



# PARTNERSHIP FOR LAND USE SCIENCE (FOREST-PLUS) PROGRAM

## Integrated Forest Management Toolbox



JAVHARI K M

**AUGUST 2017**

Forest-PLUS is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of this manual are the sole responsibility of Forest-PLUS and do not necessarily reflect the views of USAID or the United States Government.

**Acknowledgment:**

**Creation of this document by World Resources Institute India (WRI India) and Foundation for Ecological Security (FES) is gratefully acknowledged.**

**Tetra Tech Contact:**

Ben Caldwell  
Chief of Party,  
Tetra Tech ARD,  
159 Bank Street, Suite 300,  
P.O. Box 1397,  
Burlington, VT 05402.  
Tel: (802) 495-0282.  
Email: ben.caldwell@tetrattech.com

**WRI India Contact:**

Marie Duraisami  
Senior Project Associate -  
Sustainable Landscapes and  
Restoration,  
World Resources Institute India,  
2, Balbir Saxena Marg,  
Hauz Khas,  
New Delhi - 110016  
Tel: +91 8754074301  
Email: marie.duraisami@wri.org

**FES Contact**

Jagdeesh Rao Puppala  
Chief Executive,  
Foundation for Ecological Security,  
Post box no. 29,  
Jahangipura, PO Gopalpura,  
Hadgud, District-Anand,  
Vadod – 388370, Gujarat.  
Tel: +91 2692 261303  
Email: jagdeesh@fes.org.in

# Partnership for Land Use Science (Forest-PLUS) program INTEGRATED FOREST MANAGEMENT TOOLBOX

AUGUST 2017

Forest-PLUS is made possible by the support of the American People through the United States Agency for International Development (USAID.) The contents of this manual are the sole responsibility of Forest-PLUS and do not necessarily reflect the views of USAID or the United States Government.

# TABLE OF CONTENTS

<b>ACRONYMS AND ABBREVIATIONS</b> .....	<b>1</b>
<b>I. INTRODUCTION</b> .....	<b>3</b>
I.1 NATIONAL WORKING PLAN CODE, 2014.....	4
I.2 INTEGRATED FOREST MANAGEMENT TOOLBOX .....	5
I.3 SCOPE.....	8
I.4 METHODOLOGY.....	8
<b>2. PHASE I: PREPARATION AND DATA COLLECTION</b> .....	<b>12</b>
2.1 DEFINE SCALE.....	12
2.2 IDENTIFY KEY STAKEHOLDERS.....	12
2.3 DEVELOP GRID AND SAMPLING DESIGN .....	13
2.4 INSTALL NECESSARY HARDWARE AND SOFTWARE.....	14
2.5 CONDUCT AN INCEPTION WORKSHOP .....	16
2.6 DATA COLLECTION.....	17
2.6.1 Forest Resources Observatory .....	17
2.6.2 GFW MapBuilder.....	18
2.6.3 Forest Data Kit.....	18
2.7 OUTPUT.....	21
<b>3. PHASE II: ANALYSIS OF ECOSYSTEM SERVICES, MAP OF POTENTIAL FOREST MANAGEMENT ACTIVITIES AND ECOSYSTEM SERVICES DIAGNOSTIC</b> .....	<b>22</b>
3.1 ANALYSIS OF ECOSYSTEM SERVICES .....	22
3.1.1 Biodiversity Conservation.....	22
3.1.2 Water Resource management.....	24
3.1.3 Carbon Sequestration.....	25
3.1.4 Provisioning Services.....	25
3.2 MAP OF POTENTIAL FOREST MANAGEMENT ACTIVITIES.....	27
3.2.1 Input.....	27
3.2.2 Processing of Information .....	28
3.2.3 Output.....	31
3.3 IDENTIFICATION OF TRADE-OFFS AND SYNERGIES BETWEEN ECOSYSTEM SERVICES .....	31
3.3.1 Input.....	31
3.3.2 Processing of Information .....	33
3.3.3 From Trade-offs to Synergies.....	34
3.3.4 Output.....	35
<b>4. PHASE III: FROM ANALYSIS TO WORKING PLAN PRESCRIPTION</b> .....	<b>36</b>
4.1 DEVELOPMENT OF DRAFT WORKING PLAN.....	36
4.2 VALIDATION WORKSHOP .....	37
4.3 USE OF IFMT RESULTS.....	37
<b>5. CONCLUSION</b> .....	<b>39</b>
<b>ANNEX - 1 CONSULTATION WITH HP FOREST DEPARTMENT TO DEVELOP IFMT</b> .....	<b>40</b>
<b>ANNEX - 2 CREATION OF WEB MAP AND WEB APPLICATION</b> .....	<b>41</b>
<b>ANNEX - 3 INDICATIVE LIST OF LAYERS IN GEOSPATIAL DATABASE</b> .....	<b>50</b>
<b>ANNEX - 4 ADDING LAYERS IN GFW MAPBUILDER</b> .....	<b>51</b>
<b>ANNEX - 5 GUIDELINES FOR FILLING OF FDK FORMS</b> .....	<b>54</b>
<b>ANNEX - 6 BIODIVERSITY ASSESSMENT</b> .....	<b>56</b>
<b>ANNEX - 7 RESULT INTERPRETATION FOR CLART</b> .....	<b>57</b>
<b>ANNEX - 8 DEVELOPMENT OF WORKING PLAN</b> .....	<b>58</b>
<b>REFERENCES</b> .....	<b>60</b>

## LIST OF TABLES

TABLE 1.1: NWPC THEMES AND REQUIREMENTS.....	6
TABLE 1.2: IFMT TOOLS AND NWPC THEMES.....	7
TABLE 1.3: WORK FLOW OF IFMT.....	10
TABLE 2.1: SUMMARY OF FDK FORMS.....	21
TABLE 3.1: DATA LAYERS FOR PREPARATION OF MAP OF FOREST MANAGEMENT ACTIVITIES.....	27
TABLE 3.2: CLASSIFICATION OF DATA FOR MAPPING.....	28
TABLE 3.3: EXAMPLE OF DIAGNOSTIC SHEET FOR PRIORITIZATION OF ECOSYSTEM SERVICES.....	32
TABLE 3.4: EXAMPLE OF DIAGNOSTIC SHEET FOR PRIORITIZATION OF FOREST MANAGEMENT ACTIVITIES FOR ECOSYSTEM SERVICES.....	32
TABLE 3.5: COMPLETED DIAGNOSTIC SHEET FOR PRIORITIZATION OF AREAS FOR ECOSYSTEM SERVICES.....	33
TABLE 3.6 COMPLETED DIAGNOSTIC SHEET FOR PRIORITIZATION OF FOREST MANAGEMENT ACTIVITIES FOR ECOSYSTEM SERVICES.....	34
TABLE 4.1 LIST OF CHAPTERS THAT CAN BE FILLED USING IFMT.....	36

## LIST OF FIGURES

FIGURE 1.1 IFMT OUTPUT IN GFW MAPBUILDER.....	8
FIGURE 2.1 FORMULA FOR CALCULATING SAMPLE SIZE.....	13
FIGURE 2.2 SCREEN SHOT OF GFW MAPBUILDER FOR CREATING WEB MAP.....	15
FIGURE 2.3 SCREEN SHOT OF GFW MAPBUILDER WEB APPLICATION.....	16
FIGURE 2.4 GFW MAPBUILDER WITH LULC LAYER FOR RAMPUR DIVISION.....	18
FIGURE 3.1 EXAMPLE OF SPECIES DIVERSITY IN RAMPUR DIVISION (DUMMY DATA).....	24
FIGURE 3.2 CLART OUTPUT FOR RAMPUR DIVISION.....	25
FIGURE 3.3 EXAMPLE OF AREAS WITH HIGH NTFP DEMAND IN RAMPUR DIVISION (DUMMY DATA).....	27
FIGURE 3.4 DEMONSTRATION OF DATA PROCESSING FOR RAMPUR DIVISION.....	29
FIGURE 3.5 DRAFT MAP OF FOREST MANAGEMENT ACTIVITIES FOR RAMPUR DIVISION.....	31
FIGURE 3.6 MAP OF POTENTIAL FOREST MANAGEMENT ACTIVITIES SHOWING OVERLAP IN ECOSYSTEM SERVICES.....	33
FIGURE A1 PLOT CONFIGURATION OF MAIN PLOT AND SUB-PLOTS.....	54

# ACRONYMS AND ABBREVIATIONS

APCCF	Additional Principal Chief Conservator of Forests
BMC	Biodiversity Management Committee
CCF	Chief Conservator of Forest
CLART	Composite Landscape Assessment and Restoration Tool
DBH	Diameter at Breast Height
DFO	Divisional Forest Officer
DGF&SS	Director General of Forests & Special Secretary
ESS Diagnostic tool	Ecosystem Services Diagnostic tool
FDA	Forest Development Agency
FDK	Forest Data Kit
FES	Foundation for Ecological Security
Forest-PLUS	Forest - Partnership for Land Use Science
FRA	Forest Rights Act
FRI	Forest Research Institute
FRO	Forest Resources Observatory
FSI	Forest Survey of India
GFW	Global Forest Watch
GIS	Geographic Information System
GoI	Government of India
GPS	Global Positioning System
HoFF	Head of Forest Force
HP	Himachal Pradesh
ICFRE	Indian Council of Forestry Research and Education
IFMT	Integrated Forest Management Toolbox
IT	Information Technology
IUCN	International Union for Conservation of Nature
IVI	Importance Value Index
JFM	Joint Forest Management
JFMC	Joint Forest Management Committee

LULC	Land Use and Land Cover
MoEFCC	Ministry of Environment, Forest and Climate Change
NTFP	Non-timber Forest Products
NWPC	National Working Plan Code, 2014
ODK	Open Data Kit
PBR	People's Biodiversity Register
PCCF	Principal Chief Conservator of Forests
PRA	Participatory Rural Appraisal
PWPR	Preliminary Working Plan Report
ROAM	Restoration Opportunities Assessment Methodology
ROM	Restoration Opportunities Mapping
USAID	United States Agency for International Development
WPO	Working Plan Officer
WRI	World Resources Institute

# I. INTRODUCTION

With a forest cover of 70.17 million hectares comprising 21.34% of its total geographical area (Forest Survey of India 2015, 38), India's forests provide an array of ecosystem services that support social and economic development. Historically, forests have been critical to economic development, particularly by providing timber and other raw material to meet burgeoning industrial needs. They also play a critical role in supporting the livelihoods of millions of households living in and around forests who are dependent on forests for food, fodder, fuelwood, Non-Timber Forest Products (NTFP) and other services (MoEF 2015, 3). The array of regulatory and provisioning ecosystem services provided by forests was recognized as early as 1952 by the National Forest Policy which prescribed that the country should maintain at least 20% area in plains and 60% in the hills as forests, constituting about 33% of India's geographical area (GoI, 1952).

Over the years, India's forest policies have moved towards participatory forest management. The National Forest Policy of 1988 envisaged community involvement in the protection and regeneration of forests while also recognizing the rights of local communities to usufructs such as fuelwood, fodder, minor forest produce, and small timber (GoI, 1988). Subsequently in 1990, the Joint Forest Management (JFM) program was introduced which brought together local communities to form Joint Forest Management Committees (JFMCs). The JFMCs were mandated to protect defined forest areas and in turn were entitled to benefits in the form of food, fodder, fuelwood, NTFPs and small timber, as well as a share in the regenerated timber whenever it was harvested. There are more than 118,213 JFMCs managing 22.94 million hectares of recorded forest area (FRI, 2011 quoted in TERI, 2015, 5). While JFM granted access to usufructs from forests, the Forest Rights Act of 2006<sup>1</sup> (FRA) established legal provision for individuals and collective community rights to forests.

Today, there is an emphasis in forest management on ensuring sustained delivery of ecosystem services along with greater involvement of local communities in the decision-making process. This new approach is manifested in the National Working Plan Code, 2014 (NWPC) which calls for management of forests for multiple regulatory and provisioning ecosystem services. Working plans are statutory requirements and all forests are to be sustainably managed under the prescriptions of a working plan (NWPC 2014, 10). In addition to focus on ecosystem services, the NWPC calls for use of Geographic Information System (GIS) and remote sensing data in forest management and emphasizes consultation with stakeholders, particularly local communities in finalizing working plan prescriptions.

Preparation of working plans is a highly technical exercise and Indian forest department officers hold the required specialized training in forests and extensive field experience. State forest departments are also equipped with Information Technology (IT) and GIS cells that aim to use state-of-the-art technology in forestry. With the NWPC however, it has become necessary to develop tools and build capacities that leverage not only officials' knowledge but also available datasets and existing technologies. This broad suite of tools and skills should combine knowledge and capacities of various forest cells, including the GIS cell, IT cell and Working Plan Unit with engagement with multiple stakeholders. This will facilitate complex analysis that is essential for managing forests for regulatory and provisioning ecosystem services such as biodiversity conservation, water resource management, carbon sequestration and provisioning of fuelwood, fodder and NTFPs for local communities.

To support India's state forest departments in operationalizing the NWPC, the Partnership for Land Use Science (Forest-PLUS) developed an Integrated Forest Management Toolbox (IFMT). The IFMT is a model that can assist senior and mid-level forest department officials to develop working plans in accordance to the NWPC. The IFMT consists of a suite of tools developed and adapted by WRI India and FES that facilitate

---

<sup>1</sup> Legislated as the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, the FRA recognizes community forest resource rights over common amenities and sites of cultural, religious or other significance, and the right to protect, conserve, regenerate and manage their community forest resources for sustainable use. Additionally, FRA also recognizes Individual land right titles to Scheduled Tribes and other traditional forest dwellers who prove their cultivation of forest land on or before December 13, 2005



collection of geo-spatial and primary data and mapping of forest management activities in a consultative manner to ensure optimum flow of regulatory and provisioning ecosystem services. This user manual provides details of the workflow, methodology, approach, preparation, data collection, analysis and interpretation of results using the IFMT. It provides guidance to other state forest departments and agencies who want to use IFMT to prepare working plans in their target areas.

This manual is organized into four sections. The first section provides an overview of NWPC's salient features and IFMT. The second section details preparation and data collection; this includes conducting an inception workshop, grid and sampling design and description of Forest Resources Observatory (FRO), Global Forest Watch (GFW) MapBuilder and Forest Data Kit (FDK). This is followed by a section on analysis of ecosystem services, mapping of potential forest management activities and discussion on trade-offs and synergies between ecosystem services. This section provides steps for converting FDK data into spatial layers for analysis of ecosystem services and method to map potential forest management activities. This is followed by a consultation using the Ecosystem Services Diagnostic Tool (ESS diagnostic) to move from trade-offs to synergies between ecosystem services. The final section is on moving from analysis to working plan prescription. It provides details of developing draft working plans using IFMT output, conducting a validation workshop and submitting final Working Plan. To ensure ease of use, this manual provides step-by-step guidance for use of tools along with examples wherever necessary, using demo data for Rampur division of Himachal Pradesh (HP) state forest department.

## **I.1 NATIONAL WORKING PLAN CODE, 2014**

Four key distinguishing features of the NWPC are discussed below.

