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Kalinga - Apayao State College Forest Laboratory Area Its Contribution to Tree Biodiversity Conservation and Carbon Sequestration

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Abstract: **The study aimed to assess the contribution of the KASC Forest Laboratory in terms of tree biodiversity conservation and carbon sequestration. The study employed inventory and listing of species with their corresponding diameters. The tree diameters with 10 cm above were processed using allometric equation (Brown, 1997) to arrive at the carbon sequestration in the area. Simpson biodiversity index was used to evaluate the species diversity and Shannon index for the species richness of the area. There were 55 species, with Simpson diversity index of 0.236 indicating high species biodiversity of the area while the Shannon index was 2.39 which indicates high species richness. The carbon sequestration of the area has stored 151.68 Mg of carbon for the duration of 15 years from establishment. The KASC Forest Laboratory area has an average of 2.12Mg/ha/year of carbon which is comparable to some plantation in the Philippines. Knowing the potentials of the different species planted in grassland for its role in carbon sequestration and biodiversity conservation, there is a need to disseminate the result for information dissemination.**

Keywords: **KASC Forest Laboratory, Tree Biodiversity Conservation, Carbon Sequestration.**

1. INTRODUCTION

The increasing global concern on climate change has once again made forests and, for that matter, the field of forest management a favorite topic in the science and technology sector as well as among governments and communities concerned about the worsening and increasingly frequent and widespread floods, typhoons, landslides, droughts, and wildfires that have become commonly attributed to such climate change.

Forest management aimed at increasing the long-term storage of carbon in terrestrial ecosystems is a potential climate change mitigation measure which could also greatly impact the biological diversity of forest ecosystems. Biological diversity, or biodiversity, is defined within the Convention on Biological Diversity (CBD) as ‘the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems’ (CBD Article 2).

In the Philippines, the resurgence of concern for forests has been embodied in President Benigno S. Aquino III’s Executive Order 26 known as National Greening Program (NGP) and Executive Order 23 that seeks a moratorium on the cutting and harvesting of timber in natural and residual forests.

Forest as defined under Department of Environment and Natural Resources Memorandum Circular 2005-08 “land with an area of more than 0.5 hectare and tree crown (or equivalent stocking level) of more than 10 percent. The trees should be able to reach minimum height of 5 meters of maturity in situ. It consists either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground cover or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes, which have yet to reach a crown density of more than 10 percent or tree height of 5 meters are included under forest."

The world's forests have a substantial role in the global carbon cycle. IPCC (2007a) reports the latest estimates for the terrestrial sink for the decade 1993-2003 at 3,300 MtCO2/yr, ignoring emissions from land-use change (Denman et al., 2007, cited by Nabuurs et al., 2007).

Shively (2003) as cited by Labata et al 2012 reported that the Philippines rank seventh among the tropical countries in ability to sequester carbon. Ideally, forests are carbon sinks but because of deforestation, they are currently sources of carbon dioxide. Forest ecosystems are also converted into plantation or croplands by slash and burn because of food production.

Philippine forest ecosystems have likewise been a source and sink of carbon. From the 1500s to the modern era, it is estimated that deforestation has contributed 3.7 Gt C to the atmosphere (Lasco, 1998 cited in Lasco et al., 2005). Of this amount, 70% (2.6 Gt) was released this century alone. However, present land-use cover also absorbs carbon through regenerating forests and planted trees. The vast areas of degraded land in the Philippines in fact offer great potential for carbon sequestration through rehabilitation activities such as reforestation and agroforestry (Lasco et al., 2005).

In 1994, the leadership of the Kalinga-Apayao State College commits its institution to be the Center of Excellence in Watershed Management which means conserving the forest. The abovementioned commitment opens the window for the Bachelor of Science in Forestry. The faculty members and its students established various activities such as plantation development which serves as laboratory area of the students.

Various studies had been conducted to evaluate the carbon sequestration potentials of forest and its contribution to biodiversity conservation, however, limited literature is available on the contribution of forest as field laboratory of students in state colleges and universities, hence this research.

