International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133, Print ISSN: 2664-7125
Received: 07-03-2021, Accepted: 09-04-2021, Published: 17-05-2021
Volume 3, Issue 2, 2021, Page No. 123-127

Study of plant diversity and carbon sequestration potential in Mansamata sacred grove (SG), Paschim Medinipur, West Bengal, India

Tridib Kumar Sahoo
Department of Botany, Tamralipta Mahavidyalaya, Tamluk, Purba-Medinipur, West Bengal, India

Abstract
Today global warming is a tremendous environmental problem in our earth. Carbon emission is the main causal factor for the global warming. The amount of the greenhouse gasses (GHGs) in the atmosphere has been increased due to the industrial revolution, particularly in the last 40-50 years. Among the GHGs the carbon dioxide (CO2) and carbon monoxide (CO) emission are the major problems. Carbon sequestration is the process through which CO2 from the atmosphere is absorbed naturally through photosynthesis by the green plants and store carbon for as long as they live in terms of live biomass. India is a mega-biodiversity country due to its different climatic conditions from north to south and east to west. It has direct effect in carbon sequestration; more than 116 million tonnes of CO2 is sequestered per year contributing to reduce the atmospheric carbon (Jasmine and Birundha-2011)[9]. The green trees have the high potential of tapping atmospheric carbon through photosynthesis. The sequestrated carbon is stored in the plant tissues which perform the growth of this plant. So in this study the species diversity of plants and the carbon sequestration potential of tree species were measured. The species number of tree, shrubs and herbs are respectively 9, 5 and 15 in Jakpur sacred groove area. The highest IVI found in Terminilia arjuna (Roxb.) Wight & Arn. (IVI-55.46), in Lippia geminata H.B. & K. (IVI- 59.63) and in Cynodon dactylon (L.) Pers. (IVI- 34.94) respectively among the tree, shrubs and herbs. The diversity index of tree species is 0.88, shrubs 0.78 and herbs 1.09. The total amount of carbon sequestered by the tree species in this SG is 12.644 tonnes. The study reveals that a higher amount of organic carbon become deposited in the soil in this SG. So such type of SGs play an important role for carbon sequestration in the atmosphere.

Keywords: carbon sequestration, global warming, IVI (important value index), species diversity.

Introduction

The Mansamata Sacred Grove (SG) of Jakpur, Paschim Medinipur is selected for this study because it is a highly disturbed SG. The management of this SG is keen to conserve this area in spite of the disturbance. It is said that the deity is about 400 yrs. old and was encircled by a deep forest. It gradually degraded due to agricultural activity. There are few remnants of tree species found in natural forest of this biogeographical region. The present effort of conservation includes protection of these tree species in one hand and plantation of locally available species on the other hand. Though in one part of the SG disturbed by the worshipers, the other part is kept undisturbed. In this study, it has been tried to study the species diversity and carbon sequestered in the conserved area. Tree species are one of the most important ecological services of this SG. In 2013, the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report concluded that "It is extremely likely that human influence has been the dominant cause of the observed warning since the mid-20th century." The largest human influence has been the emission of green-house gasses such as carbon dioxide, methane and nitrous oxide. Climate model projections summarized in the report indicated that during the 21st century, the global surface temperature is likely to rise a further 0.3 to 1.7°C (0.5 to 3.1°F) in the lowest emissions scenario and 2.6 to 4.8°C (4.7 to 8.6°F) in the highest emissions scenario. These findings have been recognized by the national science academies of the major industrialized nations and are not disputed by any scientific body of national or international standing. Carbon sequestration is the process involved in carbon capture and long term storage of atmospheric carbon dioxide. Carbon sequestration involves long term storage of carbon dioxide or other forms of carbon to mitigate or defer global warming. It has been proposed as away to slow the atmospheric and marine accumulation or green house gasses, which are released by burning fossil fuels. Climate change is a major global threat. Over the last century, global temperatures have risen by 0.7°C (Eliasch, 2008) [4]. Global climate change is predicted to lead to rising temperatures, sea-level rise, changing weather patterns, and more unpredictable and severe weather events. It is likely to cause changes in rainfall patterns, flooding, drought periods, forest fire frequency, and fluctuating water availability. The combined effect will decrease agricultural production and increase food insecurity (Malla and Blaser, 2010)[13]. Sustainable ecosystem management provides an effective framework for ecosystem-based climate change mitigation because vegetation characteristics like DBH, tree height, leaf area index, stem density/volume and above ground biomass can have influence on the forest productivity (Lal, 2005; Offiong and Iwara, 2012) [10, 14]. Since carbon sequestration depends on productivity, all factors that affect productivity will also affect carbon sequestration (FAO, 2012) [5]. Deforestation and forest degradation are major contributors to rising levels of CO2 in the atmosphere and the associated

