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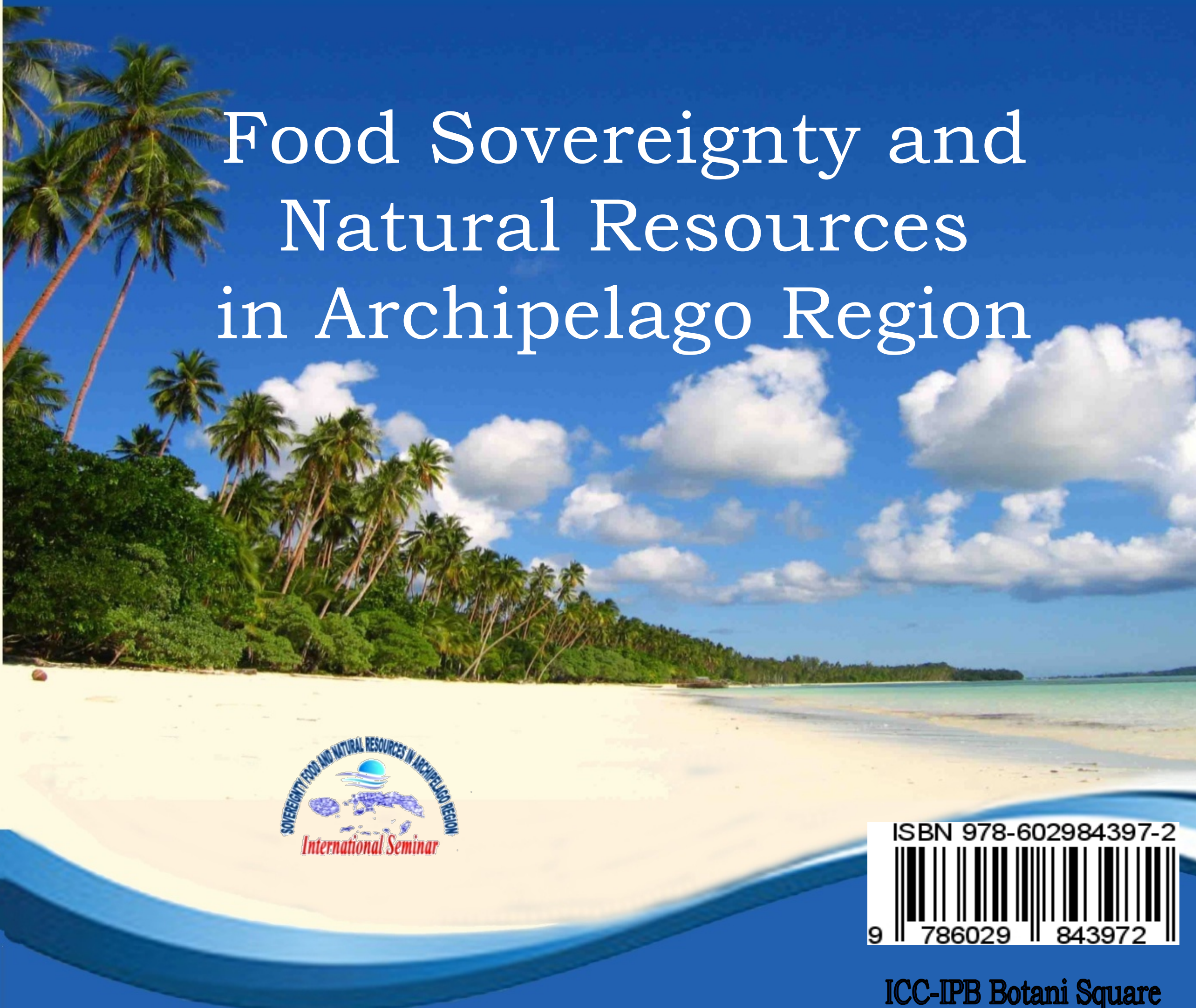

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THE BIODIVERSITY AND ECOLOGY ON THE BURU ISLAND; IMPORTANT VALUE OF CONSERVATION AND ENVIRONMENTALLY MANAGEMENT

