

Understanding the Dynamic Interactions and Environmental Problems in the *Muyong-Payoh* System of Banaue, Ifugao, Philippines through Participatory Rural Approaches

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Running Title: Dynamic Interactions in Muyong-Payoh Systems

ABSTRACT

The *muyong-payoh* system is a unique agroforestry management strategy ingrained in the culture of the Ifugao people. It also refers to a forest conservation strategy, a watershed rehabilitation technique, a farming system, or an assisted natural regeneration strategy.

Participatory Rural Appraisal (PRA) activities were conducted in Barangays Amganad and Poitan in Banaue, Ifugao province to gather information about the dynamic interactions and environmental problems in the *muyong-payoh* system.

The *muyong* provides lumber for construction, wood for the carving industry, firewood for domestic use, wildlife and fruits for food, medicinal plants, and water for irrigation and for domestic consumption. The *payohs* are where rice is cultivated.

The continuous cutting in the in the *muyong* forest decreased tree density that induced soil erosion and reduced the quantity and quality of water from the headwaters that is used as irrigation water for the *payoh*. This also led to decreased biodiversity in the *muyong*. On the other hand, the introduction of exotic tree species in the *muyong* were observed to cause changes in the water balance in the *muyong*,. The key problems *in the payoh* were reduced rice yield, wide occurrence of pests and diseases, soil erosion, collapsed walls of rice terraces, and poor irrigation.

To mitigate the problems in the *payoh* and to sustain the *muyong* forest, policymakers should consider policy guidelines on the introduction of exotic tree and faunal species as these contribute to decreasing biodiversity in the area and create an imbalance in the *muyong-payoh* ecosystem. A reforestation program using indigenous species should be carefully planned, too.

Amganad and Poitan farmers agreed on rehabilitation and reforestation of their *muyong* as a major solution. They suggested capacity building as the best solution for problems in the *payoh*. Seminars on integrated pest management, repair of terrace walls, and use of tractors as a substitute for human labor were other possible solutions expressed by the farmers.

PRA serves as avenue for community members to express their local ecological knowledge on environmental degradation in *muyong-payoh* systems and propose viable solutions to address these problems.

Keywords: agroforestry, indigenous system, tropical secondary forest, rice terraces

INTRODUCTION

The *muyong-payoh* system is a unique agroforestry management strategy ingrained in the culture of the Ifugao people (Butic and Ngidlo, 2003; Cagoco, 2006). It also pertains to a strategy to conserve the forest, a technique to rehabilitate the watershed, a farming system, or an assisted natural regeneration strategy (Butic and Ngidlo, 2003). The system is comprised of the following different land uses, each has important functions and as a whole contribute to the sustainability of the system: communal forest (ala or inalahan), woodlot (muyong or pinugo), swidden farms (habal), settlement areas (boble), rice terraces (payoh), and grasslands (magulon) (DENR, 2008; Madulid, 2010).

According to Serrano and Cadaweng (2005), *muyong* in Ifugao dialect refers to forest or woodlot with clearly demarcated boundary adjacent to Ifugao settlements. *Muyongs* are found in 9 of 11 municipalities of Ifugao province (Hangdaan, 2000 as cited by Serrano and Cadaweng, 2005). It can be a small forest patch covered with timber and fruit trees, climbing rattan, bamboo, palm, and other associated natural vegetation. Ifugaos often use it as source of fuelwood. The *muyong* constitutes an essential part of the agroforestry system in the steep mountainous region. It plays a critical role in sustaining the land use system as an integral part of the Ifugao people's lives and culture since it protects lower farmlands from runoff and erosion.

Indigenous Ifugao families or individuals privately own and manage the *muyong* (Butic and Ngidlo, 2003; Serrano and Cadaweng, 2005). They acquired the *muyong* through inheritance (DENR, 2008), purchase (Hangdaan, 2000), long usage claim of land, and recent establishment on fallow swidden or *uma* land. The *muyong* owners do not have land title deeds (Butic and Ngidlo, 2003). A typical *muyong* measures about 100 m² to about 5 ha (Dacawi, 1982 as cited by Butic and Ngidlo, 2003). Ownership of large areas of *muyong* is an indicator of high social status or affluence in Ifugao culture. During the early years, the low caste in the Ifugao society (*nawotwot*) established the *muyongs* to uplift their economic and social status in the community (Serrano and Cadaweng, 2005).