changes in the Earth's climate. Tropical forest ecosystems are being degraded and deforested at the average rate of 8-15 million hectares per year. Many communities around the world are engaged in conservation of forests or a part of forest mostly for their religious needs. Therefore conservation of these ecosystem resources has led to voluntary carbon sequestration efforts. Sacred groves can come under the clean development mechanism (CDM) process and achieve carbon mitigation by increasing carbon stocks in these selected carbon pools.

Sacred groves (SGs) are a group of trees or a patch of vegetation protected by the local people through religious and cultural practices evolved to minimize destruction. The concept and beliefs of sacred trees and groves of forests are one of the best practices to conserve natural resources. Around 1,00,000 to 1,50,000 SGs are reported in India (Malhotra *et.al*. 2001) [12]. They play an important role in soil and water conservation as well as carbon sequestration. Therefore these groves are the best example of *in-situ* conservation of biodiversity. It is rightly said that SGs are the natural gene pool preservers and example of habitat preservation through community participation (Gadgil and Vartak, 1975) [6]. One of the most important ecosystem services is carbon sequestration. Large trees are the most effective organisms to stock atmospheric carbon. Most of the SGs have large trees conserved by different tribal communities. Contribution of these SGs managed by tribal communities towards carbon sequestration has not been done though many authors have acknowledged it. A calculation of carbon sequestered in the groves both in the level of vegetation and soil was done to find out the amount of carbon sequestered. There is limitation of scientific studies that magnify the role of SGs managed by tribal communities for climate change mitigation. This study focus on the estimation of selected tree species carbon stock and their variation across different diameter at breast height of tree height and stem density in the study area. Sacred groves of Paschim Medinipur district are solely under community management and are not governed by any statutory bodies and standardized conservation method. Communities with diverse ethnic identity are responsible for management of different groves since days unknown. It is these people whose proximity to wildlife is unquestionable and it is these people who have most zealously preserved its biodiversity in the form of its enumerable sacred groves, though unaware of the great treasure they have preserved. It would not be an exaggeration to say that, in this region, particularly in the western stretches of this district, there are many sacred groves preserved in villages as refugees of local biodiversity.

Study Area

The study plots were laid down in Jakpur Mansamata Mandir and it′s campus, Paschim Medinipur, W. B. India. The area is around 15.6 hec. The Jakpur village is located at the bank of the Kansabati River, about 3.3 km distance from Jakpur Railway Station of South Eastern Railway Division. The geographical limit of this area is 22.362353 N latitude and 87.38999 E longitudes. There exits a patch of remnant of natural vegetation in the study area. Later some indigenous species has been planted.

Materials and methodology

Minimum size and minimum number of quadrats were determined by the species area curve method (Oosting-1958) [15].

IVI is calculated by the formula - IVI = RDOM+RD+RF Or, IVI= RA+RD+RF (Curtis, 1959) [2].

Where, IVI=Important Value Index, RDOM= Relative Dominance, RD= Relative Density, RF= Relative Frequency and RA= Relative Abundance.

