

Inter-dependency of forest diversity and service towards the potency of ecotourism development in Pegunungan Arfak nature reserve

Lukas Yowel Sonbait¹, Hermanus Warmetan², Hotlan Manik¹ and Reinardus Liborius Cabuy^{2*}

¹*Faculty of Animal Husbandry, University of Papua, Manokwari, Indonesia 98314*

²*Department of Forestry, Faculty of Forestry, University of Papua, Manokwari, Indonesia 98314.*

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ABSTRACT

Forest as a complex ecosystem possesses a number of services for living. Inter-dependency among various components in ecosystem will generate benefits and long-term existences. This study aims to understand the potential of forest and environmental resources for sustainability and economic development by way of forest diversity assessment. Plot samples in both villages, Mokwam and Syoubri, were designed to reveal forest structure and diversity through importance value and Shannon wiener index scores. To understand the correlation between traditional willingness with the gardens, agricultural lands, and forest resources, ANOVA one-way test was performed. Principle component analysis was applied to display correlation among intent use, benefited value, accessibility, and sustainability through scoring. The result indicated forest diversity in both areas was quite diverse specified by importance value and shannon wiener index. However, an interaction between people and land resources was very significant ($r^2 = 0.79$) and significant ($r^2 = 0.49$) in both, Mokwam and Syoubri, respectively. PCA pointed out a very positive correlation between frequent use and benefited value, while a negative correlation indicated between frequent use and future sustainability of use. In general, the prospect of ecotourism development was potential when considering natural and forest resources sustainability and socio-cultural uniques of the local villagers.

Key words: Economic income, Forest diversity, Frequent use, Sustainability, Localvillagers.

Introduction

Economic development is an important indicator to achieve a better life. Stimulating economic growth will benefit people by way of fulfilling all necessities of the daily needs either direct or indirect that possibly for the long run will be available (Goodwin *et al.*, 2008; FAO 2017). With an equal distribution of economic incomes generated in a whole area, it turns out to be a pivotal benchmark for sustainable economic growth and simultaneously scales up national status and alleviate gap of economic disparity (Yemiru *et al.*, 2010; Peterson, 2017).

Forest as a whole complex ecosystem possesses tremendous resources not only as a dominant patron of timber and not-timber forest products (NTFP's) but beyond that it has been abundantly beneficial through its services (Toman, 2003; Artim *et al.*, 2008; World Resources Institute, 2015). Traditional life along the tropical region had long been resourceful with forest services provided over generations. Through forest services, millions of benefits can be generated and those eventually will scale up traditional living expectation and invigorate small-scale economic activities around traditional communities (Elliott II *et al.*, 2007). There are

*Corresponding author's email : reinnardcabuy@gmail.com

a number of services that forest can provide such as tourism park, playing ground and outbound arena, hacking, camping, and birds sing service. Those are tangible resources that can be added as a potential chunk of income and an economic boost for local people.

Papua Island has been prominent as one of the unique regions in Indonesia, representing a well-functioning natural environment and forest ecosystem, considering as a rich region with the high abundance of flora and fauna as a complexity of natural life cycle exist (van Heist *et al.*, 2010). Noting, there are more than 20,000 vascular plants, 3,000 orchid species, insects exceed 200,000 species, and 164 species of amphibians are found there. Papuan forests are concerned as the most completed and representative vegetation types from the high-land to the coastal ecosystem in the tropics (Takeuchi *et al.*, 2003; Beehler, 2007).

As a long-run manifestation of natural resource existence, forest in Papua has been home for more than thousands of living organisms from small insects up to the large-size mammals (Beehler, 2007). Interaction with the forest will be undoubtedly fundamental due to intense interdependency. As a home, the forest provides a tangible benefit such as daily food, water, the habit of living and many more that potentially exist as a synergic circumstance (Cabuy *et al.*, 2012). Such a good and balanced ecosystem, will gain a potential development of forest services and eventually boost local economic activity and drive income allocation among traditional communities (Lekitoo *et al.*, 2017). Therefore, this study wants to highlight the importance of forest as a home towards the existence of forest services provided which eventually invigorate small-scale economic adaptability for the local communities.

