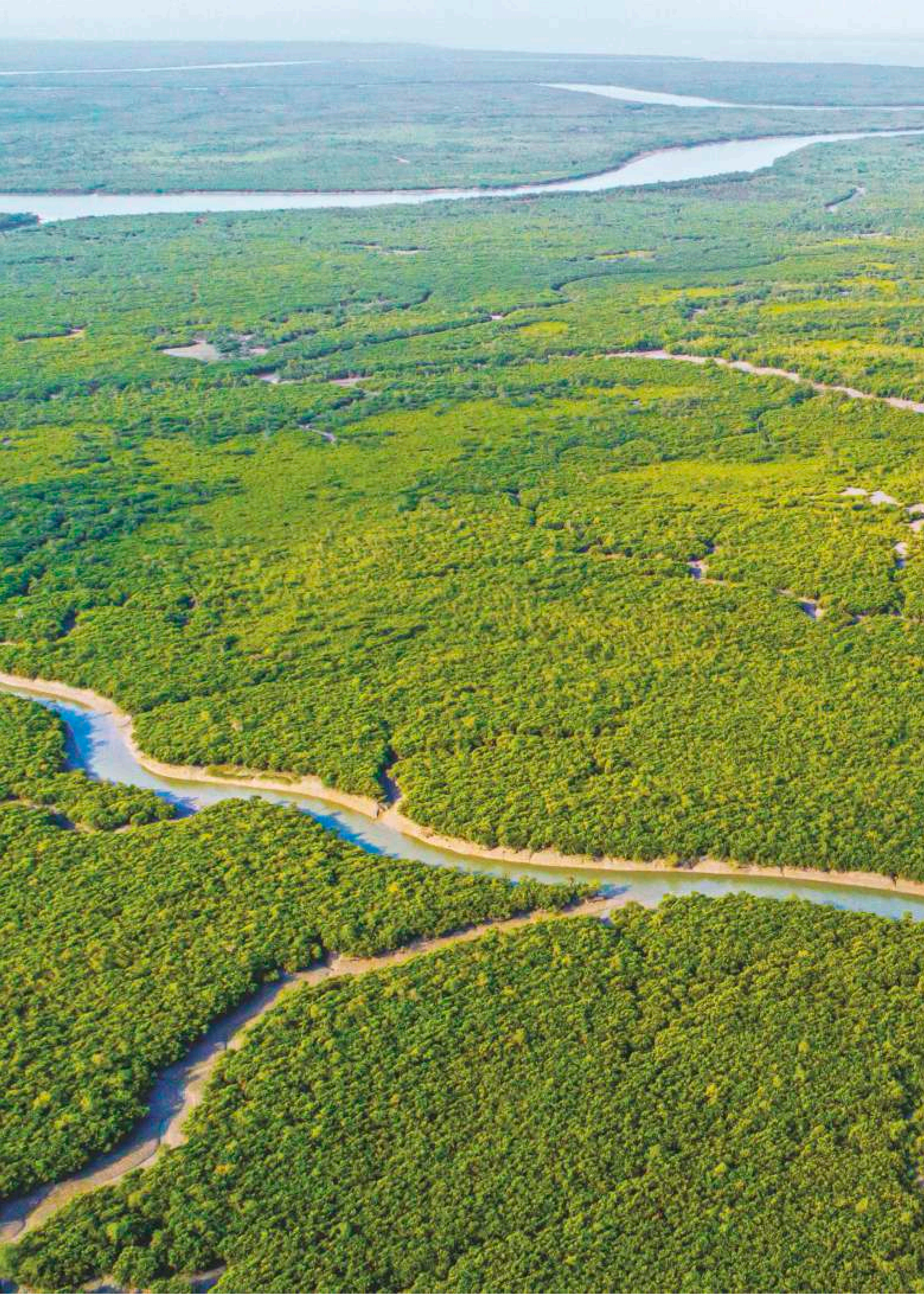

12

NEW INITIATIVES

Introduction 12.1

There is continuous endeavor at FSI to keep pace with technological advancements to meet the information needs of the forestry sector. From time to time new initiatives are taken, which contribute significantly in updating methodologies, generate new information and eventually leading to greater precision and enhancement of knowledge. Information about some of the important initiatives undertaken in the last two years and published as Technical Information Series of FSI are being presented in this chapter.

