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Criteria and Indicators framework to measure the sustainability of forest resources in India and their contribution to SDGs and GFGs

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Abstract

The concept of sustainable development (SD) cohesively argued to present a satisfactory resolution to the environmental vs. development dilemma in the UN Conference on Human Environment held in Stockholm (1972) and very succinctly elaborated in "Our Common Future" the report of the World Commission on Environment and Development (1987). Having been adopted as Agenda 21 at the Earth Summit (1992), the global community re-affirmed its commitment to SD at the World Summit on Social Development in Copenhagen (1995), the World Summit on SD in Johannesburg (2002) and at Rio +20 in 2012. The outcome at Rio+20 was documented as "The Future We Want" into a set of SDGs (Sustainable development Goals) also known as the Agenda 2030. The efforts were also made to integrate the SDGs into sustainable management of world's forest at UNFF. These efforts fructified into the UN General Assembly in 2017 adopting a set of six Global Forest Goals (GFGs) and 26 associated targets to be reached by 2030, which are voluntary and universal and in sync with the SDGs.

The criteria and indicators (C&I) approach for Sustainable Forest Management (SFM) provides a framework for monitoring, assessment and reporting of part of the SDGs and GFGs. Considering the C&I approach as a potent tool, country's across the world adopted the same in realizing these global goals for sustainable management of their forest resources. As a result eleven regional and international initiatives on C&I approach for SFM have emerged. One of these initiatives is Dry Forests in Asia, a regional initiative for the development and implementation of national-level C&I for the sustainable management of dry forests in Asia (also known as the India-Bhopal Process).

India developed its national set of C&I into 8 criteria and 37 indicators. These were then adopted and integrated into its national forest planning process at Forest Management Unit (FMU) level through National Working Plan Code (NWPC) 2014. Following the adoption of NWPC 2014, as a logical next step the country now needs to create a system of national monitoring and evaluation of implementation and achievements of SFM and to integrate it into the SDGs and GFGs.

The proposed paper is an attempt to evolve a set of indicators to measure the contribution of forests in achieving the relevant targets within the SDGs. The baseline information / data when compared with the observed values of the identified indicators, would facilitate in quantifying the change in the forestry conditions. Such analysis is important for interpretation, measuring and monitoring the sustainability of forest resources and to evaluate the contribution towards relevant SDGs and GFGs at the country level. The C&I framework provides an opportunity to develop and adopt globally accepted format for consistency and standardized reporting.

Keywords: Criteria and indicator, Bhopal-India Process, Sustainable Forest Management

Introduction

Sustainable Forest Management (SFM) is described by the United Nations as “a dynamic and evolving concept [that aims] to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations” (General Assembly 2007). It is widely discussed and accepted that the SFM is considered as integral part of Sustainable Development (SD). International Tropical Timber organization (ITTO) came-up with Criteria and Indicators (C&I) approach for SFM quite before the United Nations Conference on Environment and Development (UNCED) Earth Summit organized in 1992. Post-earth summit, countries all over the globe initiated development of C&I approach for achieving SFM. Eleven major regional and international processes have been developed so far representing different forest areas across the world (Linser et al., 2018). These C&I Processes are –

- the International Tropical Timber Organization (ITTO)’s C&I for the sustainable management of tropical forests; (March 1992)
- the Pan-European Forest Process on C&I for SFM under the Ministerial Conference for the Protection of Forests in Europe, known also as FOREST EUROPE (June 1993);
- the Montréal Process on C&I for the conservation and sustainable management of temperate and boreal forests (February 1995);
- the Amazon Cooperation Treaty Organization (ACTO) Tarapoto Process on C&I for the Sustainability of Amazon forests, recently renamed the “process of harmonized C&I of ITTO–ACTO (Tarapoto) for the sustainability of the Amazon forests” (February 1995);
- the Association of Southeast Asian Nations (ASEAN) C&I for the sustainable management of tropical forests in Southeast Asia (July 2000);
- the Low Forest Cover Countries Process, also known as the Tehran Process (March 2002);
- the African Timber Organization (ATO)/ITTO C&I process (May 2001);
- the Dry-Zone Africa Process on C&I for the sustainable management of dry-zone forests in sub-Saharan countries (November 1995);
- the Near East and North Africa (NENA) Process on C&I for sustainable management of Dry-zone forests (October 1996);
- the Lepaterique Process of Central America on C&I for SFM (January 1997); and
- the Dry Forests in Asia Regional Initiative for the development and implementation of National-level C&I for the sustainable management of dry forests in Asia (also known as the Bhopal-India Process) (December 1999).

The C&I approach is a globally recognized framework that provides an opportunity to countries concerned to accommodate the ground realities for monitoring, assessment and reporting (MAR) of each identified indicators. C&I approach is a commonly recognized appropriate tool for defining, monitoring, reporting, and assessing progress towards achievement of SFM (Caswell et al., 2014; Baycheva et al. 2013; Linser, 2002; Linser and Wolfslehner, 2015; Linser, 2017; Raison et al. 2001; Mendoza and Prabhu, 2003; Siry et al., 2005; UNECE 2014; Wolfslehner et al. 2014).

The periodic assessment of forests through the C&I framework can facilitate in measuring the achievement of Sustainable Development Goals (SDGs) and Global Forest Goals (GFGs).

