REDD+ STRATEGY FOR FOREST CARBON SEQUESTRATION IN INDIA

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ABSTRACT

Deforestation and forest degradation due to land use, land cover change (LULCC) have become one of the prime contributors to global greenhouse gas (GHG) emissions, after fossil fuel combustion. Greenhouse gas emission from forestry is occurring in the atmosphere as a result of forest biomass combustion, forest fires and decomposition of deadwood materials. This is how increasing carbon dioxide in the atmosphere is adding to the global warming and climate change. Many worldwide recognized studies have measured that forest ecosystems have the capacity to absorb more than 1/3rd of total carbon dioxide from the atmosphere which is the minimum requirement for keeping the atmospheric temperature under 2 °C by 2030. One of the commonly accepted methods for reducing carbon is carbon sequestration through forests. India has committed to capture 2.5 to 3 billion tonnes of CO_2 by enhancing forest and tree cover through 2030. To achieve this target, India has adopted REDD+ (Reducing Emissions from Deforestation and Forest Degradation) strategy which aims to mitigate climate change by enhancing forest carbon sequestration through incentivizing forest conservation. Furthermore, this strategy strives to address the drivers of forest degradation and deforestation and also provides a roadmap for forest carbon stocks enhancement and sustainable forest management through REDD+ actions. This study investigates REDD+ contribution against global warming and climate change in India through forest carbon sequestration.

Keywords: *deforestation, carbon emission, carbon sequestration, REDD+*

INTRODUCTION

India is a huge developing country and known for its mega-biodiversity and diverse forest ecosystems. It holds the 10th place among the most forest rich countries in the world. Total forest and tree cover of India accounts for 24.56 % (80.73 million hectares) of the total geographical land of the country and have shown a growth of 1 % as compared to previous estimate [1]. Forests provide a large range of ecosystem services like food, fuel, fodder, and timber. They play crucial role in maintaining the hydrological cycle, protecting and conserving terrestrial biodiversity and help to prevent land degradation and salinization

[2]. Forests sequester and store carbon (C) from the air, in this way help to reduce greenhouse gas emissions. Forests act as a carbon remover by contributing as both a carbon sink and a tool to absorb additional carbon. Forest carbon sequestration prevails when net balance of C emissions by the forests is negative. Forestry sector has the ability to not only sustain its carbon but also sequester additional C from the atmosphere [3]. But climate change, increasing deforestation and forest degradation due to land use, land cover change (shifting cultivation, huge biotic pressures, and diverted forest lands as response to developmental activities, etc.) [4] are reducing forest's potential to keep the net C emission in negative. To avoid such massive loss of forest ecosystem, India has taken various national and global initiatives to enhance carbon sinks and GHG reservoirs in forests. In 2015, India submitted its INDC (Intended Nationally Determined Contribution) to the UNFCCC (United Nations Framework Convention on Climate Change) and pledged to create more carbon sinks to store 2.5 to 3 billion tonnes of carbon dioxide (a major GHG responsible for global warming) with the help of additional increased forest cover by 2030 [5]. REDD+ is one such mechanism which complements the targets of India's INDC and aims to avoid deforestation and carbon emissions from conservation and enhancement of forest carbon stocks through sustainable forest management (SFM). SFM technique brings forth a holistic approach by maintaining the three pillars of sustainability namely - social, economic, and environmental functions of all kinds of forests through improving or enhancing their productivity, biodiversity, regeneration capacity and their potential to comply the needs of present and future generations without causing any harm to other ecosystems [6].

CARBON AND OTHER GHG EMISSIONS IN INDIA

While discussing the global issues such as climate change, sea level rise, and increasing frequency of heat waves, we incline to focus on GHGs in the atmosphere which trap atmospheric heat by absorbing infrared radiations [7]. CO_2 is the most dominant GHG but apart from this there are number of others that are causing global climate change. These are - methane (CH_4), nitrous oxide (N_2O), and trace gases (group of "F - gases") which have significant amount of impact on global warming to date [8]. These greenhouse gases are produced by burning of fossil fuels (natural gas, oil and coal), trees and other biological materials, solid waste and due to certain chemical reactions (e.g., cement manufacturing). Methane is emitted from livestock and other agricultural practices. Nitrous oxide is produced during industrial and agricultural activities. Fluorinated gases (hydrofluorocarbons, sulphur hexafluoride, perfluorocarbons, and nitrogen trifluoride) are synthetic and most powerful gases emitted from various industrial practices [9]. The chart below (Figure 1) produced by World Resources Institute presents the breakdown of global GHG emissions in 2016, estimated on the basis of CO_2eq (carbon dioxide equivalents) [8].

