for forests and while a large proportion, 5,584.37ha (20.21%) for agriculture. Marginal forest lands can be found mostly in villages at lower slopes of Mt. Banoy along the boundary line with the municipality of Lobo (Batangas City Zoning Division-OCPDC, 2017).

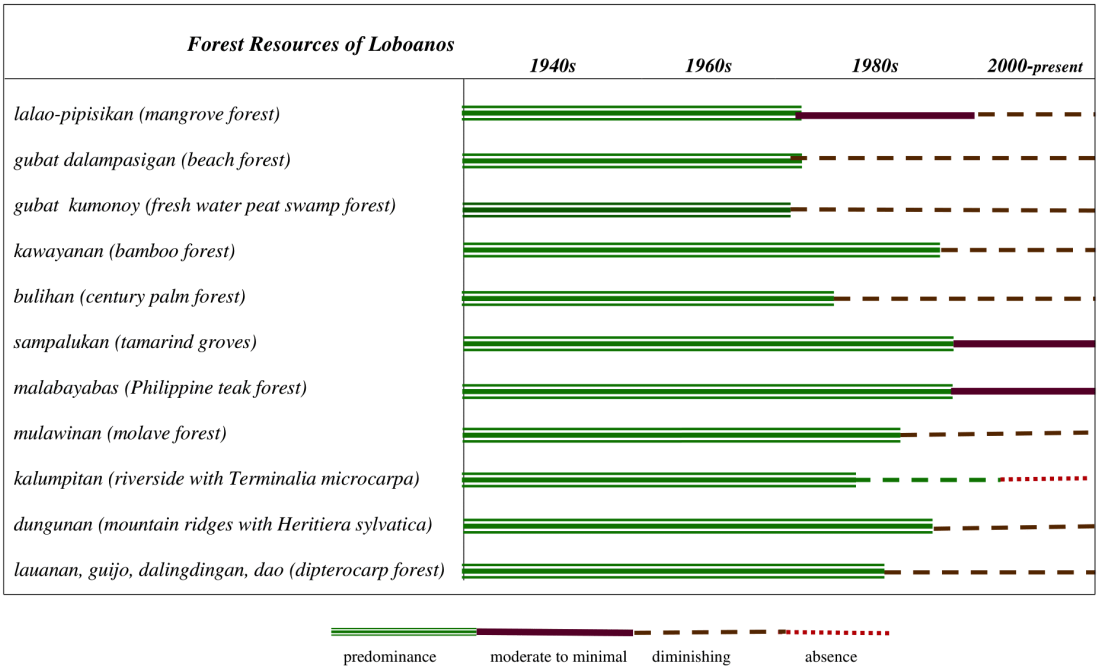

Fig 8. Significant changes in forest resources in the study area based on local ecological knowledge (1940s-present).

