Forestry Sector in India is Net Source of Green House Gases (GHGS)

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Abstract: More than 275 million people are deriving their sustenance and livelihood needs from forests and causing forest degradation due to unsustainable harvest of forest produce. India is committed to achieve sustainable development of forests. The inadequate finance, capacity and research are key issues for sustainable development of forests in India. The consumption of wood and wood-based products has been considered for the estimation of emissions from forestry sector. The carbon sequestration has been estimated on the basis of productivity of forests and tree outside forests. The forestry sector in India will be a net source of Green House Gases (GHGs) till 2051 if policies and programs of forestry sector are implemented at the current pace and commitment. The forestry sector will also be net source of GHG till 2051 if the policies and programs suggested above are implemented moderately but the intensity of emissions will be low. The forestry sector may become net sink of GHG's only if policies and programs are implemented aggressively with full commitment. The aggressive implementation of policies and programs will not only improve the quality of forests but also improve the quality of the life of the forest dependent communities by providing them a sustained livelihood which in turn benefit environment. The political commitment is very low for the forestry sector in India. If this continue in future, it would not be possible to achieve the scenario based on aggressive scenario. The Intended Nationally Determined Contributions (INDCs) for forestry sector announced by the Government of India on 2nd October, 2015 are extremely difficult to achieve.

Keywords: GHG, forest degradation, fuel wood, sustainable forest management (SFM) and Intended Nationally Determined Contributions (INDCs).

1. INTRODUCTION

Forest plays an essential role in maintaining earth's climate by stabilizing the concentration of Greenhouse gases from the atmosphere. They provide multiple resources and services which ultimately help in livelihood generation and reduction of poverty of forest dependent communities (IPCC 2007) [11]. Forests ecosystem are reservoir of terrestrial biodiversity and represent nearly 90% of World's terrestrial biodiversity (Novotny *et al*. 2006) [15]. Protective functions and environment services provided by forests are countless. They are critical for hydrological integrity of various ecosystems (FAO 2008a) [2]. The importance of forests is now widely recognized and efforts are being made for their protection and conservation. In last 25 years globally the Forest area primarily designated for conservation of biodiversity has increased by 150 million hectares, area reported for soil and water conservation has increased by 185 million hectares and area reported for Environment protective function has increased by 210 million hectares (FAO, 2015) [3]. Despite increasing conservation efforts in past 25 years the threat of deforestation persists as world has lost close to 129 million hectares of forest area resulting in reduction of carbon stocks in forest biomass by 17.4 Gt. It is likely that the current global trend of declining forest and biomass will continue in near future (FAO, 2015) [3]. Forests are national resources of global concern as changes in forests affect the globally important goods and services (FAO, 2015) [3]. Thus, conservation and sustainable management of forests and other ecosystems is now one of 17 Global Goals that made up the 2030 agenda for Sustainable Development at the United Nations development summit on 25th September 2015 (UNDP, 2015) [16]. India has successfully addressed the problem of deforestation in recent years. But forest degradation remains a growing concern. Between 2003 and 2015 continuous improvement has been reported in India's Forest cover as it increased by 14,906 square kilometers or 2.17%, whereas the Growing stock in Forests (GS) reduced significantly by 586.387 million cubic meters or 12.26% (Table **1**). There is little increase of growing stock as shown in ISFR 2015. The inventory done by FSI in 60 sample districts is changed for every ISFR. It is not possible to compare the data. It is a big constraint for the ISFR. The net carbon sequestration and emission has been considered. The five pool of carbon is generally used for estimating carbon stock. It is net carbon annual inventory.

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Table 1: Trends of Forest Resources as Reported in India's State of Forest Reports (IFSR)

Forest Resource Accounting Variable	ISFR 2003	ISFR 2005	ISFR 2009	ISFR 2011	ISFR 2013	ISFR 2015	Net Change between 2003 to 2015	% Change between 2003 to 2015
Forest Cover (in square kilometers)	686,767[3]	692,027[4]	690,899	692,027	697,898	701,673	14,906	2.17
Growing Stock in Forests (million cubic meters)	4781.414	4602.04	4498.7	4498.73	4173.36	4195.047	-586.367	-12.26
Growing Stock in Forests and Tree outside forests (million cubic meters)	6413.752	6218.28	6098.2	6047.15	5658.05	5768.387	-645.365	-10.06

Source: FSI 2003 [4]; FSI, 2005 [5]; FSI 2009 [6]; FSI 2011 [7]; FSI 2013 [8]; FSI 2015 [9].

