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To cite this article: Manoj Kumar, Madan Prasad Singh, Hukum Singh, Parag Madhukar Dhakate & NH Ravindranath (2020) Forest working plan for the sustainable management of forest and biodiversity in India, *Journal of Sustainable Forestry*, 39:1, 1-22, DOI: [10.1080/10549811.2019.1632212](https://doi.org/10.1080/10549811.2019.1632212)

To link to this article: <https://doi.org/10.1080/10549811.2019.1632212>



Published online: 01 Jul 2019.



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BERLYN REVIEWS



Forest working plan for the sustainable management of forest and biodiversity in India

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ABSTRACT

Forests are one of the major sources of livelihood that need to be conserved. In India, there have been continuous efforts to evolve a scientific basis for sustainable management of forests. In recent century, this has primarily been addressed through “forest management plans,” also known as “working plans.” To make the plans uniform for each of the forest management units, guidelines have been issued by Government of India in the name of “working plan code,” which are revised periodically to match present days’ requirement. A working plan largely deals with the present state of the forest, outcomes of past management, and proposal of future management on a scientific basis. With a significant lapse of time, the role of forests has been recognized beyond mere supply of timber (a major resource) to fulfilling the demands of minor resources and ecological services. This has transformed the basis of forest management and the working plans. With reference to India, we discuss the relevance of working plan for sustainable management of forests; highlights of the most recent working plan code (2014); relevance of the code with reference to climate change and biodiversity, future perspectives, and recommendations for better management of the forests.

KEYWORDS

Climate change; forest inventory; forest management; working plan code

Introduction

Conservation and management of natural capitals (including forests) has become one of the top priorities globally. Available natural capitals can be considered as the pool of resources or as an ecosystem (Lant, Ruhl, & Kraft, 2008). Conservation and management practices of natural capitals should focus on the sustained yield and maintaining the flow of ecosystem services (Ingram, Redford, & Watson, 2012). For achieving the sustained yield and improved ecosystem services, there is a need to formulate effective planning. Forests are one of the major natural resources that support sustenance of the human population. At the same time, they are under the influence of climate change and human-

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induced pressures affecting sustainability (Allen et al., 2010; Bonan, 2008; Dale et al., 2001; Kramer, Leinonen, & Loustau, 2000; Kumar, Rawat, Singh, Ravindranath, & Kalra, 2018; Millar, Stephenson, & Stephens, 2007; Savita, Kumar & Kushwaha, 2018; Savita et al., 2018; Thuiller, 2007; Watson, Zinyowera, & Moss, 1996). This has called attention of planners to formulate strategies to achieve the “Sustainability,” defined as “the maintenance of natural capital” (Morelli, 2011). There is an urgent need to harmonize balance between production from forests and ecological goals through planning processes performed at the national, regional, and local levels (Bettinger, Boston, Siry, & Grebner, 2016).

The significance of forest protection supporting sustainability is well witnessed in the Constitution of India. The Constitution of India under the constitution (42nd amendment) Act, 1976, added article 48A which reads as “Protection and improvement of environment and safeguarding of forests and wild life – The State shall endeavour to protect and improve the environment and to safeguard the forests and wild life of the country”. Similarly, fundamental duties for every citizen were added during 42nd amendment Act, 1976, as Article 51A (51A Fundamental Duties) which says “It shall be the duty of every citizen of India – (g) To protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures” (National Forest Commission, 2006). However, the efforts for a structured and scientific forestry planning in India were initiated long ago, beginning with the appointment of Dr. Dietrich Brandis as the first Inspector General of forest in 1894, and the formulation of the first National Forest Policy in 1894. Since then, attempts have been made to evolve more reasonable basis of forest planning and management. This primarily involved the integration of scientific basis for the conservation of natural resources to meet emerging needs of the country and society.

Forests being a renewable resource can be sustained in eternity with well-planned management interventions. The need for management and planning of forests evolves over time with population driven demands. Forest planning is often subjective and unique to situations and problems being addressed. This may also vary according to the forest tract dealt with respect to its characteristics and composition, risks involved, long-term vision, and the requirements visualized at local or national level. Historically, in India, management of forests to retain a sustainable yield, working plan (also called as forest working plan or forest management plan) has been the main instrument in practice for almost 150 years. Although, the initial focus of these plans was primarily to fetch sustained yield of timber which has gradually shifted to the wider concerns of sustainable management of forests. This deals to address the concerns of ecosystem services, environmental stability, biodiversity conservation, climate change, carbon sequestration, soil moisture retention, water yield, minor forest produce in the form of important nonwood forest products, pharmaceutical and other industrial requirements, rights of the forest dweller communities and also the concerns of the forest fringe communities and overall forest-dependent life support system varying from local level to the national scale. For example, in recent years after the enactment of reducing emissions from deforestation and forest degradation (REDD +) initiative, the requirement of a working plan would shift to fulfill the need to give quantitative evidence about the forest resources to fetch payment benefits. This demands information related to biodiversity conservation, carbon sequestration, and enhancement of rural livelihoods which could fit in the working plans.

National Working Plan Code – 2014 (NWPC, 2014) is the most recent working plan code (hereafter simply referred as “Code”) that elaborates the adoption of prescriptions for the preparation of the working plan in the country. The Code is a written document prescribing methods and tools to be adopted while developing a working plan for a forest management unit (FMU) following a standard procedure. The Code attempts to bring uniformity in forest management planning across the country so that the quantitative information at the divisional level may be integrated and up-scaled to state and national level in a standardized framework (NWPC, 2014). It attempts to integrate information related to Criteria and Indicators (C&I) for sustainable forest management (SFM), carbon sequestration and mitigation, climate change, biodiversity monitoring and conservation, forest certification, enumeration and management of non-timber forest products (NTFPs), preparation of micro-plans for joint forest management (JFM), fringe forest management, water resource management, soil and water conservation, forest health and diseases, forest fires and protection. It focuses on systematic grid-based sampling design and application of modern technologies such as remote sensing (RS), geographical information system (GIS), and global position system (GPS) to have more reliable and verifiable information. It attempts for forward and backward linkages between forest inventory under forest resource assessment for a working plan and the national forest inventory (NFI) done by Forest Survey of India (FSI) (NWPC, 2014). The NFI is an effort to collect qualitative and quantitative information for a number of estimates of forest resources (Tewari & Kleinn, 2015). India’s NFI primarily assesses the growing timber stock, apart from describing the characteristics of forest as different type groups (FSI, 2015) on a periodic basis covering almost 112 observations if all components of vegetation are available (Thakur, Kumar, & Verma, 2018).

There has been a paradigm shift in the preparation of working plans in India. Post-Independence era (i.e. after 1947), forestry witnessed a shift in the priority of forest management from production to conservation forestry, particularly after the enactment of forest conservation act in 1980. According to FAO (1982), assessment done in the year 1980 for the tropical forests, India shared 80% of the total intensively managed forests of tropical countries (Devendra, 2007). Although the history of adopting working plan is much older, the working plan code has been prescribed and adopted twice for achieving uniformity in the preparation of working plans in India; the first code is of 2004, and the second being recently revised code of 2014.