Trees Outside Forest Resources in India[1] 12.2

Trees Outside Forest (TOF) resources play a vital role in the socio-economic life of rural India and generate valuable ecosystem services in urban and rural parts of the country. These are found in diverse formations in the rural and urban landscapes in the country like small woodlots, block plantations, trees along linear features such as roads, canals, bunds, etc. and scattered trees on farmlands, agricultural lands, homesteads, community lands and urban areas. Timber and panel products of TOF origin have emerged as the major alternative to timber from forests and thus TOF have significantly obviated pressure from forests. It also acts as an important source for timber and fuel wood and contributes to carbon sequestration and conservation of biodiversity, provides habitat for wildlife and help in microclimate stabilization. Thus TOF resources contribute significantly to sustainable agriculture, food security and rural household economies.

Considering the ecological and economic importance of TOF resources, the Technical Information series focused on TOF resources in India, evolution of assessment methodology and important outcomes. The TOF methodology that was followed from 1991 to 2001, was confined to State or group of districts only. The study area was stratified according to agro-ecological zones (AEZ) and village was taken as sampling unit for the inventory in rural areas. For urban TOF, the Urban Frame Survey (UFS) block maps of National Sample Survey Organization (NSSO) were taken as sampling unit. This was modified in 2001 and was continued till 2016. Under this methodology, the country was stratified into 14 physiographic zones based on the similar vegetation type, climate, soil etc. Thereafter, 60 districts spread over the entire country representing all the physiographic zones were selected for the detailed inventory of TOF in a cycle of 2 years. For inventory of TOF (Rural), high-resolution satellite data was used to stratify TOF resources of the selected districts into three strata, namely block, linear and scattered. The methodology of TOF assessment was further improved in 2016 and the cycle of the new design for TOF was fixed at 10 years. All TOF grids are marked with numbers 1 to 10 in a sequential manner. Grids of a particular number are taken for

[1] *FSI Technical Information Series Volume 2, No. 1, 2020*

inventory in a particular year. Both TOF (Rural) and TOF (Urban) inventory are carried out in the selected grids.

In this Technical information series, for the first time, the extent of TOF in the country has been assessed at 29.38 m ha which is 8.94% of the total geographical area of the country. TOF form nearly 38% of the carbon sink in forest and tree cover of the country. The scattered and block plantations contribute more than 90% of the TOF volume of the entire country. *Mangifera indica, Azadirachta indica, Acacia arabica* and *Cocos nucifera* are the major species found in TOF in rural areas which are contributing most to the total growing stock, whereas, *Cocos nucifera, Areca catechu, Mangifera indica and Azadirachta indica* are the major TOF species in the urban areas of the country.

The potential annual yield of timber from TOF using the inventory data has been generated on the basis of dominant species. For calculation of potential annual yield, only timber species were considered. The rotation period of different timber species available with FSI from State Forest Departments and other sources was used. Using the estimates of growing stock and rotation period of the species, annual potential yield was calculated for each State by applying Von Mantel's formula. The potential annual yield of timber from TOF has been assessed at 85.16 MCUM.

12.3 India's Nationally Determined Contribution of creating an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 eq through additional forest & tree cover: Possibilities, scale and costs for formulating strategy[2]

Under the United Nation Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) in Paris in December 2015, countries made post 2020 climatic action commitments called Nationally Determined Contributions (NDC). The NDCs will largely determine whether the world will achieve an ambitious 2015 agreement and is put on a path towards a low-carbon, climate-resilient future 'by keeping global temperature rise in this century well below 2° Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5° Celsius[3] (UNFCCC, 2015)'.

India has submitted its NDC to the UNFCCC in October 2015, which outlines the post 2020 climate actions the country intends to take under a new international agreement. There are three quantified targets in India's NDC; the first one related to emission intensity of GDP, second about the contribution of renewable energy to the overall installed power and the third about achieving additional carbon sink of 2.5 billion to 3.0 billion tonnes through additional forest and tree cover by 2030. This Technical Information series focusses on the third target related to forestry sector.

Achieving this ambitious target requires a well-planned strategy taking into consideration all possible interventions within the forests and all other available lands. With an objective to provide important inputs in formulating a strategy to achieve the NDC target, FSI had undertaken a detailed exercise for exploring the possibilities. The implications of above NDC target in terms of actions on the ground, associated cost and carbon sequestration levels etc were analyzed in this exercise. A bottom-up approach was followed wherein computations for each State has been done according to the States' circumstances and available lands and using State, forest type and physiographic zone specific emission/removal factors and cost norms.

