Biodiversity Assessment of Mt. Kababalitan, Arakan Valley

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Abstract

The main objective of this study was to assess the biodiversity of flora and fauna and the physico-chemical characteristics of the soil for forest rehabilitation. The point- line intercept method was used to determine the species richness, evenness, abundance, and diversity present in the study site. Soil samples were collected and subjected to laboratory analysis to determine the amount and presence of macro and micro nutrients, pH, bulk density, and other factors that may affect species diversity. The results revealed that there is a low diversity index of flora species in the site; laboratory analysis of the soil also revealed a general feature of low fertility this low soil fertility can account for low species diversity of the study site. However, rehabilitation of the forest can still be possible. Planting of indigenous tree species is recommended.

Keywords: *biodiversity, forest, rehabilitation*

Philippines is a party to the Convention on Biological Diversity (CBD) entered into force to incorporate people into biodiversity protection. According to O'Riordan (2002), biodiversity has its links to ecosystem properties, have cultural, intellectual, aesthetic and spiritual values that are important to society. Biodiversity is both ecological and social phenomenon (O'Riordan Tim & Kleemann-Stoll, 2002). The World Resources Institute (2002) has warned that the declining rate of the long term productive capacity of the ecosystems have had the devastating implications for human

development and species welfare. Hence, it is imperative to incorporate people into biodiversity protection.

Biodiversity is expected to be high in a forest ecosystem. But because of deforestation and other forms of land conversion, the rainforest that once covered the earth's land surface by about 14% has declined mere to 6%; it was also estimated that there were about 50,000 species lost every year (Baker, 2008). Despite the great value of the forest ecosystem, it still being degraded and lost because of economic value that makes forest conversion more profitable than conservation.

The destruction of the forest has disastrous effect on the unique and rich biodiversity of the Philippines. In fact, the forest area in the Philippines has fallen from 21 million hectares in 1900 to less than 6 million in 1996 (DENR, 2002). The loss of Biodiversity has negative impacts on vital ecosystem functions such as water retention, erosion control, carbon storage, and mineral recycling. To combat this detrimental problem, the government has implemented reforestation projects to bring back the lush forest vegetation. Nonetheless, reforestation projects failed to consider the effects of the strategy, it employed in reforesting our countryside. While reforestation was supposed to restore the lost forest, the forest plantations were established primarily for profit. Thus, the government used fast-growing exotic species like Mahogany (Swietenia mahagoni) and Gmelina (Gmelina arborea Roxb) which have had some negative impacts on the productivity of the land and on the biodiversity of the area.

One of the major problems of Philippine forestry is the utilization of some 5,270,000 hectares of wastelands a large portion of which is covered with *cogon* grass, *Imperata cylindrical;* this vast area of unproductive land is largely the result of forest destruction by shifting cultivation, domestically known as *kaingin.* Since exotic species are planted beyond their native range, they often lack the fruits, flowers, or insects required by local wildlife. With the inhibited growth of native plants, many native/endemic animals are displaced. Fast growing exotic species are also poor substitutes to our native/indigenous species whose timbers are highly valued. The study shows that weeds maintain soil humidity and structure.

On the other scenario, rainforests are increasingly vulnerable to fire; as trees are slashed and burned by peasant farmers, the once-vast rainy ecosystems are reduced to dry fragments this trend is leading to a drier climate worldwide and is also contributing to the greenhouse effect.

The issue of slash and burn has been the pressing problem of the Local Government of Arakan Valley. After a series of forest fires in the area in 1980, the once lush forest of Lanao Kuran in Arakan Valley was not able to recover especially because of the continuous slash and burn practices of the community. The grown trees were cut for charcoal and the bottom part of the hill were cleared

for farming. However, farming did not sustain due to the quality of the soil, which was no longer suitable for the crops they planted. Hence, the forested hill was almost barren with *Imperata cylindrica* and *Asplenium onopteris* as the most dominant species that survived in the area over the years. The community has the desire to restore the forested area; hence, this project was conceptualize to rehabilitate Mt. Kababalitan.

Objective of the Study

The main objective of the study was to assess the biodiversity of Mt. Kababalitan the basis for future rehabilitation and policy formulation.

The specific objective of this study is:

1. To determine the profile of Mt. Kababalitan in terms of:

    1.1 Biodiversity

    1.2 Soil Properties (physical and chemical characteristics)

Materials and Methods

This study was conducted using the line-point intercept method to assess the flora and fauna of the five sites with a 200 m transect line. Laboratory analysis for soil samples was also employed and other physico-chemical characteristics of the site. The area is located at $7^0$18' 35" North and $125^0$14'25" East with an elevation of 960 m above sea level. With scarce rainfall, the average temperature during the on-site sampling was between 31-32 degree Celsius at an average relative humidity of 55-65 %.