2. Dry Forests in Asia Regional Initiative (Bhopal-India Process)

The Dry Zone Asia Initiative evolved in 1999 with participation from nine Asian countries viz. Bangladesh, Bhutan, China, India, Mongolia, Myanmar, Nepal, Sri Lanka, and Thailand. Since this initiative was started at Indian Institute of Forest Management (IIFM), Bhopal and in India, it was named as Bhopal-India Process (BI). Bhopal-India process has semblance with internationally recognized processes specifically the Dry Zone Asia and International Tropical Timber Organization (ITTO) initiatives on SFM. The criteria and indicators of Bhopal-India

Process have undergone revisions in the year 2005, which coincides with the revision of ITTO initiatives in 2005 (Linser et al., 2018).

2.1 The Indian C&I framework

Taking Bhopal-India C&I as a base, IIFM developed the national set of Criteria and Indicators for Sustainable Forest Management in India for the tropical forests in the country. The first set of national C&I was developed in the year 1999 and since then has gone for revisions and the most comprehensive set of C&I was developed in 2008 with 8 criteria and 37 indicators. These C&I integrate environmental, economic, social, and cultural values, extending well beyond the narrow consideration of the provision of wood products and making these sets unique in their holistic approach to sustainable forest management. (Kotwal et al., 2008).

Using the C&I approach, the present study attempts to measure the sustainability of forest resources in India and their contribution to specially the SDG 15 in the framework as recognized by the FAO (<https://www.fao.org/sustainable-development-goals/tracking-progress/en/>).

2.2 Measuring progress on SDG 15 through C&I approach

The sustainable development goal (SDG) 15 supports to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. The SGD 15 has 9 targets and 14 associated indicators. The C&I approach for SFM has been recognized globally as a potent tool for monitoring, assessment and reporting of direction of change towards sustainable management of forests. One of the indicator identified under the SDG 15 is ‘progress towards sustainable forest Management’. The C&I approach holistically encompasses the three pillars of sustainability e.g. ecological; economical; and socio-cultural aspects. Therefore, the C&I for SFM may address / contribute other associated goals of sustainable development. Thus, to begin with a C&I framework for SDG 15 has been attempted in the proposed research paper. However, this could be suitably extended to address other SDGs also.

The SDG 15 exclusively deals with the ‘Life on Land’. The five sub-indicators under Target 15.2 measure progress on the three dimensions of SFM (i.e. economic, social and environmental), while also considering the intergenerational equity into account (<https://www.fao.org/forestry/sfm/85101/en/>). The analysis of sub-indicator with respect to National Set of C&I for SFM in Indian context is discussed in the following section.

2.2.1 Forest area net change rate: monitors the rate at which forest area changes over time

Reporting of total natural forest area and its periodic monitoring would indicate the direction of change in the area under forest cover. In India, data of forest area are being compiled and published bi-annually by a Government of India institute namely Forest Survey of India. In addition, the information on tree cover outside the forest is also being compiled. The information on forest and tree cover in India and its changes over time is analyzed in table 1.

Table 1: Forest and tree cover and change over time in India

Year	Forest Cover (Sq km)	Percentage of total geographical area	Tree Cover (Sq km)	Percentage of total geographical area	Forest & Tree cover (Sq km)	Percentage of total geographical area	Change (in %)
2019	712249	21.87	95027	2.89	807276	24.56	0.17
2017	708273	21.54	93815	2.85	802088	24.39	0.23
2015	701673	21.34	92572	2.82	794245	24.16	0.15
2013	697898	21.23	91266	2.78	789164	24.01	Base year

Source: Status of Forest Report, Forest Survey of India

The increase in the extent of forest and tree cover in India is indicating positive change over the period from 2013 to 2019. The C&I framework provides an opportunity to understand the direction of change and equip

forest managers and administrators to suggest prescriptions for interventions/efforts within a timeframe. India's national set of C&I for SFM, has been incorporated in National Working plan Code 2014, a guiding document for preparation of Working Plans in the country, facilitate to assess, monitor and reporting of quality of forest as well. The intended situation is conversion of moderately dense forest to dense forest; open to moderately dense forest.

2.2.2 Proportion of forest area located in legally established protected areas: indicates the extent to which forest is managed for the protection and maintenance of biodiversity and other natural and cultural resources.

Protected Areas (PAs) contribute significantly in protection and conservation of biodiversity. The more area under PAs indicates keeping the natural area intact which in turn contributing for the sustainable management of forest.

The assessment based on C&I approach indicates the change in area under the PA from base year or the assessment year. This will facilitate the policy makers and custodian of the area to manage protected areas effectively for both qualitatively and quantitatively. The area declared as protected area within the total forest area in India is reported by the Wildlife Institute of India (WII). The data for the period 2000-2020 is analyzed in table2.

Table 2: Protected Areas (PAs) of India from 2000 to 2020 (As of December 2020)

Year	No. of National Parks	Area Under National Parks (km ²)	No. of Wild Life Sanctuaries	Area Under Wildlife Sanctuaries (km ²)	No. of Community Reserves	Area Under Community Reserves (km ²)	No. of Conservation Reserves	Area Under Conservation Reserves (km ²)	No. of PAs	Total Area under PAs (km ²)
2000	89	37803	485	108863	-	-	-	-	574	146666
2006	96	38392	503	111229	1	0	4	43	604	149665
2007	98	38429	507	111529	5	21	7	95	617	150074
2008	99	39442	510	113123	5	21	45	1260	659	153846
2009	99	39442	512	113395	5	21	45	1260	661	154118
2010	102	40284	516	113843	5	21	47	1382	670	155530
2011	102	40284	518	113999	5	21	52	1801	677	156105
2012	103	40500	526	114933	5	21	59	2013	693	157468
2013	102	40500	532	117124	19	31	64	2233	717	159887
2014	103	40500	535	118291	43	58	64	2233	745	161082
2015	103	40500	541	118866	44	60	71	2549	759	161975
2016	103	40500	543	118918	45	60	72	2566	763	162044
2017	103	40500	544	118932	46	73	76	2588	769	162092
2018	104	40501	544	118932	46	73	77	2594	771	162099
2019	101	40564	553	119757	163	833	86	3858	903	165013
2020	104	43716	566	122420	214	1302	97	4483	981	171921