We discuss in detail the scientific basis of forest management in India by evolving and adopting working plans. The study focuses upon, (1) the milestones of forestry evolution in India with special emphasis on adoption and revision of working plans over a period, (2) major highlights of the most recent working plan code (2014) with special reference to climate change and biodiversity, (3) gaps and scope of future recommendations for mainstreaming and addressing the emerging issues of climate change and biodiversity conservation. The study will be relevant for the forest managers and planners to understand the emerging needs and gaps while formulating or adopting a working plan for their specific purpose or region.

Milestones of forestry evolution and forest working plan

The literature about the management of forests in India through a working plan trace back to the early days of nineteenth century. Forest working plan in India perceived major

attention when the book titled “Preparation of forest working-plans in India” by WE D’arcy (1891) described the various aspects of working plan preparation. D’arcy (1891) defined working plan as a forest regulation prescribing the application of certain cultural rules, and the execution of certain works, in order to produce a given desired result. Accordingly, a working plan sets forth the purpose with which a forest should be managed so as to best meet the interests, and thus the wishes of the owner; and indicates the means by which this purpose may be achieved. The present-day working plan is the main instrument of forest planning and forest working in the country for scientific management of forests. It is a much useful document for evaluating the present status of forests, past management and its impacts, and the prescriptions for future management interventions (NWPC, 2014). Among various planning of activities in any sector of the modern Indian economy, Forest Working Plan is said to be the first document of the detailed plan of activities. Over the years, changing needs of the society has manipulated the role of forests in various ways. As a result, the forest management plans over the year also witnessed a significant change. Recently revised code of the year 2014 is the latest code in the country which acts as a guideline for preparing working plans in the country. A brief account of the evolution of forestry and working plan in India along with the salient features of the revised code is discussed ahead.

Evolution of forestry in India¹

Ancient India

1700–500 BC² : Upanishads and Vedas (ancient Sanskrit texts) describe flourishing civilization in harmony with forests.

400 BC: Gautama Buddha attained salvation under Bodhi tree (i.e. Banyan tree, *Ficus religiosa*) and banyan trees recognized as an entity for the worship by most of the Indians.

32–297 BC: Emperor Chandragupta Maurya appointed a special officer to protect the forest for purposes, *viz.* religious study, forest produce, grazing of royal elephants and hunting.

268–232 BC: Emperor Ashoka promoted tree planting along roads and the cultivation of medicinal plants.

399–645 AD³ : Chinese pilgrims described dense forests in India.

1526–1800 AD: Tree felling for army movement, animal hunting, migration of people to forests, and felling of trees near villages for agriculture witnessed.

The era of unregulated exploitation

1806: Captain Watson was appointed as the first Conservator of forests in the country to secure control over teak forests in Malabar and Travancore to serve the needs of East India Company for making ships.

1842: Deforestation accelerated due to the expansion of transport and communication lines in the form of railway, electricity, and ships where the extensive requirement of timber was inevitable. Railway service began in 1853 which accelerated exploitation of timber from forests.

1853: Shortage of teak led to the first plantation of teak at Nilambur, Kerala.

¹(Source: Silviculture Museum, Forest Research Institute, Dehradun).

²Before Christ.:

³Anno Domini.:

1855: Lord Dalhousie laid down a permanent policy for forest administration in India.
1860: Sir Dietrich Brandis prepared the first forest management plan for Pegu Yomo Forests of Myanmar.

Dawn of organized forestry

1864: First forest policy in the country was laid down; it allowed felling of forests for revenue generation and agriculture expansion.

1878: Sir Dietrich Brandis appointed as first Inspector General of Forests in India.

1891: D'Arcy wrote treatise "Preparation of Forests Working Plans in India" and illustrated guidelines for the preparation of working plans in a systematic manner.

1894: Imperial Forest School was set up at Dehradun to train forest managers within India. The Forest Act, 1878 was enacted; it regulated the rights of people over forests.

The rise of research-driven forestry

1906: Systematic research in forestry began with the establishment of Imperial Forest Research Institute, Dehradun.

1921: The book 'Silviculture System' was published describing methods of replacing forest crops.

1927: Indian Forest Act, 1927 was notified. This is still in force.

1928: The very first book on species-wise Silviculture practices viz. 'Silviculture of Indian Trees' was published in three volumes.

1929: Ribbentrop prepared working plan code for Uttar Pradesh, India.

The growth of plantation forestry

1952: The Forest Policy (1952) recommended to bring one-third area of India under forest through plantation programmes.

1952: Seth revised the working plan code for Uttar Pradesh, India.

1966: The modern Indian Forest Service was created to manage forests.

1972: The Wildlife Protection Act, 1972 was enacted.

1976: Social Forestry was introduced on recommended of National Commission on Agriculture.

Conservation overtakes including carbon perspective

1980: Forest Conservation Act was enacted to ensure forest conservation and regulate diversion of forest land for development projects.

1986: Environment protection act enacted for the protection and improvement of the environment.

1988: National Forest Policy 1988 gave the highest priority to forest conservation through the involvement of people and also emphasized tree plantation outside the forest.

2002: The biological diversity act enacted to conserve the biodiversity, its sustainable use and equitable benefit sharing.

2006: Forest right act enacted to ensure the protection of rights of the tribal community, also known as the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.

2010: Establishment of National Green Tribunal (NGT) under national Green Tribunal Act 2010 for expeditious disposal of cases relating to the protection of environment and conservation of natural resources including forests.

2018: Draft national forest policy formulated to address the issues related to the conservation, protection and management of the forests.

Evolution of working plan in India

The first need for a working plan emerged as a consequence of haphazard fellings, heavy grazing, fire and exigency of accounting valuable timbers. Mr. UV Munro, the then Superintendent of Forests in Travancore, in 1837 estimated the number of Teak trees fit for felling based on his own personal experience and judgment which initiated the idea of fixing and forecasting the annual yield on the basis of some kind of computation with certain assumptions and the rate of growth of trees. As a corollary to this, introduction of the working plan in India is credited to Mr. UV Munro. However, a true beginning of the proper forest management under a forest working plan was made by Dr. Dietrich Brandis, a German-trained forester appointed by Britishers, who also served as the first Inspector General of Forests in India, worked out the number of trees to be felled in a year by classifying trees according to diameter classes and estimated First Class trees (trees over a prescribed diameter) that should be felled in one year as would be replaced by the trees of the growing stock of the Second Class trees (FRI, 1961). Brandis's method of yield regulation in irregular forests was widely acclaimed as "the Indian Method" and was appreciated all over the world. Dr. Brandis worked extensively for the planned management of forests during the British era of India and forest working plan could witness considerable scientific progress. Dr. Brandis is also considered to be the father of modern forest management. Dr. Brandis prepared the first forest working plan for Pegu Yomo Forests of Myanmar in 1860 (Singh, 2007b). However, the famous teak plantation of Nilambur by Conolly and Chattu Memon in 1840 is considered as the birth of human-induced forest management in India (Melkania, 2007).

A major setback to the evolution of the working plan was faced in 1882 when the forest department was decentralized. This caused the deviation in the prescriptions of the working plans under the influence of local government. However, again in 1884, Sir Wilhelm Schlich, the then Inspector General of Forests, brought the control of the preparation of the working plan and the management of forests under the prescriptions of these working plan under the centralized control of his office for the whole India. He created a separate working plan branch and the powers of the office of Inspector General of Forests were strengthened for effective management of forests through working plans.