As a forest management system, *muyong* combines specific trees and crops based on economic and cultural values. *Calamus manillensis* (litoko), *Areca catechu* (betel-nut) and *Ficus minahasse* are some of the indigenous plants found in *muyong*. Fruit trees, climbing rattan, bamboo, palm, and other associated natural vegetation are also present (Rondolo, 2001; DENR, 2008, Serrano and Cadaweng, 2005). In their own way and using local resources, the Ifugao people developed their *muyongs* as they shared and exchanged planting materials and labor through generations.

The *muyong* or forest land has been the source of irrigation water for their rice fields in the rice terraces called *payohs* in Ifugao dialect; litter and nutrients for organic fertilizer; fuelwood and lumber for construction (SITMo, 2008), and wood for the carving industry. It protects farms in the downslope from soil erosion and water runoff, and maintains soil fertility and plant biodiversity.

Management practices in the *muyong* vary. One of these is to regulate the harvest of trees and to apply silvicultural operations (DENR, 2008). Enrichment planting, as introduced by government, involves using fast-growing reforestation species in the *muyong*. The practice of agroforestry is an economic assurance for crop loss in the rice terraces (Butic and Ngidlo, 2003). Value-added tree crops like rattan, coffee, and citrus are also integrated in the *muyong*.

The *payohs* or irrigated rice terraces lie immediately below the *muyongs*. They measure 100 to 250 m² (Magcale-Macandog et al., 2012). They are the most dominant agricultural land use in the landscape (DENR, 2008). For thousands of years, the Ifugao people have maintained their *muyongs* for biodiversity, food security, and economy that largely depend on the production of their *payohs*. The *payohs* are maintained to produce rice, vegetables, and some edible aquatic organisms (SITMo, 2008). The management of the *payohs* is family- or clan-based with assistance from the community (*bayanihan*) (Malingan-Sapdoy, 2007).

In Banaue municipality, *payohs* cover 4,327 ha and account for 15% of its total land area, 13,688 ha of woodland, and 10,280 ha of grasslands (Bantayan et al., 2009). The *muyongs* offer several benefits. Hence they are not converted into *payohs*. The Ifugao people consider it very important to sustain and preserve the *muyong* and *payoh*. The biophysical elements are also crucial in the traditional sustainable agricultural practices of the people. Tribal rituals and communal activities always form part of their rice production cycle. The community ensures to cultivate every field in rice terraces cluster, maintain the irrigation system, and sustain the forest lands (Malingan-Sapdoy, 2007). The use of sunflower as fertilizer increases soil fertility (Magcale-Macandog et al., 2012). The farmers plant the indigenous or local rice varieties in the *payoh* fields.

The *muyong* system is considered as an effective production system as it is self-sufficient in producing food and water for the Ifugaos. However, there are growing threats to the system that lead to its deterioration. These threats include population increase that leads to the exploitation of goods from the system; land conversion and abandonment; reduced farm labor; biodiversity loss; and watershed destruction (DENR, 2008). To address these threats, mitigating measures were implemented by the government and non-government groups. The government initiatives include the issuance of Presidential Decree (PD) No. 260 in 1973 which identified the Ifugao landscape as valuable in the world culture. It was later amended in 1978 by PD No. 1501. It included penalties for alteration, modification and destruction of the original features of the landscape. In 1994, Executive Order (EO) No. 158 formed the Ifugao Rice Terraces Commission (ITC) to handle the concerns on the landscape. In line with this EO, the restoration and preservation of the landscape were given emphasis. The ITC was later recreated to Banaue Rice Terraces Task Force (BRTTF) in 1999 (DENR, 2008). ITC and BRTTF were not successful in their endeavors to restore and preserve the landscape due to lack of resources and support from the government (Rossler, 2012). This led the Banaue Rice Terraces to the World Heritage in Danger List. In 2002, BRTTF was abolished and its responsibilities were transferred to the Ifugao Provincial Government. The provincial government implemented different conservation

and development projects funded by the National Commission for Culture and the Arts (NCCA). The projects included irrigation and water system development; fruit tress seedling production; roads stabilization; pathways and creeks, road repair, road and bridge construction, trails and food path, native village development at the provincial capitol grounds, tinawon rice production, municipal tourism facility, livelihood assistance and other support services (DENR, 2008).

There were also non-government organization initiatives for the restoration and management of the Ifugao Rice Terraces. The Save the Ifugao Terraces Movement (SITMo) assists the local government in the implementation of programs for the terraces' sustainable development which include ecotourism, indigenous rice production improvement, provision of micro-hydro dams for renewable energy and restoration of indigenous knowledge and practices (Cagoco, 2006; DENR, 2008; SITMo, 2008). The organizations' contributions and achievements were credited to its partnership with the local government, private sectors and local communities (SITMo, 2008).

