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Review: Types of socioecological production landscapes of the Philippines based on dominant biodiversity: status, problems and future directions

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Abstract. *Buot IE Jr, Buhay AFV. 2022. Review: Types of socioecological production landscapes of the Philippines based on dominant biodiversity: status, problems and future directions. Biodiversitas 23: 3755-3770.* The dominance of human activities in socioecological production landscapes (SEPLs) known as biocultural landscapes in some literature, results in the overutilization of natural resources and loss of critically important biodiversity, either cultivated or wild. The anthropocentric perspective prevailing at this time of the Anthropocene Epoch, disrupts the traditional harmonious human-nature relationship in biocultural landscapes, particularly, the socioecological production landscapes (SEPLs) known as *satoyama* landscapes in Japan. This adversely affects biodiversity and hence, ecosystem services in surrounding communities in the Philippines and beyond. In this paper, SEPLs, biocultural landscape and *satoyama* are used interchangeably to refer to landscapes where human culture has greatly influenced the resulting biodiversity of a landscape. This study provides an overview of the SEPLs in the Philippine context. It reviews and furthers the inquiry in a previous study which identified examples of *satoyama* landscapes or SEPLs in the Philippines based on the main crop or dominant biodiversity. The objectives of the current paper are to present an updated list of SEPLs in the Philippines based on the main crop or dominant biodiversity; determine its status and problems; analyze its role in sustainable development and map future directions to sustain a harmonious human-nature relationship that would result to an abundance of biodiversity and overflowing ecosystem services. The local and international scientific literature on the status and problems of the identified SEPLs in the Philippines were reviewed. Results indicated that in addition to the three types identified by Buot and Osumi in 2004, nine more were included in this paper. The 12 SEPLs types identified were classified according to their main crop, namely: rice in muddy walled or stone-walled terraces; rice mixed with other crops; corn; vegetables, sweet potato, gabi/taro; cassava; coconut; coffee; cacao; tobacco; and rice-fish. These SEPLs contribute to various Sustainable Development Goals (SDGs), either directly or indirectly. Incidentally, there are prevailing problems observed such as exploitation of natural resources due to the increasing population of migrants in the upland as a result of poverty. Simultaneously, the indigenous sustainable practices were weakened with the aging population while the youth showed a lack of interest in farming, leading to biodiversity loss and cultural erosion. Strategic actions including strengthening institutional partnerships, empowering indigenous communities, sustainable management of natural resources, and ensuring good governance and equitable sharing of resources are discussed. These steps will ensure biodiversity conservation and harmonious living in Philippine SEPLs.

Keywords: Biocultural landscapes, biodiversity conservation, production landscapes, *satoyama*, socioecological systems, sustainable development

INTRODUCTION

Biodiversity is under threat nowadays. In fact, environmental experts and scientists would agree that global biodiversity loss has been at an unprecedented rate in the last century (Millennium Ecosystem Assessment, 2005). Many protection and conservation projects have been proposed, yet these measures have not been enough to halt or even reduce the rate of biodiversity loss (Duraiappah and Nakamura 2012; Larsen et al. 2015; Heywood 2017). Human exploitation, rapid urban development, coupled with the impacts of invasive species, among others, continue to threaten biodiversity. Moreso, the known to be rich biodiversity in developing countries is pressured by population increase and poverty, triggering local communities to overconsume natural resources (Squires 2014; Buot 2021). On the other hand, some biologically and culturally rich landscapes are abandoned and left unmanaged, resulting in similar biodiversity decline (Duraiappah and Nakamura 2012; Raatikainen et al. 2017). These overarching problems at the regional and global scale should be given immediate attention. Hence, experts are searching for concepts and approaches to help save the remaining biodiversity on earth in a more sustainable manner.

In 2007, Hong defined biocultural landscapes as a dynamic land where the local's ecological knowledge is applied in utilizing natural resources, particularly, biodiversity, as well as the locals' cultural practices to develop the land. The agelong coexistence of man and nature systems led to the coined term "biocultural landscape". Hence, such areas where various land cover including upland forest, lowland vegetation and agricultural areas have been aligned to the local communities' cultural values and management systems.

Examples of a biocultural landscape can be found all over the world. One globally known example recognized by the Conference of the Parties (COP) of the Convention on Biological diversity (CBD) as an initiative to conserve biodiversity is the *satoyama* (Berglund et al. 2014; Buot and Osumi 2004; Morimoto 2011). This is a landscape covered with patches of farmlands, forests, grasslands, and local communities, generally seen in rural areas of Japan (Buot 2008; Fukamachi and Yukihiro 2011). These are areas with good human-nature interaction resulting in favorable environmental conditions and high biodiversity, as well as a variety of ecosystem services.

Since there were various names around the world that were similar to the characteristics of *satoyama*, the International Partnership for the *satoyama* (IPSI) coined an all-encompassing term called socio-ecological production landscapes. IPSI defined Socio-Ecological Production Landscapes or SEPLs as "dynamic mosaics of habitats and land uses where the harmonious interaction between people and nature maintains biodiversity while providing humans with the goods and services needed for their livelihoods, survival and wellbeing in a sustainable manner" (IPSI, 2012). Essentially, SEPLs is a biocultural landscape. Hence, in this paper, biocultural landscapes, *satoyama* and SEPLs are used interchangeably.

In the Philippines, biocultural landscapes have been in existence for over hundreds of years. The local northern landscapes in Ifugao, known as *muyong*, consist of forest patches with adjacent rice paddies, also locally known as *payoh*. These and other agricultural areas are located along the hillside, adjacent to human settlements. In nearby localities, *pinuchu* or *pinugo* is the term used to refer to forests (Santiago and Buot 2018a; Serrano and Cadaweng 2005). Other local names related to SEPLs in the Philippines are *lakon/batangan/saguday* (Mountain Province), *lasang or bungtod* (Cebu), and *gubat* (Southern Luzon and Bicol), among others, depending on the dialect of each locality (Buot 2008, 2014; Molintas 2004; Bagsit and Jimenez 2015). The *muyong* system has been part of the traditional practices of the Ifugaos and has been managed and cultivated for subsistence farming, fuelwood, sources of raw materials for construction, wood handicrafts and other non-wood products. This terraced landscape located in Banaue, Ifugao is well-known as the Ifugao Rice Terraces (IRT). It is renowned for its rich traditions and aesthetic and cultural value, hence, it has been included as one of UNESCO's World Cultural Heritage sites and FAO's Globally Important Agricultural Heritage Systems (GIAHS).