A significant progress in the preparation of systematic working plan was made during the period 1884–1914 because of the diligent efforts of forest officers and upgrading of scientific knowledge after the publication of the first standardized form or code for writing working plan in a book "Preparation of forest working-plans in India" by D'arcy (1891). This provided adequate guidelines for the systematic preparation of working plans. The working plans prepared under this period were brief and simple yet systematic although they usually lacked stock-mapping and demarcation of forest compartments. This was mostly because of the non-availability of maps on suitable scales (FRI, 1961). Yields were mostly controlled by area as working plans lacked adequate enumeration of growing stock. After the establishment of Imperial Forest Research Institute in 1906 at Dehradun (renamed as Forest Research Institute – FRI) to organize and lead forestry research in the country, the work of checking working plans was given to the Superintendent of Working Plans stationed at FRI. From this point onwards, working plans reached the stage of academic discussion in India and received various scientific inputs based on findings of research undertaken for the enumeration of growing stocks and working of

forests based on silvics (the study of the life history and characteristics of forest trees especially as they occur in stands and with particular reference to environmental influences) of the species, techniques of regeneration, silvicultural treatments, volume and yield tables, and other scientific inputs. Uttar Pradesh, the host state of FRI during the period achieved major progress in the preparation of working plans while the other states also made noteworthy progress.

After India became independent in the year 1947, forest departments made great effort to bring forests of the country under the working plans. Different states/provincial governments adopted their own provincial working plan codes appropriate to their regional requirement and thus it lacked uniformity at the national level. In 1923, Trever and Smythies prepared handbook titled “Practical Forest Management” describing procedures for the preparation of the working plan. This was followed by the publication of the first code of working plan which was adopted by most of the states for a much longer time (Melkania, 2007). In 1929, Ribbentrop prepared a working plan code for Uttar Pradesh which was later revised in 1952 by Seth (Singh, 2007b). After independence, different states prepared codes for preparing working plans suiting their local requirements thus working of forests lacked uniformity at the national level. Among all codes of this period, the most quoted code was “Uttar Pradesh Working Plan Code” by Mr. SK Seth published in 1962 (Singh, 2007a). Moreover, working plan preparation got further strengthened after the creation of full-fledged Ministry of Environment and Forests (MoEF) by bifurcating the Ministry of Agriculture in 1985 (renamed in 2014 as Ministry of Environment, Forest and Climate Change, MoEF&CC) showing its strong commitment and the acceptance of climate change as a key issue in conservation and management of natural resources.

A major turning point occurred in the year 1995 when Mr. TN Godavarman Thirumulpad filed a writ petition with the Hon. Supreme Court of India to protect the Nilgiris forest land from deforestation by illegal timber operations (famous as *Godavarman* case) and the Court suspended tree felling across the country. In its first order in 1996, the Supreme Court interpreted the word forest by its dictionary meaning while applying the Forest Conservation Act (FCA) of 1980, according to which any forest, regardless of ownership, would be subject of the FCA. Section 2 of the Act specifies that no State Government or other authority may allow the use of any forest land for any non-forestry purpose without prior approval from the Central Government. The Court order temporarily suspended all tree felling in all forests with the exception of prescriptions of working plans of FMUs as approved by MoEF. The 1996 Court order allowed tree felling subject to the condition that States prepare working plans to be approved by the MoEF. Until the 1996 order of the court, States have been extremely slow in preparing and implementing these working plans. Between 1997 and 2002, only 14% of working plans were completed, and in 2001 the states of Manipur and Mizoram had still not submitted any working plans at all (Rosencranz, Boenig, & Dutta, 2007). Corollary to the Court’s order, the MoEF adopted a uniform code, the National Working Plan Code – 2004 for the preparation of working plans for the management of forests under the prescriptions of a working plan. The Code works as a guiding set of instructions for the preparation of the working plan in India in a uniform manner following the standardized procedures mentioned in the code. From this point onwards, uniformity could be seen in the preparation of working plans of India among the various states.

A brief account of the evolution of working plan in India

1837: Introduction of the working plan in India by Mr. UV Munro, the Superintendent of Forests in Travancore.

1840: The famous teak plantation works of Nilambur by Conolly and Chattu Memon considered as the birth of human-induced forest management in India.

1860: Sir Dietrich Brandis prepared the first forest management plan for Pegu Yomo Forests of Myanmar.

1882: Decentralization of forest department which acted as a major setback for the management of forests following the principles of a working plan.

1884: Wilhelm Schlich, the Inspector General of Forests, brought the control of the preparation of the working plan and the management of forests under the prescriptions of the working plan under the centralized control of his office for the whole India.

1891: WE D'Arcy wrote book "Preparation of Forests Working Plans in India" and illustrated guidelines for the preparation of working plans in a systematic manner.

1906: Establishment of the Imperial Forest Research Institute, Dehradun (later renamed as Forest Research Institute) to organize and lead forestry research in the country. The work of checking working plans was given to the Superintendent of Working Plans stationed at FRI.

1923: Trever and Smythies prepared handbook entitled "Practical Forest Management" describing procedures for the preparation of the working plan.

1929: Ribbentrop prepared working plan code for Uttar Pradesh, India.

1952: Seth revised the working plan code of Uttar Pradesh prepared by Ribbentrop.

1962: Mr. SK Seth prepared Working Plan Code for the State of Uttar Pradesh.

1996: Hon'ble Supreme Court ordered no forestry operations to be carried out in the forests unless accompanied by prescriptions in the working plans of the FMUs as approved by the MoEF.

2004: The Ministry of Environment and Forest, Government of India adopted a uniform code for the first time for whole of India in the name of "National Working Plan Code – 2004".

2014: First revision of the working plan code 2004 was made and a new revised code "National Working Plan Code 2014" was adopted which had a major focus on the sustainable management of forests and biodiversity in India.

Looking at the exigencies of making forest management more people-centric and oriented toward providing goods and services from the forests on a sustainable basis, safeguarding the concerns of biodiversity conservation together with the rights of forest communities for non-timber forest produce, grazing grounds, fuel, water bodies, etc. as per the provision of the Forest Right Act, 2006, and to mainstream the climate change mitigation and adaptation in forest working plans, revision was made in the prevailing code of 2004 and a new working plan code 2014 was adopted which focuses on the sustainable management of forests and biodiversity in India (NWPC, 2014).

Salient features of the National Working Plan Code 2014

The overall objective of the NWPC (2014) is to provide sustainable management of forests and its biodiversity as envisaged in the National Forest Policy of the country. It integrates

the major dimensions of ecological (environmental), production (economic), and social (including cultural) well-being by addressing the concerns of biodiversity conservation and development, JFM, community forest management, fringe forest management, water resource management, soil and water conservation, forest health and diseases, forest fire protection, climate change mitigation and adaptation, carbon sequestration and management, REDD +, etc. through the application of modern tools and techniques for the preparation of working plans.

NWPC (2014) suggests for a periodic revision of the working plans after every 10 years with an exception in revision where the conversion period of the crop is fixed for more than 10 years, the review is suggested at the end of 10th year. Revision is suggested to account for the detailed description of the present status of forest land, the effects of past treatment and to meet the demands of environmental, economic, and social dimensions, lay down the appropriate future prescriptions. The time period for the making of a working plan for a forest division is prescribed as 2 years with an assurance that the entire state (for which working plans are being prepared) gets staggered over the period of 10 years, and the revision of working plans does not accumulate. The responsibility of ensuring all forest workings in a state as per approved working plan is entrusted with the Principal Chief Conservator of Forest, Head of Forest Force (PCCF, HOFF) of the State concerned.