These initiatives to address the problem in the rice terraces can still be improved and new initiatives can still arise when further identification of the problems is conducted. Hence, this study is conducted.

Participatory rural appraisal (PRA) methodologies enable local partners to "express, enhance, share, and analyze their knowledge of life and conditions, and to plan and to act" (Chambers, 1994). The community becomes appreciative of its indigenous knowledge and feel empowered through participatory processes. Further, PRA makes the information generated and analyzed available to, owned by, and shared by local people.

This study sought to understand in-depth the environmental problems and dynamic interactions in the *muyong-payoh* system of Banaue, Ifugao through the conduct of PRA. It aimed to document the local ecological knowledge of the communities on the importance of *muyong* in the productivity of the *payoh* rice terraces, in the supply of water and nutrients, and in the control of soil erosion. The lack of policies and guidelines to regulate the introduction of new and exotic plant species, and low awareness of biological diversity served as impetus to engage the local people to craft doable solutions to the various environmental problems that beset them.

METHODOLOGY

The study used participatory rural appraisal (PRA) to gather information about the dynamic interactions in the *muyong-payoh* systems in Barangays Amganad and Poitan, Banaue, Ifugao. The various PRA activities included transect line, timeline, resource flow mapping, community-based mapping, causal diagram, and SWOT analysis. Sixty participants with 30 for each barangay joined the PRA. They comprised elders, farmers, and local government officials.

Transect mapping involved walking through the community to capture its general bio-physical composition. Basic information included elevation, topography, faunal and floral composition, and land uses.

In the timeline activity, the participants identified events that took place in their communities at various time frames: 1940-1950, 1950-1970, 1970-1990, and 1990-present. The timeline highlighted significant developments, land use change, cropping systems practiced, and crops and trees planted in the *muyong-payoh* systems.

In resource flow mapping, the participants illustrated the flow of materials among the various resources within the *muyong-payoh* systems. This activity elicited the local farmers' knowledge of the resource flows within the systems. It analyzed the benefits obtained from and the influence of households or communities on the systems. Participants drew arrows in the prepared diagram to aid them in identifying the exchange of materials between the *muyong-payoh* system and their local communities.

In community-based mapping, selected participants illustrated a series of maps that showed the various resources from the *muyong, payoh*, and settlement areas in their communities and the corresponding changes through time.

The causal mapping illustrated the changes and drivers of change in the *muyong-payoh* systems. Causal mapping showed the relations and interrelatedness of the factors that caused the problems in the community. The participants identified and ranked these problems based on the degree of their effects on the communities and the communities' proposed solutions.

The strengths, weaknesses, opportunities, and threats (SWOT) analysis probed into the internal strengths and weaknesses of the communities to implement the solutions. Opportunities and threats are external factors that may affect how solutions to problems are implemented.

RESULTS AND DISCUSSION

A. Transect Line

Barangay Amganad and Poitan are situated along mountain slopes of the Cordilleras Mountain Range in the Province of Ifugao. Carved along the mountain slopes, the *payoh* terraces allowed planting of agricultural crops, primarily irrigated rice. *Muyong* forests are maintained above the *payoh* terraces. Major land uses include agricultural for the *payoh* terraces, forest in the *muyong*, and residential areas.

Barangay Amganad (Fig. 1) lies about 1120 to 1240 m above sea level (masl). The *payoh* terraces are situated from 1120 to 1200 masl, while the *muyong* forest is above 1200 masl. The main residential area is about 1210 masl where the municipal

road cuts across the landscape with smaller clusters of houses along the *payoh* terraces.

Barangay Poitan (Fig. 2) exhibits flat to steep topography identical to Barangay Amganad. Elevation ranges from 990 to 1200 masl. The dominant land use remains agricultural at 990 to 1030 masl. Residential areas are found at elevations of 990 masl and 1080 masl. The *muyong* forest is in the uppermost portion of the barangay at an elevation of 1200 masl.

B. Timeline

1. *Muyong*

Despite the practice of shifting cultivation or *kaingin* in the early 1940s, the *muyongs* in Barangay Amganad and Poitan were thickly forested with big trees and wild native fruit trees, and inhabited by abundant wildlife (Fig. 3). The *muyongs* provided raw materials for construction, habitat for various wildlife species, and clean water for the communities.