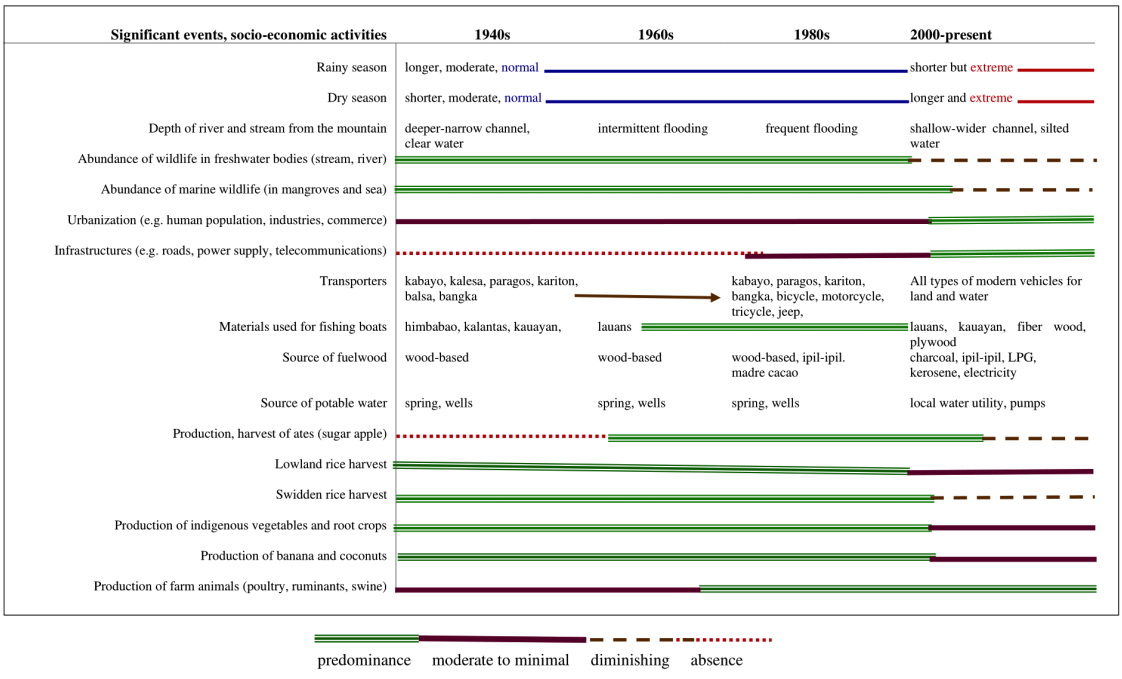

Fig 9. Significant changes in the Philippine teak forest landscape based on local ecological knowledge of *Loboanos*.

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Discussion

The Philippine Teak Forest and people in the *lasang-baybay* landscape: A framework for a harmonious interaction

Knowing the importance of the Philippine teak forest to the humans of Batangas province (Table 2, Figs. 3-7), there is a need to design a framework for harmonious interaction between the two opposing sectors of this *lasang-baybay* forests and agroscape. In the early times, when human populations were low, the relationship was somewhat mutualistic. The forest resources, the coastal resources, and the villagers were one. However, with the recent population explosion, this has not been the case anymore. Resources are dominated by humans, as in the case of so many *satoyama* (*lasang*) and *satoumi* (*baybay*) throughout the world.

Results in this study illustrated a diminishing trend towards the depletion of biodiversity resources (Figs. 1, 8 and 9), causing potential local extinction of various plant resources and loss of ecological services from the PTF landscape. Thus, the authors proposed a conservation framework, as shown in Figure 10. This was constructed through systems thinking, illustrating the synergy of the conservation roles of various stakeholders or actors (subsystems): (1) the policy and regulating institutions (*e.g.*DENR, PGENRO, LGUs), (2) private institutions and individuals, research and educational institutions (*e.g.* BatStateU, UPLB, and other HEIs), and most importantly, (3) the local communities as important conservation allies. The framework also shows the anthropocentric drivers that can have impacts on the PTF. These pressures, together with the actors can influence the state of the PTF.

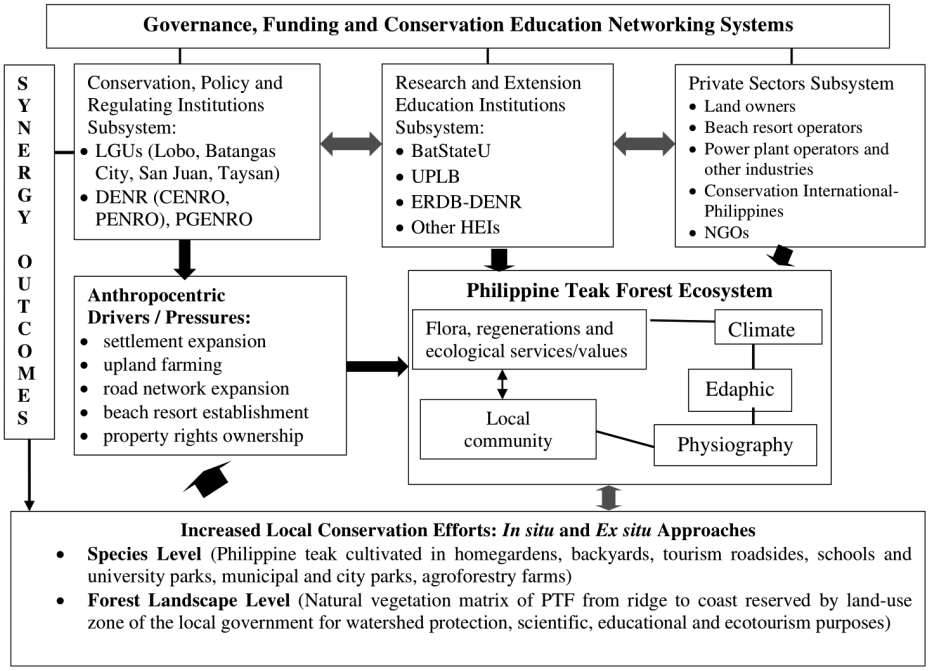

Fig 10. Proposed conservation framework for the Philippine teak forest (PTF) in Batangas Province.