According to Buot and Osumi (2004), there are three *satoyama*-like landscape types found in the Philippines. These can be distinguished according to the dominant agricultural crop. First is the *satoyama* landscape with rice as the main crop; the second is dominated by mixed rice and other crops such as coconuts, banana, coffee and other important cash crops, and the third is characterized as farms with corn as the main crop (Buot and Osumi 2004; Buot 2008; Buot 2014; Buot and Rabena 2020). However, the Philippine SEPLs are threatened due to population pressure brought by rapid migration to the uplands of families suffering from poverty and land policy (Buot and Osumi 2004). Human activities have profoundly influenced and shaped ecosystems and landscapes through the centuries (Médail 2017). The human impacts have affected biodiversity and other ecological processes (Mace et al. 2012; Concepción et al. 2015; Wardle 2016). Other than the stress from anthropological activities, considerable additional threats, such as increasing human demands, rapid urbanization, industrialization, and climate change, to name a few, are constant challenges in achieving biodiversity conservation and sustainable living.

Areas pressured by human activities are moderated through this concept of living in harmony with nature. In well-functioning SEPLs, the local community engages in livelihood activities wherein the interaction between people and the environment maintains or enhances biodiversity. This in turn becomes beneficial to the environment and the human society, including their wellbeing, when biodiversity conservation is achieved. The local people's effort in adapting to the changing environment while reaping its goods and services from one generation to the next developed sustainable landscapes. Many papers (Aguilar et al. 2021; Bélair et al. 2014; Buot 2014; Buot 2008; Buot and Osumi 2004; Kalindekafe et al. 2000; Kamada 2017; Serrano et al. 2019; Takeuchi 2001), noted that such harmonious interaction in SEPLs is diminishing with pressures characterizing the Anthropocene Epoch, aggravating climatic changes and anomalies. This disruption in the harmony of the human-nature interaction adversely affects biodiversity and hence, ecosystem services in surrounding communities in the Philippines and beyond.

This paper provides an overview of the SEPLs in the Philippine context. The objectives of this paper include, 1) to provide an updated list of SEPLs in the Philippines, 2) to analyze the role of SEPLs in sustainable development in agriculture and natural resources, 3) to determine the status and problems of the Philippine SEPLs, and 4) map future directions of Philippine SEPLs.

DATA COLLECTION

This paper reviews the local and international scientific literature on the status and problems of the identified SEPLs in the Philippines. The focus was on the status and problems as described by the authors. Each paper was analyzed and synthesized. The main search engine used was Google Scholar, using keywords, such as 'socioecological landscapes in the Philippines,' ' *satoyama* Philippines,' 'Production Landscapes,' 'biocultural landscapes, 'agricultural landscapes,' 'traditional rural landscapes,' 'traditional agroforestry systems in the Philippines,' and the like. Other reputable scientific literature was also retrieved from the Research Gate website, journal article repositories such as Science Direct, Taylor and Francis, Wiley and Sons, and the official website of the International Partnership for the *satoyama* Initiative (IPSI), and some government institutions.

UPDATED LIST OF BIOCULTURAL LANDSCAPES OF THE PHILIPPINES

Table 1 provides an updated list of biocultural landscapes or socioecological production landscapes (SEPLs) in the Philippines. In addition to the 3 types identified by Buot and Osumi (2004), nine more are included in this paper. The first three types, rice, *Oryza sativa* L. as the main crop (Figure 1), mixed rice and other crops, and corn, *Zea mays* L. as the main crop) Table 1 is well discussed in the paper of Buot and Osumi (2004). Understandably, rice, *Oryza sativa* being a staple in the Philippines and in many parts of Asia, has been the main crop in many SEPLs (Suneetha et al. 2018; UNU-IAS 2015, Buot, 2014; Duraiappah et al. 2012; IPSI, 2012; Buot and Osumi 2004; Oku and Fukamachi 2000). The range of varieties used is from the most common to the rarest heritage rice in many indigenous communities. Common rice varieties are used by most farms throughout the Philippines while the heirloom rice is used in Banaue, Mayoyao, Kiangan, Hungduan and many parts of Ifugao, Mountain Province and other provinces with actively engaged indigenous farming populations (Santiago and Buot 2018b).

In the highlands of northern Luzon Island, a unique type of SEPL has been documented (Buot 2014; Buot 2007; Buot and Okitsu 1998, 1999). Vegetables such as cauliflower (*Brassica oleracea* var, *botrytis* L.) broccoli, (*Brassica oleracea* var. *italica* L.), lettuce (*Lactuca sativa* L.*)*; potatoes, (*Solanum tuberosum* L.); pepper (*Capsicum annuum* L.) and many others, serve as the main crop in farms located along the slopes in high elevations (2000-2300 m above sea level) of Mt. Pulag and Mt. Akiki (Figure 2). People daily nurture their vegetables for the family and the extra harvests are sold in the market. On the other hand, according to Baliton et al. (2020) the vegetables that are cultivated in the lowlands of Quezon are bitter gourd (*Momordica charantia* L.), lima bean (*Phaseolus lunatus* L.), pole sitao (*Vigna sesquipedalis* L.), pigeon pea (*Cajanus cajan)* and bottle gourd (*Lagenaria siceraria)*.