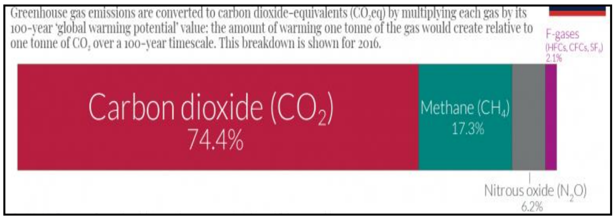


Figure 1. Global greenhouse gas emissions by gas in 2016 [8]

In Figure 1, CO_2 (as the largest contributor) accounted for around three quarters (74.4 %), CH_4 contributed 17.3 %, N_2O accounts for 6.2 %, and other emissions such as HFCs (hydrofluorocarbons), CFCs (clorofluorocarbons) and SF_6 (sulphur hexafluoride) account for 2.1 % of total emissions.

Each of greenhouse gases has relatively varying contributions to global warming, hence varying amounts of time to stay in the atmosphere that range from a few years to thousands of years. These GHGs stay in the atmosphere for an enough long time to get mixed well, which means that the measured amount in the atmosphere is almost same everywhere in the whole world, no matter what the source of emissions are. Certain greenhouse gases thicken the earth's blanket by effectively warming the earth than others. In terms of climate impact, GHGs have two important characteristics: 1. How well the gas absorbs the energy and 2. How long the gas remains in the atmosphere [10]. "Global Warming Potential" (GWP) is a method of accounting for the warming of different gases adopted by IPCC which is defined as a measure of total energy absorbed by a gas on a range of time-periods (usually 100 years - GWP_{100}), compared to CO_2. The larger the GWP, the larger the warming caused by the particular gas [9]. The following Figure 2 shows global warming potential of GHGs over 100-year timescale (GWP_{100}).

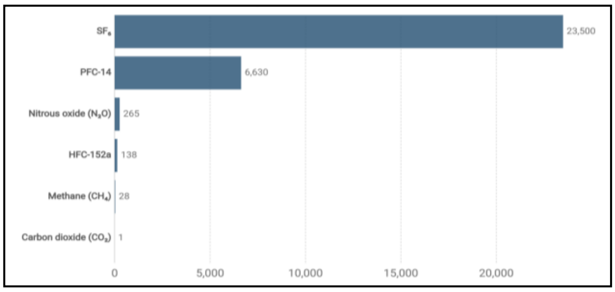


Figure 2. Global warming potential of greenhouse gases over 100-year timescale (GWP_{100}) (Note: This figure does not include climate change feedback effects) [8]

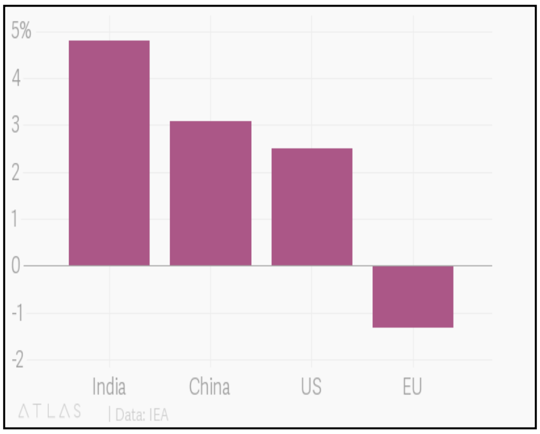
CO_2 serves as a baseline for other GHG's GWP values. From the figure above, CO_2 has a GWP of 1, which means that CO_2 concentration persists in the atmosphere for thousands of years. Methane has 28 times more GWP than CO_2, i.e. it will have 28 times higher warming effect than 1 tonne of CO_2 for a 100-year time scale. Nitrous oxide has 265 times more GWP than CO_2 for a 100-year time scale. SF_6 has the highest warming impact with GWP_{100} value of 23,500 (Figure 2). CHCs, HFCs, HCFCs, PFCs and SF_6 are known as high-GWP gases as they trap substantially more energy than CO_2 [10].

