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The blue carbon wealth assessment and redistribution among Indian coastal states and UT's

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Abstract: To the climate change mitigation three blue carbon ecosystems (BCEs)- mangroves, sea grasses, meadows and salt marshes plays the important role by sequestrating blue carbon in their ecosystems. Mangroves, tidal marshes and seagrasses store more carbon per unit area than terrestrial forest such as tundra, taigas, deciduous forestland tropical rainforest. India is having nine coastal states and four coastal union territories, 7516.6 km coastline and total 2,305,143 sq km exclusive economic zone (EEZ) does not belong to the higher annual carbon sequestration potential countries. As total blue carbon wealth of India are generating from 4949 Sq km of mangroves , 193.09 Sq km of sea grasses and 301.5 Sq km of salt marshes but that is not equally distributed along the states and UTs as per their size of EEZs. This paper aims to present the status of different blue carbon ecosystem areas and their annual blue carbon sequestration potential states/UTs wise. Also we have shown here a management framework for the blue carbon wealth assessment and redistribution among the coastal states and UTs in India.

Keywords: Blue Carbon, Blue carbon wealth, Carbon Sequestration, Blue Carbon ecosystems (BCEs), Social cost of carbon (SCC), EEZ.

1. INTRODUCTION

Fossil fuels burning and land use changes are increasing carbon dioxide (CO2) concentration in global atmosphere. To mitigate the climate change reduction of greenhouse gasses (GHGs) emission specially CO2 and by increasing the area of natural C sinks like ocean ecosystems and terrestrial ecosystems are very important [1][2][3].

Blue carbon term was coined in 2009 giving importance to marine ecosystem conservation and management due to its high potential to capture CO2 as a natural C sink. Half of the world biological carbon is stored in marine organisms [4][5].

Among the different marine ecosystem mangrove, sea grasses meadows and salt marshes are three most important ecosystem that can capture highest quantity of carbon from the atmosphere in their ecosystem**.** All these marine ecosystems are different from other territorial ecosystem due to their higher capacity of holding carbon in its soil [6][7].

As a natural carbon sink mangrove ecosystem is special for its capacity to store 10-15% of global annual carbon storage in coastal sediment though it occupy only 0.5 % of world coastal area [8].

Another natural carbon sink among the three important blue carbon ecosystems(BCEs) that can found in some selected shallow water marine area like lagoon, bay and coastal continental shelf are flowering marine plants. Seagrass is also called the marine engineers for its role to mitigate climate changing [9][10].

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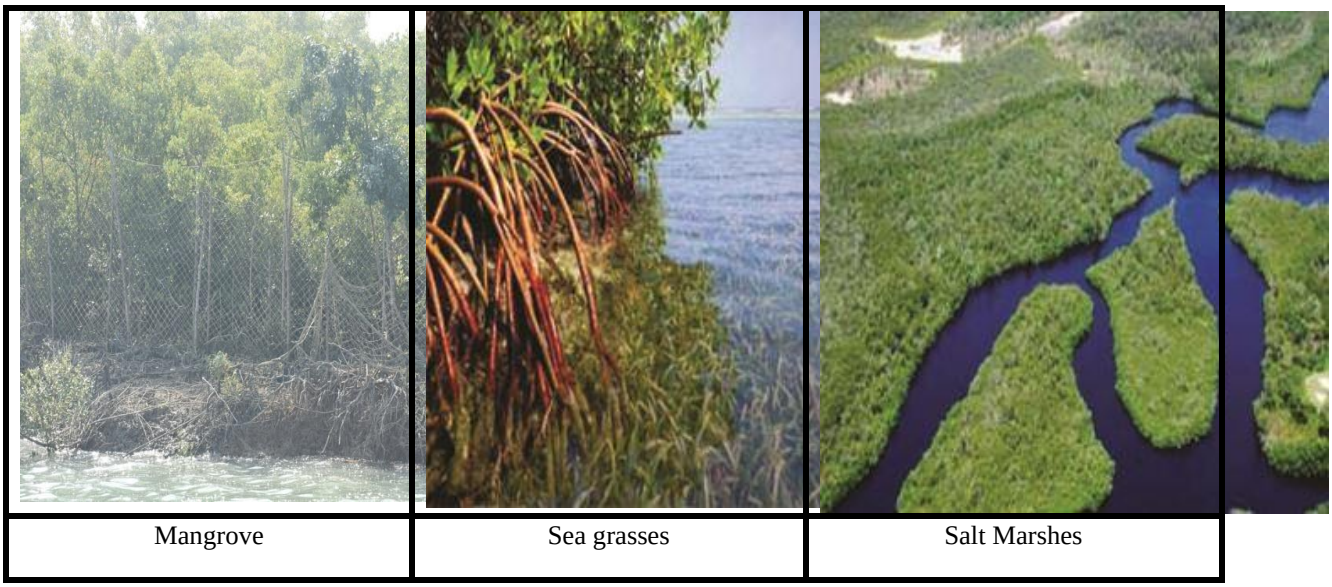