In the uplands of Bicol peninsula, Mountain Province and Bataan, local communities are into sweet potato farming system (Guiriba 2019; Lirag 2019; Abas 2014). Sweetpotato *(Ipomoea batatas* L.*)* is cultivated in the rainfed terraced fields along mountain sides, riverbanks, mountain slopes of swidden farms as well as in home gardens (1000-1400m above sea level) in Mountain Province (Kwiatkowski 2013). In Bicol, it is also cultivated in *satoyama* landscapes (Guiriba 2019; Lirag 2019). Sweetpotato is recorded to be cultivated in the sloping uplands of Bataan (Balilla et al. 2012). Large farms of sweet potato are found in the rainfed flatlands of Tarlac, Pampanga and Zambales (Flores et al. 2016; Jarzebski, 2016). Sweetpotato is a common staple among mountain villages besides being served as snack food in many places and cultures in the southeast and east Asia. It is high in nutritional value (Padmaja et al. 2012; Rumbaoa et al. 2009; Truong et al. 2018) and relatively easy to grow (Gatto et al. 2021; Flores et al. 2016).

Figure 1. Rice as the main crop in this typical *satoyama* landscape in the northern Philippines' Ifugao Rice Terraces. (Photo by UPOU Mitsui Project)

Table 1. Main plant biodiversity in the updated socioecological landscapes or *satoyama* landscapes in the Philippines

SEPLs Type	Locality	Sources
1. Landscape with rice (*Oryza sativa* L.) (common or heirloom) as the main crop in muddy walled or stone walled terraces	Ifugao, Sarangani Province,	Buot and Rabena (2020) Serrano et al. (2019) Santiago and Buot (2018) Prasad et al. (2017) Zapico et al. (2015) Buot (2014) Buot and Osumi (2004)
2. Landscape with mixed rice (*Oryza sativa* L.) and other crops	Quezon, Bicol region, Leyte	Serrano et al. (2020) Buot and Osumi (2004)
3. Landscape with corn (*Zea mays* L.) as the main crop	Cebu, Sarangani Province	Aguilar et al. (2021) Amper et al. (2018) Buot and Osumi (2004)
4. Landscape with vegetables as main crop (Cordillera highlands and in Nueva Vizcaya and Quezon)	Benguet, Ifugao and Nueva Vizcaya, Quezon	Baliton et al. (2020) Guzman et al. (2017) Buot (2014) Buot (2007) Buot and Okitsu (1998, 1999)
5. Landscape with sweetpotato (*Ipomea batatas)* as main crop	Bohol, Camarines Sur, Mountain Province, Bataan, Tarlac, Pampanga, Zambales	Guiriba (2019) Lirag (2019) Cabahug et al. (2018) Flores et al. (2016) Abas (2014)
6. Landscape with gabi/taro (*Colocasia esculenta*) as main crop	Batanes, North Cotabato, Palawan, Benguet, Mindoro	de Guzman et al. (2014) Balangcod and Vallejo (2013) Matthews et al. (2012)
7. Landscape with cassava (*Manihot esculenta*) as main crop	Bukidnon, Lanao del Sur, Negros Occidental, Misamis Oriental, Bohol, Cotabato, Isabela, Zamboanga del Sur	Bavor (2016) Calica and Ceynas (2015) De Lara et al. (2016) Cerilles (2015)
8. Landscape with coconut (*Cocos nucifera*) as main crop	Batangas, Bukidnon, Quezon, Lanao del Norte and Bicol Region	Moreno et al. (2020) Ruales et al. (2020) Vallaser et al. (2020) Dar (2019) Gurbuz and Manaros (2019) Bouquet (2017)
9. Landscape with coffee (*Coffea arabica*) as main crop	Iloilo, Cavite, Benguet, Quezon Province, Kalinga	Baliton et al. (2020) Anciro et al. (2020) Nelson et al. (2019) Tad-Awan et al. (2013)
10. Landscape with cacao (*Theobroma cacao*) as main crop	Palawan, Davao	Paguntalan et al. (2020) Villason and Olguera (2020) Chandra et al. (2017) Huesca (2016) Quilloy (2015) Dressler et al. (2012) Sopsop and Buot (2011a, b) Dressler and Pulhin (2010)
11. Landscape with tobacco (*Nicotiana tabacum)* as main crop	La Union, Pangasinan, Cebu, Iloilo	Appau et al. (2019) Rubinyi (2014) Subade et al. (2014) Acda and Cabangon (2013) Estoque et al. (2012)
12. Landscape with rice-fish farming system	Cavite, Pampanga and Bulacan, Ifugao, Laguna	Salas et al. (2016) Hu et al. (2015) Miao (2019) Bajet et al. (2012) Halwart et al. (2012)

The *Tagbanua* tribe in Palawan mostly cultivates gabi (*Colocasia esculenta* L.) on their farms and home gardens for subsistence. This is a different kind of SEPL. Similarly, locals in North Cotabato also plant gabi for their own

consumption (Matthews et al. 2012). The indigenous group in Batanes, called the *Ivatans*, engages in a root crop-based farming system including gabi together with yam, (*Dioscorea alata* L.*)* and sweet potato (*Ipomoea batatas* L.). This system is practiced all year round to maintain food security during typhoon season (de Guzman et al. 2014). In Mindoro, the ethnic group called *Hanunuos* practice the indigenous farming system of planting root crops like taro and yam. Some wild species of gabi are found in the steep mountain slopes of Palawan and in the neighboring forest of Benguet (Balangcod and Vallejo 2013; Bulanda 2015). Wild gabi was also documented to be abundant on the lower slopes of Mt. Apo in North Cotabato, where large patches of gabi are found on stream banks and grasslands (Matthews et al. 2012). Many locals use the tuber of gabi as a rice substitute while its leaves are usually cooked with meat or blanched as a side dish (Balangcod and Vallejo 2013).

