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RESEARCH ARTICLE

ECONOMICS OF CARBON SEQUESTRATION IN SOUTH KHERI FOREST DIVISION OF UTTAR PRADESH

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ABSTRACT

Forests have been an integral part of any biological ecosystem and it has been damaged to the level that now it is not only important for our revival but it's a question of our survival. The deforestation is a major problem worldwide on account of various factors. The conversions of forests to other land uses is responsible for around 10% of net global carbon emissions .The estimates of the net release of carbon at the global level are highly uncertain. The estimates of annual carbon emission (gross) from deforestation for India are 41 Mt to 42 Mt. Another estimate of the annual net carbon emissions shows that the emissions from the forestry sector in India are nearly offset by carbon sequestration in forests. The forest rich nations flagged the issue of deforestation for the first time in COP-13 at Bali in the year 2007. The basic concept of of Reduced Emission from deforestation and degradation (REDD) was brought in and they stated that REDD'S basic concept is simple: governments, companies or forest rich countries should be rewarded for keeping their forests instead of cutting them down. The issues were discussed in subsequent meetings of conference of parties (COP) in the following years but the political as well as the administrative will of the international communities were conspicuous by its absence. The COP-21 at Paris is a new mile stone in climate change agreement and it is certain that unless a proper market structure is not given to the forest rich countries the concept of REDD+ will not be operationalised. Today Kyoto protocol is almost dead and the international community's need to have a new well built market structure with all the binding rules in place is urgently required if REDD+ is to be kept alive.

INTRODUCTION

An agreement was reached in Paris on 12 December 2015 on a successor to the Kyoto Protocol that will apply to all signatory states, not just developed countries. Prior to the conference, countries published Intended NDCs for reducing global greenhouse gas emissions. This was a bottom-up approach, with the aim that aggregated contributions would add up to a 2oC limit on global temperature increases. However, the UN Framework Convention on Climate Change (UNFCCC) analysis of these showed that the pledges as made would not, if implemented, achieve the 2 oC limit, as they would reduce expected warming of 4-5oC to around 2.7oC. In response, there were calls from various negotiating groups, including the EU and the UK, for any agreement at Paris to include provisions for five yearly reviews of pledges. Developed countries also called for clear rules and transparency on emission reporting to ensure targets were met.

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An unexpected outcome of the conference was that the ambition of the emissions goal has been increased beyond what was previously agreed to keeping temperatures "well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels". The agreement also set an aim for emissions to peak "as soon as possible" and for emissions from human activity and absorption by carbon sinks to balance sometime in the second half of the century

Role of forests in addrressing climate change

It's well recognized that the forests play a critical role in addressing climate change. Reductions in deforestation and forest degradation can result in lower greenhouse gas emissions and more sequestered carbon. Since the Conference of parties (COP) in Bali, there has been increased recognition of the role of forests in reducing green house gas emissions (GHG). This led to the gradual development and expansion of the scope of forest-based climate change mitigation actions in the context of the Reducing emissions from deforestation and forest degradation (REDD+). Forests are also well recognized

for their role in adaptation. Conserving and enhancing forests strengthens resilience for the climate and for communities. Article 5 of the Paris Agreement specifically integrates forest-based climate change mitigation and adaptation measures in the operational scheme of the Agreement. Article 5.1 states that Parties should take action to 'conserve' and 'enhance' sinks and reservoirs of greenhouse gases including forests. This provides a legal basis to require Parties to 'conserve' and 'enhance' ecosystems when taking Intended-Nationally Determined Contributions (INDCs) to address climate change. Article 5.2 encourages 'implementation' and 'support', among others, of REDD+, and alternative policy approaches such as joint mitigation and adaptation approaches for integral and sustainable management of forests. It also reaffirms the importance of non-carbon benefits of forests.