Objectives of the Study:

The general objective of this study was to assess the carbon sequestration potentials and biodiversity conservation of the KASC Forest Laboratory Area.

Specifically, this study aimed to:

1. determine the aboveground biomass and carbon density stored in the area; and
2. Determine the tree biodiversity of the laboratory area.

Methodology:

Time of the Study: This study was conducted from May 2014 to September 2014.

Data Gathering Techniques: The researcher gathers the diameter and species of the higher plants found in the KASC Forest Laboratory. Perimeter of the area was taken with the use of GPS and GIS Technology.

Organization of Data: The data were collated, encoded and processed with the use of GIS and Microsoft Excel 2007.

Carbon Stock Assessment: This study quantified the carbon stocks found within the above-ground biomass. Total enumeration was conducted. Diameters and local names of trees having 10cm and above dbh were recorded.

Above-ground biomass was computed using the following allometric equation (adopted from Brown, 1997):

$$Y(kg) = \exp[-2.134 + 2.530 * \ln(D)]$$

Data gathered:

1. Species of the plants
2. Diameter of the plants
3. Corner points of the KASC Forest Laboratory area

Data Analyses:

Data from primary sources were analyzed by quantitative methods. The descriptive tools (i.e. mean, frequencies and percentage) were used to analyze quantitative data using Microsoft Excel.

2. RESULTS AND DISCUSSION

Study Site:

The study site is located at the eastern portion of the State College. The KASC Forest Laboratory Area has approximately 5.112 hectares.