Line –Point Intercept Method

Line-point intercept method was used to quantify the relative abundance of organisms in the area. Five (5) transect lines measuring 200 m each were positioned along the five (5) sampling sites of the study area. Twenty five (25) quadrats were randomly laid along each transect line with an approximate distance of 8 meters per quadrat for each transect. Every quadrat is measured by 40 x 40 cm; points were designated per quadrat.

Laboratory analysis

Soil samples from the bottom, middle and top of each transect line were collected. At least 100 grams of soil sample taken 6 inches from the surface were submitted for laboratory analysis to determine the pH, bulk density, water holding capacity, presence of organic matter and macro and micro nutrients present in the soil, and other chemical properties of the soil.

The temperature per transect was recorded. Direction and relative humidity of the site were also determined during the sampling. The five sites had uniform temperature and relative humidity during the sampling. All sites of the study were exposed to direct sunlight.

The transects were mapped with a GPS, and for assignment each quadrat was pointed. There were 25 randomly assigned quadrats per transect. For each transect, physical count of flora and fauna was conducted.

A survey within the nearby forest vicinity was also done to determine the common types of trees; the researcher interviewed some residents is the community. There was also a series of consultation with the Barangay Officials of the community on the purpose of rehabilitating and declaring the area as a protected zone for reforestation before the on-site biodiversity assessment.

The Site of the Study

The project site is located in Region XII, Arakan North Cotabato which is 21 kilometers away from Poblacion Arakan. The Brgy Lanao Kuran has thirteen Sitios with a total land area of 2, 754 ha. The barangay has a mountainous terrain with a large portion of grassland and some generating second growth forest. The area has silty clay, sandy loam and limestone soil. Forty five (45) ha of the land area was donated to Brokenshire College thru the United Church of Christ (UCCP) and Social Concerns Foundation (SCF), 5 ha of which is in Pinedan. The 900 m^2 site was designated for the Health Center and another 800 m^2 for the UCCP chapel. There is a cave within the barangay which could be a possible eco-tourism site.

The municipality of Arakan is important; as it is part of Mt. Sinaka which was declared as Municipal Reservation and Wildlife Sanctuary. The unabated cutting of trees or clearing of forest for agricultural purposes have endangered the environment and the sustainable source of livelihood of the people.

Mt. Kababalitan at Sitio Moyas, Arakan Valley, South Cotabato, was once covered with plants and wild animals. However, in 1982, a long period of heat resulted to wild fires; since then, the forest was not able to restore its rich flora and only few plants have survived such as *Piper adduncum* (Spiked pepper) (not endemic to the place), *Asplenium onopteris* and *Imperata cylindrica*.

Results and Discussion

Table 1.
Grass species richness and proportions among sites

Site	Number of Species	Percent of total species	Percent unique to site
1	10	83.3	16.67
2	7	58.3	0.0
3	7	58.3	0.0
4	7	58.3	0.0
5	9	75	8.33
Total	12	_	_

In all transects, a total of twelve grass species were found namely: *Imperata cylindrical, Centaurea nigra, Asplenium onopteris, Chromolaena odorata, Polygala variabilis hassk, Exaltata nephrolepis, Melastoma malabathricum, Russula spp, Piper adduncum, Spathoglottis plicada, Ageratum conyzoides* and *Cynodon dactylon.*

Table 1 above shows the number of species, proportion of total species, and proportion of species unique to each site. *Melastoma malabathricum* and *Chromolaena odorata* are found only in Site 1 and *Spathoglottis plicada* is found only in Site 5. *Imperata cylindrica, Asplenium onopteris, and Centaurea nigra* are found in all sites. *Exalta nephrolepis, Cynodon dactylon, Ruussula spp, Polygala variabilis Hassk, Ageratum conyzoides, and Piper adduncum* are intermediately distributed among the sites.