As reported in Forest survey of India reports (Table **1**), though there is an increase of 2.17% in forest cover of the country since 2003, the growing stock of the forests reduced by 12.26%. As a result the growing stock of country declined by 10.06%. The reduction in growing stock indicates degradation and reduction in forest quality (FSI, 2011) [7]. Within the recorded forest, degradation is a major concern as 94.96% of forest is prone to crop injuries and 55% of RFA has adequate regeneration, while 39.94% has inadequate and 5.05% has no generation (FSI, 2015) [9]. Despite improved forest cover, sharp reduction in GS[1], inadequate regeneration, soil erosion[2] and significant crop injuries underlines forest degradation and deteriorating forest health in India. Forest degradation is difficult to detect from spatial data and is critical parameter to monitor impacts on biodiversity carbon sequestration and potential deforestation (FAO, 2015) [3]. India is committed to implement sustainable forest management. National Forest Policy, 1988 formulated four years before the Earth summit, embodies all elements of Sustainable Forest Management, and also has strong policy, legal and institutional framework for its implementation. India has long tradition for managing forests on the basis of scientific prescription but not able to do so due to inadequate finance, capacity and technology. Moreover around 275 million people derive their full or partial livelihood from the forests unsustainably which is major driver of forest degradation in the country. Forest degradation directly impacts sequestration of GHG and enhances emissions.

Given the context, estimated projections of GHG emissions and removals from forestry sector (From 2016-2051) under three different scenarios are presented in this paper. This paper also analyzes the increasing trends of forest degradation and its drivers in India.

2. FOREST DEPENDENCE AND KEY DRIVERS OF FOREST DEGRADATION IN INDIA

Direct and indirect benefits provided by forests in India are enormous (FSI, 2011a) [7]. Forests provide direct benefits to the local communities in India in form of fuel wood, fodder, timber and NTFPs are of significant religious and cultural significance to the hill and tribal communities (Bahugana and Bisht, 2013) [1]. Ecosystem services provided by forests is not limited to only carbon sequestration, as they help in disaster mitigation and control; conservation of soil and moisture; water retention and supply and are reservoir of terrestrial biodiversity (TERI 2013). The minimum approximate value of goods and services provided by forests annually in India is estimated at INR 6.96 lakh crores (Bahugana and Bisht, 2013) [1].

A significant population of India is dependent on forest resources for fulfilling their needs. Fuel wood, fodder and timber are three key direct services provided by forest to the community. Over 853 million people in India use fuel wood, 199.6 million of those collect fuel wood directly from forests, 38.49% of total livestock in India is directly dependent on forests for grazing, around 275 million people living in and around forests are deriving their full or partial sustenance needs from forests (FSI, 2011a) [7].

Globally, India accounts for highest annual wood removal of 434,766 thousand cubic meters, 88.6% which is fuel wood (FAO, 2015) [3]. Annually, 216.47 million tons of fuel wood is consumed in India, of which 27.13% comes directly from natural forests. This rate of

[1] GS of Forests reduced by 282.68. Million cubic meters in six years between 2003 and 2011 in past 8 year while it reduced by 325.369 million cubic meters in just two years between 2011 and 2013.

[2] 87% of forest area in India is estimated to have soil erosion.

[3] Forest cover corrected for change of scale reported in IFSR 2009.

[4] Forest cover corrected for change of scale reported in IFSR 2009.

consumption is well beyond sustainable limits (FSI, 2011a) [7] as 61.17% crops in forest area are prone to from Girdling and illicit felling for fuel wood and timber collection (FSI, 2015) [9]. Unsustainable harvest of forest produce and NTFPs degrades the ground and middle flora of the forests. Grazing affects 81% of country's forest area, heavy and excessive grazing and lopping for fodder affect vegetation. 6.15% of forest area is prone to injuries from lopping (FSI, 2015) [9]. The National Forest Policy 1988 of India stresses on protecting the rights and concession of tribals and forest dependent poor communities on forest resources for fulfilling their domestic requirements of fuel wood, fodder, NTFP (MoEF, 1988) [13]. The policy also stresses on conservation and management of forest resources primarily for maintaining ecological security and heritage of the country (MoEF, 1988) [13]. Efforts have been made for fulfilling the increasing demand of fuel wood and timber from tree outside forests or farm forestry. The demand for timber required by various industries (Construction, real state, production of agricultural equipment's, pulp-wood) is primarily fulfilled from farm forestry in India. Still the intense pressure on natural forests for fuel wood, fodder, timber and NTFP for fulfilling the domestic and industrial needs is a major cause of forest degradation in India.