Study to assess carbon sequestration in a tropical forest

In order to assess the carbon stored in a tropical forest, a study was carried out by me in a tropical forest lying in the district of Lakhimpuri Kheri of Uttar Pradesh (foothills of Nepal popularly called Terrai area) Lakhimpuri Kheri district of Uttar Pradesh is very rich in forest and wild life. The total geographical area of the state is 240,928 Sq Km of which 14,461 Sq Km is the forest cover which constitutes 6% of the total geographical area of the district The district Kheri has two forest divisions namely, South Kheri Forest Division, North Kheri Forest Division and one Dudhwa Tiger reserve. The forest of south Kheri Forest Division mainly comprises Sal (*Shorea robusta*) and its associates, Teak (*Tectona grandis*) and other miscellaneous species. Besides Sal and Teak some of the main tree species are Arjun (Terminalia arjuna), Kanju (Holoptelia integrifolia), Kachnar (Bauhinia variegata) Gutel (Trewia nudiflora) etc. The forest has middle canopy in form of Amlosa (Bauhinia malabarica), Kathneem (Murraya koenigii) etc and undergrowth of varying intensity depending upon the biotic pressure otherwise the most of the areas in Kheri forest Division is under tremendous biotic as well as human pressure and this is evidently reflected in encroachments, grazing and repeated forest fire. In past these forests were owned by the private people, mainly by land lords in the early nineteenth century for cultivation. Between the year, 1861 to 1875 these owners felled these forests recklessly for poles in all accessible areas, lying south of Ul river. In the vicinity of Gola(name of a place) and other comparatively larger villages, the forests were clear-felled for firewood and charcoal. This wasteful process was stopped when the Forest Department took over the management of the forest in 1877 and for the first time the forest, adjoining the Madha village was brought under fire protection. Between the year 1887 and 1889, strip felling were initiated in the Gola forest and later replaced by improvement felling during the first Working Plan Period of 1891 to 1894. The entire forest was managed on the basis of different prescriptions given in the Working Plan including the felling of valuable trees. For the management of Sal forest improvement exclusively felling were carried out. As much the forests of South Kheri Forest Division are quiet old and possess well grown valuable species of Sal and its associates. The present study area is situated to the South of Sharda river and lies between $28^0 0^{\text{‟}}$ to $28^0 3''$ north latitude and $80^0 60''$ to $80^0 35''$ east longitude. The main chunk of the reserve forest presents a continuous and fairly compact, though irregular, triangular outline. Its northern part lies between the Sharda river in the East and Ul river in the West. The forests are easily accessible by road and rail. The nearby railway stations are Mailani, Kukra and Gola gokarnath.

Statement of the study area

The total area of the South Kheri Forest Division is 41136.74 hact. The total area of the Forest Division is administratively divided into subdivisions, ranges, blocks and compartments. Compartments are the basic smallest administrative units from the forestry point of management. There are 349 total compartments in the entire forest area of south Kheri Forest Division out of which Twenty five compartments have been indentified for the purpose of carbon sequestration analysis. Of the total twenty-five compartments randomly surveyed sampling was undertaken with a view to ear marking 1% of the total area for complete enumeration in terms of girth measurement at breast height. The total area of the twenty-five compartments selected for the present study comes to the total of 3212.80 ha. These compartments represent the all possible forest types for the purpose of detailed study i.e. enumeration and data collection. A sample size of 1% of the total compartment area was selected. In order to achieve this plot of designated dimension amounting to 1% of the total compartment area was randomly laid out in each compartment. The total area thus, came to 32.13 ha. The relative advantages of the partial enumeration or sampling are many like reduced cost and saving of time, relative accuracy, knowledge of error etc. A total eight thousand two hundred and two trees were enumerated of which Teak constitutes the highest number i.e. 3903 followed by Sal which figured around 1557. Jamun was the third largest in number. The following table presents the total number of tree species wise and their percentage components of the total.

Table 1. Total numbers of trees enumerated

S.no.	Name of species	Total number of trees	Percentage of the total
1.	ARJUN(*Terminalia arjuna)*	156	1.90
2.	ASNA(*Terminalia elliptica)*	163	1.99
3.	BAHERA*(Terminalia bellerica)*	4	0.05
4.	BARGAD*(Ficus bengalensis)*	9	0.11
5.	BEL*(Aegle marmelose)*	28	0.34
6.	DUDHI*(Wrightia tinctoria)*	24	0.29
7.	GOOLAR*(Ficus glomerata)*	6	0.07
8.	JAMUN*(Syzygium cumini)*	516	6.29
9.	KANJI*(Pongamia pinnata)*	35	0.43
10.	KAIM*(Linaria caucasigena)*	5	0.06
11.	KHAIR*(Acacia catechu)*	21	0.26
12.	KUSUM*(Schleichera trijuga)*	21	0.26
13.	LAVERA*(Lavendula vera)*	1	0.01
14.	MAHUA*(Madhuca indica)*	48	0.59
15.	NEEM*(Azadirachta indica)*	1	0.01
16.	PEEPAL*(Ficus reliogosa)*	3	0.04
17.	ROHINI*(Mallotus philippensis)*	492	6.00
18.	TEAK *(Tectona grandis)*	3903	47.59
19.	SAL*(Shorea robusta)*	1557	18.98
20.	SHISHAM*(Dalbergia sisso)*	1	0.01
21.	TENDU*(Diospyros melanoxylon)*	28	0.34
22.	SAFEDA*(Eucalyptus spp.)*	339	4.13
23.	KUKAT	841	10.25
	TOTAL	8202	