The world's countries have different share of heat-trapping gas emissions into the atmosphere. The emerging economies, like India and China, and developed nations, like United Nations, Russia and Japan, are playing the leading role in the world carbon emissions [11]. After China and the US, India is the third largest emitter of GHGs in the world. In 2014, total GHG emissions in India were 3,202 $MtCO_2e$ (million metric tons of carbon dioxide equivalent), accounting for 6.55 % of total global GHG emissions. In India, 68.7 % of GHGs are produced by energy sector, followed by agricultural activity, industry, LUC (land-use change) and forestry that contribute 19.6 %, 6.0 %, 3.8, and 1.9 % respectively [12]. From 1990 to 2014, GDP increased by 357 % in India, while greenhouse gas emissions raised up to 180 %. As the world average, India emits twice as much GHGs relative to GDP [12]. CO_2 emissions in India are rising more swiftly than in any other high energy-consuming countries (Figure 3a). In 2018, according to IEA (Paris-based International Energy Agency), India's CO_2 emissions grew by 4.8 % from the previous year. But "despite this growth, per capita emissions in India remain low at only 40 % of the global average", further the report added. In absolute terms, India is after China and US in CO_2 emissions (Figure 3b) [13].

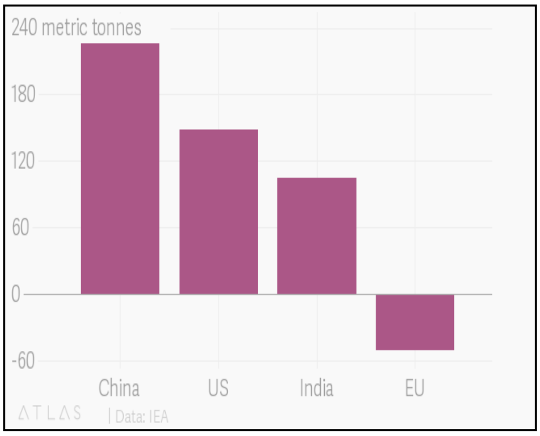
India accounted for 7 % of total global CO_2 emissions in 2018, as compared to the US's 14 %.

In the fiscal year 2019 - 2020, CO_2 emissions in India dropped by an estimated 30 $MtCO_2e$ due to effect of the novel corona virus (COVID-19) in early 2020 (Figure 4) [14]. However, it was the result of countrywide lockdown in March which tripped the country's 37-year emissions rising trend into reverse. The studies have estimated 15 % fall in emissions as compared to the previous year [15].

According to the reports and studies, decreased human foot print due to COVID-19 will not have any permanent impact on global warming unless climate strategies are developed into a sustainable recovery.



a)



b)

Figure 3. CO_2 emissions growth rate in India: a) growth rate of CO_2 emissions in 2018, b) absolute CO_2 emissions growth in 2018 [13]

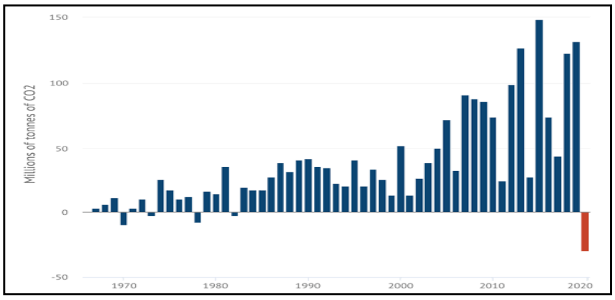


Figure 4. Annual CO_2 emissions fall by 30MtCO_2e (1.4 %) in the financial year 2019-2020 [15]

RISE IN TEMPERATURE DUE TO DEFORESTATION AND FOREST DEGRADATION

Global temperature rise is the consequence of massive land use and land cover change and major forest loss is also the result of the same. According to ITTO (International Tropical Timber Organization), the current degraded forest land is 850 million ha and it is estimated to rise at the rate of 12.9 million ha/year [16]. Many studies [17, 18] have agreed that vegetation could highly influence the global temperature by exchanging the incoming and outgoing energies. These energy exchanges include radiative transfer, latent heat transfer and sensible heat transfer through vegetation [19]. The surface temperature is the estimation of thermal infrared radiation emission or radiometric temperature [18].

Trees and forests stabilize the temperature by balancing the absorbed and reflected energies and keep the environment friendly for living beings. Human activities, through LULUCF (land use, land-use change and forestry) are altering the exchanges of energies and radiations and as a result, due to the disturbed balance of energy transfer temperature is rising. Deforestation and forest degradation have been identified as a significant net source of heat trapping gas emissions, like CO_2. Depletion of forests causes land to reflect back more sunlight, alter air currents above and raise the local temperature variance [20]. As of 2019, deforestation and other land use changes have accounted for almost 11 % of annual global GHG emissions [21]. Deforestation contributes in temperature rise by both carbon emission and its effect on physical processes. The following map (Figure 5) reflects effects of deforestation on regional temperature change on the hottest day of the year from present day (1981 - 2000), as compared to the pre-industrial levels [21].