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Abstract

The pattern of biodiversity can potentially be affected by geology, geography and topography of an area. Understanding diversity of species and their ecosystem are very important for environment balance assessment. Therefore we need a baseline study for each taxa like plants, reptiles, amphibians, birds and mammals. Of course complex interactions are taking place simultaneously between and within ecosystems with the landscape. The maintenance of species, ecosystems and ecological services within an area (such as Buru Island) must, therefore, take into account the supporting interactions with adjacent areas, and endeavor to maintain these processes. Surveys in Buru were surveyed extensively on January 2012. There are approximately 161 morph species of plant was recorded (including 112 genera from 57 families), 75 species of birds, 4 frogs, 11 lizards and 3 snakes also found in this study. Of the 28 species of mammals that are known to occur on Buru, 16 were positively identified in the study. Plant and animals found in Buru Island consist of many endemic species. Also there are protected species under Indonesian law, and species threatened listed under CITES protocol. All species of animals may use a variety of habitats at different stages in their life cycles. This use may be seasonal or occasional in times of 'stress' such as extreme weather, and are therefore essential for the survival of the population.

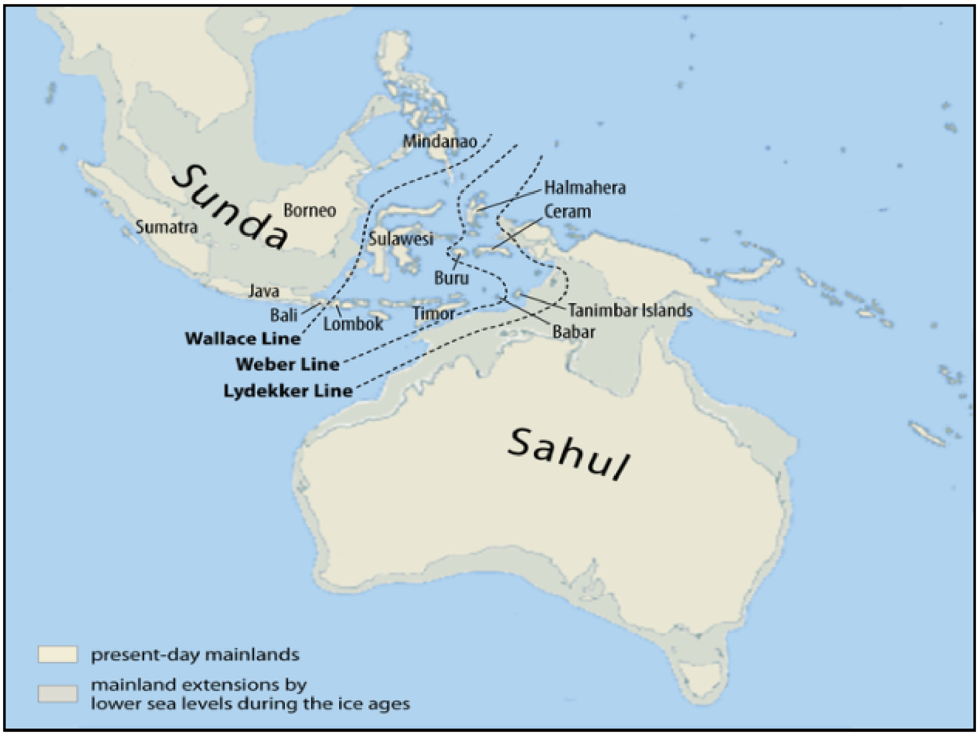
Key Word : *Buru Island, diversity species and ecosystem*

INTRODUCTION

Conservation of flora and fauna effectively requires accurate informations related to the distribution, endemism, local richness, and taxonomic composition of each species. Understanding diversity of species and their ecosystem is very important for environment balance assessment.

As it is known that the line of separation of fauna by AR Wallacea has long been informed the dispersal patterns of animals in Indonesian. Java, Borneo, and Sumatera during the Pleistocene connected to Asia by land, so these regions have the same animals (Primack *et al.* 1998).