1. **Landscape approach:** While working plans are developed for recorded forest areas, the NWPC places emphasis on adopting a landscape approach for sustainable land use management within the forest division (NWPC 2014, 16). A landscape approach will assist in planning forest management activities where the flow of ecosystem benefits is beyond the forest area. In the context of participatory forest management, greater involvement of local communities will help in planning interventions outside forest areas that will ensure flow of provisioning ecosystem services such as fodder, fuelwood and NTFPs to local communities.
2. **Management of forests for multiple ecosystem services:** The NWPC specifies many core objectives for management planning, which include regulatory services such as biodiversity conservation, water resource management, carbon sequestration, and provisioning services such as fuelwood, fodder, and NTFPs. These approaches resonate with India's international commitments including the Aichi Biodiversity Targets, India's National Contribution to mitigate climate change at the Paris Agreement through increase carbon sequestration through forestry, and the Bonn Challenge to restore 21 million hectares of degraded land and forests by 2030.
3. **Participatory management:** The NWPC emphasizes adopting a consultative approach in preparing working plans. With nearly 30% of forest area managed by JFMCs (FRI, 2011 quoted in TERI, 2015, 5), and individual and collective forest rights being recognized, it is essential to include local stakeholders in the process of developing working plans. Consultations help combine the expertise of local communities with existing datasets, tools and expertise of forest department. Knowledge of local committees such as Biodiversity Management Committees (BMCs) and watershed committees have a bearing on not only management of forest areas but also how flow of ecosystem services is achieved in non-forest areas. According to the prescribed procedure for preparation of working plans, 'consultation' constitutes the first step (NWPC 2014, 23) of the working plan process and is implicit in other steps such as field visits and preparation of the Preliminary Working Plan Report (PWPR). The NWPC envisages various levels of consultation, both within the forest department and with external stakeholders. The key forms of consultation are listed below.

- a. Setting up a standing consultative committee for the state under the chairmanship of Principal Chief Conservator of Forests (PCCF Head of Forest Force (HoFF)) with members from state (including Chief Wildlife Warden), Ministry of Environment, Forest and Climate Change (MoEFCC), FSI and its regional centers and Indian Council of Forestry Research and Institution (ICFRE)(NWPC 2014, 22).
  - b. Consultation with FSI on required tools and technologies including geo-spatial hardware, software, computers, internet access, and other accessories (NWPC 2014, 19).
  - c. Consultation with local stakeholders during preparation of the PWPR; this should include persons from local people's forum, JFMCs, village panchayats and Forest Development Agencies (FDA). The purpose of this consultation is to understand expectations of people dependent on forests, so that the same can be accommodate as far as possible to the extent that they are compatible with the technical feasibility of sustained management of forests (NWPC 2014, 21).
  - d. Consultation with local people for preparation of village micro plans to collect data, understand problems, and understand availability of resources (NWPC 2014, 73).
  - e. Consultation with relevant organizations to identify good practices and transfer technology in this field (NWPC 2014, 85).
  - f. Additionally, it is recommended that a Working Plan Team be constituted under the leadership of the Divisional Forest Officer (DFO) with multi-skilled members including staff and official of forest department, other government departments, civil society, research organizations and academia.
4. Technical and technological advancements: Preparation of working plans is based on stock and vegetation maps which have traditionally been prepared through ground surveys. The NWPC considers major technical advances in mapping and calls for use of GIS, remote sensing and Global Positioning System (GPS) data for preparing forest cover maps of forest divisions. There is strong impetus for development of geo-spatial databases, use of multi-dated satellite images for analysis and collection of field data using digital platforms that can support conversion of field data to geo-spatial layers. The purpose of a geospatial database is to integrate divisional information at the state level and further at the national level in a standardized framework.

## **I.2 INTEGRATED FOREST MANAGEMENT TOOLBOX**

The procedural and technical advances in the NWPC require skills and tools that can assist state forest departments in operationalizing landscape approaches to forest management. The IFMT consists of a suite of tools and methods that aim to strengthen management of forests by supporting forest officials in developing working plans as per the NWPC. The IFMT performs the following tasks:

- Facilitates collection of geo-spatial data
- Provides a digital platform for collection of primary data and assists in conversion of data into geo-spatial layers
- Assists forest officials in analyzing the flow of regulatory ecosystem services such as biodiversity conservation, water resource management and carbon sequestration, and provisioning services such as availability of fodder, fuelwood, and NTFPs
- Provides a methodology for mapping forest management activities to understand ensuing trade-offs between ecosystem services
- Provides a consultation mechanism to enable discussion among stakeholders on prioritizing ecosystem services and forest management activities.

The IFMT was developed as a proof-of-concept model for the Himachal Pradesh forest department. The process of developing IFMT was consultative, with regular interaction and feedback from officers of HP forest department. The toolbox was demonstrated for Ani forest division, Rampur working circle, Himachal Pradesh. See Annex 1 for the consultation with the HP Forest Department in the course of development of the tool.

Table 1.1 provides the broad distinguishing themes and specific requirements of NWPC and Table 1.2 provides a description of individual tools and methods of IFMT.

**Table 1.1: NWPC themes and requirements**

Theme	NWPC Requirement
<b>Landscape approach</b>	<ul style="list-style-type: none"> <li>• Landscape approach adopted for sustainable land use management within the forest division (NWPC 2014, 16)</li> </ul>
<b>Management of forests for multiple ecosystem services</b>	<ul style="list-style-type: none"> <li>• Emphasis on biodiversity conservation, water resource management, carbon sequestration and provisioning of fuelwood, fodder, NTFPs (NWPC 2014, 11-14)</li> <li>• Area specific prescription for proper management of forests in a forest division (NWPC 2014, 10)</li> <li>• Identification of overlapping working circles, for example territorial forest circle, JFMCs, and community forests (NWPC 2014, 12)</li> </ul>
<b>Participatory management</b>	<ul style="list-style-type: none"> <li>• Involvement of fringe communities in the protection and management of forests (NWPC 2014, 7, 21, 73)</li> <li>• Consultation with local stakeholders (NWPC 2014, 21, 73)</li> <li>• Experts from research institutions (NWPC 2014, 22)</li> <li>• Consultation with organizations (NWPC 2014, 85)</li> <li>• Standing Consultative Committee (NWPC 2014, 22)</li> </ul>
<b>Technical and technological advancements</b>	<ul style="list-style-type: none"> <li>• Development of a geo-spatial database with 41 indicative layer list (NWPC 2014, 60)</li> <li>• Collection of field data using digital platforms (NWPC 2014, 68)</li> <li>• Analysis for biodiversity conservation (NWPC 2014, 27)</li> <li>• Analysis for carbon sequestration (NWPC 2014, 16)</li> <li>• Analysis for fodder, fuelwood, NTFP (NWPC 2014, 29)</li> <li>• Analysis and geo-spatial layer for water resource management (NWPC 2014, 13)</li> </ul>

**Table 1.2: IFMT tools**

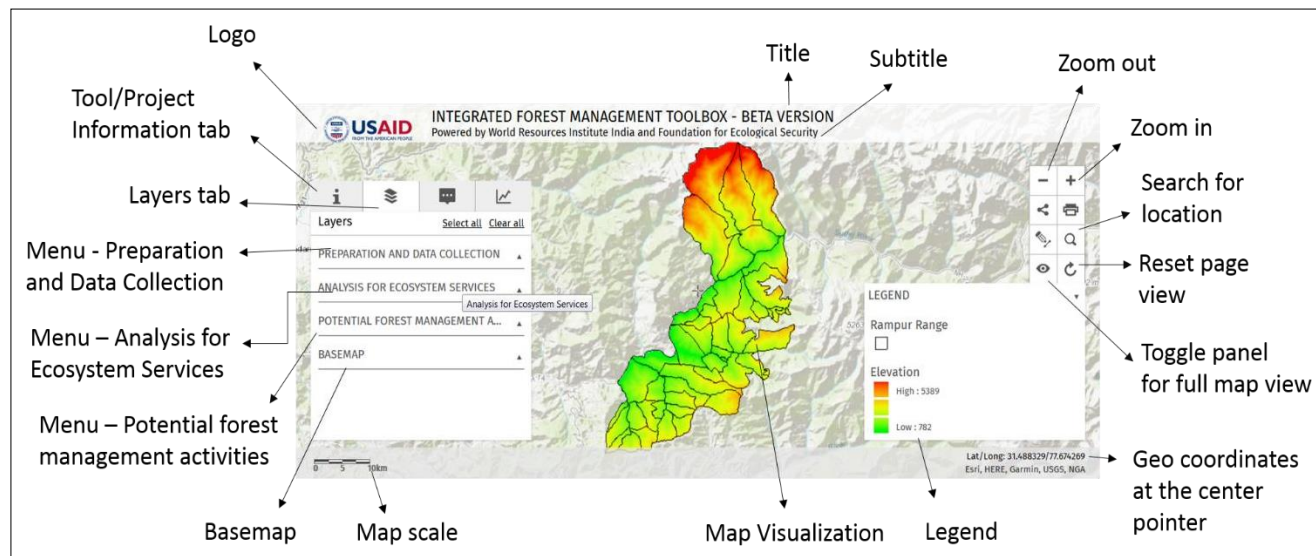
Tool/ Method of IFMT	Description <sup>2</sup>
<b>Forest Resources Observatory (FRO)</b>	A repository of data from publicly available data sources that can provide all mandatory spatial layers called for by the NWPC.
<b>Forest Data Kit (FDK)</b>	An android application that provides a digital platform for collection of field data. The data can be analyzed and processed to create geo-spatial layers for regulatory and provisioning ESS as output.
<b>Restoration Opportunities Assessment Methodology (ROAM)</b>	Underpinning methodology of IFMT that helps identify areas for potential forest management activities (spatial mapping) and provides framework for participatory approach.
<b>Composite Landscape Assessment and Restoration Tool (CLART)</b>	Tool for identifying areas based on recharge potential.
<b>GFW MapBuilder</b>	Online platform for collating and viewing multiple geo-spatial layers.
<b>Ecosystem Services Diagnostic Tool (ESS diagnostic)</b>	Mechanism for stakeholder engagement to identify trade-offs and synergies between ecosystem services.

---

<sup>2</sup>The individual tools were developed by WRI India (ROAM, GFW MapBuilder, ESS diagnostic) and FES (FRO, FDK and CLART). The tools were adapted and integrated to form the IFMT.

The output from IFMT, which consists primarily of geo-spatial layers, is viewed using the GFW MapBuilder. The GFW MapBuilder is an online platform through which IFMT is shared with stakeholders. Figure 1.1 depicts the IFMT home page along with a description of key functions.

**Figure 1.1 IFMT output in GFW MapBuilder**



### I.3 SCOPE

The IFMT can be used by senior and mid-level officers of India’s state forest departments to develop working plans for their forest divisions. It is important to note that the output from IFMT is not a final working plan. Rather, IFMT helps identify different areas where forest management activities can be implemented for realizing flow of ecosystem services and provides a consultation mechanism to involve local stakeholders in the process of identifying appropriate forest management activities. This output will assist Working Plan Officers (WPO) in finalizing working plan prescriptions and provides a foundation for writing the working plan. Additionally, IFMT assists in establishing a geo-spatial database as called for by the NWPC.

### I.4 METHODOLOGY

The interaction of the constituent tools and methods of IFMT is underpinned by the Restoration Opportunities Assessment Methodology<sup>3</sup>, and adapted to India. Specifically, IFMT is built on spatial mapping and a participatory, flexible approach of ROAM for landscape-level planning. This methodology provides a framework for combining ‘digital mapping’ and ‘knowledge mapping’ approaches to identify areas for implementing forest management activities. Digital mapping involves use of GIS and remote sensing data in the form of geospatial layers. In IFMT, FRO provides the basis for digital mapping. Knowledge mapping is a combination of knowledge and stakeholder input. The extensive forestry knowledge of forest department staff and officials such as beat guards, CCFs, DFOs, WPO, staff from GIS and IT cells forms the core of knowledge mapping. This

<sup>3</sup> *A Guide to ROAM* available at [https://www.iucn.org/downloads/roam\\_handbook\\_lowres\\_web.pdf](https://www.iucn.org/downloads/roam_handbook_lowres_web.pdf).

knowledge is equally supported by input from stakeholders obtained during consultations<sup>4</sup> and surveys (using FDK).

IFMT functions in three phases.

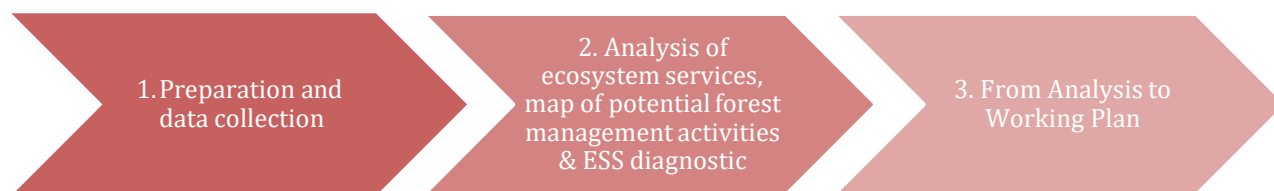
1. Phase 1 - *Preparation and data collection*: Preparation refers to the series of steps to be carried out before using IFMT. This involves identifying key stakeholders, developing the sampling grid and design, organizing an inception workshop, and setting up required hardware and software equipment. The preparatory stage will be followed by data collection using FRO and FDK. The FRO provides the mandatory layers called for by NWPC. The geo-spatial layers are stored in a single database and uploaded to GFW MapBuilder. The FDK is a digital platform that can be used to collect primary data from the field.
2. Phase 2 - *Analysis of ecosystem services, map of potential forest management activities and ESS diagnostic*: In this step, data collected in phase-1 through FDK will be converted into geo-spatial layers pertaining to biodiversity conservation, carbon sequestration and provisioning of fuelwood, fodder and NTFPs. The CLART tool will be used to create a layer on recharge potential for water resource management. Subsequently, a map of forest management activities will be developed based on consultation with officers of forest department and local stakeholders. This will be followed by a half-day consultation where the ESS diagnostic will be implemented to facilitate stakeholder discussion on trade-offs and synergies between ecosystem services.
3. Phase 3 - *From analysis to Working Plan prescription*: In the final phase, the WPO will develop the draft Working Plan using output from IFMT. The draft Working Plan will be presented to stakeholders in a validation workshop. Thereafter, the draft Working Plan will be sent to the Standing Consultative Committee for review. The final Working Plan will then be submitted to MoEFCC.

A detailed work flow for IFMT along with persons involved is provided in Table 1.3.

---

<sup>4</sup> Consultation in IFMT includes inception workshop, village and household survey using FDK, consultation on trade-offs and synergies between ecosystem services and validation workshop.