3. FOREST GOVERNANCE AND POLICY INITIATIVES IN INDIA

India has strong policy, regulatory and institutional framework to implement sustainable forest management. The role of Central Government is policy making and planning while the role of state government is implementation. The National Forest Policy, 1988 embodies all elements of sustainable forest management. The prime objective of the policy is ecological security of the Nation with the safeguard to fulfill subsistence and livelihood need of the forest dependent communities, particularly tribal and women. The policy also mandated the involvement of people in the conservation, protection and management of forests. The forest governance has been shifted from regulatory to participatory mode of forest governance. The Joint forest Management (JFM) Institution has been established with a resolution by Government of India in 1990. Officials from forest department along with community manage forests with benefit sharing mechanism on the principle of Care and share. At present, more than 22 million hectares of forests has been managed by more than one lac JFM Committees. All States and Union Territories have adopted the JFM mechanism as a major tool for the forest management. However efforts are needed to ensure benefit sharing of resources and encourage community participation in decision making under JFM. The regulatory tool for sustainable forest management are Indian Forest Act, 1927, Wildlife Protection Act, 1972, Forest Conservation Act, 1980, Forest Right Act, 2006, Biological Diversity Act, 2002 and legislations for the protection of trees outside forests. There are many contradictory and overlapping provisions in various legislations. Efforts have not been made to resolve contradictions. The Forest Right Act, 2006 provide the tenurial security to the Gram sabha based Forest Governance. The JFM institution has to be synchronized with the Gram sabha based Forest Governance. Many provisions of the Wildlife Protection Act have to be synchronized with Forest right Act, 2006. It is fact that implementation of many of these legislation is poor which hampers necessary progress in Forestry sector (MoEF & CC, 2014) [14].

4. KEY RECOMMENDATIONS FOR ACHIEVING PROGRESS TOWARDS SUSTAINABLE FOREST MANAGEMENT IN INDIA

Long term commitment and concentrated efforts are needed for development and conservation of nation's forest resources against increasing demand and exploitation. Following measures may be helpful for achieving the desired progress in sector.

- Green India Mission (GIM) one of the eight mission under National Action Plan on Climate change has received little attention and financial assistance. Implementation of GIM with full commitment to achieve its financial as well as physical targets is imperative for conservation and enhancement of Forest resources and welfare of Forest dependent communities in India. The mission should continue in the same spirit and pace beyond 10 years.
- The poverty alleviation schemes must be linked with forest conservation schemes to avoid further degradation as Government took the initiative in Green India Mission and various external aided forestry projects. Livelihood of forest dependent communities should be taken on priority by Forest Department in such schemes to avoid unsustainable harvest of forest produce.
- Capacity of State Forest department and community has to be built with respect to implementation of policies, plans for the sustainable Forest Management. The carbon

assessment and socioeconomic survey may be made a compulsory exercise while preparing the forest working plan.

- As reported in Forest sector report 2010 there remains a 20% gap between the sanctioned strength and filled in posts for field staff in Forest department. Immediate steps must be taken for filling of the vacancies of frontline staff in the Forest Department (ICFRE, 2010) [10].

- Forest Governance to be synchronized with Gram Sabha based forest governance limiting forest department to technical guidance, monitoring and implementation of forest related legislations.

- Efforts must be made to limit the harvest of forest produce, particularly fuel wood and fodder under sustainable limit to avoid forest degradation and to promote better regeneration.

- Policy intervention to permit private sector for plantation and restocking of degraded forests and Industry should to be encouraged to plant more and high yielding varieties to produce more wood for meeting local demand and sequester more carbon.

- There is a need to produce high yielding varieties for promoting the Agro Forestry Production in consonance with National Agro forestry policy 2012.

- To check the forest degradation, the income generating activities for the communities are as important as the conservation activities. Thus adequate financial allocations must be made to the forestry sector for covering the expenditure on livelihood generation activities of the forest dependence communities.