Source: National Wildlife Database, Wildlife Institute of India (http://www.wiienvis.nic.in/Database/Protected_Area_854.aspx)

The area set-aside for the PAs in India has increased to 1,71,921 sq km from 146666 sq km during the period 2000 and 2020, which shows an increase of 18.9% from the base year or reporting year. The C&I framework not only indicates the change but enable the field foresters to assign weightage to associated indicators to achieve the desired goal.

2.2.3 Monitoring, assessment and reporting of sustainable forest management

Criteria and indicators framework provides an opportunity to monitor, assess and report progress of sustainable forest management both at the forest management unit (FMU) and at national level. As India has adopted SFM with National Working Plan Code 2014 evolved from the Bhopal-India process, the same can be used assessing the progress of its implementation through a system of data collection at FMU level and collation at the national level. Such a framework based on the current system of data availability in the country with their comparison in terms of value and description of the indicator is provided in the Table 3 along-with the direction of change over the last decade (2011-2019). Two additional indicators that are important in reporting on SDG15.2 and GFG1.3 are suggested in this table and the information for these is available at the national level.

Table 3: Compilation of data on Criteria and indicators of Bhopal-India Process for measuring progress towards SFM

Indicators	Value / data / description	Nature of indicator	Applicability																																				
CRITERION 1: MAINTENANCE / INCREASE IN THE EXTENT OF FOREST AND TREE COVER																																							
Indicator 1.1: Area of forests under different legal classes (RF, PF, UF and others)	Entire forest area is notified as Reserve Forest and Protected Forest. Area of the forest under different legal classes (Reserve Forest, Protected Forest, Un-classed Forest, Village Forest, etc.) along with number and date of notification for creation of reserve/protected forest is given; and mention is made of various forest settlements. Pending forest settlement work is also to be quantified.	Quantitative indicator and reporting may facilitate in demarcation of forest	National & FMU																																				
Indicator 1.2: Forest area under different working circle/ management plan	Range wise entire forest area is covered under Working Plan/ management plan	Quantitative indicator	FMU level																																				
Indicator 1.3 Percentage of forest with secured boundaries	Secures 100% of forest boundaries. The forest boundary can be natural or artificially created. Relatively more portion covered under natural boundary will indicated high degree of protection	Quantitative and indicator reflects the qualitative change	FMU level																																				
Indicator 1.4: Land use, land use change and forestry (LULUCF)	It is to be described here that the base year status of land use and forest cover is maintained or improved. Multi-dated satellite images may be used for change analysis and preparing change matrix. Change Matrix describes the change in land use, trees outside forests (TOF) and forest cover for the division over the period of last plan or such other period of two or more assessments by showing the extent of areas changing from one land use to another and one forest class cover to another between the two periods. Summary of changes occurred during last plan period may be given. Details will come in divisional area statement, including list of area (range wise / beat wise) diverted under FCA, FRA and also mention non-forest land/degraded forest given for compensatory afforestation under FCA, encroachments, etc.	Quantitative indicator and reporting may facilitate classification of area as per LULUC	FMU level																																				
Indicators 1.5: Threats to the forest	All other threats to the existence of forests	Qualitative indicator and reporting may facilitate in identification of threats and remedial measures	FMU level																																				
Indicator 1.6: Distribution of different forest types	The base year status of forest types along with GIS map may be referenced for any further change/shift.	Quantitative indicator	FMU level																																				
Indicator 1.7 Tree cover outside forest area	National scenario <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Type/ Category</th> <th>2011</th> <th>2013</th> <th>2015</th> <th>2017</th> <th>2019</th> </tr> </thead> <tbody> <tr> <td colspan="6" style="text-align: center;">Percentage of total geographical area</td> </tr> <tr> <td>Tree cover</td> <td>2.76</td> <td>2.78</td> <td>2.82</td> <td>2.85</td> <td>2.89</td> </tr> </tbody> </table> Source: Forest Survey of India	Type/ Category	2011	2013	2015	2017	2019	Percentage of total geographical area						Tree cover	2.76	2.78	2.82	2.85	2.89	Quantitative and indicator reflects the qualitative change	National & FMU																		
