United Nations
Educational, Scientific and
Cultural Organization

Organización
de las Naciones Unidas
para la Educación,
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Mexico
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Exploring Frameworks for

TropicalForest Conservation

Integrating Natural and Cultural Diversity for Sustainability, a Global Perspective

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Published in 2018 by the UNESCO Office in Mexico, Presidente Masaryk 526, Polanco, 11560, Mexico City, Mexico, in collaboration with the Ecology Institute, Camino Antiguo a Coatepec, El Haya, 91070 Xalapa Enríquez, Veracruz.

ISBN: 978-607-7579-79-3

Original idea, concept, coordination and supervision of the editing and publication: The UNESCO Office in Mexico.

Conception, Edition and General Coordination of the project:
Nuria Sanz, Head and Representative, UNESCO Office in Mexico

Editorial work:
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Graphic and cover design:
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The UNESCO Office in Mexico would like to thank to Professor Robin Dennell,
member of the Scientific Committee of the World Heritage Thematic Programme HEADS.

Printed in Mexico.

Editor
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Exploring Frameworks for

Tropical Forest Conservation

Integrating Natural and Cultural Diversity for Sustainability. A Global Perspective

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The Ifugao agrocultural system: bridging culture and nature to enhance tropical biodiversity

Abstract

The Ifugao agrocultural system offers a means to better understand the sustainability of indigenous agricultural ecology and promises to contribute to successful practices in the maintenance of biodiversity in the tropics. Similar to other agricultural systems in Southeast Asia, the complexity of Ifugao agriculture can be considered an agroecosystem, where agricultural, ecological, and cultural institutions are intertwined. Recent archaeological work in the region suggests a more recent origin of wet-rice cultivation, as late as ca. 300 BP, which coincided with the arrival of the Spanish. Forest management and wet-taro cultivation, however, appear to have been practiced by the Ifugao as early as ca. 600 BP. Microbotanical and macrobotanical analyses indicate that Ifugao have been utilizing forest resources and clearing forest cover long before the adaptation of wet-rice cultivation. Investigating the Ifugao agrocultural practices provides an opportunity to look into a living agricultural system where components are interrelated and integrated into economic, political, and religious spheres. Moreover, the Ifugao system presents a case study to address agricultural problems, economic and ecological sustainability of current farming systems, and their implications on state agricultural policies.

Introduction

Rice terraces dominate the landscape in Ifugao, Philippines (Figure 1). However, the success and maintenance of the Ifugao agricultural system is based on the complementarity of paddy-field rice cultivation with swidden fields and managed forests (Acabado 2012a). Customarily, the Ifugao agricultural system is guided by integrated patterns of mixed farming that include the management of private forests (*muyung*), communal forests (*hinuob*), swidden (*uma*) cultivation of sweet potatoes, pond-field cultivation of rice, inter-cropping of many secondary domesticates (i.e. sweet potatoes, potatoes, cabbage, and other cash crops), and the raising of pigs, chickens, and other livestock (Conklin 1980, p. 36). As such, although rice terraces dominate the Ifugao landscape, their agricultural system is considered as complementary system (Rambo 1996) since swiddening, agroforestry, and irrigated rice pond fields are interlinked by ecological and cultural facets.

An illustration of Ifugao agricultural strategies is presented in Figure 2: within a particular watershed, several types of land use categories make up the agricultural system (Table 1). Two types of forest cover: *hinuob*: upslope public forest often composed of open access communal areas; *muyung*: privately owned woodlots and managed with definite boundaries; *uma* (swidden): unirrigated slopeland, cultivated with root crops (usually, sweet potatoes); *latangan* (house terrace): residential site; *na-ilid* (drained field): levelled terraced area for cultivation and drainage of dry crops such as sweet potatoes and legumes; and, *payoh* (irrigated rice field): levelled, terraced farmland, bunded to retain water.

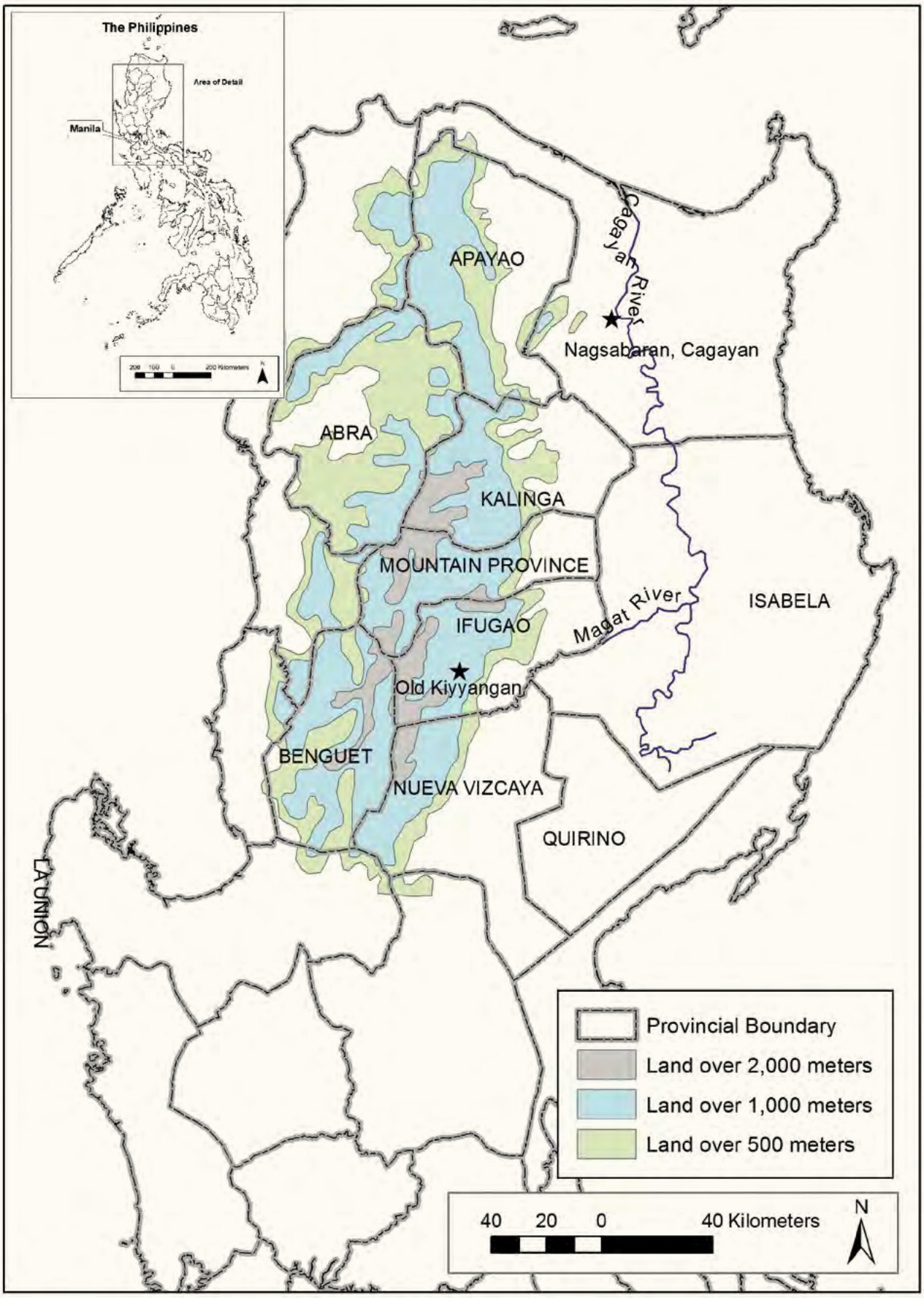

Figure 1. Map of the northern Philippines.