An attempt has been made first to understand the magnitude and scale of actions required to achieve the target and then the possibilities of implementation, while looking at the availability of

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[2] *FSI Technical Information Series Volume I, No. 3, 2019*

[3] *Paris agreement, UNFCCC, 2015*

land for different activities. The study is based on calculations on time series data on forest cover, its past and projected changes i.e flux, stratification of changes (activity data) in terms of forest types, emission and removal factors for each forest type and land use and land cover area figures. The figures used in the study are largely from the primary data reported by FSI in ISFRs. Data on land availability under different categories has been taken from different credible sources.

Analysis of trend of carbon in India's forest & tree cover vis-à-vis NDC target helps in understanding implication of increasing carbon sink through forest & tree cover. The study presents different scenarios and magnitude of actions required for achieving the NDC target for creating additional carbon sink through additional forest and tree cover in the country. The information may be found useful in providing inputs for drawing a comprehensive strategy to achieve the NDC target in terms of possible interventions, potential carbon sink in respect of each intervention and cost involved in implementation.

Trend of carbon sink through forest & tree cover analyzed in the study, provides an understanding of the implications of the NDC target vis-a-vis creation of additional carbon sink by different activities of restoration of forests and tree plantations. The study, reveals that if the NDC target is not above the 'Business As Usual (BAU)' level, then the increase in carbon sink by 2030 to the target level may be achieved by just sustaining the existing policies and programmes of conservation and afforestation.

12.4 Variability in forests and optimum sample size for estimation of Growing Stock in different districts of the country: a ready reckoner for working plan preparation or any other forest resource assessment exercise[4]

Information on forestry parameters such as distribution of timber species, volume, biomass, carbon stock, regeneration status, population etc is vital for Forest managers, planners and policy makers for strategic planning and management of forest resources. On the basis of forest resources assessment, the past growth and productivity of a forest area is evaluated for sustainable forest management.

Encompassing the ecological, economic and social dimensions of the National Forest Policy, it is necessary to carry out monitoring and assessment of forest resources (with regard to biodiversity, climate change and carbon emission/sequestration) on the basis of sound, statistically robust sampling design, especially in the present changing scenario of forest resources management. The scientific management of the forests is essentially required at all levels, for planning and management of forests.

Working plan is one such important tool which helps in evaluating the status of forest resources, assessing the impacts of past management practices and deciding about suitable management interventions for the future. In Working Plans, growing stock has traditionally been used for calculation of sustainable yield of timber from forests. Growing stock is an important indicator of forest productivity which has gained importance due to the significant role of forest in climate change mitigation. The growing stock data forms the basis for calculation of biomass and carbon stock in the forest. Further, the United Nations Framework Convention on Climate Change (UNFCCC) guidelines for implementation of REDD+ requires that every country should have a National Forest Monitoring System (NFMS) consisting of satellite based forest monitoring system and National Forest Inventory.

[4] *FSI Technical Information Series Volume 2, No. 3, 2020*

Forest inventories are primarily aimed at assessing the growing stock and other quantitative and qualitative parameters of the forests. Forest inventory is mostly a sampling based exercise. Determination of sample size is an important step in constructing a sample design. This document provides optimum sample size for different districts of the country for conducting inventory to estimate growing stock. It gives district wise information on coefficient of variation (CV) and sampling intensity of growing stock at different allowable errors. The optimum sample size i.e. optimum number of plots to be included in the sample, which may provide the estimates of population parameters within the prescribed limit of error, is of great importance. Thus instead of prescribing sampling intensity, the allowable level of error in the estimates at division/range level say 5% to 10% at the 95% confidence level is fixed.

As any sample survey involves cost, time and manpower, it is necessary to have optimum sample size for timely completion of the survey within the prescribed budgets. The sample size depends mainly on the variability of the attribute (parameter) under assessment and permissible error. The surveyor can decide the sample size at different allowable errors depending upon availability of man power, time and cost. Both variability and allowable errors will have bearing on the sample size. More the variability of main characteristic means larger the sample size. Similarly, lesser the allowable error means larger the sample size.

12.5 A new grid-based algorithm for detecting locations of change in forest vegetation in a pin-pointed manner over large landscapes[5]

Forests are facing increasing pressure due to rapid growth in population, industrialization, urban sprawl, infrastructure projects, spreading of agricultural land use and adverse climate change. In this scenario, close monitoring of forest resources has become an essential requirement for managing the forest ecosystems for ensuring environmental benefits to the society. With the growing pressures on the country's forest, now there is an emerging need of detecting the changes occurring in the forests at an early stage, in an accurate manner with reduced cycle of revisit.