In the map, the colours show variation in local temperature. Red colour shows net increase in temperature on the hottest day of the year whereas blue colour highlights net decrease. The boxes highlight outcomes for North America (left), Europe (centre), and Asia (right) [21]. Deforestation is the deep cause of concern for stabilizing the atmospheric temperature in the country like India where demands for land and forest resources are increasing day by day.

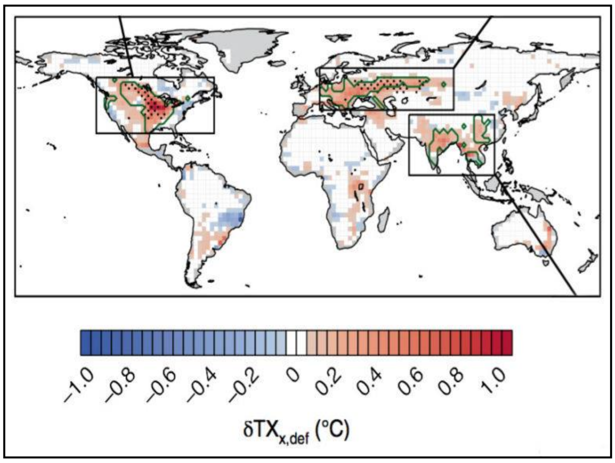


Figure 5. The effects of deforestation on regional temperature [21]

REDUCING EMISSIONS OF CO_2 THROUGH FOREST CARBON SEQUESTRATION

As we have already known, the concentration of carbon dioxide is accelerating in the atmosphere mostly because of unlimited energy production, fossil fuel combustion and high rate of deforestation due to agricultural activities. Fossil fuels, such as oil and coal, contain CO_2 and decaying and burning of plant biomass produces carbon that is captured by the living plants from the atmosphere through the process of photosynthesis over the period of millions of years. We are emitting those carbons back to the atmosphere just in a few hundred years [22]. According to NOAA (National Oceanic and Atmospheric Administration) from State of the Climate in 2019 and the American Meteorological Society, "From 1850 to 2018, 440 ± 20 Pg C (1 Pg C = 10^{15}g C) were emitted as CO_2 from fossil fuel burning [23]. For 2018 alone, global fossil fuel emissions reached 10 ± 0.5 Pg C yr^{-1} for the first time in history [23]. About half of the CO_2 emitted since 1850 remains in the atmosphere. The rest of it has partially dissolved in the world's oceans" [22, 23].

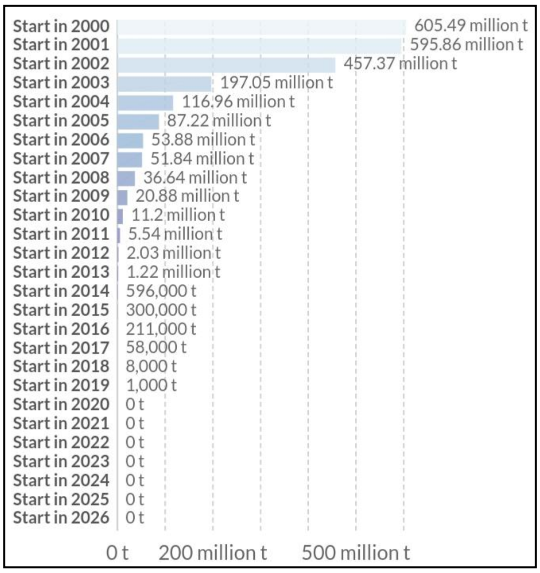
Average global atmospheric CO_2 in 2019 was 409.8 ppm (parts per million) with a range of uncertainty (± 0.1 ppm), a new highest record. From 2018, it has increased by 2.5 (± 0.1 ppm) which is similar to the increment that occurred between 2017 and 2018. Global growth of carbon dioxide in the atmosphere in the 1960s was around 0.6 ± 0.1 ppm/year. However, from 2009 to 2018, the CO_2 growth rate has been 2.3 ppm/year [22]. Over the past 60 years, the annual increase in carbon dioxide in the atmosphere is almost 100 times faster than past natural increases, like those happened at the end of the last ice age 11,000 - 17,000 years ago [22].

The diagrams below (Figure 6) show the remaining annual carbon budget under various mitigation scenarios to keep the average global temperature rise below 1.5 °C (Figure 6a) and 2 °C (Figure 6b). Scenarios are based on the CO_2 reductions necessary if mitigation had started - with global emissions peaking and quickly reducing in the given year [24].

