

# Deforestation and forest degradation in India – implications for REDD+

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*Reducing emissions from deforestation and forest degradation (REDD+) is considered as an important mechanism under the UNFCCC aimed at mitigating climate change. The Cancun Agreement on REDD mechanism has paved the way for designing and implementation of REDD+ activities, to assist countries experiencing large-scale deforestation and forest degradation. Contrary to the general perception, the present analysis shows that India is currently experiencing deforestation and forest degradation. According to the latest assessment of the Forest Survey of India, the net annual loss of forests is estimated to be 99,850 ha during the period 2007–2009, even though the total area under forests has increased. The REDD+ mechanism aims to provide financial incentives for reducing deforestation and forest degradation. India, despite having robust legislations, policies and remote sensing capabilities, is not ready to benefit from the emerging REDD+ mechanism, with potential flow of large financial benefits to rural and forest-dependent communities from international financial sources.*

**Keywords:** Climate change, deforestation, forest degradation, global warming.

CLIMATE change is projected to be more severe and immediate than shown earlier by the Intergovernmental Panel on Climate Change (IPCC)<sup>1</sup>. According to recent modelling studies, climate change impacts are already occurring and are likely to exacerbate even in the short and medium-term periods. There is consensus on the need to limit global warming to  $\leq 2^\circ\text{C}$ , which may require limiting the atmospheric concentration of CO<sub>2</sub>-eq greenhouse gases (GHGs) at 450 ppm or below. Achieving this target will require rapid implementation of mitigation strategies for achieving deep emission cuts.

Global forest sinks can contribute to one-third of the total abatement by 2050, with major contribution from avoided deforestation in tropical forest-rich countries<sup>2</sup>. Forests can contribute to climate change mitigation in four ways: (i) increase in forest area through reforestation; (ii) increase in carbon density of existing forests at both stand and landscape scales; (iii) sustainably managing forests for harvesting forest products and (iv) reducing emissions from deforestation and degradation<sup>1</sup>. The potential of the last activity has already been recognized in global climate negotiations by means of REDD or

reducing emissions from deforestation and forest degradation. The other three activities, namely forest conservation, sustainable management of forests (SMF) and enhancement of forest carbon stocks, are also now a part of what is called REDD+ mechanism currently being negotiated under the United Nations Framework Convention on Climate Change (UNFCCC).

The forest sector can play a key role in filling the gap between the mitigation pledges by Annex I countries and the cumulative mitigation necessary to achieve  $2^\circ\text{C}$  stabilization target<sup>3,4</sup>. The mitigation potential of the forest sector has been estimated in the range 2.7–13.8 GtCO<sub>2</sub> annually by 2030, constituting 8.2–13.5% of the total mitigation potential at a cost of less than US\$ 100/tCO<sub>2</sub> (ref. 1). Including deforestation and degradation as additional actions on sustainable management in a well-designed carbon trading system could provide the finance and incentives to reduce deforestation rates up to 75% in 2030, and the addition of afforestation, reforestation and restoration would make the forest sector carbon neutral at a reasonable cost<sup>5</sup>. The review also estimated that the finance required to halve the emissions from the forest sector by 2030 could be about US\$ 17–33 billion a year, potentially indicating the scale of financial flows.

This article aims at assessing the REDD+ mechanism in the Indian context, the current status under the global UNFCCC negotiations, implications of REDD+ for India, readiness of India for the mechanism, criteria for identification of locations and potential for REDD+ in India.

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**UNFCCC actions on REDD+: Bali to Durban**

'Reducing emissions from deforestation in developing countries and approaches to stimulate action' was first introduced at the 11th session of Conference of Parties (COP) to the UNFCCC, Montreal in 2005 by Papua New Guinea and Costa Rica, and received wide support from all the countries. The 'Bali Action Plan' finalized at the COP13 in Bali 2007 recognized the importance of REDD as well as additional activities. Thus the Bali Action Plan included REDD in developing countries, and the role of conservation, SMF and enhancement of forest carbon stocks in developing countries. Thus, REDD has been referred to as 'REDD-Plus or REDD+'. It also launched a programme of work on methodological and policy issues relating to REDD+ under UNFCCC.

