Training Manual on REDD+ Measurement, Reporting and Verification




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Training Manual on REDD+ Measurement, Reporting and Verification

Indian Council of Forestry Research and Education

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सत्यमेव जयते

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Dr. Suresh Gairola, IFS

महानिदेशक
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Foreword

Climate change is one of the main challenges being faced by the society. Forests are both source and sink of carbon and, therefore, are now integral component of international efforts dealing with climate change. Degradation and conversion of forests in general, and tropical forests in particular to other land uses are major causes of greenhouse gas (GHG) emissions besides fossil fuel burning. Therefore, it becomes imperative to address deforestation as part of an integrated strategy to reduce global GHG emissions. According to fifth assessment report of Intergovernmental Panel on Climate Change, emissions from deforestation and forest degradation in developing countries constitute about 9-11% of total anthropogenic greenhouse gas emissions.

United Nations Framework Convention on Climate Change (UNFCCC) programmes under Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries aims to achieve the climate change mitigation objectives. With India's initiatives, the concept of REDD has been accepted to be a comprehensive and holistic approach popularly called REDD+. REDD+ approach recognizes the importance of conservation of forests as a means of preventing emissions as well as maintaining and enhancing forest carbon stocks. REDD+, moreover, offers considerable biodiversity and sustainable development benefits, and has the scope of being a cost effective mitigation measure. Paris Agreement has reaffirmed the role of conservation and enhancement of forest carbon stocks along with reducing emissions from deforestation and forest degradation. Article 5 of the Paris Agreement calls upon Parties to support REDD+ actions.

Indian Council of Forestry Research and Education (ICFRE) is proactive in the field of forests and climate change, significantly contributing in climate change issues relevant to the forestry sector at national and international levels. As about 1,73,000 villages are forest fringe villages in India, there is obviously large dependence of communities on forest resources. Now it is high time to implement REDD+ projects in India.

I am hopeful that this training manual on REDD+ brought by ICFRE under ICIMOD funded REDD+ Himalayas Project will immensely help in developing better understanding of less understood REDD+ project modalities and procedures as well as measurement, reporting and verification (MRV) guidelines and it will enable to the stakeholders, field foresters and communities to implement REDD+ in a better manner in the field. I compliment the contributors for putting in their best efforts for conceptualizing and preparing this training manual.

(Dr. Suresh Gairola)

Preface

Among all the greenhouse gases, carbon dioxide (CO_2) is the essential component of our atmosphere and makes life possible on planet earth. The amount of heat trapped in the atmosphere by the greenhouse gases is in delicate balance with the global climate systems. Increase in atmospheric concentration of greenhouse gases especially CO_2, due to anthropogenic activities over the last century, has become a cause of concern to ecosystems as well as for the human beings. These concern have been duly, substantiated by successive reports of the IPCC and has brought to the fore of global community to agree upon the measures to control these emissions through various agreements under United Nations Framework Convention on Climate Change (UNFCCC).

Reducing emissions from deforestation and forest degradation in developing countries and role of conservation, sustainable management of forests and enhancement of forest carbon stocks (collectively known as REDD+) is one such programme agreed under UNFCCC that help in reducing emission from deforestation and forest degradation and at the same time also acknowledges the role of conservation, sustainable management of forests and enhancement of forest carbon stocks for capturing the carbon emissions through forestry activities and also to provide financial incentives to the communities actively involved towards the implementation of these programmes at field level. Since the REDD+ negotiations started at UNFCCC, various REDD+ pilot projects have been developed globally and registered in the existing voluntary carbon offset markets. Now the methodological guidance for REDD+ are complete under Warsaw framework for REDD+ and it is the time for countries to go for REDD+ actions.

ICFRE in collaboration with International Centre for Integrated Mountain Development (ICIMOD) is poised to undertake REDD+ Himalaya Project where focus of action *inter alia* is North-East region of the country. Besides capacity building programme for REDD+ in the North-East region the project envisage undertaking a REDD+ project in the state of Mizoram. ICFRE acknowledges the financial support provided by ICIMOD, GIZ and BMU for implementing REDD+ Himalaya Project. This training manual on REDD+ has been prepared by keeping in view the requirements of agreed methodologies, focusing on addressing drivers of deforestation and forest degradation, assessment of forest carbon stocks linked to land use, developing social and environmental safeguards while implementing the projects.

Contributors
REDD+ Himalayas Project
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Contents

Abbreviations Used

^0C	:	Degree Centigrade
A/R	:	Afforestation and Reforestation
AFOLU	:	Agriculture, Forestry and Other Land Use
APDD	:	Avoided Planned Deforestation and/or Degradation
ARR	:	Afforestation, Reforestation and Revegetation
AUDD	:	Avoiding Unplanned Deforestation and/or Degradation
CCBS	:	Climate, Community & Biodiversity Standards
cm	:	Centimeters
CO_2	:	Carbon Dioxide
COP	:	Conference of Parties
FAO	:	Food and Agriculture Organization of United Nations
FCPF	:	Forest Carbon Partnership Facility
FSI	:	Forest Survey of India
GHG	:	Greenhouse Gas
Gt	:	Giga Tonne
Ha	:	Hectare
ICFRE	:	Indian Council of Forestry Research and Education
ICIMOD	:	International Centre for Integrated Mountain Development
IFM	:	Improved Forest Management.
IPCC	:	Intergovernmental Panel on Climate Change
LISS	:	Linear Imaging Self Scanning Sensor
LULUCF	:	Land Use, Land Use Change and Forestry
Kt	:	Kilo Tonne
m	:	Meter
M	:	Million
m^2	:	Square Meter
Mg	:	Mega Gram
ml	:	Milliliter
MRV	:	Measurement, Reporting and Verification
PDD	:	Project Design Document
PES	:	Payment for Ecosystem Services
PRA	:	Participatory Rural Appraisal
QA	:	Quality Assurance
QC	:	Quality Control
REDD	:	Reducing Emissions from Deforestation and Forest Degradation
REL	:	Reference Emission Level
RIL	:	Reduced Impact Logging
SIS	:	Safeguard Information System
SMF	:	Sustainable Management of Forest
t	:	Tonne
UNFCCC	:	United Nations Framework Convention on Climate Change
VCS	:	Verified Carbon Standard
VCU	:	Verified Carbon Unit
VER	:	Verified Emission Reduction
VVB	:	Validation/Verification Body

1

Concept of REDD and REDD+

1.1 Climate Change

Intergovernmental Panel on Climate Change (2014) stated that "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems". Earth's atmosphere is made up of various gases released by the natural processes and anthropogenic activities.

The earth's atmosphere acts like a blanket of greenhouse gases which traps the long wave terrestrial radiations released by the planet earth. This is a natural phenomenon and also known as greenhouse effect. However, human activities have increased the concentration of greenhouse gases into the atmosphere which is responsible for the trapping of the outgoing long wave terrestrial radiations into the earth atmosphere resulting, an increase in atmospheric temperature.

According to IPCC (2014), globally CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emission increase from 1970 to 2010, with a similar percentage contribution for the period 2000–2010. Various anthropogenic activities have increased GHGs concentration by 10 $GtCO_2eq$ between 2000 and 2010 e.g. energy supply (47%), industry (30%), transport (11%) and buildings (3%) sectors. Further it is also considered that globally, economic and population growth continues to be the most important drivers of elevated CO_2 emissions from fossil fuel combustion.

1.2 Forest and Climate Change

The impact of climate change has alarmed the global community and attracted the interest of scientific communities towards various mitigation and adaptation measures. Forest ecosystem plays a significant role to reduce the impact of climate change. Intrinsically forest and climate change are directly linked to each others. Forests are known as the sink as well as the source of carbon. They have a significant role in various geo-chemical cycles *i.e.,* carbon, water and energy cycles. Forest ecosystem absorbs the carbon-dioxide from the atmosphere and releases the oxygen into the atmosphere. The various anthropogenic activities like burning of fossil fuels, industrial as well as urban growth etc are increasing the concentration of CO_2 and

other harmful greenhouse gases into the atmosphere (Fig.1.1). In forest ecosystem the carbon is stored in the growing stock (standing trees, herbs, shrubs etc) and also in the soil. The cutting down of trees and removal of vegetation from the forest ecosystem for fuelwood, timber, fodder etc. release out the stored carbon in the form of CO_2. Hence overall we can say that when there is reduction in the quality of forest, the CO_2 releases out by the forests into the atmosphere and on the other hand increasing growing stock of forest ecosystem increases absorption of CO_2. Globally, the deforestation and forest degradation has become one of the major causes of greenhouse gas (GHG) emissions besides burning of fossil fuels. The IPCC WG III (2007) estimated emissions from deforestation in the 1990s to be at 5.8 $GtCO_2$/yr whereas, fifth assessment report of IPCC estimate that, annual greenhouse gas emission flux from land use and land-use change and forestry activities accounted for approximately 4.3-5.5 $GtCO_2$eq/yr or about 9-11% of total anthropogenic greenhouse gas emissions (IPCC, 2014). The overall contribution from agriculture, forestry and other land use (AFOLU) sector is around one quarter of the global anthropogenic greenhouse gas emissions.

Forests are considered to provide a large climate change mitigation opportunity at relatively lower costs along with significant co-benefits. Global forests cover around 30% of earth's surface, spread over about 4 billion hectares of land mass. Forestry mitigation options including reduced deforestation, forest management, afforestation, and agroforestry are estimated to contribute 0.2-13.8 $GtCO_2$/yr of economically viable abatement in 2030 at carbon prices up to 100 USD/tCO_2eq (IPCC, 2014).

The agenda item on "Reducing emissions from deforestation in developing countries and approaches to stimulate action" was first introduced into the COP agenda at its eleventh session in Montreal (December 2005). Reducing emissions from deforestation and forest degradation in developing countries dominated the UNFCCC negotiations in various COP decisions to achieve the climate change mitigation objectives. In Indian context, Rawat and Kishwan (2008) highlighted that the forest conservation based climate change mitigation approach and advocated for compensating countries for the carbon conserved through sustainable management of forests and enhancement of forest carbon stocks. This Indian approach later on become the '+' part of REDD agenda in UNFCCC.

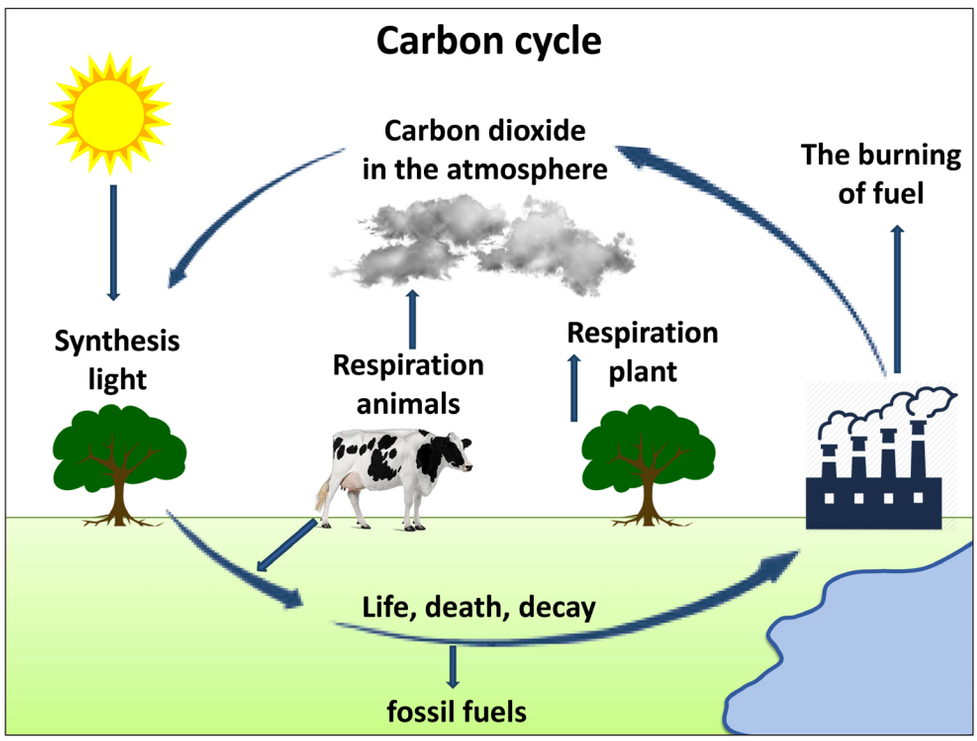


Fig. 1.1. Various source of CO_2 emission into the atmosphere

1.3 Evolution of REDD+ under UNFCCC

13th session of the conference of parties (COP13) of UNFCCC was held at Bali (Indonesia) in 2007. A major decision to stimulate action on reducing emissions from deforestation and forest degradation in developing countries was adopted in COP 13 by including *inter-alia*, forest conservation, sustainable management of forests and enhancement of forest carbon stocks as a policy approach for achieving climate change mitigation objectives. The decision 1/CP.13 provides a mandate for several elements and actions for the country parties:

- Further strengthening and supporting ongoing efforts;
- Support for and facilitation of capacity-building, technical assistance and transfer of technology relating to methodological and technical needs and institutional needs of developing countries;
- Explore a range of actions, identify options and undertake demonstration activities to address drivers of deforestation relevant to each country's national circumstances;
- Mobilize resources to support the efforts mentioned above.

Following 13th session of COP, the Subsidiary Bodies for Scientific and Technological Advise (SBSTA) of UNFCCC initiated a work programme on methodological issues, during which the country parties identified the main issues relating to implementation of activities on reducing emissions from deforestation and forest degradation. The COP, at its fifteenth session (Copenhagen, 2009), adopted a decision (Decision 4/CP.15) on methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

1.4 Cancun Agreements on REDD+

16th session of Conference of Parties (COP 16) of UNFCCC was held at Cancun (Mexico). During the session, parties agree to boost action for curbing the emissions from deforestation and forest degradation in developing countries with technological and financial support. The decision on REDD (paragraph 70 of the decision 1/CP.16 of Cancun Agreements) encourages developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities, as deemed appropriate by each country Party and in accordance with their respective capabilities and national circumstances:

(a) Reducing emissions from deforestation } REDD
(b) Reducing emissions from forest degradation } REDD+
(c) Conservation of forest carbon stocks } + (Plus)
(d) Sustainable management of forest } + (Plus)
(e) Enhancement of forest carbon stocks } + (Plus)

The REDD+ mechanism agreed by Cancun agreements (1/CP.16), also includes a number of principles and clauses concerning safeguards such as: (i) the need for good forest governance, (ii) respect for the rights of indigenous people and members of local communities, and (iii) protection and conservation of biological diversity and ecosystem services.