Carbon Estimation

In order to find out carbon in a forest ecosystem of the selected forest study areas, carbon in stem, branches, root system, leaf litter & herbs and shrubs and soil were found out so as to get a complete carbon picture in a unit forest area.

Stem

Circumference of every species was recorded at breast height level and from this figure the diameter for each individual species was calculated by dividing circumference with 3.4(Value of π) The next stage was to work out the volume of each and every species listed in the study area through regression equation developed for individual species by Forest Survey of India (State of forest report 2009). Green weight is calculated by simply multiplying volume of that particular species. The wood samples are dried in the laboratory at a controlled constant temperature of 70^0 C until the wood sample is completely dried. The dry weight of a stem of an individual species is calculated simply by multiplying green weight of the sample of that particular species with dry weight factor of that species Calculation of carbon in a stem of every species is worked out by the chemical analysis (Walkley-Black Method,1934 Reaffirmed 2006). The carbon content of the stem is calculated by simply multiplying dry weight of the stem with carbon factor and this gave the carbon content present in the stem of that particular species.

Branches

The carbon is also locked in branches of the stem. A fully grown tree is very branchy, the branches are thick on the lower side and as onegoes up the stem, the branches become thinner. To find out carbon stocking in the branches, two branches of each tree species were chosen, one, the lower most branch and the second branch, just above the first branch. It was not possible physically to calculate carbon in the entire branch system therefore, only two branches were taken for study. The lower branch (henceforth will be called as branch-1) and the upper branch (henceforth will be called branch-2) of all the individual species were cut into small pieces of five centimeter**.** They were tagged properly with their botanical names, name of compartment, time and date of sample collection and their fresh/green weights were immediately taken and duly recorded. The samples were analyzed with walkley- Black method as stated earlier to find out carbon content. Here also the sample of cylindrical wood was taken out through Pressler's borer as was done in case of stem.

Leaf litter, herb and shrub

Leaf litter, herb and shrub were also collected from those ten compartments from where the soil samples were collected. For leaf litter a quadrate of 1 meter x 1 meter was laid out and all the leaves falling into this quadrate were collected and put into a cloth bag, tagged properly with all details and weighed. Likewise, for herb and shrub collection a quadrate of 2 meter x 2 meter was laid and all the herbs and shrubs falling into it were cut at the ground level and put into a cloth bag. All the samples were properly tagged with all details. Leaf litter sample and herb/shrub samples were analyzed in the the laboratory by using Walkley-Blamethod (2006) for carbon analysis.

Root

It is very difficult to dig out the roots and actually measure its volume and weight. That is why the secondary data was used for estimation of root carbon. The biomass of the roots, branches and leaves of a Sycamore tree are known to be around 26%, 11% and 1% of the total biomass respectively (Catriona Culnas, Ecometrica, 2011). Based on this assumption, the carbon in root has been considered to be 26% of the total carbon present in stem and branches.

Soil Carbon

Soil samples were collected from ten compartments out of the twenty five compartments chosen for study area. The reason for having chosen only ten compartments was primarily avoidance for repetition for similar areas. Only those ten compartments were chosen which were found to be different from each other in the physical features of the soil. The rest of the compartments were either alike in its totality or the forest floor looked alike A Pit of 1 meter x 1 meter was dug with the help of spade. Soil samples were collected at four levels firstly, zero level i.e. the ground level, secondly, at the depth of 30 centimeter, thirdly at the depth of 60 centimeters and fourthly at 100 centimeter. Nearly 1 Kg sample of the soil was collected, weighed and duly recorded. Soil samples were immediately analyzed in the laboratory for its carbon content.