5. METHODOLOGY FOR ESTIMATION OF SOURCE / SINK FROM FORESTRY SECTOR

In India, there is tree growth inside forests and outside forests also. Tree outside forests play key role to meet demand of fuel wood, timber and other wood products for industry. Natural Forests play key role for providing ecosystem services and livelihood to the forest dependent communities. While, calculating source and sink for forestry sector, emissions and removals from both Forests and TOF is considered.

Biomass Gain and Loss method has been adopted to estimate source and Sink of GHG from forestry sector. Sink has been estimated on the basis of annual average productivity for forests as per the factors available in IPCC guidelines 2006.The annual average productivity of forests and TOF vary from species to species.

The forestry sector impacts other sectors and impacted by other sectors. The socio-economic, demographic, biological and cultural factors have been considered while projecting the consumption of wood and wood products. The emissions have been estimated based on consumption of wood/wood products and forest fire.

For estimating source (total emissions from forestry sector), emissions from fuel wood, fire and pulp wood have been accounted under forestry sector. The consumption of timber, paper and pulp will increase with the pace of projected economic growth, urbanization, higher literacy rate and population increase. Though, a reduction in per capita fuel wood consumption for cooking is projected in coming years due to urbanization, higher income of rural population and present marketing and schemes by Government of India. But the projected increase in population and subsequent increase in number of brick kilns, hotels and restaurants in semi-urban areas will contribute toward overall increase in consumption of fuel wood for energy future scenario's (Figure **1**).

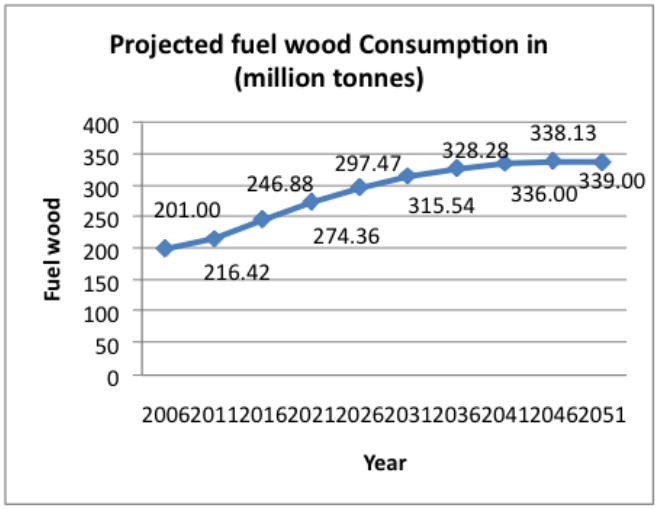

Figure 1: Projected fuel wood consumption.

Subsequently the consumption of pulp wood is also estimated to increase with increasing population and growing economy (Figure **2**).

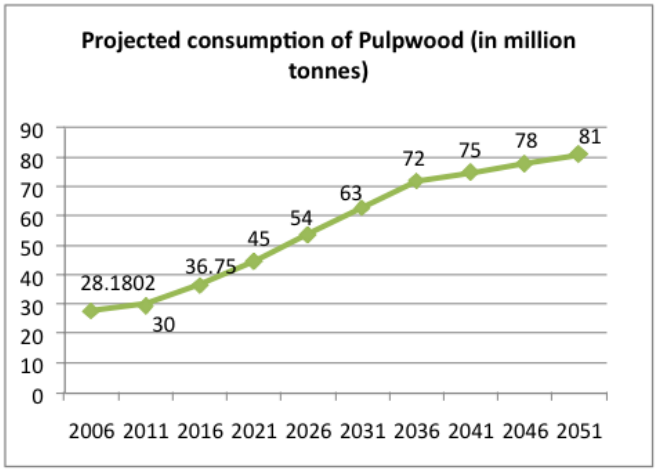

Figure 2: Projected consumption of pulpwood.

With latest technological advancements made in GIS based fire alert system by various state Forest Departments in India. It is assumed that the Emissions due to Forest Fire incidences will slightly decrease in projected scenarios.

For estimating CO_2 removals, the average annual productivity for timber growth in Forests and TOF is considered as 1.8m^3/ha/year and 10m^3/ha/year respectively for years 2006, 2011 and 2016.