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Indicator 1.8: Shifting cultivation (Jhumming)	Jhumming is also a prevalent traditional agricultural practice in some parts of the country, especially in the north-eastern region. Details of the land tenure system, present status and sustainability of jhumming or shifting cultivation may be provided.	Qualitative indicator and reporting may facilitate management of landscape	FMU level																																				
Additional indicator: Change in area of forest cover - dense, open, scrub forests, pastures, deserts etc.	National scenario <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Type/ Category</th> <th>2011</th> <th>2013</th> <th>2015</th> <th>2017</th> <th>2019</th> </tr> </thead> <tbody> <tr> <td colspan="6" style="text-align: center;">Percentage of total geographical area</td> </tr> <tr> <td>Very dense</td> <td>2.54</td> <td>2.54</td> <td>2.61</td> <td>2.99</td> <td>3.02</td> </tr> <tr> <td>Moderately dense</td> <td>9.76</td> <td>9.70</td> <td>9.59</td> <td>9.38</td> <td>9.38</td> </tr> <tr> <td>Open forest area</td> <td>8.75</td> <td>8.99</td> <td>9.14</td> <td>9.18</td> <td>9.26</td> </tr> <tr> <td>Scrub</td> <td>1.28</td> <td>1.26</td> <td>1.26</td> <td>1.40</td> <td>1.41</td> </tr> </tbody> </table>	Type/ Category	2011	2013	2015	2017	2019	Percentage of total geographical area						Very dense	2.54	2.54	2.61	2.99	3.02	Moderately dense	9.76	9.70	9.59	9.38	9.38	Open forest area	8.75	8.99	9.14	9.18	9.26	Scrub	1.28	1.26	1.26	1.40	1.41	Quantitative and indicator reflects the qualitative change	National & FMU
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Non-Forest area	77.67	77.51	77.4	77.0	76.92				
Source: Forest Survey of India									
CRITERIA 2: MAINTENANCE, CONSERVATION AND ENHANCEMENT OF BIODIVERSITY									
Indicator 2.1 Forest composition and distribution	Based on the vegetation survey and forest inventory and compartment descriptions, a summary of important trees and other species found in the area with their floristic composition and condition (age class, health, and quality of the trees) is given. The effect of geology and soil; and climatic parameters (rainfall and temperature) on the distribution of forest types, specific composition (sub types), ecological relations; distribution of species; unique and specific vegetation etc. may be explored and described. Help of experts on species distribution models may be taken.	Quantitative and distribution indicator	FMU level						
Indicator 2.2 Plant species diversity	Biodiversity assessment in terms of density, frequency, total basal cover, dominance, IVI, etc. should be given. Efforts should be made to make a base year documented species diversity status for future reference using GIS tools. Base year documented species diversity is maintained or enhanced under sustainable management of forests.	Quantitative and indicator reflects maintenance or enhancement of biodiversity	National & FMU level						
Indicator 2.3: Status of Biodiversity conservation in forests	Status of implementation of the state guidelines/ strategic plan, if any should be given; Other in-situ and ex-situ conservation efforts undertaken for sensitive/RET/ IUCN Red List species and their habitats	Descriptive and reporting may facilitate in conservation of biodiversity	FMU level & National						
Indicator 2.4: Status of species prone to over exploitation	Harvesting time and level of such species should be prescribed and implemented	Quantitative and reporting may facilitate in identification of species prone to over-exploitation	FMU level & National						
Indicator 2.5: Conservation of genetic resources	Preservation plots, sample plots, medicinal plants conservation areas, community conservation areas, etc.; genetic diversity with the help of research organizations should be documented and monitored through research studies as far as possible especially for NTFPs including MAPs.	Descriptive and indicator reporting may facilitate in documentation of uniqueness of the species of plants and animals and protection measures for their existence	FMU level & National						
Indicator 2.6: Fauna and their habitats	Give description of flagship wild species including mammals, birds, reptiles, amphibians, etc. along with their suitable habitats and micro habitats.	Quantitative and indicator reflects maintenance or enhancement of biodiversity	National & FMU level						
Indicator 2.7: Threats and challenges to wildlife	Give details regarding habitat fragmentation/ loss, illegal trade, road and rail networks, extended habitats in proximity to protected areas for rare and endangered species; man-animal conflict.	Descriptive and indicator reporting may facilitate in documentation of habitat fragmentation/ loss, illegal trade, road and rail networks, extended habitats in proximity to protected areas for rare and endangered species; man-animal conflict.	FMU level & National						
Indicator 2.8: Protection and management of fauna	Details of measures taken and its effect therein.	Descriptive indicator reflects management of fauna	National & FMU level						
CRITERIA 3: MAINTENANCE AND ENHANCEMENT OF FOREST HEALTH AND VITALITY									
Indicator 3.1: Status of regeneration	Number of seed origin seedlings should be recorded to determine the state of natural regeneration. The numbers / range may vary as per FMU level working plan prescriptions.	Quantitative and indicator reflects health and vitality of forest	FMU level						