At COP16 in Cancun in December 2010, the governments adopted the decision that was negotiated at COP15 in 2009 on REDD+, i.e. encouraging developing countries to undertake mitigation actions by realizing the full scope of REDD+ activities. The 'Cancun Agreement' provided a three-phase process for the developing countries to undertake mitigation through REDD+ activities according to their national circumstances and capacities with financial and technological support from the developed countries. These three phases would involve the following:

- Phase 1: Development of a national plan, policies and measures, and capacity-building.
- Phase 2: Implementation of the national plan, policies and measures, and further capacity-building, technology development and transfer, and results-based demonstration activities.
- Phase 3: Results-based actions with full measurement reporting and verification.

In the Phase 1 or 'readiness' phase, the developing countries are encouraged to develop:

- National REDD+ strategy.
- National or sub-national forest reference emissions level.
- Robust and transparent national forest monitoring system.
- System to provide information on the safeguards to maintain environmental integrity, protect the rights of indigenous people and preserve biodiversity.

COP17 at Durban, South Africa produced a landmark decision to extend the Kyoto Protocol into the second commitment period while initiating a process (note 1) – to be finalized by 2015 – to negotiate a new legal basis for future climate actions to take effect from 2020 onwards. Pursuant to the Cancun decision, important decisions on REDD+ were made, viz. decisions on systems for providing information on safeguards; modalities for forest reference (emission) levels (FRLs) (note 2); and REDD+ financing (note 3).

Decision on safeguards provides generic guidance on systems for providing information on environmental and social safeguards. Systems for providing information on safeguards should also provide information that is transparent, consistent, constantly updated and accessible by all stakeholders while taking into account national circumstances, sovereignty, legislation, international obligations/agreements and gender considerations. They should be country-driven, flexible and consistent with the guidance UNFCCC while building upon the existing systems. Countries are supposed to provide a summary of the information on safeguards in their national communications.

Quite significantly, the decision on FRLs allows the development of subnational reference (emission) level as an interim measure while transitioning to a national reference (emission) level. The FRL should be developed based on the most recently adopted IPCC guidelines while maintaining consistency with the national GHG inventories. They should follow an incremental approach with progressive improvement over time using better data and methods with the provision of adequate and predictable support. 'Significant' carbon pools and activities should not be excluded. The decision also invites the developing country parties to voluntarily submit their FRLs while agreeing to set up a process for its technical assessment.

The decision on REDD+ financing provides for supporting 'result-based actions' on REDD+ (note 4) in developing countries by 'result-based finance' from a public, private, bilateral and multilateral, and alternative sources provided they are fully 'monitored, reported and verified'. Appropriate market and non-market-based approaches can be developed by the COP to support such 'result-based actions'.

**REDD+ under the Cancun Agreement and Durban decisions – challenges and unresolved issues**

The Cancun Agreement clarified the scope and type of eligible REDD+ activities; main element of environmental and social safeguards and a phased approach to REDD+ implementation clearly specifying the readiness actions expected from countries. On the methodological side, the Cancun Agreement identified the key methodological challenges for further work, including: the identification of LULUCF activities relating to drivers of deforestation and degradation, and the issues relating to estimation of emissions and removals from them; development of modalities for the establishment of national or sub-national FRL and national (or sub-national) monitoring, reporting and verification (MRV) system; development of guidance on safeguards and development of modalities for the national (or sub-national) REDD+ MRV systems.

**Table 1.** List of resolved and unresolved elements in reducing emissions from deforestation and forest degradation (REDD+) post Cancun Agreement and Durban decisions