The biomass expansion factor in India varies from 1-3.14. Average of 1.5 has been taken as biomass expansion factor for calculations. Using these parameters, the annual increment in the biomass in forests and TOF has been calculated. The annual increment in biomass has been converted into carbon by using a default value of 0.5. The CO_2 sequestration has been quantified by using a default value 3.67.

Under the projected scenario's with the implementation of Green India Mission and various other legal, technical, social and conservation tools for implementing sustainable forest management (SFM), an improvement in the income of forest dependent communities (FDCs), quality of forests, productivity as well as growing stock is being envisaged. It is assumed that the introduction of high yielding varieties of agroforestry species in near future will enhance the carbon sequestration as well as fulfil the demand of forest produce to an extent. These factors will add to the growing stock of the forest substantially. Many factors such as social, economic, demographic and biological will also rationalize the increase and decrease in the demand of various forest products. For the estimation of source and sink from forestry sector, these factors have also been considered along with economic growth in estimations.

6. REFERENCE SCENARIO

The projections for Reference scenario have been developed considering the present trend in implementation of policies and programmes in the forestry sector. It is projected, while considering the increasing population, growing economy that the productivity of forests and TOF will remain same till 2051.

The reference scenario indicates that the policies and programmes of forestry sector will be implemented with the same pace and commitment as it was implemented in the past, and also without any policy interventions for higher productivity and conservation.

Productivity of forests and TOF is therefore projected as 1.8 m^3/ha/year for and 10 m^3/ha/year respectively for Forests and TOF for years 2021, 2026, 2031, 2036, 2041, 2046, 2051.

Accordingly CO_2 emissions and removal from forestry sector are estimated from 2006 to 2051 at the interval of five years are as under Table **2**.

7. ALTERNATE-1 SCENARIO

This scenario refers to the partial implementation of suggested recommendations to achieve sustainable development of forests. There will be little improvement in the productivity of forests and TOF. The emissions will also be marginally low due to better forest fire control.

Table 2: Table CO_2 Emissions from Forestry Sector in RES (Million Tonnes)

	2006	2011	2016	2021	2026	2031	2036	2041	2046	2051
Total CO_2 emissions	392.51	421.92	482.84	539.16	587.71	626.95	656.22	672.49	679.91	680.06
Total CO_2 removals	403.00	398.23	398.87	408.11	415.03	422.36	427.25	432.14	437.02	441.91
Net CO_2 emissions	-10.49	23.70	83.97	131.05	172.68	204.59	228.97	240.35	242.88	238.15
Source / Sink	**Sink**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**

*Under this scenario the forestry sector was net sink in 2006 but it will be net source in future till 2051.

Table 3: Table CO_2 Emissions from Forestry Sector in ALT-1 (Million Tonnes)

	2006	2011	2016	2021	2026	2031	2036	2041	2046	2051
Total CO_2 emissions	392.51	421.92	482.40	538.28	586.53	625.47	654.55	670.75	678.06	678.26
Total CO_2 removals	403.00	398.23	398.87	448.75	492.34	545.57	608.57	626.13	636.78	647.42
Net CO_2 emissions	-10.49	23.70	83.52	89.53	94.20	79.90	45.98	44.62	41.28	30.85
Source / Sink	**Sink**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**	**Source**

*The forestry sector was net sink in 2006 but it will be net source in future till 2051.

Table 4: Table CO_2 Emissions from Forestry Sector in ALT-2 (Million Tonnes)

	2006	2011	2016	2021	2026	2031	2036	2041	2046	2051
Total CO_2 emissions	392.51	421.92	481.94	537.42	585.33	623.99	652.87	668.88	676.22	676.45
Total CO_2 removals	403.00	398.23	398.87	544.31	685.94	751.03	767.67	887.79	914.71	941.64
Net CO_2 emissions	-10.49	23.70	83.07	-6.90	-100.61	-127.05	-114.79	-218.90	-238.49	-265.18
Source / Sink	**Sink**	**Source**	**Source**	**Sink**	**Sink**	**Sink**	**Sink**	**Sink**	**Sink**	**Sink**

*The forestry sector was net sink in 2006 and net source in 2011.