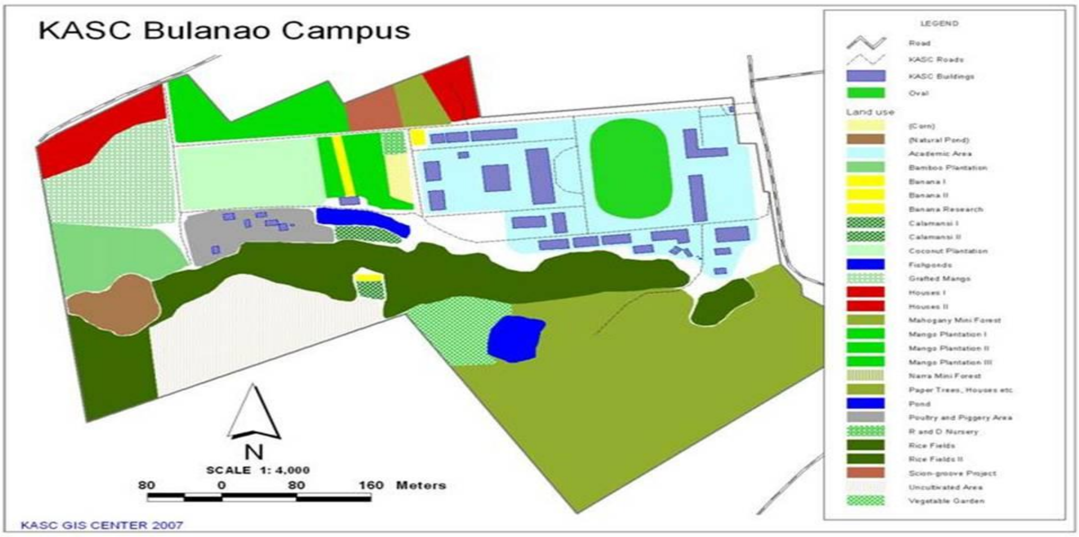

Figure: 1. The Kalinga-Apayao State College campus

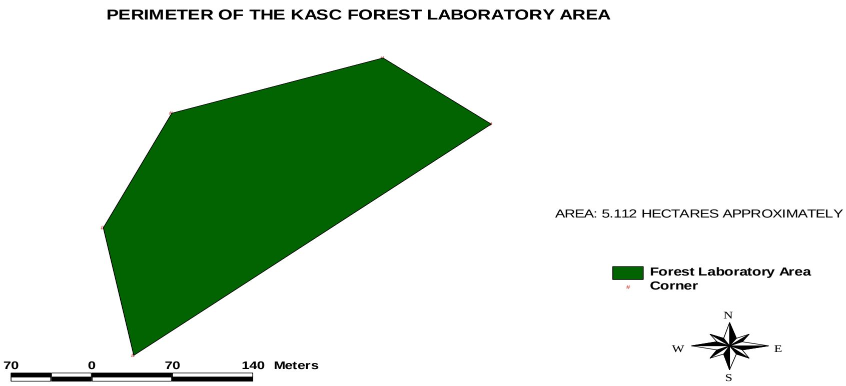

Figure: 2. The KASC Forest Laboratory area

BIODIVERSITY CONTRIBUTION:

Species biodiversity may be used to indicate the 'biological health' of a particular habitat. However, care should be used in interpreting biodiversity measures. Some habitats are stressful and so few organisms are adapted for life there, but, those that do, may well be unique or, indeed, rare. Such habitats are important even if there is little biodiversity. Biodiversity embraces the variety of life from plants to animals, from micro- to macro-organisms, from genes to genomes and ecosystems. Table 1 presents the biodiversity of higher plants in the study area.

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Table: 1. Biodiversity of higher plants

Species	Scientific Name	Number of Individual	Percentage
Alim	*Mallotus multiglandulosa* (Reinw. ex Blume) Harms.	43	4.32
American Kapok	*Ceiba pentandra* (L.) Gaertn.	24	2.41
Anabiong	*Trema orientalis* (L.) Blume	5	0.50
Antipolo	*Artocarpus blancoi* (Elm.) Merr.	2	0.20
Antsoan Dilau	*Cassia spectabilis* L.	4	0.40
Avocado	*Persea americana* Gaertn. *Persea gratissima* Gaertn	3	0.30
Bagalunga	*Melia dubia* Cav.	8	0.80
Banato	*Mallotus philippensis* (Lam.) Muell.-Arg.	3	0.30
Basikong	*Ficus botryocarpa* Miq.	1	0.10
Benguet pine	*Pinus insularis* Endl.	1	0.10
Big Leaf Mahogany	*Swietenia macrophylla* King	3	0.30
Bignai	*Antidesma bunius* (L.) Spreng.	28	2.81
Binayuyu	*Antidesma ghaesembilla* Gaertn.	2	0.20
Binunga	*Macaranga tanarius* (L.) Muell.-Arg.	21	2.11
Caimito	*Chrysophyllum caimito* L.	20	2.01
Dalingdingan	*Hopea foxworthyi* Elm.	1	0.10
Dalunot	*Pipturus arborescens* (Link.) C.B. Rob.	1	0.10
Dudua Bulate	*Hydnocarpus anthelmintica* Pierre	4	0.40
Duhat	*Syzygium cumini* (L.) Skeels	4	0.40
Fringon	*Bauhinia monandra* Kurz.	1	0.10
Gmelina	*Gmelina arborea* Roxb.	1	0.10
Governor's Plum	*Flacourtia jangomas* (Lour.) Raeusch.	465	46.69
Hauili	*Ficus septica* Burm.	6	0.60
Himbabao	*Broussonetia luzonica* (Blanco) Bur.	14	1.41
Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit.	2	0.20
Isis	*Ficus ulmifolia* Lam.	68	6.83
Kabuyau	*Citrus macroptera* Montr.	4	0.40
Kahoy dalaga	*Mussaenda philippica* A. Rich.	1	0.10
Kakauate	*Gliricidia sepium* (Jacq.) Walp.	1	0.10
Kalumpit	*Terminalia microcarpa* Decne	2	0.20
Kamagong	*Diospyros philippensis*	5	0.50
Lago	*Prunus grisea* (C. Muell.) Kalkm.	2	0.20
Lanete	*Wrightia pubescens* R.Br. ssp. laniti (Blanco	1	0.10
Ligas	*Semecarpus cuneiformis* Blanco	2	0.20
Lukban	*Citrus grandis* (L.) Osb.	2	0.20
Malapapaya	*Polyscias nodosa* (Blume) Seem.	61	6.12
Malabuho	*Sterculia oblongata* R. Br.	2	0.20
Mangga	*Mangifera indica* L.	1	0.10
Marang	*Litsea perrottetii* (Blume) F.-Vill	3	0.30
Matang-araw	*Melicope triphylla* (Lam.) Merr.	22	2.21
Molave	*Vitex parviflora* Juss.	1	0.10
Nangka	*Artocarpus heterophyllus* Lam.	6	0.60
Narra	*Pterocarpus indicus* Willd. forma *indicus*	2	0.20
Paguringon	*Cratoxylum sumatranum* (Jack) Dyer	28	2.81
Philippine ash	*Fraxinus griffithi* C.B. Clarke	1	0.10
Philippine chestnut	*Castanopsis philippinensis* (Blanco) Vid.	2	0.20