In the 1950s to 1970s, the local people cut trees to support the growing demand for raw materials by the wood carving industry of Brgy, Amganad. Coupled with shifting cultivation (*kaingin*) farming, tree cutting added pressure to the *muyong* forests and resulted in water shortage and decrease in bird species. In Barangay Poitan, the *muyong* forests remained intact as indiscriminate cutting of trees did not take place. The people collected twigs and crooked branches for firewood. When it was necessary to cut trees for domestic use, the locals were required to replace the cut trees with new seedlings. In the 1970s, the community in Barangay Poitan learned the art of wood carving and used chainsaw to harvest timber. The use of chainsaw provided convenience to obtain raw materials for the wood carving industry. Wood was also continuously utilized to meet the demands for house construction of a growing population. In Barangay Amganad, an exotic tree species, *Gmelina arborea*, was introduced in the *muyong*.

Cutting of trees continued to the 1980s, and this sustained the growing needs of the wood carving industry. The local people started to notice the dwindling wildlife and illegal cutting of trees using chainsaws. During this period, exotic tree species that include mahogany (*Swietenia macrophylla*), *gmelina* (*Gmelina arborea*) and Japanese alder (*Alnus japonica*) were introduced in Barangay Poitan.

From 1990 onwards, many ecological and cultural problems emerged. Exotic species of plants and wildlife became known. The national government started to intervene in the worsening condition of the *muyong* forests through reforestation programs in the 1990s up to the present (Fig. 3). The Central Cordillera Agricultural Programme (CECAP) introduced mahogany (*Swietenia macrophylla*), *gmelina* (*Gmelina arborea*), and Japanese alder (*Alnus japonica*) tree species. Pine trees and other species used by the paper industry were also introduced in the *muyong* forests in both

barangays. The tree species for the paper industry did not grow well in the *muyongs*. This prompted the locals to revive the use of indigenous trees and to address the reduced water yield. Though the practice of *kaingin* came to a halt, trees were continuously felled using chainsaws to feed the wood carving and house construction demands. Water quantity and quality of the rivers and springs began to deteriorate. Only the young trees remained to grow and mature in the *muyong* forests.

2. *Payoh*

During the Japanese occupation, the authorities prohibited the people from planting rice (*Oryza sativa*). The locals grew sweet potato (*Ipomea batatas*) as source of carbohydrate and planted *binalok* as source of fiber. Reportedly, some locals planted native rice. When the Japanese reign ended in 1946, the locals began to plant Tinawon, a local variety of rice again on fertile, well-irrigated rice paddies (Fig. 4) in both barangays. Barangay Poitan farmers started to cultivate new rice varieties in the early 1950s while Barangay Amganad farmers followed this practice in the 1990s. The locals of both barangays consumed the vegetables and root crops planted in the fertile *payoh* terraces. Mudfish (*Neochanna galaxiidae*), native shells, Japanese fish introduced during the war, and species of fish and snails (*inago*) inhabited the rice fields in Barangay Amganad and constituted the local people's diet until the late 1990s. The people from both barangays used community labor (*bayanihan*) in the conduct of their farm activities during the early times.

In the 1950s, the locals fertilized rice fields in Barangay Amganad using rattan leaves and stalks. They continued to practice *Bayanihan* during harvest and planting seasons and during irrigation. They observed that well-irrigated rice fields became dry. They attributed this to the appearance of numerous earthworms and golden apple snails (*Pomacea canaliculata*), commonly known as the golden *kuhol*. Meanwhile, in Barangay Poitan, no significant changes occurred in the *payoh* system. Local people consumed aquatic snails, fish, insects (*tat-tayon, iwi*), grasses (*amat, lakiwe*), and local spider (*lawa-lawa*) for food. They also practiced farming rituals.

From the 1970s to the 1980s, mudfish, tilapia, frogs, and Japanese fish prevailed in the rice fields of Barangay Amganad. In the 1980s, the people planted *tinawon* rice and vegetables in the rice field using traditional farming system. They used organic fertilizers, practiced *bayanihan*, and performed traditional rice rituals. One ritual was the use of *wakal* or vines when insects damaged the rice plant. Another was to offer livestock to the gods to control insect infestation in the fields. The locals carried out these indigenous rituals and beliefs to protect their fields and ensure bountiful harvests. During this period, the golden snail (*kuhol*) proliferated and infested the rice plants which lead the people to believe the *kuhol* to be the cause of their declining rice harvest.

A powerful earthquake damaged the *payohs* in 1990. This brought a huge change in the *payohs*. Practitioners of traditional farming declined as they began to age. The practice of pagan ritual started to diminish. In the 1990s, new farming technologies like

rotors and micro tillers encouraged the young generation in both barangays to become more interested in farming because these pieces of equipment made cultivation of the rice field easier. When introduced in the early 1990s, high-yielding rice varieties became more commonly planted in Barangay Poitan. Alongside new rice varieties, the golden snail was introduced. As observed, this caused a decline in the population of mudfish, Japanese fish, *tilapia*, *batikul*, and other edible fish. During this period, the people of Barangay Poitan observed insect pests, diseases, field rats, golden snail, and earthworms in their field.