Mangrove	Sea grasses	Salt Marshes

Fig 1. Mangrove, Sea grasses [20], Salt Marshes [20]

In India salt marshes are found in low energy temperature, high tidal coastal wetlands. 14 different saline marine organisms are considered as a sensitive biological ecosystem under Indian CRZ-coastal regulation zone [11].
each Sq km of three marine ecosystem sequestrate different amount of carbon per year as salt marshes having highest 245 ± 26tC yr−1 km−2 then mangroves 174 ± 23tC yr−1 km−2 and seagrass 138 ± 38 tC yr−1 km−2 [12][13][14][15]. The global assessment shows that

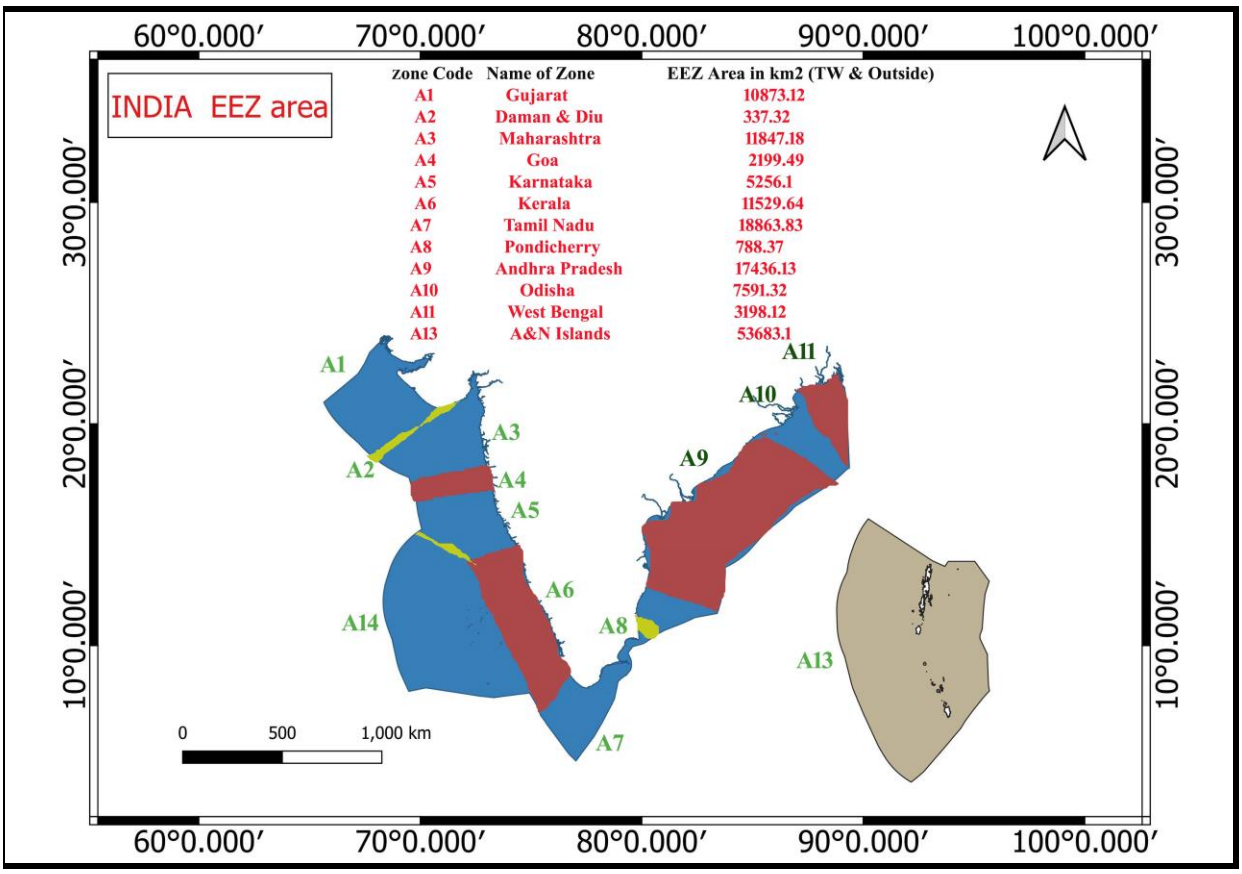

Fig 2. EEZ area of coastal states of India

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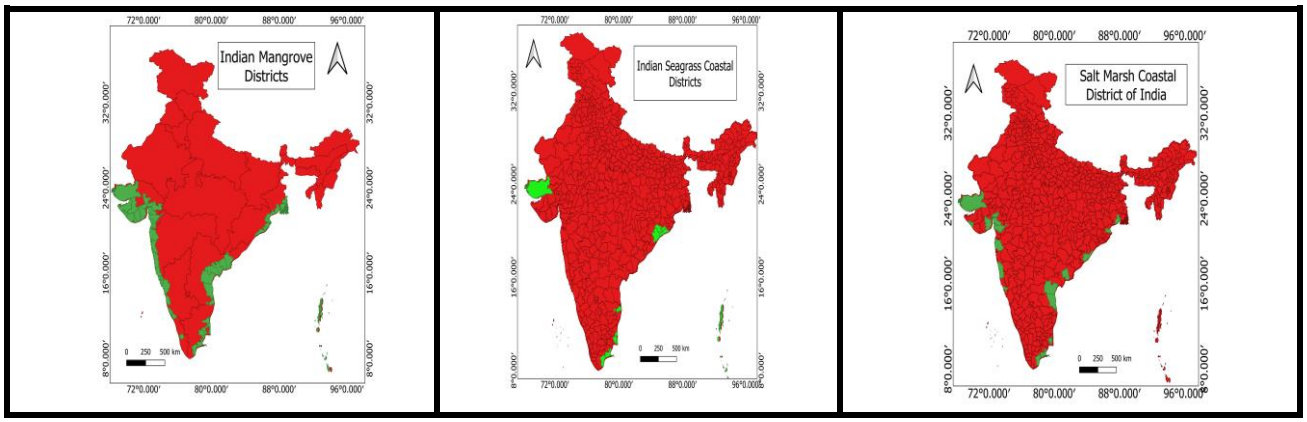
these three BCEs sequestrate 81.2MtC yr−1 in all nations and its value is US$190.7 ± 29.5 bn yr−1 [16]. This blue carbon wealth contribution does neither depends on the countries coastline nor EEZs. India having a long coast line and large EEZ area [18] is not a surplus blue carbon wealth generating country as its BCEs are not equally distributed along the coastline or among the EEZs of states and UTs. So the objectives of this study are 1) to assess the blue carbon wealth of different coastal states and UTs of India among three BCEs and 2) to device an integrated management framework for blue carbon wealth redistribution in India.