COP decision 1/CP.16 requests developing country Parties aiming to undertake REDD+ activities are mandated to develop the following elements, in accordance with national circumstances and respective capabilities:

(i) A national strategy or action plan for REDD+
(ii) A national forest reference emission level and/ or forest reference level or, if appropriate, as an interim measure, sub-national forest reference emission levels and/or forest reference levels.

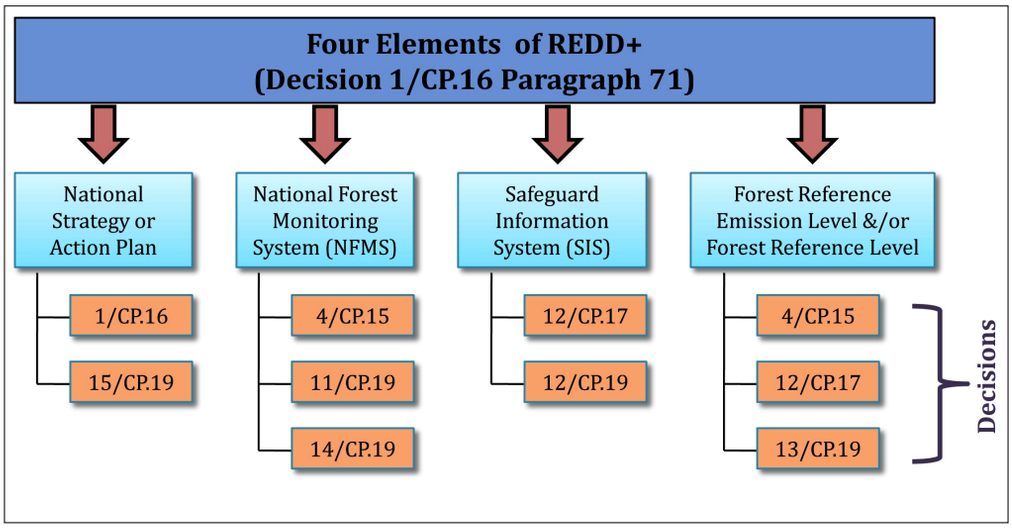


Fig. 1.2. Essential elements of REDD+ and relevant COP decision

(iii) A robust and transparent national forest monitoring system for the monitoring and reporting of the REDD+ activities, if appropriate, subnational monitoring and reporting as an interim measure.

(iv) A system for providing information on how the safeguards are being addressed and respected throughout the implementation of the REDD+ activities while respecting sovereignty.

1.5 REDD+ Safeguards

COP decision 1/CP.16 *inter-alia* also developed following Guidance and Safeguards while undertaking REDD+ activities:

(i) The REDD+ activities:

- (a) Contribute to the achievement of the objective set out in Article 2[1] of the UNFCCC;
- (b) Contribute to the fulfilment of the commitments set out in Article 4[2], paragraph 3, of the UNFCCC;
- (c) Be country-driven and be considered options available to Parties;
- (d) Be consistent with the objective of environmental integrity and take into account the multiple functions of forests and other ecosystems;
- (e) Be undertaken in accordance with national development priorities, objectives and circumstances and capabilities and should respect sovereignty;
- (f) Be consistent with Parties' national sustainable development needs and goals;
- (g) Be implemented in the context of sustainable development and reducing poverty, while responding to climate change;

[1] The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

[2] The developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by 14 developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.

(h) Be consistent with the adaptation needs of the country;

(i) Be supported by adequate and predictable financial and technology support, including support for capacity-building;

(j) Be results-based; and

(k) Promote sustainable management of forests.

(ii). When undertaking the REDD+ activities, the following safeguards should be promoted and supported:

(a) That actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements;

(b) Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;

(c) Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples;

(d) The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in REDD+ actions;

(e) That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the REDD+ actions are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits;

(f) Actions to address the risks of reversals; and

(g) Actions to reduce displacement of emissions.

The 17th session of Conference of Parties (COP 17) of UNFCCC held at Durban in 2011 and decision 12/CP.17 was adopted which provides the guidance on systems for providing information on how safeguards are addressed and respected and modalities relating to forest reference emission levels and forest reference levels as referred to in decision 1/CP.16 along with the guidelines for submissions of information on reference levels.

Further, during the 19th session of Conference of Parties (COP 19) which was held in Warsaw, 2013, parties agreed on a package of decisions, named as Warsaw Framework for REDD+ that addresses a series of methodological guidance, institutional arrangements and results-based finance. The highlights of the 'Warsaw REDD+ Framework' are as follows:

(i) Results-based finance for the full implementation of activities (decision 9/CP.19)**:** Results-based finance provided to developing country Parties for the full implementation of REDD+ activities may come from a variety of sources, public and private, bilateral and multilateral, including alternative sources. Developing country Parties seeking results-based payments should provide the most recent summary of information on how all REDD+ safeguards have been addressed and respected before they can receive results-based payments. The decision encourages entities financing the REDD+ activities through the wide variety of sources, including the Green Climate Fund in a key role, to collectively channel adequate and predictable results-based finance in a fair and balanced manner, taking into account different policy approaches (decision 9/CP.19).

(ii) Institutional arrangements for REDD+ finance (decision 10/CP.19): Interested REDD+ developing country Parties will have to designate a national entity or focal point. These national entities or focal points, and relevant entities to hold their meeting in conjunction with the first sessional meetings of the Subsidiary Bodies. The national entities or focal points (of developing country Parties) may, nominate their entities to obtain and receive results-based payments, consistent with any specific operational modalities of the financing entities providing them with support for the full implementation of the REDD+ activities (decision 10/CP.19).

(iii) Measuring, reporting and verification (MRV) (decision 14/CP.19): MRV of REDD+ activities is to be consistent with guidance provided in decision 4/CP.15. The data and information used by Parties in the estimation of anthropogenic forest-related emissions should be transparent and consistent over time and with the established forest reference emission levels and/or forest reference levels; and data and information should be provided through the biennial update reports by Parties (decision 14/CP.19).

(iv) Guidance and procedure for technical assessment of reference emission levels/ reference levels submitted by the Parties (decision 13/CP.19): Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels were adopted. The decision further invites Parties, in particular developed country Parties, and relevant international organizations to support capacity-building in relation to the development and assessment of forest reference emission levels and/or forest reference levels (decision 13/CP.19).

(v) Timing and frequency of submission of summary of information on how safeguards are addressed and respected (decision 12/ CP.19): Developing country Parties undertaking the REDD+ activities should provide a summary of information on how all of the safeguards are being addressed and respected throughout the implementation of the activities. The summary of above information should be provided periodically and be included in national communications, or communication channels agreed by the Conference of the Parties or other communication channel, including via the Web Platform of the UNFCCC, after the start of the implementation of REDD+ activities (decision 12CP.19).

(vi) Addressing drivers of deforestation and forest degradation: On the drivers of deforestation and forest degradation the COP, *inter-alia*, encourages Parties, organizations and the private sector to take action to reduce the drivers of deforestation and forest degradation, and to continue their work to address the drivers of deforestation and forest degradation and share the results of their work (decision 15/CP.19).

(vii) National forest monitoring systems: The decision mandates development of Parties' national forest monitoring systems for the monitoring and reporting of the activities, should take into account the guidance provided in decision 4/CP.15 and be guided by the most recent IPCC guidance and guidelines, as adopted or encouraged by the COP, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources, and removals by sinks, forest carbon stocks, and forest carbon stock and forest-area changes (decision 11/CP.19).

Further, it also decides that robust national forest monitoring systems should provide data and information that are transparent, consistent over time, and are suitable for MRV of anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest-area changes resulting from the implementation of the REDD+ activities, consistent with guidance on MRV.

In 21st session of the Conference of the Parties (COP 21) held at Paris, Parties recognized the role of forests as carbon sink for mitigation of climate change under Article 5[3] of UNFCCC.

It encourages all Parties, developed and developing countries, to take action to conserve and enhance emissions sinks and reservoirs, including forests. It also encourages countries to "take action to implement and support, including through results-based payments" for REDD+ activities. The various COPs have adopted number of decisions on REDD+. A list of important COP decisions on REDD+ are given in Annexure I.

[3] The Parties shall: (a) Support and further develop, as appropriate, international and intergovernmental programmes and networks or organizations aimed at defining, conducting, assessing and financing research, data collection and systematic observation, taking into account the need to minimize duplication of effort; (b) Support international and intergovernmental efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities, particularly in developing countries, and to promote access to, and the exchange of, data and analyses thereof obtained from areas beyond national jurisdiction; and (c) Take into account the particular concerns and needs of developing countries and cooperate in improving their endogenous capacities and capabilities to participate in the efforts referred to in subparagraphs (a) and (b) above.

2

REDD+: Carbon Market and Financial Mechanism

2.1 Carbon: A New Tradable Commodity

With Kyoto Protocol coming in force, a new tradable commodity in the name of 'Greenhouse gas emissions' was created in the form of emission reductions or removals. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon or carbon dioxide equivalent. Carbon is now tracked and traded like any other commodity. This is known as the "carbon market." In order to understand the carbon markets, it is important to recognize the differences between two fundamentally different types of carbon commodities:

- Allowances (are created by cap-and-trade systems)
- Offsets (are created by baseline-and-credit systems)

A cap-and-trade system aims to internalize the costs of emissions, and thus drives actors to seek cost-effective means to reduce their emissions. The challenge in a cap-and-trade programme is to determine the appropriate level at which to set the cap, which should be stringent enough to induce the desired level and rate of change, while minimizing overall economic costs.

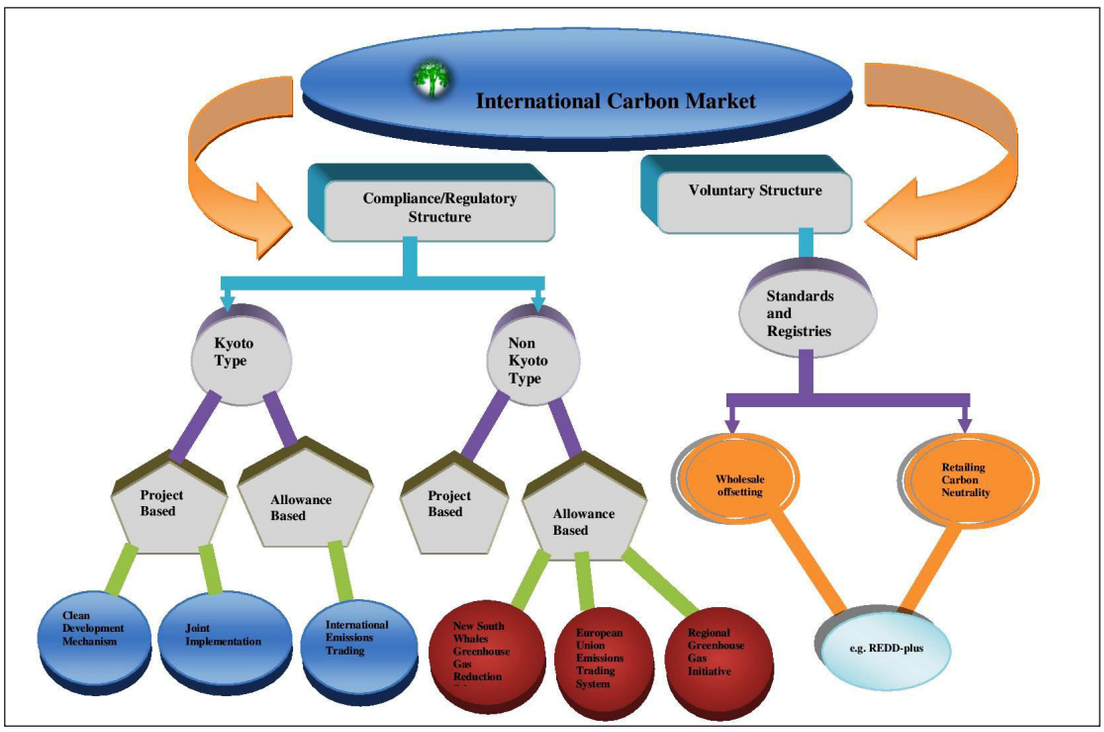
A baseline-and-credit system in contrast, does not entail a finite supply of allowances. It does not involve projects that are implemented under the umbrella of a cap-and-trade system. Rather, more credits are generated with each new project implemented. These credits can then be used by buyers to comply with a regulatory emission target, to "offset" an emitting activity.

Carbon markets exist both under compliance schemes and as voluntary programs. Compliance markets are created and regulated by mandatory national, regional or international carbon reduction regimes such as market mechanism developed under Kyoto Protocol. Compliance markets have certain rules and law at various national as well as sub-national level and also called regulated markets. Compliance markets are generally cap and trade markets where companies, governments, or other entities buy carbon allowances in order to comply with caps on the total amount of carbon dioxide they are allowed to emit. However, voluntary carbon markets offers businesses, NGOs and individuals to offset their own emissions on a voluntary basis by purchasing carbon credits. These can be credits created either under CDM or under other carbon offset standard. This voluntary market operates not because of government obligations and has also become very important for forestry projects. Voluntary carbon credits, *i.e.* Verified Emission Reduction (VER) are mainly purchased by the private sector. Corporate Social Responsibility (CSR) and public relations are the most common motivations for buying carbon credits.