Materials and Methods

Study site

This study took place in two villages, Mokwam and Syoubri, the administrative area of Warmare, Manokwari during May to July 2017. In general, these areas are situated in the high land mountainous region ranges from 1,200 m to the 2,000 m asl. A number of areas were dominated by mountains and hills with a slope up to the 75° and very rugged and rocky. The area was wetter indicated by a high intensity of annual rainfall ranges from 1500 to 2000

mm/year. The average temperature was 27.7° C and the relative humidity of 84.3 % (BMKG 2016) with the maximum temperature occurred in May and the lowest in March. However, in some spots, it will reach lower temperature and higher humidity (<20° C and >80%). Soil type was dominated by entisol with a rough texture and low organic and nitrogen compound. A small portion covered by sandy and dusty.

Plot and sample design

Several study plots were designed to perceive forest structure, composition, and density in both Mokwam and Syoubri forests. Systematic line plot sampling was applied with a length of a baseline of 1 km and 100 m interval for plot design. Therefore, there are 10 sampling plots for tree inventory for each location. In total, there were two baselines that purposively created in both selected forested villages. Besides, gardens were identified in order to obtain whole information regarding potential incomes generated from the forest and surrounding gardens. Garden was identified through field study and data collected such as how many gardens, how big it was, what was the importance of it for supporting daily living income. In order to obtain those data, some selected key respondents were asked through questionnaires around the relationship between the forest and their socio-economic interactions. For the future sustainability of use, four key aspects such as frequent use, benefited value, accessibility towards forest resources, and the future prospect were recorded. All the data recorded for the duration of three months period (February to April). The intent use aspect data was collected in quantitative (how many times the interaction occurred within three months period), while for the benefited value, accessibility and future sustainability, data gathered qualitatively then converted to quantitative through scoring from 1 (less benefiting, very difficult, and less threatening) up to 10 (very benefiting, easy to find, and very threatening).

Socio-cultural aspect

Population in both villages was slightly different of which Mokwam was higher (257 people) than of Syoubri (74 people) (BPS statistic of Manokwari regency, 2012). Questionnaire data were taken by purposively selecting key respondents (10 % of the total population) from two villages who consider to

frequently access gardens, agricultural lands, forest resources and hold customary right as well as public figures for gaining a better understanding of forest and natural resource status. Therefore, 26 respondents ($n = 26$) were selected from Mokwam and seven chosen respondents ($n = 7$) from Syoubri were taken. These selected respondents then participated in the whole discussion process through questionnaires interview and data collection during this field study.

Data Analysis

Forest vegetation was identified taxonomically in each sampling plot. These then calculated to obtain importance value index for understanding dominance of tree species and shannonwiener index for the diversity value of tree species toward two selected baselines. ANOVA was tested to perceive the correlation between family members and how often they interacted with their gardens, agricultural lands, and forest resources for living. In addition to understanding the correlation among intent use, benefited value, accessibility towards forest resources, and the future sustainability, principal component analysis (PCA) was performed using 'vegan package'. All data calculated using R statistical program 3.4.3. (R Development Core Team, 2017; Oksanen *et al.*, 2018).

Results

ANOVA one-way test for the correlation between number of families and frequency of interaction with their garden, agricultural lands, and forest resources to fulfil daily basic needs indicating very significant in Mokwam with a P -value of 0.03 and $r^2 = 0.79$, while correlation was significant in Syoubri with the P -value of 0.26 and $r^2 = 0.49$ (Fig. 1). In general, those relationships showed a positive indication of how intense traditional villagers toward their gardens, agricultural lands, and forest resources in conjunction with the fulfillment of basic daily necessities. From those types of interaction, it was found that a handful of harvesting products from gardens, agricultural lands, and forest resources were sold primarily to the market in order to scale up livelihood incomes. It was obvious that generating economic activities in the community has existed in both villages.