Although uneven, composition taxonomic of species between Papua and some island in Maluku is similar. Aru Islands and New Guinea, for example, relating to Australia, so the wildlife in this area is different from the animals in the tropics of Asia (Corlett 2009; Primack *et al.* 1998). The pattern of biodiversity can potentially be affected by geology, geography and topography of an area.



that separate 'Biogeographic Zones' (source: en.wikipedia.org)

Figure 1 Map of Southeast Asia and Australia showing imaginary lines

Buru is located on the center of a mixing zone (Figure 1) between Australia and Asia (the Wallacea region). Buru Island contains a distinctive fauna representing a mix of the two regions. Geologically, Buru Island tends to be closed to The Bird's Head region of Papua, Eastern Indonesia (Hall 1996) and is probably a remnant crustal fragment of the Australian continent, and part of the inner Banda Arc but isolated from surrounding islands for millennia. Buru Island and the rain forest that it supports is considered as a unique eco-region by WWF (Buru Rain Forests: 115; Wikramanayake *et al*. 2001) due to its small size and outstanding biologically distinctiveness.

This paper is a result of basic research projects to support the assessment of high conservation value (HCV) in a unit of forest management in North Buru. However, the data of diversity of flora and fauna collected in this research are excellent for studying biodiversity and terrestrial ecosystems in Buru Island.

MATERIALS AND METHOD

Study Site

Fieldwork was carried out to complete and cross-check available secondary data. Due to the scant nature of the secondary data, fieldwork and surveys (Figure 2) were implemented for each of the major biodiversity taxa (Plants, Frogs and reptiles, Birds, and Mammals). The studies were conducted on January 8-27th 2012.

Figure 2. Map of the Buru Island

Plant surveys

Forests were assessed using a rapid assessment methodology. Time-consuming quantitative vegetation plots were not used as the survey team wanted to cover as much area as possible in order to assess species that are high conservation priorities. Plant identification is problematic as herbarium voucher specimens in Indonesia that are incomplete. However, experts from Universitas Negeri Papua (Dr. Charlie Heatubun, FLS) consulted international experts to be able to identify all plant types to genus level and almost all to species level.

Amphibians and Reptiles

Information of reptiles and amphibians for Buru Is. is very poor. In addition, many species of amphibians are susceptible to forest disturbance and can provide clear indicators of suitable forestry practice. Surveys were carried out in primary and secondary forest, and in lower montane forest, as well as ad hoc surveys during journeys to surveys locations. The surveys employed VES (visual encounter survey) and patch sampling for hand capture. Vocalisation for frogs was also used. Community interviews and habitat assessments were conducted at the village level, especially for species that may have been missed during the survey.

Mammals

Survey of mammals and other vertebrates were conducted using sampling techniques including live trapping of ground-dwelling mammals (rats), opportunistic hunting of common arboreal and invasive species (cuscuses and civets) and mist-netting bats. The surveys were augmented through semi-structured interviews with hunters, assessing food availability and forest condition, and direct (visual) and indirect (prints, calls, scat) sightings whilst undertaking habitat assessments. Community interviews and habitat assessments were conducted at the village level.

Birds

Due to the effectiveness of surveying birds (vocal and visual) and the completeness of identification material (bird identification guides and vocalizations available on the internet), bird surveys were the most quantitative biodiversity surveys during the assessment. Birds survey were assessed using transects primarily along abandoned logging roads as well as along primary forest (with a newly developed road in lower montane forest and using hunting paths and rivers through primary lowland forest). A similar amount of census points (16 in total for each vegetation type) were taken to enable comparison of biodiversity between vegetation types (lowland and lower montane forest) and the impact of logging on lowland forest as well as recovery of biodiversity after distance through logging.

Available data of local bird names and their abundance and behaviour were noted.

RESULT AND DISCUSSION

Globally, regionally or nationally significant concentrations of biodiversity values

Tropical forests are one of the most biologically rich ecosystems on earth. All species are of some importance, and have individual roles and niches within an ecosystem. Conservation needs to focus of those *vulnerable* and *irreplaceable* species that are of globally, regionally or nationally significance (Jennings *et al*. 2001), as well as species protected by Indonesian law and those commonly traded. There were 161 species of plants found, comprising four species of frogs, 11 species of lizards, three species of snakes, 75 species of birds and 16 species of mammals. Each taxon will be comprehensively discussed as follows:

a. Plants

Extensive surveys were conducted in Buru. Out of the 161 morph species recorded (including 112 genera from 57 families) only *Gyrinops moluccana* and 2 species of *Nepenthes* (pitcher plant) were considered high conservation values (protected by law and listed under CITES).