The weighted proportion of each transect provides a measure of species diversity. Thus, Imperata cylindrical was found to be the highest in terms of the number of individuals in all transects. This is due to the fact that *Imperata cylindrical* is known to be a widespread invader in many subtropical and tropical regions with over 490 million hectares (1.2 billion acres) infested worldwide (Lippencott and McDonald 1996). Moreover, the warm temperature and slightly acidic soil in Mt. Kababalitan contributes to the growth of *Imperata cylindrical*. According to Wilcut et al., (1988), *Imperata cylindrica* is tolerant of a wide variety of soil conditions, including variations in fertility, organic matter, and moisture; it grows best in relatively acidic soils (pH 4.7). Hence, temperature markedly affects shoot and rhizome growth, with an increased growth occurring at 29º/23ºC (day/night) (Wilcut et al., 1988).

Table 2.
Relative frequency of grass species across all sampling sites

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Total	Relative frequency
Imperata cylindrica	24	15	14	22	17	92	.37
Asplenium onopteris	15	17	15	14	11	72	.29
Exalta nephrolepis	1	2	0	0	8	11	.044
Cynodon dactylon	1	2	2	0	5	10	.040
Spathoglottis plicada	0	0	0	0	2	2	.008
Russula spp	1	3	3	3	0	10	.040
Centaurea nigra	7	2	1	6	6	22	.088
Polygala variabilis hassk	5	0	1	1	7	14	.056
Ageratum conyzoides	0	2	1	2	1	6	.024
Piper adduncum	3	0	0	2	3	8	.032
Melastoma malabathricum	1	0	0	0	0	1	.004
Chromolaena odorata	1	0	0	0	0	1	.004
Total	59	43	37	50	60	249	

**25 quadrats/site*

Table 2 shows the number of quadrats*; each of the species was observed in all sites and the corresponding relative frequencies. *Imperata cylindrica* and *Asplenium onopteris* have the highest relative frequencies, followed by *Centaurea nigra* , *Polygala variabilis Hassk* , *Exalta nephrolepis* ,

Cynodon dactylon , *Russula spp* , *Piper adduncum* , *Ageratum conyzoides* , *Melastoma malabathricum* , and *Chromolaena odorata*.

Table 3.
Grass species diversity among sites

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5
Species Richness	10	7	7	7	9
Evenness Index	0.734	0.584	0.708	0.525	0.786
Shannon's Diversity Index	1.689	1.136	1.378	1.022	1.7264
Effective Number of Species	5.4	3.0	4.0	2.8	5.6

Table 3 shows the parameter estimates of a grassland community in Mt. Kababalitan, Lanao Kuran, Arakan Valley. Site 1 had the greatest number of species, followed by sites 5, 2, 3, and 4. However, the number of individuals was more evenly distributed among each species in site 5, followed by sites 1, 3, 2, and 4. The Shannon's diversity index and the effective number of species were also greatest in site 5, followed by sites 1, 3, 2, and 4. The effective number of species was determined in each site to provide an intuitive comparison of biodiversity species biodiversity the sites. The effective number of species is a value equivalent of the number of species that are equally abundant. In the case of site 5, the biodiversity is equivalent to 5.6 equally abundant species.

Table 4.
Soil testing of the sites according to pH Level.

Site	Soil Reaction (pH) 1:1	Description
1	6.5	Slightly Acidic
2	6.2	Slightly Acidic
3	6.3	Slightly Acidic
4	6.2	Slightly Acidic

5	6.3	Slightly Acidic

As seen in the laboratory result of the soil per site, all of the sites are slightly acidic. Hence, it can be deduced that the general description of the pH of the soil is slightly acidic with a mean pH level of 6.3.

Most of crops will grow satisfactorily on soils with a pH ranging from 6.2 to 8.3 (Herrera, 2005). It has been proven that soil pH can be raised by applying lime to the soil. As observed in the site, ashes (lime) are observed on the surface of the soil in all sites. Noting from history and from the testimony of the residents, forest-fire was the cause of denudation of the forest. Hence, it can be deduced that the contributing factor which decrease the soil acidity is the presence of lime in the soil as the product of burned plants three decades ago.

The *Imperata cylindrica* commonly known as cogon grass, dominates the area of their study. This type of grass, even if apparently green is flammable. Some residents mentioned that every time the long drought happens, fires would likely to occur in the site; and the precursor of the fire is the dried cogon leaves on the ground, considering its flammable characteristic.

Table 5.
Soil testing of the sites according to presence of Organic Carbon (OC) and Organic Matter (OM).

Site	Organic Matter (%)	Description	Organic Carbon (%)	Description
1	1.43	Very Low	1.03	Very Low
2	3.54	Medium	2.66	Low
3	5.09	High	3.92	Low
4	2.74	Medium	1.63	Very Low
5	6.46	Very High	4.86	Medium

The average presence of organic matter is 3.85% in all sites; it indicates a medium presence of organic matter. However, in Site 5, it reveals a very high presence of organic matter. The site 1 indicates a very low presence of organic matter.