At the bottom of this framework (Fig. 10), the *in situ* and *ex situ* conservation efforts are listed in the species and landscape levels. These varying efforts are mainly localized, allowing the subsystems to be involved in conservation efforts firsthand. At the local level, there were already identified conservation initiatives that must be supported continuously to perpetuate the intergenerational ecological services of the Philippine teak and other plant resources. Integrating these approaches will harmonize the interaction among the ecosystem and human actors towards the conservation of PTF.

The outputs of the analysis on the local ecological knowledge show that the Philippine teak forest was one of the mosaics of locally valuable resource types in Batangas Province. Unfortunately, urbanization, infrastructure development, and agricultural expansion have affected these resource base and pose major challenges for reconciliation ecology.

Given today's continuing fragmentation resulting in patchy occurrences of *T. philippinensis*, there are still local practices that may serve as practical models of human-forest interaction. The existence of the Philippine teak forests within the agricultural zone from ridges to coast shows the ecological integration of this forest in the *lasang-baybay* landscape. Reconciliation ecology should not only save the threatened species in the landscape level; it should also nurture existing socio-ecological interaction outside (*ex situ*) the remaining area where there are humans, i.e. Philippine teak trees associated with swidden patches, forage plantations, native pineapple plantations, grazing patch, rice paddies, in backyard woodlots, near sports facility, along village roadside, and in beach resorts. These are some evidences showing that the Philippine teak, apart from its dry wildland habitat can co-exist with the caring local humanity. The members of the local community are important social allies that must be tapped for long-term conservation programs.

In the proposed framework (Fig. 10), understanding the local drivers of threats to the PTF will allow the policy, regulatory, and research institutions to address these challenges and do restoration efforts for both the species level and forest ecosystem. According to Adams et al. (2016), conservation approaches can be highly varied but localized, building from local knowledge, stakeholder values and peculiarities of natural systems. While there is competition for resource use by anthropocentric players and ecocentric conservation practitioners (Burkhard *et al.,* 2012), the policy and regulatory approaches and solution-based science still play an essential role for effective policy development, decision-making and implementation of conservation actions (Adams *et al.,* 2016).

Conclusion and Recommendations

The local community has valuable knowledge about the diverse plant resources, not only from the Philippine teak forest but also from the *lasang-baybay* (*satoyama-satoumi*) landscape. Cultivated plants are the best alternatives to sustained exploitation of some indigenous ones (*mulauin* and *malabayabas*) that are used for essential livelihoods and material necessities of the local population. Since the old times, molave trees have been used to build houses, as seen in the century-old dwellings, suggesting the earlier cause of its dwindling abundance in the wild until the present time. This could be the reason for the dominance of *T. philippinensis* in a limestone habitat in Lobo, Batangas, where *V. parviflora* is expected naturally to have overlapped. As soon as other plant resources in the landscape are exhausted for dwellings, firewood and boat makings, anticipated misuse of other locally lesser-preferred species (*T. philippinensis* and *Terminalia polyantha*) is expected soon. Hence, there is a need for the local community to be given institutional encouragement to

preserve natural patches of native plants from the ridge to coast, and at the same time, continue integrating the indigenous flora in their farms and homegardens for posterity use values.

As Janzen (1988) puts it to address ecological restoration of the tropical dry forest: “The frontier is gone. The audience is local. The power is local. In the near future, almost all members of tropical societies living on dry forest soils will be settled on firmly titled land and will be leading a real or vicarious urban life with amenities such as good roads. Survival of a wildland will depend on regional policy decisions by government institutions and planning commissions, and those decisions will be made in conjunction with the local community”.

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