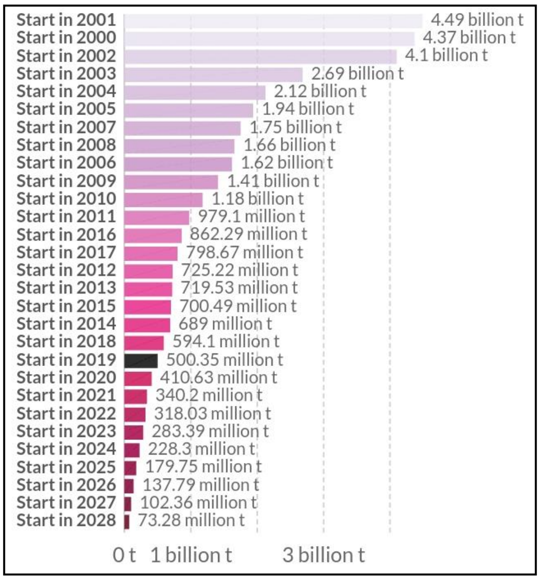
The longer we delay, the lesser carbon budget will remain to keep the temperature under control. In the case of 1.5 °C, if we start intensive mitigation activities in 2020, then we need to cut off almost all the generated emissions, whereas by keeping the temperature rise below 2 °C, the remaining carbon budget would be 410.63 million t, if the mitigation started in the same year. Every year that we are not maintaining the targeted reduction in C, we are using up more than 10 % of our remaining budget in the 1.5 °C scenario. The consequences of temperature above 1.5 °C are extremely serious and for that effective measures need to be taken at both local and global level [25].

Carbon emission reduction through forest carbon sequestration is the most cost effective and world acknowledged and accepted measure for climate change mitigation. Carbon sequestration is the process in which the atmospheric carbon is absorbed by the plants and trees through photosynthesis and these carbons are stored in biomass (branches, trunks, foliage and roots) and soils [26]. The chemical equation of this process in which C is "sequestered" from the atmosphere in the form of CO_2 is given below:

$$6CO_2 \text{ (absorbed C)} + 6H_2O + \text{Sunlight} = C_6H_{12}O_6 \text{ (glucose)} + 6O_2 \text{ (oxygen released)}$$



a)



b)

Figure 6. Global carbon budget to keep the temperature rise below 1.5 °C and 2 °C: a) CO_2 reductions needed to keep global temperature rise below 1.5 °C (Note: Carbon budgets are based on a > 66 % chance of staying below 1.5 °C, b) CO_2 reductions needed to keep global temperature rise below 2 °C (Note: Carbon budgets are based on a > 66 % chance of staying below 2 °C) [24]

The absorbed CO_2 is used by the trees for the growth of leaves, trunk and branches. Forests work as carbon sink as they help to offset the sources of CO_2 to the atmosphere such as forest fires, deforestation, biomass decomposition and fossil fuel emissions [26]. The viability of forests to help reduce emissions is examined by NASA's international research team, led by Jean-Francois Bastin of ETH - Zurich in Switzerland, who performed direct measurement of forests around the world to develop a model for measuring the Earth's forest restoration potential [27]. The study has found that the Earth's ecosystems have the capacity to support another 900 Mha of forests indicating 25 % more forested land than we have now. According to the author, about 205 Gt (1 Gt = 1 billion Mt) of carbon could be captured by growing more than a half trillion trees which will help to reduce atmospheric carbon by approx. 25 %. Such amount of reduction is enough to offset the around 20 years of human-emitted carbon at current rate or around half of the human-produced carbon emissions since 1960 [27]. Although the study has grabbed worldwide attention, at the same time it faced some criticisms from the science communities. Many scientists question the viability of the estimates of this study of how much C can be captured through forest restoration. How long will it take to create a dent in the atmospheric concentrations of carbon? How much resources and money will it require to perform a global forest restoration? How the global climate will respond to such a huge forest restoration? Growing a billion hectares of trees equal to the size of Canada and the United States is not easy. It will take thousands of years to grow and almost a century to come to maturity. This approach needs a comprehensive evaluation of every potential impact that it may have on the global carbon cycle and Earth's climate [27].

REDD+ FOR ENHANCING FOREST CARBON SEQUESTRATION

Restoration of forests boosts carbon sequestration, but the extent of sequestration depends on the level of recovery of plant biomass and soil carbon which further depends on national goals, economic factors, socio-cultural and institutional barriers that determines the speed of change [28]. The opportunities for forest restoration are more than 2 billion ha worldwide [28]. If all the forest degradation and deforestation were terminated and possible “wide-scale reforestation” restored, global C emission can be decreased by almost 9 Gt CO_2/year by 2030 [29]. Observing the role of forests as potential carbon sink, the UNFCCC developed REDD+, to reverse deforestation and forest destruction for combating the global climate change. The potential importance of REDD+ to reduce total GHG emissions is illustrated in the Figure 7.