Organic matter in soil is represented by plant debris or litter in various stages of decomposition through humus; it includes the living organisms in the soil. The presence of organic matter has long been recognized as an essential component of a highly productive soil. It plays an important role for plant growth and diversity.

The overall description of the site reveals a low to very high presence of organic matter. Thus, it can be deduced that the diversity of plant species that thrive in the site has a direct

correlation to the presence of organic matter in the soil. Consequently, the low presence of organic matter corresponds to the low flora diversity of the site.

The soil organic matter was reported as the percentage of organic matter (dry weight) in the upper soil profile 4-6 inches deep; it was related to the cation exchange capacity of the soil, soil water-holding capacity, nitrogen mineralization rates, and microbial activity. Also, the soil organic matter provides the chemical and biological basis for soil components (sand, silt, and clay) to form soil aggregates, and it is critical to key physical processes such as water and gas exchange, penetration resistance, and compaction. In addition, soil organic matter is about 60% in carbon the amount of organic matter is predictor of the amount of carbon in soils (The H. John Heinz III Center for Science, 2002).

The breakdown of physically uncomplexed OM, ultimately into inorganic constituents, is mediated mainly by soil microorganisms, which derives energy and nutrients from the diverse range of molecules in the SOM. If the nutrients are not taken up by the microorganisms, they are available for plant uptake (E. G. Gregorich, 2006).

Since the laboratory result as the study revealed a low soil organic matter of the site, this depicts a low soil quality and low soil productivity.

Table 6.
Chemical Characterization of the Sites

CHEMICAL CHARACTERIZATION								
Site	Exchangeable Bases (m.eq/100 g of soil)						Total Base Saturation (%)	Sulfur (ppm)
	Ca	Mg	Na	K	CEC	EA		
1	2.13	27.52	0.07	0.01	33.58	10.04	74.80	53.16
Description	L	VH	VL	VL	H	VH	H	H
2	1.65	17.89	0.16	0.04	23.43	13.52	59.30	23.13
Description	L	VH	VL	VL	M	VH	M	L
3	4.19	17.38	0.10	0.11	25.83	10.71	67.10	49.75
Description	M	VH	VL	VL	M	VH	H	M
4	14.22	15.91	0.05	0.07	39.11	13.51	69.10	59.28
Description	H	VH	VL	VL	H	VH	H	H
5	6.71	14.39	0.06	0.36	33.60	15.63	57.90	59.45
Description	M	VH	VL	VL	H	VH	M	H

Legend: VH: very high, H: high, M: moderate, L: low, VL: very low

As seen in Table 6 above, there is a very low amount of calcium (Ca) present in Sites 1 and 2. However, calcium is high at Site 4. The overall Calcium presence in the study area is moderate. In the case of the presence of magnesium (Mg), Sites 1 to 5 depict a very high presence. For Sodium (Na) and potassium (K), have a low presence among the five sites. The overall exchangeable acidity (EA) of the five sites is very high. The overall Cation Exchange Capacity (CEC) ranges from moderate to high. The CEC is calculated as the sum of exchangeable bases (Ca, Mg, Na, and K) and exchangeable acidity. The average base saturation on the other hand is 65.64%, which is high.

The Exchangeable Acidity (EA) is a measure of pH buffering capacity; while the Cation Exchange Capacity (CEC) is a calculated value which is estimated as soil's ability to attract, retain, and exchange cation elements-Ca, Mg, Na, and K are basic cations which are necessary plant elements/nutrients.

The amount of exchangeable bases and the Cation Exchange Capacity (CEC) are the important properties of soils and sediments. They relate information on the soil's ability to sustain plant growth, retain nutrients, buffer acid deposition, or sequester toxic heavy metals(BRIX, 2008). CEC is important for maintaining adequate quantities of plant with calcium (Ca^{2+}), magnesium (Mg^{2+}), and potassium (K^{+}) in soils.

Soils with a high CEC will tend to hold on to nutrients better than soils with a low CEC. However, this is not the case in the study based on the laboratory result. There is a moderate CEC of the area on study. It can be construed then that it has a low tendency to hold nutrients which could indicate a low soil fertility.

Closely related to CEC is the base saturation, which is the fraction of exchangeable cations that are base cations (Ca, Mg, K and Na); the higher the amount of exchangeable base cations, the more acidity can be neutralized in the short time. Base Saturation is also used as an indicator of soil fertility (BRIX, 2008). Base Saturation is directly related to pH; when the percent base saturation increases, the pH also increases.