Figure 2. The Ifugao terrace ecology

In Ifugao society, rice is both economically and ritually valued. In fact, the amount of rice land holdings is one of the bases for an individual's social standing (wealth and prestige). The Ifugao also prefer to eat rice than sweet potatoes, which grown on swidden fields. Harold Conklin (1980) and Peter Brosius (1988) observed that sweet potato provides more than half of the starch requirements of the Ifugao during the period of their studies (between 1960 and 1980) (Conklin 1967, 1980). This explains the prestige value of rice in Ifugao culture. With this in mind, we would expect that the distribution of swidden fields in the Ifugao environment would be inversely correlated to the distribution of rice terraces (under the assumption that Ifugaos reserve their more productive/irrigable agricultural lands for rice production), but spatial data and ethnographic (Acabado 2012b) suggest otherwise. We argue that since rice and its associated cultural materials are prestige-based; swidden fields provide more carbohydrate than rice produced in the terraces (Acabado 2015). The existence of managed forests also augments the system by providing forest products that serve as alternative source of livelihood – in addition to its role in the Ifugao ecology.

The uniqueness of the Ifugao rice terracing tradition rice terraces became the basis for its listing in the UNESCO's List of World Heritage in 1995. This listing recognizes the "…absolute blending of the physical, socio-cultural, economic, religious, and political environments… indeed, it is a living cultural landscape of unparalleled beauty" (UNESCO N.D.). Not only are the rice terraces a testimony to the ingenuity and intelligence of the Ifugao in their transformation of this mountainous landscape, but they also represent an enduring balance of the environment and the cooperative ability of the entire Ifugao community to develop and sustain the terraces. The terraces are not just productive habitats for village sustenance, they are also the sites for ritual practice that integrates and sustains the social fabric of the Ifugao. Moreover, they are the anchor for a diverse and productive environment that involves communal forest lands, taro and other wetland crops, and a complex agro-ecosystem that includes multiple cropping of herbs, a finely tuned annual cycle, zoning and

planning, and livestock production as part of a system regulated by religious rituals and cooperative social organization.

The Ifugao Rice Terraces was included on the World Heritage List in recognition of its Outstanding Universal Value under criteria (iii), (iv), and (v) (Table 2). The terraces were considered cultural landscapes that "…are illustrative of the evolution of human society and settlement over time, under the influence of physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal" (Operational Guidelines of the 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage).

In this paper, we present the importance of understanding subsistence patterns to better manage tropical biovidersity. Intensive cultivation systems are known to contribute to the reduction of biodiversity, but the Ifugao agricultural system appear to enhance species diversity by providing various ecological niches, even in the paddy-fields. Particularly, we focus on the role of the Ifugao agrocultural system in the maintenance of the Ifugao landscape, cultural identity, and biodiversity.

Land use		
Local Term	Land Usage	Description
Magulon	Grassland	exposed ridge and slope land; untilled; with low herbaceous grasses; public (in any given region); unmanaged; minimal value; source of roof thatch, game; not cultivated without new irrigation sources; usually far from densely inhabited areas
'Inalāhan	Forest	slopeland; undisturbed soil, naturally woody cover; public (for residents of same watershed region); unmanaged; source of firewood, forest products, game.
Mabilāu	Caneland	(high grassland, cane grassland, secondary growth *Miscanthus* association): mostly slopeland, unworked soil, covered with various stages of second-growth herbaceous and ligneous vegetation dominated by dense clumps of tall canegrass; some protection and management (canegrass much used for construction, fencing, etc.).
Muyung	Woodlot	slopeland; unturned soil; covered with high tree growth (timber and fruit trees, climbing rattans, etc.); privately owned and managed (some planting of tree, vine, and bamboo types), with definite boundaries; valued for timber, other products, and protection of lower farmland from runoff and erosion.
Uma	Swidden	slopeland, cultivated and often "contour-ridges" heavily planted with sweet potatoes; moderately intercropped (including rice below 600-700 m); discrete temporary boundaries for cultivation period of several years.
Latāngan	House Terrace	leveled terrace land; surface smooth or paved but not tilled; primarily house and granary yards; workspace for grain drying, and so forth; discrete, often fenced or walled.
Na'īlid	Drained Field	leveled terrace land, surface ditched and mounded (usually in cross-contoured fashion) for cultivation and drainage of dry crops such as sweet potatoes, legumes; discrete boundaries, privately owned; kept in this temporary state for a minimum number of seasons before shifting to permanent form of terrace use.
Payoh	Pond Field	leveled, terraced farmland, bunded to retain water for shallow inundation of artificial soil; carefully maintained for cultivation of wet-field rice, taro, and other crops; privately owned, discrete units, permanent stone markers.

Table 1. Land use categories in Ifugao, Philippines (from Acabado 2015)

A number of scholars (e.g. Butic and Ngidlo 2003; Camacho et al. 2012; Camacho et al. 2016) have argued for the active application of indigenous knowledge in biodiversity conservation. All of these cited references have referred to the Ifugao muyung as the classic example of how local knowledge can contribute to sustainable conservation programs. Undeniably, the Ifugao agroforestry management has become the symbol for an effective ecological conservation.

As a case study that highlights the success of the Ifugao agroecological system, particularly, the practice of muyung agroforestry management, we re-analyze and present survey data obtained by the Project Management Office, Globally Important Agricultural Heritage Systems, Department of Environment and Natural Resources, Cordillera Administrative Region, Philippines from the Municipality of Hungduan, in the Province of Ifugao (GIAHS 2011). Data presented in this paper is part of a larger research program that aimed to provide quantitative assessment of the biodiversity index of the Ifugao agirultural system. In this paper, we only focused on three Ifugal land use categories: muyung (privately-owned woodlots), uma (swidden fields), and payoh (rice terraces).

The Ifugao

The term Ifugao refers both to the province and the ethnolinguistic group who traditionally inhabit the region. There are five main Ifugao groups: *Ayangan, Tuwali, Yattuka, Kalanguya, and Keley-i.* They are separated by social and poitical boundaries, each trying to be distinct from the other yet bound by a common identity, that of being Ifugao - people of *Pugaw* or the Earthworld, a realm in their cosmos inhabited by mortal beings. These different Ifugao groups may have slight differences in language and practices but such variations are more exceptions than the general rule.

The Ifugao, as a group, are one of the most studied ethnoliguistic group in the Philippines mainly because pioneer American anthropologists focused their work among the Ifugao. At the turn of the twentieth century

Criterion	Description
(iii)	The rice terraces are a dramatic testimony to a community's sustainable and primarily communal system of rice production, based on harvesting water from the forest clad mountain tops and creating stone terraces and ponds, a system that has survived for two millennia.
(iv)	The rice terraces are a memorial to the history and labour of more than a thousand generations of small-scale farmers who, working together as a community, have created a landscape based on a delicate and sustainable use of natural resources.
(v)	The rice terraces are an outstanding example of land-use resulting from a harmonious interaction between people and their environment which has produced a steep terraced landscape of great aesthetic beauty, now vulnerable to social and economic changes.

Table 2. UNESCO criteria for the inclusion of the Ifugao Rice Terraces into the World Heritage List.

two prominent figures in Philippine anthropology, Roy Barton and Henry Otley Beyer, began their decades long investigation of the Ifugao. It is these two scholars who initially proposed the 2000-3000-year old origin for the Ifugao rice terraces, using observations and qualitative speculations on how long it would have taken the Ifugao to modify the rugged topography of the area (Barton 1919; Beyer 1955). This 'long history' has become the dominant narrative that found its way into textbooks and national histories. On the other hand, several scholars have proposed a more recent origin of the Ifugao rice terraces (i.e. Keesing 1962; Lambrecht 1967; Acabado 2009, 2012a). Using evidence from lexical information, ethno-historic documents, and archaeological data, these studies suggest that the terraced landscapes of the Ifugao are the end-result of population expansion into the Cordillera highlands in response to Spanish colonization. Lowland-mountain contacts even before the Spanish arrival might have facilitated the movement of lowland peoples to the highlands when the Spanish established bases in their locales.