Vegetation analyses revealed that there were 45 tree species found in Mokwam with the five domi-

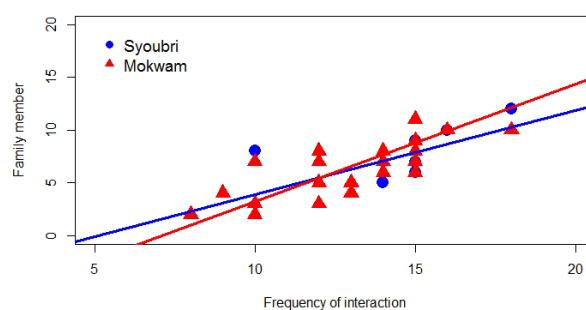


Fig. 1. Multiple correlations describing a number of family member towards how intent the interaction with garden, agricultural lands, and forest resources in both villages, Mokwam and Syoubri.

nant trees such as *Psychotria* sp., *Garcinia* sp., *Ardisia* sp., *Poteria* sp., and *Helisia* sp. On the other hand, 35 were identified in Syoubri with the five dominant trees such as *Psychotria* sp., *Calophyllumprostanum*, *Polysias* sp., *Protea* sp., and *Pouteria* sp. *Psychotria* sp., turned out to be the most dominant tree species found in both forested areas which indicated by the highest score of importance value index and shannon wiener index of 14.61 and 0.09 in Mokwan and 17.38 and 0.10 respectively in Syoubri.

Principle component analysis revealed the correlation among frequency of interaction, accessibility, benefited value, and sustainable future of gardens, agricultural lands, and forest resources in both areas. In was indicated positive correlation between frequency of interaction and benefited value in both villages (Fig. 2). However, a negative correlation was seen between the correlations between frequency of intensity and sustainable future. It was slightly that the availability of sources was gradual will be vanished and it will decrease the potential distribution and availability in both areas. In addition, the correlation between frequency of intensity and access were slightly negative and it will be more difficult for the long period as the intensity of use is massive (Fig. 2).

Discussion

Trend of forest cover

Surrounding forests in Mokwam and Syoubri were still in the good shape in terms of resources and biodiversity values. Noticed that forest structure was distributed normally from seedlings up to the trees. In addition to the density, it seemed that both

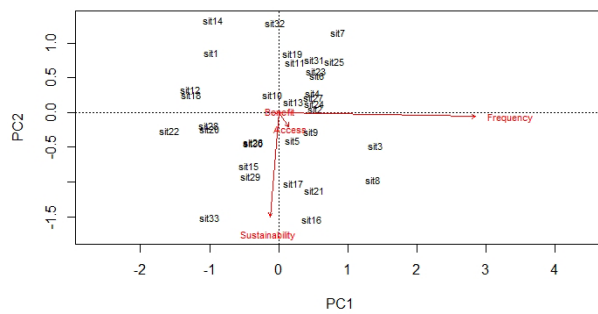


Fig. 2. PCA indicated multiple correlations in how often the interaction occurred, what was the benefit gathered, the accessibility towards resources, and sustainability for the future.

had medium forest density per hectare by more than 200 trees found that covered by more than 30 tree species. Humagain *et al.* (2017) classified medium-density forest covering with standing tree from 101 up to 500 trees per hectare. Tropical forests tend to be dense as pointed out by Etigale *et al.* (2013) in Nigeria with *Gmelina arborea* tree species up to 300 standing trees per hectare and the basal area of 36.68 m². Forest canopy covering was also high which revealed a general normal distribution and less disturbing factors affected into the forest structure (Abis and Brovkin, 2016). Shannon index was relatively medium specified the diversity in both forested areas were in moderate level. There were several factors indicating forests in these areas in the ideal shape such as the natural landscape in which a handful of those was in the slope areas which was difficult to access and occupy. Small-scale use of forest resources was another indicator of sustainability in those areas (Ruitenbeek and Cartier, 1998; May *et al.*, 2017). Traditional villagers extracted forest resources just for daily needs which were a small portion with a low intensity. 'Forest as a mother' term was a pivotal key in generating the understanding of how important forest existence in the socio-cultural aspect of villagers in the area. The terms then preserve the forest and its resource to be used in the appropriate way. The role turned out to be an effective way as reported by Nimachow *et al.* (2010) in Aka tribes of Arunachal Pradesh for preserving numerous forest resources through a development of indigenous knowledge system (IKS). However, there were still forest disturbance activities, uncontrolled fires, unintended natural destructions, and some anthropogenic activities were actively getting involved and changed the structure and composition of the surrounding forests. Small-