Indicator 3.2: Area affected by forest fire	Forest fire management should be integral part of forest working (management) plan and efforts should be made to minimize and manage the forest fire and the losses.	Quantitative and indicator reflects protection measures in forest	FMU level & National
Indicator 3.3: Area damaged by natural calamities	Frequency and extent of area affected should be documented for planning management interventions to minimize the impact.	Quantitative and indicator reflects historic perspective of natural calamity occurrence	FMU level & National
Indicator 3.4: Area protected from grazing	Forest areas under regeneration operations should be notified as closed area for grazing. In other areas which are open to grazing the number of livestock should be restricted to the carrying capacity of the area. For this purpose carrying capacity of such areas need to be assessed.	Quantitative indicator and reporting facilitate the management of forest	FMU
Indicator 3.5: Lopping practices	Status of existing of lopping practices during fodder/NTFPs collection extent of damage to the affected species, if any; and period of lopping, etc. should be provided.	Quantitative and monitoring, reporting may facilitate in non-destructive harvesting of NTFPs and it's quality	FMU level
Indicator 3.6: Area infested by invasive weed species in forests	Details to be given of forest areas infested by different invasive species. Plantation (AR / ANR) areas are free from weeds.	Quantitative indicator. Monitoring and reporting may facilitate the management of forest	FMU
Indicator 3.7: Incidences of pest and diseases	Practically necessary details of different incidences of pest and diseases are provided. Scientific information with regard to attack of fungus and other insect pests should be mentioned.	Descriptive indicator. Monitoring, reporting reflects incidences	FMU level
Indicator 3.8: Forest degradation and its drivers	Details of drivers of forest degradation like unregulated removal of forest produce, encroachment, over grazing, mining, etc. along with the area description under different levels of degradation.	Descriptive indicator reporting suggests measures for sustainable management of forest	FMU level
Indicator 3.9: Pollution control and protection of environment	Incidences, extent of forest land degradation due to pollution (soil, water, in some cases air) and the measures taken to mitigate them.	Descriptive indicator	FMU level
CRITERIA 4: CONSERVATION AND MAINTENANCE OF SOIL AND WATER RESOURCES			
Indicator 4.1: Area treated under soil and water conservation measures	Degraded/ prone to soil erosion forest areas are generally identified in working plans. They should be treated strictly as per working plan prescriptions and their impact should be periodically monitored and reported.	Quantitative and indicator monitoring, reporting may facilitates in management of forest and landscape at large	FMU level & National
Indicators 4.2: Duration of water flow in the selected seasonal streams	Flow periodicity of major streams need to be recorded at periodic interval and should be mapped for national reporting.	Quantitative and indicator monitoring, reporting may facilitates in management of forest and landscape at large	FMU level & National
Indicator 4.3: Wetlands in forest areas	Details of wetlands in the forest areas along with maps may be provided for periodic monitoring using remote sensing technology. No reduction in wetlands from the base year, should be ensured. Addition of new wetlands and water bodies may be provided.	Quantitative and indicator monitoring, reporting may facilitates in management of forest and landscape at large	FMU level & National
Indicator 4.4: Water level in wells in the vicinity (up to 5 kms) of forest area	Periodic monitoring of water level with respect to annual rainfall should be provided for the status of ground water assessment.	Quantitative and indicator monitoring, reporting may facilitates in management of forest and landscape at large	FMU level & National
Indicator 4.5: Status of aquifers	Details of aquifers to monitor their sustainability.	Quantitative and indicator monitoring, reporting may facilitates in management of forest and landscape at large	FMU level & National
CRITERIA 5: MAINTENANCE AND ENHANCEMENT OF FOREST RESOURCE PRODUCTIVITY			

Indicator 5.1: Growing stock of wood	National scenario					Quantitative and indicator reporting may facilitates in management of forest production	FMU level & National	
	Type/ Category	2011	2013	2015	2017			2019
	(in cubic meters)							
	Growing Stock	4498.73	4173.36	4195	4218	4273.47		
Source: Forest Survey of India								
Indicator 5.2: Growing stock of bamboo	Growing stock of bamboo indicating the number of clumps and clump size with respect to base year; number of clumps and clump size is maintained or increased with respect to base year.					Quantitative and indicator monitoring, reporting may facilitates in management of bamboo	FMU level & National	
Indicator 5.3: Increment in volume of identified timber species	Mean annual increment (MAI) of tree species is maintained or increased with respect to base year.					Quantitative and reporting of indicator facilitates in management of forest productive	FMU level & National	
Indicator 5.4: Efforts towards enhancement of forest productivity through quality plantation activities	Details to be given based on survey and assessment of areas under the plantation. About 10% of the total forest area may be brought under production forestry by raising quality plantation, however no forest land or any portion thereof can be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for afforestation.					Quantitative and reporting of indicator facilitates in management of forest production	FMU level & National	
Indicator 5.5: Carbon Stock	Details of biomass for carbon stock assessment may be given based on the forest types and land use.					Quantitative indicator	FMU level & National	
Indicator 5.6: Carbon sequestration and mitigation	Enhanced carbon sequestration through recognised and innovative silvicultural practices, eco-restoration of degraded/ mined out forestlands, improved biomass productivity, etc. results in improving forest health and vitality. Forest soil must be kept as healthy and fertile as possible and the forest crops must be kept as vigorous as possible to produce as rapidly as they can till the biomass production attains its most desirable level. The growing stock of trees must be so constituted that it provides regularly the greatest possible quantity of the desired products including intangible benefits. All these will entail that the specific composition and the structure or form of the forest must harmonise with the environment or factors must harmonise with the environment or factors of the locality and the species grown and the methods of silviculture adopted must be suitable to the site to ensure full growth.					Quantitative indicator	FMU	
Additional Indicator: Extent of seed production area and seed orchards	Area set-a-side for the production and collection of quality seeds.					Quantitative and reporting of indicator facilitates in production and multiplication of quality progeny	FMU level & National	
CRITERION 6: OPTIMIZATION OF FOREST RESOURCE UTILIZATION								
Indicator 6.1: Recorded removal of timber	Annual collection should not exceed average annual increment put by the growing stock (GS). The total removal by all means should be compared with the annual prescribed yield under the Working Plan.					Quantitative and monitoring, reporting of indicator may facilitates in management of forest	FMU level & National	
Indicator 6.2: Recorded removal of fuel wood	Proper recording of fuel wood collected from the FMU by the community should be made. Only fallen and dead branches and twigs to be collected by the forest dwelling communities. The total removal by all means should be compared with the annual prescribed yield under the Working Plan.					Data is quantitative and monitoring, reporting of indicator may facilitates in compilation of information on the demand and supply	FMU level & National	
Indicator 6.3: Recorded removal of bamboo/rattans	Assessment of bamboo/rattans and mechanism for generating quantified data on their removal and sharing with the community should be provided.					Quantitative and monitoring, reporting of indicator may facilitates in compilation of information on the demand and supply	FMU level & National	
Indicator 6.4: Recorded removal of locally important NTFPs including MAPs	Annual collection of non-timber biomass should not exceed average annual production and average production of the division. The total removal of NTFPs by all means should be compared with the annual prescribed yield under the Working Plan.					Quantitative and monitoring, reporting of indicator may facilitates in compilation of information on the demand and supply	FMU level & National	