Another unique SEPL in the Philippines is where cassava is the dominant crop. Cassava (*Manihot esculenta)* was considered an important crop in farms located at Bukidnon (Jomoc et al. 2013), Lanao del Sur (Rascal et al. 2012) and Negros Occidental (Mendoza et al. 2020). In Bohol, cassava is the known main crop found in steeply sloping areas (Bavor 2016). Likewise, cassava is grown in the uplands from 400-500 masl of Misamis Oriental (Gonzaga et al. 2019). In Cotabato, large farmlands are cassava-based and commonly produced as an ingredient for animal feeds (Calica and Ceynas 2015; De Lara et al. 2016). It was considered essential produce in most root crop-based farms in Philippine *satoyama*. Mainly because of its ability to grow in highly degraded soils, particularly in soils with low fertility and high acidity. Hence, cassava is a suitable crop for intensive agricultural activity (Gatto et al. 2021; Bull et al. 2011).

Generally, farm landscapes in Quezon and Bicol regions are dominated by coconut (Boquet 2017). Moreover, coconut (*Cocos nucifera* L.) is not difficult to propagate. It can grow in different land types from coastal areas to the steep slopes of the uplands. Coconuts are known for their various uses from food to construction materials. Hence, many multiple cropping systems applied by local farmers in Luzon Island are composed of coconut multi-cropped with banana, just like in Batangas, as seen in figure 3. This is also true in Cavite, due to the crop's productivity and profitability (Parreño-de Guzman et al. 2015). While typhoon-prone areas like Albay and Leyte employ indigenous farming practices like coconut-based vegetable farms as protection for immature plants from heavy rainfall (Moreno et al. 2020; Ruales et al. 2020; Narvaez 2019).

The next identified *satoyama* type is where coffee (*Coffea arabica)* (Cabactulan and Collantes 2022) is the dominant crop. The *Suludon* and *Ati* ethnic groups located in the mountainous area of Iloilo, have been employing a coffee-based farming system intercropped with bananas (Nelson et al. 2019). This agroforestry system is also evident in Kalinga, in Cavite (Anciro et al. 2021) and in higher elevations of Quezon province (Baliton et al. 2020), Cavite (Cubillo 2016) and Benguet (Tad-awan et al. 2013). Coffee-based cropping systems are commonly cultivated and intercropped by subsistence farmers with annual crops. This is to diversify the food supply for families and stabilize the annual agricultural yield (Cubillo 2016).

Figure 2. Vegetables as the main crop in a *satoyama* landscape in the northern Philippines' Mount Akiki slopes (Photograph by IE Buot Jr)

Figure 3. Coconut-based landscape mixed with banana in Batangas (Photograph by AFV Buhay)

Followed by coffee dominant *satoyama* is another tree-crop-based landscape where the primary crop is cacao (*Theobroma cacao L.*). There are cacao farms located in Davao (Quilloy 2015; Villason and Olguera 2020). Cacao-based farms are also documented around the *guba* or *giba*, the local term for old-growth forest in Palawan (Sopsop and Buot 2011a, b; Dressler and Pulhin 2010). The *Tagbanuas*, an ethnic community in Palawan engage in cacao-based farming systems, to move their attention from shifting cultivation. Cacao is commonly planted below tall mature trees or intercropped in an agroforestry farm (Conservation Alliance 2013).

Another identified distinctive type of SEPL is *satoyama* with tobacco (*Nicotiana tabacum* L.*)* as the main crop. It was documented in Cebu that tobacco is cultivated as the main crop component in an indigenous agroforestry farming system called *Naalad.* This is applied specifically during the dry season. Tobacco-based farms were also recognized in La Union and Pangasinan where women oversee its propagation (Acda and Cabangon 2013). Tobacco-based subsistence farms are also located in the low mountain ranges of Isabela, heavily cultivated by the local tribe called *Ibanags* (Peters 1987).

The last on this list is the *satoyama* landscape with rice as main crop mixed with aquaculture-product mostly fish, while some also have shrimp, crabs and turtles with soft shells (Hu et al. 2015). Although this is not widely practiced in the Philippines, *Ifugaos* are also known in rice-fish farming culture (Ananayo and Richins 2016), similar agri-aquaculture farms were documented near the swamps connecting Pampanga and Bulacan (Salas et al. 2016). This practice is known as a replacement for rice monoculture because the rice-fish system is observed to produce greater yield (Hu et al. 2015 Bhattacharyya et al. 2013; Ahmed and Turchini 2021). According to Abubakar (2015), the fish also consumes the pests that fall off from the rice or that attach to its stem.

ANALYZING THE ROLE OF BIOCULTURAL LANDSCAPES IN SUSTAINABLE DEVELOPMENT IN AGRICULTURE AND NATURAL RESOURCES

To analyze the role of biocultural landscapes or SEPLs in sustainable development, the authors identified the ways in which each SEPLs or *satoyama* landscapes contribute to addressing the 17 sustainable development goals (SDGs) of United Nations Development Programme (UNDP). Table 2 shows a list of landscapes and their direct and indirect contributions, followed by a brief description of each type.

The identified direct contributions of rice-based SEPLs located in the Cordilleras are no poverty (SDG 1), zero hunger (SDG 2), climate action (SDG 13) and life on land (SDG 15). These contributions to SDGs can be observed from the influences of traditional farming systems being practiced among the terraced rice paddies. Local or indigenous rice varieties are produced from traditional farming practices and are evident to be resilient to pests, diseases and for climate impacts, hence considered an effective strategy to climate change adaptation (Setboonsarng and Gregorio 2017). Therefore, increased harvest and secure food supply while conserving biodiversity are attained.