The priority plant species required attention were all kinds of orchids (Orchidaceae) and all kinds of *Nepenthes* spp. (Nepenthaceae) and eagle wood of Buru Island, *Grynops moluccanum* (Thymeliaceae), that have been included in the CITES Appendix I and II. In addition, white meranti (*Shorea selanica*) and red meranti (*Shorea montigena*) are endemic to Buru Island and the Maluku Islands. Although those have not yet included on the list or attachment of protected species (IUCN, CITES, Rules / Regulations of the Republic of Indonesia), a special attention should be given to their regeneration stock in nature. Moreover, as endemic species to Buru Island with a narrow distribution area, they can lead to the possibility of being globally threatened.

Other endemic Plant species to Buru Islands are *Myristica alba* (Myristicaceae), *Calophyllum undulatum* (Calophyllaceae), *Elaeocarpus crenatus* (Elaeocarpaceae), *Trichospermum buruensis* (Tiliaceae), *Casearia glabra* (Flacourtiaceae), *Passiflora moluccana* var. *moluccana* (Passifloraceae), *Rhododendron buruensis* (Ericaceae), *R. impressopunctatum* (Ericaceae), *R. malphigidum* (Ericaceae), R. *seranicum* (Ericaceae), *R. toxopei* (Ericaceae), *Vaccinium retusifolium* (Ericaceae), *Sciaphyla buruensis* (Triuridaceae), *Calamus buruensis* (Arecaceae), and *Pholidocarpus* sp. (Arecaceae). These all endemic plant species have not yet been seriously studied to find out their conservation status in accordance with the guidelines internationally established by IUCN or nationally by the Ministry of Forestry of Republic of Indonesia.

Resin or *celebica Agathis* (Araucariaceae) is a priority species which has been protected by the local communities in the survey area because this species could produce sap or copal that can support their incomes.

b. Reptiles and Amphibians

As many as 18 species of amphibians and reptiles were successfully identified in this study. The identified amphibians and reptiles consisted of four (22%) species of frogs (*Rana daemeli*, *Limnonectes* sp., *Litoria infrafrenata, Duttaphrynus melanostictus*), eleven (61%) species of lizards (*Emoia caeruleucauda, E. kordoana, Eutropis multifasciata, E. rudis, Cryptoblepharus* sp., *Lamprolepis smaragdina, Hemydactilus frenatus, Broncochoela jubata, Draco beccarri, Varanus indicus, Varanus* sp.), three (17%) species of snakes (*Boiga irregularis, Python reticulatus, Ramphotyphlops braminus*). The data were the results of the species identification of reptiles and frogs found in lowland of primary forest habitat and hilly secondary forest, respectively, near the areas of Waedanga village and Ukalahin village and upland forest (Waedea water conservation area). One species, the monitor lizard *Varanus indicus*, was defined as a high conservation value.

The results of this survey were dominated by the taxon of reptiles, especially the Scincidae. Although the taxon of amphibian comprised only four species, the encountered taxon of amphibian had an abundant population in their habitat. Several species of reptiles and frogs can be used as a bio-indicator for environmental changes in the future because they have a limited population and spread in every habitat. Tree frogs, land frogs, and the frogs that lived in the river relatively had a very limited distribution. Endemic species with limited spread were very sensitive to damage or environmental changes (Petocz 1987). Frogs are usually very easily influenced by the changes in water quality / chemistry or other microhabitat modifications. In line with this, the efforts to maintain the stability of such habitats as rivers, small streams, marshes and ponds will help the life of frogs in nature.

c. Birds

The assessment survey recorded 75 species of birds. Of these, 32 species are high conservation values, consisting of 9 endemic species (2 endemic species were not recorded on the survey but likely to still occur in the higher elevations of Buru), 19 protected species under Indonesian law, and 2 threatened species (Vulnerable). In addition, 17 species are listed under CITES protocol. All species have been evaluated to have a viable population (either based on direct observation of birds seen or an expert opinion considering to the potential carrying capacity of the assessment landscape that is greater than 100,000 hectares. See Appendix 2 for a list of all TRP bird species.

d. Mammals

Of the 28 species of mammals known to occur on Buru, 16 species were positively identified. Four listed species, *Pteropus ocularis, Pteropus temmincki, Babyrousa babyrousa,* and *Cervus timorensis,* are vulnerable, whereas, only 1 species becomes Endangered species, *Pteropus melanopogon*. *Cervus timorensis* is also protected under Indonesian law. No other species are considered to be HCV targets because all found mammal species are non endemic species to Buru, and not listed under CITES.