2. EXPERIMENTAL METHODS OR METHODOLOGY

2.1 State wise three blue carbon ecosystems(BCEs) area

Table 1. shows the area covered by three different BCEs in coastal state and UT's along with EEZ areas. All data were collected from secondary data sources. Fig 2. was generated by selecting the districts those lies in the coastline were these BCEs were found by using QGIS open source software. From the previous study it was found that annually 174 ± 23 tC, 138 ± 38 tC and 245 ± 26 tC can be sequestrated in per Sq km area of mangroves, seagrasses and salt marshes [1].



(a) (b) (c)

Fig 3. (a) Mangrove Districts of India, (b) Seagrass Districts of India, (c) Salt marshes District of India.

Zone Code	Name of Zone	EEZ Area in km2	Mangrove Cover area in Sq Km	Seagrass Area in Sq Km	Salt marshes area in Sq Km
A1	Gujarat	10873.12	1177	16.99	1443
A2	Daman & Diu	337.32	3		0.6
A3	Maharashtra	11847.18	320		6
A4	Goa	2199.49	26		2
A5	Karnataka	5256.1	10		
A6	Kerala	11529.64	9		
A7	Tamil Nadu	18863.83	45	398.81	61
A8	Pondicherry	788.37	2		0.7
A9	Andhra Pradesh	17436.13	404		40
A10	Odisha	7591.32	251	85.47	15
A11	West Bengal	3198.12	2112		30
A13	A&N Islands	53683.1	616	14.6	60
A14	Lakshadweep		9	0.72	

Table1. State wise three blue carbon ecosystems(BCEs) area[18][19][9][11]