Indicator 6.5: Demand and supply of timber and important non-timber forest produce	Description of recorded removal for agricultural customs, local needs, market and marketable produce including that of forest development corporations and other agencies may be given. Consumption of wood by wood based industries and other end users may also be given. Assessment and evolving mechanism to meet the demand may be provided.	Quantitative and monitoring, reporting of indicator may facilitates in compilation of information on the demand and supply	FMU level & National
Indicator 6.6: Import and export of wood and wood products	Data on import and export of wood and wood products may be collected and analyzed for the entire division.	Quantitative and monitoring, reporting of indicator may facilitates in analysing import and export potential of wood and wood products	FMU level & National
Indicator 6.7: Import and export of NTFPs	Data on import and export of NTFPs may be collected and analyzed for the entire division.	Data is quantitative and monitoring, reporting of indicator may facilitates in analysing import and export potential of NTFPs	FMU level & National
Indicator 6.8: Removal of fodder	Description of cattle rearing community of forest dwellers with regard to removal of fodder and availability of palatable species and pasture lands, etc.	Quantitative and monitoring, reporting of indicator may facilitates in accounting of contribution of forest	FMU level & National
Indicator 6.9: Valuation of the products	Valuation of products may be done by including past and current prices of different forest products with price trend.	Data is quantitative and monitoring, reporting of indicator may facilitates in accounting of contribution of forest	FMU level & National
CRITERION 7: MAINTENANCE AND ENHANCEMENT OF SOCIAL, CULTURAL AND SPIRITUAL BENEFITS			
Indicator 7.1: Number of JFM committees and area (s) protected by them	Number of JFM committees / Biodiversity Management Committees	Data is quantitative and indicator reflects the participatory management of forest resources	FMU level & National
Indicator 7.2: Status of empowerment of JFMCs	Should match the JFM resolution; extent of the forest area under JFM.	Descriptive indicator	FMU level
Indicator 7.3: Labour welfare	Details of welfare measures along with direct employment in forestry activities	Descriptive indicator	FMU level
Indicator 7.4 Use of Indigenous knowledge	Documentation of the indigenous traditional knowledge and incorporation of the same in the micro-plans and other prescriptions of the plan.	Descriptive indicator	FMU level
Indicator 7.5: Extent of cultural/sacred groves	Information on area/species and the communities involved in the conservation and maintenance should be documented and communities be encouraged and supported in their efforts.	Descriptive indicator	FMU level
Indicator 7.6: Ecotourism areas and activities	Areas inside and adjoining designated forests, which have ecotourism potential are being visited by tourists, will be identified and systematically documented. The natural attributes viz. landscape, waterscape and wildlife and also the humanscape will be enlisted and explained for effective ecotourism management.	Quantitative and indicator reflects the eco-tourism potential and activities	FMU level & National
Indicator 7.7: Social customs	Prevalent social customs relevant to forests.	Descriptive indicator	FMU level
Indicator 7.8: Status of compliance of Forest Right Act (FRA)	Status of registration of all the claims and settlement of the genuine claims along with list of individuals and communities to whom forest area is allotted, enlistment of those locations whom physical possession has been handed over on ground and its position on the forest map (with lat./long.), status of forest management of areas given to allottee.	Quantitative indicator	FMU level & National
Indicator 7.9: Other Rights and Concessions	A brief account of other rights and concessions, their extent, nature, etc. which are to be regulated or met under working plan prescriptions should be given (details are to be given in	Descriptive indicator	FMU level

	the appendix). Rights granted under JFM/PESA, etc. should also be included.		
Indicator 7.10: Dependency of local people on NTFPs	Economic dependency on NTFP along with clear rights and responsibilities to access, use and manage the NTFPs resources; registration status of gatherers, traders and other stakeholders; existing regulation mechanism on transit storage and trade of NTFPs.	Quantitative and indicator reflects the contribution of NTFP in their livelihoods	FMU level
Indicator 7.11: Other aspects	Other aspects, which are not mentioned above but are intrinsic to forests. For example the impact and the dependency of transhumant populations mostly the grazer community which have not been well addressed in the working plan is required to be assessed. The season and area of grazing, migration route, transition ca	Descriptive indicator	FMU level
CRITERION 8: ADEQUACY OF POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK			
Indicator 8.1: Existing policy and legal framework and their compliance	Status of compliance for sustainable management of forests may be given.	Descriptive indicator	National & FMU level
Indicator 8.2: Status of approved working plan and compliance	A summary of prescription of approved working plan and valid reason for deviations in implementation of the plan should be given (as per deviation statement).	Quantitative and indicator reflects the scientific forest management	FMU level & National
Indicator 8.3: Number of forest offences	Details of all the cases booked and taken to court of law	Quantitative and indicator reflects the management of forest	FMU level & National
Indicator 8.4: Status of research and development	Application of research findings in addressing the problems along with appropriate transfer of technology to field should be given.	Quantitative and indicator reflects the R&D in forest sector	FMU level & National
Indicator 8.5: Human resource capacity building efforts	Adequate and appropriate training modules for each level of officials communities, and other stake holders are to be planned & implemented	Quantitative and indicator reflects the competent human resources	FMU level & National
Indicator 8.6: Forest Resource Accounting	All tangible benefits should be reported. Progressive and positive efforts should be made to quantify intangible benefits also.	Quantitative and indicator reflects the contribution of forest in national account	FMU level & National
Indicator 8.7: Budgetary allocation to the forestry sector	Budget provision of the last plan period may be provided and the prescribed budget may be justified accordingly.	Data is quantitative and indicator reflects the budgetary allocation for forest management	FMU level & National
Indicator 8.8: Existence of monitoring, assessment and reporting mechanism	Monitoring and evaluation parameters may be provided for all the prescriptions of the plan as control forms. Forest management unit level information system may be provided for reporting and dissemination.	Indicator reflects the implementation of C&I framework for management of forest	FMU level & National
Indicator 8.9: Public awareness and education	The efforts to increase public awareness of the importance of and the benefits provided by forests and sustainable management of forest along with list of the published material such as brochures, pamphlets, leaflets, posters, etc.; meetings with the general public to inform them of the benefits provided by forests to society; details of forestry/ environmental awareness and education programmes conducted for students.	Indicator reporting may facilitate in creation of awareness and education for the responsible management of forest	FMU level & National
Indicator 8.10: Adequate manpower in forest division	The details of sanctioned, permanent, temporary, and seasonal posts are given in the appendix. It should also include number of filled and vacant posts on a particular date when the working plan is under revision. The requirement of daily wage/contractual man power may also be mentioned in this chapter. The rates of past and present wages should also be mentioned.	Indicator monitors the adequacy of manpower in forest division	FMU level