Issues	Resolved	Unresolved
Scope and scale of REDD+ activities	Scope according to the decision in the Cancun Agreement includes all previously agreed elements: Reducing emissions from deforestation, from forest degradation, conservation of forest carbon stocks, sustainable management of forest and enhancement of forest carbon stocks. The Durban decision provides for sub-national forest reference (emission) level (FRL) that may cover areas less than the entire national territory as an interim measure while transitioning to a national FRL.	Exact definition of activities remains unclear.
Drivers of deforestation	The Cancun decision makes reference to drivers of deforestation and requests developing countries to address the drivers of deforestation and forest degradation. Subsidiary Body for Scientific and Technological Advice (SBSTA) has been requested to develop a programme of work addressing the drivers.	Exact scope of drivers in terms of proximate and underlying drivers of deforestation and degradation has not been specified. The Cancun Agreement does not clearly specify the nature of activities linked to drivers of deforestation and degradation.
Monitoring, reporting and verification (MRV) for safeguards	Annex I of the Cancun Agreement includes guidelines on how REDD+ should be implemented, and mentions respect for rights of indigenous peoples and local communities and conservation of natural forests and biodiversity. The Durban decision on safeguards provides more clarity on the system for providing information on safeguards.	Timing and frequency of submission of the first and subsequent summary of information on safeguards is yet to be decided. SBSTA also has to consider if more guidance about information on safeguards is needed to ensure transparency, consistency, comprehensiveness and effectiveness.
Financing REDD	The Durban decision on REDD+ financing provides for financing of 'result-based actions' by 'result-based financing' from private, public, bilateral, multilateral and alternative sources, and includes consideration of both market and non-market (i.e. fund-based) approaches to financing for REDD+ activities.	There is a lack of clarity on the use of market or non-market approaches for funding REDD+ actions.
Methodological issues	MRV	The Cancun Agreement provides a phased approach to development of MRV and capacity-building.
	Reference levels	The Durban decision provides for elaboration of sub-national FRL as an interim measure while transitioning to a national FRL. The FRL should be developed using the most recently adopted IPCC guidelines. 'Step-wise' approach to developing FRL with progressive improvement in data and methods is provided. 'Significant' carbon pools and activities should not be excluded in the construction of the FRL and consistency with the national green house gases inventory should be maintained.
		MRV modalities remain largely unclear. SBSTA has been given the task of developing modalities for measuring, reporting and verifying emissions reductions from activities for consideration for COP18.
		No clarity regarding the 'significant' C pools or activities. Modalities for the technical assessment of FRL remain to be negotiated.

Durban decisions on REDD+ follow up on the mandate from the Cancun Agreement, and carry the process forward with key decisions of safeguards, FRL and financing as mentioned above. Although much progress has been made at Cancun and Durban, many issues remain to be resolved. Issues like exact definition of REDD+ activities, modalities for MRV, timing and frequency of submission of information on safeguards, modalities for technical assessment of FRL, timing of transition to national level FRL and REDD+ implementation and clarity on use of market or non-market-based approaches for

REDD+ financing need to be addressed before REDD+ becomes a reality.

Table 1 provides a brief overview of the status of various REDD+ issues in light of the Cancun Agreement and Durban decisions.

### REDD+ in the Indian context

The Forest Survey of India (FSI) has been periodically monitoring area under forests since 1987. FSI defines a

**Table 2.** Area under forests (m ha) at different time periods according to estimates provided by the Forest Survey of India (FSI)

Forest type	Year of assessment							
	1985–87	1995–97	1997–99	1999–2001	2001–03	2003–05	2005–07	2007–09
Dense	36.14	36.73	37.74	41.68	39.06	38.72	40.25	40.42
Open	28.16	26.61	25.99	25.87	28.78	28.99	28.84	28.78
Total	64.20	63.34	63.73	67.55	67.83	67.71	69.09	69.20

The data on area under forests are taken from State of Forest Reports (SFRs). Data for 2007–09 come from SFR 2011, for 2005–07 from SFR 2009 and so on.

forests as ‘all the lands, more than one hectare in area, with a tree canopy density of more than 10%’. According to the State of Forest Report (2011) produced by FSI, area under forests in India is estimated to be 69.20 m ha (during 2009), making up 21.02% of the total geographical area of the country<sup>6</sup>. In India, the progressive forest policies and programmes have significantly contributed to reduced rates of deforestation, increased afforestation and overall stabilization of area under forests, and even increase in gross area under forests. India is thus one of the few tropical countries where forest cover has stabilized or increased. The factors contributing to stabilization of forest cover as well as forest carbon stocks in India include: legislations such as Forest Conservation Act, 1980; afforestation programmes like social forestry and Joint Forest Management (JFM), and community awareness and participation<sup>7</sup>.

#### *Components of REDD+ in the Indian context*

There is a significant lack of clarity regarding the components of REDD+, other than deforestation. In this section, the components of REDD+ mechanism are analysed in the Indian context.

(i) *Deforestation in India:* Most definitions describe deforestation as long-term or permanent conversion of land from forest to non-forest. In the Marrakesh Accord, deforestation is defined as ‘the direct human-induced conversion of forested land to non-forested land’. The Food and Agriculture Organization defines deforestation as ‘the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10% threshold’<sup>8</sup>. The area under forest as reported by FSI periodically is presented in Table 2. A cursory reading of Table 2 would show that generally forest area at the national level is indeed increasing consistently from 1995–97 (63.34 m ha) to 2009–11 (69.20 m ha). This leads many to believe that deforestation is not taking place in India.