Other reasons are considerations such as certification, reputation and environmental and social benefits. Some companies offer clients to neutralize their carbon. The private sector can either purchase carbon credits directly from projects. The story behind the credits plays a crucial role in these markets. Agriculture, Forestry and Other Land Use (AFOLU) projects are usually valued highly for their social and environmental benefits, as they deal with people's livelihoods and the protection of important ecosystems. Structure of international carbon markets is given in Figure 2.1.

The premise of the forest carbon markets rests on the idea that payments for land-based emissions the reductions to incentivize activities that enhance carbon storage across landscapes making it financially feasible for communities to keep trees standing. The prevailing uncertainty of commitments under second commitment period of the Kyoto Protocol and Pre-2020 ambitious targets resulted in collapse of global carbon market under it, the voluntary markets for forest carbon offsets experienced steady growth over the recent past as projects that reduce emissions by avoiding deforestation, planting trees, or enhancing carbon sequestration in forests reach maturity and as buyers continue to incorporate offsetting as a core strategy for neutralizing the emissions they cannot reduce or for meeting carbon regulation. In 2016, these markets transacted 156.3 $KtCO_2e$ from forestry and land use in overall 1868.20 $KtCO_2e$ from all the sectors representing the significant contribution of forest-based emission reductions (Ecosystem Marketplace, 2017).

Fig. 2.1. Structure of international carbon market



2.2 Voluntary Forest Carbon Offsetting Market

The voluntary market is currently the active international source of demand for forestry offsets. In 2016, renewable and forestry and land use were the two most traded offset categories by volume, with 18.3 and 13.1 $MtCO_2e$ traded, respectively. However, the value of the forestry and land use offsets market was more than triple that of the renewable market, and comprised 46% of the total value of the voluntary carbon markets (Ecosystem Marketplace, 2017).

Measuring and verifying the co-benefits of forest carbon projects is now "business-as-usual" as project developers seek to deliver beyond-carbon outcomes and mitigate risk. There are several other co-benefits associated with the REDD+ implementation such as local jobs and alternative income streams as well as the community trainings are exactly the project activities that will successfully reduce deforestation and forest degradation. Financial mechanism in voluntary carbon market is depicted in Figure 2.2.

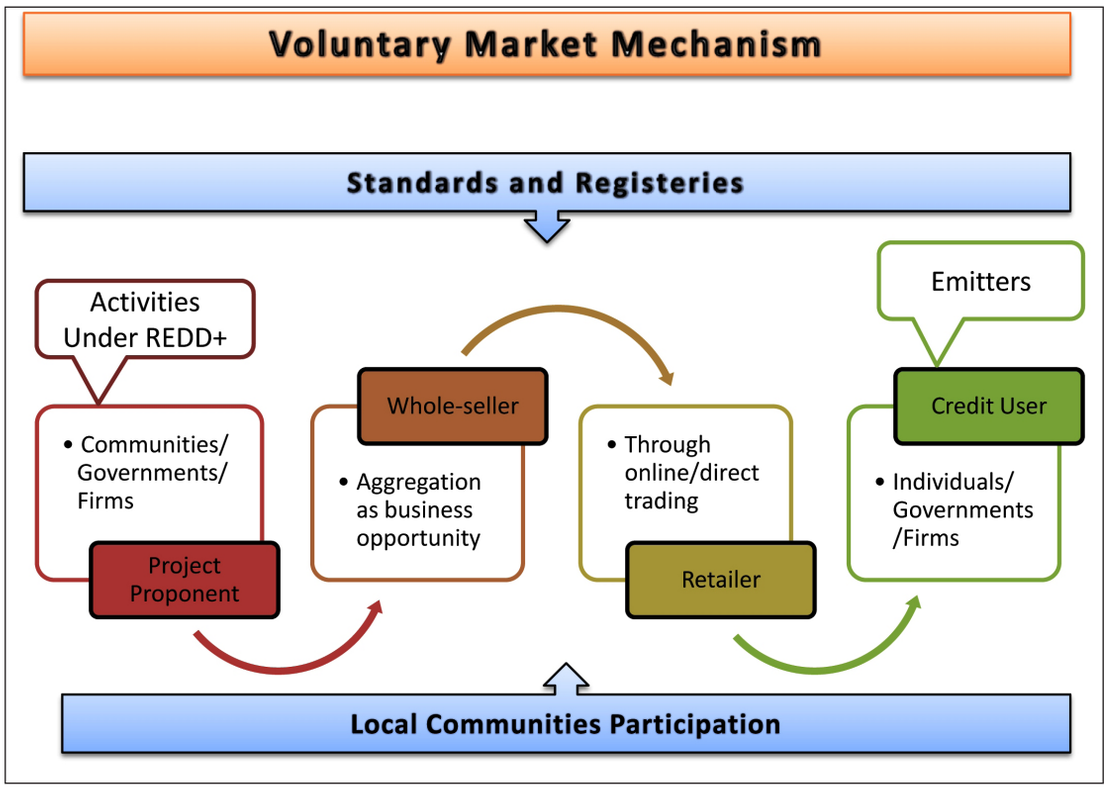


Fig. 2.2. Financial mechanisms in voluntary carbon market

2.3 REDD+ Financial Mechanism

Multilateral institutions such as the World Bank's Forest Carbon Partnership Facility (FCPF) have ramped up funding for REDD+ over the past few years, overshadowing the bilateral and private foundation funding supplying the bulk of funds. The Forest Investment Program (FIP), which is backed by multilateral development banks such as the World Bank, the Asian Development Bank, and the African Development Bank, also increased its REDD+ funding. FIP has now pledged a total of $639 million for efforts to reduce deforestation in eight countries, and donors have committed an additional $50 million to a Dedicated Grant Mechanism that aims to extend participatory governance and promote transparency for indigenous peoples and local communities. The World Bank's BioCarbon Fund has also created a new funding initiative for forests, Initiative for Sustainable Forest Landscapes in December 2013 (Ecosystem Marketplace, 2014). Financial resources play an important role in implementing REDD+ action to reduce deforestation and degradation and conservation of forest carbon stocks. In addition to the cost for the actual implementation (planning, capacity building, improved forest governance), the fundamental principle behind REDD+ is that payments will be made to compensate for incomes that are foregone when forests are not cleared and conserved for its mitigation and adaptation benefits (the *opportunity cost*).

Further, the Green Climate Fund (GCF) could be tapped to finance REDD+ initiatives. The fund, emanating from the 2010 Cancun Agreements, was established under the UNFCCC to help developing countries to reduce their emissions and adapt to the adverse effects of climate change. Developed countries pledged $100 billion via a mix of public and private financing but commitments to the fund materialized slowly. The Green Climate Fund's initial capitalization target of $10 billion was achieved during COP 20 in Lima (Peru) in December 2014.

2.4 Green Climate Fund (GCF)

Decision 9/CP.19, the Conference of the Parties (COP) to the UNFCCC encouraged the Green Climate Fund (GCF) to play a key role in collectively channeling adequate and predictable results-based finance in a fair and balanced manner, taking into account different policy approaches, while working with a view to increasing the number of countries that are in a position to obtain and receive payments for results-based actions.

The concept of results-based finance includes payments directly for verified results achieved. In the case of REDD+, results are defined as mitigation outcomes that is greenhouse gas emission reductions and/or enhancements in forest carbon stocks (sinks) measured and verified against a benchmark (FREL/FRL) expressed in tonnes of carbon dioxide equivalent per year. In addition, 'results-based finance' (RBF) may include incentives for intermediate, predefined, and measurable milestones or outputs (such as policy performance and results from REDD+ phase 2 activities) that will be necessary in order to effectively reduce deforestation and forest degradation, and ultimately leading to phase 3 results. This will allow a greater number of countries at national and/or sub-national levels to gain access the necessary finance in order to catalyse actions towards achieving REDD+ results.

The terms "results-based payment" (RBP) and "results-based finance" (RBF) appear to be used indistinctively in UNFCCC decisions and GCF Board documents. RBF denotes payments against verified REDD+ results as well as financing for intermediate, predefined and measurable milestones or outputs, using the various financial instruments of the GCF, including grants and concessional lending. Thus RBF can be considered as a broader concept in which RBP is embedded, offering more flexible and innovative approaches necessary to accommodate the different national circumstances of developing countries and their varying degrees of progress in the different phases of REDD+ implementation.

The GCF currently provides support to maintain and amplify efforts to implement the early phases of REDD+ in recognition that REDD+ offers a cross-cutting approach to contribute to global efforts to reduce emissions and contribute to low emission and climate resilient development pathways in developing countries, while simultaneously generating local benefits, which in some cases could assist with adaptation to climate change.

GCF Readiness and Preparatory Support Programme

In its Seventeenth Board meeting[4], GCF agreed on support for the early phases of REDD+ on Readiness and Preparatory Support Programme. Resources are available in the form of financial and technical support, by the means of templates and technical guidance and up to USD 1 million per country per year (not exclusive for REDD+, but for all activities identified by the National Designated Authority). Readiness Funding can be accessed for a variety of readiness activities, as appropriate. As an example of some REDD+ activities that could be supported through the readiness programme are:

(a) Establishing and strengthening National Designated Authority (NDA) or Focal Point (FP): Under this category, the NDA/FP may strengthen its national

[4] GCF document No. GCF/B.17/16 dated 2 July 2017.

coordination and consultation mechanisms. All key relevant actors in climate change including the REDD+ national entity/focal point to the UNFCCC are expected to be involved in this process to ensure the country effective engagement with the GCF.

(b) Strategic framework, including the preparation of country programmes: This category includes developing a country programme, which may extend to a national REDD+ strategy/action plan (e.g. analysis of policies and measures, stakeholder consultations, analysis of drivers of deforestation, financial analysis and assessment to identify financial gaps, barriers and needs, and so on).

(c) Support for accreditation and accredited direct access entities: The NDA/FP may use the GCF readiness resources to support national or regional entities specialised in REDD+ activities that are candidates for accreditation for direct access, to understand the GCF accreditation process and build their capacity in fiduciary standards and environmental and social safeguards or the Cancun safeguards.

(d) Information sharing, experience exchange and learning: The Readiness Programme may support information and knowledge sharing, including conducting regional workshops with NDAs/FPs, existing and potential AEs, REDD+ national entity/ focal points, civil society and other stakeholders to raise awareness of the modalities of the Fund and opportunities to engage in REDD+ implementation.

(e) Formulation of national adaptation plans and/or planning processes: Where land based activities are identified for addressing adaptation priorities, countries may explore possible complementarily between their adaptation plans with REDD+ activities.

The GCF Board in its eighteenth meeting vide decision B.18/07[5] decided to set, for the REDD+ results-based payments pilot programme only, the valuation of results at USD 5 per tonne of verified emission reductions of carbon dioxide equivalent (t CO2 eq). It also decided to allocate up to USD 500 million to the request for proposals for the pilot programme for REDD+ results-based payments. The board further decides to adopt the request for proposals for the pilot programme for REDD+ results based payments and scorecard has been developed as "pass" for a proposal to be eligible for the pilot programme.

2.5 Voluntary Carbon Standards

The voluntary markets serve companies and other entities that are not legally committed to reduce their emissions due to international commitments or national legislation. These companies buy carbon credits in order to be able to claim that they are 'offsetting' their greenhouse gas emissions (or part thereof). The voluntary carbon market lacks the centralized oversight structure of the compliance markets linked to the International negotiations, therefore many offset buyers in the voluntary carbon market request third-party certification as an assurance that veracity of offset project claims has been assessed. This reliance on third party certification is particularly common for forest offset projects. Investors and buyers of forest offset credits see these certification schemes as a quality assurance. Table 2.1 represents the summary of various voluntary carbon standards and their background and objectives involved in Voluntary offset market.

[5] GCF document No. GCF/B.18/23 dated 2 November 2017.

Table-2.1: Summary of voluntary carbon standards

Standard	Background	Objectives	Applicability
Climate, Community and Biodiversity Alliance (CCBA) Standards. (http://www.climate-standards.org/)	Climate, Community and Biodiversity Alliance, is a partnership between research institutions, corporations, and environmental groups since 2005.	Standards aim to provide flexible rules and guidance for the development of sub-national land-based projects that deliver climate, community and biodiversity benefits in an integrated and sustainable manner.	Intended to be used by project-developing organizations using a project design guidance framework.
Carbon Fix Standard (CFS) (http://www.carbonfix.info/)	Launched in 2007 with support of more than 60 organizations.	Standard promotes that A/R projects in the voluntary carbon market sequester carbon, restore forests, and deliver benefits to people and the environment in a practical, transparent and comprehensive way.	Used by A/R carbon projects-mainly in developing countries.
Plan Vivo Standards (http://www.planvivo.org/)	Originates from a research project in southern Mexico, initiated in 1994.	Promotion of sustainable livelihoods among communities, smallholders, and farmers; to provide ecosystem services and promotion of the protection and planting of native and naturalized tree species.	Designed for use by project-developing organizations for land-based carbon projects in developing countries.
Social carbon (http://www.socialcarbon.org/)	Developed in 1998 by the Brazilian non-profit organization Ecological Institute originating from a carbon sequestration project in the Brazilian state of Tocantins.	Adding value to GHG mitigation projects through continuous improvement of social, environmental, and economic performances.	Designed for use by project-developing organizations for land-based carbon projects that operate in developing countries.
International Standardization Organization (ISO) ISO 14064-2:2006 ISO 14064-3:2006 (http://www.iso.org/iso/home.html)	ISO is a worldwide federation of national standards bodies that designs international standards after a technical committee for a specific sector is established.	Provision of a framework for quantification, monitoring, and reporting of greenhouse gas emission reductions or removals on project level and guidance on validation and verification of greenhouse gas assertions.	Intended to be used by standard organizations and project developing organizations for providing evidence of credible and verifiable GHG assertions.
Verified Carbon Standard (VCS) (http://www.v-c-s.org/)	Initiated in 2005 by The Climate Group, the International Emission Trading Association, and the World Economic Forum.	The VCS program seeks to provide a robust global GHG accounting standard for carbon offset projects participating in the voluntary carbon market.	Intended to be used by project developing organizations of emission reduction projects.
Gold Standard (http://www.goldstandard.org)	The Gold Standard is a globally trusted regulatory framework for the development of projects in climate and environment theme.	Gold Standard is a high quality carbon offsetting standard which provides verified emission reduction along with additional social and community benefits.	Intended to be used by project developing organization regarding emission reduction and community participation to provide additional benefits.
American Carbon Registry Standard	The American Carbon Registry (ACR) is the first private voluntary greenhouse gas registry. It is a nonprofit enterprise of Winrock International and was founded in 1996.	ACR works in both the voluntary carbon market and California's regulated carbon market.	It comprises of set of methodologies for both voluntary carbon market and California's regulated carbon market according to which project developers can develop a carbon offset project by highlighting its various given activities.