Flora of Ecosystem

a. Lowland forests

Lowland forests in the survey areas included the forest formation of *Dipterocarps Lowland forest* dominated by *Shorea selanica* (Dipterocarpaceae), *Shorea montigena* (Dipterocarpaceae), and several kinds of light woods such as *Palaqium amboinensis* (Sapotaceae), *Terminalia complanata* (Combretaceae), *Sterculia* sp. (Sterculiaceae), *Calophyllum* spp. (Calophylaceae) and *Garcinia* sp. (Clusiaceae).

The forest formation was characterized by the presence of a clearly stratification of the forest and was composed of several layers of trees that made up the forest canopy and a number of growth levels on tree species and other life forms such as shrubs, lianas, epiphytes, and herbs.

The original condition of lowland forest of Buru Island could still be seen in sacred areas protected by the indigenous communities around Waedanga village especially around Waenebu watershed. Tree species such as *Arthocarpus heterophylus* and *Arthocarpus* sp. (Moraceae), and a number of fig tree species (*Ficus* spp. – Moraceae), forest nutmeg (*Myristica* sp. and *Knema* sp. – Myristicaceae), Kenanga (*Cananga odorata* – Annonaceae) and Sengon (*Paraserianthes falcataria* – Mimosoideae; Fabaceae) were seen in association with Meranti trees in this type forest. In addition, Sengon seemed so dominant along the banks of the river and some of the open areas and competed with fast-growing type of species such as Samama trees (*Neolamarckia moluccensis* - Rubiaceae).

In addition to tree types, some life forms of typical plant were seen in this forest type although not too diverse and complex, such as palms, lianas, herbs and epiphytes, including ferns and orchids. Palm (Arecaceae family) is dominated by *Areca vestiaria*, *Arenga pinnata*, *Calyptrocalyx spicatus*, *Caryota rumphiana*, *Pinanga rumphiana,* and *Rhopaloblaste ceramica*. Lianas or vines are dominated by species of the families of Menispermaceae, sirih-sirihan (*Piper* spp. - Piperaceae) and rattans, namely *Calamus* spp. and *Daemonorops* sp from Arecaceae family. Meanwhile, encountered herbaceous plants were some kinds of aroids (Araceae), some kinds of gingers (*Zingiber* sp., *Alpinia* sp., *Amomum cf. Aculeatum* and *Phlorantodium* sp. - Zingiberaceae), *Costus* sp. (Costaceae), *Phrynium pubinerve* and *Donax caniformis* (Marantaceae) and

other ground covering plants.
Besides orchids and epiphytic ferns, another Epifit also found was ant house plants (*Myrmecodia* spp. - Rubiaceae).

b. Highland forests

High land forests in the survey areas ranged from 800 m to 1300 m above sea level, characterized by forest vegetations which were quite tight and tended to have trees with small diameters, excepting for a few species of trees that looked as dominant trees as well as some types of conifers. Based on the observation conducted along the logging road between the airport and the water spring of Waedea, the elevation was approximately from 1200 to 1300 m above sea level. Woody plant species dominated upland forest come from Myrtaceae family.

Upland forests are dominated by woody plant species from the family of Myrtaceae, and one kind of its trees is *uhun* wood (local name for Buru) or *Leptospermum* sp. (Myrtaceae), which belongs to the commercial type that has a strong class and primary durable class with high wood density. Other types of Myrtaceae are *Syzygium* spp., *Tristaniopsis* spp. and *Leptospermum* aff. *flavescens*.

The group of conifers or needle-leaved plants is one of the upland forest identifiers. The common types are *Dacrydium* sp., *Dacrycarpus* sp., *Phyllocladus* aff. *hipophyllus* and *Agathis celebica*. Besides, *Casuarina aff. papuana* (Casuarinaceae) were also seen on the sidelines of the forest canopy and there are growing in open areas, including on the both sides of the logging road.

In general, the upland forests in the survey areas are the most well-protected and do not suffer from a negative impact of deforestation. This is because the topography is very heavy and it lacks the potential type of commercial wood / tree (meranti) in the upland forests.