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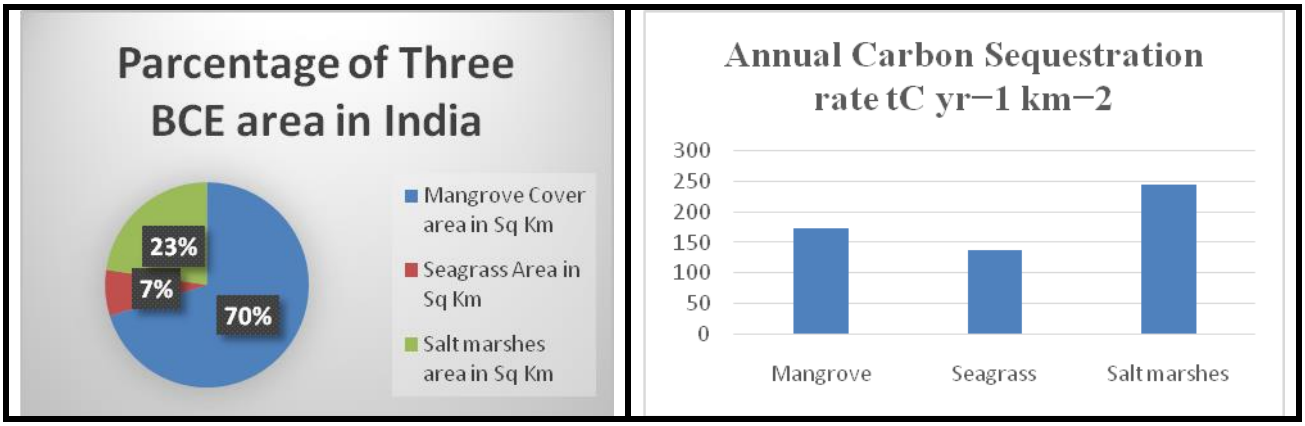

(a) **(b)**

Fig 4. (a) Percentage of three BCE area in India, (b) Annual Carbon Sequestration rate tC yr−1 km−2 in three BCEs

2.2 Methodology to calculate blue carbon wealth contribution

$S_i = \sum_{j=1}^{3} Aij\ sj$

Where, Si= Absolute annual carbon sequestration potential of state i in tonne.
Aij= Area in Km of state i in j type BCE (Blue Carbon ecosystem).
s1= 174 ± 23 tC yr−1 km−2 , the annual sequestration rate for mangroves[1].
s2= 138 ± 38 tC yr−1 km−2, the annual sequestration rate for seagrass meadows[1].
s3= 245 ± 26 tC yr−1 km−2, the annual sequestration rate for salt marshes. [1]

Study shows that the total annual carbon sequestrate potential in all three BCEs is: G_S= 81.2MtCyr−1, and total wealth generated is:$G_{W=}$ US$190.7 bn yr−1 [1].

So, $W_i = S_i * (G_W / G_S)$ US$ And $TW = \sum Wi$

Where, W_i Annual carbon wealth contribution of state i and TW is the total blue carbon wealth of India.

2.3 Methodology to calculate blue carbon wealth redistribution

$WR_i = W_i - EEZ_i * (TW/TEEZ)$
Where, WR_i is the wealth redistribution value, of coastal state I in US$.
EEZ_i is the exclusive economic zone of state i and
TEEZ is the total exclusive economic zone of India.
If WR_i ispositive then that state is blue carbon wealth donor state and
WR_i is negative then that state is blue carbon wealth recipient state.

3. RESULTS AND DISCUSSION

3.1 State/UT wise the absolute annual carbon sequestration potential

In Fig 5. annual carbon sequestration potential are shown. Three top states are Gujarat (43%) with 560677.62tC yr−1 , West Bengal(29%) second with 374838tC yr−1 and third Andaman and Nicobar Islands(8%) with 109198.8tC yr−1sequestration potential. Then Maharashtra ,Tamil Nadu and Andhra Pradesh come in their potential to capture carbon in BCEs. Total annual carbon sequestration potential of India is calculated as 1.3 MtC yr−1 that is much leaser than the top ranking country like Australia10.6 MtC yr−1, United States7.5 MtC yr−1 and Indonesia 7.2 MtC yr−1[1] .

