Xi'an ShiyouDaxueXuebao (ZiranKexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN:1673-064X
E-Publication:Online Open Access
Vol: 66 Issue 01 | 2023
DOI 10.17605/OSF.IO/2KBW8

ASSESSMENT AND ANALYSIS OF CARBON DIOXIDE SEQUESTRATION OF MANGROVE SPECIES IN COASTAL AREAS IN A CITY OF SOUTHERN PHILIPPINES

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Abstract

This study aimed to assess the mangrove species and to measure the carbon dioxide sequestration in the coastal areas of Tangub City. This study utilized the descriptive evaluative survey. The purposive sampling technique was used to assess the mangrove species through the identification of individual based on CV-CIRRD Primavera 2000. Every mangrove species in the sampling areas was determined and the carbon dioxide sequestrations rate was measured based on algorithm. There were eight (8) species under of the five (5) families. The four (4) coastal barangays in Tangub City are still in state of moderate diversity with the value of 0.7508 for Lorenzo Tan, 0.6931 for Maquilao, 0.7525 for Garang and 0.6479 also for Maloro but in minimal level. The mangrove forest sequestered more than the amount of 31,505,143 pounds or more than 14.2 million kilograms of carbon dioxide. The relationship between the mangrove population and carbon sequestration was measured using the Pearson's correlation and the result revealed an r-value of 0.944 with perfect correlation as giving by the degree of correlation. Meanwhile, the p value 0.000 was less than tabular value 0.05 therefore, the relationship was statistically significant.

Keywords: Mangrove, Sequestration Rate, Assessment, Analysis

INTRODUCTION

Mangroves are known to have a high carbon sequestration rates that is equivalent to tropical forests. They allocate proportionally more carbon belowground and have higher below-to above ground carbon biomass ratios than terrestrial trees (Alongi, 2012). Most carbon in mangroves is stored as large pools in soil and dead roots.

It is proclaimed that mangrove environments are among the most productive and biologically complex environment on the planet (Guebas et al., 2005). Mangroves form typical ecological environments which offer an appropriate habitat for a loaded assemblage of species. Mangrove is considered as reservoirs for communities of zooplankton, phytoplankton, and fish. Moreover, the mangroves functions as breeding ground, hatchery and nursery for juvenile of fish whose matured occupied other environments (e.g. sea grass beds and coral reefs). The unique landscape with aerial roots, trunks, branches and leaves hosted a huge amount of organisms. This environment was an ideal habitat for some crustacean species which inhabit among the roots, on the

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trunks or even in the canopy. A huge amount of organisms like amphibians, reptiles, insects, aves and mammals flourish in this environment and contributed with its way of life to its unique characteristic. Apart from its ecological purpose, mangroves representatives such as Rhizophora spp. assembled as a physical barrier against tidal phenomena and ocean pressures using their huge aboveground aerial root systems.

Interestingly, mangroves are also important in the prevention of storm surge caused by typhoons because they act as barriers of waves caused by ocean currents and tidal waves. They also act as absorbent of organic waste caused by pollution as by product of decomposition in the oceans and other bodies of water.

Despite of its vast importance, mangrove forest encountered a serious problem, such mangrove deforestation resulted a mangrove forest loss in Southeast Asia and the Philippines due to the rapid growth of aquaculture development (Dodd & Ong 2008). In the Philippines, fifty (50) percent of approximate mangrove deforestation can directly explain or point out for brackish-water pond development for aquaculture production (Primavera, 1995).

Global warming occurs due to the increased concentration in greenhouse gases, mostly carbon dioxide (CO_2), is one of the main critical global problems that keep on posing challenges in biodiversity of the environment. The unrestrained production of greenhouse gases (GHGs) if not addressed appropriately can cause permanent and catastrophic damage to the total biosphere. Increasing concentration of GHGs in the atmosphere might lead to vary in energy balance in the global climate. Among the anthropogenic GHGs, carbon dioxide (CO_2) is the most dominant and is accountable for more than half the radiation related with the greenhouse effect (Solomon and Srinivasan, 1996). One of the options being considered to lessen the increase of CO_2 in the atmosphere are tropical forest conservation and establishment (Frumhoff et al., 1998).