From 1990 onwards, many ecological and cultural problems emerged. Natural calamities caused erosions and landslides on the *payohs* which affected irrigation and influenced the locals to abandon their rice fields. CECAP introduced million fish *taptampi*.

Farmers in Barangay Poitan started to plant high yielding rice varieties (HYV) in the early 1990s while the farmers in Barangay Amganad started to plant HYV in the early 2000. Farmers in both barangays observed that the planting of HYVs coincided with the appearance of pests and diseases in rice crop. The insect pest *lu-lut* or leaf folder, field rats, *kuhol*, *kiwit*, and earthworms started to proliferate in the rice fields in Barangay Poitan since the late 1980s.

In 2001, one-foot-long earthworms with a diameter about the size of a finger appeared in the rice fields and became pests in Barangay Amganad. The local people attributed soil erosion and breakdown of walls of *payoh* terraces in 2007 to the appearance of earthworms. Water shortage intensified. Faunal and floral biodiversity in the rice fields continued to decrease. Pests and diseases became rampant. The declining interest of some of the local people in farming the *payoh* magnified the problems and challenges as alternative off-farm job opportunities arrived. The locals stopped their practice of synchronized planting because most of their rice fields were converted to other land uses particularly in Barangay Poitan. The local government unit of Banaue initiated the restoration of the abandoned rice fields. Organic fertilizers were introduced to restore soil fertility in Barangay Amganad.

Resource Flow

Figure 5 illustrates the local respondents' understanding of the resource flow within the *muyong-payoh* system. The *muyongs* are sources of numerous quality goods and services for the people of Barangay Amganad and Poitan. They provide firewood and lumber for domestic consumption. They are also sources of wildlife and fruits for food and medicinal plants. They serve as the backbone of the people's economic activities as they provide the inputs for livelihood such as wood for the carving industry, and fruits and ornamental plants sold in the market. The *muyongs* provides water with which to irrigate the *payohs* and also for domestic consumption. In addition, they hold aesthetic, cultural, and recreational importance.

The *payohs* are where rice, vegetables and some root crops are planted, harvested for home consumption, and sold in the market if they are in excess. Some local people obtain fish, snails, field rats, and even insects and consume these as food. Portions of the *payohs* are allocated for growing ornamental plants. Light materials such as cogon grasses for roofing are obtained from the *payohs*. Stalks and flowers of wildings such as sunflower (*Helianthus annuus*) are harvested to serve as organic fertilizers in the rice fields. Rice stalks are incorporated back in the soil in the rice terraces during land preparation to serve as organic fertilizer for the subsequent rice crop. In return, households at the lower elevations are the sources of human labor needed to manage the forested areas of the *muyongs* and cultivate the lands in contiguous *payohs*.

Community-based Mapping

The purpose of this activity was to identify the drivers and impacts of events that affected the configuration of the community's landscape. Community-based mapping used the same timeline discussed earlier.

1. Brgy. Amganad

Figure 6 shows the changes that occurred in the community configuration of Brgy. Amganad.

Muyong. In the 1940s-1950s, many trees in the *muyong* were indigenous. Pine trees were few. Game animals such as deer, wild boar, and birds including eagles abound in the forests. Spring water was clean and abundant even in dry season. Shifting cultivation or *kaingin* was evident. Forested areas were converted to agricultural land and planted to sweet potato.

During the 1950s, trees were cut to support a budding wood carving industry. Cutting of trees and rampant *kaingin* farming resulted in water shortage and decrease in bird population.

The 1960s saw a gradual increase in introduced species such as pine trees from Baguio City simultaneously with a decrease in indigenous trees. *Kaingin* farming proliferated because of a growing population.

In the 1980s-1990s, the total number of indigenous and introduced trees in the *muyong* diminished. Richness of wildlife species also declined; birds were only seen during the dry season. During summer, the people experienced water shortage. Soil erosion in certain parts of the *muyong* started to occur. Community members availed themselves of off-farm jobs like mining and construction in Baguio City. This led to reduced rate of deforestation in the *muyong* associated with *kaingin* activities.

From 2000 onwards, only a few mature indigenous trees remained in the *muyong* forests, with the wildlife almost gone. Springs are usually dry from February to May. Enhanced soil erosion incidents occurred. Since only a few trees remain for

cutting, *kaingin* farming almost ceased due to the growing number of alternative off-farm livelihood opportunities.