**Table 1.3: Work Flow of IFMT**



	Phase 1	Phase 2	Phase 3
<b>Description</b>	This phase involves identifying key stakeholder, designing sample grid, organizing inception workshop and setting up hardware/software requirements. This is followed by collection of spatial and field data.	In this phase, data collected in phase 1 will be analyzed for flow of ecosystem services and map of potential forest management activities will be developed. Thereafter, stakeholder consultation on trade-off and synergies between ecosystem services will be held.	In this phase, output from IFMT will be used to develop draft Working Plan. This will be shared with stakeholders in a validation workshop and thereafter with the Standing Consultative Committee.
<b>Stakeholders involved</b>	<ul style="list-style-type: none"> <li>Working plan team</li> <li>IT cell, GIS cell</li> <li>WPO</li> <li>Beat guards</li> <li>Local communities (JFMC, BMC, FDA, village panchayat)</li> <li>Civil society</li> <li>Research institutions</li> </ul>	<ul style="list-style-type: none"> <li>Working plan team</li> <li>GIS cell</li> <li>CCFs, DFOs</li> <li>WPO</li> <li>Local communities (JFMC, BMC, FDA, village panchayat)</li> <li>Civil society</li> <li>Research institutions</li> </ul>	<ul style="list-style-type: none"> <li>Working plan team</li> <li>Standing Consultative Committee</li> <li>DFOs, CCs</li> <li>Local communities (JFMC, BMC, FDA, village panchayat)</li> <li>Civil society</li> <li>Research institutions</li> <li>WPO</li> <li>GIS and IT cell</li> </ul>
<b>Tools &amp; Methods</b>	<ul style="list-style-type: none"> <li>FRO</li> <li>FDK</li> <li>GFW MapBuilder</li> <li>ROAM</li> </ul>	<ul style="list-style-type: none"> <li>ROAM and ROM</li> <li>CLART</li> <li>ESS Diagnostic</li> </ul>	<ul style="list-style-type: none"> <li>IFMT</li> </ul>
<b>Consultation</b>	<ul style="list-style-type: none"> <li>Inception workshop</li> </ul>	<ul style="list-style-type: none"> <li>Half-day consultation</li> </ul>	<ul style="list-style-type: none"> <li>Validation workshop</li> </ul>

<p><b>Activities</b></p>	<ul style="list-style-type: none"> <li>• Create preliminary list of stakeholders to be involved in consultation (NWPC 2914, 21).</li> <li>• Grid and sampling design</li> <li>• Conduct inception workshop</li> <li>• Set up required hardware and software infrastructure</li> <li>• Set up GFW MapBuilder</li> <li>• Collate geospatial layers using FRO. (NWPC 2014, 60)</li> <li>• Collect primary data from the field using FDK.</li> </ul>	<ul style="list-style-type: none"> <li>• Using data collected from FDK, calculate Biodiversity Index, Importance Value Index (IVI) and biomass.</li> <li>• Run CLART tool for layer on recharge potential.</li> <li>• Develop map of potential forest management activity using GIS data, input from forest department officials and consultation with local communities.</li> <li>• Conduct half-day consultation with stakeholders to implement ESS diagnostic to identify trade-offs and synergies between ecosystem services</li> </ul>	<ul style="list-style-type: none"> <li>• Use IFMT output to develop draft Working Plan</li> <li>• Present draft Working Plan to stakeholder in validation workshop. Incorporate comments as applicable.</li> <li>• Present draft Working Plan to Standing Consultative Committee for review.</li> <li>• Revise draft to finalize the Working Plan and send it to MoEFCC.</li> </ul>
<p><b>Output</b></p>	<ul style="list-style-type: none"> <li>• GFW MapBuilder site for the IFMT.</li> <li>• Mandatory geo-spatial layers hosted database.</li> <li>• Primary data collected from field</li> <li>• Through consultation, list of past forest management activities and working plan circles.</li> </ul>	<ul style="list-style-type: none"> <li>• Geospatial layers on biodiversity, water, carbon and provisioning services (fodder, fuelwood and NTFP).</li> <li>• Map of potential forest management activities with stakeholder input.</li> <li>• Final working plan prescriptions based on stakeholder discussion</li> </ul>	<ul style="list-style-type: none"> <li>• Working Plan<sup>5</sup></li> </ul>

The following chapters will explain in detail the various phases of IFMT.

---

<sup>5</sup> Produced by the officer responsible, not an output of the IFMT; see Annex 8



## 2. PHASE I: PREPARATION AND DATA COLLECTION

This phase involves a series of discussions and activities to help prepare and plan for developing the working plan. This includes defining scale, identifying key stakeholders, setting up prerequisites for launching IFMT, and collecting data. This phase will include an inception workshop to share the plan and obtain stakeholder input for formulating working plan prescriptions. Detailed descriptions of various steps in this phase are provided below.

### 2.1 DEFINE SCALE

In initiating the working plan preparation process, the first step is to record geographical scope, including the name of the division, its geographical location, and demographic and administrative details. This would also include marking out different working circles such as JFM, Catchment Area Treatment, and biodiversity conservation. Since IFMT adopts a landscape approach, the output is intended to provide a ‘big picture’ view of potential forest management activities and working plan prescriptions. Although individual tools within IFMT have different scales, the integrated output is not appropriate for a detailed analysis of any one area and should not be applied at fine scales (for instance, at beat level). Rather, the IFMT looks at sustainable land use management at landscape level within the forest division as called for by the NWPC (NWPC 2014, 16).

### 2.2 IDENTIFY KEY STAKEHOLDERS

Since consultation is a key part in preparation of working plans, it is essential to identify stakeholders who should be involved in the development of working plan. Typically, these would include representatives from within the forest department, representatives from other related line departments such as revenue, agriculture, tribal affairs, science and technology, and power, community representatives, non-governmental organizations, and research institutions.

Those involved in developing a working plan will need to convene the following teams to coordinate and lead the work.

1. Standing Consultative Committee: The NWPC requires that a Standing Consultative Committee be formed under the chairmanship of the PCCF. This Committee includes representatives from different state departments, the MoEFCC and technical experts (NWPC 2014, 22). It may be noted that as a state-level body, the same Standing Consultative Committee may advise on multiple working plans. The mandate of the Standing Consultative Committee is to review the PWPR, consider and finalize the working plans and conduct mid-term reviews of the working plans. The Committee should be supported by forest department staff and specialists who will engage on a periodic basis with the working plan process.
2. Working plan team: As already mentioned, preparation of a working plan as per the NWPC requires different types of skills and expertise. Although not explicitly mentioned in the NWPC, collaborative work within the department as well as with external partners may be facilitated by the establishment of a working plan team that is responsible for implementing the working plan process. This team, under the Chairmanship of the DFO, may include representatives from the GIS and IT Cells who lend mapping expertise, a representative from the FDA who can facilitate engagement with the JFMCs, a *Zila Panchayat* representative (where relevant), and civil society organizations that can facilitate stakeholder engagement.
3. As a first step, the working plan team should gather preliminary information as follows:

- a. Institutional stocktaking to identify the presence of different institutions in the division which can be involved in the stakeholder consultation. This will result in a longlist of institutions which can be classified according to the extent of their involvement in the forestry sector. This involvement may be positive or negative, direct or indirect.
- b. Forest management activities stocktaking to identify which management activities have been previously implemented in the area. This information is often available in previous working plans, annual plans of operation, project plans, and attendant reports.
- C. Any available micro plans, People's Biodiversity Registers (PBR), compensatory afforestation commitments, or other similar documents that can provide input to working plan prescriptions.

## 2.3 DEVELOP GRID AND SAMPLING DESIGN

The NWPC recognizes the need to have monitoring and assessment of forest resources based on grid based systematic sampling. This will ensure that quantitative and qualitative information at the divisional level can be integrated and scaled up at the state and national level (NWPC 2014, 15). The IT and GIS cells of the forest department along with CCFs from the concerned division will be involved in determining sample size and design.

The first step in designing a grid-based sampling design is to determine sample size. According to the NWPC, determination of optimum sample size depends on four factors: 1) the variability of main characteristics in the population, 2) allowable error in the estimation (typically  $\pm 5\%$ ), 3) time and 4) cost factors. The general formula used is given in Fig 2.1 below (NWPC 2014, 61).

**Figure 2.1 Formula for calculating sample size**

$$n = \frac{t_v^2 \left(\frac{CV}{AE}\right)^2}{1 + 1/N \left(\frac{CV}{AE}\right)^2}$$

Where,

$n$  = sample size,

CV = Coefficient of variation of the main characteristic/attribute (which can be calculated through past WP or pilot survey or using correlated variable. In absence of any these it can be asked from FSI from similar nearby area of that forest type),

AE = allowable error (%),

$t_v$  = value of t-statistic with  $v$  degrees of freedom and 5% significance level

$N$  = total number of plots of optimum size of main characteristic in the population (division/Range etc.)

Generally the population is very large for forest resource assessment (the total number of possible plots in this case is practically infinite) making the denominator approximately one; therefore sample size equals the numerator in the formula (NWPC 2014, 61). It is important to note that the optimum sample size will depend on the coefficient of variation in any parameters chosen, be it species diversity or basal area. Therefore, the higher the variation, the higher the number of samples required.

Once the sample size is calculated, a system of grids of latitudes and longitudes can be laid over the entire division. Based on the sample size, the sample plots ( $N$ ) are chosen systematically from the grid for collecting primary information. It should be noted that the NWPC does not provide an exact method for selecting sample points from the grid and any systematic method can be used. After the sample plots are determined, the center point of samples should be selected and overlaid on topographic sheet of the forest area. This will provide

details of the area where the plot is located (for instance, the name of village), which can then be shared with the beat guard for primary data collection.

## **2.4 INSTALL NECESSARY HARDWARE AND SOFTWARE**

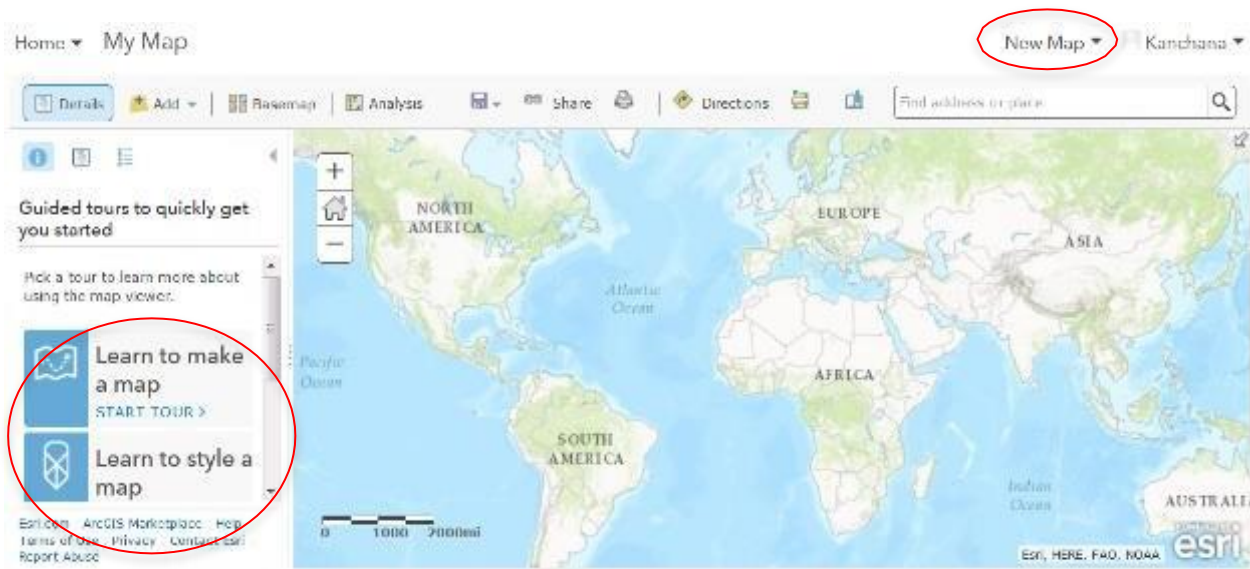
The NWPC requires Working Plan Units to be equipped with required tools and technologies along with necessary geo-spatial software, hardware devices like computers, GPS, internet access, and other accessories. Staff from the IT and GIS cells of forest department should ensure that the following hardware and software requirements are available for launch of IFMT.

1. A dedicated computer with internet for IFMT along with a static IP address (host) for running the Toolbox.
2. ArcGIS installed in the computer. ArcGIS is the preferred software due to its advanced features.
3. A geospatial server to host all relevant spatial layers. This can also be the ArcGIS Server (ArcGIS Enterprise software to be installed). Though the space requirement depends on data, 8-10 GB is desirable to host data for all districts.
4. Android mobile or tablet devices for installing FDK, which is an application that can be downloaded from the Google play store<sup>6</sup>.
5. A public ArcGIS online account to create web maps for GFW MapBuilder. The GFW MapBuilder requires a web-server space of 0.5 GB. It is essential to ensure that server space is available for transferring and hosting FDK data, geospatial layers from FRO (and other sources), GFW MapBuilder and other working plan related maps or data.
6. While determining software and hardware requirements, the forest department should consult with FSI. FSI will study the present status of GIS capacity of the state (hardware, software, trained manpower) and suggest program of upgrading the same to meet the requirements of NWPC.
7. Once the hardware and software requirements are in place, the GIS cell can create a GFW MapBuilder webmap and web application for the forest division. GFW MapBuilder is an online platform for hosting and visualizing IFMT. Its main functionality is to display GIS layers coming from different sources in a single application and to run pre-defined analysis for areas specified by the user. The following steps are involved in creating web maps.
  - a. Sign into ArcGIS online account. Web map is the second menu in the Toolbox
  - b. To create a new web map, click on 'Map' in the top menu bar to open a new blank web map. Basic tutorials are available in the left panel to make a map and style a map.
  - c. In the demonstration for Rampur division of HP forest department, a public map was created for Rampur division of HP forest department and can be found by searching for 'IFMT-Menu 2-Ecosystem Services'. This map can be saved and any modification can be carried out in it.

---

<sup>6</sup>Available in Google Play as Open Data Kit (ODK)

**Figure 2.2 Screen shot of GFW MapBuilder for creating web map**



The complete steps for creating a web map along with screen shots is provided in Annex-2. After creating a web map, the web application can be created as follows.

- a. Download the GFW MapBuilder files attached below. Unzip the configuration files (index.html, report.html and resources.js). These are the files that need to be hosted in the web server.