Forest loss or deforestation in India in a given period can be estimated at the district or state level from: (i) area of forest remaining forest; (ii) afforested area (planted

forest area reaching the canopy cover threshold of 10%) and (iii) area of forest converted to non-forest purposes. However, with no such data available from FSI reports and the monitoring process, as a first approximation, it can be estimated from the net changes in forest cover at disaggregated levels such as the state or district. It is assumed here that the districts or states recording a net decrease in forest cover between two periods of assessment are experiencing deforestation. The following area changes can be estimated during the two successive periods based on changes in area at the state level based on the respective FSI reports:

#### *Area changes during 2003–2005 based on comparison at the state level:*

- Sum of all states with a net gain in forest area or with positive change in forest area is 1,366,100 ha.
- Similarly, the sum of all states with a net loss or negative change in forest area aggregated to 130,600 ha (65,300 ha annually; Table 3).

#### *Area changes during 2005–2007 based on comparison at the state level:*

- Sum of all states with a net gain in forest area or with positive change in forest area is 316,000 ha.
- Similarly, the sum of all states with net loss or negative change in forest area aggregated to 93,700 ha (46,850 ha annually; Table 3).

#### *Area changes during 2007–2009 based on comparison at the state level:*

- Sum of all states with the net gain in forest area or with positive change in forest area is 500,000 ha.
- Similarly, the states with net loss or negative change in forest area aggregated to 866,00 ha (43,300 ha annually; Table 3).

Thus the net annual forest loss or deforestation is estimated to be 65,300 ha during 2003–05, 46,850 ha during 2005–07 and 43,300 ha during 2007–09, even though the national total area estimates show a net gain (Table 2).

**Table 3.** Area under forests and deforestation status for major states and national total (sq. km) according to estimates of SFRs provided by FSI

State	Area revised			Area	Change in area		
	2003 (SFR_2005)	2005 (SFR_2007)	2007 (SFR_2009)	2009 (SFR_2011)	2003–05	2005–07	2007–09
Andaman and Nicobar	6,807	6,663	6,662	6,724	-144	-1	62
Andhra Pradesh	44,412	45,231	46,670	46,389	819	1,439	-281
Arunachal Pradesh	67,692	67,472	67,484	67,410	-220	12	-74
Assam	27,735	27,758	27,692	27,673	23	-66	-19
Bihar	5,573	6,807	6,804	6,845	1,234	-3	41
Chhattisgarh	55,992	55,929	55,678	55,674	-63	-251	-4
Delhi	174	177	176.58	176.2	3	0	0
Goa	2,164	2,156	2,212	2,219	-8	56	7
Gujarat	14,814	14,604	14,620	14,619	-210	16	-1
Haryana	1,576	1,604	1,594	1,608	28	-10	14
Himachal Pradesh	14,359	14,666	14,668	14,679	307	2	11
Jammu and Kashmir	21,273	22,689	22,537	22,539	1,416	-152	2
Jharkhand	22,569	22,722	22,894	22,977	153	172	83
Karnataka	35,246	36,200	36,190	36,194	954	-10	4
Kerala	15,595	17,284	17,324	17,300	1,689	40	-24
Madhya Pradesh	76,145	77,739	77,700	77,700	1,594	-39	0
Maharashtra	47,514	50,661	50,650	50,646	3,147	-11	-4
Manipur	17,259	16,952	17,280	17,090	-307	328	-190
Meghalaya	16,925	17,205	17,321	17,275	280	116	-46
Mizoram	18,583	18,600	19,183	19,117	17	583	-66
Nagaland	14,015	13,665	13,464	13,318	-350	-201	-146
Odisha	48,353	48,755	48,855	48,903	402	100	48
Other states	311	307	310	311	-4	3	1
Punjab	1,545	1,660	1,664	1,764	115	4	100
Rajasthan	15,821	16,012	16,036	16,087	191	24	51
Sikkim	3,262	3,357	3,359	3,359	95	2	0
Tamil Nadu	23,003	23,314	23,551	23,625	311	237	74
Tripura	8,123	8,173	7,985	7,977	50	-188	-8
Uttar Pradesh	14,127	14,346	14,341	14,338	219	-5	-3
Uttarakhand	24,460	24,493	24,495	24,496	33	2	1
West Bengal	12,389	12,970	12,994	12,995	581	24	1
Aggregate change in area gain and loss					Gain = 13,661 Loss = -1,306	Gain = 3160 Loss = -937	Gain = 500 Loss = -866

Thus it can be concluded that India has been experiencing significant scale net forest loss during the last few years.