Payoh. The native *tinawon* was the only rice variety planted in the rice fields from 1940 to 1990. In 2000, lowland varieties were introduced. The people grew other crops that include legumes, particularly string beans (*Phaseolus vulgaris*) and mungo (*Vigna radiata*); leafy vegetables like *pechay* (*Brassica rapa pekinensis*) and cabbage (*Brassica oleracea*); and root crops like sweet potato (*Ipomea batatas*). Yield was abundant, with little known pests and diseases in the fields in the 1940s-1950s. In 1990, rice yield began to taper off as pests and diseases became rampant with the introduction of high yielding rice varieties planted in the *payoh* terraces.

The *bayanihan* system was common in the 1940s to 1950s but declined later. Farmers practiced farm rituals where they offered livestock before planting and during harvest and synchronized their farm activities until 1990. During the 1990s, the younger generation became reluctant to practice farming rituals. The number of farmers and young laborers decreased. Some of the farmers preferred to work in off-farm activities. Farms became abandoned.

Community. Villages began to form between payohs in the 1940s. Foot trails connected villages of four to five households. Farming was the major economic activity. Alternative sources of livelihood included weaving by women and wood carving by men. Local people started to raise pigs, chickens, and ducks in their backyards as food sources.

The population grew steadily from 1960 to the present. The period marked the rapid rise of infrastructure in the community. Foot trails and roads became cemented. Concrete houses with galvanized iron roofing replaced native huts with cogon roofs. Houses sprouted along the road in the 1970s and encouraged economic activities, particularly trade and tourism. Residential houses and commercial and industrial establishments appeared along the road and proliferated in the 1980s.

2. Brgy. Poitan

Figure 7 illustrates how the *muyong-payoh* system in Brgy. Poitan underwent changes through the years.

Muyong. The *muyong* teemed with wildlife in the 1940s and 1950s. Some wildlife species moved down from the *muyong* to the rice fields and fed on planted crops. Many households used spring water from the *muyong* for domestic purposes including drinking. Local people caught native fish like mudfish and eel in the river.

In the 1960s, *kaingin* farming led to a gradual decline in the number of trees and wildlife in the *muyong*. To have a steady supply of drinking water, some local people started tapping spring water and connected it to their households through pipes. The river began to widen with a decrease in the number of fish caught.

During the 1980s, the wildlife moved farther from their original *muyong* habitat, coupled with an abrupt decrease in trees within the *muyong* forests. The once free-flowing springs began to dry up and reduced water supply to households. During this time, erosion started to occur in the *muyong* and the river began to swell. As the human population continued to grow, solid wastes, particularly trash, accumulated in the river and caused the fish population to decrease.

From 2000 to the present, wildlife retreated and migrated to the mountains outside of the original *muyong*. Springs continued to dry up and soil erosion heightened. The volume of sediments in the river increased and affected aquatic life forms. Water quality decreased because solid wastes were continually dumped into the river and made the water unsafe for domestic use (Fig. 7).

3. CausalDiagram

A causal diagram showed the relationships of issues and events among various components of the *muyong-payoh* system in Barangay Amganad and Poitan (there is only 1 diagram for the two barangays). The diagram evolved from the participants' knowledge of the occurrence of natural events and human activities that impacted their *muyong-payoh* system (Fig. 8). The various issues raised reflected the problems that the participants identified in the succeeding activities.

The major problems in the *muyong-payoh* system were the reduction in tree density in the *muyong* forests and reduced rice yield in the *payoh* terraces. The communities were aware of the interconnectedness of the *muyong* forest and the *payoh* rice terraces as shown in the causal diagram (Fig. 8).

Reduced tree density.The cutting of trees for wood carving, for house construction, and for fuelwood resulted in the reduction of tree density in the *muyong*. With the limited available labor for farming, the *muyong* forests remained uncleaned and cut trees unreplaced with new seedlings as practiced for many generations. The conversion of patches of *muyong* forests into agricultural land and burning of trees are other factors that reduced forest tree density. Natural calamities like typhoons have also contributed to the decrease in number of trees in the *muyong*.

Reduced tree density brings about lower quantity of fresh air and lesser shade leading to a hotter environment. Fewer trees mean smaller habitat and refuge for wildlife which result in decreased wildlife biodiversity. Now, only a few birds thrive in the *muyong-payoh* system. Fewer trees in the forest also mean less materials available for wood carving, construction, and fuelwood. Another major impact of reduced tree density is low water supply to adjoining *payoh* plots, susceptibility of forest soil to erosion due to direct exposure to raindrops, and less tree roots to hold on to the fertile topsoil and to induce infiltration of water into the water table. Reduced tree density also results in less leaf litter that covers and protects the forest topsoil from erosion, and provides habitat and resource to a diverse leaf decomposer community.