Previously thought to be at least 2,000 years old, archaeological work has now established that the rice terraces were a response to the incursion of Spanish colonization in the Magat Valley lowlands to the northeast in the 17th century (Keesing 1962; Acabado 2009, 2010, 2012a). The rice terraces may have been developed in already pre-adapted pond fields originally developed for taro and other wetland farming (Acabado 2012a). Other components of this complex community farming system include the maintenance of communal forests in the highlands, common lands for other highly bio-diverse plantings of forbs, and integration of swine and water buffalo into the subsistence and ritual patterns of the community.

Radiocarbon dates from terrace studies indicate the antiquity of rice farming in the terraces no earlier than the late 16th century (Acabado 2009, 2010a, 2010b, 2012a, 2012b, 2012c, 2015, 2017) and that fields in the early settlement of Kiyyangan (Kiangan, Ifugao) were most likely wetland agricultural pondfields for the cultivation of taro. These pondfield systems nonetheless prepared terrain and waterways for the development of rice terraces as accommodation and resistance to Spanish control of the people and resources of the region by escaping into mountain refugia. Macrobotanical data have shown that the Ifugao who settled the Old Kiyyangan Village were exploiting timber resources for house construction and source firewood as early as 1350 CE. We surmise that forest clearance also started during this period, but intensified soon after Spanish colonization. Ifugao agroforestry management would have develop after the shift to wet-rice cultivation.

As opposed to other upland areas in the Philippines, the Cordillera Region has not experienced massive settlement by migrant lowland populations (for discussions, refer to Cruz et al. 1986; Kerkvliet 1979). Ifugao Province, in particular, is still dominated by Ifugao themselves. This population composition is one of the main reasons why deforestation is not a big problem in Ifugao. Whereas population movements in other parts of the Philippines were related to lowland farmers being pushed to the uplands (Eder 2006; Fujisaka 1986; Olofson 1983, 1985), the long history of resistance against outsiders allowed the Ifugao to endure the flow

of non-Ifugao migrants. The culture of resistance also provided the impetus for the Ifugao to continue practicing their indigenous agroecological system.

Muyung: Forest Management Practice of the Ifugao

An important aspect of Ifugao agricultural terrace ecology and maintenance is the land use category of *muyung/pinugo*, or privately owned woodlots. These woodlots serve as the watershed of a particular terrace system and are invaluable for terraces whose primary source of water are the springs located in these woodlots. Although hydrologic studies (Hamilton and King 1983) in the last three decades suggest that heavy forest cover would actually result in more usage of groundwater, these woodlots protect low-lying fields from runoffs and erosion, and maintain supply of surface and irrigation water (through cloud-intercept), stabilizes relative humidity, improve soil's nutrients and physical and chemical properties (Bruijnzeel 1990; Saberwal 1997). Indeed, increases in logging activities in the vicinity of Banaue in the early 1980s accelerated runoffs and evapotranspiration, intensifying Ifugao's water shortage during the dry season (Eder 1982).

The addition of carving industry in the Ifugao economic base after the 2nd World War and intervention of the national government in forest conservation negatively affected the management of the *muyung/pinugo* system (Sajor 1999). These carvings are sold locally, especially in the tourist town of Banaue. Although the carving industry itself was not a problem, Philippine national policies on logging disrupted the local Ifugao forest management system. Previously, the Ifugao were able to access and obtain logs from their community's *muyung/pinugo*, whilst properly observing indigenous regulations on logging. The total log ban imposed by the Philippine national government, however, prevented them from accessing their wood supply. Since woodcarving became a lucrative economic alternative for the Ifugao, and with the lack of access to an easily available wood supply, the carving industry became an impetus for illegal logging activities in the *muyung/pinugo* system. The uncontrolled logging in the *muyung/pinugo* system has devastated some of the terrace systems in Ifugao. Undeniably, agroforestry and agricultural ecological issues stand out in discussion of the Ifugao landscape.

The Ifugao's *muyung* system stands out among indigenous silviculture, horticulture and soil and water conservation methods. To ensure sustainable water supply for the rice fields, the Ifugao manages forestlands as watersheds and agro-forests through an efficient assisted natural regeneration (ANR) system. They successfully practiced ANR long before its recognition in the forestry sector as a strategy for forest regeneration. The Ifugao attributes value to the forest on the basis of their cultural ways and practices (Butic and Ngidlo, 2003).

Adopting agroforestry in woodlots and multiple cropping in swidden farms, the Ifugao ensured another economic source in case of crop failure in the terraces. Fruit bearing trees, coffee trees, bananas, rattan for handicrafts, wood

for carving, medicinal herbs and mushrooms, bamboos of different kinds are just a few of the assortments found in the muyung. Edible rattan (*Calamus manillensis*) is also included in almost all woodlots. Rattan is integrated in woodlots for its edible fruits and poles/canes for handicraft (Rondolo, 2001). The Ifugaos have been using ANR quite successfully without professional intervention for many years. Activities in the muyung include thinning, cleaning, pruning and salvage cutting (Camacho et al. 2012). These activities are done to enhance the growth and development of natural stands. In addition, harvesting of timber crops is highly selective by nature. Selection is based on the muyung owner's extensive knowledge of the various tree species and their uses. According to Rondolo (2001), the Ifugaos have their own plant classification system. Plants are classified based on taxo-morphological characteristics and according to use. The Ifugaos' knowledge of rattan classification is more detailed and accurate than most formally trained botanists.

Muyung and the Rice Terraces

Not much has been written about the interdependence of the terraces and its surrounding forests yet the Ifugaos know that one cannot exist without the other. The local concept of forests being "tudung di payo" (literally translates to "shield of the rice fields") connotes a very wide synergy of the Ifugao's natural environment and his rice terracing culture. In both ritual and practical day-to-day activities, the forest plays a significant role in the sustainable cultivation of the fields below it. Among the landed *kadangyan* or the local nobility, the transfer of terraced fields necessitates the transfer of its mandatory accessories including heirloom jars, rice granaries and its very own muyung. These accessories are called *unnud di payo*, that which follows the rice field. By custom law, the muyung, being *unnud di payo,* can only be inherited by the heir to whom the principal rice field is bequeathed.

The muyung serves as a buffer zone for the terraces in more aspects than one. The mountainous topography of the rice terraces makes it very vulnerable to even uneventful climatic conditions. During summer when water is scarce, the thick muyung canopy provides shade that minimize the drying up of the numerous fresh water springs that the terraces depend on for irrigation. During the wet season, sufficient forest cover is effective in preventing soil run-off that could otherwise cause siltation of pond fields and rivers. Soil nutrients from decaying foliage in the underbrush constantly fertilize low-lying terraces when brought down the slopes during downpours, minimizing the need for synthetic fertilizer inputs. Other than that, the muyung harbors diverse flora relied upon by Ifugaos for their biological pest-control methods, dye sources, medicine and others.

Before the onset of modern construction materials and even today, the muyung are a reliable source of housing and other construction materials. The wood carving industry of the Ifugaos on the other hand has been sustained by the muyung since the tourism boom in the 1970s without causing irreversible damage to the integrity of the forest as a fine example of managed biodiversity. In fact, the national government

through the Department of Environment and Natural Resources' Memorandum Circular No. 96-02 exempts muyungs from the coverage of the total log ban being implemented in the country, thereby recognizing the sustainability of this indigenous forest management system. In case of failure of crops in the terraces, muyung resources are a reliable source of alternative income for terrace farmers.