Climate change is one of the main concerns of human generation today. The most current Inter- governmental Panel on Climate Change (IPCC) assessment report concluded that there is powerful evidence that human activities have inflated the world's climate (IPCC 2001). The increase in global temperatures has been recognized to emission of greenhouse gasses, notably CO_2 (Schimell et al. 1996). Forest environments can be the sources and carbon sinks (Watson et al. 2000). Deforestation and flaming of forests discharge CO_2 to the atmosphere. Indeed, land-use alters and forestry is accountable for about 25 percent of the entire greenhouse gas emissions. However, forest environment also help lessen greenhouse gas concentrations through absorbing the carbon from the atmosphere by the process known as photosynthesis. Of the entire world's forests, tropical rain forests have the best potential to sequester carbon mainly through reforestation, conservation and agroforestry of existing forests (Brown et al. 1996)

Despite better conservation and localized forestation efforts, mangrove depletion or degradation in the Philippines is still predictable (Samson & Rollon 2008). Thus, the assessment of the remaining mangrove ecosystem and information on carbon dioxide (CO_2) sequestration on mangrove is still limited. From this point of view, this study is

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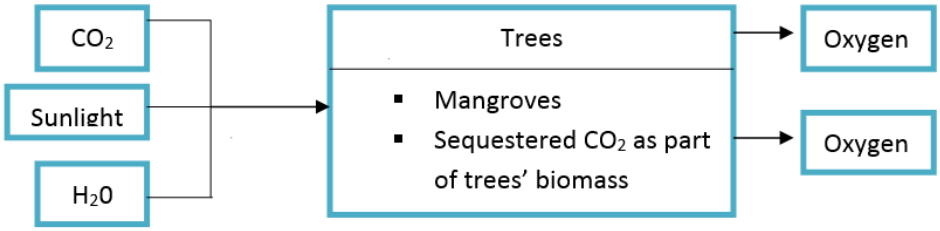
aimed to assess the mangrove species and to measure the carbon dioxide sequestration in the coastal areas of Tangub City, Misamis Occidental.

CONCEPTUAL FRAMEWORK

The basic idea behind this paper was that trees are able to absorb CO_2 from the atmosphere through photosynthesis. Part of the carbon dioxide absorbed becomes part of the biomass. In general, trees compose fifty (50) percent carbon based on oven dry weight (Lacto, Rodel, 2000). In addition to this idea, this research prompted to evaluate the population density and measure the carbon dioxide sequestration rate in the coastal area of Tangub City. The conceptual framework of the study is shown in Figure 1.

Fig 1: Schematic diagram



Variables such as **carbon dioxide**, **sunlight**, and **water** are the primary components which plants used in the process known as photosynthesis. Primarily, carbon dioxide is an inorganic compound produced by animals as waste product during the process of respiration. Photosynthesis makes use of carbon dioxide to generate energy and carbohydrate. It is very important for the plant such as mangrove to import carbon dioxide because it serves as one of the key components for the plants to survive. On the other hand, sunlight is absorbed by the chloroplasts of the plant cell in order to produce carbohydrate and energy in the form of ATP. Water is also an important component absorbed by the plants to maintain its turgidity.

Trees such as mangroves are considered as primary producers in the ecological systems because they are food producing (autotrophic) organisms.

Carbon dioxide sequestration is the characteristic of mangrove trees to absorb carbon dioxide even with great concentration. It has been a public knowledge that mangrove species are said to be “extreme absorber” of carbon dioxide because of their faster photosynthetic activity. Thus, mangrove species facilitate the sequestration of carbon in the atmosphere. Sequestrating carbon dioxide can be done by weighing the biomass of the mangrove or by measuring the diameter of the tree vs. its height.

Plants being photosynthetic does not only accounted for producing carbohydrate but also in producing **oxygen** that is useful for other organisms such animals in breathing. Oxygen that is available in the atmosphere participate in the animals’ metabolic and respiration processes.