Table 2. Direct and indirect contributions of SEPLs to Sustainable Development Goals (SDG)

SEPLs type	Direct	Indirect
Rice based SEPLs	(SDG 1) No poverty (SDG 2) Zero hunger (SDG 13) Climate action (SDG 15) Life on land	(SDG 3) Good health and wellbeing (SDG 4) Quality education (SDG 5) Gender equality (SDG 8) Decent work and economic growth (SDG 10) Reduced inequalities
Corn based SEPLs	(SDG 2) Zero hunger (SDG 3) Good health and wellbeing (SDG 8) Decent work and economic growth (SDG 15) Life on land	(SDG 1) No poverty (SDG 4) Quality education (SDG 5) Gender equality (SDG 10) Reduced inequalities (SDG 12) Responsible consumption and production (SDG 13) Climate action
Sweetpotato-Gabi-Cassava based SEPLs	(SDG 2) Zero hunger (SDG 3) Good health and wellbeing (SDG 5) Gender equality (SDG 13) Climate action	(SDG 1) No poverty (SDG 4) Quality education (SDG 8) Decent work and economic growth (SDG 10) Reduced inequalities (SDG 15) Life on land
Coconut based SEPLs	(SDG 2) Zero hunger (SDG 5) Gender equality (SDG 8) Decent work and economic growth (SDG 13) Climate action (SDG 15) Life on land	(SDG 1) No poverty (SDG 3) Good health and wellbeing (SDG 10) Reduced inequalities (SDG 12) Responsible consumption and production
Tobacco, cacao, coffee and vegetable based SEPLs	(SDG 1) No poverty (SDG 2) Zero hunger (SDG 5) Gender equality (SDG 8) Decent work and economic growth	(SDG 3) Good health and wellbeing (SDG 12) Responsible consumption and production (SDG 13) Climate action (SDG 15) Life on land

Corn-based SEPLs are usually important to rural families where rice is scarce (Amper et al. 2018). In fact, corn is the next most important crop as many Filipino farmers rely on corn as a source of food and livelihood (Signabon 2017; Redfern et al. 2012). It is also a source of feed for poultry and livestock (Navarro and Salazar 2014; Vidad and Duran 2022; Dowswell et al. 2019). Hence, not only does this SEPL type stabilize food security, but it also provides work, which contributes to SDG 2 and SDG 8, zero hunger and work and economic development respectively.

Sweetpotato-Gabi-Cassava-based SEPLs are widely distributed in the Philippines, but dominantly found among typhoon-prone provinces along the coast of the Pacific. Harvests of these root crop-based SEPLs are consumed as food and cultivated as buffer crops during typhoon season (Gatto et al. 2021; Chandra et al. 2017; Magcale-Macandog et al. 2010; Bertuso, 2019;). These crops are the staple food in remote uplands and a source of income in the lowlands. These *satoyama* landscape types positively influence the alleviation of poverty, food security, climate action, SDG 1,2 and 13 respectively. While women are commonly knowledgeable about cultivars and are mostly in charge of fieldwork labor while men do the land preparation (Akter et al. 2017). Hence gender equality is practiced among root crop-based SEPLs, contributing to SDG 5.

Coconut-based SEPLs in Southern Luzon and Bicol Region are found to have cash crops in between rows of coconut which supports rural families affected by typhoons. These cash crops, add resilience to climate change, while providing a source of income to farmers. Thus, contributing to zero hunger (SGD 2), decent work and economic growth (SDG 8) and climate action (SDG 13). Women in coconut-based farms in Bukidnon are in charge of maintaining effective management practices, thereby reflecting gender inclusivity, contributing to SDG 5 (Valleser et al. 2020). The intercropping practice in coconut-based *satoyama* landscapes is observed to reduce susceptibility to pest and diseases resulting in the conservation of biodiversity and preservation of indigenous species (Reynolds et al. 2015). Studies revealed that coconut-based *satoyama* landscapes with intercrops of fruit trees and other perennials are highly capable of being effective carbon sinks (Magat 2009; Mukul et al. 2016; Davis et al. 2017). This practice promotes protection among agroecosystems, contributing to SDG 15.

Tobacco is a high-value cash crop that largely supports farmer's income and is considered the major source of livelihood. And it is planted in a rotation cropping basis with corn or other crops in many parts of the country (Dejarme-Calalang et al. 2015). This is especially true for tobacco farmers from the northern part of the Philippines and even in Cebu. Hence, providing cash and food to each farmer's household while promoting work and economic development. The women in La Union and Pangasinan who oversee the propagation of tobacco demonstrate gender equality, where women play a proportionate role in efforts to achieve successful tobacco-farming management practices. The same is true for other SEPLs types (Table 2) where coffee, cacao and vegetables are the main crop. Hence, these SEPLs support SDGs 1, 2, 5, and 8.

In summary, the SEPLs' role and direct contributions to SDGs as discussed, are quite significant. SEPLs are also indirectly contributing to other SDGs (Table 2). This clearly shows us that SEPLs are indeed important landscapes. It is therefore the obligation of everyone to help conserve these landscapes as they help attain SDGs: food security (SDGs 1, 2, 8, etc.) while conserving our dwindling biodiversity (SDGs 13 and 15).

Problems of the Philippine SEPLs

Most of the forests of SEPLs in developing countries, including the Philippines have human settlements also. People who live within and near the forest rely heavily on its diverse goods and services, resulting lots of problems. Table 3 identifies the current problems and causes among SEPLs in the country.

One of the identified problems of *satoyama* or biocultural landscapes in the Philippines is the overexploitation of natural resources (Buot and Osumi 2004; Squires 2014; Buot 2021). Forest areas are severely threatened by this problem (Table 3). According to the Philippine Statistics Authority (PSA), the population growth rate is currently at 1.52%, and is about 112.5 million in total. Amidst the increase in population trend, it is expected to decelerate in the coming years. Yet, the projection shows that the country adds an estimated 2 million people annually and would reach the peak population increase in 2075 with a total of 153.4 million people (PSA, 2019). The growing population basically means more mouths to feed. With heightened food insecurity, instances such as over-extraction of resources in rainforests and expansion of small-scale farms to neighboring forested mountains also rapidly increase (Vinceti et al. 2012; Rizvi et al. 2015; Rueda 2021). Moreover, the ripple effect of poverty leads poor families in the over-populated and resources-scarce lowlands to migrate to the uplands where SEPLs are commonly located (Smith 2021; Kong et al. 2019; Suh 2012; Olabisi 2012). The total dependence on natural resources for their day-to-day needs, coupled with unsustainable practices, exacerbated this problem. This continuously destroys the livelihood of indigenous people residing in remote areas as they compete with the migrants for resources (Büscher and Dressler 2012; Peñaflor and Gata 2020) and integration of modern and commercial agricultural practices (Bernadas and Peralta 2017), leading to the decline of biocultural landscape integrity.