RESULT

The chief dominant species of the South Lakhimpur Kheri has been Sal(Shorea robusta) but over a period of time the character of the vegetation has changed on account of the introduction of several exotic species like, teak, Safeda (Eucalyptus spp.) etc. The main purpose of introducing exotic species had been to keep the survival rate of the plantation high, since failure has always attracted criticism from across the society. There are three main working circles in which the forest of South Lakhimpur Kheri Forest Division is managed and they are namely, Sal Improvement Working Circle, Teak Working Circle and Block Plantation Working Circle. This would be pertinent to understand that working circle is the unit area in which the forest is kept, depending upon its specific requirement for its management. Every working circle has a different set of management prescription for the forest it contains. Since it would have been unwieldy to carry out enumeration in the entire 41136.74 hectares of the forest to calculate the quantum of carbon therefore, it was proposed to go in for enumeration in randomly sampled study area of the forest for this purpose. There are three main working circles, under which the entire study area falls in. The carbon per unit

Table 2. Area statement of the south kheri forest division

S .no.	Working Circles	Total		Grand Total
		Reserve Forest	Vested Forest	
1	Sal Improvement	12279.5	183.4	12462.9
2	Teak	15917.7	2212.1	18129.8
3	Forest Block Plantation	8430.74	2113.3	10544
	Total	36627.94	4508.8	41136.7

Source: Thesis on carbon sequestration in natural sal(shorea robusta) forest of south kheri forest division, lakhimpur by uma shanker singh(2013)

area i.e. carbon per hectare as obtained was multiplied with the total area of the forest land to reach the total carbon available in the above ground level as well as below ground stratum. Table 2 presents the total area of South Kheri Forest Division under different Working Circles. The total carbon content has been worked out hectare wise for above as well as the below ground biomass and has been presented in the following table:

Table 3. Per hectare above and below ground carbon of the study area

S.NO.	Above ground carbon (AGC)				Total carbon per hectare in AGC (in ton) (2+3+4+5)	Below Ground		Total carbon per hectare in BGC (in ton) (7+8)	Total carbon per hectare(in ton) (6+9)
	Carbon calculated per hectare(in ton)					Carbon calculated per			
	Stem	Branch	Leaf	Herb & Shrub		Soil	Root		
1	2	3	4	5	6	7	8	9	10
	469.128	7.969	0.237	0.0225	477.3565	0.223	124.070	124.293	601.649

Source: Thesis on carbon sequestration in natural sal(shorea robusta) forest of south kheri forest division, lakhimpur by uma shanker singh (2013)

Table 4. Total Above and Below Ground Carbon of South Kheri forest division

S.NO.	Working Circle	Total area(in ha.)	AGC calculated per hectare(in ton)	Total above ground carbon (in ton)	BGC calculated per hectare(in ton)	Total below ground carbon (in ton)	Total carbon in the forest area (5+7) (in ton)
1	2	3	4	5	6	7	8
1	Sal Improvement	12462.9	477.356	5948685.49	124.293	1549051.2	7497736.72
2	TEAK	18129.8		8653562.03		2253407.2	10906969.3
3	Forest Block Plantation	10544		5032791.55		1310550.4	6343341.91
	Grand total	41136.7	477.356	19635039.1	124.293	5113008.8	24748047.9

Source: Thesis on carbon sequestration in natural sal(shorea robusta) forest of south kheri forest division, lakhimpur by uma shanker singh(2013)

The above ground carbon comes to 477.356 ton per hectare whereas the below ground carbon comes to 124.293 ton per hectare as per the data and chemical analysis carried out for various components of the trees and soil. The total carbon per hectare works out to be 601.649 per hectare.

Total Carbon in South Kheri Forest Division

The three working circles under which the entire forest of South Kheri Forest Division is being managed are also uniformly distributed geographically. The samples studied and analyzed were also taken in such a fashion that it had the representation of the entire forest therefore, it could be safely said that the results which have been obtained are almost very near to truth. The following table shows the carbon in stem, branch, leaf, herb and shrub, soil and root for the entire South Lakhimpur kheri forest division.