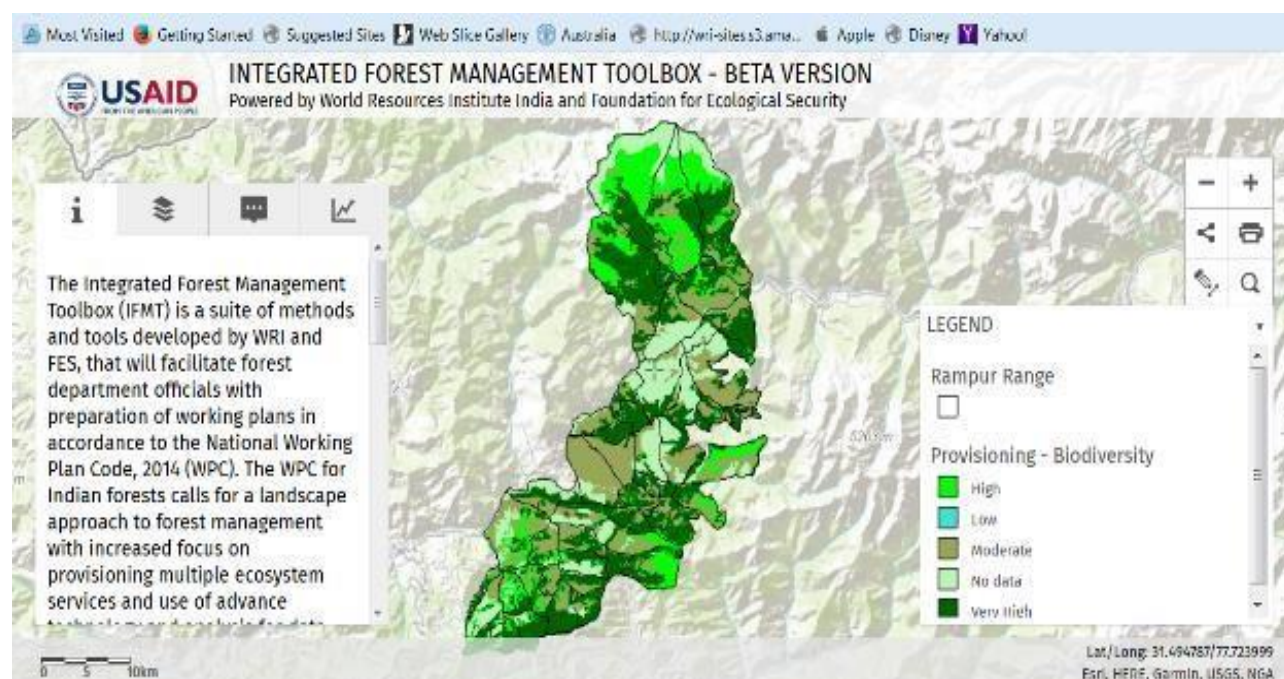


Mapbuilder.rar

- b. Unzip the downloaded file and open the file - resources.js with Notepad++ (Notepad++ is available for download in the link - <https://notepad-plus-plus.org/download/v7.3.3.html>)
- c. Code customization for creating web application and customizing tabs is provided in Annex-2.
- d. Once the code customizations are done, save the resources.js file. Open downloaded index.html file in a browser to visualize the changes offline.
- e. Host the downloaded three files – index.html, report.html and updated resources.js in a web server. This makes the application go online. Get the web link from server to visualize the application from anywhere.

An example of GFW MapBuilder web application for Rampur division is provided in Figure 2.3.

**Figure 2.3 Screen shot of GFW MapBuilder web application**



## 2.5 CONDUCT AN INCEPTION WORKSHOP

The working plan team should organize an inception workshop<sup>7</sup> to create awareness about the working plan process and development. The workshop should be organized as early in the preparation stage as possible, preferably before field data collection. Participants should include members of the Standing Consultative Committee and working plan team, staff and officers of forest department, representatives from JFMCs, FDA, BMCs, village panchayat, other village committees, representatives from FSI, ICFRE and other research institutions, civil society, and members from other government departments as required. Typical objectives of the workshop include the following:

1. To share information on the working plan process
2. To provide an overview of the strategy and tools to be used including FDK and Participatory Rural Appraisal (PRA) and ensure early buy-in from stakeholders
3. To capture existing knowledge and perceptions, including identification of on-going work that can be leveraged to support the goals of the working plan
4. To identify past forest management activities (such as afforestation, natural regeneration, bamboo plantation, enrichment plantation and so on) and identify set of criteria such as bio-physical or socio-economic to help identify areas where forest management activities are required

<sup>7</sup>The concept and method of organizing inception workshop is adapted from ROAM (IUCN and WRI 2014, 51)



The working plan team should ensure that the workshop is interactive, facilitates participation and gathers feedback from stakeholders. This can be achieved by scheduling a mix of break-out groups and plenaries. The following themes can be discussed:

1. Collectively identify forest management objectives.
2. Collectively identify what are the key drivers of land use change and their impacts on forests. Discuss how land challenges can be addressed through different forest management activities.
3. A landscape approach requires the assessment area to be sub-divided based on relatively homogenous bio-physical and/or socio-economic characters. For IFMT, this involves identifying different working plan circles, particularly those that overlap. This is important to trace the flow of and prioritize ecosystem services. With stakeholders from local communities, identify working circles for flow of provisioning services such as fuelwood, fodder and NTFP.
4. Create a list of forest management activities and criteria for choosing areas for implementing these activities. This will provide input for mapping of potential forest management activities in phase-2.

The inception workshop will enable the forest department to initiate stakeholder consultation, obtain critical buy-in for working plan development strategy and identify areas where forest management activities can take place.

## **2.6 DATA COLLECTION**

Once preparation is complete and sample plots are identified, data collection can be initiated. IFMT enables two types of data collection: 1) collection of geo-spatial data using FRO and 2) collection of primary data from field using FDK. It also emphasizes drawing upon stakeholder knowledge and perceptions through consultative mechanisms. The tools and processes involved in each are detailed below.

### **2.6.1 FOREST RESOURCES OBSERVATORY**

The NWPC requires the GIS cell of the forest department to create a database of geo-referenced layers of spatial data for an area on different themes relevant to forest management. It identifies 41 geospatial layers (out of which 19 are mandatory) that are to be collected by the GIS cell and provided to the WPO. The list of layers is provided in Annex-3. Some of these layers, such as division boundary, range boundary, beat boundary, compartment boundary, and block will be available with the forest department. For other layers, possible sources are provided in the NWPC. The FRO tool of IFMT can provide all layers that are publicly available.

The following steps should be followed in collating geospatial layers:

1. Create a checklist of mandatory and indicative list of geospatial layers called for by NWPC
2. Identify those available with the forest department and collate in a geospatial database
3. Identify the required layers that are publicly available. FRO contains over 600 geospatial layers including river basins, soil, geology, land use and vegetation changes, forest types, ecoregions, physiographic zones, and non-spatial information such as demographic trends, local flora and fauna, infrastructure and availability of amenities.
4. To obtain layers from FRO, send a mail requesting specific layers to FES ([ed@fes.org.in](mailto:ed@fes.org.in) or [jayahari.km@fes.org.in](mailto:jayahari.km@fes.org.in))
5. FES will provide clipped data for the particular forest division

6. Save all geo-spatial layers in a geo-spatial server which serves as the database
7. Geospatial data saved in database or server should be uploaded in GFW MapBuilder using steps provided in the next section

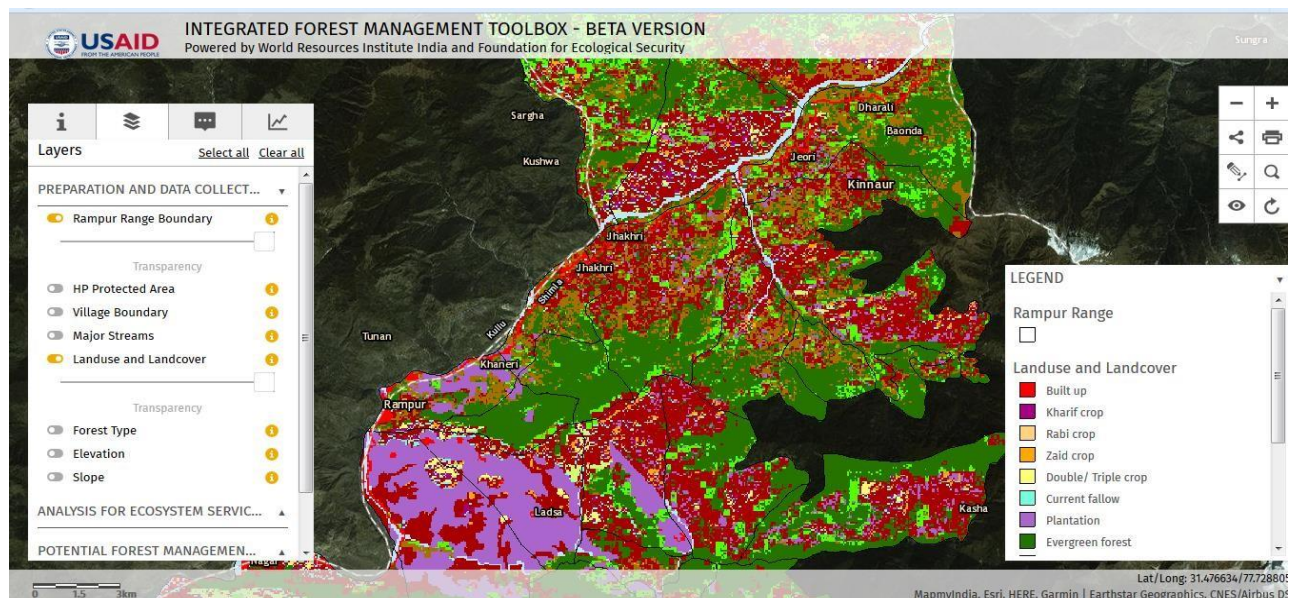
## 2.6.2 GFW MAPBUILDER

As mentioned earlier, GFW MapBuilder is an online platform for hosting geospatial layers. It allows viewing of geospatial layers online without specific GIS software and advanced GIS skills, enabling data access from any geographical location. From the geospatial server, layers can be hosted on GFW MapBuilder using the following steps:

1. Sign in to ArcGIS online account and go to web map
2. Web map provides the choice to input data from server or import shape file in zipped format from desktop or add any existing layers from ArcGIS online
3. The complete steps in adding new layers is provided in Annex-4

A screen shot of Land Use Land Cover (LULC) layers for Rampur district uploaded in GFW MapBuilder is shown in Figure 2.4.

**Figure 2.4 GFW MapBuilder with LULC layer for Rampur division**

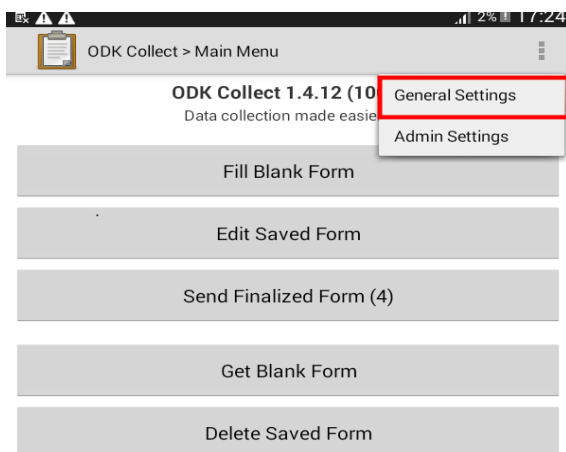


## 2.6.3 FOREST DATA KIT

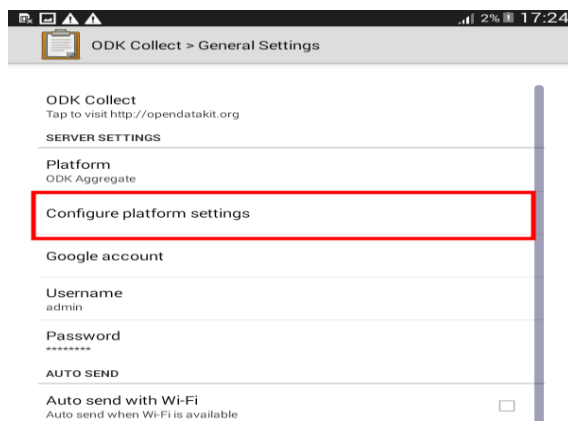
The NWPC requires collection of two major types of information from the field: 1) forest information and 2) village level information. Data collection is usually carried out by beat guards along with a team consisting of subject experts as required. The IFMT includes the FDK which can assist in the process of field data collection.

FDK is a digital, android<sup>8</sup> based data collection platform adapted from the open source tool ‘Open Data Kit’ (ODK). The process for installing and using FDK is provided below:

1. Download and install ODK Collect App in an android device. The android device will need a Google account for downloading the application.
2. Open ODK Collect and select *Settings* option followed by *General Settings*.



3. Select the *Configure platform settings* option which will open as below:

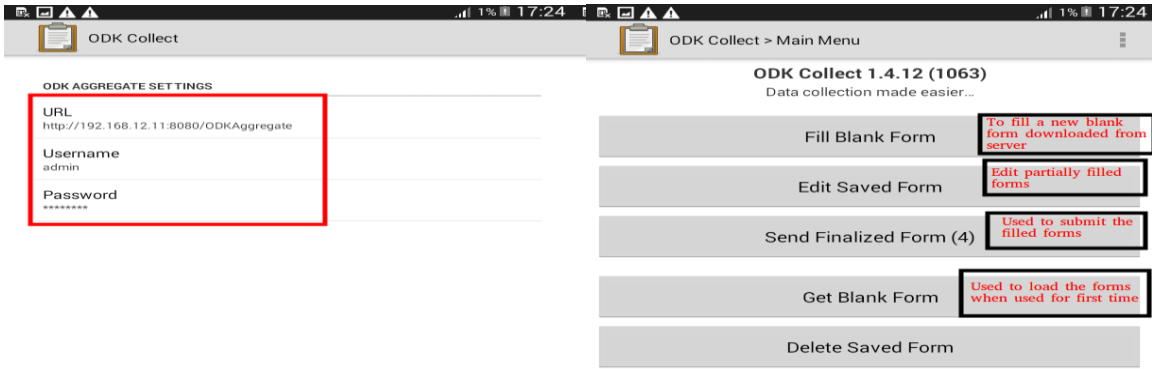


4. Fill the URL, username, and password as provided by the server administrator. These details can be generated at the time of server deployment. A handbook for server deployment will be provided separately. The user can go back to the main menu and click on *Get the blank form* option to download blank forms on to device. Once this process is done, the forms can be used offline.

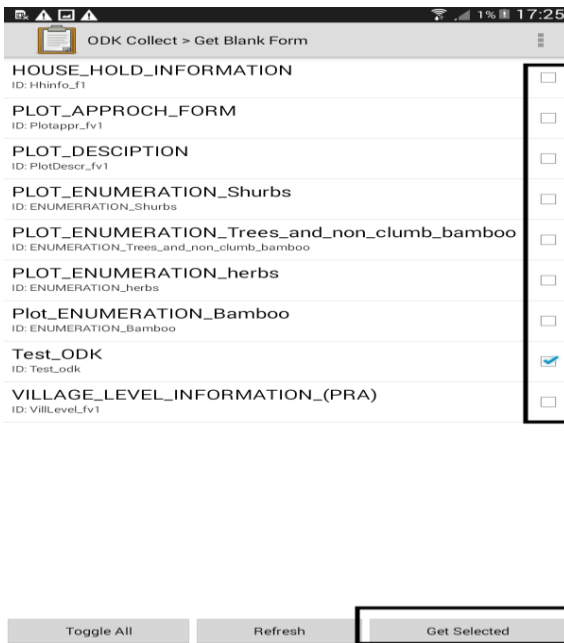
---

<sup>8</sup> Beat guards and members of the team can be provided prior training on using android device (mobile phone or tablets) and a few test plots can be filled by the team before actual field data collection. Training on use of GPS can also be provided.





- Select appropriate forms from the list of forms in FDK by selecting the *Fill Blank Form* option. The user can also edit an existing/partially filled form using the *Edit Saved Form* option. The date of survey will be automatically displayed at beginning of each form.



- At the beginning of every form, provide details on the location including geo-coordinates. It is mandatory to generate geo-coordinates at the locations from where the data is being collected. The surveyor should select *Start Geo-Point* option. If accuracy level is below 10 meters, geo-coordinates will automatically be saved in the form. In case of poor reception, the FDK will display accuracy level and the user is advised to attempt for a better reception or use the *save Geo-Point* option.
- Fill the data as called for by NWPC. The summary of forms to be filled is provided in Table 2.1.