Rain Tree	*Samanea saman* (Jacq.) Merr.	1	0.10
Sampalok	*Tamarindus indica* L.	3	0.30
Santol	*Sandoricum koetjape* (Burm. f.) Merr.	2	0.20
Tagotoi	*Palaquium foxworthyi* Merr.	14	1.41
Takip asin	*Macaranga grandiflora* (Blanco) Merr.	4	0.40
Talisai	*Terminalia catappa* L.	1	0.10
Teak	*Tectona grandis* L.f.	3	0.30
Tibig	*Ficus nota* (Blanco) Merr.	21	2.11
Tuai	*Bischofia javanica* Blume	63	6.33

Moritz (2002) stipulates that protecting the environmental context that produced existing patterns of biodiversity is the best way to maintain evolutionary processes.

As shown above, the area is composed of 55 species. The species is dominated by Gmelina (*Gmelina arborea*), this is because during the start of the reforestation activity, Gmelina was used to eliminate the cogon for its high survival percentage. Ipil-ipil and Tibig co-dominates because this species are also easy to grow. Tibig was a species originally found in the area. Other species are almost introduced in the area which was planted by students and employees of the State College. The presence of Ficus species in the attract birds which is now notable in the research area compared when it was dominated by cogon. Ficus fruit have a crucial role for birds survival through the availability of foods. Ficus as a member of figs in an study found that it is important natural source of calcium, critical for strong bones and eggshells, blood clotting and numerous cell functions**.** Figs have, on average, nearly three times more calcium than nonfig fruits and contain calcium levels higher than minimum dietary requirements for growing primates. Several fig species contain enough calcium to support a hen laying 300 eggs a year**.**

The presence of the fruit bearing trees such as Avocado, Bignai, Binayuyu, Caimito, Governor's plum, Hauili, Lukban, Mangga, Sampalok, Santol and Tibig in the area also invite birds and other wildlife species.

The KASC Forest Laboratory area contains the following as define in DAO 2007-01 such as Kamagong and Narra- critically endangered species and Molave – Endangered species.

Using Simpson index for biodiversity it registered to have 0.236 which indicates high species diversity of the area. Species richness was also computed using Shannon Index and registered a value of 2.39. Both of the index for biodiversity measurement indicates high diversity of the area.

Carbon Sequestration:

The contribution of forest laboratory areas in the accumulation carbon through time, it may take a while before they can approximate the C density of the natural forests they replace. In the Philippines, various initiatives were undertaken by government, non-government agencies and others inorder to reforest idle areas for different purposes either as a source of timber or for environmental services. The carbon sequestration potentials of individual species is shown in Table 2.