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RESEARCH DESIGN AND METHODS

This study utilizes the quantitative research and descriptive evaluative survey. The purposive sampling technique was used to assess the mangrove species through the identification of individual it was based on (CV-CIRRD Primavera 2000). Meanwhile, actual measurement on the biomass index of the mangrove based on high of the trees and the diameter of the trunk. Every mangrove species in the said areas was determined and the carbon dioxide sequestrations rate was measured based on algorithm method. An ocular survey was conducted in the coastal areas of Tangub City for the selection of the study site. The four barangays that was observed with mangrove richness in the coastal areas in Tangub City was the study site and a purposive sampling technique using the lines intersect transects. The line intersect transect (LIT) was established from the shoreline perpendicularly to the mangrove forest. Within the transect line 10x10 meters with a gap of ten meters. The mangroves within the plot was identified and recorded individually which are then classified taxonomically. The mangrove tree was determined using the field guide manual to Philippine Mangroves by Primavera et al (2004). The mangrove population status was measured by calculating using percentiles and diversity index.

MANGROVE WEIGHING

The full weight of mangrove trees is determined using the formula $W= 0.25D^2H$ based on tree species in the Southeast United States by (Duncan, Wilbur H. 2000), the algorithm to calculate the dry weight of a tree was: To find outs the dry mass of the mangrove tree. This was based on an extension journal initiated from the University of Nebraska by (Kuhns Mike and Schmidt Tom 1988). The standard tree was 72.5 percent dry matter and 27.5 percent was moisture. Therefore, to verify the dry mass of the tree, multiply the weight of the tree by 72.5 percent. To verified the mass of carbon in the tree. According to Lacto and Rodel in 2000 the standard carbon content is generally fifty 50 percent of the tree's total amount. Therefore, to calculate the weight of carbon in the tree, multiply the dry mass of the tree with fifty (50) percent. To verify the CO_2 sequestered in the tree, the carbon dioxide was composed of one (1) molecule of Carbon and two (2) molecules of Oxygen. The atomic weight of Carbon was 12.00111. The atomic mass of Oxygen was 15.9994. The mass of CO2 was Carbon + 2 * Oxygen = 43.999915. The ratio of carbon dioxide (CO2) to Carbon was 43.999915 divided 12.001115 = 3.6663. Consequently, to verify the mass of carbon dioxide CO_2 sequestered in the tree, multiply the mass of carbon in the tree by 3.6663. Pearson's Correlation – This was utilized to measured the relationships of the mangrove population and mangrove sequestration rate in the selected coastal areas of Tangub City.

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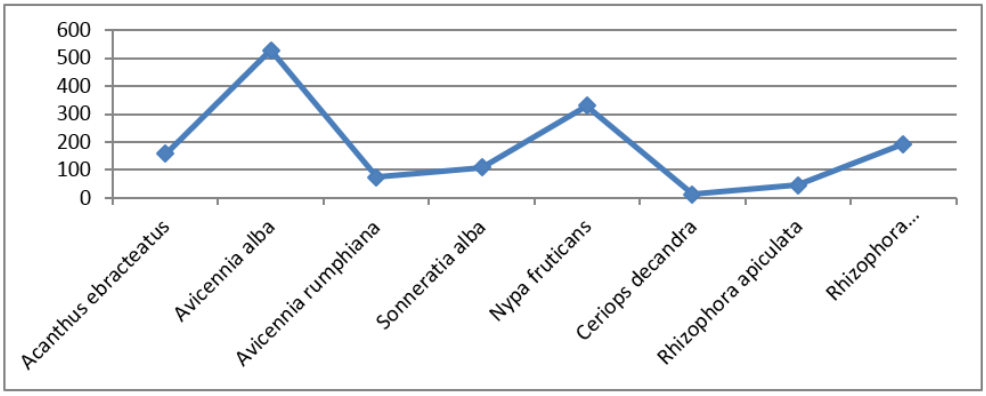
RESULT AND DISCUSSIONS