Source: Merger et al., 2011

http://www.rainforest-alliance.org/business/climate/validation-verification/standards accessed on 08/06/2017

3

Project Planning and Implementation

In order to implement the REDD+ in any forest area along with the active participation of the local communities the objectives can be designed by keeping in view the following points:

- Case studies related to different drivers for forest degradation and deforestation.
- Baseline estimation of carbon stocks in different carbon pools in the proposed area for the REDD+ implementation.
- Defining the reference level emission/ reference level for the proposed REDD+ implementation area.
- Capacity building of forest dependent communities in context of project activities related to forest carbon conservation and developing measuring, reporting and verification (MRV) system for REDD+ implementation.
- A safeguard information system at project level.
- Provision for incentivizing the local communities and development of a benefit sharing mechanism.

3.1 Orientation/Capacity Building Programme for Local Community

The REDD+ project, highlights the empowerment of forest dependent communities for forest carbon conservation and developing measuring, reporting and verification (MRV) system for implementation of REDD+ activities at project level as one of its major objective. The front line staff of forest departments and the local communities inhabiting the project area needs to be sensitized about the REDD+ concept and their participation in the project by means of consultations at village as well as forest department level. For successful development of a project, capacity building in the form of training/orientation/workshop programs on various aspects of REDD+ is always helpful. Specific training/ workshops related to climate change, role of forest in mitigation and REDD+ projects and its implementation should be disseminated among the local communities. A hands on training will also be given on forest carbon measurement and other project related activities will be beneficial during project implementation. The capacity building programmes for the frontline forest staff and local community should cover major part related to the methodology for forest carbon measurement and collection of socio-economic information at village community level. Following tentative activities could be performed for the orientation programmes:

- Introduction to the REDD+ concept.
- Introduction about the carbon, offset carbon markets, incentives generated by carbon sequestration.
- Methodologies and measurement involved in the forest carbon measurement.
- Hands on training of the equipments and materials.
- Field demonstration activities.

3.2 Provision for Capacity Building of Women Participants of the Project Areas

The indigenous people and local communities have different roles and responsibilities at their individual level as well as at community level which indicates that the men and women both have different roles towards the access of different resources available in the ecosystem. Among the other factors like class, race and caste, gender issue plays an important role in terms of forest conservation by reducing rate of deforestation and forest degradation. The gender equality and empowerment of women at household level as well as community level need to be addressed as a major thrust area. In the Himalayan ecosystem and North-East part of the country women play an important role in collecting various resources for their livelihood, *i.e.*, fuel wood, fodder, medicinal herbs and food from the forest areas and their active participation in the sustainable management of forest in context of REDD+ can bring the equality in term of gender issue. REDD+ has the potential for improving the economic status of the communities by means of generating REDD+ credits to gain the benefits in terms of financial aids available in our international carbon market from developed countries. Hence, implementing gender sensitive, poverty focused and user based REDD+ programme will be more beneficial at indigenous community level towards biodiversity conservation and to rehabilitate the forest ecosystem.

In the Himalayan region, the women face discrimination in terms of decision making at household as well as community level. Men are involved in various economic activities and decision making. Hence, highlighting the roles of women participants and their relationship with the local forest ecosystem regarding collection of fuelwood and fodder, general awareness campaign highlighting the importance of forest ecosystem towards sustainable management of forests need to be given to women of the project area. Further, there should be introduction of alternative livelihood options for women in the project area so that the economic status as well as living standard of the local communities can be raised.

In terms of management practices, active groups or teams of women participants could be formed from different locations of the project area, and there should be the provision of special training programmes regarding biodiversity management and implementation of REDD+ activities for those participants.

4

Measurement, Reporting and Verification (MRV)

The assessment of forest carbon stocks and to achieve the REDD+ benefits involves three basic steps i.e., measurement, reporting and verification. Measurement is generally divided into direct or indirect measurement of emissions or removals as a result of human activities in the forest areas of any specified project area. Direct measurement can include both field measurements and remote sensing, and can be supplemented with modeling whereas the indirect measurement involves estimation of emissions reductions using equations based on data on land areas and specific emission factors or the use of complex models that take into account a number of different parameters that affect the release or sequestration of carbon and other greenhouse gases (GHGs). Reporting refers to the presentation of information which encompasses forest-related data and estimates of GHGs and the methodologies used to derive them, as well as other related issues, such as quality assurance and quality control (QA/QC) activities and uncertainty estimation performed by the project proponents during the measurement phase. Verification refers to the assessment of the completeness, consistency, and reliability of the reported information through an independent process followed by internal and external verifiers. Verifier provides the suitable suggestions for improving the data and project activities and ultimately helps to build confidence in, and improve scientific understanding of estimates and trends.

The fifteenth session of Conference of Parties (COP 15) of UNFCCC held at Copenhagen in 2009 vide Decision 4/CP.15 on Methodological guidance for activities relating to REDD+ requested developing country Parties, *inter alia* to take the following guidance into account, in particular those relating to measurement and reporting:

(a) To identify drivers of deforestation and forest degradation resulting in emissions and also the means to address these;

(b) To identify activities within the country that result in reduced emissions and increased removals, and stabilization of forest carbon stocks;

(c) To use the most recent guidance and guidelines of Intergovernmental Panel on Climate Change, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(d) To establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that:

  (i) Use a combination of remote sensing and ground-based forest carbon inventory

approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(ii) provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities; and

(iii) are transparent and their results are available and suitable for review as agreed by the Conference of the Parties;

Warsaw COP decision 14/CP.19 on REDD+ methodological guidance *inter alia* decides that measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest-area changes resulting from the implementation of the REDD+ activities is to be consistent with the methodological guidance provided in decision 4/CP.15 and any future relevant decisions of the COP.

In the forestry sector different activities have different human-induced impacts in the carbon stock and non CO_2 greenhouse gases concentration from a particular area. These activities may vary from land to land depending upon the objectives and other basic features, *i.e.*, geographical effect, variation in livelihood options etc. Table 4.1 represents the various types of forestry activities for improving the quality of the particular forest ecosystem and to achieve the target of emission reduction from the project.

Table-4.1: Identified activities for carbon offset project in forestry sector

Activities	Description	Requirement
Plantation Forestry	Short Rotation Long Rotation	Degraded forests/Community forests
Agro-forestry	Short Rotation Long Rotation	Agricultural/Fallow Land
Grazing land management	Silvi pasture Long rotation Short Rotation	Community grazing lands
Regeneration	Promoting Native Species	Forest land with good rootstock

Measurement of forest carbon is a vital part of REDD+ implementation because CO_2 emission reductions and removals by implementing various REDD+ activities are estimated by measuring changes in the amount of forest carbon, and credits are also issued on the basis of carbon accrued through these actions. Measurement can be defined as the continuous measurement and collection of data on anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks. The measurement system must be transparent, consistent, and accurate, and uncertainty should be minimized.

For the estimation of carbon pools in a forested stand, IPCC (2003) identified five carbon pools as: above ground biomass, below ground biomass, litter, dead wood and, soil organic matter. Detailed description of above mentioned carbon pools is given in table 4.2 and figure 4.1 is representing the step wise method for estimating the total carbon.

Table-4.2: Description of terrestrial carbon pools

Pool		Description
Living Biomass	Above Ground Biomass	All living biomass above the soil including stem, stump, branches, bark, seeds, and foliage. Note: In cases where forest understorey is a relatively small component of the above ground biomass carbon pool, it is acceptable for the methodologies and associated data used in some tiers to exclude it, provided the tiers are used in a consistent manner throughout the inventory time series.
	Below Ground Biomass	All living biomass of live roots. Fine roots of less than (suggested) 2 mm diameter are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Dead Organic matter	Dead wood	Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter or any other diameter used by the country.
	Litter	Includes all non-living biomass with a diameter less than a minimum diameter chosen by the country (for example 10 cm), lying dead, in various states of decomposition above the mineral or organic soil. This includes the litter, fumic, and humic layers. Live fine roots (of less than the suggested diameter limit for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.
Soil	Soil Organic Matter	Includes organic carbon in mineral and organic soils (including peat) to a specified depth chosen by the country and applied consistently through the time series. Live fine roots (of less than the suggested diameter limit for below-ground biomass) are included with soil organic matter where they cannot be distinguished from it empirically.

Note: *National circumstances may necessitate slight modifications to the pool definitions used here. Where modified definitions are used, it is good practice to report upon them clearly, to ensure that modified definitions are used consistently over time, and to demonstrate that pools are neither omitted nor double counted.*

Source : IPCC, 2003

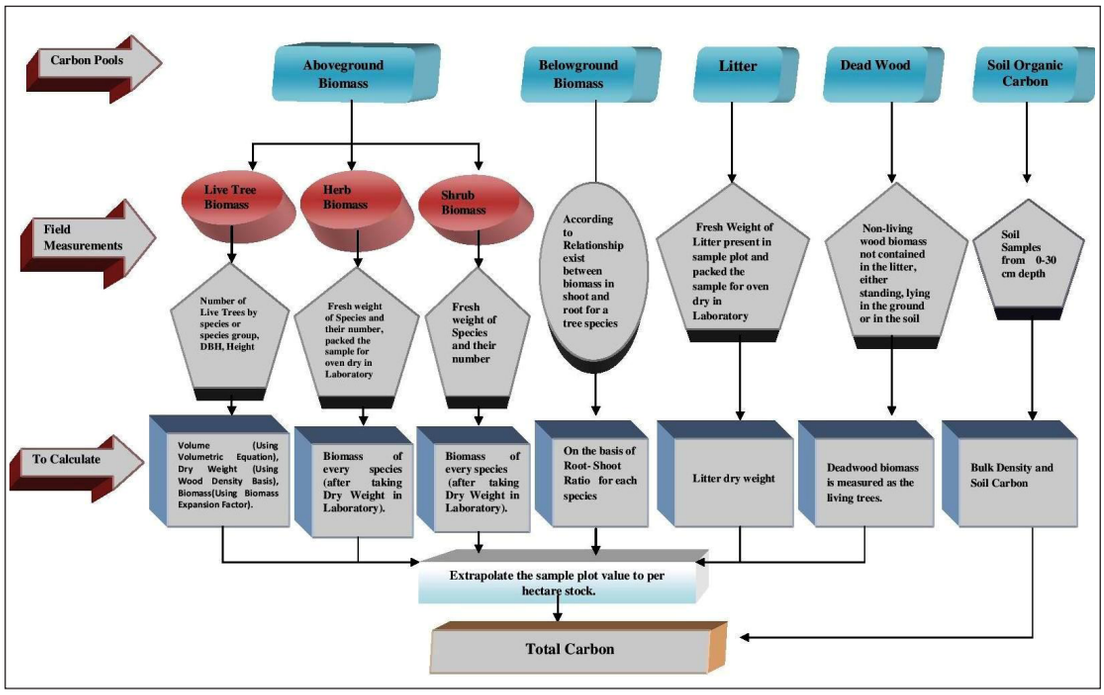


Fig. 4.1. Flow chart for estimating total carbon and different carbon pools

Box 4.1 Three tiers of estimating emissions

The IPCC (2006) also provides three tiers for estimating emissions, with increasing levels of data requirements and analytical complexity and therefore increasing accuracy

Tier 1 methods are designed to be the simplest to use, for which equations and default parameter values (e.g., emission and stock change factors) are used. For Tier 1 there are often globally available sources of activity data estimates (e.g., deforestation rates, agricultural production statistics, global land cover maps, fertilizer use, livestock population data, etc.), although these data are usually spatially coarse.

Tier 2 can use the same methodological approach as Tier 1 but applies emission and stock change factors that are based on country or region specific data, for the most important land-use or livestock categories. Higher temporal and spatial resolution and more disaggregated activity data are typically used in Tier 2 to correspond with country-defined coefficients for specific regions and specialized land-use or livestock categories.

Tier 3 higher order methods are used, including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national level. These higher order methods provide estimates of greater certainty than lower tiers. Such systems may include comprehensive field sampling repeated at regular time intervals and/or GIS-based systems of age, class/production data, soil data, and land-use and management activity data, integrating several types of monitoring.

4.1 Sample Plot Layout

As per the requirement of methodology and carbon standard to be adopted, the number of sample plots can be pre-determined based on available strata in respect of forest types and density classes. The A/R methodological tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" can be used for calculating the number of sample plot to be layout in predefined project area. After reaching the predetermined sampling point a sample plot of 0.1 ha will be laid out by measuring 22.36 m horizontal distance *i.e.* half of the diagonal in all the four directions at 45° in north-east, at 135° in south-east, at 225° in the south west, and at 31.5° in north-west corners of the plot from true north. Care should be taken for lying out the proper dimensions of the plot. Then nested subplots of size 3 m × 3 m and 1 m × 1 m will be laid out at a distance of 30 m from the centre of the main plot in all the four directions along diagonals in non-hilly area and along trails in the hilly areas for the collection of samples for shrubs and herbs/ grasses respectively. Initial plot information will be recorded in Plot Description Form as given in Annexure II and sample plot layout is shown in figure 4.2. These conditions qualify for the sample plot which lies on the plain. Hence, if the plot lies on the slop, then slope correction is required for each further measurement. While measuring the height of a tree standing on slope, first of all the slope correction factor can be calculated depending upon the angle of slope and the side perpendicular to the slope. Then the estimated height is to be multiplied by the correction factor and the value so obtained is to be subtracted from the estimated height to get the exact height of the tree.