The results are based on a very simple mathematics where the per hectare values have been multiplied with the total number of area of the entire forest division having presumed that the samples taken are the real representative of the total area. The total carbon of the forest division works out to be 24748047.9 tons which has both the components i.e. Above and Below ground carbon

Mitigation value of south kheri forest division

Putting a conservative value of US$ 10 per ton of CO2 locked in the forest of South Kheri, this small sink of 2,47,48,047.9 ton is worked to be Rs. 16,82,86,72,640 or Rs 16.8 billion. One US$ has been taken as a value of Rs. 68 in Indian currency as on today as shown in Table-5

Mitigation value of India's forests: Forest Survey Of India (FSI) has been estimating the carbon stock in the India's forest as per the methodology given in the Good Practices Guidelines (GPG) developed by the Inter Governmental Panel on Climate Change (IPCC). The carbon stock in the Indian forests has been found to be increasing by 1.48% over a period of two years. Various assessments have been done to find out the mitigation potential of the forestry sector. The forest sector can play a key role in filling the gap between the mitigation pledges by countries and the cumulative mitigation necessary to achieve 2° C stabilization target.

The mitigation potential of the forest sector has been estimated in the range 2.7–13.8 GtCO2 annually by 2030, constituting 8.2–13.5% of the total mitigation potential at a cost of less than US$ 100/tCO2 (N.H Ravindranath et al 2012). Sustainable and forest with rich biodiversity is reported to have more carbon stock than otherwise. This has been found in one study that aboveground C storage was positively associated with both functional dominance and taxonomic diversity in tropical forests (Kyle C. Cavanaugh 2014). In another study on carbon sequestration potential in the forest lands in tropical Asia it was found that Potential carbon sequestration index (PCSI) shows the highest PCSI in the more humid climates, including Peninsular Malaysia, Sri Lanka, Bangladesh, northeast India, and the western coastlines of India, Thailand, and Myanmar .The lowest PCSI values were found in the drier portions of western India and the mountainous portions of northern India The locations of medium or higher PCSI would be the places that could store the most carbon when operating under no constraints due to the presence of humans (Louis R. Iverson 1993).

History of reduced emission from deforestation and degradation of forest (redd+) in conference of parties

Reduced emissions from deforestation and forest degradation (REDD+), is one of the most controversial new issues in the climate change debate. The basic concept is simple: governments, companies or forest rich countries should be rewarded for keeping their forests instead of cutting them down. Forests cover a total of 4 billion hectares worldwide, equivalent to 31% of the total land area. Although this figure may seem high, the world's forests are disappearing. Between 1990 and 2000 there was a net loss of 8.3 million hectares per year, and the following decade, up to 2010, there was a net loss of 6.2 million hectares per year. Although the rate of loss has slowed, it remains very high, with the vast majority occurring in tropical regions.

Table 5. Total above and below ground carbon of South kheri Forest Division with the mitigation value in Rs.

S.No.	Working Circle	Total Area (in ha.)	Total above Ground carbon (in tons)	Total below Ground carbon (in tons)	Total carbon in the forest area (4+5) (in tons)	Value of mitigation in terms of rupees
	2	3	4	5	6	7
1	Sal Improvement	12462.9	5948685.49	1549051.2	7497737	5098461160
2	Teak	18129.8	8653562.03	2253407.2	10906969	7416738920
3	Forest Block Plantation	10544	5032791.55	1310550.4	6343342	4313472560
	Grand total	41136.7	19635039.1	5113008.8	24748048	16,82,86,72,640

Source: Thesis on carbon sequestration in natural sal(shorea robusta) forest of south kheri forest division, lakhimpur by uma shanker singh(2013)

Table 6. Carbon stock in indian forest

Pools	Carbon stocks in Forests in 2011 as given in ISFR 2013	Carbon stock in Forest in 2013 as given in ISFR 2015	Net Change in Carbon stock	Percent increase
Above ground	2,192	2,220	28	1.28
Below ground	694	695	1	0.14
Dead wood	27	29	2	7.41
Litter	130	131	1	0.77
Soil	3,898	3,969	71	1.82
Total		6,941	103	1.48