Table 1: Mangrove species in selected sampling coastal barangays in Tangub City

Mangrove species	Lorenzo Tan	Maquilao	Garang	Maloro	Total
Acanthus ebracteatus	23	0	118	16	157
Avicennia alba	112	56	215	145	528
Avicennia rumphiana	25	14	22	13	74
Sonneratia alba	2	20	71	15	108
Nypa fruticans	63	33	163	71	330
Ceriops decandra	4	3	2	4	13
Rhizophora apiculata	16	18	0	12	46
Rhizophora mucronata	30	140	21	1	192
Grand total	275	284	612	277	1448

The selected sampling coastal area of Tangub City was composed of eight (8) mangrove species namely: Acanthus ebracteatus, Avicennia alba, Avicennia rumphiana, Sonneratia alba, Nypa fruticans, Ceriops decandra, Rhizophora apiculata and Rhizophora mucronata. There were species of mangrove not found in some sampling coastal barangay such as Acanthus ebracteatus not present in barangay Maquilao and Rhizophora apiculata not observed in barangay Garang. The mangrove species in the area was compose of five (5) families the Acanthaceae, Avicenniaceae, Lythraceae, Palmae and Rhizophoraceae. Belong to family Acanthaceae was the mangrove species Acanthus ebracteatus, for the family of Avicenniaceae the mangrove species were Avicennia alba and Avicennia rumphiana. Sonneratia alba was belong to family Lythraceae and Nypa fruticanswas belong to Palmae family. Meanwhile, in family Rhizophoraceae there were three (3) mangrove species found in the selected sampling area namely the Ceriops decandra, Rhizophora apiculata and Rhizophora mucronata.

Figure 2: Mangrove population status in selected sampling coastal areas of Tangub City



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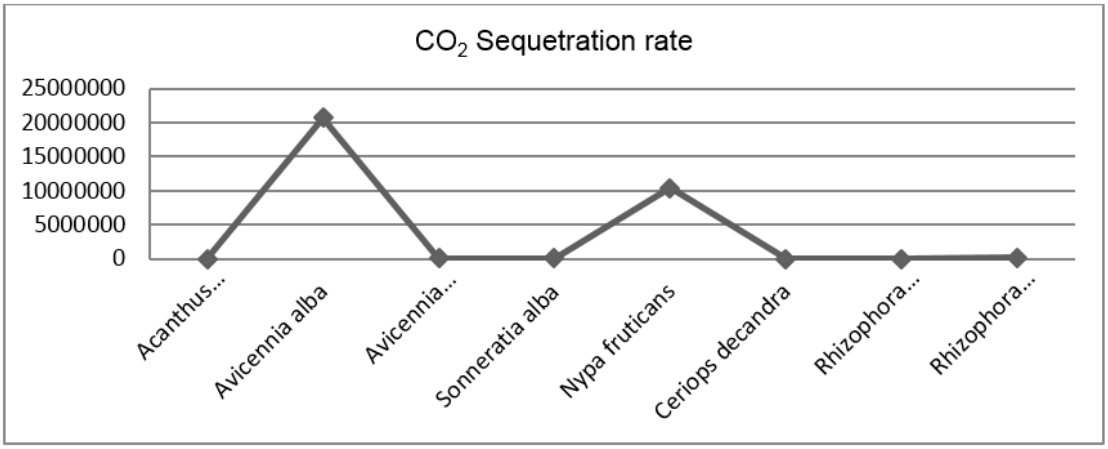
This figure implies the population status observed in the selected coastal barangays of Tangub City. The population of Avicennia alba got the highest in terms of distribution with a total amount of 528 individuals and followed by Nypa fruticans with and amount of 333 individuals. Meanwhile, the Ceriops decandra was in the lowest in rank with a number of 13 individuals for the reason that mangrove species was utilized as additive for the coconut wine and the timber was also utilized for firewood's or even charcoal.