Table: 2. Carbon Sequestration Potential of Individual Species

Species	Carbon Density (Kg)
Alim	4590.64
Anabiong	670.98
Antipolo	370.62
Antsoan Dilau	510.52
Avocado	192.99
Bagalunga	132.67
Banato	18.05
Basikong	35.05
Benguet pine	3487.79
Bignai	46.67
Binayuyu	1174.24

Binunga	1890.70
Caimito	184.13
Kabuyao	18.05
Dalingdingan	69.10
Dalunot	91.88
Duduang Bulate	69.10
Duhat	18.05
Fringon	50.34
Gmelina	81100.90
Governor's Plum	427.71
Hauili	1396.58
Himbabao	224.22
Ipil-ipil	11433.97
Isis	18.05
Kahoy dalaga	18.05
Kakauate	250.60
Kalumpit	1354.62
Kamagong	79.85
Kapok	802.79
Lago	104.24
Lanete	133.83
Ligas	201.76
Lukban	439.71
Malabuho	452.10
Mahogany	7695.28
Malapapaya	28.63
Mangga	8691.90
Marang	136.60
Matang-araw	18.05
Molave	888.58
Nangka	461.61
Narra	8828.01
Philippine ash	68.39
Philippine chesnut	18.05
Rain Tree	2976.96
Sampalok	132.87
Santol	1739.73
Tagotoi	142.58
Talisai	83.30
Teak	2428.55
Tibig	5224.51
Tuai	53.10
Total	151,677.23

Increasing terrestrial carbon sequestration can be conducted through plantation establishment in grassland areas which can help in the moderation of global warming and carbon emission in the atmosphere.

As shown on the table, the entire area has approximately stored 151,677.23 kilograms of carbon. This only shows that the forest laboratory area contributed in carbon sequestration for a period of atleast 15 years. This is equivalent to a carbon density of 29.67 Mg/ha which is comparable to a teak plantation as to the findings of Lasco et al with carbon density of 35Mg/ha. Even if the species used for plantation development are fast growing, C stored in the natural forests is observed to be far higher than the C contained in tree plantations. For instance Mindanao, tree plantations of fast growing species with varying ages contain C density of around 3.65 Mg/ha to 54.32 Mg/ha while the Dipterocarp natural forest contains 119.43 MgC/ha. C density values of tree plantations represent 3-45% only of the C density of a natural dipterocarp forest. The notable accomplishment is that from the original vegetation of KASC forest laboratory area which is composed dominantly of grass with average of 8.5 Mg/ha of carbon density as claimed by Lasco et al was transformed into a more stable carbon stock. In the case of Benguet pine (*Pinus kesiya*) which was planted in 2003, have an average 0.025 Mg/tree of carbon density or 1.42 $Mgha^{-1}yr^{-1}$ which is comparable to the findings of Patricio and Tulod 2010 on their study on the carbon sequestration potential of Benguet Pine (*Pinus kesiya*) plantation in Bukidnon, Philippines found that the biomass of *P kesiya* ranges from about 22 to 607 $Mgha^{-1}$ including soil carbon with an average rate of carbon sequestration of 12.7 $MgCha^{-1}yr^{-1}$ apparently because it is fast growing considering that the current study considers only the above ground biomass.

For Kalumpit (*Terminalia catappa*) which were planted on the same year, the average carbon density was 0.011 Mg/tree. In general, the KASC Forest Laboratory area has an average of 2.12$Mgha^{-1}year^{-1}$ which is comparable to some plantation in the Philippines.

3. CONCLUSION

Indeed the establishment of forest laboratory area is important in both conservation of biodiversity and carbon sequestration. Reforestation activities in grassland areas increase C density with atleast 1.98 Mg/year in the entire 5.112 hectares. It also diversified the grassland area from former grass dominated transformed into higher plants vegetation.

From the result of the study, it could be underlined that reforestation efforts using different species can help in ex-situ biodiversity conservation and carbon sequestration. Reforestation activities in degraded areas increase C density with a mean annual accumulation of up to about 2.12 MgC/ha/yr which is better compared to its grassland vegetation. Planting of endemic species in the area contributes to ex-situ biodiversity conservation which can serve as mother trees and use in educational and scientific purposes. Small scale plantation can also improve environmental quality locally (water quality, habitat restoration) and globally (climate change).

4. RECOMMENDATION

1. Continuing effort to reforest the grassland portion of the KASC Forest Laboratory area using indigenous species found in the province.
2. Information dissemination on the contribution of tree plantation in grassland areas its contribution to biodiversity conservation and carbon sequestration.

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