Source- Indian state of forest report(ISFR) 2015

Aside from the devastating effects tropical forest loss has on biodiversity and forest dependent communities, a major consequence of deforestation and forest degradation is the release of heat trapping carbon dioxide (CO2) into the atmosphere. Forests provide vast carbon sinks that when destroyed emit CO2 into the atmosphere, either by burning or degradation of organic matter. CO2 is one of the most potent greenhouse gases and the primary component of anthropogenic emissions .The conversion of forests to other land uses is responsible for around 10% of net global carbon emissions .The estimates of the net release of carbon at the global level are highly uncertain. The estimates of annual carbon emission (gross) from deforestation for India are 41 Mt to 42 Mt. Another estimate of the annual net carbon emissions shows that the emissions from the forestry sector in India are nearly offset by carbon sequestration in forests under succession and reforested plantations. (Ravindranath and Somsekhar 1995). Reforestation on a suitable scale in the tropics Solving the problem of deforestation is a prerequisite for any effective response to climate change. In its infancy, REDD was first and foremost focused on reducing emissions from deforestation and forest degradation. However, in 2007 the Bali Action Plan, formulated at the thirteenth session of the Conference of the Parties (COP13) to the United Nations Framework Convention on Climate Change (UNFCCC), stated that a Comprehensive approach to mitigating climate change should include Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries".

A year later, this was further elaborated on as the role of conservation, sustainable management of forests and enhancement of forest carbon stocks was upgraded so as to receive the same emphasis as avoided emissions from deforestation and forest degradation. Finally, in 2010, at COP16 as set out in the Cancun Agreements, REDD became REDD- plus (REDD+), to reflect the new components. REDD+ now includes:

- Reducing emissions from deforestation;
- Reducing emissions from forest degradation;
- (C) Conservation of forest carbon stocks;
- Sustainable management of forests;
- Enhancement of forest carbon stocks.

Within its remit, REDD+ has the potential to simultaneously contribute to climate change mitigation and poverty alleviation, whilst also conserving biodiversity and sustaining vital ecosystem services. This potential for multiple benefits raises the crucial question of to what extent the inclusion of development and conservation objectives may help or hinder the overall success of, and negotiations. In Durban, 2011 (COP-17) With regards to financing, in Decision 2/CP.17, it was agreed that results based financing for developing country may come from a variety of sources, including public, private, bilateral and multilateral sources. In Doha, 2012 (COP-18) the main areas of debate were measurement, reporting and verification (MRV) and REDD+ financing. COP-19 at Warsaw in 2013 produced a framework for REDD+ ; a package of decisions, which along with those adopted at previous COPs completes the 'REDD+ Rulebook' and gives guidance for the full implementation of REDD+. COP20 at Lima in 2014 hosted the 20th Conference of the Parties (COP20) where a number of issues in relation to REDD+ were to be clarified, such as further guidance on safeguards, and decisions on non carbon benefits and non market mechanisms. COP20 failed to address these remaining issues in Lima.

Forest as a carbon sink in paris agreement (cop-21) in 2015

The Paris Agreement establishes a binding obligation to all Parties to put forward nationally determined contributions (NDCs) that formulate a country's mitigation strategies and goals. Together with the Paris Agreement (the Agreement) the Conference of the Parties (COP) adopted a decision that guides pre-2020 action and sets out implementation details for the Agreement before its entry into force (the Decision).The Agreement includes an explicit call to developed and developing countries to conserve and enhance forests and other biological carbon reservoirs. Through cross-referencing, past decisions on REDD+ have become part of the Agreement. Alternative policy approaches such as joint mitigation and adaptation and the role of non-carbon benefits are also acknowledged. The Agreement also emphasizes the need to protect vulnerable ecosystems, and the need to ensure food security, but fails to formulate an explicit vision for land based

mitigation and adaptation. Article 5 of the Paris Agreement is mainly dedicated to forests. This Article contains just two paragraphs, the first refers to land use as dealt with under the UN Framework Convention on Climate Change (the Convention), while the second refers to frameworks, decisions and guidance adopted over the years as they relate to forests, including REDD+. Together these two paragraphs integrate by reference the complete forest related legal framework as previously defined by the Convention and decisions adopted into the Agreement. Two components of Article 5 is shown below as to emphasize the two important aspects of forest as sink and its conservation (REDD+)

Table 7. District wise Forest Cover Change Matrix (Area in sq. km)