NWPC (2014) attempts to link working plans with the National Forest Inventory (NFI) (http://fsi.nic.in/details.php?pgID=sb_10) and national set of Criteria & Indicator (C&I) for sustainable management of natural forests in India (IIFM, 2014). Collection of data for a working plan has been suggested following the procedure provided in the field data collection manual of the NFI done by Forest Survey of India (FSI), Dehradun (http://fsi.nic.in/documents/manualforest_inventory_2.pdf). However, the Code lacks explicit description and guideline for the trees outside forests which is one of the major sources of wood in India and contributes almost one-fourth of the total growing stock of the country. The limitation is witnessed also for the management of growing stocks outside forests which are not under the preview of working plans and also not under the jurisdiction of forest department. The working plans are prepared for the areas under the control of forest departments and thus demands inter-sector synergy and convergence for managing the growing stocks outside forests.

Assessment of the revised code (NWPC, 2014) confirms that there has been significant attempt while revising the code to meet the national as well as international requirements of supplying up-to-date and harmonized data and information related to a forest management unit of the country through the working plans. Data, maps, and other information of the working plans are expected to serve an important role while preparing reports as a part of national or international obligations. Efforts have also been made for promoting scientifically sound and validated methods of data collection and approach for the field enumerations. This can be well visualized after inspecting the suggested chapters in the making of the working plan as per the revised code which is illustrated in Table 1. Table 2 illustrates the lists of appendices suggested for the working plans. Tables 1 and 2 signify the robustness and worth of working plans while dealing with the issues related to climate change, biodiversity, and SFM.

The revised code attempts to bring coherency in data collection at the national level through the working plans following common protocols. All forest management units are

Table 1. Contents suggested for the working plan as per revised code 2014 (NWPC, 2014).

Executive Summary (along with the constraints faced during writing of the plan)
Chapter I: Introduction Introduction should include: a) Vision statement b) Goals and objectives of management c) SWOT analysis for prescription of strategies for achieving the goals and objectives. d) Expected outcome e) Abstract of plan prescriptions in the following format f) Works prescribed during the Plan period must be given in a tabular form along with annual target in the following format.
Chapter II: Glossary of Terms
Chapter III: List of Flora (indicating Rare, Endangered, Threatened and unique species)
Chapter IV: List of Fauna
Chapter V: Others (List of lichens, algae, fungi, etc.)
PART I (Summary of facts on which proposals are made)
Chapter 1 (The Tract Dealt with): Name and situation, Configuration of the ground, Geology, rock and soil, Climatic parameters
Chapter 2 (Maintenance/increase in the extent of forest and tree cover): Area of forests under different legal classes (RF, PF, UF, and others), Forest area under different working circle/management plan, Percentage of forest with secured boundaries, Land use, land use change and forestry (LULUCF), Threats to the forest, Distribution of different forest types, Tree cover outside forest area, Shifting cultivation (Jhumming)
Chapter 3 (Maintenance, Conservation and Enhancement of Biodiversity): Forest composition and distribution, Plant species diversity, Status of biodiversity conservation in forests, Status of species prone to over exploitation, Conservation of genetic Resources, Fauna and their habitats, Threats and challenges to wildlife, Protection and management of fauna
Chapter 4 (Maintenance and Enhancement of Forest Health and Vitality) Status of regeneration, Area affected by forest fire, Area damaged by natural calamities, Area protected from grazing, Lopping practices, Area infested by invasive weed species in forests, Incidences of pest and diseases, Forest degradation and its drivers, Pollution control and protection of environment
Chapter 5 (Conservation and maintenance of soil and water resources): Area treated under soil and water conservation measures, Duration of water flow in the selected seasonal streams, Wetlands in forest areas, Water level in the wells in the vicinity (up to 5km) of forest area, Status of aquifers
Chapter 6 (Maintenance and enhancement of forest resource productivity): Growing stock of wood, Growing stock of bamboo, Increment in volume of identified timber species, Efforts toward enhancement of forest productivity through quality plantation activities, Carbon Stock, Carbon sequestration and mitigation
Chapter 7 (Optimization of forest resource utilization): Recorded removal of timber, Recorded removal of fuel wood, Recorded removal of bamboo/rattans, Recorded removal of locally important Non Timber Forest Products (NTFPs) including Medicinal and Aromatic Plants (MAPs), Demand and supply of timber and important non-timber forest produce, Import and export of wood and wood products, Import and export of NTFPs, Removal of fodder, Valuation of the products
Chapter 8 (Maintenance and enhancement of social, economic, cultural, and spiritual benefits): Number of Joint Forest Management committees (JFMCs) and area (s) protected by them, Status of empowerment of JFMCs, Labour welfare, Use of indigenous knowledge, Extent of cultural/sacred groves, Ecotourism areas and activities, Social customs, Status of compliance of Forest Right Act (FRA), Other Rights and Concessions, Dependency of local people on NTFPs, Other aspects
Chapter 9 (Adequacy of Policy, Legal and Institutional framework): Existing policy and legal framework and their compliance, Status of approved working plan and compliance, Number of forest offences, Status of research and development, Human resource capacity building efforts, Forest Resource Accounting, Budgetary allocations to the forestry sector, Existence of monitoring, assessment and reporting mechanism, Public awareness and education, Adequate manpower in forest division
Chapter 10 (Five Year Plans): Activities taken up under preceding Five-year plan, (planwise and schemewise) and make summary suggestions for future based on details of the prescriptions provided in various chapters of the plan.
Chapter 11 (Past systems of management): General history of the forests, Past system of management and their results, Special works of improvement undertaken, Past yield, revenue and expenditure
Chapter 12 (Statistics of growth and yield including statistics of forest carbon stock): Site qualitywise local volume table must be developed and applied. Default values used with respect to estimating forest carbon stock must be brought clearly so that specific values can be developed through experimentation and research.
PART II (Future Management)
Chapter 1 (Basis of proposals): Objectives of management, Method of treatment to be adopted, Constitution of working circles, Period of working plan and necessity for intermediate revision
Chapter 2 (Description related to silvicultural aspects, yield, harvest and regeneration): Name of working circle clearly marked on GIS-based maps, General constitution of working circle, General characteristics of vegetation, Felling series, cutting sections and JFM areas, Blocks, compartments and JFM area (marked on GIS-based maps), Special objectives of management, Analysis of the crop, Silvicultural system, Rotation period, Harvestable diameters, Reducing factors and reduced areas, Felling cycle, Division into periods and allotment to periodic blocks (PB), Calculation of the yield, Table of felling, Method of executing the felling, Subsidiary silvicultural operations cleaning and thinning, Regeneration, Associated regulations and measures

Table 2. Appendices suggested for the working plan (NWPC, 2014).