Diversity Index ($\bar{H}$) $=\{(\frac{ni}{N})\ \text{Log}\ (\frac{ni}{N})\}$, (Shanon & Wiener, 1963) [16]; Where, ni= IVI of individual species and N= IVI of all the species.

Carbon Sequestration

Carbon Sequestration of tree species was calculated by the following way -

» Carbon Sequestration= Total Biomass X 0.47 (Mac Dicken - 1997) [11]

» Total Biomass of Tree = AGB+BGB (Sheikh et.al.-2011) [17]

AGB -- Above Ground Biomass (kg), BGB -- Below Ground Biomass (kg)

» AGB (kg) = Volume of Tree (m3) × Wood Density (kg/m3)

V= $\boldsymbol{\pi}$r2h (Bohre et.al. -2012) [1] Where, V= Volume of Tree (m3), r = radius of tree at breast height level and h = height of the tree.

» BGB (kg)= AGB × 0.26 (Hangarge et.al.-2012)[7]

Wood Density is obtained from

The website - www.Worldagrofortycentre./org/sea/products/AFD bases/WD/.

From Global Wood Density Database, (Zanne et.al.2009) [18]

When Wood Density is not available then Standard Average Density of 0.6gm/cm is applied, (Das & Mukherjee-2015) [3]

Soil collection

Soil samples were collected randomly from four places of (10x10) sq. cm. area. From each area the top soil (0-15) cm. and the sub-soil (15-30) cm were collected separately and weight was taken to measure hector wise total organic matter. Then percentage of soil organic carbon was measured by Walkely-Black rapid titration method as described by Jackson (1973) [8].

Result and Discussion

Vegetation survey i.e. species diversity study was conducted during the year 2018, in Jakpur Sacred Grove (SG) and it′s campus area. The study was done excluding the plants of worship and ornamental plants in the Mansamata temple campus. The IVI and the species diversity were shown in table – 1 and the carbon sequestration was calculated only in tree species shown in table–2.

Table 1: List of Plants with their IVI

Sl. no.	TREE species	IVI	Diversity Index
1	*Acacia modesta* Wall	17.41	0.88
2	*Adina cordifolia* (Roxb.) Brandis	32.12	
3	*Ficus benghalensis* L.	47.02	
4	*Ficus benjamina* L.	34.36	
5	*Ficus religiosa* L. Forssk.	43.37	
6	Mimusops elengi L.	30.72	
7	Psidium guajava L.	19.52	
8	Syzygium malaccense R.Br.ex Gaertn.	19.47	
9	Terminalia arjuna (Roxb.)Wight&Arn.	55.46	
	Total	299.95	
	SHRUBS		
1	Adhatoda vasica L.	50.22	0.78
2	Cassia sophera L	37.18	
3	Crotalaria alata Ham.	29.13	
4	Datura metel L.	26.54	
5	Hibiscus panduriformis Burn. f.	49.86	
6	Lantana camara L.	47.27	
7	Lippia geminata H.B. & K	59.63	
	Total	299.83	
	HERBS		
1	Aerva aspera L.	19.07	1.09
2	Cynodon dactylon (L.) Pers.	34.94	
3	Eclipta prostata (L.)L.	15.41	
4	Euphorbia hirta L.	14.24	
5	Helicotropium indicum L.	17.1	
6	Hygrophilla spinosa T. Anders	20.92	
7	Justicia simplex D. Don	21.37	
8	Mimosa pudica L.	26.91	
9	Oldenlendia corymbosa L.	15.03	
10	Phylanthus niruri L.	21.57	
11	Rungia pectinata (L.) Nees.	30.13	
12	Scoparia dulsis L.	18.91	
13	Synedrella nodiflora (L.) Gaertn.	16.99	
14	Tridex procumbens L.	13.97	
15	*Vernonia cinerea* (L.) DC. ex Wight	13.37	
	Total	299.93	