Table 3. Current problems among SEPLs in the Philippines

Problems	Causes	Sources
Overexploitation of natural resources	Population explosion; poverty-stricken lowland rural areas and upland; heightened encroachment of intensive unsustainable agriculture; food scarcity	Zapico et al. (2015) Buot and Osumi (2004)
Biodiversity loss	Slash and burn practices; forest clearing; land use change; overextraction of natural resources; loss of rice varieties	Serrano et al. (2020) Buot (2014, 2008) Buot et al. (2013) Buot and Osumi (2004) UNEP-DENR (1996)
Decline in irrigation system and lack of water	weak irrigation systems; heavy soil erosion and siltation; unstable watershed system; forest decline; over tourism	Tilliger et al. (2015) Serrano and Cadaweng (2005) McKay (2005)
Poor yield	Pest and diseases; increased vulnerability to environmental and climatic change; poor soil quality, poor water quality; declining agricultural biodiversification, poor soil drainage and fertility.	Imai et al. (2019) Boquet (2017) Camacho et al. (2016)
Pollution problem	Increasing population in production landscapes; over marginalized landscapes and rapid urbanization, unregulated tourism activities	Serrano et al. (2019) IPSI (2012)
Deteriorating observance of indigenous tradition	Aging traditional farmers; lack of interest on indigenous culture among the youth; rapid industrialization economic and socio-political factors.	Buot and Rabena (2020) Serrano et al. (2019) Zapico et al. (2015) IPSI (2012)
Youth's lack of loyalty and interest	Rapid modernization and lack of interest in agriculture and forestry fields; belittling views towards aboriginal customs; disunity of tribe members and leaders	Buot and Rabena (2020) Serrano et al. (2019) Drbohlav and Hejkrlik, (2017) Buot et al. (2013) IPSI (2012)
Land tenure insecurity	Mandated by the law; lack of resources, technical capacity, and political support from government institutions	Van der Ploeg et al. (2016) Buot and Osumi (2004) Drbohlav and Hejkrlik (2017) Ong and Kim (2017) Phil-Brett (1995)

Consequently, with overexploitation of resources, the loss of biodiversity (Table 3) is unavoidable. Hence another serious problem we have in SEPLs is biodiversity loss in both floral and faunal elements losing important keystone and endemic species. Increased forest encroachment significantly disrupts the ecosystem, resulting in unstable functions (Serrano et al. 2019; Buot 2014; Buot and Osumi 2004). Population growth is also one of the causes of threatened biodiversity (Villanueva and Buot 2015; Hughes 2017). Due to the high demand for food, the pressure on land availability and food security depletes natural resources (Gomiero 2016; Westhoek 2016). Hence, rapid land-use change results in forestland fragmentation (Rahman et al. 2016; Zhai et al. 2015; Zakaria et al. 2016; Ramirez et al. 2019; Oduro Appiah et al. 2021). This is evident in the neighboring forests in Ifugao Rice Terraces, as seen in Figure 4. These satellite images exhibit the changes in the *muyong* (forest) landscape from 1985 to 2013 to 2019. The forests were gradually cleared, and it can also be noticed how the residential areas continued to expand through the years. Migrants resort to forest clearing and intensive farming (Buot 2008; Meyfroidt et al. 2014; Imai et al. 2019). Some also collect wildlife species for illegal trade (Tobias et al. 2021; Camacho et al. 2016). Incidentally, biodiversity loss also extends to traditional varieties among agricultural crops (Aguilar et al. 2021; Gayao et al. 2016; UNEP-DENR, 1996) in the country. As a result, the Philippines has been listed as one of the hottest biodiversity hotspots in the world (Myers et al. 2000; Marchese 2015).

Another concern particularly among rice paddies is the decline in water availability (Table 3) for irrigation (McKay 2005; Lampayan et al. 2015). This was caused by many factors such as forest degradation, soil erosion, streams with heavy sedimentation and climate change following dry spells (Gheewala et al. 2018). The decline of water supply and irrigation system affects nutrient cycling and further leads to depletion of soil in rice paddies (Tilliger et al. 2015; Serrano and Cadaweng 2005).