For above ground biomass all tress having diameter of 10 cm and above are enumerated. Species and diameter class wise information obtained from the sample plot of 0.1 ha will be recorded carefully in the plot description form, border line trees, *i.e.*, the stem of the trees touch the north and west border line of the plot is enumerated. However, the stem of the trees touches the east and south border line of the plot is treated as "out trees" and information about out tress will not be recorded in the plot description form. Trees below 10 cm diameter at breast height over bark will be enumerated as sapling. One should be clear that the enumeration in the plot

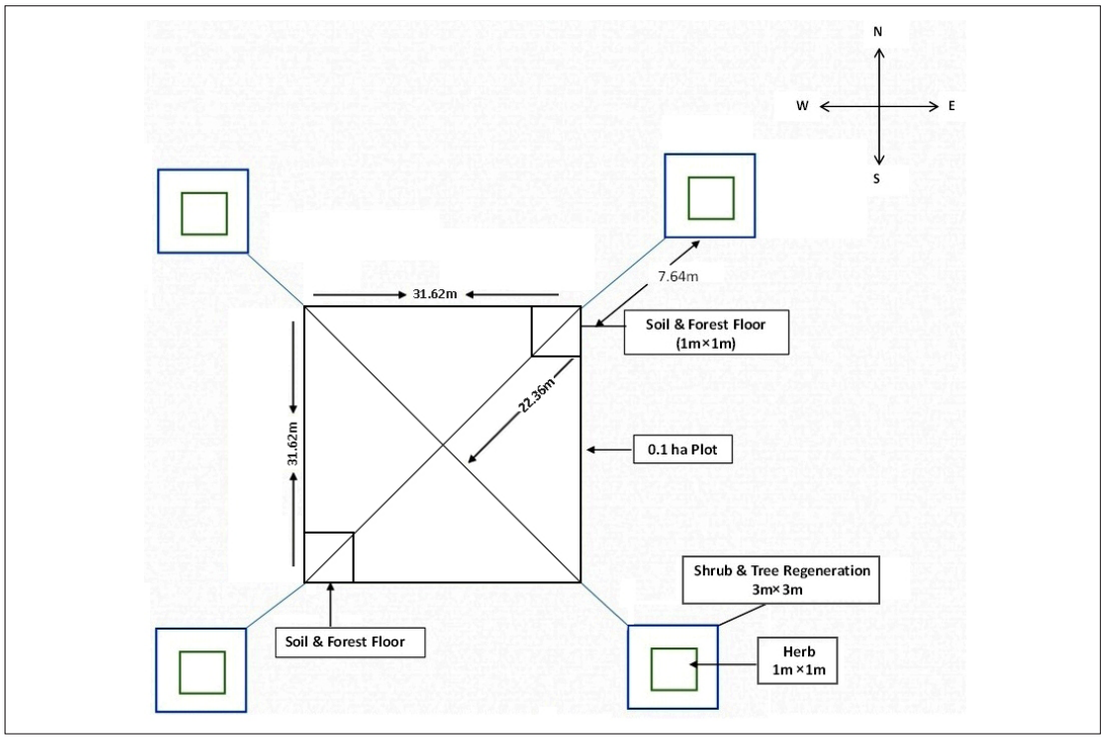


Fig. 4.2. Sample plot layout

should be started from the North-east corner and will proceed in clockwise direction. The same procedure should be followed for all the sample plots within the project boundary. The height of the trees lies in the sample plots should be measured for the dominant trees.

For shrubs, the 4 quadrats of 3 m × 3 m will be laid out at a distance of 30 meter from the centre of the main plot of 0.1 ha. The sample of every shrub will be collected and data from all the quadrats should be recorded in the plot description form. For herbs, the quadrats of 1 m × 1 m will be laid within each quadrat of 3 m × 3 m and the samples of the herbs from the quadrats will be collected and data about the herbs should be recorded carefully in the plot description form.

For litter and dead wood from the forest, a sample plot of 5 m × 5 m will be laid. More than 5 cm diameter dead timber will be collected separately for determination of deadwood biomass and remaining parts will be collected as litter samples. Fresh weight of litter will be taken with the help of weighing balance in the field and the litter samples will be collected from each plot and carried to laboratories for determining dry weight with the help of oven. For deadwood, the height and diameter of deadwood above 5 cm diameter, the lying or standing deadwood in the sample plot will be measured. Quality assurance and quality control principles for sample and data collection by the field team are given in Annexure IV.

Fig. 4.3. Complete plot layout with the help of roles and poles

4.2 Field Measurements

During the field measurements, it is very necessary that following information about past and current scenarios in the project area should be collected and recorded:

- Different maps of the project area*, i.e.,* forest type map, forest cover map, topographic map, fringe village boundaries, road maps, sapling points along with latitude and longitude.
- Surrounding areas, accessibility, and different land use system.
- Approachability of forest area from villages, roads, cities and markets.
- Land tenure/ ownership rights.
- Historical land use changes
- Livelihood options, livestock population and grazing practices.
- Fuelwood and timber extraction and source
- Various socio-economic aspects. Household level survey of the project area as per the prescribed format (Annexure III).

Quality and accuracy of field work always depends on the type of the field equipments. The equipments used for fieldwork should be accurate, calibrated and durable to use under various adverse conditions during the field visits. The table 4.4 includes the list of most of the items required during the field visit for laying out the sample plot.

Table-4.4: List of items required for field sampling

S. No	Item	S. No	Item
1	Compass	8	Caliper
2	GPS	9	Weighing scale
3	Meter tape	10	Measuring tape for fine measurements for DBH measurements.
4	Nails and numbered tags	11	Hand saw
5	Clinometer	12	Coloured ropes and poles for demarcating the boundary and centre of the plot
6	Paper and plastic bags	13	Marker pens
7	Field description forms	14	Piece of cloth/ribbon

Box 4.2 : Plot Layout

i. With the help of GPS and project sampling map, locate the centre of the plot in the particular forest type within the project area.
ii. For the purpose of future validation and verification, mark the centre and boundaries of the plot with the help of permanent paint.
iii. Assign a unique number as a permanent identity to the plot according to the sampling scheme of the project.
iv. After laying the plot with the help of ropes, start measuring the trees in one direction.
v. Mark each tree or atleast first tress as per the suitability of field conditions for further future identification and measurements.
vi. Measure the diameter of each tree at breast height (*i.e.* 1.37 cm) and record it in the permanent data record sheets/notebooks along with the species name.
vii. Measure the height of the tree using clinometers.
viii. If a tree lies on the plot boundary, then check whether 50% of tree trunk lies inside or outside the boundary. Exclude those trees whose more than 50% of the trunk lies outside the boundary.

Fig. 4.4. Marking permanent points for revisiting the plot during reassessment

4.3 Above Ground Tree Biomass Measurement

Forest measurement from individual tree to stand of trees and estimation of tree volume as well as biomass is important for assessment of biomass carbon in a forested stand.

Tree diameter measurements

The most convenient point of measurement for diameter is on the bole near the ground. However, due to the nature of tree growth, *i.e.*, shape, size, and position, it is desirable to measure diameter at the same relative position on the bole. This relative position on bole is breast height (termed diameter at breast height or DBH), at a fixed height above the ground. In India, it measured at 1.37 m above ground. The decision of breast height is based on location and position of tree on the terrain. For slopping ground, this distance measures from the uphill side of the stem.

The diameter may be measured by wrapping measuring tape firmly around the stem, perpendicular to axis. The point must be marked for repeated measurements for assessing growth rate to ensure that the same position will be measured in each occasion. Diameter tapes [mostly calibrated with unit of pi (π) *i.e.*3.142] are also used. The diameter can also be measured through calipers. Caliper are often quicker, however measure stems only across one diameter of their cross-section. Thus bias may be reduced by taking two measurements, at right angles to each other, and estimates of mean of these two measurements as stem diameter. Diameter measurement at breast height may not be representative in some cases such as deformity, swelling, branches, malformation, wound etc. at that point. In these cases following considerations should be followed.

1. Two measurements equidistant above and below the breast height should be recorded. If the difference in measurements is low, arithmetic mean will serve the purpose, otherwise, quadratic mean will be a better option.
2. Alternatively, measurement may be recorded from a single point by selecting one position of representative size.

Following precautions are to be observed while measuring tree diameter

- On slopping ground measurements should be taken from the uphill side of the stem.
- For leaning trees (on level ground), the point will be on the under-side of the tree parallel to the axis of the stem.
- Trees forked below breast height should be treated as a double stem *i.e.* two separate tree.
- Trees forked above breast height should be treated as a single stem and measured according to the position of tree on ground or hills.
- Trees forking at breast height or slightly above are measured at the point of minimum diameter below the fork.
- Coppice crops should be measured from ground level.

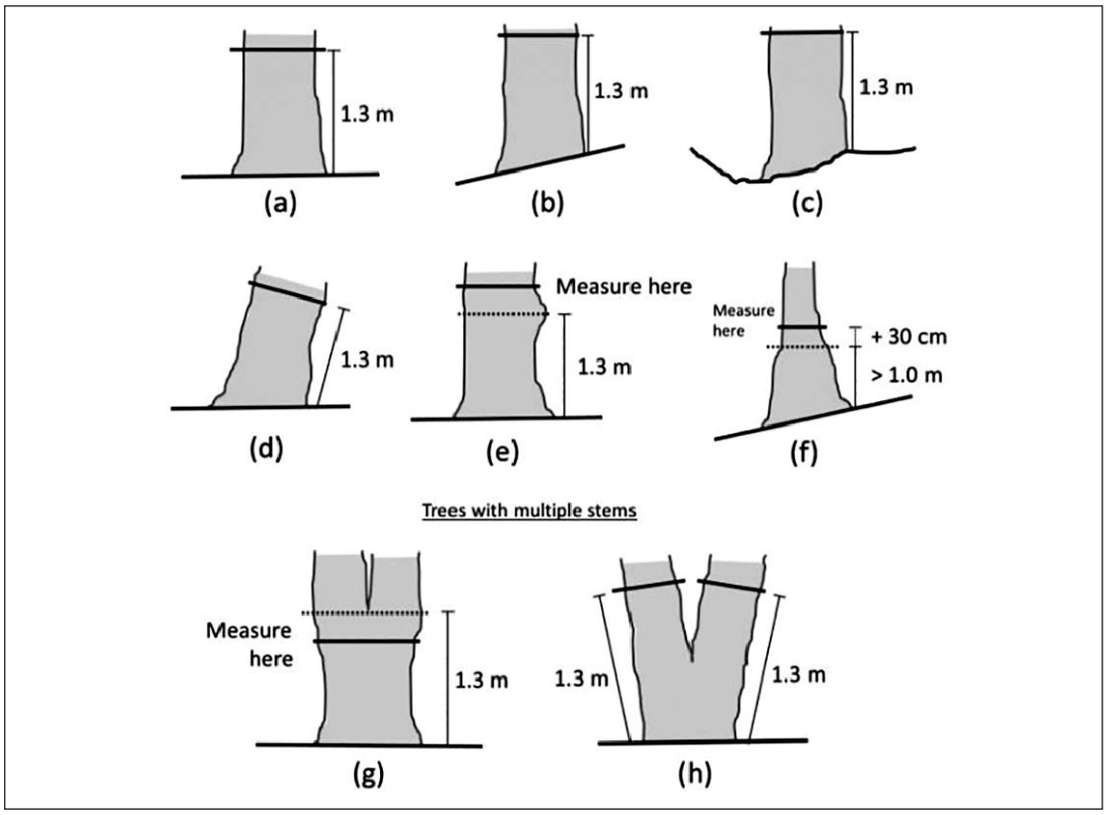


Fig. 4.5. Tree DBH measurements under different situations

Besides this, following precautions should also be ensured for proper and accurate measurements.

- The loose mounds of soil and litter should be displaced and cleared.
- The vines, moss, loose bark and other loose material at breast height should be removed.
- The breast height should be fixed by using a fixed height stick.
- Measure at right angles to the stem axis. Keep tapes taut.
- Special attention should be placed for buttressing and fluting situations to ensure standardization and comparability of records. Normally, measurement is made above the buttress/fluting. Where this extends well up the bole, an arbitrary height is specified, e.g. 3 m above ground. Different scenarios for measuring the tree DBH is given in figure 4.5.

Height Measurement

The height of tree is important characteristics for measuring the total amount of wood contained in tree. It is the vertical distance from ground level to the highest given point on the tree known as tip of the tree. Identifying actual tree top and the fact that the tree top may not be directly over the base of the tree are main sources of error for tree height measurements. Therefore, the concept of merchantable tree heights is adopted with the view of utilisation perspective. It is the height of the tree (or the length of trunk) up to which a particular product may be obtained. Height can be measured through ocular estimate, non instrumental, (shadow method, single pole method). Specifically tree-height measurements can be done with the help of clinometers, altimeters, relaskopes or hypsometers.

Fig. 4.6. Marking of trees on the boundaries of the plot

Fig. 4.7. Tagging and numbering of tree on aluminum strips lies within the plot boundary

Box 4.3 : Steps to measure height of the tree using clinometer

i. Slight to the top of target tree and read the scale.
ii. Slight to the bottom of the same tree and read the scale.
iii. Add these two measurements which will be the tree height.

Measuring tree height

i) Walk around the tree and find the best location to view the top of the tree.

ii) Stand far enough away from the tree so that the top of the tree is less than 90 degrees above the line of sight.

iii) Always stand up-slope of the tree (fig 4.8). Standing down-slope of the tree should only take place when no other option exists.

iv) Measure height of dominant canopy trees.

v) Follow the instructions provided by the manufacturer of the instruments.