Ifugao Indigenous Forest Management

While the term muyung refers generally to woodlots, Ifugaos identify two kinds of forests based on management and property rights. The first type of Ifugao forest is the muyung or pinugu, owned and managed by a single family, passed down from earlier generations or purchased from other families based on strict rules of custom law. The second type is the Inalahan or communal forest owned and managed by a village (boble). This second type of forest usually defines boundaries and hunting grounds of neighboring villages where propriety rights are exclusive to the village to whom stewardship has been vested since time immemorial. The inalahan cannot be subjected to sale or any form of encumbrance by anyone. Both types of forests are in their nature, private properties under Ifugao custom law; a conflict point given national laws of the Philippine following the antiquated Regalian Doctrine where it states that all lands belong to the State - public property. At this point, we would like to emphasize that indigenous peoples' concept of communal lands is not the same as public property.

The muyung system is the only indigenous forest management practices that government recognized; thus owners can acquire a Muyung Resources Permit (MRP) from the Department of Environment and Natural Resources (DENR) through the issuance of Memorandum Circular No.96-02. Through this permit, Ifugao communities can lay claim over the trees they planted in their muyung, thus encouraging them to manage, conserve, protect and preserve their muyung or forest.

Biodiversity in the Ifugao Agroecological System

The Ifugao agroecological system illustrates how indigenous knowledge contributes to the maintenance of biodiversity. Among the Ifugao, the various land-use (Table 2) categories exhibit varying degrees of floral and faunal species densities. As mentioned above, intensive agricultural systems tend to reduce species diversity since such systems, by definition, favors single-cropping. To understand the relationships between the different land use categories and the role of managed forests in Ifugao, a survey conducted by the Project Management Office, Globally Important Agricultural Heritage Systems, Department of Environment and Natural Resources, Cordillera Administrative Region, Philippines, provided a baseline data on the success of Ifugao agroecological system. Combining a bottom-up approach (focus group discussions) and pedestrian survey, the project provided qualitative and quantitative indices

of biodiversity in the town of Hungduan, Ifugao. The GIAHS-DENR survey team conducted a larger study, but we are only using small segment of their datasets, which are enough to highlight the importance of indigenous/local ecological management systems.

To determine the floral diversity in the Ifugao agroecological system, the GIAHS survey team obtained data from multiple land use categories in the municipality of Hungduan in Ifugao Province. Data from two muyung systems, three uma fields, and two payoh systems were obtained to establish biodiversity levels in the respective land use categories. Standard biovidersity indices were used in the investigations: Species Richness (R), Number of Individuals (N), Shannon-wiener Diversity Index (H'), Simpson's Index (D), Shannon's Equitability Index, and Sørensen's Similarity Index (IS).

Muyung flora assessment

As mentioned above, muyung are privately-owned woodlots by families who are also the owners of nearby rice terraces. The muyung tree-cover, which is located on top of a terraced slope, provide protection against run-off and are sources of wood for fuel, timber for house construction, traditional medicine, and wood for carving. Most farmers consider the muyung as a watershed that provides water for the terraces, and it is now widely understood that the forest cover actually uses more water (Bruijnzeel 1990; Saberwal 1997). In the Poblacion muyung, 10 indigenous tree species were identified and recorded. Talanak (*Alstronea candolleana*), Tabangawon (*Weinmania hutchinsonii*), Umug (*Clethra canascens*), Dulnuan (*Glochidion sp.*) and Amumuhong were the dominant tree species, with Importance Values of 86.7265, 33.9198, 28.2997, 16.0557 and 15.7004, respectively (Table 3) (GIAHS 2011, p. 17). It also has a diverse understorey vegetation, with 24 documented species. The dominant species with their respective summed dominance ratio values as shown in Table 4 are

SPECIES	DENSITY	RELATIVE DENSITY (%)	RELATIVE DOMINANCE	IMPORTANCE VALUE	RANK
Talanak (*Alstronea candolleana)*	21	32.3077	54.4188	86.7265	1
Tabangawon (*Weinmania hutchinsonii)*	12	18.4615	15.4583	33.9198	2
Umug (*Clethra canascens*)	13	20.0000	8.2997	28.2997	3
Dulnuan (*Glochidion sp.*)	6	9.2308	6.8249	16.0557	4
Amumuhong*	6	9.2308	6.4696	15.7004	5
Gutmo (*Syzygium sp.*)	2	3.0769	3.2940	6.3710	6
Hauili (*Ficus septica*)	2	3.0769	2.0776	5.1545	7
Halinghingon (*Eurya amplexicaulis*)	1	1.5385	2.0776	3.6161	8
Tibig (*Ficus nota*)	1	1.5385	0.6889	2.2274	9
Gahatan(*Cryptocarya sp.*)	1	1.5385	0.3875	1.9260	10

Table 3. Muyung timber Inventory within the GIAHS Project Site at Barangay Poblacion, Hungduan, Ifugao (* Local name) (adapted from GIAHS 2011, p. 18).

SPECIES	RELATIVE DENSITY	RELATIVE FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Cyperus sp	14.4737	9.7561	19.3517	1
Baksi (*Melastoma malabathricum)*	14.4737	7.3171	18.1322	2
Umug (*Clethra canscens)*	11.8421	9.7561	16.7202	3
Sword fern (*Nephrolepis hirsutula*)	13.8158	4.8780	16.2548	4
Fern-Kilob (*Dicranopteris linearis)*	5.9211	4.8780	8.3601	5
Halinghingon (*Eurya amplexicaulis)*	5.9211	2.4390	7.1406	6
Atilba *(Viburnum luzonicum*)	3.2895	4.8780	5.7285	7
Betel nut (*Areca catechu)*	1.9737	7.3171	5.6322	8
Fern *(Sticherus sp.)*	1.9737	7.3171	5.6322	9
Rono (*Mischantus sinensis*)	3.2895	2.4390	4.5090	10
Malatabako (*Elephantopus mollis)*	3.2895	2.4390	4.5090	11
Musa sp.	3.2895	2.4390	4.5090	12
Macaranga dipterocaprifolia	1.9737	4.8780	4.4127	13
Binunga *(Macaranga tanarius)*	2.6316	2.4390	3.8511	14
Fern (*Blechnum orientales)*	1.3158	4.8780	3.7548	15
Fern (*Sphenomeris sp.*)	1.3158	2.4390	2.5353	16
Acorus calamus	1.3158	2.4390	2.5353	17
Poa sp.	1.3158	2.4390	2.5353	18
Wikstromea sp.	1.3158	2.4390	2.5353	19
Tree fern (*Cyathea ontaminans)*	1.3158	2.4390	2.5353	20
Kulo-kulot *(Urena lobata)*	1.3158	2.4390	2.5353	21
Balangbang *(Medinilla speciosa)*	1.3158	2.4390	2.5353	22
Vine	0.6579	2.4390	1.8774	23
Hawili (*Elaeoarpus pendulus)*	0.6579	2.4390	1.8774	24

Table 4. Understorey Vegetational Analysis of Muyung with GIAHS sites at Poblacion, Hungduan, Ifugao (adapted from GIAHS 2011, p. 18).

Cyperus sp. (19.3157), *Melastoma malabathricum* (18.1322), *Clethra canascens* (16. 7202), *Nephrolepis hirsutula* (16.2548) and *Dicranopteris linearis* (8.3601) (GIAHS 2011, p. 17).