Because most of the forested areas have heavy topographies, the distribution of plant species is very interesting, especially the criteria of lowland forests that could be recognized up to the height of 800 m above sea level. On the contrary, some types of highland plants found at an altitude of about 300 m above sea level--*Castanopsis buruana* and *Lithocarpus* sp. from the family of Fagaceae --were also present. During the observation they were in blossom. In addition, *Agathis celebica* (Podocarpaceae) is also spreading in this forest type and becomes the main tree species that are protected by the communities as resin-producing trees.

c. Riparian Vegetation / Periodic Swamp Forest

Vegetations not only along the watershed of Waenebu and a few places around Waedanga village but also in swampland near Kasuari Camp showed the characteristics as the group of vegetations or different forests from lowland forests around them. Likewise, there are several natural lakes or ponds found on the path between Dusun Waerei and Desa Ukalahin. Riparian vegetation / Periodic Swamp Forest is characterized by waterlogged soil conditions, either temporarily (periodic) during the rainy season or permanent as it is adjacent to the watersheds. As a result, plants that grow in this type habitat should be adaptable to conditions where water is abundant. Some of the dominant tree species in the periodic swamp forest are among others: *Terminalia* sp. (Combretaceae), *Arthocarpus* sp. (Moraceae), *Campnosperma* sp. (Anacardiaceae), *Dillenia* sp. (Dilleniaceae) and *Schuurmansia* sp. (Ochnaceae) as well as *Canarium* sp. (Burseraceae) which is in form of bush. Other dominant vegetations were pandan (Pandanus sp. - Pandanaceae), teki-tekian rawa (Cyperus spp., and Mapania spp. - Cyperaceae), rattan (Calamus sp., and Daemonops sp. - Arecaceae) and palem asam paya (*Pholidocarpus* sp. - Arecaceae). The surface vegetations were dominated by *Selaginella* sp. (Selaginellaceae), paku-pakuan (*Nephrolevis* spp. – Fern & Ferns allies) and *Osbeckia* sp. (Melastomataceae).

In the transitional area between riparian vegetation / Periodic swamp forest and lowland forest was found white meranti (Shorea selanica) associated with the types of trees in the periodic swamp forest vegetation as mentioned earlier. White meranti potential of the commercial type is so big that there is an opportunity to economically exploit this habitat type.

Sagu (*Metroxylon sagu* - Arecaceae) supposed to grow in the habitat of this vegetation type is only a cultivated crop planted by local residents but their numbers are limited and they scattered sporadically in springs near the local village.

d. Vegetation in Non-Forested Areas

Non-forested areas in the survey areas were actually grassland (savanna) of kayu putih with dominant vegetation being alang-alang *Imperata cylindrica* (Poaceae) – kayu putih *Melaleuca leucadendron* (Myrtaceae). This vegetation type is more influenced by minimal rainfall and fire as determinants. With low precipitation (dry climate), these areas are vulnerable and prone to fires, not to mention the condition of red-yellow podsolic soil which is poor in nutrient and prone to erosion, and the influence of local people living in HPH concession that often burns the forest to open a new plantation.

Other non-forested areas were open areas on the right side of the road and the former settlement of employees (base camp) which was abandoned and is undergoing primary succession. Alang-alang (*Imperata cylindrica*) and wild carnivores (*Nephentes* spp. - Nephentaceae) were dominant inhabitants of the areas.

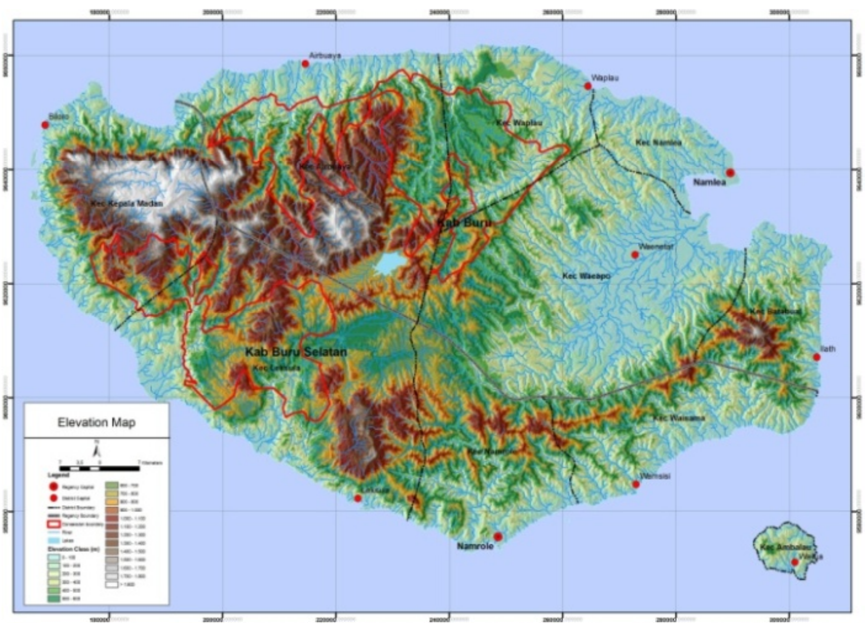
Other plant species (secondary forest vegetation) or indicators showing that a succession stage is taking place in these non-forested areas were *Commersonia bartramia* (Tiliaceae), *Trema orientalis*