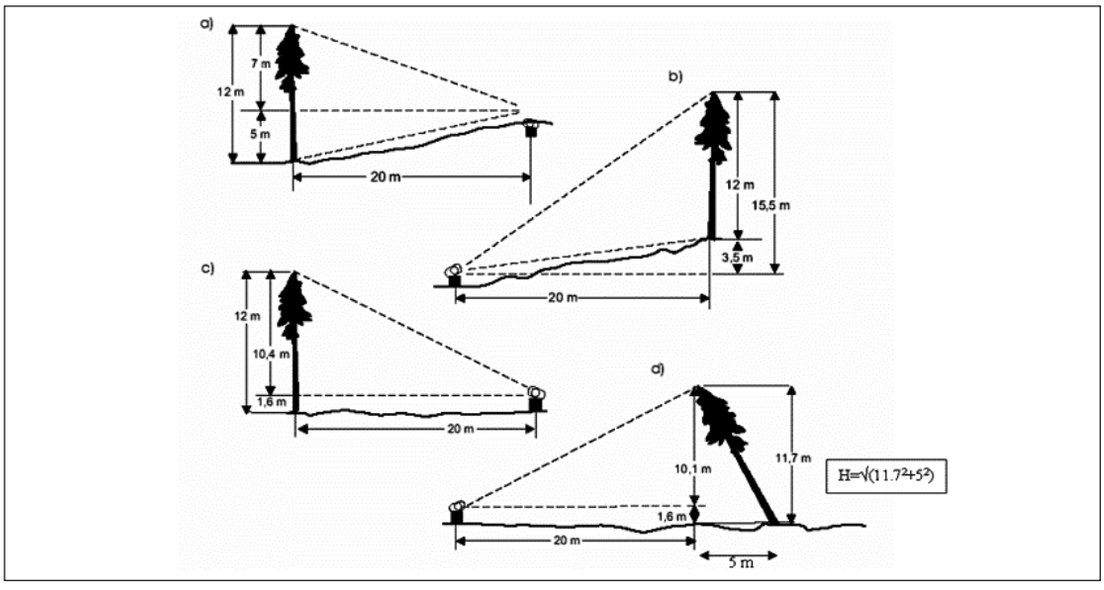


Fig. 4.8. Different arrangements to measure tree heights at different location

vi) Place chalk mark on the tree to indicate that the tree has been measured.

vii) All trees should be tagged with the placement of an aluminum numbered tag and nail.

viii) Record species name with the local name and the associated DBH and height.

ix) When all of the trees in the plot have been measured, there should be a double-check to see that all of the trees have been measured.

4.4 Above Ground Non Tree Biomass Measurements

The above ground non tree biomass generally includes shrub and herbs. The direct weighing of samples from fixed plot area according to standards is often used to make estimates of biomass of above ground non tree biomass which is also known as understorey species.

Fig. 4.9. Preparation of samples for herb, shrub and litter biomass by the field team

Shrub Biomass

Plots of 3 × 3 m will be laid for the shrub biomass estimation as per the sample plot layout scheme. Species name and number of each shrub should be recorded in the prescribed format. Harvest all the shrubs in the plot and weigh. Sample of known quantity should be brought to the laboratory for the further estimation of the biomass. Sample should be dried to constant weight in the oven and the values are extrapolated to per hectare stock.

Herb Biomass

Sampling of the herbs is done by lying 1×1 m plots. The following steps could be followed for the herbs biomass estimation:

- Species name and number of each herb should be recorded in the prescribed format.
- Harvest all the herbs in the plot.
- Fresh weight of each species should be taken through portable weighing machine and recorded in the prescribed format.

- Sample should be properly packed, labeled and brought to the laboratory for further estimation.
- Estimate the dry weight of the sample by drying it in an oven.
- Extrapolate the sample plot value of dry herbs to per hectare stock.

Below Ground Biomass

Relationship exist between biomass in shoot and roots for a tree. In the absence of default value of the root-shoot ratio of the local tree species, IPCC (2003) default factors can be used for the estimation of below ground biomass.

Litter

Litter is defined as the layer of dead organic matter lying on the forest floor which generally includes the mixture of leaves, branches etc. The steps for measuring the litter biomass are as follows:

a) Collect the litter completely present in the sample plot by laying out the quadrat of 1 m x 1m at all the four corners lying inside the plot boundary.

b) Record the fresh weight of the total litter collected.

c) Take a sample of known quantity of the litter.

d) Sample should be properly marked, packed, brought to the laboratory for further estimation.

e) Oven dry the litter sample at 85^0 C till constant weight.

f) Extrapolate the sample plot value of dry litter to per hectare stock.

4.5 Soil Organic Carbon

IPCC (2006) guidance on carbon accounting refers only upper 30 cm of soil. This zone is intended to cover the actively changing soil carbon pools. In each sample plot three sampling points will be selected as replicate at each point and soil sample from 0-30 cm depth will be collected.

Collection of soil sample for carbon estimation

Forest floor and litter from an area of 1 m $\times$ 1 m, at sampling point will be removed and a pit of 30 cm wide, 30 cm deep and 50 cm in length will be dug out. Soil from three sides of the pit of 0 to 30 cm depth will be scraped with the help of a *khurpee* and bulked. This soil will be mixed thoroughly and about 500 g soil will be collected for further laboratory analysis. The soil sample will be kept in a polythene bag and tightly closed with thread. A label showing sample details will be kept inside the bag before closing the bag.

Collection of soil sample for bulk density estimation

Insert the bulk density core sampler(of known volume) in between 0 – 15 cm depth with the help of hammer, up to the top of the core. Remove the core carefully so that the soil inside the core may not drop down. Collect the entire soil in a polythene bag, and bring it to laboratory. Repeat this exercise again in the soil 15–30 cm depth. Keep these soils in oven at 65ºC till it completely dried. Measure the dry weight of the soils, and calculate the bulk density of the soil.

Bulk density of the soil = Dry weight of the soil (gm) / Volume of the core (cm^3)

Fig. 4.10. Collection of soil samples

Finally, average of both the above densities will be taken for final calculation of the soil weight of that particular site.

Estimating percent course fragment in the soil

Percent coarse fragment (> 2mm size) in soils is estimated to work out the correct soil weight. After taking the weight of the sample dried for bulk density, this sample will be put in the 2 mm sieve, and pour the water over it. Soil particles less than 2 mm will go away with water. Take out the fraction from the sieve, and dry it and weigh it. Calculate the percentage of the coarse fragment.

Preparation of the sample for soil organic carbon estimation

Open the polythene bag and spread the samples on a brown paper sheet in the laboratory. Let the sample dry at room temperature in the laboratory. Avoid direct sun drying or oven drying. After drying the samples, grind it and sieve it through 2 mm sieve. This sieved sample is used for soil organic carbon estimation.

4.6 Estimation of Total Biomass and Carbon Stock

Biomass is defined as the total amount of living organic matter (aboveground and below ground) in trees. Biomass can be measured directly or through estimation functions For estimating biomass by any of the method, *i.e.*, species wise regression equation, generic equation, species wise yield estimation, volume estimation by using standard yield tables can be used which will give results in the form of the biomass of the related carbon pool excluding soil organic carbon. Further the biomass is converted to carbon by dividing the value by two. Generally carbon stocks are reported in terms of tonnes per hectare.

$$Carbon = \frac{Biomass}{2}$$

This will give the estimate in the form of pool wise carbon stock per plot. Estimation of expansion factor will further help to extrapolate the value of carbon stock per plot to per hectare.

$$Expansion\ Factor = \frac{1000m^3}{Area\ of\ plot\ (m^2)}$$

Estimation of Above Ground Biomass

a) Above ground standing tree biomass: Standing tree biomass can be measured by using direct measurement method or allometric biomass regression equation. The commonly used approach to estimate the biomass of standing trees is the use of the allometric regression equation or biomass equation with the help of measured DBH and height from field inventory data. If local allometric equations are available, the biomass can be assessed easily by using them. If such equations are not available, then it is better to develop site-specific allometric equations by collecting data from individual trees. Allometric equations for estimation of biomass have been developed for most Indian tree species and are available in the published literature. The steps involved for estimating the biomass by using DBH and height data are as follows:

- Identify a suitable biomass equation. Use location specific species equations where available, if not, use generic equation.
- Calculate the biomass for each tree using the identified equation.
- Calculate the total biomass of standing stock in the plot by summing up the calculated biomass of individual trees in each plot and multiplying with the expansion factor to obtain the biomass per hectare.

b) Above ground non tree biomass: The above ground non tree biomass is estimated by using the following steps:

- Weigh the sub-sample of known fresh weight after continuous intervals during the oven drying till the dry weight of the sample becomes constant.
- Total biomass of the whole sample can be calculated by using simple calculation for estimating moisture content:

$$Dry\ weight = \frac{Dry\ weight\ of\ sub-sample}{Fresh\ weight\ of\ sub-sample} \text{ X } Fresh\ weight\ of\ whole\ sample$$

- The biomass for whole plot can be calculated by multiplying the dry weight with an expansion factor calculated from plot size.

Below Ground Biomass

The method for estimating the root biomass is not given in any standardized form. The estimation of root biomass is a complex, tedious and expensive task in itself. However root biomass ranges from 10-40% of the aboveground biomass, hence for considering this pool the most common approach is to use the values addressed by various scientists / researchers in the existing published literature or default values on root: shoot ratio for different forest wise. Where no information is available, IPCC default root: shoot ratio can be used by using the following equation:

Belowground biomass=Aboveground biomass*Root:Shoot Ratio

Dead Organic Matter

a) Standing deadwood: For standing dead wood first steps is to calculate the volume of the wood by using the following equation:

$$Volume\ (m^3) = \frac{1}{3}\pi h(r_1^2 + r_2^2 + r_1 * r_2)$$

Where:

h = height of the standing dead wood (m)

r_1= radius at the base (m)

r_2=radius at the top (m)

Further the overall biomass for standing deadwood is estimated by:

Biomass=Volume*Wood density

b) Litter: Litter biomass can be calculated by simple moisture content method used for estimating the above ground non tree biomass.

Soil Organic Carbon

Soil organic carbon percentage is estimated by standard Walkley and Black (1934) method. Soil samples are analysed for required parameters viz bulk density and organic carbon as per the following procedures:

a) Bulk Density: The estimation of bulk density for coarse fragments of 2 mm fraction for a particular depth say 30 cm (in grams/cm^3) can be done by using the following equation:

$$Bulk\ Density\ (g/cm^3) = \frac{Oven\ dry\ mass(g/cm^3)}{Core\ volume\ (cm^3) - \left(\frac{Mass\ of\ coarse\ fragments\ (g)}{Density\ of\ rock\ fragments\ (g/cm^3)}\right)}$$

b) Estimation of Organic Carbon: The organic matter (humus) in the soil gets oxidized by chromic acid (potassium dichromate plus concentrated sulphuric acid) utilizing the heat of dilution of sulphuric acid. The untreated chromate is determined by back titration with ferrous ammonium sulphate (redox titration).

Reagents Required:

(i) 1N potassium dichromate (49.04g of AR grade, potassium dichromate per liter of solution)

(ii) 0.5N (approx.) ferrous ammonium sulphate (196 g of the hydrated crystalline salt per litre containing 20 ml of concentrated sulphuric acid). This solution is relatively more stable and convenient to work than that of ferrous sulphate.

(iii) Diphenylamine indicator: 0.5g diphenylamine dissolved in a mixture of 20 ml of distilled water and 100 ml of concentrated sulphuric acid.

(iv) Concentrated sulphuric acid (sp.gr 1.84) containing 1.25 per cent silver sulphate (in case of soils free from chloride use of silver sulphate can be avoided)

(v) Ortho-phosphoric acid (~0.5%) and sodium fluoride (chemically pure).

Fig. 4.11. Preparations of soil samples for laboratory analysis

Procedure: The soil is ground and completely passed through 0.2 mm sieve and 1.00 g is placed at the bottom of a dry 500 ml conical flask (Corning Pyrex). 10 ml of IN potassium dichromate is pipetted in and swirled a little. The flask is kept on asbestos sheet. Then 20 ml of sulphuric acid (containing 1.25 % silver sulphate) is run in and swirled again two or three times. The flask is allowed to stand for 30 minutes and thereafter 200 ml of distilled water is added. Add 10 ml of ortho phosphoric acid, 0.5g sodium fluoride and 1 ml of diphenylamine indicator. The contents are titrated with ferrous ammonium sulphate solution till the colour flashes from blue-violet to green. A combination of ortho phosphoric acid and sodium fluoride is found to give a sharper end point. Simultaneously a blank is run without soil. If more than 7 ml of the dichromate solution is consumed the determination must be repeated with a smaller quantity (0.25-0.5g) of soil.

Calculation:

$$\text{Organic carbon (\%)} = 10(B\text{-}T)/B*0.003*(100/\text{wt. of soil})$$

Where B=volume (in ml) of ferrous ammonium sulphate solution required for blank titration; and T=volume of ferrous ammonium sulphate needed for soil sample.

4.7 Estimation of Total Carbon Stocks from all the Pools

After calculating the biomass (t/ha) from the project area the total carbon stock from the complete project area can be calculated by using the following steps:

- First of all divide the calculated biomass (t/ha) by two to get the values in tonnes of carbon per hectare. Further, the carbon stock for living and standing dead trees, above and belowground, can be calculated directly at the plot level. The carbon stocks for the different components should be summed within plots to give per plot carbon stock in tC/ha by using following equation:

Total carbon stock per ha (tC/ha) Cha = $C_L + C_{DOM} + C_{Soils}$

Where,

C_L = Carbon removals by sinks in living biomass (includes above and belowground biomass) (tC/ha)

C_{DOM} = Carbon removals by sinks in dead organic matter including litter (tC/ha)

C_{Soils} = Carbon removals by sinks in soils (tC/ha)

- The plot level results are then averaged to give mean for the stratum. The carbon stock of living biomass (tC/ha) for baseline (C_{LB}) and project area (C_{PLB}) are calculated.
- Where soils, dead wood, forest floor and non-tree vegetation are included, they have to be calculated differently and averaged to obtain mean for the stratum as carbon stock in tC/ha. The carbon stock for dead organic matter under baseline (C_{DOM}) and project area (C_{PDOM}); and for soil organic carbon under baseline (C_{Soils}) and for project area (C_{PSoils}) are calculated.
- If the project were divided into multiple strata then each would be calculated separately. For e.g. plantations on fallow lands and community wastelands could be treated separately.
- The carbon stocks per unit area are then multiplied by the area of the project or entity to produce an estimate of the total carbon stock (tC).