**Table 2.1: Summary of FDK forms**

Form name	Description	Form name in FDK
Plot approach Form	This form provides a set of information to be collected during journey of the survey team to the plot locations.	PLOT_APPROACH_FORM
Plot description forms	This is general information to be provided about all sample plots.	PLOT_DESCRIPTION_FORM
Plot enumeration forms		
Plot enumeration forms for trees and bamboos	The data for filling up this form should be collected from main plot by enumerating the trees and non-clump bamboos.	PLOT_ENUMERATION_Trees_and_non_clump_bamboo
Bamboo clump enumeration Form	The data for filling up this form should be collected from the mail plot for bamboo clumps.	PLOT_ENUMERATION_Bamboo.
Plot enumeration form	Liter, shrub, climber, and tree regeneration data should be collected through this form from all sub plots laid around the main plot.	PLOT_ENUMERATION_Shrubs
Plot enumeration form	Data regarding herbs should be collected in this form from all sub plots laid around the main plot.	PLOT_ENUMERATION_Herbs
Village level data collection		
Village level information to be collected through PRA	Details of fuelwood demand, grazing intensity and socio-economic conditions.	VILLAGE_INFORMATION_PRA
Household information	Household information collection is mainly associated with forest resource extraction and the fodder extraction from forest and private lands	HOUSEHOLD_INFORMATION

8. General guidelines on filling of forms are given in Annex-5.
9. The data collected through FDK should immediately be saved in the server. In extreme cases where a server is not available, the mobile devices can be brought to the GIS cell and directly transferred to the server there.

## 2.7 OUTPUT

At the end of phase-1, the forest department will be equipped with a database of geospatial layers as called for by NWPC, a second database of primary information collected from the field and input from stakeholders on potential areas for forest management activities.

# 3. PHASE II: ANALYSIS OF ECOSYSTEM SERVICES, MAP OF POTENTIAL FOREST MANAGEMENT ACTIVITIES AND ECOSYSTEM SERVICES DIAGNOSTIC

This section covers the second phase of IFMT and contains three components. The first component is an analysis of ecosystem services based on data collected using FDK. This will be followed by development of a map of potential forest management activities. The final component is implementation of an Ecosystem Services Diagnostic tool.

## 3.1 ANALYSIS OF ECOSYSTEM SERVICES

The NWPC enshrines ecosystem services as a key management objective for Indian forests. The IFMT provides space for analyzing major regulatory and provisioning ecosystem services including biodiversity conservation, water resource management, carbon sequestration, and provisioning of fuelwood, fodder and NTFPs. The following section details the steps involved in analysis of ecosystem services in IFMT.

### REGULATORY SERVICES

#### 3.1.1 BIODIVERSITY CONSERVATION

IFMT assists the WPO in developing working circles for biodiversity conservation by analyzing data collected from the field using FDK. Analysis can be carried out in two ways: 1) through biodiversity assessment and 2) overlaying relevant geospatial layers.

1. Biodiversity assessment: The NWPC indicates that biodiversity assessment can be done by calculating Important Value Index (IVI), species richness and species diversity. The calculation can be carried out as follows.
  - a. IVI: the data collected during enumeration such as the number of individuals of each species and DBH of trees are utilized to derive secondary attributes such as basal area, density and frequency. The IVI is calculated as the sum of relative dominance, relative density and relative frequency (formula provided in Annex-6). It is assumed that the dominance of a species increases with an increasing importance value and that the species with lowest importance value is the least dominant one.
  - b. The number of species in a community is referred to as species richness when the topography of a compartment is homogenous.
  - c. A community displays high species diversity if many equally or nearly equally abundant species are present. Communities with few species that are dominated by one species are least diverse. Species diversity index such as the Shannon index is calculated separately for trees, shrubs and herbs (formula provided in Annex-6).
  - d. Once calculations are carried out, the values are converted into geo-spatial layers. The calculation of biodiversity index from field data is presented below.
    - i. The plot enumeration form of FDK will collect the following details (NWPC 2014, 71)

(DD/MM/YYYY)

Compartment No..... Block /Village ..... Beat .....  
Range ..... Division..... ALT .....  
LAT..... LONG..... Grid No.....

S. No	Species name	Local name	DBH (OB) in cm	Height of selected dominant trees	NTFP utility		Remarks, if any, about the tree condition
					Part of the tree	Approx. weight and or no.	

- ii. The FDK automatically records geographical coordinates of points where sampling is done. For every plot, the species name, DBH and height of tree along with other details are entered. This will be converted to a database file format or can be viewed in excel sheet by downloading from the FDK Server. For instance, plot A may have the following details.

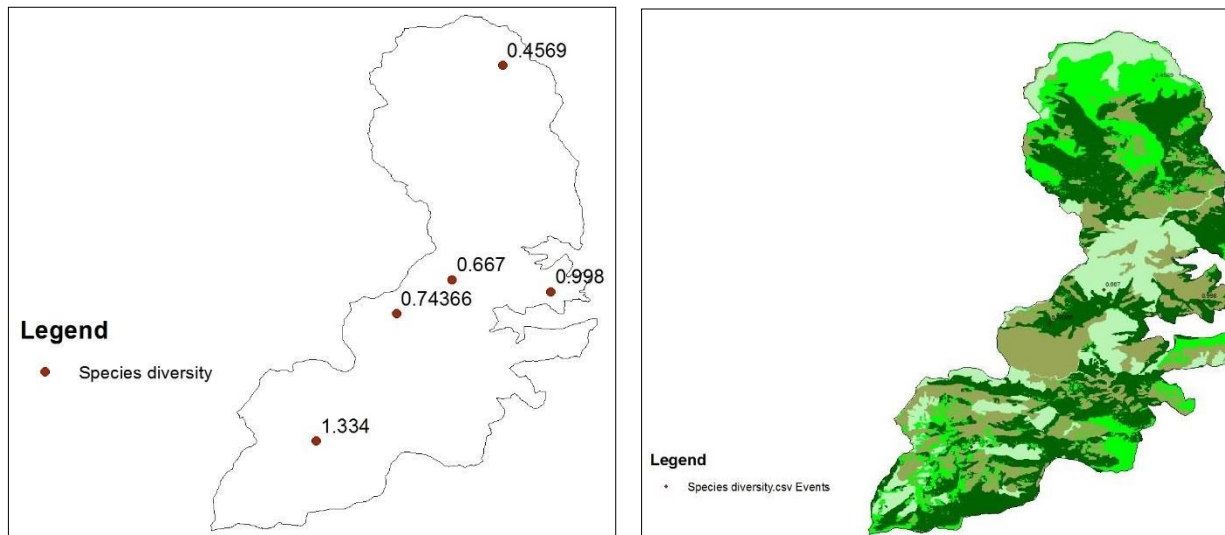
Plot	Latitude	Longitude	Species	GBH (cm)	Height (m)	Part	Weight
A	31.3244	77.5971	Cedrus deodara	21	10	Leaf	3
A			Abies pindrow	15	5	Seed	2.2
A			Quercus	14	6	Fruit	4
A			Xylia xylocarpa	14	7	Fruit	4
A			Haldinia cordifolia	13	8	Flower	1.5
A			Mallotus philippensis	12	9	Seed	1.01

- iii. When all plot data are collected, the biodiversity index is calculated using the formula (Annex-6) and a table will appear as below.

Plots	Latitude	Longitude	Species Diversity
A	31.32445	77.5971	1.334
B	31.4723	77.7218	0.667
C	31.4613	77.8123	0.998
D	31.66887	77.76829	0.4569
E	31.44124	77.67123	0.74366

- iv. This data can be projected in ArcGIS by importing the database file and using the display X-Y data option. The point data can be converted into a spatial map showing areas of high and low biodiversity by changing the symbology in ArcGIS and selecting species diversity attribute and change to gradient colors as in example below.

**Figure 3.1 Example of species diversity in Rampur division**  
(data displayed is only for demonstration)



- v. Overlaying geospatial layers: Working circles for biodiversity conservation can also be identified and spatially mapped by overlaying of relevant geospatial layers. GFW MapBuilder allows users to ‘switch-on and switch-off’ layers which enables visualization of different layers simultaneously. For instance, if layers on protected areas and human wildlife conflict are overlaid, the common areas would indicate potential working circles where management activities can enhance connectivity between protected areas, help mitigate human-wildlife conflict and improve biodiversity in the region. Additionally, field data will also provide information on areas affected by invasive species, allowing WPO to prioritize these areas for management activities aimed at removing invasive species.

### 3.1.2 WATER RESOURCE MANAGEMENT

IFMT provides the CLART tool for analyzing water resource management. CLART provides a composite approach for utilizing spatial data to classify land area based on its recharge potential. CLART assesses recharge potential based on soil type, porosity, permeability, mineral composition/texture, drainage, slope of the area and land use/land cover. In the demonstration of IFMT for Rampur division, the above datasets were obtained from publicly available sources. The CLART script overlays the datasets to classify areas based on their recharge potential.

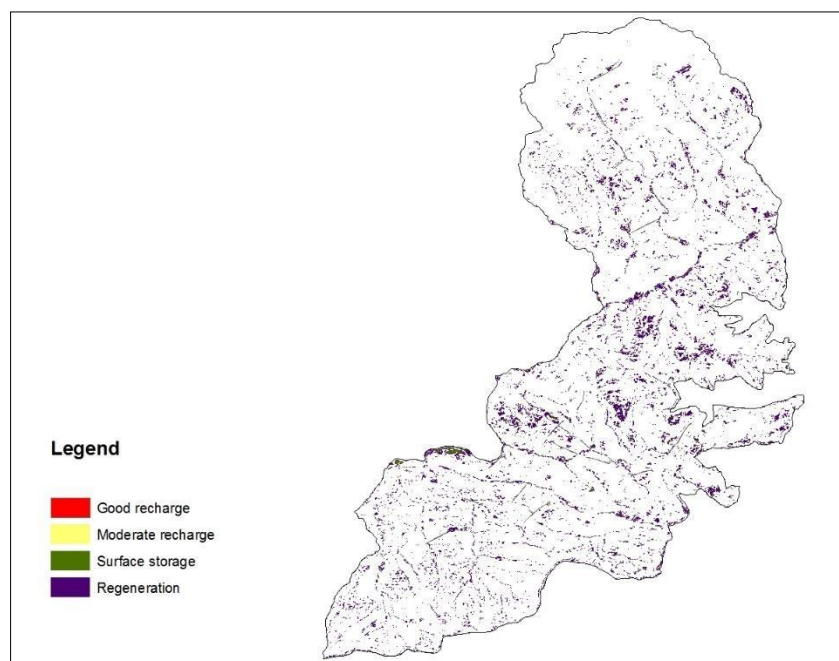
The process for using CLART involves the following steps.

1. Run the CLART script to obtain a geo-spatial layer. CLART tool has a python script which can run the algorithm to develop spatial layer. The technical manual on CLART will provide information on python script.
2. Save the layer to the geo-spatial server.
3. Upload CLART layer to the GFW MapBuilder.

The geo-spatial layer of CLART classifies areas into ‘good recharge, moderate recharge, surface storage and catchment conservation areas’. Working circles on water resource management can prioritize regions with good

and moderate recharge potential for improving ground water. Similarly, for regions where only surface storage is possible, infrastructure related activities can be recommended. A table on interpreting recharge potential based on CLART results is provided in Annex-7. Figure 3.2 provides an example of CLART output for Rampur division.

**Figure 3.2 CLART output for Rampur division**



### 3.1.3 CARBON SEQUESTRATION

The NWPC emphasizes the role of forests as source or sink for greenhouse gases. IFMT allows analysis of carbon sequestration through data collected from the field. Based on DBH and height, volume can be calculated which can then be used in volumetric equations to estimate biomass and carbon content (Lakhchaura, 2016). The process for developing working circles for carbon sequestration is given below.

1. Process FDK data from the server to obtain criteria for carbon sequestration. The calculations that underpin data processing are based on the NWPC (NWPC 2014, 65) and volumetric equation (Lakhchaura, 2016).
2. Convert the values to geo-spatial layers and save in the geo-spatial server.
3. From geo-spatial server, upload the carbon layers to GFW MapBuilder.

### 3.1.4 PROVISIONING SERVICES

The NWPC recommends that forest management should consider needs of forest dependent communities in preparing working plans. Working circles for provisioning services can be developed based on data from the village and socio-economic survey of FDK. The socio-economic survey provides information on socio-economic status of the people living in and around the forest and their dependence on forests for their livelihood. The household and village level survey provides information on fuelwood demand and grazing requirements. This data can be spatially mapped and areas with high fuel wood demand or grazing intensity can

be marked as working circles for management practices such as silvipasture or Charagah as allowed under applicable legislations and government policies.

An example of calculation of demand for fuelwood, grazing land, and NTFP is given below (FDK will collect the following information):

### B.1. Private lands (non-cultivated) /community lands

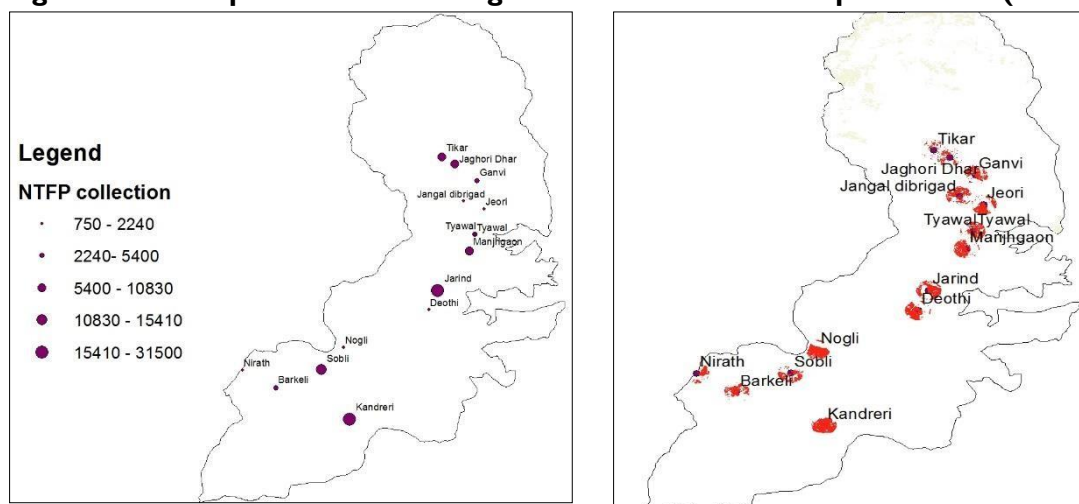
Parameters	Small timber, etc.	Fuel wood	Leaf fodder	Grasses	NTFP products	Quantity of fodder used for stall feeding	Quantity of total fodder sold/ purchased
1	2	3	4	5	6	7	8
Quantity (qtl) per week							
Duration of collection a - no. of weeks in a month							
b - no. of months in a year)							

### B.2. Forests lands

Parameters	Small timber, etc.	Fuel wood	Leaf Fodder	Grasses	NTFP products	Quantity of fodder used for stall feeding	Quantity of total fodder sold/ purchased
1	2	3	4	5	6	7	8
No. of head loads per week							
Weight of each head load (kg)							
Time consumed (hrs) for collection per day							
Distance traveled for collection per trip (km)							
Quantity (qtl) per week							
Duration of collection a - no. of weeks in a month, b - no. of months in a year)							

Using household and village information, the demand for provisioning services can be mapped spatially. The database is uploaded to ArcGIS using geographical coordinates of sampled villages. Choose NTFP demand or grazing requirements as attribute to be spatially mapped. An example of mapping villages with NTFP demand and grazing land requirements is given in Figure 3.3.