Appendices	Title	Description
Appendix I	Divisional area statement	<ul style="list-style-type: none"> • Listing of block ranges, villages, compartments, subcompartments, coupe. • Composition and density of trees, site quality, growing stock, area, number of cattle units permitted and other details.
Appendix II A	Enumeration and its results	<ul style="list-style-type: none"> • Details of compartment history including major NTFPs. The figures to be detailed by working circles, felling series, blocks and compartments and/or beat, sub-beat and village. • Abstract or summary of assessment of enumeration with estimated total growing stock.
Appendix II B	Biodiversity assessment	<ul style="list-style-type: none"> • Detailed report of biodiversity assessment to be annexed indicating biodiversity richness of the area. • Density (tree/unit area), frequency of occurrence (%), total basal area (m²/ha) and Important Value Index (IVI) of trees, saplings, seedlings, climbers, herbs, grasses and sedges to be tabulated.
Appendix II C	Regeneration surveys	<ul style="list-style-type: none"> • Regeneration survey data to be analyzed and reported.
Appendix II D	Socio economic survey	<ul style="list-style-type: none"> • Report on socio-economic survey indicating dependency of people on forests.
Appendix III	NTFP (including MAPs) Estimation	<ul style="list-style-type: none"> • Estimated quantities along with type of plants, their part, and its utility, area, species, etc. • Scientific and local name of species, location where found, area, potential harvestable quantity, estimated harvest, etc.
Appendix IV	Research plots	<ul style="list-style-type: none"> • List of existing sample plots, linear increment plots, tree increment plots, preservation plots, protected trees, plus and elite trees, NTFPs, seed orchards, etc. • Location and description of each of the plots.
Appendix V	Rights, concessions, grazing regulations, and notifications	<ul style="list-style-type: none"> • All Government settlement reports, orders. and notifications including the notifications under Forest Rights Act (FRA)
Appendix VI	Schedule of rates	<ul style="list-style-type: none"> • The current schedule of rates of timber, NTFPs, and other forestry works
Appendix VII	Leases, contracts, transfers	<ul style="list-style-type: none"> • Details of leases, contracts, land transfer cases (FC Act and FRA), other related activities, etc. • Approved rehabilitation and reclamation plan for each mining lease and stipulated conditions of environmental and forest clearances.
Appendix VIII	Ranges, beats and their headquarters and area	<ul style="list-style-type: none"> • Rangewise and beatwise constitution of blocks and compartments along with maps.
Appendix IX	Buildings and rest houses	<ul style="list-style-type: none"> • List of forest buildings, rest houses, their location by lat./long., number of suites/rooms, distance from road and altitudes, etc.
Appendix X	Divisional Forest Officers	<ul style="list-style-type: none"> • List of DFOs served in the division is given right from the day of formation of the division
Appendix XI	Joint Forest Management (JFM)	<ul style="list-style-type: none"> • The details of JFM villages (range wise) along with location by lat./long., area allotted to JFM, status of micro plan
Appendix XII	Fire	<ul style="list-style-type: none"> • Details of all fire cases (range wise) for at least past three years. • Severity and burnt area
		<ul style="list-style-type: none"> • Others appendices such as list of forest offences may also be added

required to prepare maps following standard protocols. A common projection parameter having the definition of spheroid as WGS84, datum WGS84 and Universe Transverse Mercator (UTM) projection system has been suggested while making spatial layers. Use of modern tools of RS, GIS, and GPS supported with high-end computing devices or work stations has been suggested for the preparation of spatial layers. It has been suggested to incorporate 19 mandatory GIS layers while altogether it suggests for total 41 spatial layers. Table 3 illustrates indicative lists of layers suggested for the working plans.

Table 3. Indicative list of spatial layers suggested for working plans (* indicates mandatory layers) (NWPC, 2014).

S. N.	Spatial layers	Possible sources
1	Division boundary*	Maps in the division/department
2	Range boundary*	Maps in the division/department
3	RF and PF boundary*	Maps in the division/department/SOI toposheets/existing digitized boundary
4	National parks and wildlife sanctuaries*	Maps in the division/department/WII
5	Beat boundary	Maps in the division/department
6	Block*	Maps in the division/department
7	Compartment boundary*	Maps in the division/department
8	Location of all the offices*	Maps in the division/department/GPS
9	Village locations*	Survey of India (SOI) toposheets/Census
10	Road network*	SOI toposheets/Google Earth
11	Railway line	SOI toposheets
12	Forest check gates*	Maps in the division/department/GPS
13	Rest houses	Maps in the division/department/GPS
14	Stream network*	SOI toposheets/Satellite Images/ASTER DEM
15	Nurseries*	Maps in the division/department/GPS
16	High resolution satellite imagery*	National Remote Sensing Centre (NRSC)
17	Forest cover*	Forest Survey of India (FSI)/self-interpretation
18	Forest type/stock map*	FSI/maps in the division/department
19	Police station/chowkis	SOI Toposheets/Police Department's Map
20	JFMCs*	GPS
21	Plantation locations in the last 15/20 years	Maps in the division/department/GPS
22	Forest depots	Maps in the division/department/GPS
23	Fire locations recorded in the last 5 years	FSI's website and conversion of the same in to point coverage
24	Parent geology	Maps from GSI
25	Protected areas*	Maps in the division/department/WII
26	Wildlife corridors	Maps in the division/department/WII
27	Eco-tourism spots	Maps in the division/department/GPS
28	Soil type	NBSS&LUP map on 1:250,000 scale
29	Altitude zones*	ASTER DEM
30	Slope	ASTER DEM
31	Aspect	ASTER DEM
32	Fire affected area	Burnt area mapping using IRS P6 LISS III data
33	Fire sensitive spots	Grid analysis using FSI's forest fire spots data
34	Encroachment*	Existing map in the division/remote sensing based change detection
35	Management areas and working circles	To be identified/created in GIS in the course of preparing WP
36	Location of saw mills	Existing maps/GPS survey
37	Mining areas	Existing maps/GPS survey
38	Grid layer of rainfall	Indian Meteorological Department, Pune
39	Grid layer of temperature	Indian Meteorological Department, Pune
40	Forest research plots	GPS
41	Seed production areas/Plus trees/CSOs	GPS

Integration of climate change, biodiversity and sustainability related issues

The NWPC (2014) provides ample scope to mainstream and addresses the issues of climate change and biodiversity conservation through working plans in India. Detailed systematic enumeration with appropriate geo-coordinates at repeated periodic cycles of working plan revisions which is generally 10 years, ensures spatial and temporal information about the changes in species composition, species range shifts, changing biodiversity, physiological changes in plant life cycles, the growth pattern of species, changing boundaries of forest ecosystems, etc. These changes may be induced by climatic or other stressors including human interferences. To distinguish between the climatic and non-climatic stressors, creation and maintenance of sufficient numbers of preservation and

sample plots have been recommended. These plots are supposed to be representative patches of existing forests as far as possible in their pristine form. The code suggests to preserve and protect these plots from all kinds of disturbances including human interferences so as to allow progression toward climax stage only under the influence of changing climate. This is meant primarily for studying the correlation between vegetation changes under the influence of climate change. On the other hand, systematic working of forests also provides the opportunity for maximizing the yield and improved carbon stocking and thus it is targeted to assist in climate change mitigation.