Soil erosion and poor water quality. The continuous cutting of trees in the *muyong* forests leads to lower tree density which induces soil erosion and reduces water quantity and quality for irrigation of the *payoh* terraces. Some areas of the *muyong* are converted for agricultural production. This decreases water flow from the *muyong* to the rice paddies and causes siltation in the stream and river during the rainy season. Ever since the kaingin system became rampant in the 1940s, the number of wildlife like birds and wild boar in the *muyong* dwindled.

Pests and diseases. According to the locals, earthworms damaged the walls of the rice terraces and caused erosion. This led to low rice yield identified as the main problem in the *payoh* system. Some of the locals attributed the proliferation of earthworms to the use of organic materials like pig manure, compost, and organic fertilizer (Fig. 8). Other pests reported in the *payoh* terraces were golden snail or *kuhol*, leaf folder or *lu-lut*, and field rats. These started to proliferate in the 1990s. Several rice diseases emerged with the introduction of other rice varieties. Some rice field owners applied chemical insecticides or pesticides to increase rice yield. The tree borer is also a common pest of trees in the *muyong* and contributes to lower tree density in the forest.

Farm labor. Decreasing farm labor is a problem, too, and manifests in the reduced number of cultivated *payoh* terraces. Cultural practices are no longer observed as the younger generation has little or no interest in tradition. Manual farm labor becomes obsolete as the locals favor mechanical farming. This technology can increase efficiency and productivity yet it can threaten conventional ways of farming. The locals fear the possible effect of gasoline seepage in their rice field when using a tractor. Migration aggravates the problem as local people seek employment in nearby areas like Baguio City which offer economic activities. On-farm wage is low compared to off-farm jobs. To attract labor for the harvest season, some rice field owners offer higher wages resulting in lower farm net income. The preference of many people for work in the industrial sector limits the practice of farming traditions in a contemporary setting.

4. Problems and Solutions Identification

Farmers identified the problems they experienced in their farms. Subsequently, they tried to find possible solutions to the problems as shown in Table 1.

Barangays Amganad and Poitan encountered three major problems in the *muyong*. These included degradation of forest cover, soil erosion, decreasing biodiversity, and diminishing water quantity from the headwaters. The key problems in their rice fields were crop pests, soil erosion, and poor irrigation attributed to continuous cutting of trees in the *muyong*. The people were aware of the possible causes of their problems. They said they would act on the problems given ample assistance from other stakeholders. The farmers of both barangays agreed to rehabilitate and to reforest the *muyong* as part of their solution. They proposed capacity building as the best solution to problems in the *payoh*. Their other possible solutions consisted of seminars on integrated pest management, repair of terrace walls, and use of tractors as substitute for human labor.

5. SWOT Analysis

The research team discussed and analyzed strengths, weaknesses, opportunities, and threats (SWOT) with farmer-participants. The results of the SWOT analysis served as bases for planning specific solutions to problems identified in the *muyong* (Table 2) and *payoh* (Table 3) of the two barangays.

Two common problems in the *muyong* of Brgys. Amganad and Poitan were continuous cutting and diminishing number of trees and increased incidents of soil erosion or landslide. The best solution identified for the *muyong* was forest upstream rehabilitation. The major problems of the *payoh* in both barangays were crop pests and poor irrigation. To address these problems, the farmers proposed a capacity-building program.

In Brgy. Amganad, a tree seedling nursery already exists and is a potential source of indigenous tree seeds. The nursery complements the efforts to reforest the *muyong*. The farmers know how to raise and transplant seedlings. Their knowledge will benefit a forest upstream rehabilitation program. Stakeholders should work together for this program to succeed as they share the spirit of *bayanihan*. The local government units (LGUs) of Banaue, along with state universities and colleges (SUCs) and government agencies (GAs) like the Municipal Agriculture Office (MAO), Department of Agriculture (DA), and Department of Environment and Natural Resources (DENR) can provide training and seminar on integrated pest management to solve related problems in the *payoh*. Some farmers reportedly export organic rice. If properly developed, the export of organic rice can be a significant business for the community.

For Brgy. Poitan, farmers perceived replanting of indigenous trees as the best way to address problems in the *payoh*. Brgy. Poitan farmers also know how to cultivate seedlings for reforestation. Through their *bayanihan* tradition, they can assist one another to reforest the *muyong*. The proposed solution for crop pests was the use of pesticides. Repairing the damaged rice terraces walls can minimize problems on soil erosion and poor irrigation. To till the rice field, farmers suggested using the tractor and micro tiller as substitute for the decline in farm labor.