scale forest activities such as chopping trees and branches still occurred in the forest intended for daily needs and housing constructions. Several fires also happened during the dry season in some spots on account of the conventional land burning management for agricultural purpose. Katterings *et al.* (1999) high lighted the importance of slash-and-burn as a common method in Indonesia in terms of land clearance for agriculture with several benefits such as more space available, able to fertilize lands with the ash content, improve soil structure, and minimize pests and or disease. The cascade of floods and landslides reportedly occurred which potentially diminish bio-diversity and tree species richness in the area that considered as one of the natural reserve regions in Indonesia. It turned out that garden opening in the sloping areas was the main driving factor of landslide occurred (Ningthoujam *et al.*, 2016).

Forest service and ecotourism potential development

Given that forestedlands in Mokwam and Syoubri were well-functioned and in the ideal shape, that is indicating a potential service will render for thousands of living organisms inside the forest. It was indicated that these forests likely contained millions of undercover organisms, multiple floral vegetation, numerous vascular plant diversities as specified by shannon and importance index scale. These will augment complex species interaction and competition among thousands of living organisms and possibly contributed towards the enrichment of endemic floral and faunal species (Clark *et al.*, 2016; Varenus, 2017). Singer *et al.*, 2014, noted that variation of predator effects in the plants will be diverse due to variation in herbivore communities on those plants and because of the likelihood of variation in herbivores in both abundance and the types of interactions that can involve other trophic levels.

A moderately diverse forest in both are as becomes apparent as a potential domain for myriads of uniquely endemic floral of faunal for the sake of living such as famous bird-fly butterfly (*Ornithoptera* spp.) Arfak paradise (*Astrapianigra*), Parotiabarat (*Parotiasefilata*), and Namdur polos (*Amblyornisinornatus*), as well as multiple species of Orchidaceae and flowering plants. It was likely that the interaction among forest, small organism, birds, and mammals as a whole ecosystem in the area have mutually existed (Naeem *et al.*, 1999). Both for-

ests, obviously render multiple-scale benefits ranging from food sources, places for playing, interacting, and living. Dense, relative high forest canopy and fruits from the tree were an ideal habitat for birds to stay such as *Astrapianigrai* and other 320 bird's species reportedly found in the high region of Pegunungan Arfak Nature Reserve. A wide distribution of flowering plants along the forested area will rivet various species of *Ornithoptera* spp., that widely known as an endemic butterfly which only found in the area. Retaining the ideal condition of the forest and minimizing any related disturbance surrounding the area will be a long-term manifestation and potential development of ecosystem service.

On the other hand, anthropogenic activities related to forest resource and land management in both areas were indispensable. Forest was pivotal for traditional settlers around the Arfak mountain. The positive correlation ($r^2 = 0.79$ and $r^2 = 0.49$) between people and forest and land areas was a certainty of an interdependent living pattern over generations that can harm a whole balanced ecosystem. A continuation of forest disturbances through anthropogenic activities will be potentially disturbing an ultimate domain for endemic and unique faunal and floral species on both forested lands (Belshaw and Bolton, 1993; Conde and Rocha, 2006; Marzano and Dandy, 2012). It was apparent a glaring threat in terms of boosting a potential ecotourism development for generating income. Frequent and intense interaction with the forest in Mokwam and Syoubri will diminish biotic components and worry unique faunal species as well as likely to reduce ecosystem service and for natural attraction.

Focusing on enlightening the environmental participatory experience through ecotourism in both Mokwam and Syoubri means to invigorate multi-scale interactions and generate income for villagers. The current status of natural and forest resources including socio-cultural characteristics will become a fundamental advantage for the area to be developed. In addition, guaranteeing natural resource sustainability, high and endemic biodiversity and socio-cultural uniques in both areas definitely will fulfill a basic principle of ecotourism and potential to acquire huge multi-scale benefits for the villagers and regional area. However, engagement of all stakeholders is pivotal to implement forest-based ecotourism in the area including local non-government organizations (NGO's) for intensive participa-

tion, local, regional and national governments through supportive regulations and policies (Kim, 2013; Kenawy *et al.*, 2017).

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