Managed forest units help in mitigating the climate change impacts by storing additional carbon than the unmanaged or poorly worked forests. Growing trees absorb carbon dioxide from the atmosphere and store them to mitigate global warming effects. Detailed enumeration as suggested in revised code is expected to help in testing and monitoring the carbon sequestration rate and carbon sequestration potential of different silvicultural practices. Systematic measurement and monitoring of carbon sequestration will help in the implementation of the concept of REDD + as adopted by the United Nations Framework Convention on Climate Change. This will assist in developing an appropriate strategy of REDD + implementation for ensuring payments to local people. Chapter 4 and Chapter 6 of the code demand detailed information on the maintenance and enhancement of forest health and forest resource productivity, respectively (Table 1). Table 1 illustrates other required information as separate chapters of the working plan for supplementing information on a wide range of parameters that would provide a holistic view of forest management and its impact at the level of the forest management unit. Uniformity in data collection and enumeration through revised code will help the integration of information available at forest management unit for country-level projection. This will help in planning, designing, and implementing the national and international policies appropriate for sustainable management, use and conservation of forests.

The revised code suggests to integrate the principles of C&I specifically worked out for the natural forests of India through Bhopal – India process (IIFM, 2014) to ensure SFM through the working plans. The sets of C&I is expected to facilitate in evaluating the maintenance of ecosystem integrity together with the enhancement of people's well-being. The Criterion is considered as "a standard that a thing is judged by" or "an identifiable element of sustainability against which forest management can be assessed". Criteria are set forth for defining and clarifying a basic framework for managing forests on a sustainable basis that outlines certain basic Principle. An Indicator is a variable which could be periodically measured to give trends of the suitability of forests (IIFM, 2014). The code suggests compiling information on all eight Criteria of sustainable management as identified by IIFM (2014), which are: 1. Forest area by type and successional stage relative to land area, 2. Protected forest area by type, successional stage and protection category relative to the total forest area, 3. The degree of fragmentation of forest types, 4. The rate of conversion of forest cover (by type) to other uses, 5. Area and percentage of forests affected by anthropogenic and natural disturbance, 6. Complexity and heterogeneity of forest structure, 7. Numbers of forest-dependent species, 8. Conservation status of forest-dependent species. Besides, these criteria are also to be supplemented with all 37 Indicators of IIFM (2014) for the identification and verification of the trends of sustainable in a forest management unit. This makes the working plan holistic in approach for addressing the issues of climate change, biodiversity and sustainable management of the forests.

Carbon inventory: biomass and soil carbon

Carbon inventory at the national level is done mainly through the NFI of FSI. However, to make it more comprehensive and robust, the code suggests forward and backward linkage between forest inventory of working plan and the inventory of FSI. The forward linkages have been ensured by suggesting the working plan methodology of enumeration following the exact methods of NFI. The code suggests using NFI data as a historical reference for a particular forest grid as backward linkage. The code has adopted grid-based systematic sampling of NFI for the working plans to ensure the linkages between NFI and working plans. The grid-based systematic sampling design also offers a better opportunity to revisit the area for change detection. The total carbon stocked in the forest is divided into different pools similar to the Good Practices Guidance developed by IPCC (2003). Changes in carbon stocks in these pools are to be estimated following the methods of IPCC (2003). Working plans are suggested to highlight the gaps in data collection and research needs explicitly for further refinement of the inventory. Use of IPCC Tier 2 and Tier 3 methodology has been suggested to provide estimates of greater certainty. This is expected to have a better link between biomass and soil carbon dynamics.

A detailed enumeration of trees for the distribution of trees into diameter classes of different species has been limited to the measurement of standing biomass of trees having diameter at breast height above 10 cm. The code does not suggest enumeration of trees below 10 cm diameter. However, for the estimation of carbon stock additional nested quadrats of size 5 m x 5 m has been suggested for the estimation of dead wood above 5 cm diameter, subject to the availability of resources and fund. All woody litter below 5 cm diameter is to be enumerated from the four nested quadrats of size 3 m x 3 m and from the same plot, all shrubs and climbers are to be uprooted and weighed for the estimates of biomass and carbon. Estimate for the herbs, grasses and leaf litter and data on humus and soil carbon of the forest floor is to be obtained from the nested quadrats of 1 m x 1 m plots of NE and SW corners and a pit of size 30 cm x 30 cm x 30 cm is suggested within these plots to collect composite samples of soil for the estimate of soil organic carbon. The schematic diagram of field enumeration plots is shown in [Figure 1](#). The code appears skeptical while making enumeration at these finer details as it suggests to collect information from the national inventory of FSI, if the survey is restrained by cost.

Biodiversity and its conservation

Biodiversity assessment of the forests has been suggested in the working plans for the flora, fauna, and the microorganisms. It has not just been limited to the assessment, but it also stresses for the information on maintenance, conservation, and enhancement of biodiversity. Enumeration of plants in terms of density (number of trees per unit area), frequency of occurrence, dominance for the trees, shrubs, sapling, herbs, climbers, grasses, sages has been suggested. Information on biodiversity of animals and other microorganisms, from species to ecosystem levels has also been suggested. Introduction chapter (Chapter 1) as indicated in [Table 1](#), recommends the listing of flora, fauna, lichens, algae, fungi, etc. The detailed assessment has mainly been advised for the major plant and faunal species while the assessment for the lower forms of life such as algae, fungi,

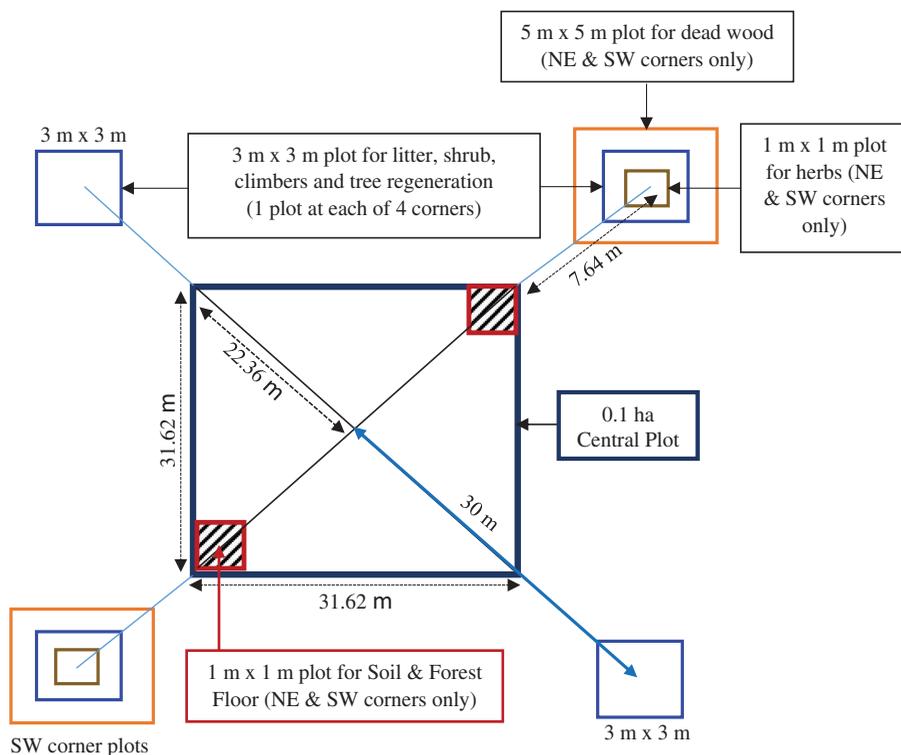


Figure 1. Schematic representation of field enumeration plots (NE: North East, SW: South West) (NWPC, 2014).

lichens, epiphytes, parasites, etc. is suggested to be done with the support from State Biodiversity Boards constituted after the enactment of Biodiversity Act, 2002. The number of species and the changes over time has been suggested for the monitoring of biodiversity of major species. These changes include the status on number and abundance of floral and faunal composition, identification and listing of important Rare, Endangered and Threatened (RET) species together with the status of invasive species. Inclusion of enough number of variables for its reporting under various chapters of the working plan ensures monitoring of forest biodiversity trends as per the indicative lists of major variables of COST action 43 group of European Union (E43, C, 2006). This is expected to assist in developing conservation and management plan for the improvement of biodiversity. Sustainable use and harvest of the species by the communities are to be ensured by restricting the rights in a way that it suffices the sustainability as defined under the Biodiversity Act 2002 which states “sustainable use means the use of components of biological diversity in such a manner and at such a rate that does not lead to the long-term decline of the biological diversity thereby maintaining its potential to meet the needs and aspirations of present and future generations”.