The source of funds to implement development projects emerged as an issue in the two barangays. The current funds were inadequate to sustain rehabilitation activities. Rehabilitation and reforestation of the *muyong* requires a steady source of funds. In Barangay Amganad, the export of organic rice can enhance economic activity in the area. In Barangay Poitan, the active efforts of the LGU to promote tourism in the area can be a strategy to finance the rehabilitation of the *muyong*.

CONCLUSION AND RECOMMENDATION

Barangay Amganad and Poitan lie along long mountain slopes elevated between 990 and 1240 meters above sea level. The *payoh* terraces are carved along the mountain slopes to allow planting of mainly irrigated rice. *Muyong* forests are maintained above the *payoh* terraces.

The *muyong* is a source of products and services for both barangays. It provides lumber for construction, wood for the carving industry, firewood for domestic use, wildlife and fruits for food, and medicinal plants. The *muyong* also provides water to irrigate the *payoh* and for domestic consumption.

Farmers plant rice, vegetables and root crops in the *payoh*. The harvest is for home consumption and any excess becomes sold in the market. Some of the local people get fish, snails, field rats, and insects from the *payoh* and consume these as food. They even allocate a portion of the *payoh* to grow ornamental plants. They use cogon grass from the *payoh* as roofing material.

Despite the practice of shifting cultivation or *kaingin* in the early 1940s, the *muyong* in both barangays remained thickly forested with wild native fruit trees and abundant with wildlife. In the 1940s-1950s, many trees in the *muyong* were indigenous. Deer, wild boar, and birds including eagles inhabited the forest. Spring water was clean and in abundant supply during the dry season. Shifting cultivation or *kaingin* and conversion of forested areas to agricultural land for sweet potato planting were practiced.

In the 1950s, trees were cut to support a budding wood carving industry. Coupled with rampant *kaingin* farming, tree cutting resulted in water shortage and decreased bird population. From 2000 to the present, wildlife retreated deeper into the forest and migrated to the mountains outside of the original *muyong*. Springs continued to dry up and soil erosion increased.

Introduced in the 1970s, the local people planted high-yielding rice varieties in their *payoh*. Along with new rice varieties, the golden fish was introduced. Later, it was observed to cause a decline in mudfish, Japanese fish, *tilapia*, *batikul*, and other edible fish population. Insect pests, diseases, field rats, golden snails, and earthworms became rampant during this period.

The 1990s and succeeding years gave rise to many ecological and cultural problems. Impacts of natural calamities on the *payoh* manifested in soil erosion and landslide that affected irrigation of the rice field and led the locals to abandon their field. Exotic plant and animal species were introduced. Various diseases of rice emerged with the introduction of new rice varieties. The insect pest *lu-lut* or leaf folder, field rats, *kuhol*, *kiwit* and earthworms started to proliferate in the rice field. In 2001, foot-long earthworms with finger-sized diameter spread and became pests in the *payoh*. In 2007, the local people attributed soil erosion and breakdown of the walls of *payoh* terraces to

the earthworms. Water shortage intensified, too. Faunal and floral biodiversity in the rice field continued to decrease while pests and diseases became widespread.

The continuous cutting in the *muyong* forest decreased tree density that induced soil erosion and reduced the quantity and quality of water from the headwaters that is used as irrigation water for the *payoh*. This also led to decreased biodiversity in the *muyong*. On the other hand, the introduction of exotic tree species in the *muyong* were observed to cause changes in the water balance in the *muyong*. The key problems *in the payoh* were reduced rice yield, wide occurrence of pests and diseases, soil erosion, collapsed walls of rice terraces, and poor irrigation.

The two communities experienced a decrease in farm labor as manifested in the reduced number of cultivated *payoh*. Farm cultural practices started to disintegrate as the younger generation had little or no interest in observing their tradition.

To mitigate the problems in the *payoh* and to sustain the *muyong* forest, policymakers should consider policy guidelines on the introduction of exotic tree and faunal species as these contribute to decreasing biodiversity in the area and create an imbalance in the *muyong-payoh* ecosystem. A reforestation program using indigenous species should be carefully planned, too.

Amganad and Poitan farmers agreed on rehabilitation and reforestation of their *muyongas* a major solution. They suggested capacity building as the best solution for problems in the *payoh*. Seminars on integrated pest management, repair of terrace walls, and use of tractors as a substitute for human labor were other possible solutions expressed by the farmers.

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