Table 3: Diversity index of the mangrove population status of the selected sampling coastal areas of Tangub City

Diversity Index	Lorenzo Tan	Maquilao	Garang	Maloro
Taxa_Species	8	7	7	8
Individuals	275	284	612	277
Dominance_D	0.2492	0.3069	0.2475	0.3503
Simpson_1-D	0.7508	0.6931	0.7525	0.6497
Shannon_H	1.633	1.477	1.541	1.371

Generally, the mangrove population in the selected sampling coastal barangays were observed to have a diversity index that is less than one but more distant to zero. This means that all the sampled barangays are directly accounted for coastal activities like human interruption such as deforestation, aquaculture production, conversion of mangrove forest into fishponds, and others. Simpson diversity index indicated that the value of D ranges between 0 and 1 with this index, 1 represents infinite diversity and 0 no diversity. Based on the observations made, figure 3. showed that the four (4) coastal barangays in Tangub City are still in the state of diverse with the value of 0.7508 for Lorenzo Tan, 0.6931 for Maquilao, 0.7525 for Garang and 0.6479 also for Maloro but in minimal level. In the four coastal barangays that were studied, barangay Garang still had the highest in terms of diversity eventhough only seven (7) in "taxa_S" or number of species.

Figure 3:CO_2 sequestration rate in mangrove populations of the selected sampling coastal areas of Tangub City



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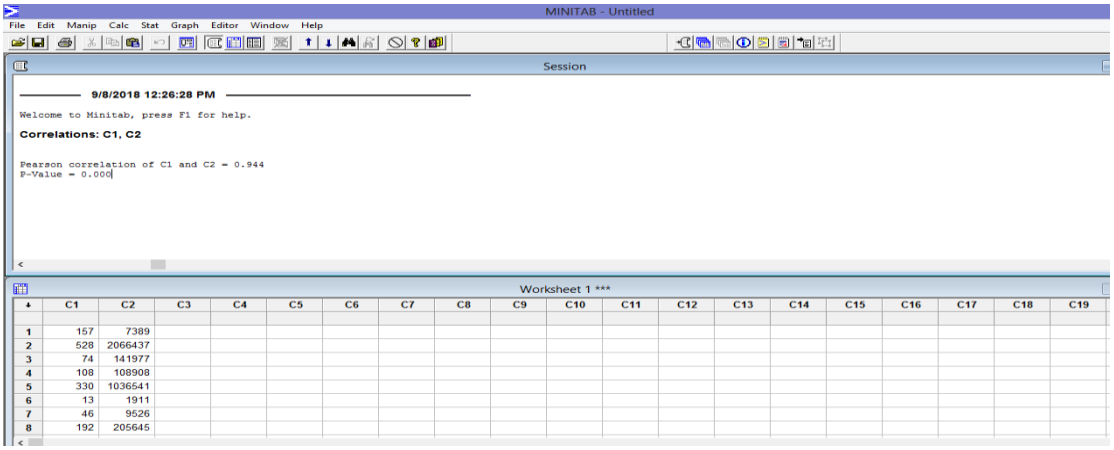
The CO_2 sequestration rate of mangrove population in the selected sampling coastal areas of Tangub City has an amount of 31,505,143 pounds (lbs) or more than 14.2 million kilograms (kg) of carbon dioxide. According to Lasco et. al., (2016), mangrove tress are among the highest sequestration rate of carbon as part of their physiological process. This type of plants are highly exposed to sunlight and water making them more reactive that absorbs water and carbon dioxide quickly and turn net producer of oxygen as a by-product of photosynthesis.

Table 4: Amount CO_2 sequestered in mangrove populations of the selected sampling coastal areas of Tangub City

CO_2 sequestration	Lorenzo Tan	Maquilao	Garang	Maloro	Total
Acanthus ebracteatus	829.40	0.00	6102.37	457.59	7389.36
Avicennia alba	3131117.12	824971.59	11761631.62	4946650.25	20664371
Avicenniarumphiana	37376.55	49770.95	41099.20	13730.10	141976.8
Sonneratia alba	318.16	31667.07	52183.38	24739.29	108907.9
Nypafruticans	660017.13	179380.53	8515917.71	1010101.35	10365417
Ceriopsdecandra	37.32	144.67	1586.11	143.20	1911.3
Rhizophoraapiculata	1090.12	2130.35	0.00	6305.64	9526.11
Rhizophoramucronata	3202.93	200515.47	1917.86	8.26	205644.5
Grand total	3833989	1288581	20380438	6002136	31505143

The mangrove population that harbours the highest amount of 20,664,371 pounds (lbs) of carbon dioxide was the Avicennia alba. This species of mangrove is deemed highly adaptive to the environment with lesser life cycle making them grow and reproduced fast. Nypa fruticans followed the highest in terms of carbon sequestration rate amounted to10,365,417 pounds (lbs) and lowest in carbon sequestration was the Ceriop decandra with an amount of 1,911.3 pounds (lbs) only. The mangrove population and the carbon dioxide sequestration rate were proportional in terms of results.