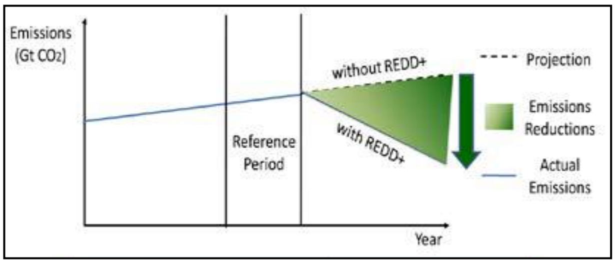


Figure 7. REDD+ potential for reducing GHG emissions (Note: Green shaded area is reduced emissions from REDD+ actions) [28]

About REDD+

The expression RED (reducing emissions from deforestation) was first used by the coalition for Rainforest Nations led by Papua New Guinea, noticing that deforestation has caused 12 - 15 % of the global GHG emissions [30, 31]. UNFCCC introduced REDD (reducing emissions deforestation and forest degradation) at COP-11 (11th UN Conference of Parties), Montreal, in 2005. As a result of the 2-year long process of negotiations and decisions under the UNFCCC’ Subsidiary Body for Scientific and Technological Advice (SBSTA), REDD is converted to “REDD+” during Bali Action Plan in 2007. “+” insertion at COP-13, in the acronym REDD, broadens the scope for forest-based climate change mitigation options by including all operations connected to restoration, conservation and sustainable forest management [31].

Successive COPs, since 2007, have developed rules, guidance and modalities to steer the REDD+ implementation, notably during COP-15 in Copenhagen (2009), many methodological guidelines and principles were defined by the adoption of decision 4/CP.16, and in Cancun (2010), at COP-16, Parties adopted the “Cancun Agreements” (Decision 1/CP.16) which consists of five REDD+ activities [32]:

- reducing emissions from deforestation,
- reducing emissions from forest degradation,
- conservation of forest carbon stocks,
- sustainable management of forests,
- enhancement of forest carbon stocks.

In Warsaw, at COP-19 (2013), the parties to UNFCCC have prescribed seven REDD+ decisions that are referred to as “Warsaw Framework for REDD+”. This framework provides a set of rules that enable countries to properly implement REDD+. It includes the following decisions [33]:

1. Decision 9/CP.19: Work programme on results-based finance.
2. Decision 10/CP.19: Institutional arrangements.
3. Decision 11/CP.19: National forest monitoring system.
4. Decision 12/CP.19: Safeguards
5. Decision 13/CP.19: Technical assessment of reference levels.
6. Decision 14/CP.19: Measurement, reporting and verification
7. Decision 15/CP.19: Drivers of Deforestation and forest degradation.

The elements required for REDD+ [32]

The Cancun Agreement (paragraph 71) urges nations to have the four elements described below to access RBFs (results-based finances) in place for REDD+ implementation:

- *NS/AP (Decision 1/CP.16; 15/CP.19):* A National Strategy (NS) or Action Plan (AP) has the vision of the country in respect of REDD+ implementation. The actions it plans to implement are to follow the five REDD+ activities.

- *NFMS (Decision 4/CP.15; 11/CP.19):* National Forest Monitoring System (NFMS) is a transparent and robust monitoring structure that measure, report and verify the results of the actions taken for REDD+ activities.
- *FRL/FREL (Decisions 4/CP.15; 12/CP.17; 13/CP.19; + Annex (FREL) and or (FRL)):* Forest Reference Level (FRL) or Forest Reference Emission Level (FREL) is the benchmarks that measure the reduction in emission/strengthening of removals which have been achieved through REDD+ related actions.
- *SIS (Decision 12/CP.17; 12/CP.19):* Safeguard Information System (SIS) allows countries to report about the good practices that have been implemented to maximize the outcomes of REDD+ actions.

REDD+ implementation in phases (Decision 1/CP.16) [32]

The Cancun Agreements (paragraph 73-74) stipulated the phases of REDD+ implementation described below:

- *Phase 1: Readiness:* Countries design national strategies and action plans with relevant stakeholders, build capacity and work on policies and measures for REDD+ implementation.
- *Phase 2: Implementation:* This phase includes results-based demonstration activities and requires additional capacity building, technological advancement, and transfer.
- *Phase 3: Results-based actions:* Results-based actions are implemented at the national level and results are fully measured, reported, and verified.