*Area changes during 2003–2009 based on comparison at the district level:* Forest loss or deforestation is estimated adopting the same method discussed above for the state level, but considering the district as a unit. Districts reporting reduction in area under forests between two periods are considered to be experiencing deforestation. District-level analysis (Table 4) of national-level deforestation for the three periods is estimated to be: 200,800 ha for the period 2003–05; 127,300 ha for the period 2005–07 and 199,700 ha for the latest assessment period of 2007–09.

This indicates significant annual deforestation of 100,400 ha, 63,650 ha and 99,850 ha for 2003–05, 2005–07 and 2007–09 respectively.

It can be concluded that at the national level, India has been experiencing significant forest loss during the last few years, even though total area estimates as reported by

FSI show a gain of 1.49 m ha during the period 2005–2009. According to another estimate<sup>9</sup>, if one subtracts plantations from total forest cover, India's native forests were actually declining at the rate of 0.8% to 3.5% per year for 2000–05.

(ii) *Forest degradation:* Defining forest degradation is complex and there is no standard internationally accepted definition of degradation. The IPCC Special Report on 'Methodological options to inventory emissions from direct-human induced degradation of forests and revegetation of other forest types' defines degradation as 'direct human-induced long-term loss (persisting for  $X$  years or more) of at least  $Y\%$  of forest carbon stocks (and forest values) since time ( $T$ ) and not qualifying as deforestation'<sup>10</sup>. However, this definition has operational limitations because  $X$  (human-induced long-term loss),  $Y$  (% of forest carbon stocks) and the minimum area of forest to be measured are difficult to define<sup>1</sup>. Forest degradation is a complex process and its drivers may be completely

**Table 4.** Forest area loss estimated at district level (in ha) based on FSI<sup>6,17,18,\*</sup>

	2003–05	2005–07	2007–09
Number of districts where forest area declined	130**	174*	118*
Total forest area converted to non-forest, where the canopy cover declined (<10% canopy cover)	–200,800	–127,300	–199,700
Number of districts where forest area increased	112*	164*	162*
Increase in forest area (>10% canopy cover)	327,268	200,200	327,300

\*Not based on the revised estimates, since district-level data are not available. \*\*There was no change in forest area in the remaining districts.

different from those for deforestation, thus presenting greater challenges in assessment or monitoring as compared to deforestation<sup>11</sup>.

Assessment of degradation at the national level could be done using forest area data from FSI, which present forest area according to four tree canopy cover densities<sup>6</sup>:

- Very dense forest (VDF) – All lands having tree cover with canopy density more than 70%.
- Moderately dense forests (MDF) – All lands having a tree cover with canopy density between 40% and 70%.
- Open forests (OF) – All lands having a tree cover with canopy density between 10% and 40%.
- Scrub – All forest lands with poor tree growth, mainly small or stunted trees having canopy density less than 10%.

In the absence of data on changes in forest carbon stocks, it may be possible to use forest tree canopy density as an indicator of forest status, particularly from the perspective of forest biomass stocks and degradation<sup>12,13</sup>. Any patch of forest moving from higher crown class to lower crown class, could potentially be considered to be subject to forest degradation. Extent of forest degradation in India can be estimated based on the area subject to decline in crown canopy density between two time periods based on reports of the FSI.

*Forest degradation during 2003–2005:* Tables 5–7 present the forest cover change matrix for the period 2003–05, 2005–07 and 2007–09 respectively. As can be seen from Table 5, a net decrease in MDF by 140,900 ha is reported. At the same time, the area under VDF has increased only by 5100 ha. Thus bulk of the MDF has been converted to lower canopy density classes such as OF and/or non-forest categories, indicating reduction in the tree crown density and the associated carbon stocks.

*Degradation during 2005–07:* It can be seen from Table 6 that the area under MDF has declined by 93,600 ha, whereas VDF has increased by only 3,800 ha. This clearly indicates that MDF has been converted to low canopy density classes such as the OF and scrub, potentially leading to reduction in carbon stocks.

*Degradation during 2007–2009:* There is only a decrease in area under OF and gain in area under dense and moderately dense forests, and thus no degradation (Table 7).

Thus the assessment of forest degradation based on tree crown densities shows that it varies across different assessment periods: degradation occurred during the period 2003–05 and 2005–07 and during 2009–11 there was no degradation.