The muyung in Brgy. Nungulunan, on the other hand, provided fifteen (15) tree species (Table 5). Similar to the Poblacion muyung, the Brgy. Nungulunan muyung has a diverse understorey vegetation with 38 recorded species (Table 6). The dominant species with their respective Summed Dominance Ratio (SDR) values are Gepas or Paniki tea (18.2147), ferns species namely: Leather leaf fern (17.5203), Kilob (6.5799), sword fern (3.8806) and Balangbang (3.6499) (GIAHS 2011, p. 19).

SPECIES	DENSITY	RELATIVE DENSITY (%)	RELATIVE DOMINANCE	IMPORTANCE VALUE	RANK
Gutmo (*Syzygium myrtoides*)	20	29.8507	60.1689	90.0196	1
Bini*	10	14.9254	8.3191	23.2445	2
Hawili (*Elaeoarpus pendulus*)	6	8.9552	13.6743	22.6295	3
Galiwgowon (*Antidesma leptocladum*)	10	14.9254	6.9841	21.9094	4
Binakal	4	5.9701	1.2263	7.1965	5
Tungor (*Ardisia ap.*)	3	4.4776	1.9700	6.4476	6
Carmomohong*	3	4.4776	0.7268	5.2044	7
Tukong (*Rubus sp.*)	2	2.9851	1.2872	4.2723	8
Chacop*	1	1.4925	2.5049	3.9974	9
Balete (*Ficus benjamina*)	2	2.9851	0.7119	3.6970	10
Butec*	2	2.9851	0.5436	3.5287	11
Colocong*	1	1.4925	0.7349	2.2275	12
Anatap*	1	1.4925	0.4349	1.9274	13
Mongmogong*	1	1.4925	0.4349	1.9274	14
Latpeng(*Ficus variegate syrcomoides*)	1	1.4925	0.2783	1.7709	15

Table 5. Result of Timber Inventory for Muyung within the GIAHS Project Site at Barangay Nungulunan, Hungduan, Ifugao (* Local name).

SPECIES	DENSITY	FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Gepas/Paniki tea (*Sacandra glabra*)	355	100	18.2147	1
Leatherleaf fern (*Selaginella sp.*)	355	80	17.5203	2
Kilob (*Dicranopteris linearis*)	125	40	6.5799	3
Alolokdo/Sword fern (*Nephrolepis cordifolia*)	60	40	3.8806	4
Balangbang (*Medinilla speciosa*)	21	80	3.6499	5
Wild strawberry (*Rubus niveus*)	15	80	3.4007	6
Coleus sp.	25	60	3.1215	7
Gutmo (*Vaccinium whitfordii*)	14	60	2.6647	8
Rono(*Mischantus sinensis*)	30	40	2.6347	9
Tungor*	7	60	2.3740	10
Palm grass (*Curculigo palmifolia*)	23	40	2.3440	11
Ivy plant(*Philodendron sp.*)	5	60	2.2910	12
Galiwgiwen (*Antidesma leptocladum*)	18	40	2.1364	13
Fern (*Pteris sp.*)	16	40	2.0533	14
Atilba (*Viburnum luzonicum*)	8	40	1.7211	15
Bini*	8	40	1.7211	16
(*Clethra canscens*)	7	40	1.6796	17
Payong-payong (*Cyperus iria*)	7	40	1.6796	18
Dalingdingan (*Hopea foxworthyi*)	7	40	1.6796	19
Cyperus sp	5	40	1.5965	20
Macaranga sp.	5	40	1.5965	21
Grass (*Brachiaria sp.*)	4	40	1.5550	22

Unknown(moss like)	15	20	1.3174	23
Orchid (*Bulbophylum sp.*)	15	20	1.3174	24
Pugad lawin (*Asplenium nidus*)	13	20	1.2343	25
Anablon (*Macaranga sinensis.*)	7	20	0.9851	26
Tabangawon (*Weinmania hutchinsonii*)	6	20	0.9436	28
Hapon (*Crassocephalum crepidioides*)	5	20	0.9021	29
Fern (*Araiostegia davalloides*)	5	20	0.9021	30
Binakal*	4	20	0.8606	31
White orchid (*Orchis purpurea*)	3	20	0.8190	32
Malagawed (*Piper sp.*)	2	20	0.7775	33
Higop (*Hoya sp.*)	2	20	0.7775	34
Orchid (*Bulbophylum sp.*)	2	20	0.7775	35
Galamay bakes (*Schefflera odorata*)	2	20	0.7775	36
Balanti (*Homolanthus sp.*)	2	20	0.7775	37
Gabi-gabi (*Alocasia sp.*)	1	20	0.7360	38

Table 6. Understorey Vegetational Analysis of Muyung with GIAHS sites at Nungulungan, Hungduan, Ifugao (*Local names) (adapated from GIAHS 2011, p. 20).

Swidden fields (uma)

For most of the inhabitants of upland areas, shifting cultivation has been an integral part of their way of life. Its practice involves the rotation of fields between short periods of cropping and longer periods of fallowing. Although it has many forms (Thrupp et al. 1997; Spencer 1966; Conklin 1957), burning seems to be one of its unifying and indispensable aspects (Conklin 1959; Peters and Neunschwander 1988).

Shifting cultivation is also referred to as swidden cultivation especially in the anthropological literature. In many popular literatures, "slash-and-burn," which is a derogatory term, describes tropical subsistence systems practiced by indigenous populations and is assumed to be a primitive subsistence strategy. Studies, however, show that peoples who engage in this type of farming are not primitive either in technology or in culture (Peters and Neuenschwander 1988), and their geographic distribution is not historically limited to the tropics. Although most of swiddeners today are located in the tropics, the term swiddening is an Old English term that means "burned clearing" (Ekwall 1955; Izikowitz 1951; Conklin 1957).

In Ifugao, swiddening is an essential part of their way of life. As described by Conklin (1980, p. 24) and Acabado (2012b, 2015), shifting cultivation is a form of complementary partial swidden farming. All of the Ifugao villages have access to swidden land and no community relies solely on swidden cultivation. *Uma* fields are established in burned clearings on hillsides, usually too steep or unsuited for irrigated terracing. Fields are cropped for about three years and then fallowed for two or three times that period.

SPECIES	Relative Cover	RELATIVE HEIGHT	RELATIVE FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Camote (*Ipomea batatas*)	355	100	18.2147	15.1157	1
Raintree (*Samanea saman*)	355	80	17.5203	7.5911	2
Alagacy (*Leucosyke capitellata*)	125	40	6.5799	5.5056	3
Uoko (*Mikania cordata*)	60	40	3.8806	5.4101	4
Jackfruit (*Artocarpus heterophylla*)	21	80	3.6499	5.0082	5
Puriket (*Bidens pilosa*)	15	80	3.4007	4.6341	6
Pallang (*Psophocarpus tetragonolobus*)	25	60	3.1215	4.2515	7
Atelba (*Viburnum luzonicum*)	14	60	2.6647	4.0967	8
Pegion *pea* (*Cajanus cajan*)	30	40	2.6347	3.7602	9
Buntot pusa (*Pennisetum polystachyon*)	7	60	2.3740	3.7602	10
Sitao (*Phaseolus sp.*)	23	40	2.3440	3.7168	11
Anablo* (*Wikstroemia sp.*)	5	60	2.2910	3.4332	12
Bulakmanok (*Ageratum conyzoides*)	18	40	2.1364	3.3450	13
Rono (*Mischantus sinensis*)	16	40	2.0533	3.2871	14
Braken fern (*Pteridium aquilinum*)	8	40	1.7211	3.0715	15
Pineapple (*Ananas comosus*)	8	40	1.7211	2.8219	16
Piwis (*Ficus benguetensis*)	7	40	1.6796	2.8139	17
Perpon (*Acalypha wilkesiana*)	7	40	1.6796	2.7338	18
Conyza Canadensis	7	40	1.6796	2.0822	19
Sword fern (*Nephrolepis cordifolia*)	5	40	1.5965	1.8495	20
Hapon (*Crassocephalum crepidioides*)	5	40	1.5965	1.6950	21
Wild orchids (*Orchis purpurea*)	4	40	1.5550	1.6947	22
Mutha (*Cyperus rotundus*)	15	20	1.3174	1.5399	23
Hulape (*Paspalum conjugatum*)	15	20	1.3174	1.5225	24
Saluyot (*Corchorus olitorius*)	13	20	1.2343	1.5176	25
Makahiya lalaki (*Mimosa invisa*)	7	20	0.9851	1.2990	26
Vines	6	20	0.9436	1.2816	27
Gatas-gatas (*Euphorbia hirta*)	5	20	0.9021	1.1612	28