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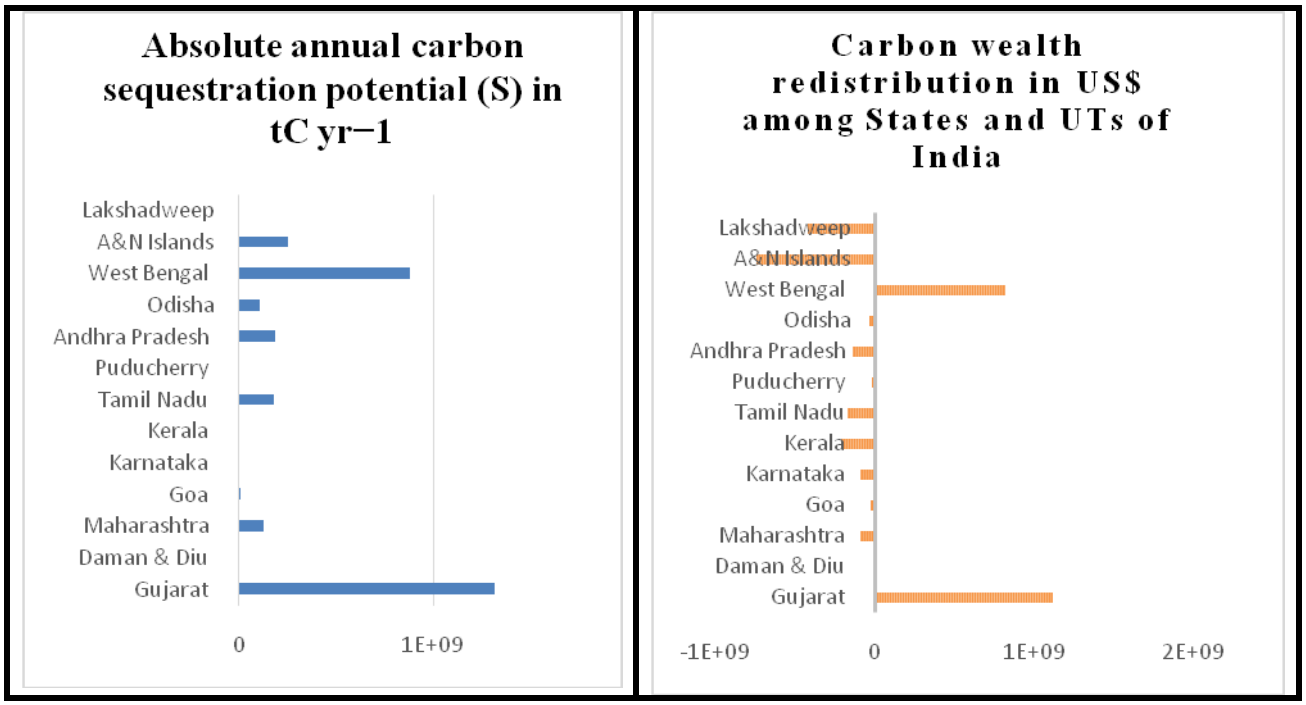

(a) (b)

Fig 5.(a) State/UT wise the absolute annual carbon sequestration potential and (b) Annual blue carbon wealth redistribution

3.2 Blue carbon wealth assessment redistribution framework

This study found that India generate US$3.09bn yr−1 blue carbon wealth but this wealth is not distributed equally through the coastal states and UTs. So using the framework mentioned in 2.3 this study aimed to find out the annual blue carbon wealth redistribution amount. In the Fig 5(b). the states and UTs those are in negative side are the blue carbon wealth recipient state or UT and those are in positive side are blue carbon wealth donor states. It is found that Gujarat and West Bengal are two top donor states and their blue wealth redistribution amount is US$1.11bn yr−1 and US$0.820bn yr−1respectively.

CONCLUSION

Using the prior study data set this study assessed the annual blue carbon sequestration potential of all the coastal state and UTs by estimating the area of three important blue carbon ecosystems(BCE) for its role to mitigate the climate change. Using the global data we also estimated the blue carbon wealth of Indian state and UTs. Blue carbon sequestration benefits are taken by all the states as a whole but the amount of blue carbon wealth are not generated in proportion with their EEZ areas so by proposing the blue carbon wealth redistribution framework this study found the blue carbon wealth donor(Gujarat, West Bengal) and recipient states and the amount of redistributed wealth. The Indian policy maker can implement this framework for better fund implementation of marine ecosystem conservation and maintenance. In future this study can be continued using remote sensing and machine learning techniques to find the BCEs area with better accuracy and to identify their changes to maintain the blue carbon wealth inventory well.

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