(iii) *Forest conservation:* This may be considered as maintenance of area and carbon stocks in intact forests by effective law enforcement, development measures and land-use planning. In the Indian context, forest area covered under Protected Area (PA) system of about 15.87 m ha covering 660 PAs, could be considered as areas subjected to forest conservation in the UNFCCC context. The area under PA management is increasing in India. Since in the PAs, all extraction is regulated or banned, the forest vegetation, biodiversity and in turn forest carbon stocks are potentially conserved. The Reserved Forest area may not be considered as forest conservation area in the UNFCCC context, since bulk of the forest is subjected to tree canopy cover change (Tables 5–7).

(iv) *Carbon stock enhancement:* This could involve restoring carbon stocks in degraded forests or creating forests where none currently exists. Approaches may include afforestation, reforestation, restoration (through natural regeneration, assisted natural regeneration or planting), rehabilitation, or forest landscape restoration<sup>14</sup>. Potential activities to be included as carbon stock enhancement activities under the UNFCCC context could be: afforestation, reforestation and assisted natural regeneration through improved management, tending operations, gap-planting, denser stocking, longer rotation periods, forest restoration and rehabilitation of degraded forests.

(v) *Sustainable management of forests:* This was introduced in the UNFCCC negotiations, and incorporated in the Bali Action Plan and the later COP decisions on REDD+. SMF can be understood as maintenance or improvement in existing forest canopy cover and carbon stocks in forests over time through sustainable management practices. SMF in the Bali Action Plan context

**Table 5.** Forest cover change matrix for India between 2003 and 2005 (in sq. km) according to estimates provided by FSI<sup>18</sup>

Class	VDF	MDF	OF	Scrub	NF	Total of 2003
VDF	5,431,300	12,100	2,300	0	6,100	5,451,800
MDF	19,100	33,187,800	77,700	1,900	119,100	33,405,600
OF	6,500	55,200	28,558,500	6,700	297,300	28,924,200
Scrub	0	500	14,500	3,815,000	174,400	4,004,400
NF	0	9,100	334,200	23,900	256,573,100	256,940,300
Total of 2005	5,456,900	33,264,700	28,987,200	3,847,500	257,170,000	328,726,300
Net change	5,100	-140,900	63,000	-156,900	229,700	0

VDF, Very dense forest; MDF, Moderately dense forest; OF, Open forest; NF, Non-forest. Source: FSI<sup>9</sup>.

**Table 6.** Forest cover change matrix for India between 2005 (revised) and 2007 (in sq. km) according to estimates provided by FSI<sup>17</sup>

Class	VDF	MDF	OF	Scrub	NF	Total of 2005
VDF	8,321,900	12,700	4,500	500	7,600	8,347,200
MDF	22,000	31,560,800	194,800	4,200	213,000	31,994,800
OF	3,500	182,100	28,056,000	18,600	414,900	28,675,100
Scrub	0	1,500	16,100	4,082,800	28,200	4,128,600
NF	3,600	144,100	566,300	46,400	254,820,200	255,580,600
Total of 2007	8,351,000	31,901,200	28,837,700	4,152,500	255,483,900	328,726,300
Net change	3,800	-93,600	162,600	23,900	-96,700	

Source: FSI<sup>7</sup>.

**Table 7.** Forest cover change matrix for India between 2007 and 2009 (in sq. km) according to estimates provided by FSI<sup>6</sup>

Class	VDF	MDF	OF	Scrub	NF	Total of 2007
VDF	83,133	229	21	0	45	83,428
MDF	311	316,054	1,903	81	1,888	320,238*
OF	20	2,929	281,917	455	3,406	288,728
Scrub	0	82	488	41,305	175	42,050
NF	7	1,442	3,491	335	2,547,545	2,552,820
Total of 2009	83,471	320,736	287,820	42,176	2,553,060	3,287,263*
Net change	43	498	-908	126	240	

\*Difference in totals due to rounding of decimals.

potentially refers to the application of forest management practices for the primary purpose of maintaining or enhancing carbon stocks over time. It also refers to management of forests in such a way that the long-term productivity of the forest is maintained through implementation of practices such as low-impact logging.

SMF can occur in all the existing natural forests and plantations subject to prescribed sustainable management practices. Thus all forests subject to activities leading to maintenance or increment of forest carbon stocks, by means of improvement in the quality of existing stocks and sustainable extraction of biomass (e.g. reduced impact logging) may be considered to be under SMF.

Although Reserve Forests and plantations raised in the degraded forest area are supposed to be managed using the so-called 'working plan' approach, it is not so clear if this approach is indeed based on sustainable management principles. It is therefore somewhat difficult to delineate the area subjected to SMF in India. However, as a first-order approximation, all forests being managed under an

approved working plan could be considered to be subject to SMF.