**Figure 3.3 Example of areas with high NTFP demand in Rampur division (dummy data)**



### 3.2 MAP OF POTENTIAL FOREST MANAGEMENT ACTIVITIES

IFMT provides a methodology for spatially mapping forest areas for various management activities based on biophysical and socio-economic criteria, discussion within the forest department and consultation with local stakeholders. The mapping process adopts a landscape approach and will identify broad areas within the forest division where certain forest management activities can be implemented for ensuring sustained flow of ecosystem services. The following section will explain in detail the process for developing a map of potential forest management activities.

#### 3.2.1 INPUT

The input for the mapping process includes making a list of previous forest management activities, establishing criteria for prioritizing particular management activities in a region, and consulting with stakeholders. These details should be collected from the inception workshop and FRO. Based on discussion, a list of data layers will be selected for mapping forest management activities. A list of suggested data layers is provided in Table 3.1.

**Table 3.1: Data layers for preparation of map of forest management activities**

Sl. No	Data type
1.	Land use and land cover
2.	Rivers and water bodies
3.	Soil and geology to identify areas where tree growth is not possible
4.	Slope and elevation
5.	Forest/ tree cover
6.	Forest type
7.	Village locations
8.	Protected areas boundary
9.	Compartment boundaries

The data must be clipped to the area of interest.



### 3.2.2 PROCESSING OF INFORMATION

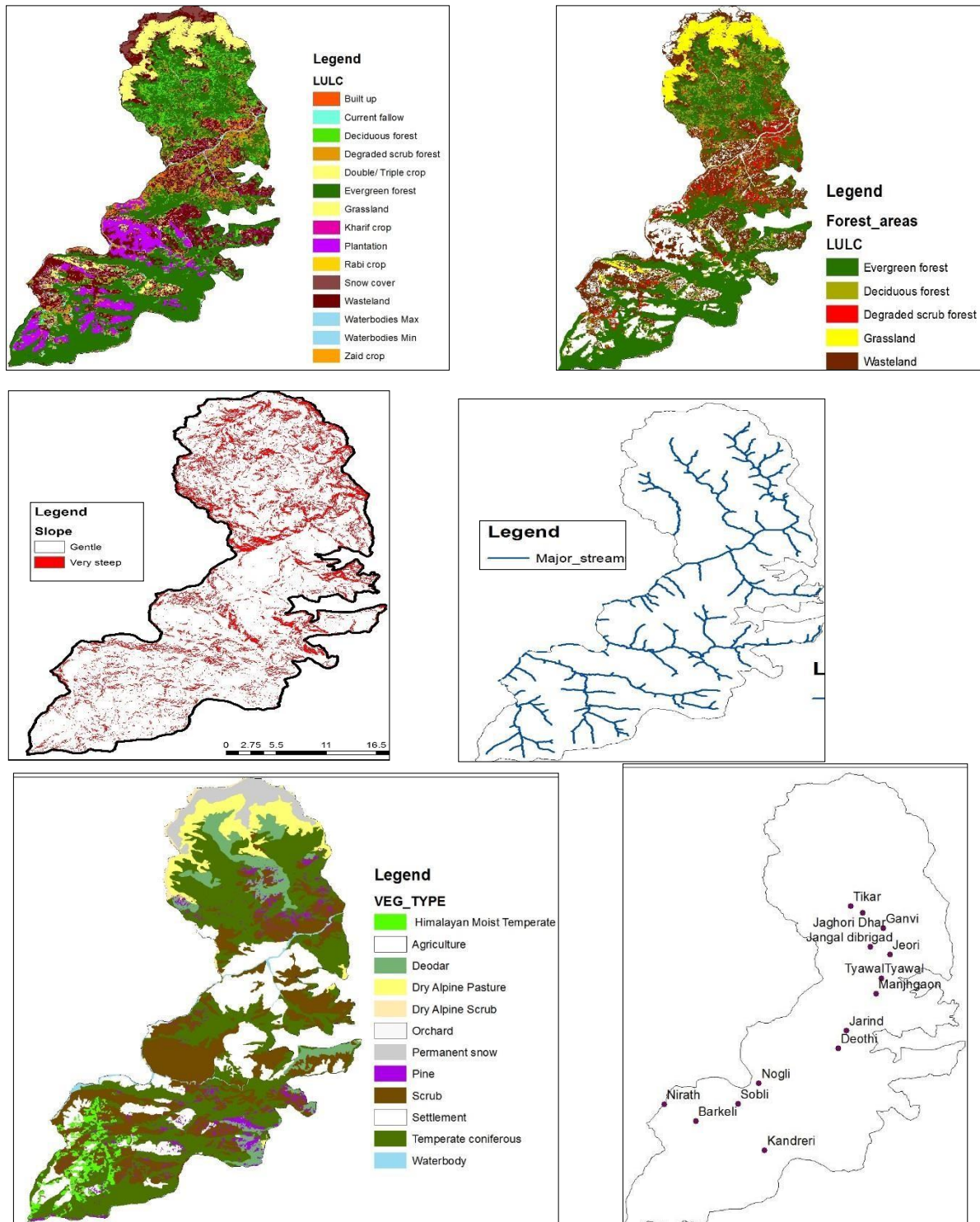
Processing of information involves classifying and overlaying various layers. The steps in this process are as follows:

1. Classify collected data to facilitate interpretation of over-laid spatial data as provided in Table 3.2.

**Table 3.2: Classification of data for mapping**

Sl. No	Data type	Analysis
1.	Land use and land cover (LULC)	Use the ‘extraction tool of ArcGIS’ (available with ArcGIS license) to excluded areas where forest management activities are not possible, such as waterbodies, built up areas, agriculture land and permanent snow. See Fig 3.4 for example of data processing.
2.	Rivers and water bodies	Use “Classify” tool in ArcGIS to classify streams as first, second and third order. For analysis, use third order streams and major river.
3.	Soil and geology to identify areas where tree growth is not possible	Use this data to exclude areas where tree-based forest management activities are not possible.
4.	Slope and elevation	Classify areas based on elevation and slope where only certain forest management activities are possible.
5.	Forest/ tree cover	Classify data as: Very dense- >70% Moderately dense- 40%-70% Open forest- 10%-40% Scrub- <10%
6.	Forest type	Classify forests as per FSI standard
7.	Village locations	Provide buffer of 1 km (Buffering distance are subjective and will depend on biophysical conditions of the forest. For example, a narrow stream can be given a small buffer to identify river bank plantation but for a wide flowing river with larger flood plain a larger buffer can be given.)

**Figure 3.4 Demonstration of data processing for Rampur division**



2. Overlay the maps thus obtained and identify areas where forest management activities are possible. For instance, afforestation/ plantation can be a potential forest management activity in areas where

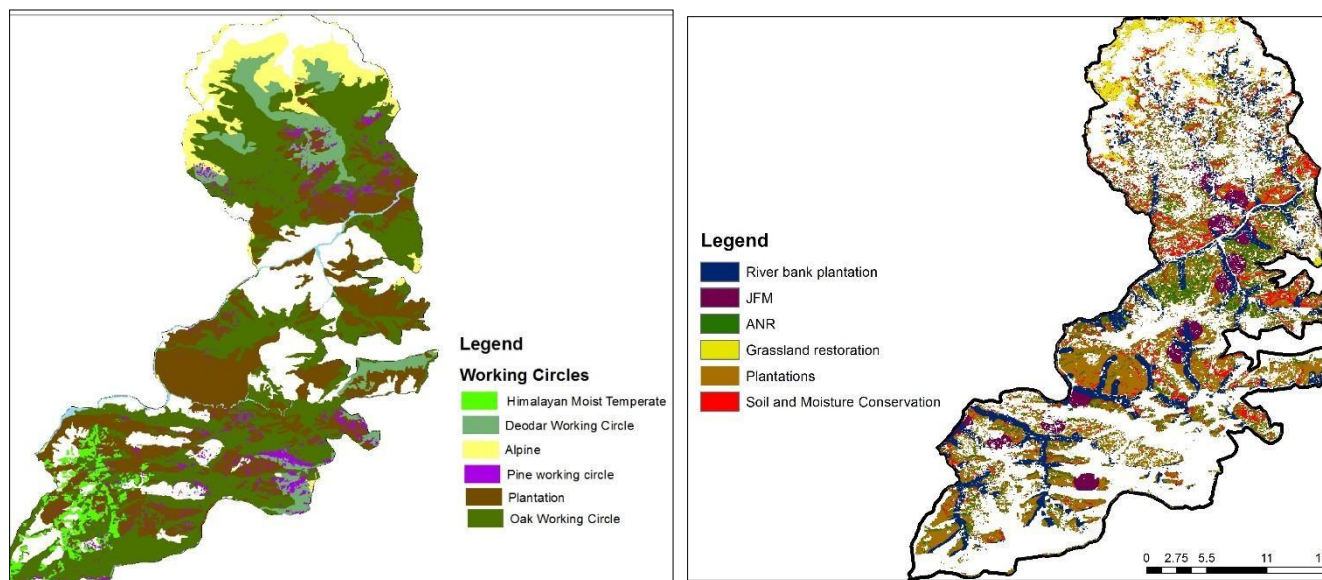
there is less than 70% tree cover and rootstocks are not available. In areas where there are JFMCs and elevation is less than 1000 meters, bamboo plantations may be recommended. In a similar way, identify areas along with potential forest management activities for the target area.

3. Forest management activities in a division are those planned under the working plan, such as biodiversity conservation, JFM, protection, soil and moisture conservation, plantations, etc. Sometimes these activities are mapped as forest working circles that are mutually exclusive or sometimes as overlapping working circles, that goes across the division. Such management activities can be spatially mapped using a set of criteria in GIS analysis. For instance, using “Overlay” and “Reclassify” tools in ArcGIS, classify the areas as follows.
  - a. Forests below canopy cover 70% into ANR, enrichment planting, gap plantations, pasture development
  - b. Areas with slope > 30% and less than 4000m elevation into “plantation for slope stabilization/ SMC”
  - c. River buffer areas into “Riverine plantations”
  - d. Degraded areas/wastelands into “Plantations”
  - e. Areas in village location buffer into JFM areas
  - f. During the half-day consultation with stakeholder (Section 3.3 below), identify overlapping working circles where there is a trade-off between ecosystem services. For instance, an area which has high demand for NTFP may fall under a working circle suited for plantation. Mark out such areas in the map of potential forest management activities.

### 3.2.3 OUTPUT

The above process creates a map that shows potential areas for different forest management activities. This map may have many areas of intersection where more than one forest management activity can be possible. A draft map of forest management activities for Rampur is provided in Figure 3.5.

**Figure 3.5 Draft map of forest management activities for Rampur division**



## 3.3 IDENTIFICATION OF TRADE-OFFS AND SYNERGIES BETWEEN ECOSYSTEM SERVICES

As discussed in the previous section, within a forest division there will be overlapping working circles with more than one potential forest management activity. Consequently, it is necessary to identify what ecosystem service needs to be prioritized in an area and which forest management activity would yield the ecosystem service and what are the associated co-benefits. Importantly, such decisions should be made in consultation with stakeholders. The Ecosystem Services (ESS) Diagnostic Tool is a mechanism that enables stakeholders to systematically deliberate trade-offs and synergies between ecosystem services associated with forest management activities and subsequently develop working plan prescription that will enhance the flow of priority ecosystem services.

### 3.3.1 INPUT

The working plan team should convene a half-day consultation to implement the ESS diagnostic. Participants should include forest officials, local communities, experts, and civil society. The following are the inputs required for the consultation:

1. The list of stakeholders (from phase-1)
2. The ESS diagnostic kit consisting of two sets of scoring sheet (one for prioritization of area for ecosystem services – Table 3.3 and another for prioritization of forest management activities for ecosystem services – Table 3.4), sticky dots, and comments sheet.
3. Participants use sticky dots to indicate presence (green), absence (red) and partial presence (yellow) for flow of ecosystem services. In case of green and yellow, weightage (1 to 10) can be assigned.

**Table 3.3: Example of diagnostic sheet for prioritization of ecosystem services**

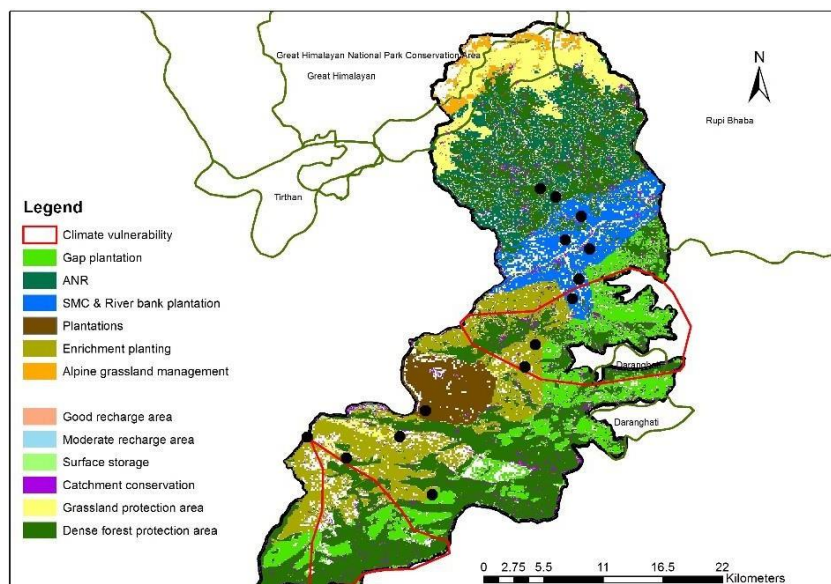
Area	Provisioning			Regulatory		
	Fuelwood	Fodder	NTFP	Biodiversity	Water	Carbon
Plot 1						
Plot 2						

**Table 3.4: Example of diagnostic sheet for prioritization of forest management activities for ecosystem services**

Forest management activities	Provisioning			Regulatory		
	Fuelwood	Fodder	NTFP	Biodiversity	Water	Carbon
Afforestation/ Plantation						
Assisted Natural Regeneration						
Protection						
Alpine grassland management						
Enrichment plantation						
Slope stabilization						
Plantations in hilly areas						
Riverine plantations						
Pasture and grazing land development						
Plantation of NTFP plant species						

4. The map of forest management activities and geospatial layers on ecosystem services can be visualized in the GFW MapBuilder to depict trade-offs in ecosystem services. Figure 3.6 provides an example of areas in Rampur division where multiple forest management activities are possible.

**Figure 3.6 Map of potential forest management activities showing overlap in ecosystem services**



### 3.3.2 PROCESSING OF INFORMATION

At the consultation, the WPO should present the GFW MapBuilder map of potential forest management activities and flows of ecosystem services to the stakeholders. Specifically, present examples of areas where trade-offs between ecosystem services can be seen. This step will help stakeholders understand the ecosystem services associated with forest management activities.