As revealed by the laboratory result in the Table 6, there is a high level of exchangeable base saturation, which is also directly related to exchangeable acidity which is very high in the five sites. This can be construed that there is a high possibility of decreasing pH level of the soil in the long run, which may become unhabitable for plant growth

Table 7.
Trace Elements of the site

Site	TRACE ELEMENTS (ppm)				
	Cu	Zn	Fe	Mn	B
1	0.84	0.60	24.92	14.00	1.00
Description	L	M	L	L	M

2	1.54	1.00	51.70	22.60	0.56
Description	L	M	M	L	M
3	1.39	1.08	47.60	21.70	0.88
Description	L	M	L	L	M
4	1.63	1.62	31.53	13.02	0.77
Description	L	H	L	L	M
5	1.90	2.38	119.64	16.20	0.78
Description	L	H	H	L	M

Legend: VH: very high, H: high, M: moderate, L: low, VL: very low

Table 7 reveals the overall scenario of the presence of trace elements in the soil. In all sites, Boron is moderate. The presence of Manganese on the other hand is low in all sites. For the presence of Iron, there was a low in Site 1, Site 3, and Site 4. It is moderate in Site 2; and it is high in Site 5. Zinc is moderate in Site 1, Site 2 and Site 3. However, its presence is high in Site 4 and Site 5. The presence of copper is low among the five sites in all locations.

Trace elements are essential for plant growth in small quantities, but they can be toxic in large quantities. Copper, which is vitally important to root metabolism; it helps form compounds and proteins, amino acids; and a host of organic compounds. More than 99% of the Cu in the soil solution is complexed by organic matter as confirmed from the results above.

Table 8.
Physical Characterization of the soil according to site.

Field Identification	Physical Characterization						
	MF	Bulk Density (g/cm^3)	WHC (%)	Mechanical Analysis (%)			
				Sand	Silt	Clay	Class
Site 1	1.14	1.02	90.55	39.13	33.47	27.40	Clay Loam
Site 2	1.10	0.76	89.18	31.13	42.13	26.73	Loam
Site 3	1.10	0.68	92.25	37.13	33.47	29.40	Clay Loam
Site 4	1.11	0.91	99.46	25.67	34.27	40.07	Clay
Site 5	1.11	1.07	99.47	46.33	37.60	16.07	Loam

Table 8 describes the soil texture of the site on study. Clayish Loam is the soil texture of Site 1 and Site 3. The soil texture of Site 2, and Site 5 is loam. The Site 4 is clay.

Soil texture (particularly soil clay content) plays direct and indirect roles in chemical and physical protection mechanisms (Alain F. Plante, 2006). In relation to cation exchange capacity (CEC) clay has a great capacity to attract and hold cations because of its chemical structure. Sand has no capacity to exchange cations because it has no electrical charge.

Bulk density is an indicator of soil compaction. In agricultural terms the bulk density of the soil can be used to give an indication of the porosity and structure of the soil which will, govern O_2 and H_2O movement in the soil. Bulk density is dependent on soil texture and the densities of soil

mineral (sand, silt, and clay) and organic matter particles, as well as their packing arrangement. The factors that may influence the measurement of bulk density are organic matter content of the soil, its porosity and the soil structure, where these factors will intern control hydraulic conductivity, or in other words the water holding capacity of the soil.

The result above revealed a moderate to low bulk density of the soil, which would correspond to clayish and loamy soil as seen in Table 8. This can be construed that the general characteristics of the soil is it has a moderate water holding capacity. This may be due to the fact that one factor that may affect bulk density is the organic matter content of the soil. In table 5, results reveal a medium to very high presence of organic matter in the soil especially among sites 3,4 and 5. While in sites 1, there is a low presence of organic matter, which would correspond to high bulk density. The overall characteristics of the soil in terms of bulk density in relation to its water holding capacity is moderate. Hence, it can hold a moderate amount of water. However, during dry seasons, the amount of water that it can hold may not be able to sustain plant growth, especially that the area is exposed to direct sunlight and no vegetation can prevent transpiration and evaporation from the soil. As mentioned above, a survey for common type of tress that grew within the nearby forest vicinity was done. There was also an interview with some residents within the community and series of consultation with the Barangay Officials and the community on the purpose of rehabilitating the area and declaring it as a protected zone before the conduct of the on-site biodiversity assessment. A Barangay resolution was passed to declaring the area as Protected Zone for Reforestation.

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