In the absence of clear definitions and guidelines, it is difficult to estimate the area that may qualify for the three activities in India, namely forest conservation, enhancement of carbon stocks and SMF.

### Implications of the Cancun Agreement on REDD+ for India

The Cancun Agreement created a framework for REDD+ action by countries in a phased manner, specifically listing the phased actions required from the countries immediately in the first phase. The following section looks at India's readiness for REDD+ in terms of these actions.

#### *National REDD+ strategy*

As part of the first phase of activities, countries are supposed to develop a national REDD+ plan or strategy. It

would involve selecting the most effective REDD+ strategies with the highest returns by assessing the status of national forests, identifying the location of deforestation, degradation and activities resulting in carbon stock enhancement and their drivers; assessment of the abatement opportunities as to their economic costs and benefits; and prioritizing them in a national REDD+ pathway through a broad suite of policies and measures while ensuring the relevant safeguards as mentioned in Annex I of the UNFCCC Decision<sup>15</sup>.

While India has a broad suite of policies and measures in place for addressing deforestation and degradation and enhancing forest carbon stocks, a dedicated institutional structure needs to be put in place to formulate and implement a national REDD+ strategy with a clearly defined mandate, roles and responsibilities. So far India has not prepared a REDD+ strategy as required under the UNFCCC.

#### *Developing a MRV system for REDD+*

As part of the Cancun Agreement, countries are supposed to develop a robust and transparent national forest monitoring system with the capacity to consistently and accurately monitor changes in forest cover and carbon stocks over time. There is a general consensus that this forest monitoring system would be a combination of remote sensing and ground-based systems<sup>11</sup>.

India has a distinct advantage of having a mature and well-developed national forest monitoring system based on remote sensing combined with extensive ground-truthing with a long time series of data on forest cover according to different canopy cover density classes<sup>6</sup>. With some modifications, it is possible for India to detect the location of deforestation and degradation with sufficient accuracy. Information on the areas subject to conservation, enhancement of carbon stocks and SMF could also be obtained through a combination of data from administrative and other sources, and remote sensing. Currently, India does not have a forest inventory system based on permanent plots. India will have to develop a robust system for monitoring of carbon stocks in forests through a network of permanent monitoring plots to provide sufficiently accurate sub-national estimates of carbon stock changes.

#### *Setting the forest reference (emission) level*

The most challenging component of the readiness activities is developing a national or sub-national FRL. In order to set a FRL, along with the present and historic information on forest area and carbon, an analysis of factors driving deforestation and degradation is imperative. For the plus component, it is equally important to understand the drivers of deforestation and degradation, since

these drivers are inversely linked to enhancement of carbon stocks, conservation of forests and SMFs. Data on the various drivers of deforestation, degradation and activities resulting in carbon stock enhancement and conservation can potentially be gathered through a combination of remote sensing and other non-spatial information such as administrative records.

For FRL estimation, future areas subject to deforestation, degradation, carbon stock enhancement, SMF and forest conservation can be projected based on the past trends and policy drivers using time-series data on forest cover since 1987 and non-spatial information available from administrative records and other data sources. However, availability of consistent historical carbon stock information presents a more significant challenge. It can be addressed to some extent by developing carbon stock values according to proxies such as canopy cover through future monitoring and correlating them with the past patterns.

#### *System for information on safeguards*

Currently India does not have a system of providing information on environmental and social safeguards. In order to effectively monitor safeguards, it will be necessary to evolve a clearly defined set of indicators and criteria for parameters such as forest governance structures, respect for rights of indigenous peoples, and full and effective participation of relevant stakeholders, along with a system to monitor these<sup>16</sup>.

### **Conclusion**

Tropical forests are one of the most significant reservoirs of carbon in the world. Tropical deforestation accounts for about a fifth of the global CO<sub>2</sub> emissions. Reducing deforestation and forest degradation as well as activities leading to carbon stock enhancement in developing countries present a unique opportunity for cost-effective global climate change mitigation while delivering multiple benefits such as biodiversity conservation, livelihood generation and maintenance of ecosystem services.