An exclusive chapter (Chapter 3) on Maintenance, Conservation, and Enhancement of Biodiversity is suggested for the working plans (Table 1). This largely deals with providing information on the composition and spatial distribution of the species. Status on *in-situ* and *ex-situ* conservation of RET and IUCN Red List species is to be elaborated. The plan

should also have the status of species prone to overexploitation. Fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge of indigenous people is to be ensured as per the provisions of the Biological Diversity Act 2002. The documentation and monitoring of genetic resources for its conservation and the identification and description of flagship wild species including mammals, birds, reptiles, amphibians, etc. is to be provided. Information on prioritization of sites of habitats of important species is to be delivered along with the description of habitat fragmentation, habitat loss, illegal trade, extended habitats in proximity to existing habitat and man-animal conflict-related issues. It should also describe in detail the measures taken for all conservation efforts together with their major impacts witnessed. The overall aim of the plan should focus on the maintenance, conservation, and enhancement of the biodiversity largely following the principles of Biodiversity Act, 2002.

Climate change impact, adaptation, and mitigation-related issues

Forests and climate operate at varying spatiotemporal scales. Role of forests in influencing the climate and vice versa is becoming a matter of concern for understanding climate change. Therefore, forests have emerged as a global common concern in recent years for defining its crucial role in mitigation and adaptation strategy for climate change (Kumar, 2018). Climate change and variability affect the ability of land resources to support different types of forests (Dale et al., 2001). Thus, forests are exposed to various levels of vulnerability under the influence of climate change. Understanding vulnerability of forest ecosystems and the probable impacts is crucial for the effective management planning of forests to address adaptation and mitigation options. Therefore, there is a need for the consideration of issues related to impact, adaptation, and mitigation in working plans.

The revised code aims at improving the forests and its productivity through effective intervention and planning and thus increasing the carbon sequestration capabilities of the forests which reduces the atmospheric carbon dioxide concentration. Deforestation and degradation related issues of forests are to be addressed through the working plan for the implementation of issues related to REDD + and ensures efforts and mechanisms to measure forest carbon. The code, therefore, directly or indirectly deals with the issues of climate change impacts, adaptation, and mitigation. The revised code ensures adequate monitoring through measurable and verifiable indicators of climate change. Monitoring of climate change impacts is supported through the detailed observation which is to be recorded and revised periodically as per the suggestion of revised code. The systematic observations based on grid-based sampling make it possible to monitor the changes periodically. As the forests generally operate on large temporal scales, it becomes necessary to monitor the changes occurring within the forests at various levels preferably for a longer duration which is supported by the working plan code. Climate change impacts are generally assessed through measuring changes in other associated attributes of forests which can be a consequence of direct or indirect impacts. The code ensures monitoring of these attributes in the form of species range shifts, changing biodiversity, extinction of species, physiological changes in plant life cycles, forest growth pattern of species, changing boundaries of ecosystems, changes in other factors which can stress forest ecosystems. Evidence which can be linked to climate change such as the increase in the

frequency and severity of forest fires, changing water regimes and expanding forest insect infestation, etc. are also to be monitored through the working plans.

Projection of climate change impacts upon forests by using climate envelope models and niche-based models for mapping habitat suitability and shifting of habitats under projected climate change scenario require data and field-based observation for testing and validation of models. Working plan code provides scope to document variables which can be used for habitat suitability modeling. In recent years, climate change impacts are also projected by using a dynamic vegetation model such as IBIS (Foley et al., 1996), LPJ (Sitch et al., 2003), JULES (<https://jules.jchmr.org/>), etc. (Kumar et al., 2018). This requires information on various input variables related to climatic/meteorological data, topographic, land, or soil related data in addition to the information related to vegetation and its physiological attributes. The revised code suggests for the compilation of majority of the information that can be used for climate change vegetation modeling; however, it has very limited scope to measure and compile information related to vegetation physiology and functional traits necessary for performing growth simulation by using process-based dynamic vegetation models. Physiology and plant functional trait-related information for testing these models primarily include data on slope of stomatal conductance relationship (non-dimensional), intercept of the stomatal conductance relationship ($\text{mol H}_2\text{O m}^{-2} \text{s}^{-1}$); maximum Rubisco activity ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{s}^{-1}$), specific leaf area ($\text{m}^2 \text{ kg}^{-1}$), allocation factor of the total photosynthate in leaf, root and stem, residence time of carbon in years in leaf, root and stem, plant traits of growth form, etc. The incorporation of such information in the working plan for selected forest ecosystems could be suggested to make the plan more scientific and comprehensive. However, systematic continuous observation suggested by the code helps in identifying the trends of habitat shifting for the important species, tracing the changes of productivity and other associated impacts related to climate change. This provides an opportunity to develop conservation and adaptation plans to mitigate the impacts of climate change.

Opportunities and way forward to mainstream the issues of conservation through working plans

Forest working plan is probably the first record of detailed planning in the modern Indian economy. The systematic approach for the management as well as monitoring of the forests has been dealt with in the revised code. The updating of the records on a temporal basis for the compartment history, control forms, annual plan of operations, etc. gives a unique opportunity for understanding and dealing with the conservation-related issues. Earlier, the prime focus of the working plans was to scientifically manipulate the forests in a way to gradually replace original native species with the preferred species of commercial importance such as Teak and Deodar. However, through the revised working plan code the focus is more toward the conservation of the forests while meeting the societal needs. This includes the protection of the rights of people inhabiting in and around the forests for the regulated extraction of forest produce upon which they are marginally dependent.

Available information on the socioeconomic status of the communities is suggested to be utilized for evaluating the dependence of the communities living in fringe villages or inside the forests. The magnitude and extent of extraction of timber, fuelwood, fodder, NTFPs, grazing,

and other livelihood related aspects need to be evaluated as per the revised code. All the villages within the reach of 3 km from the forests are to be recognized as forest fringe villages for which socioeconomic evaluation is suggested. The number of JFM committees, areas protected by them and the empowerment status are required to be documented in working plans. The extent of cultural and sacred groves, social customs, ecotourism areas, compliance of forest right act or any other rights as given by the central or the local government, kind of concessions given to the communities and other related aspects are to be compiled in the working plans. These all aspects primarily focused on social establishments and its direct relationship with the forests is to be presented exclusively as a separate chapter (Chapter 8) (Table 1). This provides an excellent opportunity to trace the socioeconomic conditions of the people over a period of time and formulate an action plan for uplifting the socioeconomic conditions. At the same time, available information will definitely help policymakers to formulate plans that have orientation for reducing their dependency upon the forests without compromising with the improvement of their economic conditions.