Table 7. Vegetational analysis for the Habal area in Sitio Hubot, Hungduan, Ifugao. (*Local name) (adapted from GIAHS 2011, p. 27).

The GIAHS survey sampled three: Sitio Hubot, Poblacion, Hungduan; Barangay Abatan, Hungduan; and, Nungulunan, Hungduan. The third site was on fallow (*ublag*) while the first two were actively cultivated. The swidden field in Sitio Hubot, Poblacion, had twentyeight (28) plants species within the transect lines (Table 7). Sweet potato or camote (*Ipomea batatas)* predominated the field; this was followed by *Samanea saman, Leukosyke capitellata, Mikania cordata* and *Artocarpus heterophylla.* (GIAHS 2011, p. 26).

The site at Brgy. Abatan had 42 diverse species of forest trees saplings, weeds, and agro-crops (Table 8). During the survey, the field was under crop rotation and was being prepared for the next cropping season. Five species dominated the field, namely, Anablon Rono, Gutmo, Tanghad, and Cassava (GIAHS 2011, p. 27)

SPECIES	RELATIVE COVER	RELATIVE HEIGHT	RELATIVE FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Anablon (*Macaranga sinensis)*	12.4660	23.6821	4.5977	13.5819	1
Rono (*Mischantus sinensis)*	10.7661	18.5016	6.8966	12.0548	2
Gutmo (*Vaccinium whitfordii)*	9.0662	20.7218	2.2989	10.6956	3
Tanghad (*themeda gigantea)*	7.0263	15.0381	3.4483	8.5042	4
Cassava (*Manihot esculenta)*	4.9864	11.8410	4.5977	7.1417	5
Palayen (*Lithocarpuc sulittii)*	4.5331	14.0612	2.2989	6.9644	6
Baksi (*Melastoma malabathricum)*	4.5331	8.4367	3.4483	5.4727	7
Braken fern(*Pteridium aquillinum*)	3.7625	6.5126	4.5977	4.9576	8
Alnus(*Alnus maritima)*	4.5331	7.4006	1.1494	4.3611	9
Wild strawberry (*Rubus fraxinifolius)*	3.3998	7.2526	2.2989	4.3171	10
Sedge (*Carex sp.)*	2.0399	6.3646	3.4483	3.9509	11
Tabangawen*	2.7199	7.4006	1.1494	3.7566	12
Tree fern (*Cyathea contaminans)*	2.2665	7.4006	1.1494	3.6055	13
Alolokdo/Sword fern (*Nephrolepis hirsutula)*	1.4279	5.4765	3.4483	3.4509	14
Atilba (*Virburnum luzonicum)*	2.7199	5.0324	2.2989	3.3504	15
Unknown species	3.3998	5.3285	1.1494	3.2926	16
Puriket (*Bidens pilosa)*	1.0879	3.6411	4.5977	3.1089	17
Buhlong (*Antidesma pentandrum)*	1.6999	4.7364	1.1494	2.5286	18
Camote (*Ipomea batatas)*	4.0798	0.9769	2.2989	2.4518	19
Aguingay (R*ottboellia exaltata)*	2.0399	3.5523	1.1494	2.2472	20
Hagonoy (*Chromolaena odorata)*	0.8160	2.8122	2.2989	1.9757	21
Hulape (*Paspalum conjugatum)*	1.5866	0.6217	3.4483	1.8855	22
Bulakmanok (*Ageratum conyzoides)*	0.6346	1.5689	3.4483	1.8839	23
Baguio beans (*Phaseolus vulgaris)*	0.4533	3.5523	1.1494	1.7183	24
Uuko (*Mikania cordata)*	0.5893	0.8289	3.4483	1.6222	25
Conyza Canadensis	0.8160	1.5393	2.2989	1.5514	26
Hapon (*Crassocephalum crepidioides)*	0.5440	1.6281	2.2989	1.4903	27
Kulo-kulot (*Urena lobata)*	0.6800	1.4801	2.2989	1.4863	28
Balbas kalabao (*Sphorobolus indicus)*	1.1333	1.9242	1.1494	1.4023	30
Mimosa sp.	0.4080	0.7993	2.2989	1.1687	31
Grass (*Brachiaria sp*)	0.3853	0.6513	2.2989	1.1118	32
Violet flower	0.3400	0.6513	2.2989	1.0967	33
Unknown (violet flower)	0.3400	0.6513	2.2989	1.0967	34
Bayabang/Sword fern	0.2040	0.7401	2.2989	1.0810	35
Fern (*Sphenomeris sp.)*	0.6800	0.7401	1.1494	0.8565	36
Ageratina adenophora	0.3173	0.8289	1.1494	0.7652	37
Gallingsoga parviflora	0.4080	0.4736	1.1494	0.6770	38
Pilea sp.	0.1360	0.3552	1.1494	0.5469	39
Takim baka (*Sida acuta)*	0.1360	0.2368	1.1494	0.5074	40
Tridax procumbens	0.1133	0.2368	1.1494	0.4999	41
Payong-payong (*Cyperus iria)*	0.0907	0.2368	1.1494	0.4923	42

Table 8. Vegetational analysis for habal/umah (swidden farm) at Brgy. Abatan, Hungduan, Ifugao (* Local name)

(adapted from GIAHS 2011, p. 28).