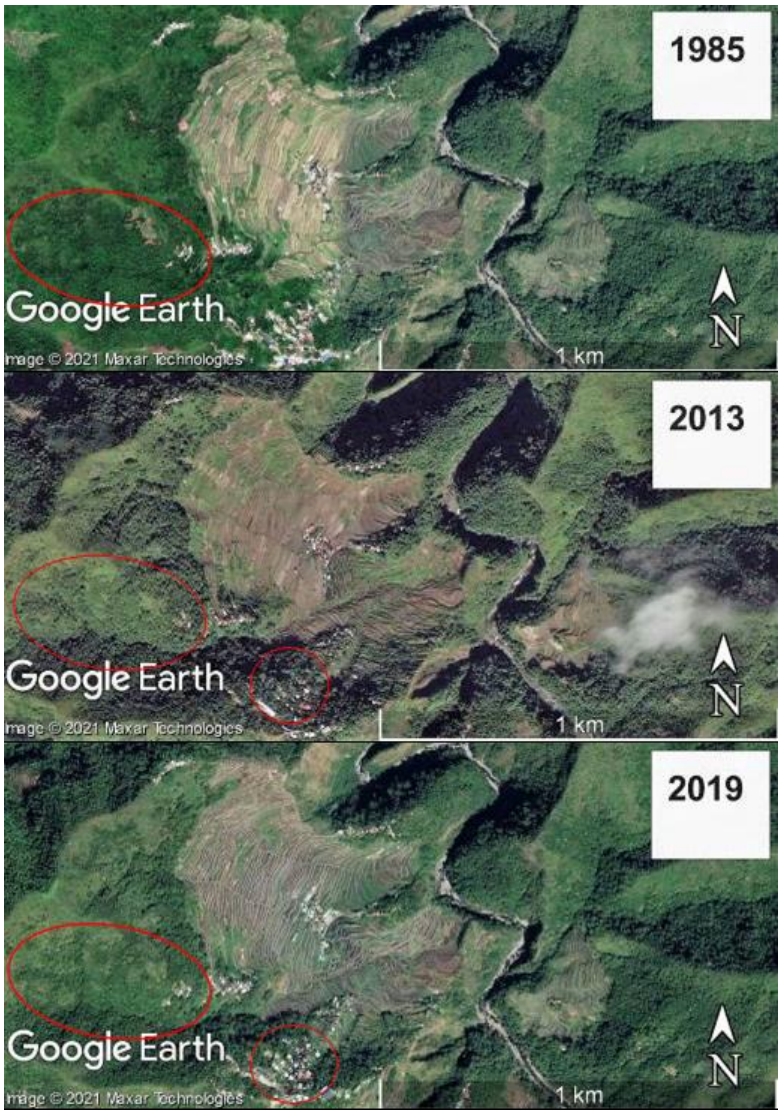

Figure 4. Google Earth Images of Ifugao Rice Terraces showing the land use and vegetation changes from 1985 to 2013 to 2019 (Google Earth Pro - Maxar Technologies, 2021)

With the pressure from the growing population, more lands are being depleted. This is a ripple effect of the pressure from the global market, leading local farmers to compromise their sustainable practice to compete with the fast-moving intensive agriculture (Frison 2016; Maja and Ayano 2021). As a consequence of the problem with the irrigation system (Table 3), poor yield is inevitable. Poor yield may also be due to the unpredictability of weather as an impact of climate change, and extreme events brought by El Niño episodes. Decreased yield may also be caused by increased vulnerability to pest and disease outbreaks, which are also the effects of sudden heavy rainfall or increase in local temperature which disrupts species behavior (Boquet 2017; Imai et al. 2019). This further results in unsustainable practices like overconsumption of chemicals (Abubakar et al. 2015).

Moreover, deteriorating observance and respect for local tradition and the indigenous culture is another problem (Table 3) faced by the *satoyama* and *satoyama*-like landscapes in the country. This is due to the aging population and the lack of interest of the youth in indigenous culture. The population of farmers is aging and the labor shortage in the agricultural sector remains to be a perpetual challenge. The transfer of traditional customs might be difficult due to increased urbanization and globalization. The youth's interest leans towards the industry, and in search for bigger opportunities outside the uplands and even outside the country. It was also believed that the introduction of Christianity in the area has caused the locals to be apathetic toward their traditional beliefs and customs (Buot and Rabena 2020; IPSI, 2012; Serrano et al. 2019). Like the rice farm biocultural landscapes, other crop farm landscapes are managed by the older generation. Their incomes are below average which could be a factor in declining interest among the youth (Boquet 2017).

The challenges of poverty in the uplands justified the young locals to migrate to urban centers to hopefully emancipate them from poverty (Tilliger et al. 2015). The transfer of traditional knowledge has also been slow and weak since the parents from indigenous families send their children to integral and formal education to earn an academic degree. This is believed to trigger the disconnection of youth from the indigenous culture (Serrano et al. 2019). This was the main social issue in most indigenous communities (Arquillano 2018; Drbohlav and Hejkrlik 2017).

Furthermore, the indigenous communities continue to struggle in fighting for their rights on ancestral domains against the state that favors large-scale agribusiness and mining has been observed to have conflicting policies (Phil-Brett 1995). This reflects the lack of government and political support for the indigenous community. Land insecurity is exacerbated when this problem is coupled with weak technical capacity and insufficient financial resources (Van der Ploeg et al. 2016; Drbohlav and Hejkrlik 2017; Ong and Kim 2017). Hence, the impacts of government policy on land are considered as a major concern in *satoyama* sites in the Philippines (Buot 2008; Buot and Osumi 2004).

In summary, the status of the biocultural landscapes in the Philippines is remarkably influenced by these many complex challenges which are interconnected with one another**.** Indeed, there is an urgent need to address these problems to prevent the disintegration of its cultural and ecological integrity.

MAPPING FUTURE DIRECTIONS OF PHILIPPINE SEPLS

Now that we have identified the Philippine SEPLs, their significant contribution to SDGs and have seen the respective problems and challenges, it is important to map the future directions to ensure the conservation of this critical biocultural landscape. Table 4 summarizes the suggested next steps and the corresponding strategic initiatives in achieving sustainably managed SEPLs in the Philippines. With the global objective to achieve sustainable development goals, the following strategies have been proposed. These actions are interconnected with the purpose of conserving biodiversity and cultural harmony in Philippine SEPLs.

Table 4. Suggested directions and corresponding practical steps in managing SEPLs

Suggested directions	Strategies / action points
Population regulation	Provision of sustainable livelihood in the lowland and upland communities; Tourism regulation and in-migration; Birth control.
Poverty alleviation	Localizing government efforts; upscaling existing programs and expanding beneficiaries, addressing food security, health and wellbeing.
Preservation of remaining ancestral lands and empowerment of indigenous communities and youth	Capacity building, conduct training, workshops and participatory activities; providing incentives to local community; policy formulation in form of laws and local ordinances.
Sustainable management of natural resources	Determination of sustainable practices that will complement and enhance indigenous practices, sociocultural and ecological experiences; use of organic fertilizer; implementation of controlled and managed harvesting;
Ensure good governance and equitable sharing of resources	Political support from government institutions; strengthening environmental policies and indigenous people rights; proper coordination and participation among stakeholders in decision making; expand partnerships and inter-agency collaborations

In order to decrease the impacts of human activities in Philippine SEPLs or *satoyama* landscapes, there is a need to regulate the increasing population and control migration in the uplands. This can be possible by providing sustainable livelihoods in the lowlands, address the insufficient resources and food insecurity. Government intervention such as enforcing birth control policy and provision of appropriate settlements among poor families may prevent them from in-migration. Resolving the problems of the growing population also addresses overexploitation of natural resources and biodiversity loss.