The current status of REDD+ implementation details in different countries can be accessed from “REDD+ Web Platform”. The “Lima REDD+ Information Hub” (decision 9/CP.19) is a part of REDD+ Web Platform which publishes information on REDD+ national strategies, reference levels, safeguards, and forest monitoring systems. It aims to increase information transparency on REDD+ results-based actions [34].

REDD+ ACTIVITIES AND IMPLEMENTATION MECHANISMS: RESPECTIVE POLICY INITIATIVES IN INDIA

The national REDD+ strategy follows the provisions prescribed by UNFCCC decisions. Most important among these are the Cancun Agreements, Warsaw Framework for REDD+ and the Paris Agreement. These three UNFCCC decisions provide the main source of guidance for REDD+ implementation in developing countries. Aim of the strategy is to optimize all kind of forest ecosystem services, such as carbon sequestration by forests, increasing carbon stocks and decreasing pressure on forests by checking the drivers of deforestation and forest degradation [34]. The objective of National REDD+ policy of India is to facilitate REDD+ programme implementation in the country in conformity with all relevant UNFCCC decisions and national legislative and policy framework for preservation and enhancement of forests and the environment [34].

REDD+ activities

The underneath five REDD+ activities encourage developing countries to adopt measures in the forestry sector for the contribution to GHG and climate change mitigation.

Reducing deforestation

Decision 16/CMP.1 defines deforestation as “the direct human induced conversion of forested land to non-forested land”. In India, large-scale deforestation has been eradicated, except for few states. At the same time, there is scope for further reduction of deforestation by increasing the performance of REDD+.

Reducing forest degradation

Forest degradation reduces the capacity of forests to perform as carbon sinks. IPCC (2003) defines forest degradation as “direct human induced activity that leads to a long-term reduction in forest carbon stock”. In India, REDD+ has huge potential to curb the degradation and depletion of forests by promoting their restoration which can contribute over 1/3rd of GHG emission reduction that India needs to reach according to the Paris Agreement goal by 2030 [35].

Conservation of forest carbon stocks

Conservation is defined as “maintenance of area under existing forests (and tree cover) to conserve, maintain, and possibly enhance the forest carbon stocks” through conservation efforts. The management of protected areas (PAs) is increasing in India where REDD+ has enough potential for “Conservation of forest carbon stocks”. According to Planning Commission (2014) [34], reducing emissions through conservation of existing protected areas, which account for 5 % of the geographical area of the country, have ability to add 2 tonnes of dry biomass/ha/year on an average thereby adding 47 Mt CO_2 eq to forest carbon sink every year.

Sustainable management of forests

In the context of Cancun Agreements, sustainable management of forests (SMF) refers “to the application of forest management practices for the primary purpose of sustaining constant levels of carbon stocks overtime”. Government of India has approved the sustainable management of forests by implementing the Forest Working Plan [34]. SMF practices incentivize the maintenance of forest carbon stocks by improving the quality of exiting stocks and sustainable exploitation of biomass.

Enhancement of forest carbon stocks

In the context of India, enhancement of carbon stocks is defined as “conversion of non-forest or degraded forests to forests through afforestation, reforestation, restoration forestry and forest management practices leading to enhancement of carbon stocks”. REDD+ has great potential for implementing these activities in India through various actions, such as agro-forestry and farm-forestry etc.

These five REDD+ activities, if aligned with the National Forest Policy (NFP), can provide a common thread that going through all projects, programmes, and schemes of forest sector by bringing all the stakeholders in the country on a common platform to ensure a comprehensive assessment and monitoring of the functioning of forest management at different levels of administration [33]. In India, there are several relevant acts and legislations, such as Indian Forest Act, 1927; Wild Life (Protection) Act, 1972; Forest (Conservation) Act, 1980; National Forest Policy, 1988; National Environment Policy, 2006; The Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; National Action Plan on Climate Change, 2008; and National Working Plan Code-2014 which provide clear synergy and support to the legislations for REDD+ implementation [34, 36]. Community-based forest governance and forest rights decentralization have been recognized as critical to the successful implementation and accomplishment of REDD+ [37].

REDD+ implementation framework in India

The legal framework of REDD+ implementation directs and guides the sustainable management of forests ensuring the protection of biodiversity and upholding the rights of local habitats and forest products. Paragraph 71 of the Decision under COP-16, determines the essential elements of a national REDD+ framework constituting a national reference level, safeguards, finances and a transparent national monitoring, reporting and verification system [34]. The broad institutional framework for REDD+ implementation is shown in the Figure 8.