SPECIES	RELATIVE COVER	RELATIVE HEIGHT	RELATIVE FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Dumduma/Wisak (*Neonauclea media*)	9.9114	16.4855	4.7619	10.3863	1
Tuai (*Bischofia javanica*)	9.3284	15.1521	3.1746	9.2184	2
Hagonoy (*Chromolaena odorata*)	7.8125	12.2672	6.3492	8.8096	3
Alagaw (*Prema odorata*)	6.9963	15.7582	3.1746	8.6430	4
Buhuit/Wild strawberry (*Rubus* sp) spsp) fraxinifolius)	6.9963	13.6975	4.7619	8.4852	5
Talahib (*Saccharum spontaneum*)	5.1306	9.0913	3.1746	5.7988	6
Cogon (*Imperata cylindrica*)	5.1306	6.4245	4.7619	5.4390	7
Balete (*Ficus benjamina*)	4.6642	7.2730	1.5873	4.5082	8
Baksi/Botgui (*Melastoma* sp) malabathricum)	3.3815	6.6669	3.1746	4.4077	9
Lapteng (*Ficus* sp.)	4.5476	6.0609	1.5873	4.0652	10
Hauili (*Ficus septica*)	3.9179	4.8487	3.1746	3.9804	11
Rono (*Mischantus sinensis*)	4.0812	5.5760	1.5873	3.7481	12
Malatabako (*Elephantopus mollis*)	1.7957	3.2244	4.7619	3.2607	13
Ipil-ipil (*Leucaena leucocephala*)	3.1483	4.8487	1.5873	3.1948	14
Guava (*Psidium guajava*)	1.1660	6.0609	1.5873	2.9381	15
Tanghad(*Themeda gigantea*)	2.3321	4.4850	1.5873	2.8015	16
Hulape (*Paspalum conjugatum*)	3.1017	0.3394	4.7619	2.7343	17
Marapait (*Tithonia diversifolia*)	2.3321	4.2426	1.5873	2.7207	18
Alolokdo (*Nephrolepis hirsutula*)	1.1194	2.1334	4.7619	2.6716	19
Botbotones (*Hyptis capitata*)	0.6996	3.5153	3.1746	2.4632	20
Balbas kalabaw (*Sphorobolus* sp.)	2.7985	2.4243	1.5873	2.2700	21
Balanti (*Mallotus mollissimus*)	2.2155	2.9092	1.5873	2.2373	22
Hapon (*Crassocephalum crepidioides*)	0.4431	1.1152	3.1746	1.5776	23
Coconut orchid (*Spathoglottis* sp.)	1.2826	1.8183	1.5873	1.5627	24
Takim baka (*Sida acuta*)	0.4664	1.0182	3.1746	1.5531	25
Fern (*Sphenomeris* sp.)	1.0494	1.9395	1.5873	1.5254	26
Bangbangsit (*Euphatorium* sp.)	1.1660	1.8183	1.5873	1.5239	27
Conyza canadensis	0.5830	1.0910	1.5873	1.0871	28
Lantana (*Lantana camara*)	0.2799	1.0910	1.5873	0.9860	29
Puriket (*Bidens pilosa*)	0.3498	0.6061	1.5873	0.8477	30
Makahiya lalaki (*Momosa* sp.)	0.2332	0.4849	1.5873	0.7685	31
Bulakmanok (*Ageratum conyzoides*)	0.1399	0.3394	1.5873	0.6889	32
Botbotones (*Cyperus kyllingia*)	0.2799	0.1939	1.5873	0.6870	33
Bayabang (*Nephrolepis codifolia*)	0.1632	0.2424	1.5873	0.6643	34
Tridax sp.	0.1166	0.2424	1.5873	0.6488	35
Grass (*Brachiaria* sp.)	0.1166	0.1939	1.5873	0.6326	36
Gatas-gatas (*Euphorbia hirta*)	0.1166	0.1939	1.5873	0.6326	37
Payong payong (*Cyperus iria*)	0.1866	0.1212	1.5873	0.6317	38
Martial law vine (*Mikania cordata*)	0.1866	0.1212	1.5873	0.6317	39
Amorseko (*Chrysopogon aciculatus*)	0.2332	0.0727	1.5873	0.6311	40

Table 9. Vegetational analysis for habal/umah (swidden farm) at Brgy. Nungulunan, Hungduan, Ifugao (* Local name) (adapted from GIAHS 2011, p. 29).

The third site, which was on fallow, had 40 documented species (Table 9) dominated by *Neonauclea media* saplings with SDR of 10.3863. *Bichofia javanica*, *Chromolaena odorata, Prema odorata* and *Rubus fraxinifolius* were the other dominant species (GIAHS 2011, p. 29.

Rice Terraces (payoh)

Rice terraces dominate the Ifugao landscape but are interdependent ecologically and socially with the muyung and the uma systems. The rice paddies are privately-owned and are one of the main measures of an individual's prestige in the community. The payoh is constructed mainly for wet-rice, but other crops are also cultivated on and around the paddy field (e.g. taro). Since paddy fields are essentially intensified systems, they tend to focus on a single crop but also provide the ecology for weeds that have the same environmental needs as wet-rice varieties. Thus, we expect to find various grasses in the irrigated terraces.

The GIAHS survey team obtained their samples from two sites: rice terraces at Poblacion, Hungduan and at Brgy. Hapao, Hungduan. As expected, both of the sites were dominated by *Oryza sativa* (Tables 10 and 11).

SPECIES	RELATIVE DENSITY	RELATIVE FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Rice (*Oryza sativa)*	43.5746	6.9444	25.2595	1
Payong-payong (*Cyperus iria)*	8.5672	6.9444	7.7558	2
Puriket (*Bidens pilosa)*	9.3058	5.5556	7.4307	3
Put-putod (*Equisetum ramosissimum)*	4.4313	4.1667	4.2990	4
Marapagay (*Echinochloa cruzgalli)*	2.9542	5.5556	4.2549	5
Balakbak (*Ludwigia octovalis)*	2.6588	5.5556	4.1072	6
Fern (*Christella sp.)*	2.8065	4.1667	3.4866	7
Bulakmanok (*Ageratum conyzoides)*	2.2157	4.1667	3.1912	8
Sedges (*Scirpus grossus*)	2.6588	2.7778	2.7183	9
Cogon (*Imperata cylindrica*)	2.2157	2.7778	2.4967	10
Gabi (*Colocasia esculenta*)	1.1817	2.7778	1.9797	11
Maiden hair fern (*Adiantum caudatum*)	1.1817	2.7778	1.9797	12
Botones (*Hyptis brevipes*)	1.1817	2.7778	1.9797	13
Bonga-bonga (*Alternanthera sessilis*)	1.0340	2.7778	1.9059	14
Takip kuhol (*Centella asiatica*)	1.0340	2.7778	1.9059	15
Palang (*Psophocarpus tetragonolobus*)	0.4431	2.7778	1.6105	16
Galliang (*Cryptosperma merkusii*)	1.4771	1.3889	1.4330	17
Mutha (*Cyperus rotundus*)	0.7386	1.3889	1.0637	18
Samsamon (*Themeda triandra*)	0.7386	1.3889	1.0637	19
Kamama (*Drynaria cordata*)	0.7386	1.3889	1.0637	20
Pilea melastomoides	0.7386	1.3889	1.0637	21
Camote (*Ipomea batatas*)	0.7386	1.3889	1.0637	22
Hulape (*Paspalum conjugatum*)	0.7386	1.3889	1.0637	23
Boto-botones (*Hyptis capitata*)	0.7386	1.3889	1.0637	24

Paragis (*Eleusine indica*)	0.7386	1.3889	1.0637	25
Gabing-uwak (*Monochoria vaginalis*)	0.4431	1.3889	0.9160	26
Sirau-sirau (*Fibritylis littoralis*)	0.4431	1.3889	0.9160	27
Tayngang daga (*Oxalis corniculata*)	0.4431	1.3889	0.9160	28
Perpon (*Acalypha wilkseana*)	0.4431	1.3889	0.9160	29
Hapon (*Crassocephalum crepidioides*)	0.4431	1.3889	0.9160	30
Tukod manok (*Synedrilla nodiflora*)	0.4431	1.3889	0.9160	31
Rumex acetosella	0.2954	1.3889	0.8422	32
Malasampalok (*Phyllanthus ninuri*)	0.2954	1.3889	0.8422	33
Grass (*Digitaria sp*)	0.2954	1.3889	0.8422	34
Cassava (*Manihot esculenta*)	0.2954	1.3889	0.8422	35
Uoko (*Mikania cordata*)	0.2954	1.3889	0.8422	36
Malacelery (*Allium sp.*)	0.2954	1.3889	0.8422	37
Palm grass (*Curculigo palmifolia*)	0.2954	1.3889	0.8422	38
Marapait (*Tithonia diversifolia*)	0.1477	1.3889	0.7683	39
Siling labuyo (*Capsicum frutescens*)	0.1477	1.3889	0.7683	40
Pedped (*Engelhardia colebrookeana*)	0.1477	1.3889	0.7683	41

Table. 10. Payoh vegetational Analysis for in Poblacion, Hungduan, Ifugao (from GIAHS 2011, p. 31).