In India, Forest Survey of India (FSI) is engaged in regular monitoring of forest resources in the biennial cycle using remote sensing technique and forest inventory.

In this regard, a new index called 'Grid Vegetation Change Index' (GVCI) has been used to detect changes in forests through grid based approach in a rapid manner for operational use. Four study areas, each of size approximately 400 sq km have been taken from different regions of the country namely East, West, South and North as test sites. The results of the study consistently show that the values of GVCI above a threshold, highlights change in forest vegetation with high accuracy, wherever significant change in forest vegetation has taken place. The smallest area of detecting change in this study has been kept at 1.44ha (i.e a grid size of 120m by 120m) which corresponds to area of 16 pixels of Landsat 8 data. The positive GVCI value corresponds to vegetation gain and on the other hand the negative GVCI values correspond to vegetation loss.

This, being a ratio based index, it minimizes the atmospheric effect and radiometric differences among the multi-temporal satellite images. The Vector Grid based approach used to calculate GVCI, also minimizes the errors of geo-registration.

The algorithm can be used to generate SMS alerts to notify the forest vegetation loss to the concerned officials who have registered their mobile numbers for the areas of their interest.

GVCI can be used as an operational application in detecting change in vegetation over an area of interest between two time-periods. GVCI numerical value provides quantified assessment of the degree of change. By applying the GVCI on a pair of remotely sensed images of two dates of an

[5] *FSI Technical Information Series Volume 2, No. 4, 2020*

area, one can know degree of vegetation change in every unit area (grid) of the large landscape. Based on the GVCI values, one can select those grids which show significant changes. Such 'candidate grids with significant changes' may be shortlisted for ground verification and studying the causes of change. Since the change identification is based on the index value, it is free from human subjectivity or bias.

Rapid assessment of fire affected forest areas in the country based on MODIS-detections following a sampling approach[6] 12.6

Assessment of burnt forest area provides an important input for understanding the ecological, social as well as economic impacts of forest fires. This study was carried out with the objective of developing a methodology for rapid assessment of burnt forest areas at the country-wide scale based on a statistical sampling approach. Forest Survey of India issues alerts of forest fires based on near-real time detections of forest fires by MODIS sensor. Detected forest fires in the country based on MODIS data during the fire season of 2019-2020 has been used as population for assessing the burnt forest areas in the country. The total burnt forest area in India for the fire season 2019-2020 (i.e. from 01st November, 2019 to 30th June, 2020) has been assessed 11,094 sq km with 95% confidence level, which is 1.56% of the total forest cover area of the country. Among the different physiographic zones, the maximum forest burnt area has been found in Deccan (5626 sq km) followed by Central Highlands (2160 sq km). These two physiographic zones together has contributed to 70% of the total forest burnt areas. In contrast, north-east region with maximum number of MODIS detected forest fire points in the last fire season, has only 12.50% of the total forest burnt areas.

The methodology developed is a simple and reliable procedure to estimate the forest burnt areas in a cost-effective and time-efficient manner. The burnt area estimation would be a useful data for damage assessment and planning of restoration activities in fire affected forest areas.

Hand Book of Index Maps of India for Indian Remote Sensing (IRS2) Satellite LISS-III and SOI Topographic sheets 12.7

FSI is engaged in Forest Cover Mapping of the Country since 1987 using satellite data. Wall-to-wall Forest Cover maps are prepared on 1:50,000 scale at biennial interval. The primary source of satellite data is from Indian Remote sensing series (IRS) of satellite, which is procured from National Remote sensing Centre (NRSC), Hyderabad. Survey of India (SoI) Topographic sheets i.e. 1:2,50,000 and 1:50,000 are also used in mapping exercise.

Forest Cover mapping is carried out using a standardized methodology with sequence of steps to be followed by the analysts. The first step in the mapping exercise is to acquire the satellite data of appropriate season of the required area. For this, it is essential that information about the area of interest and its coverage of satellite image is known to assist the analyst in accessing above information. The "Hand book of Index map for Indian Remote Sensing (IRS2) satellite LISS-III and SoI Topographic Sheets" has been prepared with the objective of serving an important purpose of being a ready reckoner to correctly know the number of topographic sheets and satellite imagery required for image analysis and mapping of different States and districts. This document will be very useful for State Forest Department, scientists & analysts involved in Natural Resource mapping.

[6] *FSI Technical Information Series Volume 2, No. 2, 2020*