The international negotiations on REDD+ under UNFCCC culminating in the Cancun Agreement provide for a phased approach towards REDD+ implementation with the countries undertaking REDD+ readiness activities and REDD+ implementation in the initial phases, leading up to a full-scale performance-based system in the final phase. The Cancun Agreement also identifies the specific elements of REDD+ readiness activities that countries need to work on: national REDD+ strategy, MRV system, reference emission level (REL) and a system for monitoring safeguards. While the Cancun Agreement provides clarity on some elements of REDD+, much work needs to be done on some key aspects such as

scale, source of financing, RELs, safeguards and MRV systems. The provision in the Agreement to allow sub-national REDD+ approaches as an interim measure opens the door for future forestry-based clean development mechanism (CDM) and voluntary projects to be incorporated into sub-national programmes. CDM, despite the small number of forestry-based projects, still being operational could be a vital source of experience to REDD+ negotiators as they examine options for financial, technical and institutional arrangements. Voluntary market institutions, particularly the Voluntary Carbon Standard, present a vital testing ground for innovative practices.

Although India has traditionally been characterized a low forest low deforestation (LFLD) country, our analysis suggests that there is significant deforestation and forest degradation occurring in India. Consequently, there is large potential for REDD+ activities in the country.

India is partially ready for implementing the emerging REDD+ components and mechanism, despite robust, stable and predictable forest policies, programmes and institutions. Benefit-sharing mechanisms need to be put in place for REDD+ to be successful.

## Notes

1. Durban Platform for Enhanced Action on climate change.
  2. Under the SBSTA work programme on methodological issues relating to REDD+.
  3. Policy approaches and positive incentives relating to REDD+ under the Ad Hoc Working Group on Long-term Cooperative Action.
  4. Referred to in Appendix II of decision 1/CP.16.
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1. IPCC, In *Climate Change: Impacts, Adaptation and Vulnerability* (eds Parry, M. L. *et al.*), Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 2007.
  2. Tavoni, M., Sohngen, B. and Bosetti, V., Forestry and the carbon market response to stabilize climate. FEEM Working Paper No. 15, 2007.
  3. Levin, K. and Bradley, R., Comparability of Annex I Emission Reduction Pledges. WRI Working Paper, World Resources Institute, Washington, DC, USA, 2010.
  4. den Elzen, M. G. J., van Vuuren, D. P. and van Vliet, J., Postponing emission reductions from 2020 to 2030 increases climate risks and long-term costs. *Climate Change*, 2010, **99**, 313–320.
  5. Eliasch, J., *Climate Change: Financing Global Forests*, Earthscan Publications Ltd, London, 2008.
  6. The State of Forest Report 2011, Forest Survey of India (FSI), Ministry of Environment and Forests (MoEF), Government of India (GoI), 2011.
  7. Ravindranath, N. H., Chaturvedi, R. K. and Murthy, I. K., Forest conservation, afforestation and reforestation in India: implications for forest carbon stocks. *Curr. Sci.*, 2008, **216**, 216–222.
  8. Puyravaud, Jean-Philippe, Davidar, P. and Laurance, W., Cryptic loss of India's forests. *Science*, 2010, **329**.
  9. IPCC, In *IPCC Good Practice Guidance for LULUCF sector*, Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, 2003.
  10. GOF-C-GOLD, A sourcebook of methods and procedures for monitoring, measuring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forest remaining forests, and forestation (eds Achard, F. *et al.*), GOF-C-GOLD Report version COP15, GOF-C-GOLD Project Office, Natural Resources Canada, Alberta, Canada, 2010, p. 197.
  11. Bajracharya, S., Community carbon forestry: remote sensing of forest carbon and forest degradation in Nepal. M. Sc. Thesis, International Institute for Geo-information Science and Earth Observation, Enschede, The Netherlands, 2008.
  12. Rikimaru, A., Roy, P. S. and Miyatake, S., Tropical forest cover density mapping, *Trop. Ecol.*, 2002, **43**, 39–47.
  13. Miles, L., Dunning, E. and Doswald, N., Safeguarding and enhancing the ecosystem-derived benefits of REDD+. Multiple benefits series 2. UN-REDD Programme, UNEP World Conservation Monitoring Centre, Cambridge, UK, 2010.
  14. CFRN initiatives: CCDP National REDD+ Strategy, 2011; <http://www.rainforestcoalition.org/CarbonEmissions.aspx>
  15. UN-REDD Programme, 2010; <http://www.un-redd.org/> (accessed on 12 October 2010).
  16. The State of Forest Report 2009, FSI, MoEF, GoI, 2009.
  17. The State of Forest Report 2005, FSI, MoEF, GoI, 2005.
  18. Angelsen, A., *REDD+: National Strategy and Policy Options*. (eds Brockhaus, M. *et al.*), Realising CIFOR, Bogor, Indonesia, 2009.

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