2.2.4 Forest area under independently verified forest management certification schemes: indicates the area of forest for which forest management certificates have been issued by accredited independent bodies in compliance with national and international standards.

Forest Certification is emerging as a marketing tool for appreciation of responsible management of forest and its resources. Forest Certification provides an opportunity to the environment conscious consumers to choose the product coming from the sustainably managed forest.

Presently, the area certified by the FSC in India is accounted as low as 92,918 ha with valid eight Forest Management/ Chain of Custody (FM/CoC) certification (FSC 2021). The forest certification is under the Group SLIMF (Small and Low Intensity Managed Forests) category (Table 4) and under agroforestry systems indicating adoption of FSC forest certification scheme in India by the private players.

Whereas, 13 forest divisions (Forest Management Unit) in Uttar Pradesh secured FM certification under PEFC in India. The forest certification holder is Uttar Pradesh Forest Corporation (UPFC).

Table 4: Status of forest certification in India (as in 2021)

S. No.	Certificate Holder	Certificate no. & Year	Area (in Hectares)	Species and Forest Certification details
Forest Stewardship Council (FSC)				
1	Society for Afforestation, Research and Allied Works (SARA)- Dandeli (Karnataka)	SCS - FM/CoC-00143P - 2021	2655.92	Group SLIMF - plantation <i>Eucalyptus pellita</i> , <i>Leucaena leucocephala</i> , <i>Acacia</i> spp.
2	Tamil Nadu Newsprint & Paper Ltd	SW-FM/CoC-006000 - 2021	2459.28	8620 FMU group members SLIMF <i>Eucalyptus</i> , <i>Casuarina</i> , <i>Gmelina</i> , <i>Melia</i> , <i>Acacia</i> and <i>Dalbergia sissoo</i>
3	ITC Ltd PSPD Unit (AP)	SW-FM/CoC-006945 - 2021	40111.31	9045 FMU Group members SLIMF <i>Eucalyptus</i> spp.
4	International Paper -APPM Ltd	SA-FM/CoC-010151 - 2021	26256	5883 FMU Group SLIMF - <i>Casuarina equisetifolia</i> plantation
5	JK Paper Ltd Raigarha (Odisha)	SCS-FM/CoC-005124 - 2021	16375	Group SLIMF - <i>Eucalyptus</i> spp. (70-80 tones/ha/year)
6	JK Paper Ltd. Unit – CPM (Gujarat)	SCS-FM/CoC-007694 - 2021	3454	841 Group members
7	Shivangi Industries (Rajasthan)	SCS-FM/CoC-008105 - 2021	1002	94 Group members
8	Greenply Industries Limited (Nagaland)	SCS-FM/CoC-007306 - 2021	605	60 Group members
Programme for the Endorsement of Forest Certification (PEFC)				
1	UP Forest Corporation	GIPL-FM-0001-2020	404104	Multiple FMU (13 FDs)- Natural production forest (24933 ha) + plantations + replanting or naturally regenerated + High Conservation area (72378.5 ha) - timber plus NWFPs*
Total			497022.5	

Source: <http://info.fsc.org>; www.nccf.in

2.3 Measuring progress on SDG1 and SDG2 through C&I approach

Forests provide numerous goods and services, especially the Non-Wood Forest Produces (NWFPs) in countries like India where the dependencies of local community for the sustenance, livelihood, food security and nutrition are high. The C&I framework for SFM can be used to measure the contribution of forest in addressing the SDG 1 'end poverty in all its forms everywhere'; and SDG2 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture'.

Similarly, the Global Forest Goals and targets though, are voluntary but universal and aimed at evaluating the progress made by countries in their achievement as along with progress on the Sustainable Development Goals, the Aichi Biodiversity Targets, the Paris Agreement adopted under the United Nations Framework Convention on Climate Change and other international forest-related instruments, processes, commitments and goals (UN, 2019).

Thus the C&I for SFM framework can easily be extended for measuring the progress towards achievement of the Global Forest Goals (GFG). For example GFG 2 i.e. “enhance forest-based economic, social and environmental benefits, including by improving the livelihoods of forest-dependent people” can be measured in terms of the contribution of Non-Wood Forest Produce (NWFP) in the income, subsistence need, and as food security of the forest dwelling communities.