(Tiliaceae), *Pipturus* sp. (Tiliaceae), *Polyscias* sp., *Piper aduncum* (Piperaceae), *Melastoma malabathrica* (Melastomataceae) and *Weinmannia* sp. (Sapindaceae).

Jabon tree or Samama tree species (*Neolamarckia moluccensis* - Rubiaceae) is a fast-growing species which was found almost in all open areas and had a very excellent adaptability to newly opened degraded areas. Besides, it has the potential of prospective timber when it is developed for the industrial need in the future.

Geology, Topography, Hydrology, and Climate on Buru Island

Buru Island is a non-vulcanic island located on subduction zones from two lithosphere plates that are geologically very complex. A third of the north-eastern part of the island contains granite while the rest is composed of melange rock. The northern part of this island has the Crystalline metamorphic rocks, gneiss, amphibolite and pilit and uplifted cliffs coral limestone along the coast. In the southwest there are outcrops of limestone "flysch" daro Trias and partly is a karst rock.



(Source SRTM, CGIAR vers 3 Digital Elevation Model)

Figure 3. Elevation categories accross Buru island

More than 80% of the total broad of the Buru Island is mountains spreading in the southeast, south, west and center of the island (Figure 3). In west, the highest and most extensive mountain is Mount Kapalat Mada steep climb from the sea to the highest point at 2.760 m on the Fogi mountains range. The hills are scattered around the mountains. These topography units form a series of rounded hills and ramps rather steep slope and climb up to 800 m. Instead almost all the north-eastern parts of the valley basin consist of a broad alluvial plain in the Waeapo watershed and the Kaleji Gulf. Wae Apo plateau extends about 35 km and about 15 km wide. Plain also spreads in coastal areas (coastal plain around 2-3 km wide on the north shore) and between Mountains. Examples of inter-mountain plains is Lake Rana, around Wailo at south of Lake Rana and Wae Geren valleys in Ukalahin.

Figure 4. Hydrology map of Buru Island

Buru is oval shaped and the hydrology is relatively simple with rivers radiating from the centre of the island to the peripheries (Figure 4). The largest watershed of the island is Wae Apo which is extended along a lowland plains depression in the eastern part of the island and enters the sea in the Bay near Namlea. All other rivers have short lowland plains and enter the sea abruptly and reduce the potential for flooding dramatically.

Climate patterns on Buru are very much affected by the regional seasons that are dominant wind direction. From December to May, the westerly winds bring in moist air from the Indian Ocean and shed rainfall over the entire island. June to November sees the drier winds blowing from the Australian continent and rainfalls drop, especially in the east and north of the island. Between these seasons, the southern part of the island experiences very high rainfall, presumably due to southern winds carrying, moist air which shed rain when they are pushed up abruptly over the landmass of Buru.

Analysis of Threats, Conservation and Management Issues

A serious threat will happen to the ecosystem balance on Buru Island if forest management is not well implemented. The collected data in this study are more sufficient to discuss the chances of a natural balance disorders in the future. Threats may impact integrity of the threatened viable populations, restricted range (endemic) and protected species in Buru Island, in general i.e. habitat degradation impacting biodiversity, conversion of habitats by communities, and wildlife exploitation by local community and outsiders.

Maintaining landscapes that can support natural species assemblages essentially requires maintaining forest cover, connectivity and avoiding fragmentation within the landscape. The main threat might be logging operations in rare swamp forest and forest on flatter plains, riparian zone and other ecosystems that are vulnerable, and soil erosion through timber harvesting and extraction (roads).

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