The abstract community is *Terminalia – Lippia –Cynodon.*

Table 2: Carbon Sequestration of Tree Species

SL No	Name of the plants	No. of Individuals	Biomass (In Tones)				Total Carbon Seques– tration (Tones/ Species)
			Mean AGB (Tones/ Tree)	Mean BGB (Tones/ Tree)	Total Biomass (AGB+BGB) (Tones/ Tree)	Total Biomass (Tones/ Species)	
1	*Acacia modesta* Wall.	2	0.0597	0.0155	0.0752	0.1504	0.3200
2	*Adina cordifolia* (Roxb.)Brandis	4	0.1313	0.0341	0.1654	0.6616	1.4076
3	*Ficus benghalensis* L.	7	0.1890	0.0491	0.2381	1.6667	3.5462
4	*Ficus benjamina* L.	1	0.0479	0.0124	0.0603	0.0603	0.1282
5	*Ficus religiosa* L. Forssk	4	0.1053	0.0274	0.1327	0.5308	1.1292
6	*Mimusops elengi* L.	5	0.1068	0.0277	0.1345	0.6725	1.4310
7	*Psidium guajava* L.	3	0.1093	0.0284	0.1377	0.4131	0.8787
8	*Syzygium malaccense* R.Br.ex Gaertn.	2	0.1169	0.0304	0.1473	0.2946	0.6268
9	*Terminalia arjuna* (Roxb.) Wight &Arn.	5	0.2370	0.0616	0.2986	1.493	3.1765
	Total					5.943	12.644

In this study it is seen that the total number of tree, shrub and herbs were 9, 7 and 15 respectively. Among the tree species highest IVI found in Terminilia arjuna (Roxb.) Wight & Arn. (IVI-55.46), then Ficus benghalensis L. (IVI- 47.02) shown in Table- 1,Fig-A where as in shrubs the highest IVI found in Lippia geminata H.B. & K. (IVI-59.63), then Adhatoda vasica L. (IVI-50.22) and Hibiscus panduriformis Burn. f. (IVI-49.86) shown in Table-1. Fig-B. Similarly in herbaceous species

highest IVI found in Cynodon dactylon (L.)Pers. (IVI-34.94), then Rungia pectinata (L.) Nees (IVI-30.13) and Mimosa pudica L. (IVI-26.91) shown in Table-1. Fig-C. So the abstract, plant community of this sacred grove is Terminilia - Lippia – Cynodon.

Diversity Index is related to the IVI of a plant community. This index indicates the community composition of an area. The diversity index of tree species is 0.88, where as in shrubs and herbs the diversity indexes are 0.78 and 1.09 respectively, which are shown in Table- 1.The results indicate that highest diversity found in herbaceous species. The study reveals that total amount of carbon sequestered by the tree species in this SG is 12.644 tonnes (Table-2). Among them F. benghalensis is the highest carbon sequester. Though the age of the tree species are not known, species other than F. benghalensis lag much behind in this regard. F. benghalensis is a widely worshiped species and no harm is caused to this species. A. cordifolia and M. elengi comes next to F. benghalensis (Table -2). These species are indigenous ones and are quick growing.

Table 3: Determination of Organic Carbon (%) and the total organic matter (%)

Soil type	Organic Carbon (%)					Total organic Matter (%)
	Sample A	Sample B	Sample C	Sample D	Average	
Top Soil (0-15)cm	0.874	1.215	0.837	0.934	0.965	0.965x1.72 = 1.659
Sub Soil (15-30)cm	0.983	1.489	0.819	1.117	1.102	1.102 x1.72 = 1.895

Soil organic carbon has much role to play in soil genesis. This is mostly true where more organic matter is accumulated and established under the condition of high rain and cool climate. But in lateritic soil where high temperature and dry condition prevails, the weathering of basic rocks under alternate dry and wet tropical condition of the usual process. In this study it is seen that the percentage of soil organic carbon in this SG is 0.965% in top soil and 1.102%in sub soil, which are shown in Table-3 and the percentage of total organic matters are 1.659% in top soil and 1.895% in sub soil. The result indicate that a higher amount of organic carbon become deposited in the soil of this SG. So such type of SGs plays an important role in the carbon sequestration of the atmosphere.