4.8 Application of Remote Sensing and Geographic Information System in MRV

Remote sensing provides a method for determining biomass through a combination of remote sensing data and field measurement to provide accurate and cost effective estimation of biomass across varied forest types. Project developers must be able to obtain remotely acquired satellite data covering the area of interest. Accurate data on past Land Use Land Cover (LULC) of the project area must be available in accordance with the requirement of the methodology adopted for the project.

Land use land cover analysis: Estimating the area and delineating the boundary of land-use category for the REDD+ project is the first basic step. The Forest land-use categories form the basis of estimating and reporting greenhouse gas emissions and removals from land use and land-use conversions. The categories and sub categories can be stratified by climate, soil, ecological zone, management system, forest type and density. The minimum mapping unit for LULC classes must be less than 1 ha. IPCC (2006) defines the following land-use categories for greenhouse gas inventory reporting:

(i) Forest Land: This category includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category.

(ii) Cropland: This category includes cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category.

(iii) Grassland: This category includes rangelands and pasture lands that are not considered cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, consistent with national definitions.

(iv) Wetlands: This category includes areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peatlands) and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division

and natural rivers and lakes as unmanaged sub-divisions.

(v) Settlements: This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions.

(vi) Other Land: This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available. If data are available, countries are encouraged to classify unmanaged lands by the above land-use categories (e.g., into Unmanaged Forest Land, Unmanaged Grassland, and Unmanaged Wetlands). This will improve transparency and enhance the ability to track land-use conversions from specific types of unmanaged lands into the categories above.

4.9 Baseline

The historical rates of all LULC classes and forest strata transitions must be calculated on the union of reference region, leakage area, and project area based on a remote sensing analysis. Carbon stock will change due to natural and/or anthropogenic activities in the project area. A baseline will be developed for the project against which project results can be compared and additional benefits will be estimated.

4.10 Forest Stratification

Forests will be separated into homogenous strata depending on the type and density so that the variation within each stratum is minimized. Samples can then be taken from each stratum to obtain a more efficient estimate of the total population. Stratification reduces the sampling error and sampling effort.

4.11 Sampling Design

Sampling design aims at locating the sample points in each of the selected stratum. Sampling includes deciding on the number, size and shape of the plots. It is crucial to measuring and monitoring carbon stock changes. The determination of the sample size (number of sampling plots) required per forest strata is dependent on the required. A carbon inventory based on appropriate sampling can yield reliable estimates at a limited cost and human effort. Sampling enables conclusions to be drawn about an entire population by observing only a portion of it. Sampling theory provides the means for scaling up information from the sample plots to the whole project area or even to a regional and national level (IPCC, 2003).

4.12 Permanent Sample Plot

Permanent sample plots are generally regarded as statistically more efficient in estimating changes in forest carbon stocks compared to temporary plots because typically there is high covariance between observations taken at successive sampling events in temporary plots. Permanent sample plots will be established for the assessment and monitoring of carbon stocks in the project area**.** Sample plots of 0.1 ha plot will be laid in the project zone to estimate the carbon stocks.

4.13 Identification of Drivers of Deforestation and Forest Degradation

Drivers of deforestation and forest degradation need to be identified that are present in the project area. A quantitative estimation of the drivers should be done to estimate the absolute annual carbon loss per driver. The relative contribution of each driver to the total carbon loss from deforestation and forest degradation should be calculated based on GPG-LULUCF (IPCC, 2003). Forests have been facing pressure due to grazing, fuelwood collection, medicinal and aromatic plant collection, forest fires, illegal felling etc. Drivers of deforestation or forest degradation must be mitigated through specific project activities. Some activities for example may focus on providing alternatives sources of energy to address the fuel wood collection or providing efficient cooks stoves to reduce the dependency on the fuel wood. Fodder species with high nutrient contents may be planted as a source of fodder for animals. Success of the implementation and on-going maintenance of these activities is dependent on the active involvement of all stakeholders in the planning and execution of these project activities. The *ex ante* estimation of the deforestation and forest degradation rate is based on a breakdown of the effectiveness of every project activity in decreasing any driver of deforestation and/or forest degradation as well as relative to that driver's contribution to deforestation and forest degradation collectively known as effectiveness. The effectiveness values are often challenging to quantify, and depend on local conditions and the experience.

4.14 Leakage Analysis

Leakage from drivers is estimated *ex-ante* by calculating deforestation and forest degradation rates in the area adjacent to the project area subject to leakage. Demarcation of the location and the size of the leakage belt using GIS will be helpful in monitoring. The relative impact of leakage is quantified by *ex ante* leakage cancellation factors, which express the driver-specific relative amount of leakage for the amount of deforestation or degradation that is avoided. Leakage analysis will be carried out in the leakage belt area having the chance when forest carbon activities directly cause carbon emitting activities to be shifted to another location outside of the project boundaries.

4.15 Estimation of Net Emission Reduction and Removals (NERs)

Ex ante NERs are calculated for every year of the crediting period. NERs are re-validated at every baseline update (*i.e.* 10 years). Certified units generated each year can be calculated by the incremental increase from baseline scenarios in the carbon stock from the project area.

4.16 Monitoring Plan

GHG information system will be established for obtaining, recording, compiling and analyzing data and information important for quantifying and reporting GHG emissions and/or removals relevant for the project (including leakage) and baseline scenario.

4.17 Reporting

Reporting means providing information about estimated emissions and removals, estimation methods, procedures, and systems, including present conditions and future projections in accordance with the prescribed reporting guidelines, formats and procedures, to designated organizations. Reporting enables comparison of emission reductions and removals and ensures transparency (FFPRI, 2010).

4.18 Verification

Verification in the context of MRV of greenhouse gas emissions and removals is a procedure for assessing and ensuring, from an independent standpoint, the reliability of the reporting of estimations, and the adequacy of methods, procedures, and documentation. The verification in the REDD+ project is a part of *ex-post* assessment process that confirms that the emission reductions that the project has attained and reliability of the carbon credits. Verification will be done by a third party to confirm that the project has been conducted as prescribed in the project plan.

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Sports

Annexure I

List of important COP decisions related to REDD+

S. No.	Decision No.	Title
1.	1/CP.13	Bali Action Plan
2.	2/CP.13	Reducing emissions from deforestation in developing countries: approaches to stimulate action
3.	2/CP.15	Copenhagen Accord
4.	4/CP.15	Methodological Guidance for REDD+
5.	1/CP.16	The Cancun Agreements: Outcome of the work of the *Ad Hoc* Working Group on Long-term Cooperative Action under the Convention
6.	2/CP.17	Outcome of the work of the *Ad Hoc* Working Group on Long-term Cooperative Action under the Convention.
7.	3/CP.17	Launching the Green Climate Fund
8.	12/CP.17	Guidance on systems for providing information on how safeguards are addressed and respected and modalities relating to forest reference emission levels and forest reference levels as referred to in decision 1/CP.16
9.	1/CP.18	Agreed outcome pursuant to the Bali Action Plan
10.	17/CP.18	Composition, modalities and procedures of the team of technical experts under international consultations and analysis
11.	9/CP.19	Work programme on results-based finance to progress the full implementation of the activities referred to in decision 1/CP.16, paragraph 70
12.	10/CP.19	Coordination of support for the implementation of activities in relation to mitigation actions in the forest sector by developing countries, including institutional arrangements
13.	11/CP.19	Modalities for national forest monitoring systems
14.	12/CP.19	The timing and the frequency of presentations of the summary of information on how all the safeguards referred to in decision 1/CP.16, appendix I, are being addressed and respected
15.	13/CP.19	Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels
16.	14/CP.19	Modalities for measuring, reporting and verifying
17.	15/CP.19	Addressing the drivers of deforestation and forest degradation

Annexure II

Plot Description Form

Name of Division: …….. Date: …….. Time: ……..

S. No.	Description	Inputs			
1	Quadrat No.				
2	Range				
3	Block				
4	Compartment				
5	Grid				
6	Latitude				
7	Longitude				
8	Altitude				
9	Identification Point of Plot	Locality	Landmark	Distance from Road (km)	Nearby Village
10	Legal Status	Reserve Forest ☐	Protected Forest ☐	Community Forests ☐	
11	Forest Type	Forest Type Group:			
		Sub Forest Type:			
12	Land Use	Closed Forest ☐	Dense Forest ☐	Open Forest ☐	Scrub ☐
13	Slope				
14	Aspect				
15	Rockiness and Type of the Rocks				
16	Humus	Shallow ☐	Medium ☐	Deep ☐	No Humus ☐
17	Forest Structure and Storey	Storey	Tree Species		
		Upper Storey			
		Middle Storey			
		Lower Storey			
18	Dominant Tree Height				
19	Regenerating Tree Species				
20	Regeneration Status	Adequate ☐	Inadequate ☐	Absent ☐	
21	Fire Incidence	Heavy ☐	Moderate ☐	Light ☐	None ☐
22	Presence of Grasses	Very Dense ☐	Dense ☐	Moderate ☐	Scanty ☐ Absent ☐
23	Plantation	Present ☐	Absent: ☐		
		Approx Area: Year of Plantation: Species: General Growth Condition: Any activity happened/happening related to Plantations:			

24	Drivers of Degradation	Biotic	Heavily Degraded	Moderately Degraded	Slightly Degraded	No Calamities
		Grazing				
		Browsing				
		Fire				
		Lopping/Pollarding				
		Girdling				
		Illegal Felling				
		Encroachment				
		Natural Calamities				
		Landslides				
		Any other				
25	Faunal Sighting, if any			Species		
		Mammals				
		Birds				
		Reptiles				
		Amphibians				
26	Tree – DBH and Height Measurements (31.62m X 31.62m Central Plot/Lateral Plot) Plot No.: ……					

S. No.	Species Name		DBH (cm)	Height (m)
	Common Name	Botanical Name		
1				
2				
3				
4				
5				

27	Shrub and Regeneration (3m X 3m Plot)						
	S. No	Species Name		Collar dia at base (cm)	DBH (cm) if any	Height (m)	Remarks, if any, about the conditions of shrub vegetation.
		Botanical Name	Local Name				
	Plot No. …….. Sub Plot No: ……..						
	1						
	2						
	3						
	4						
	5						
	Plot No. …….. Sub Plot No: ……..						
	1						
	2						
	3						
	4						
	5						
	Plot No.: ……..						
	1						
	2						
	3						
	4						
	5						
	Plot No. …….. Sub Plot No: ……..						
	1						
	2						
	3						
	4						
	5						
	Plot No. …….. Sub Plot No: ……..						
	1						
	2						
	3						
	4						
	5						

28	Herbs and Seedlings (1m X 1m Plot)				
	S.No.	Species Name		Height (m)	Remarks, if any, about the condition of herbal vegetation
		Botanical Name	Local Name		
	Plot No. ……………………….. Sub Plot No: ………………………..				
	1				
	2				
	3				
	4				
	5				
	Plot No. ……………………….. Sub Plot No: ………………………..				
	1				
	2				
	3				
	4				
	5				
	Plot No. ……………………….. Sub Plot No: ………………………..				
	1				
	2				
	3				
	4				
	5				
	Plot No. ……………………….. Sub Plot No: ………………………..				
	1				
	2				
	3				
	4				
	5				
	Plot No. ……………………….. Sub Plot No: ………………………..				
	1				
	2				
	3				
	4				
	5				
29	Litter Sample Collection				
	Sample No: …………………. Fresh Weight: ………………………. Sample No: …………………. Fresh Weight: ………………………. Sample No: …………………. Fresh Weight: ……………………….				

30	Soil Sample Collection								
	Erosion	Slightly ☐	Moderate ☐	Severe ☐	Gullied ☐				
	Physiographic	Hill Top ☐	Hill slope ☐	Plateau ☐	Plain ☐	Valley ☐			
	Moisture	Wet ☐	Moist ☐	Dry ☐					
	Soil Sample for Moisture	Sample No: ..... Fresh Weight: ..... Sample No: ..... Fresh Weight: ..... Sample No: ..... Fresh Weight:							
	Area covered by rock outcrops in 5m X5m area: .....%								
	Soil Sample No.Carbon Estimation:.....	Soil Sample No. Bulk Density 0-10 cm:.....	Soil Sample No. Bulk Density 10-20 cm:.....	Soil Sample No. Bulk Density 20-30 cm:.....					

Sample Collected By: .....

Date: .....