The NWFP collection has traditionally been one of the source of income for the forest dwelling communities in India as compared to timber. According to one study by the lead author in three central provinces of Madhya Pradesh, Chhattisgarh and Maharashtra revealed that NWFP resource collection contributed to 14.6% of the total average annual household incomes of the tribal communities (Table 5).

Table 5: Average income from different sources of Tribal households in Vidharbha region of Maharashtra (INR Per annum)

Particulars	Average Annual Income (INR)	% of total annual income
Average income from NWFPs	3085	14.6
Average income from Agriculture	12540	59.2
Average income from Labor	5569	26.3
Average total annual income	21194	100

Source: Primary Data Analysis based on sample of 130 tribal households (Yadav 2008a).

However, the study found huge variation in NWFP dependence of the forest dwelling communities in the three provinces. The average contribution of NWFPs for the State of Chhattisgarh was found to be 31%; whereas it was 19.3% in Madhya Pradesh and 14.6% in Maharashtra (Table 5). The study also revealed huge variation in NWFP income contribution in different zones of a province. This variation can be explained by the density of forest areas and thus high availability of NWFP resources leading to high dependence on NWFPs (Table 6). The study further revealed that local value addition in NWFPs can substantially increase price realization per unit of material sold in the market benefiting the NWFP gatherers (Yadav 2008b).

Table 6: Sources of annual income of forest dwelling communities in Chhattisgarh and Madhya Pradesh (INR per annum)

State / Name of the Zones	Average income from different sources				Average % of NWFP Dependency
	NWFP	Agriculture	Labor	Total annual income	
Chhattisgarh (Primary Data Analysis based on sample of 192 tribal households)					
Southern Part	12946 (40.3)	9731 (30.3)	9455 (29.4)	32132	39.2
Central Part	8171 (29.3)	10648 (38.2)	9083 (32.5)	27901	28
Northern part	10965 (26)	11949 (28.3)	19311 (45.7)	42226	25.5
Average of all Zones	11316 (31)	10881 (32.2)	13876 (36.8)	36073	31
Madhya Pradesh (Primary Data Analysis based on sample of 361 tribal households)					
East Part	5917 (28.0)	8982 (40.8)	7123 (32.3)	22022	28.0
South West Part	4331 (10.5)	19415 (50)	15080 (38.8)	38827	10.5
South East Part	5609 (19.4)	13985 (48.9)	9033 (31.6)	28627	19.4
Average of all Zones	5286 (19.3)	14127 (47.4)	10412 (34.9)	29825	19.3

*Figures in parenthesis shows percentage value of total income (Yadav 2008a).

Another study by the lead author highlighted existence of multiple trade channels (minimum three layers of traders in the channel), resulting into channel inefficiency in NWFP trade in central province of Madhya Pradesh. Marketing channel analysis for five selected NWFPs in Katni market was conducted for estimating gatherers' share in the consumer price through measure of channel efficiency. The gatherers share was estimated in the range of 36-65% of consumer price depending upon whether the NWFP was sold in raw form or after local value addition at the collector level. It was found that the channel efficiency significantly improved when primary processing was undertaken at collector level then if it was done by traders/processors. The study also revealed that the presence of some government agency in the NWFP marketing channel also improved the channel efficiency benefiting the gatherers (Yadav and Misra 2010). The study also found that traders were in price dictating terms to both the collectors and the end-user industry in the absence of a Government agency.

A study recently undertaken by the lead author in Sehore Forest Division of Madhya Pradesh revealed that the average contribution from the collection *Madhuca latifolia* (Mahua) flowers computed to be 7.06% of the total annual income of the sample households (ranging from 1.68% to 24.49%) (Yadav et al., 2020). Thus periodic assessment of contribution of locally significant NWFP may indicate the direction of change and progress in achievement of relevant SDGs / GFGs.

3. A suggested framework for the sustainable management of Forest in India

In order for India to graduate from scientific management of forest for sustained timber harvest to a more holistic approach of sustainable forest management principles which recognize forests not only for timber production but also diverse good and services such as biodiversity, non-timber forest produce, traditional health care, livelihoods, recreation, soils, water quality, wildlife, climate stabilization etc. While the country has adopted its national set of criteria and indicators from the Bhopal-India process and included these in the National Working Plan Code 2014, there is need for periodic review of these criteria and indicators as well as their adaptation for different types of forests that the country has. Further, there is also a need for monitoring the implementation of the SFM approach and monitoring the progress in terms of direction of change and their contribution to achievement of the relevant SDGs and GFGs as discussed in the previous sections. For this purpose, appropriate institutional mechanisms need to be set up both at the national and state levels through revisions in the national forest policy and the other regulations.

Further, the country can also establish an Indian Forest Certification System through the involvement of various stakeholders to incentivize sustainable forest management in the country and promote responsible forestry product trade within and outside the country through a market-based forest certification system.

Conclusions

C&I framework for SFM is globally recognized as a potent tool for monitoring, assessment and reporting of direction of change towards sustainable management of forests. The C&I framework could facilitate in collection and collating the data/information in a universally accepted standard format. This research article suggests development of mechanism for the periodic review of criteria and indicators as well as their adaptation for different types of forests. Further, the paper highlights the need for monitoring the implementation of the SFM and the performance in terms of direction of change, which in turn can help measure their contribution towards achievement of the relevant SDGs and GFGs.

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