In matters concerning poverty alleviation, government initiatives should highlight the critical role of local stakeholders. Localizing government efforts must be guaranteed to suppress the challenges of poverty. This can be done through programs and initiatives that target protection among the most vulnerable communities. Implementation of strategic ways to ensure food security, good health and wellbeing should be accomplished. And expanding the number of beneficiaries and upscaling the existing organizations that focus on poverty reduction.

To preserve the remaining important biocultural landscapes, the government should support the indigenous communities in opposing the encroachment of outsiders into their territories. There is also a need for the stakeholders to promote solidarity among them. Empowering the local indigenous communities through training and workshops among local people is urgent in managing the forest and agroecosystems in SEPLs (Buot et al. 2020; Buot and Rabena 2020). Giving compensation to the locals' conservation efforts is a way to keep them active in adapting to innovations without undermining the traditional knowledge (Tilliger et al. 2015; Wilson and Cagalanan 2016). These can be done by training facilitation and production of materials in pursuing income-generating activities while aiming for sustainable management of SEPLs. Capacitating the existing organization and community involvement sustain projects. This will shift intensive farming to a more sustainable practice such as agroforestry and stimulate ecological and cultural restoration (Lacaste et al. 2020; Serrano et al. 2020). Training on ecosystem approaches among small-scale farmers can be prioritized. This will help farmers understand and be more knowledgeable about the management of rice and other agroforestry products (Rabena et al. 2020). They will be more well-informed in the enhancement of sustainable agricultural crop production. Well-informed farmers about crop diversification especially in traditional agricultural landscapes will help the government's effort to eradicate hunger (Ayu et al. 2015). This approach strengthens the resilience of farms to environmental and climatic changes. Hence reducing vulnerability to pests and diseases and at the same time increasing agricultural yield and productivity. Strategic ways such as incorporating digital learning and maximizing social media among younger generations can be done (Buot et al. 2013; Serrano et al. 2019, 2020).

To realize sustainable management of natural resources, it is evident that the identification of practices customized to the different scenarios under the Philippine setting is an essential step toward sustainability of SEPLs for future generations (Salas et al. 2016; Santiago and Buot 2018; Ichikawa and Toth 2012; Buot 2008). Researchers and experts can develop a unique tool accordingly to further develop the involvement of local communities in the SEPL management (Santiago and Buot 2018). Cultural traditions are believed to have a great contribution to SEPL resilience (Buot et al. 2020). The unique farming practices that have been used by ancestors are proven to sustain productivity and biocultural diversity. Hence, the stakeholders of this generation need to meet the present needs of both natural and human society amidst the perpetual pressures of economic, socio-political and global industrialization. And the experts should suggest sustainable practices that are fitting and stable with the current indigenous knowledge system and culture of the locals (Balilla et al. 2012; Buot 2008). Furthermore, locals must engage in controlled and managed to harvest of resources, and farmers must refrain from using inorganic fertilizer to maintain good soil quality (Buot 2008; Buot 2009).

It is necessary to ensure good governance and equity for sustainable natural resource management in *satoyama*. These can be done with proper coordination among institutions with differing interests, participation of communities and stakeholders in decision making as well as in the implementation of community-based management of natural resources (UNU-IAS and IGES, 2015). Strengthening environmental policies through socio-ecological approach, involving the local communities as well as strengthening partnerships with local government units (LGUs), and national and international organizations. This expands understanding among society's capacity to endure the uncontrollable threats brought about by external factors such as climate change and to improve environmental efforts. This will not only strengthen the existing policies which support the dynamic SEPL conservation and serves as protection from external drivers but will also build the link of present and future projects to the local and global socio-ecological strategy (IPSI, 2012). The LGUs have a key role in identifying the areas in need of priority conservation as well as their authority to mobilize the community in taking part in the SEPLs management (Kalindekafe et al. 2000). The government's effort plays a major role as well in the security of land tenures among indigenous people. The rights over lands and natural resources can prevent disputes and promote social security. In this manner, it facilitates sustainable resource use in the long run.

CONCLUDING REMARKS

There are many biodiversity-rich *satoyama* or SEPLs in the Philippines that are yet to be studied. Currently, we have identified 12 types in the Philippines with rice, corn, coconut, root crops, beverage crops, vegetables, and others

as either main or intercrops. Among the identified, we found that social and external factors are pressing issues. The youth's lack of interest and the state's weak policy implementation, impede initiatives that contribute to the sustainability of Philippine SEPL. The continued fight against overpopulation pressure, poverty, and proliferation of modern agricultural practices, has exacerbated the erosion of the indigenous knowledge system within the identified biocultural landscapes. There are many studies that agree on the deteriorating impacts of unsustainable human activities, hence, there is a need to regulate overexploitation and convey to the local communities through capacity-building sustainable practices to preserve cultural values as well as biodiversity. The identified problems presented among local SEPL and practical solutions such as population regulation, poverty alleviation, preservation of remaining ancestral lands, combined with empowerment of indigenous communities, sustainable management of natural resources, and ensuring good governance and equitable sharing of resources. Collaboration with the country's existing sustainable agriculture initiatives and incorporating regenerative farming design and natural farming techniques in SEPLs management plans and framework will strengthen the integrity of the biocultural landscapes. These mechanisms have the potential to address food security among poverty-ridden families and communities with limited resources. All of these contribute to the SDGs, either directly or indirectly and will lead to the realization of sustained biocultural diversity, sustainable societies, and community wellbeing.

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