Thereafter, implement the diagnostic, which is a two-step process.

1. In the first step, stakeholders are required to discuss the type of ecosystem service that can be prioritized in the target area and assign weightage (total weightage across options cannot exceed 10).
2. At the end of the process, stakeholders will finalize the ecosystem service (and there may be more than one in some areas) to be prioritized for an area. For instance, stakeholders will discuss the ecosystem services that can be prioritized in regions A and B. They may decide that plot A offers high opportunity for provisioning fuelwood, followed by water resource management and carbon sequestration. Whereas in plot B, the major ecosystem service could be biodiversity conservation followed by water resource management. The table would be filled as follows:

**Table 3.5: Completed diagnostic sheet for prioritization of areas for ecosystem services**

Area	Provisioning			Regulatory		
	Fuelwood	Fodder	NTPF	Biodiversity	Water	Carbon
Plot A	3 ●	1 ●	1 ●	1 ●	2 ●	2 ●
Plot 2	1	1	1	3	2	0



- From Table 3.5, it is seen that Plot A offers opportunity for prioritizing three ecosystem benefits: provisioning of fuelwood, water resource management, and carbon sequestration. During discussion, it may emerge that local stakeholder prefer provisioning of fuelwood and the forest department prefers prioritizing carbon sequestration. It is important to capture these discussions in the comments sheet. Similarly, in plot B, there is competition between biodiversity conservation and water resource management.
- In the second step, stakeholders will discuss different forest management activities and assess the flow of ecosystem services associated with the activities. The table may be filled as follows.

**Table 3.6 Completed diagnostic sheet for prioritization of forest management activities for ecosystem services**

Forest management activities	Provisioning			Regulatory		
	Fuelwood	Fodder	NTFP	Biodiversity	Water	Carbon
Afforestation/ Plantation	3	0	1	2	1	3
Enrichment plantation	2	1	1	0	2	2
Pasture and grazing land development	0	3	0	0	2	1
Plantation of NTFP plant species	1	1	4	0	1	1

- From Table 3.6, it can be seen that afforestation/plantation has high score against both provisioning fuelwood and carbon sequestration. Therefore, it is the best forest management activity for plot A. However, for plot B there are no forest management activities that contribute to biodiversity conservation and water resource management and the conflict of interest continues. In such cases, secondary characters may be considered. For instance, plot B may be in proximity to a village which is dependent on ground water. In such a case, enrichment plantation can be identified as the most appropriate forest management activity.

### 3.3.3 FROM TRADE-OFFS TO SYNERGIES

The purpose of ESS diagnostic is to facilitate stakeholders to move from trade-offs to synergies while prioritizing areas and forest management activities for ecosystem services. Some strategies that facilitators from the working plan team can follow are provided below:

- Prior to implementation of the ESS diagnostic, facilitators should use GFW MapBuilder to explain to stakeholders the list of forest management activities, flow of ecosystem services, overlapping working circles and map of potential forest management activities. Include details of consultations already held with local stakeholders at the inception workshop and during collection of primary data with FDK. This allows stakeholders to understand the array of regulatory and provisioning services that can be achieved by optimizing forest management activities.
- While prioritizing areas and ecosystem services, encourage participants to identify as many ecosystem services as possible, assign weightage and record their reasons in the comments sheet. This will help document stakeholder input.

3. In discussing forest management activities and ecosystem services, facilitate discussion around co-benefits.
4. When participants deliberate forest management activities for a plot, facilitate discussion around co-benefits that can benefit different stakeholders. For instance, the type of trees used in plantations can have varied carbon sequestration, fuelwood, NTFP and water conservation benefits. Tree species can therefore be decided based upon the needs of stakeholders (in addition to biophysical characteristics of the region).

### 3.3.4 OUTPUT

At the end of the half-day consultation, the working plan team will have a list of finalized forest management activities as recommended by stakeholders. Subsequently, the map of potential forest management activity should be revised and added to GFW MapBuilder.



## 4. PHASE III: FROM ANALYSIS TO WORKING PLAN PRESCRIPTION

By this stage, the forest department officials will have an overall picture of forest management activities and working plan prescriptions that form the basis of the working plan. The output obtained is based on the best available geospatial data, field data, and stakeholder consultation. In the final phase of IFMT, the output from the Toolbox will be included in relevant sections of the working plan and a validation workshop will be organized to present the findings.

### 4.1 DEVELOPMENT OF DRAFT WORKING PLAN

The working plan is to be written by the WPO and has three parts:

1. Executive summary along with the constraints faced during writing the plan.
2. Part 1 - Summary of facts on which proposals are made: This section provides an account of administrative and biophysical characteristics of the forest division, current status of forest with respect to extent of forest, tree cover, biodiversity, forest health, vitality, soil and water resources, forest resource productivity, social, economic and cultural benefits, and past systems of management.
3. Part II – Future management: This section provides the objectives of management (including for flow of regulatory and provisioning services), working circles and forest management activities.

The working plan team should assist the WPO in developing the draft Working Plan based on output from IFMT. As mentioned in Section 2.1, IFMT adopts a landscape approach and results from the Toolbox are provided at a landscape scale. For use in the Working Plan, the working plan team should ensure that results are culled out for applicable forest areas. The draft Working Plan thus developed will be presented at the validation workshop and subsequently to the Standing Consultative Committee. Output from IFMT will assist WPO in writing specific chapters of the Working Plan. A brief outline of sections of the sections of the Working Plan that the IFMT can assist in filling is given in Table 4.1.

**Table 4.1 List of chapters that can be filled using IFMT**

Chapter of Working Plan	Section of Working Plan	Results/output from IFMT
Executive summary	Vision statement, goals and objectives of management, expected outcome, abstract of plan prescriptions	The vision, goals and objectives of forest management are finalized with stakeholders at the inception workshop. Map of potential forest management activities provides the foundation for formulating working plan prescription
Part 1 - Summary of facts on which proposals are made (Sections: 1.2,1.3,1.4,2.5,2.7,3.1,3.3, 3.8,4.1,4.4,4.8,6.1,6.6,7.2,7.4,7.8,8.10,11.2)	Bio-physical and socio-economic details, current status of forest, carbon stock and sequestration, forest resource productivity and past systems of management.	Inception workshop assists in identifying driver of forest degradation, past forest management practices and impact of past management activities. FRO tool provides GIS layers on bio-physical and climatic characteristics FDK provides field data on biodiversity (plant diversity, growing stock, bamboo) and provisioning services (demand for fuelwood, NTFP and grazing intensity).

		Analysis of ecosystem services provides data on biomass and map for carbon sequestration.
Part II – Future management (Sections 1.1,1.2)	Management objectives (forests and biodiversity, water, climate and socioeconomic considerations) and method of treatment to be adopted.	Analysis of ecosystem services provides individual geospatial layers for biodiversity conservation, water resource management, carbon sequestration and provisioning of fuelwood, fodder and NTFPs. Map of forest management activities developed in consultation with stakeholder which provides a list of management activities to be carried out in different forest areas that support the flow of regulatory and provisioning ecosystem services.

A detailed account of chapters and sections of the Working Plan than can be filled with output from IFMT is provided in Annex-8.

## 4.2 VALIDATION WORKSHOP

Before sending the Working Plan to the Standing Consultative Committee for review, the working plan team should organize a validation workshop to present the output of the process. Participants will be similar to those who attended the inception workshop. The validation workshop will typically cover the following elements:

1. A brief description of the strategy and procedure followed and tools used to develop the draft Working Plan including multiple rounds of stakeholder consultation.
2. Presentation of output from IFMT – database of geospatial layers, database of primary data and map of forest management activities for enhancing flow of ecosystem services.
3. Presentation of draft Working Plan
4. Discussion on draft Working Plan and reviewing whether stakeholder recommendations have been adequately addressed.
5. Explain how the different forest management activities will be implemented and for areas outside of forest area, what are the interventions that can be carried out to ensure sustainable land use management.

Results from the validation workshop should be kept for record and commonly accepted modifications should be made to the Working Plan. Thereafter, the draft Working Plan can be submitted to the Standing Consultative Committee for review.

The Standing Consultative Committee will deliberate and if necessary make commonly accepted changes. In case of irreconcilable difference between members, the matter may be referred to PCCF (HoFF) and DGS&SS (MoEFCC) for final decision on the matter (NWPC 2014, 22).

Thereafter, the approved draft Working Plan will be sent to the MoEFCC by PCCF (HoFF) under intimation to the state government (NWPC 2014, 22).

## 4.3 USE OF IFMT RESULTS

Application of IFMT goes beyond the Working Plan and can be of value in other project proposals as well. The results of IFMT including the map of forest management activities showing flow of ecosystem services are at a landscape level that considers forest areas and areas outside of forests within the forest division. The results for

trees outside of forests can be used to present opportunities for expansion of tree cover while ensuring flow of regulatory and provisioning services including usufructs to local communities (NWPC 2014, 16).

## 5. CONCLUSION

The NWPC embodies the growing prominence of forest conservation, ecosystem services, community involvement in forestry, and carbon sequestration in India's forest management goals. It calls for planning forest management activities that would enhance flow of regulatory and provisioning ecosystem services such as biodiversity conservation, water resource management, carbon sequestration and provisioning of fuelwood, fodder and NTFP. Importantly, it emphasizes regular consultation with local stakeholders such as JFMCs, BMCs, FDA, village panchayat, and other local committees. The goals of NWPC reflect India's contemporaneous international commitment including the Paris Agreement. India's Nationally Determined Contribution includes afforestation and enhancement of carbon stock through improved management. Much of this will occur in forest areas that fall under the purview of working plans.

The technical and analytical advances in NWPC require augmenting forest departments' existing vast knowledge with technical skills and capacity building. These include adopting a landscape approach, focusing on regulatory and provisioning ecosystem services, holding consultation with stakeholders, and using advanced tools and technologies. The IFMT seeks to assist forest department officials in preparing working plans by facilitating collection of geospatial and field data, analyzing flow of ecosystem services, mapping of forest management activities and providing an inter-woven framework for consultation with local stakeholders. Additionally, IFMT adopts a landscape approach and considers interventions in both forest and non-forest areas that would contribute to sustainable land use management. It is a first of its kind Toolbox that was developed in regular consultation with the HP forest department. The individual tools of IFMT interact in three phases: 1) Preparation and data collection, 2) Analysis of ecosystem services, map of potential forest management activities and ESS diagnostic, and 3) From analysis to working plan prescription.

The demonstration of draft IFMT and training provided to HP forest department enabled valuable feedback that have been incorporated in developing the final Toolbox. At the time of writing this manual, discussion is on-going on issues such as server requirements, sample size and design, and consultation with local stakeholder. There are also further trainings planned particularly on the use of FDK, mapping of forest management activities, and implementation of Ecosystem Services diagnostic.

This manual will enable other forest departments to use the IFMT for preparation of their working plans. It should be noted that the manual will also be tested by the HP forest department and updates, if any, will be made.

# ANNEX - I

## CONSULTATION WITH HP FOREST DEPARTMENT TO DEVELOP IFMT

As a first step in the interaction with HP forest department, a one-day workshop on ‘ecosystem approach to forest management’ was held for officials of HP forest department at Shimla on 19 January 2017. The workshop involved sessions on shifts in forest management approaches, importance of ecosystem services and developing ecosystem based restoration of degraded forests. Participants at the workshop included the PCCF (HP forest department), the PCCF (Head of Forest Force), a former PCCF and representatives from Forest PLUS, FES and WRI India. A key outcome of the workshop was the positive response received from forest department officials for preparation of working plans that include new strategies for ensuring flow of ecosystem services.

Following this meeting, the team interacted regularly with the APCCFs of IT and GIS cells and CCFs of Working Plan, Projects and Rampur division. This was followed by interaction with APCCFs, CCFs and DFOs at Shimla to understand the technical infrastructure available at the forest department and steps already undertaken in preparing working plans.

The draft IFMT was presented to HP forest department on 24 May 2017 at Shimla. The meeting was chaired by Additional Chief Secretary (forests) and attended by senior forest department officials, PCCF (HoFF), PCCF (Wildlife) and CCFs (Rampur division, IT, Projects and CAMPA). Participants raised questions and comments on IFMT and discussed in detail issues such as server space, use of FDK to collect data, mapping process and collection of geo-spatial layers. To enable deeper understanding of IFMT, it was decided that the Toolbox would be demonstrated for Rampur and Ani divisions.

Based on a request from the forest department, a week-long training was organized from 19 to 23 June 2017 at Shimla to demonstrate IFMT and train concerned forest department officials in operating it. The objectives of the training were to install necessary software, including the server for running IFMT, demonstrate collection of field data using FDK, train the IT and GIS cells in setting up GFW MapBuilder, present mapping of forest management activities and implement the Ecosystem Services diagnostic. The training was attended by DFOs (GIS cell, Projects, Solan, Rampur, Ani, Kinnaur), beat guards and staff from GIS and IT cells. On the final day of training, discussions were held on usage of IFMT with PCCF (HoFF), CCFs (Projects, IT, Working Plan, Rampur), DFOs (Ani, Publicity cell, GIS cell, Projects) and staff from IT and GIS cells. During the training, participants raised three key comments.

1. Forest officials were keen to understand server requirements and asked for comparative details of available server options. This information was forwarded to the forest department and is also provided in this manual.
2. Participants deliberated in detail the process of setting sampling grid and design. Based on the formula provided in NWPC (NWPC 2014, 61), a grid was laid for Ani division with 108 sampling points. It was acknowledged that the process will vary greatly depending on the size of the division and variation of biodiversity in the region. Participants agreed to continue this conversation to identify the optimal process for setting sample size, design and identifying sampling points.
3. Participants expressed the need for further engagement with IFMT to understand the steps involved in using the constituent tools and methods. Consequently, a few more trainings were set up.

# ANNEX - 2

## CREATION OF WEB MAP AND WEB APPLICATION

### Create web map

Web map forms the second menu in the toolbox. Menu-1 and Menu-3 are customized in the web application template in section III.

To create the web map, sign in to ArcGIS online using the link [here](#)<sup>9</sup>. You can add existing public map created for IFMT-Rampur by searching for 'IFMT - Menu 2 - Ecosystem services'. You can save this and make modifications or follow below steps to create a new map.

The first step with GFW MapBuilder is to prepare the web map.

1. After logging into ArcGIS online, click on 'map' in the top menu bar to open a new blank web map. Basic tutorials are available in the left panel to make a map and style a map.