District	Geo graphical Area	2013 Assessment				2015 Assessment				Change in Forest Cover			
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	V.D.F.	M.D.F	O.F.	Total
Almora	3,139	222	927	428	1,577	224	929	430	1,583	+2	+2	+2	+6
Bageshwar"	2,246	197	883	305	1,385	200	834	329	1,363	+3	+1	+24	-22
Chamoli	8,030	441	1,573	686	2,700	441	1561	679	2,681	N.C	-12	-7	-19
Champawat"	1,766	337	576	274	1,187	348	570	266	1,184	+11	-6	-8	-3
Dehradun"	3,088	583	695	332	1,610	620	647	35	1,602	+17	-48	-297	-8
Pauri Garhwal"	5,329	520	2,095	676	3,291	519	1954	796	3,269	-1	-141	+120	-22
Haridwar"	2,360	25	333	257	615	27	301	260	588	+2	-32	+3	-27
Nainital"	4,251	605	1,899	570	3,074	602	1939	463	3,004	-3	+40	-107	-70
Pithoragarh"	7,090	571	1,113	416	2,100	509	1013	580	2,102	-62	-100	+164	+2
Rudraprayag	1,984	241	592	297	1,130	241	591	298	1,130	N.C	-1	+1	NC
Tehrigarwal	3,642	298	1,232	618	2,148	296	1239	621	2,156	-2	+7	+3	+8
Udham Singh nagar	2,542	175	236	135	546	157	246	103	506	-18	+10	-32	-40
Uttarkashi"	8.016	570	1,957	618	3,145	570	1,778	724	3,072	NC	-179	+106	-73
Grand Total	53,483	4,785	14,111	5,612	24,508	4,754	13,602	5,884	24,240				-268

Source – India state of forest report (2013 and 2015) Ministry of environment, forest and climate change.

Very Dense Forest	All lands with tree canopy density of 70% and above.
Moderately Dense Forest	All lands with tree canopy density of 40% and more but less than 70%.
Open Forest	All lands with tree canopy density of 10% and more but less than 40%.
Scrub	Degraded forest lands with canopy density less than 10%.

- *Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1(d), of the Convention, including forests.*
- *Parties are encouraged to take action to implement and support, including through results based payments, the existing framework as set out in related guidance and decisions already agreed under the Convention for: policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries; and alternative policy approaches, such as joint mitigation and adaptation approaches for the integral and sustainable management of forests, while reaffirming the importance of incentivizing, as appropriate, non-carbon benefits associated with such approach*

Concept of carbon market in paris agreement (cop-21) in 2015

The Paris Agreement marks a historic turning point for global cooperation to address climate change. For the first time, 195 countries committed to take action to limit the global temperature rise to "well below 2C". Through the final tense hours of the negotiations, it was doubtful whether the provisions on carbon markets would survive, given the staunch opposition to them by certain Latin American countries. To the contrary, the agreement clearly establishes a new international carbon market mechanism, despite there being no reference to the words "market mechanism" or "carbon market" in the agreement. While the agreement doesn't mention "carbon markets", it allows parties to pursue "cooperative approaches" and voluntarily use "international transferred mitigation outcomes" to help meet their reduction targets, while ensuring that transparency and the environmental integrity of the regime is maintained. Article 6 of the agreement establishes a new mechanism to "contribute to the mitigation of greenhouse gas emissions and support sustainable development". The mechanism allows for the participation of both the public and private sectors, and, significantly, it aims to deliver an overall reduction in global emissions. It will operate under the "authority and guidance" of a body to be designated by countries who have signed the agreement, and the rules governing its operation will be developed by the technical group under the UN climate body (the UNFCCC), with the view to being adopted in the first meeting of the Parties, after the agreement enters into force. Countries must agree to robust accounting rules and must not double count emissions reductions. This means emissions reductions achieved in a country through the mechanism cannot be counted by that country towards their own emission reduction target if another country has bought those emissions reductions.

Why market seems a difficult proposition

The idea of making payments to discourage deforestation and forest degradation was discussed in the negotiations leading to the Kyoto Protocol, but it was ultimately not favored because of four fundamental problems: leakage, additionality, permanence and measurement. Leakage refers to the fact that while deforestation might be avoided in one place, the forest destroyers might move to another area of forest or to a different country. Additionality refers to the near impossibility of predicting what might have happened in the absence of the REDD project. Permanence refers to the fact that carbon stored in trees is only temporarily stored. All trees eventually die and release the carbon back to the atmosphere. Measurement refers to the fact that accurately measuring the amount of carbon stored in forests and forest soils is extremely complex – and prone to large errors. Although much has been