Figure 4: Relationships of the mangrove populations and CO_2 sequestration rate in mangrove populations using Pearson Correlation



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Minitab software was utilized in computing the relationships of the variables considered in the study in which correlation value was computed and significant relationships were established. Pearson correlation value of the population of mangroves and total CO_2 sequestration rate was 0.944. Based on the degree of correlation, it can be noted that there is a significant relationship between the population status of mangrove and the carbon sequestration rate. This means that the more diverse a mangrove forest is, the more carbon will be absorbed by the forest. Another notion that could be drawn from this observation is that the greener the mangrove forest, the higher rate of carbon sequestration it would initiate. This is relevant since plants/trees need inorganic carbon dioxide and convert it into an organic carbon by means of photosynthetic activities. Meanwhile, the p value was 0.000 that was lesser than tabular value 0.05 therefore it indicated that the null hypothesis was rejected.

Based on the findings of this research, the students in sciences or biology can also learn the knowledge from the process of this study. The first activity was the mangrove species identification based on taxonomic classification for the preparation for assessment study. After the identification the mangrove tree the second activity was to measure the carbon dioxide that is sequestered by the identified mangrove trees.

IMPLICATIONS

Mangroves are vital components in the coastal communities as they dictate the balance of ecosystem and the survival of marine lives. Based on the conduct of this study, it is simplified that mangroves in the area should be sustained in terms of diversity, status, and distribution. This is critical in the sense that this forest affects the lives of the people living in the coastal areas of Tangub City especially those who are dependent on fishing activities as main source of living. The mangrove area will be affected with the mega project the Panguil Bay Bridge connecting Tangub City to Tubud Lanao del Norte. In the construction process the nearest mangrove area that be affected was barangay Maloro because is nearer to the starting point of the bridge. The varieties of mangrove species in the study site should also be sustained or even put into higher number in a way that they can help mitigate the issues posed by climate change as more carbon dioxide is concentrated in the atmosphere. By this means, climate change may be mitigated by absorbing the amounts of carbon dioxide produced by living organisms and as a result of rampant developments.

CONCLUSION

The coastal area of Tangub City was composed of eight (8) species of mangroves under the five (5) families. The dominant mangrove species was the Avicennia alba, meanwhile, the limited mangrove species was the Ceriop decandra because this particular mangrove was utilized for additive for coconut wine and also utilized for charcoal into firewood. Despite human interruptions in the mangrove forest of the coastal areas of Tangub City it was found out diverse based on the results of Simpson and Shannon index. The

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sequestration rate matters on the population of the mangroves on the coastal area because result revealed that the mangrove population is high, the carbon dioxide sequestration rate was also high. From this point of view Pearson correlation revealed a 0.944 which can be interpreted that there is a significant relationship between the status of the population of mangrove and its carbon sequestration rate. Meanwhile, the p value was 0.000 that was lesser than tabular value 0.05 therefore it indicated that the null hypothesis was rejected.

RECOMMENDATIONS

The finding of this study be provided to the concern department heads of the division of Tangub City, in term of external activities such as; coastal clean-up, mangrove reforestation/plantation and mangrove conservation. To the environmental coordinator be encouraged to update and require their student, to plant mangrove trees and be parenting (care on the plant) until they graduate. To the Local Government Unit in the area may implement the rules and regulations in term of mangrove protection and conservation. The LGU may disapprove a proposal on mangrove area that will be converted into fishpond. The abandon fishpond must be planted again with mangroves for the purpose of regeneration and recovery of the area. The LGU must support and encourage the farmers particularly to the propagule growers (ready to go seedlings) of mangroves in which giving assurance on their seedling to be sold.

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