SPECIES	RELATIVE DENSITY	RELATIVE FREQUENCY	SUMMED DOMINANCE RATIO	RANK
Bulakmanok (*Ageratum coyzoides*)	12.5604	9.2593	10.9098	1
Puriket (*Bidens pilosa*)	10.8696	5.5556	8.2126	2
Cogon (*Imperata cylindrica*)	9.6618	5.5556	7.6087	3
Marapagay (*Echinochloa cruzgalli*)	9.1787	5.5556	7.3671	4
Hulape *Paspalum conjugatum*)	8.4541	3.7037	6.0789	5
Balakbak (*Ludwigia octovalis*)	4.5894	5.5556	5.0725	6
Pilea melastomoides	4.3478	3.7037	4.0258	7
Kamama (*Drynaria cordata*)	3.1401	3.7037	3.4219	8
Gabing uwak (*Monocharia vaginalis*)	3.1401	3.7037	3.4219	9
Siksik parang (*Borreria ocymoides*)	4.8309	1.8519	3.3414	10
Conyza canadensis	2.4155	3.7037	3.0596	11
Payong-payong (*Cyperus iria*)	1.9324	3.7037	2.8180	12
Fern (*Pteris vitata*)	1.6908	3.7037	2.6973	13
Uoko (*Mikania cordata*)	0.9662	3.7037	2.3349	14
Unknown sp.	0.7246	3.7037	2.2142	15
Rice seedlings (*Oryza sativa*)	2.4155	1.8519	2.1337	16
Poa sp	2.4155	1.8519	2.1337	17
Kamote (*Ipomea batatas*)	3.1401	1.8519	2.4960	18
Hapon (*Crassocephalum crepidiodes*)	2.4155	1.8519	2.1337	19
Tibig (*Ficus nota*)	0.4831	3.7037	2.0934	20
Galliang (*Cryptosperma merkusii*)	1.9324	1.8519	1.8921	21
Lupo-lupo (*Alternanthera sp.*)	1.2077	1.8519	1.5298	22
Fern (*Christella dentata*)	1.2077	1.8519	1.5298	23
Malacelery (*Allium sp.*)	1.2077	1.8519	1.5298	24

Gabi (*Colocacia esculenta)*	1.2077	1.8519	1.5298	25
Poa annua	0.7246	1.8519	1.2882	26
Digitaria sp	0.7246	1.8519	1.2882	27
Hyptis sp.	0.4831	1.8519	1.1675	28
Onion leeks *(Allium sp)*	0.4831	1.8519	1.1675	29
Takip kuhol (*Centella asiatica)*	0.4831	1.8519	1.1675	30
Cassava (*Manihot esculenta)*	0.4831	1.8519	1.1675	31
Marapait (*Tithonia diversifolia)*	0.4831	1.8519	1.1675	32

Table 11. Post harvest vegetational analysis of a payoh in Hapao, Hungduan, Ifugao (from GIAHS 2011, p. 32).

Concluding Remarks

The Ifugao agroecological system provides an excellent case where intensified agricutural system enhances biodiversity. Data from the GIAHS survey show that the Ifugao agroecological system tends to increase biodiversity because of indigenous ecological landscape management (Table 12). The survey also shows that the muyung contains most of the indigenous tree species in the region. As a managed forest, owners who are responsible for the upkeep of the forest patches favors native species as part of cultural norms and traditional ecological knowledge.

Similar to previous work that argued for the sustainability – and high biodiversity – of swidden fields (Anderson 1993; Conklin 1957; Dove 1985; Spencer 1966), the Ifugao uma has also exhibited the highest biodiversity index in the Ifugao agrocultural system. Although cultivars have changed due to market demands and cultural preference, swidden fields in Ifugao have hosted a diverse set of species, and have been demonstrated to be a sustainable practice. The Ifugao swiddening tradition counteracts the government's official policy that describes swiddening as destructive, thus prohibiting the practice.

Data presented in this article contribute to the now established thought that local knowledge systems should be tapped to maintain or enhance biodiversity. Although political and economic pressures persist, local communities are able to make decisions that matter to them – socially and ecologically. Rice terraces, and in general, the Ifugao agroecological system is maintained because of its cultural value rather than their economic returns. The main threat to biodiversity in the region is the burden to produce cash crops, which would covert forest cover into cultivable areas. Introduction of invasive species has also contributed to the threat vulnerability of the ecosystem (Castonguay 2014). Conservation programs that do not include local realities to the plans further add to the deterioration of biodiversity and heritage. As a case in point, conservation programs in Ifugao are heavily focused on infrastructure repair (irrigation canals, collapsed terrace walls) and recently, developing markets for *tinawon* varieties. The cultural foundation of agricultural production has been

LAND-USE	Sampling Sites	No. of Individuals (N)	Species Richness (SR)	Shannon's Diversity Index (H')	Shannon's Equitability Index (EH)
Muyung/Forest (Timber)	Poblacion	65	10	1.7136	0.7442
	Nungulunan	67	15	1.9103	0.7044
	Abatan	28	18	2.755	0.9533
Muyung/Forest (Understorey)	Poblacion	152	24	2.8805	0.9064
	Nungulunan	1204	38	3.0728	0.8447
	Abatan	963	32	2.8719	0.8287
	Abatan Falls	38	38	3.221	0.8758
Habal/Ublag (Swidden Farm)	Poblacion	28	28	3.1217	0.9360
	Abatan	42	42	3.3785	0.8982
	Nungulunan (Ublag)	40	40	3.3477	0.9075
Payoh (Rice Terraces)	Poblacion	677	41	3.1064	0.8365
	Hapao	414	32	3.2293	0.9318

Table 12. Biodiversity indices for various Ifugao land use categories from GIAHS sampled areas in Hungduan, Ifugao (adapted from GIAHS 2011, p. 36).

largely ignored, and the unintended consequences to Ifugao customary culture have been magnified (Acabado and Martin 2015).

In recent decades, the National Irrigation Administration (NIA), a state agency, has taken the lead in the maintenance of irrigation systems in Ifugao. This activity is associated with funds provided by the national government. Although it is still the farmers who carry out the repairs and maintenance of the system, they are paid monetarily by the project. This has immense implications in the sustainability of the Ifugao agricultural system as the basic socio-political dynamic that has regulated the social and ecological fabric of the Ifugao has been eroded. NIA sponsored a project to convert the Ifugao irrigation system into concrete structures in Hapao, Hungduan in 2003. The principle behind the structural change was conceived by engineers who thought that concrete irrigation channels require less maintenance than earthen structures. Most of the workers who were hired to help with the constructions were local farmers. They were paid monetarily, based on the prevailing wage standards. However, a few weeks after the completion of the project, a typhoon caused several small landslides that buried segments of the system. The local farmers could not muster enough workers as farmers were waiting for the national government to pay them to repair the damaged portions of the system. In the summer of 2012, the system is still inoperable.

Conservation programs in Ifugao, and elsewhere, should give primacy to Traditional Ecological Knowledge. As reinforced by the data provided in this essay, local knowledge and perceptions are invaluable in developing and implementing sustainable programs. As the nature of production in the region is increasingly leaning towards the market economy, the need for a bottom up approach to biodiversity

conservation has never been more crucial. The recognition by the national government of effective indigenous forest management systems and customary practices on natural resources management needs to be translated into policies that would effectively integrate age-old knowledge in contemporary environmental conservation initiatives.

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