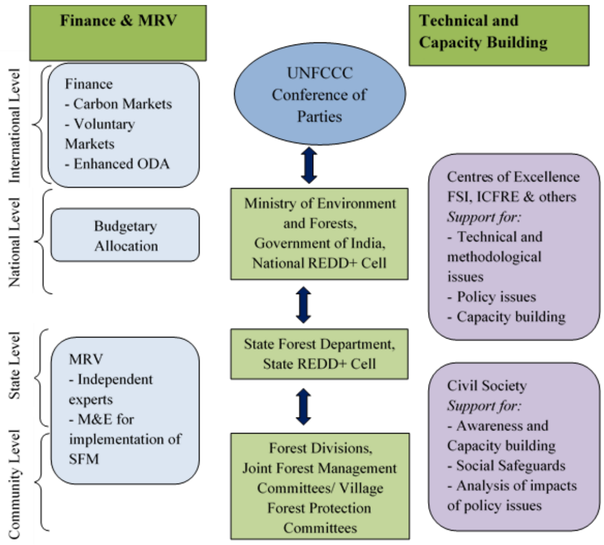


Figure 8. REDD+ institutional framework [36]

National safeguards

Paragraph 69 of Cancun agreement requires developing countries to follow safeguards with a view to ensure gender balance, protect traditional rights of the local communities, full participation of indigenous people and other stakeholders and conservation of biodiversity by implementing the REDD+ activities [34]. India intends to facilitate all REDD+ incentives from international sources to flow adequately to the local dwellers who participate in the sustainable management of forest resources.

National forest reference emission level (NFREL)

A country that intends to reduce emissions by halting deforestation and forest degradation uses FREL as the benchmark to analyse progress of its performance [36]. India gives a high priority to the development of a reference level for carbon stocks in its forests and tree cover with an objective of monitoring, reporting and verification of (i) baseline forest carbon stocks, and (ii) incremental forest carbon stocks [38].

Monitoring, reporting and verification (MRV)

In India, a robust and simple monitoring mechanism is required for efficient implementation of REDD+. Therefore, for the sustainable forest management, there is a need to identify the national level institutions for carbon assessment through monitoring, reporting and verification on the basis of criteria and indicators approach. The optimum application of the instruments from new technologies such as GIS, remote sensing must be very useful in the whole process of MRV [39].

Finances

REDD+ financing options provide a national level incentive-based mechanism for inducing and rewarding stabilization and enhancement of forest carbon stocks [36]. The outcome document resulting from Paragraph 77 and 78 of the AWG-LCA (Ad Hoc Working Group on Long-term Cooperative Action under the Convention) urges the parties to find financing options for the efficient implementation of RBAs in the context of NS/APs, PAMs, and capacity building. For finances, India favours a flexible combination of market-based approach and non-market based approach. There is also a need to adopt separate financial approaches for the two types of carbon stocks, such as to ensure (i) change in carbon stocks and (ii) baseline carbon stocks to provide positive incentives for REDD+ policy regime [38].

Capacity building

Capacity building is a crucial requirement for the process of REDD+ readiness. There must be officials at every level of forest governance, supporting institutions and forest dependent local communities, on various matters ranging from awareness about forest policies to the benefit-sharing under REDD+ mechanism, environmental and social safeguards and MRV mechanisms [39, 40].

CONCLUSION

The forests are a unique, safe and cost-effective carbon capture and sequestration technology which is available naturally with the potential to normalize the global C emissions. Due to heavy pressure on forests as a result of rapid infrastructural and technological development, deforestation and forest degradation have caused approximately 11 % of global CO_2 emissions. REDD+ (Reducing Emissions from Deforestation and Forest Degradation) has emerged as a significant carbon-sequestration mechanism since its inception in COP-13 (2007) at the UNFCCC in Bali. Paris agreement on climate change, in Article 5 also identifies the role of forests as climate change mitigation option and indicates to the parties to implement and support REDD+. India has developed its National REDD+ strategy in line with the UNFCCC decisions that is formulated on the basis of existing national circumstances complying with Green India Mission, National Action Plan on Climate Change and India's NDC to UNFCCC.

To achieve the desired results from REDD+, India needs to improve forest governance, reduce deforestation and dependence on forests and maintain sustainable harvest. At national level, the country needs to fix target for emission reduction and incorporate REDD+ tools in order to attain this target. For REDD+ preparedness and REDD+ readiness, capacity building of all stakeholders is required, including community and forest department officials. Availability of finances can be managed from Forest Carbon Partnership Facility (FCPF) at international level and at national level through CAMPA, GIM, and Green Highways Policies etc. Overall, REDD+ is a helpful instrument if implemented effectively and efficiently to reduce emissions through C sequestration in forests for climate change mitigation and it also complies with SDG 15- "Life on Land".

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