Guidelines for filling of Information/observations
Extracted from manual for National Forest Inventory of India, FSI, 2002*

Heading	Item	Particulars
Legal Status	Reserve Forest	An area so constituted under provisions of Indian Forest Act 1927 or State Forest Acts, having full degree of protection. In reserve forest all activities are prohibited unless permitted
	Protected Forest	The area notified under provisions of Indian Forest Act 1927 or State Forest Acts, having full degree of protection. In protected forest all activities are permitted unless prohibited.
	Community Forest	Forest Land owned by the indigenous communities of a particular area will come under this category.
Land Use	Closed Forest	All forest with a forest cover of trees with canopy density of 70-100% and above (Canopy density is defined as the relative completeness of canopy expressed as percentage taking closed as 100. Standing in a plot or in area around it observe the tree growth and assess the percentage of the space covered)
	Dense Forest	All lands with a forest cover of trees with canopy density 40-68%
	Open Forest	All lands with a forest cover of trees with canopy density 10-39%
	Scrub	Inferior tree growth chiefly of small or stunted trees. With Canopy density less than 10%.
Rockiness	High	When more than 80% area is covered by rock.
	Medium	When 30-80% area is covered by rock
	Low	When less than 30% area is covered by rock
	No rock	Rock Absent and entire land surface is available for tree growth
Humus	Shallow	When humus is less than 5 cms thick
	Medium	When the thickness of humus layer is from 5 cms to under 10 cms
	Deep	When the thickness of humus layer is 10 cms and more
	No Humus	When the humus layer is absent.
`Canopy Layer or Storey	No Storey	Crop is absent or found young and canopy formation has not taken place.
	One Storied forest	A small height variation may exist even in one storied forest
	Two Storied	Variation in canopy layers distinguishable into upper and lower storey
	Three or more storied forest	The variation in height is very large and in most cases it is not possible to group the trees in canopies.
Dominant Tree Height		The average height of dominant trees occurring in the plot or its surround of 2 ha. area will be estimated. The estimated height will be checked by measuring a few trees say 2-3 trees and average height will be recorded in the nearest metre.
Regeneration Status	Adequate	18 or more seedlings
	Inadequate	Less than 18 seedlings
	Absent	No. Seedlings

Fire Incidences	Heavy	When more than 50% of area is affected by fire
	Moderate	When 10-50% of the area is affected by fire
	Occasional	When less than 10% of the area is affected by fire
Presence of Grasses	Very Dense	Where more than 50% of the surface is covered by grass
	Dense	Where 25-50% of the surface is covered by grass
	Moderate	Where 10-25% of the surface is covered by forest
	Scanty	Where less than 10% of the surface is covered by grass
	Absent	No Grass

*FSI (2002). The Manual of Instructions for Field Inventory. FSI, Dehradun (http://fsi.nic.in/documents/manualforest_inventory_2.pdf).

Annexure III

Questionnaire for Household Survey
Socio-Ecological Survey of Villages adjoining Forest

General:

1. Questionnaire No. ..... 2. Date: .....
3. Village Name: .....
4. GPS Location: Lat: .....º.....'.....'' N Long: .....º.....'.....'' E
5. Identification Mark: .....
6 Altitude :.....(m) amsl

Household Specific:

7. Name of Respondent: .....
8. Age: ..... years 9. Sex: M ☐ F ☐
10. Education: Illiterate ☐ Primary ☐ High School ☐ Intermediate ☐ Bachelor and above ☐
11. Religion: ..... 12. Caste: .....
13. Language spoken : .....
14. What type of house do you have?

a) Mud/thatch b) Brick c) Cement
d) Wood e) Any other .....

15. Number of individuals in family by age:

Age	Males	Females	Total
Adult (above 18yrs)			
Children (below 18yr)			
Children (below 8 yrs)			
Total No. of family members =			

16 Family Education Status:

Educational Level	Illiterate	Primary	High School	Intermediate	Bachelor	Any Other
Male						
Female						

17. Main Source of Income:

Agriculture ☐ Service ☐ Self Employed ☐ Any Other .....
Approximate Income (Rs.).....

Livestock Resources:

18. Specify the availability, number and uses of livestock:

	Y/N	Numbers	Used for?
Cows			
Buffaloes			
Ox			
Sheep			
Goats			
Chicken			
Horses			

Mule			
Any other			

19. Fodder Collection– Record number of men/women/children who collect fodder, and specify other details

From where do you Collect Fodder?	Own field ☐ Forest ☐ Community Forest ☐ Any Other .....
Amount of Fodder Collected (kg/day)	
Amount of Fodder Consumed (kg/day)	
Who collects the fodder?	Male ☐ ..... Female ☐ ..... Children ☐ .....
Time spent for collection of fodder (per day)	
Distance traveled for fodder collection (km)	

Grazing:

20 Animals go for grazing: (Y/N) ..... where: .....

21. Animals graze for how long? (Hour/day) .....

22 How much quantity of vegetation animals grazes in the field: .....

.....

Forest Resources:

23. Species (plants sp.) used for food?

Common Name	Botanical Name	Useful Plant Part	Source

24. Species used for Medicinal purposes?

Common Name	Botanical Name	Useful Plant Part	Source

25. Species are used for Timber Extraction?

Common Name	Botanical Name	Source

26. Species are used for fodder?

Common Name	Botanical Name	Source

27. Species are used for fuelwood?

Common Name	Botanical Name	Source

28. Animal Diversity in the area?

Common Name	Zoological Name	Remark

29. Bird Diversity in the area?

Common Name	Zoological Name	Remark

Agricultural Resources:

30. Do you own land? Y/N: ..... If yes, how much land do you own? .....

31 .Agriculture Practices:

Crop	Area (unit location specific)	Cropping season (Kharif/Rabi)	Mode of irrigation

32. Agriculture Inputs:

	Quantity	Monetary input
Seed		
Chemical Fertilizers		
Manure		
Pesticides		
Labour		
Others		

33. Agriculture Outputs:

Crop	Production	Self Consumption	Sold in Market	Income from agricultural Practices

Energy Resource:

34: Mode of Fuel Used (Tick as per below):

Purchased wood ☐ Coal ☐ Cow dung ☐ Electric Appliances ☐

Cooking Gas ☐ Bio (Gobar) Gas ☐ Wood collected from forest ☐

Agricultural Residue ☐ Any Other.....

35. Fuel Wood Collection – Record number of men/women/children who collect fuel wood, and specify other details –

From where do you collect fuel wood?	Own field ☐ Forest ☐ Community Forest ☐ Any Other .....
Amount of fuel wood Collected (kg/day)	
Amount of fuel wood Consumed (kg/day)	
Who collects the fuel wood?	Male ☐ No. ..... Female ☐ No.....
Time spent for collection of fuel wood (per day)	
Distance traveled for fuel wood collection (km)	
Which species are preferred?	
In which season the collection of fuel wood is maximum	
Remarks:	

Forest Fires:

36. Is there any forest fire event reported in the forest: .....

37. How much area is affected by the forest fires: .....

38. What are the areas affected by forest fires:.....

39. What are the causes of forest fire: .....

40. Measures adopted to control the spread of fires: .....

Timber Logging:

41. Is there logging of timber: (Y/N) ..... If Yes, (tick purpose as below)

Commercial Sale ☐ Local Enterprises ☐ Domestic Use ☐ Any Other.....

42 Source of timber: Forest ☐ Community Forest ☐ Own Land ☐

43 Amount of timber logged per month: .....

44 Use of Timber Extracted .....

45. Any other remarks?

.....

.....

.....

46. Understory Collection for Manuring and Bedding

From where do you collect Understorey Vegetation?	Own field ☐ Forest ☐ Community Forest ☐ Any Other .....
Amount of Understorey Vegetation (kg/day)	
Who collects the Understorey Vegetation?	Male ☐ No. ..... Female ☐ No.....
Time spent for Understorey Vegetation (per day)	
Distance traveled for Understorey Vegetation (km)	
Which plant species are preferred for collection	
Remarks:	

Name of the Investigator: .....

Signature of the Investigator:.....

.....

Thumb Impression/Signature of the Respondent (Optional):

Date: .....

Annexure IV

Quality Assurance/ Quality Control

Those responsible for aspects of data collection and analysis should be fully trained in all aspects of the field data collection and data analyses. Standard operating procedures should be followed rigidly to ensure accurate measurement and re-measurement.

Quality Assurance

Data collection in field **:** During all data collection in the field, proper care should be taken to enter the data in the forms. In addition, all data sheets should include the name of the data collector responsible for recording data. After data is collected at each plot and before the field worker leaves the plot, double checking should be conducted to make sure that all data are correctly and completely filled.

Data sheet checks **:** At the end of each day all data sheets must be checked to ensure that all the relevant information was collected. If for some reason there is some information that seems odd or is missing, mistakes can be corrected the following day. Data sheets shall be stored in a dry and safe place while in the field.

Field data collection Hot Checks **:** After the training of field workers has been completed, observations of each member should be made. A lead coordinator shall observe each member during data collection of a field plot to verify measurement processes and correct any errors in techniques.

Any errors or misunderstandings should be explained and corrected. These types of checks should be repeated throughout the field measurement campaign to make sure incorrect measurement techniques have not started to take place.

Data Entry checks **:** To ensure that data is entered correctly, the person entering data (whether during fieldwork or after a return to the office) will recheck all of the data entered and compare it with the original hard copy data sheet before entering another sheet. Field members have a good understanding of the field sites visited, and can provide insightful assistance regarding potential unusual situations identified in data sheets. Communication between all personnel involved in measuring and analyzing data should be used to resolve any apparent anomalies before final analysis of the monitoring data can be completed. If there are any problems with the plot data (that cannot be resolved), the plot should not be used in the analysis.

Quality Control

Field measurement error estimation **:** A second type of field check is used to quantify the amount of error due to field measurement techniques. To implement this type of check, a complete re-measurement of a number of plots by people other than the original field worker is performed. Plots should be randomly or systematically chosen to be re-measured. Where clustered plots are used, all plots within a selected cluster shall be measured. All trees shall be re-measured in each plot. Field workers taking measurements should not be aware of which plots will be re-measured whenever possible.

Data Entry quality control check **:** After all data has been entered into computer file(s), a random check shall be conducted. Sheets shall be selected randomly for re-checks and compared with data entered for consistency and accuracy in data entry. Personnel experienced in data entry and analysis will be able to identify errors especially oddly large or small numbers. Errors can be reduced if the entered data is reviewed using expert judgment.

Glossary

Additionality	:	Emission reduction or removals that's has been achieved additionally in absence of any registered project activity or without any further project activity.
Afforestation	:	Planting of new forests on lands that historically have not contained forests.
Baseline	:	The carbon stock projections for the project area in the absence of the project. The carbon stock changes during project implementation are useful in demonstrating additionality. In case there is no natural regeneration in the project scenario, the baseline can be assumed to be constant as before project implementation
Carbon pool	:	"Pool", means a reservoir and a system which has the capacity to store or release carbon is known as carbon pool.
Carbon Stock	:	The sum of all the quantities of carbon contained in different carbon pools of any ecosystem.
Climate Change	:	United Nations Framework Convention on Climate Change, in its Article 1, defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".
Climate Variability	:	Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability)
Ecosystem Services	:	The benefits people obtain from the ecosystem are called as Ecosystem Services. According to Millennium Ecosystem Assessment classification, the services can be classified as provisioning services where goods are produced and provided by the ecosystem like food, water, fibre, etc.; regulating services, as benefits are obtained from regulation of the ecosystem processes. Climate regulation, flood control, water purification are some of the examples of regulating services; the non-material benefits from the ecosystem such as aesthetics, spiritual, educational, recreational services, etc. are the cultural services provided by the ecosystem that enrich the quality of life; most important services of the ecosystem are the supporting services that are needed to produce all other services like nutrient cycling, soil formation and primary productivity in the ecosystem.

Equivalent Carbon Dioxide (CO_2) Emission : The amount of carbon dioxide emission that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a well-mixed greenhouse gas or a mixture of well-mixed greenhouse gases. The equivalent carbon dioxide emission is obtained by multiplying the emission of a well-mixed greenhouse gas by its Global Warming Potential for the given time horizon. For a mix of greenhouse gases it is obtained by summing the equivalent carbon dioxide emissions of each gas. Equivalent carbon dioxide emission is a standard and useful metric for comparing emissions of different greenhouse gases but does not imply the exact equivalence of the corresponding climate change response

Forest Degradation : The United Nations Environment Programme defines a degraded forest as: a secondary forest that has lost, through human activities, the structure, function, species composition or productivity normally associated with a natural forest type expected on that site. Hence, a degraded forest delivers a reduced supply of goods and services from the given site and maintains only limited biological diversity. Biological diversity of degraded forests includes many non-tree components, which may dominate in the under-canopy vegetation. The IPCC defines forest degradation as: a direct human induced loss of forest values (particularly carbon), likely to be characterized by a reduction of tree cover. Routine management from which crown cover will recover within the normal cycle of forest management operations is not included.

Forest Management : It refers to the management (or sustainable management, as opposed to destructive logging) of existing forests, in the context of a carbon project, usually in order to enhance carbon stocks in the forest. This is different from afforestation and reforestation, although it equally represents a sink activity. Forest Management is not eligible under the Clean Development Mechanism but is eligible under Joint Implementation.

Greenhouse Gases (GHGs) : Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect.

Leakages : Leakages in a forestry mitigation project can result from unaccounted extraction from the project site, induced deforestation outside the project boundary, incomplete inclusion of carbon pools in baseline calculation, emission from which may occur during the project's lifetime

Measurement : It refers to the fact that accurately measuring the amount of carbon stored in forests and forest soils is extremely complex – and prone to large errors.

Mitigation : A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Monitoring : refers to the collection and archiving of all relevant data necessary for determining the baseline and project-based measuring of anthropogenic emissions by sources (or sinks) of GHG within the project boundary (and leakage of emissions).

Project Design Document (PDD) : PDD is the key document involved in the validation and registration of a project activity.

Reference Level : Reference levels are expressed as tonnes of CO_2 equivalent per year for a certain period known as reference period against which the emissions and removals from a results period will be compared.

Reforestation	:	Planting of forests on lands that have previously contained forests but that have been converted to some other use.'
Resilience	:	It is the capacity of an ecosystem to return to a former state after a disturbance sufficiently large enough to alter the system in some way (e.g., fire).
Sink	:	Any process, activity or mechanism that removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol from the atmosphere.
Source	:	Any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol into the atmosphere.
Sustainable forest management (SFM)	:	It is a dynamic and evolving concept that aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. SFM considers seven thematic elements: (i) extent of forest resources; (ii) forest biological diversity; (iii) forest health and vitality; (iv) productive functions of forest resources; (v) protective functions of forest resources; (vi) socioeconomic functions of forests; and (vii) legal, policy and institutional framework.
The Intergovernmental Panel on Climate Change (IPCC)	:	It is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts
United Nations Framework Convention on Climate Change (UNFCCC)	:	The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."
Verification	:	refers to the process in which a recognized independent third party must confirm that claimed emissions reductions have occurred. This is a precondition for the issuance of carbon credits (e.g., for Clean Development Mechanism projects) by the UNFCCC.
Voluntary Markets	:	are markets outside regulatory carbon markets and do not involve international agreements. They are driven by voluntary commitments from organizations (e.g., energy companies, airlines) and individuals.

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