The information to be compiled following revised code has ample scope for planners to have a quick insight into the multitude of conservation aspects. This includes information related to the floral and faunal diversity, status of threatened categories of flora and fauna, health of the forests from its canopy to soil, productivity of the forests, climate change impacts upon forests, type and extent of social pressure that drives forest degradation (forest resource dependence) or its conservation (like sacred grooves) and other issues of conservation. The focus of the government has now shifted more toward the conservation as compared to the earlier approach of extraction for meeting industrial requirements. This is also reflected in the revised working plan code. The focus is now for the extraction of NTFPs instead of the timber. The intentions are more for utilizing NTFPs as a source of revenue and livelihood support to forest-dependent communities without comprising with the forest conservation. More stress is toward the improvement of the degraded forest lands, gap filling of open space to improve the diversity and density, actions for enhancing the productivity of the forests and adoption of silvicultural practices for cleaning, thinning and improving regeneration of the forests. The revised code inherits the major merits of conservation practices. Moreover, the code provides an opportunity for the planners and managers to have a quick overview of the needs and prioritization options for the conservation.

Recommendations

The NWPC inherits the merits of the sustainable management of forests. The code aims at conservation of the forests together with the improvement of its health and productivity. The code ensures to protect the rights of the people for regulated extraction of forest products making it social oriented. The working plans formulated on the guidelines of NWPC for a given FMU provide a consolidated overview of planning and management, salient features, resource related issues, inventory of resources, future recommendations and other information crucial for the planners in quick decision-making. In the absence of working plans, every so often the information might be available in the discrete form requiring compilation for collecting overview of the forest units. Given all the merits which recent NWPC inherits, there can be few suggestive steps to further improve it. Some of the suggestions are described below.

- (i) Although the working plans represent detailed overview for every forest management units in India, however, it fails to give a holistic picture at the national level. The preparation of the working plans for every unit may not have the same starting point thus the enumeration generally differs in time-space. For example, if enumeration of a unit represents inventory or stock for year 2000, the other units may represent similar information for years other than 2000. This makes it difficult to generate a baseline for the national level assessment which is often a requirement for various international treaties and conventions and also for the national level planning. Most of the information is now mandatory and recommended in the form of GIS layers. This provides an opportunity to integrate available information at the national level (although with a time lag). However, there is no existing mechanism as of now to integrate information at the national level. This makes the utility of the working plan more or less very specific to local applications.
- (ii) The NWPC has adopted the various methodologies of field enumeration from the existing NFI of FSI. This is a welcome sign for making enumeration coherent. However, the code has not clearly mentioned to adopt new methodology once the FSI revises methodology of field enumeration.
- (iii) The preparation of working plan often requires trained human resources of a specific domain such as taxonomist, RS-GIS expert, Socio-economist, etc. Every unit may not have such trained human resources and thus it demands innovation to establish networking of technical staffs in a coordinated manner through some institutional setup. This is expected to facilitate the preparation of a working plan with greater accuracy and efficacy in a timely manner.
- (iv) The major focus of the working plans is now shifted to the extraction of NTFPs which was otherwise toward the extraction of timber. However, there is a lack of adequate knowledge related to the management of NTFPs on a sustainable basis. There should be an adequate focus for making inventory, growth, regeneration, maintenance, harvesting, processing, market linkages, value addition, end use, etc. relevant for each of the identified NTFP species. The code suggests for the support and coordination from the concerned State Biodiversity Board. However, the fact remains that State Biodiversity Boards are themselves struggling with dearth of trained human resources as most of them are at infancy stage of establishment. There is a need to establish a network with universities and research institutes to fulfill the ambitious and genuine requirements of the working plans. Nevertheless, in 1906 the scrutiny of working plans through the superintendent of working plan stationed at Forest Research Institute, Dehradun was for this very purpose which needs to be revived by involving more such institutes to establish linkages of working plans with research.
- (v) Enumeration and revision of working plan at a gap of 10 years' interval may require revisiting of the FMUs in between where the enumeration of NTFPs and other rare, endangered and threatened category species may lose its sight at this wider gap of time.
- (vi) Modelling forest growth and projections of climate change impacts using dynamic vegetation models have been a growing science. However, the testing of existing models and the development of such models for regional applications demand a lot of information for the parametrization of

models. The NWPC could have been more specific for fulfilling such data requirement, which is missing in its present form. Thus, there is a need to compile such information through a working plan in consultation with the modelers.

- (vii) The NWPC specifies for the establishment of the long-term monitoring through preservation plots and permanent sample plots. This is much crucial for studying various successional stages under the influence of climate. However, there is a need to be more pragmatic and demands serious attention for its maintenance and up keeping, as many of the early days plots stands neglected while many are lost. There is a need to encourage proper maintenance of these plots which are precious for forest research and NWPC can act as a promising instrument.
- (viii) The NWPC should incorporate suggestion to collect statistics that could be helpful for a forest-based entrepreneur. A comprehensive account of raw materials, cost, estimates of supply and demand, etc. appropriate for forest-based industries could find its place in the working plans. The short-term and long-term goals for the development of forest-based industries could be highlighted at the regional level. This will encourage the proliferation of forest-based industries which will eventually assist in the uplifting of economy of the local people.
- (ix) A field guide in the form of a practical manual for each of the enumeration, activity, data compilation and other processes involved may be documented as a handbook for the staffs involved in the preparation of working plans.
- (x) The prescriptions of working plans should be coherent with the priorities and objectives of the state-specific action plans on climate change.

Conclusion

The working plans have been the scientific basis of forest management in India over a century. The working plan for a forest unit is prepared following the suggestion drafted in the working plan code. Working plan code is revised periodically to meet the present-day requirements and the most recent revised code is of the year 2014 named as National Working Plan Code – 2014 (NWPC). The NWPC tries to integrate vital information necessary for sustainable management of forests and biodiversity. It also necessitates the implementation of actions that are appropriate to manage a forest to ensure sustained yield and improve its health. At the same time, the code also ensures to protect the rights of forest dwellers for the regulated extraction of forest-based resources. The supply of fuel, fodder, and NTFPs from the forests to support the livelihood of the people inhabiting in and around the forests is supported by the code. The code provides a scientific basis of managing resources while meeting the present and future demand. The focus on biodiversity conservation is not limited to the assessment but it also demands information on maintenance, conservation, and enhancement of biodiversity. The code recognizes the importance of climate change related issues and finds a place for the assessment of impacts in the form of species loss, alteration in type, distribution, and composition. The utilization of modern tools has been visualized in the form of application of RS-GIS, GPS, computational and analytical systems for near real-time monitoring of resources while up keeping the past records in digital formats. Although there still lies a gap as discussed by us, nevertheless, the NWPC seems to be a promising guide for the planners

and managers to scientifically manage the forests for achieving the common goal of sustainable management.

Acknowledgement

Authors are thankful to Sh. SR Reddy, Asst. Silva (Experimental), Forest Research Institute, Dehradun for his critical insight and appropriate suggestion at multiple places while compiling the information.

Competing interest

Authors declare that there are no competing interests while submitting the manuscript for its publication.

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