written about addressing these problems, they remain serious problems in implementing REDD+, both nationally and at Project level. All the above points raised are very valid and important and gives us enough reason to understand why funding for REDD+ is very difficult. Forests in India or anywhere are open treasure and countries with the maximum pressure on its ecosystem cannot keep it intact. Land use change is a measure problem for the conservation of forest and leads to degradation of forests. Deforestation not only lead to overall degradation of forest ecosystem but also emits carbon dioxide. Tropical deforestation has been responsible in part for the increasing concentration of CO2 in the atmosphere. According to recent estimates by the FAO, tropical deforestation during the decade 1981 to 1990 was 15 Mha/year. The contribution of tropical deforestation to global CO2 has been estimated as M 1.6 (+ 1.0) Gt of carbon annually. The estimates of the net release of carbon at the global level are highly uncertain. The estimates of annual carbon emission (gross) from deforestation for India are 41 Mt3 to 42 Mt.4 Another estimate of the annual net carbon emissions shows that the emissions from the forestry sector in India are nearly offset by carbon sequestration in forests under succession and reforested plantations (N.H.Ravindranath and B.S.Somsekhar 1995). If we examine one example of forest degradation at a very local level in eight districts of Uttrakhand as shown in ISFR, 2015(Table-7) this will be amply clear that how deforestation and forest degradation goes unabated unabated has estimated the change in forest cover in the different districts in.

Unabated despite the best possible efforts put up by the Forest Department. Deforestation and degradation is a socio-economic problem and in a way reflects the poverty and lack of vital social parameters essential for a society. From the above table it may be deduced that there is a huge degradation in very dense and moderately dense forest cover in Uttrakhand .This clearly shows that how difficult it is to protect an open tract of forest land. The other area of difficulty in selling Carbon Credits is that we do not have the actual estimate the carbon available species wise in a forest in particular and forest type wise in general. This subject requires maximum study and huge investment in research and development. The other issue is permanence and we do not know yet that how long the carbon would be locked in forest. The forest is vulnerable to forest fire worldwide and is not protected from expansion of agricultural use either. The federal governments across the world do not spend the money required to keep forest sustainable. In India the budgetary allocation in forestry sector revolves around 0.6-0.7% of the total governmental outlays which is highly inadequate for the sustenance of forest even at the basic level. Article 6 of Paris Agreement envisages that carbon market has to be operational under the "authority and guidance" of a body to be designated by countries. The creation of this body will entail long and intense diplomatic parleys amongst different nations with particular reference to changed stance and relationship of USA and China.

Why forestry projects were not funded in kyoto protocol: Annual global carbon dioxide emissions account for around 10-17% from deforestation. Kyoto Protocol does not adopt any effective mechanism for considering forest conservation or the prevention of deforestation as an action for mitigating climate change. When the Kyoto Protocol and its rules were being negotiated, the Parties to the UNFCCC considered reducing deforestation to be an attempt to weaken emissions-reduction commitments and were opposed to any kind of role for forests in the Protocol. This relates to uncertainty around issues such as the permanence of carbon in forests or the high risk of leakage. Instead, the Kyoto Protocol focused on small-scale forest planting as a way to remove carbon from the atmosphere. The Kyoto Protocol only recognizes the possibility for Annex I Parties to account for net changes in greenhouse gas emissions by sources, and removal by sinks, resulting from direct human-induced land use change and forestry activities. Since 1990, this has been limited to afforestation, reforestation and induced activities related to agricultural soils and the the eligibility of land use, land-use change and forestry activities such as afforestation and reforestation.

It also limits the compensation that countries can receive for reducing deforestation to a maximum of 1% of the base year emissions of that country. Given the political uncertainty around the participation of Annex I Parties in the second commitment period of the Kyoto Protocol, rainforest nations are now looking into what will happen after Paris Agreement in 2015. With the Paris Agreement entering into force on November 4th 2016, climate negotiators at this years' climate talks (COP-22) in Marrakesh(2016) could not be able to address the issue of REDD+ and failed to focus on how REDD+ fits into other items on mitigation, accounting, transparency, and markets. The REDD+ has been a very sensitive issue and most of the people living in and around forest depend on it for their lively hood. REDD+ has been a very contentious issue in the international agreement in conference of parties and unless a market structure with binding rules are not provided with, the concept of REDD+ will not blossom. REDD+ is also a trillion dollar market for international players. Lots and lots of issues are to be decided in post COP-21. Most of the forest rich nations are poor countries in term of GDP growth and other human development indices therefore; questions are also raised that most of the largest carbon dioxide emitter countries may keep on growing at the expanse of poor countries. The other question is to simplify the rules for registration of carbon credits unlike CDM rules under Kyoto protocol.

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