Conclusion

The SGs are not only store houses of species diversity but also great carbon sequesters. SGs are hardly disturbed as they are under the vigilance of local people. In the present context of global warming community conserved SGs can play a great role in trapping carbon, a major source of climate disturbance. It is suggested that this community conservation process should be given adequate administrative help irrespective of religious beliefs so as to encourage carbon sequestration.

Reference

1. Bhore, P. Chubey, OP and Singhal, PK. Biomass Accumulation and Carbon Sequestration in Dalbergia sissoo Roxb. International Journal of Bio-Science and Bio-Technology,2012:(3):29-44.
2. Curtis JT. The Vegetation of Wisconsin, University Wisconsin Press, Madison, 1959.
3. Das M, Mukherjee A. Carbon sequestration potential with height and girth of selected trees in the Golapbag Campus, Burdwan, West Bengal(India). Indian J. Sci. Res, 2015:10(1):53-57.
4. Eliasch J. Climate Change: Financing Global Forests, Review Paper. ISBN and Crown. United Kingdom, 2008.
5. FAO- Corporate Document Repository, Chapter– IV: Volume tables and equations: http: // www. fao. org / documents, 2012.
6. Gadgil M, Vartak VD. Sacret Groups of India: A Plea or Continued Conservation: Journal of Bombey Natural History Society, 1975:72:341-320.
7. Hangarge LM, Kulkarni DK, Gaikwad VB. Mahajan M, Chaudhari Nisha. Carbon Sequestration potential of tree species in Somjaichi Rai (Sacred grove) at Nandghur village, in Bhor region of Pune District, Maharashtra State, India. Annals of Biological Research, 2012:(7):3426-3429.
8. Jakson ML. Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd, New Delhi, 1973.
9. Jasmin, SKS and Birundha VD. International Journal of Research in Commerce and Management, 2011:1(8):36–40.
10. Lal R. Forest Soils and Carbon Sequestration. Journal of Forest Ecology and Management, 2005:220:242-258.
11. Mac Dicken KG. A Guide to Monitoring Carbon Storage in Forestry and Agro- forestry Projects. In Forest Carbon Monitoring Program. Winrock International Institute for Agricultural Development, Arlington, Virginia, 1997.
12. Malhotra KC, Gokhale Y, Chatterjee S, Shrivastava S. Cultural and Ecological Dymentions of Sacret Groups in India. Indian National Science Academy, New Delhi and Indira Gandhi Rastriya Manab Sangrahalaya, Bhopal. 30 pages, 2001.
13. Malla Y, Blaser J. The Role of Social Forestry in Climate Change Mitigation and Adaptation in the Asian Region, assessment paper. RECOFTC, ASFN, and SDC: Thailand, 2010.
14. Offiong RA, Iwara AI. Quantifying the stock of soil organic carbon using multiple regression models in fallow vegetation, Southern Nigeria. Ethiopian Journal of Environmental Studies and Management EJESM, 2012:5(2):1-20.
15. Oosting H J. The study of Plant Communities, W. H. Freeman and Co., USA, 1958, 43-46.
16. Shannon CE, Wiener W. The Mathematical Theory of Communication Univ, Illinois Press, Urbana, 1963.

17. Sheikh Mehraj A, Kumar Munesh, Bussman Raine and Wand Todaria N P. 2011. Carbon Balance and Management, 1963Doi, 2011: 10. 1186 / 1750- 0680 – 6 – 15.
18. Zanne AE, Lopez-Gonzalez G, Coomes DA, llic J, Jansen S, Lewis SL *et.al*. Global wood density database. Towards a worldwide wood economics spectrum. Ecology Letters, 2009:12(4):351-366.