7.1. ALTERNATE SCENARIO - 1

The average annual productivity under Aternate-1 scenario has been projected 1.9 m^3/ha/year for 2021, 2.0 m^3/ha/year for 2026, and 2.1 m^3/ha/year for 2030 and 2.2 m^3/ha/year for 2036 to 2051. The average productivity for TOF under ALT-1 scenario has been projected for 11 m^3/ha/year for 2016, 12 m^3/ha/year for 2021, 13 m^3/ha/year for 2026, 14 m^3/ha/year for 2031, 15 m^3/ha/year for 2036-2051.

Accordingly CO_2 emissions and removal from forestry sector are estimated from 2005 to 2050 at the interval of five years are given in Table **3**.

Though India will be net source of GHGs in future but the intensity will be low in comparison to the reference scenario due to partial implementation of suggested measures mentioned in previous section.

7. ALTERNATE-2 SCENARIO

This scenario is projected considering implementation of the measures suggested in and is being done aggressively with full pace and commitment, with allocation of adequate financial resources in future. The efforts will result into substantial improvement in the productivity of the forests and TOF. The average annual productivity of forests in India under Alternate scenario-2 has been projected 2 m^3/ha/year for 2021, 2.2 m^3/ha/year for 2026, 2031 and 2036 and 2.5 m^3/ha/year for 2041, 2046 and 2051. The productivity for TOF has been projected 12 m^3/ha/year for 2021, 14m^3/ha/year for 2026, 16 m^3/ha/year for 2031 and 18m^3/ha/year for 2036 and 2041, 20 m^3/ha/year for 2046 and 2051.The better implementation of policies and programmes will also impact emissions due to control of forest fire. Accordingly CO_2 emissions and removal from forestry sector are estimated from 2006 to 2051 at the interval of five years are given in Table **4**.

Due to better implementation of policies and programme for sustainable development of forests, the sector will be net sink in future from 2021 to 2051. The Government of India has announced the INDCs for forestry sector on 2nd October and targeted to achieve 2.4 to 3 billion tons of e Co_2 by 2030 which does not look achievable due to lack of political commitment towards forestry sector.

LIMITATIONS

The estimation of GHG emissions from forestry sector is based on secondary data which is limited. The assumptions are based on qualitative and quantitative considerations. There is need to have primary research for the estimation of GHG emissions and analysis of India's State of Forestry report.

REFERENCES

[1] Bahuguna VK and Bisht NS. Valuation of Ecosystem Goods and Services from Forests in India, Indian forester, Dehradun 2013.

[2] FAO (Food and Agriculture Organization) 2008a. Climate Change and Food Security: A Framework Document. Rome: FAO 2008a.

[3] Food and Agriculture Organisation (FAO). Global Forest Resource Assessment, 2015, How are World's Forest changing? Rome, Italy 2015.

[4] Forests Survey of India. India's State of Forests report, Forests Survey of India (MoEF), Dehradun 2003.

[5] Forests Survey of India. India's State of Forests report, Forests Survey of India (MoEF), Dehradun 2005.

[6] Forests Survey of India. India's State of Forests report, Forests Survey of India (MoEF), Dehradun 2009.

[7] Forests Survey of India. India's State of Forests report, Forests Survey of India (MoEF), Dehradun 2011a.

[8] Forests Survey of India. India's State of Forests report, Forests Survey of India (MoEF), Dehradun 2013.

[9] Forests Survey of India. India's State of Forests report, Forests Survey of India (MoEF), Dehradun 2015.

[10] Indian council of Forestry Research and Education (ICFRE). Forest sector report in India, Dehradun 2010.

[11] IPCC. Climate Change. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. vander Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK 2007; 976.

[12] Ministry of Environment and forests (MoEF). National Mission for a Green India 2010. http://www.naeb.nic.in/documents/GIM-Report-PMCCC.pdf last accessed on 12.01.2015.

[13] Ministry of Environment and Forests. National Forest Policy, 1988, Ministry of Environment and Forests, Government of India, New Delhi 1988.

[14] Ministry of Environment, forests and Climate Change: Reference document for REDD+ in India, December 2014.

[15] Novotny V, Drozd P, Miller SE, Kulfan M, Janda M, Basset Y, and Weiblen GD. Why Are There So Many Species of Herbivorous Insects in Tropical Rainforests? Science 2006; 313: 1115-1118. https://doi.org/10.1126/science.1129237

[16] United Nations Development Programme. Sustainable development Goals: Website link: http://www.undp.org/content/undp/en/home/mdgoverview/post-2015-development-agenda/goal-15.html last accessed on 30.11.2015.

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