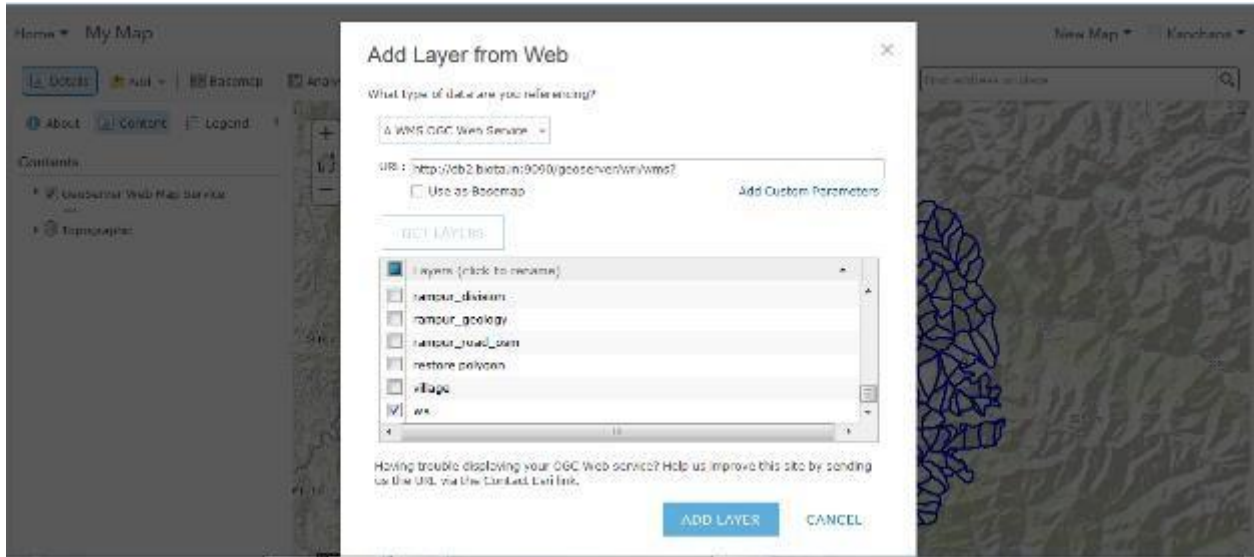


2. To add a layer from the web, click 'add' and then open 'add layer from web'. A popup will open where various services from the web can be added. Choose the appropriate web services from the menu. The following web services can be added into the web map.
  - ArcGIS server web service
  - WMS OGC web service
  - WMTS OGC web service
  - WFS OGC web service
  - Tile layer
  - KML file
  - GeoRSS file

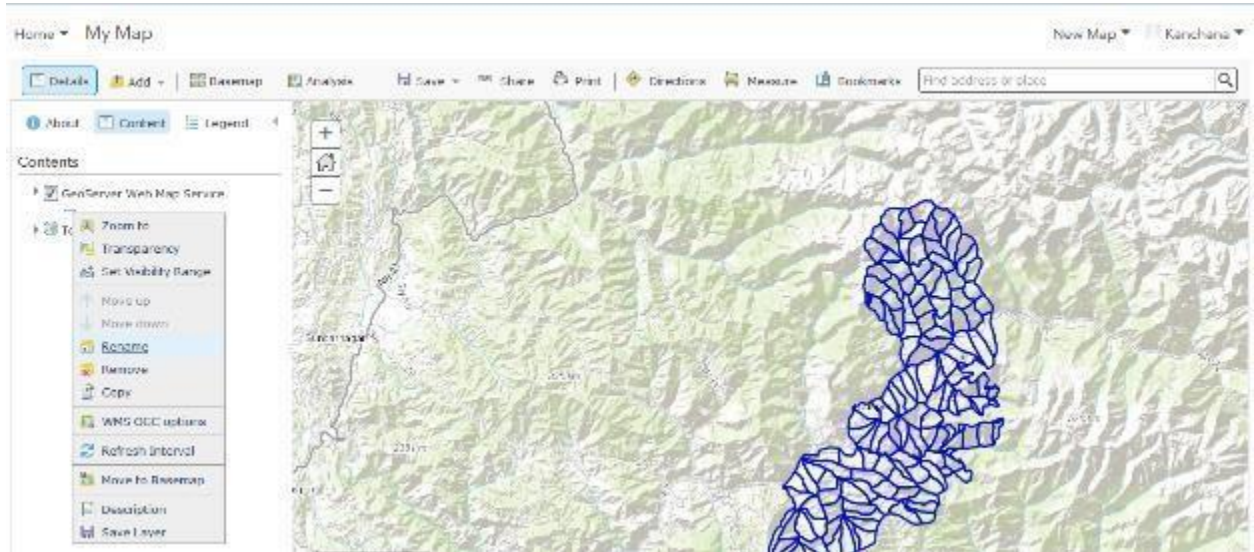
<sup>9</sup> <http://www.arcgis.com/home/index.html>



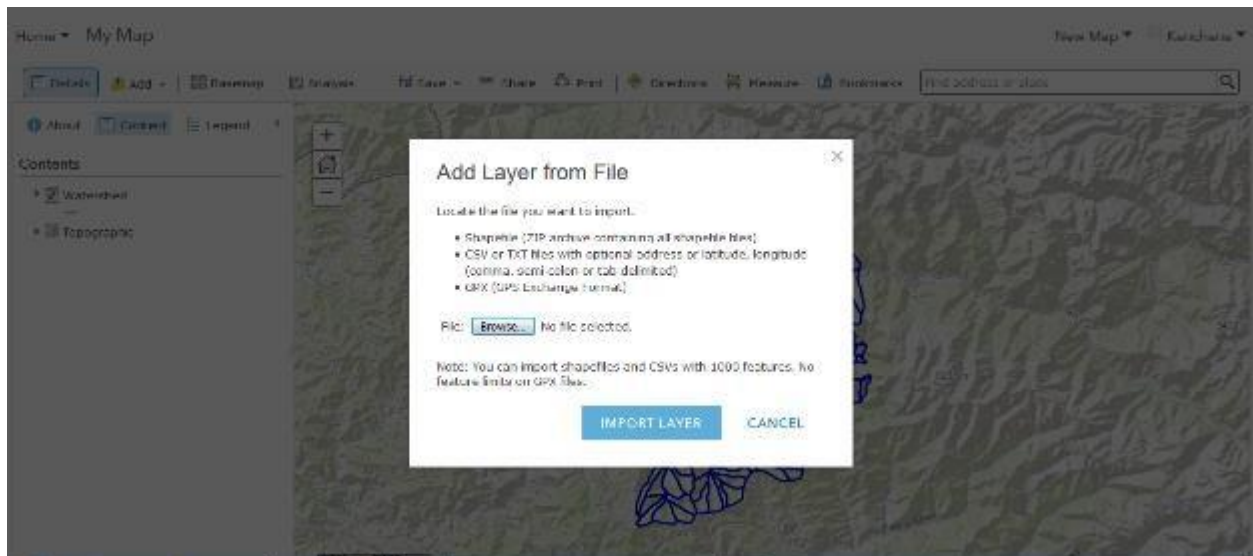
- CSV file
  - Bing basemap
3. To add a WMS service from the web, choose 'A WMS OGC web service' from the drop down and add the URL of the WMS service. 'Get Layers' will fetch the list of available layers in the service. Choose the layer of interest to add.



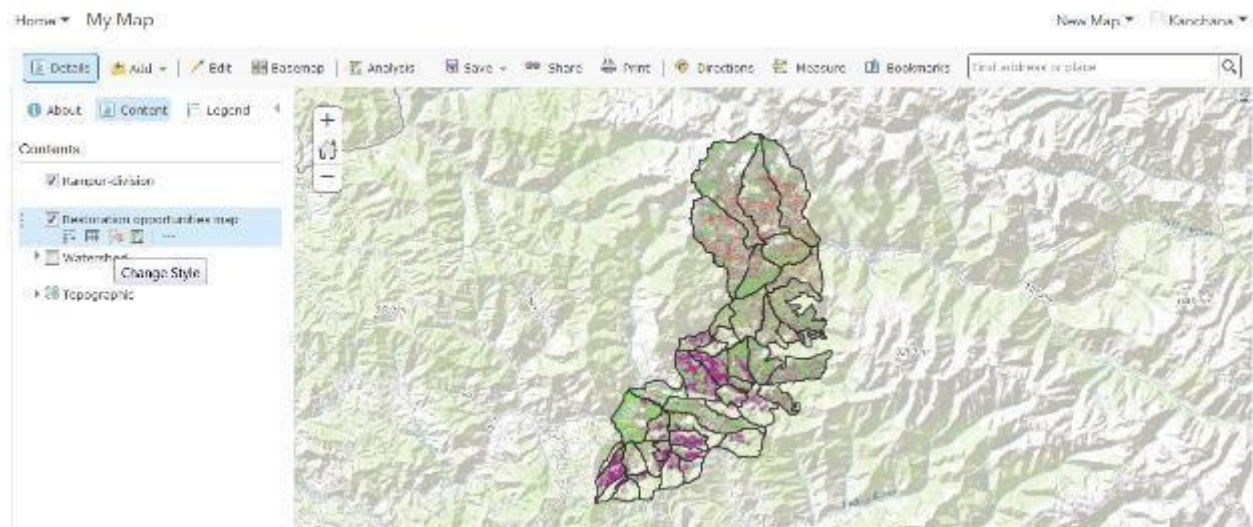
4. Click on the options below the name of the added layer to rename the layer as desired.



5. To add a vector layer from a local file, select 'add layer from file' under 'Add' option. Upload the zipped shape file into MapBuilder. Click on the options (appears as ...) below the name of the added layer to rename the layer as desired.

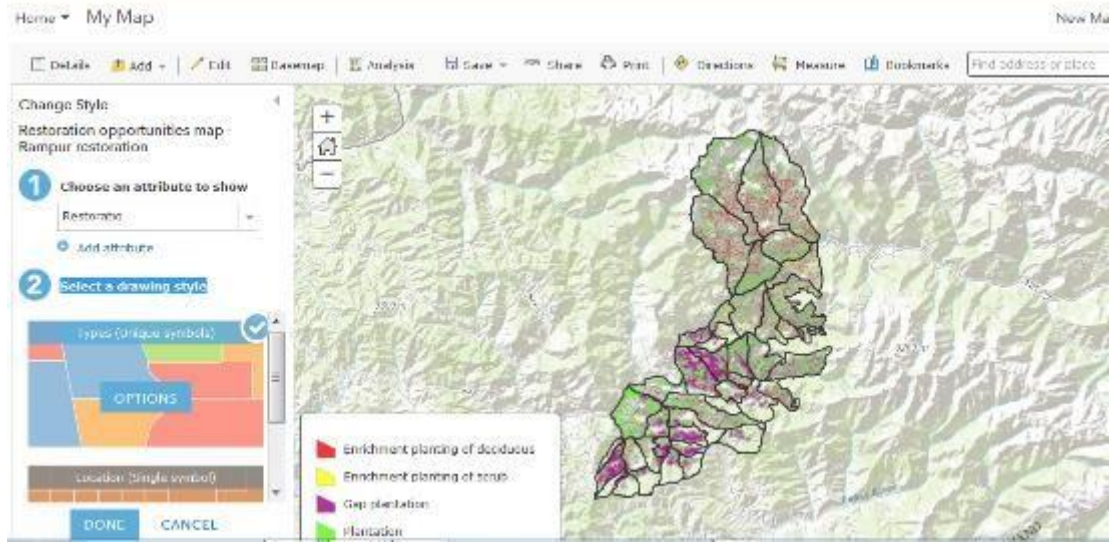


6. To style the vector layer: Under the added shape file, icons show various options like show legend, show table, change style, perform analysis and more options. By selecting 'change style', the layer can be customized for the styling.

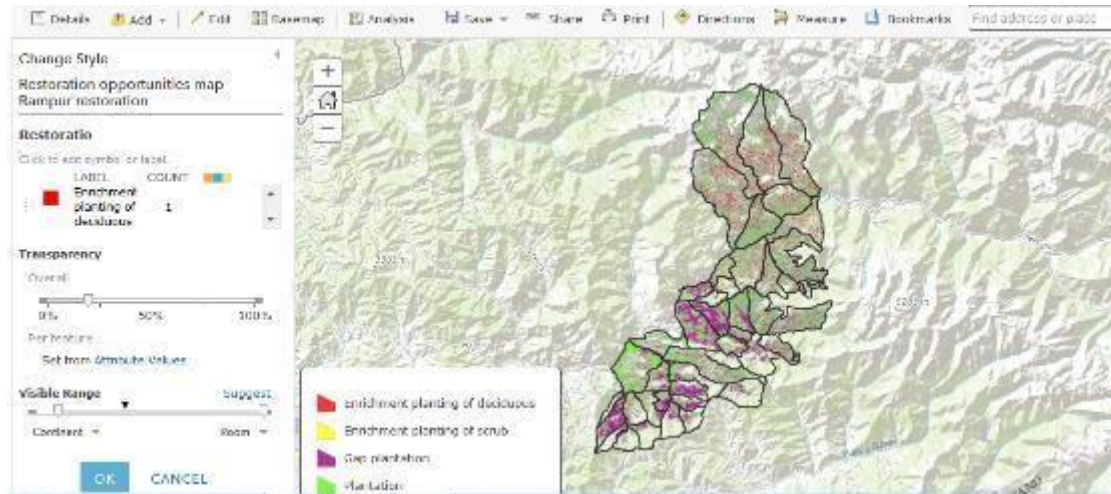


- i. Choose the attribute that contains the legend information under 'choose an attribute to show'
- ii. Use 'select the drawing style' to adjust styling.

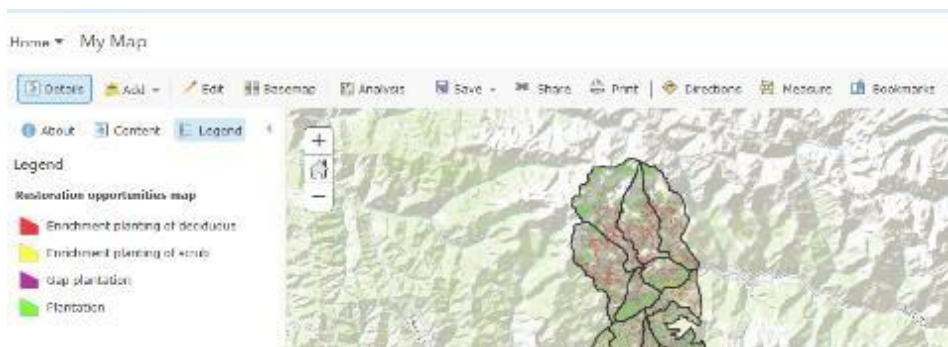




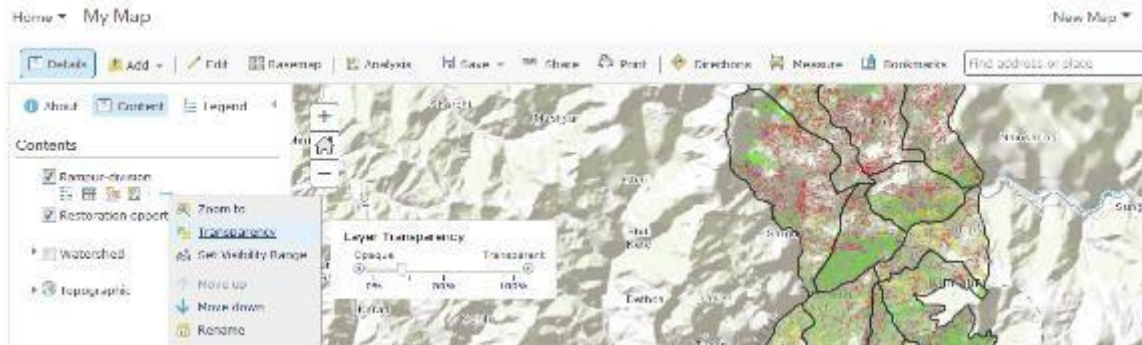
iii. Selecting 'options' routes you to customize the color palette and label.



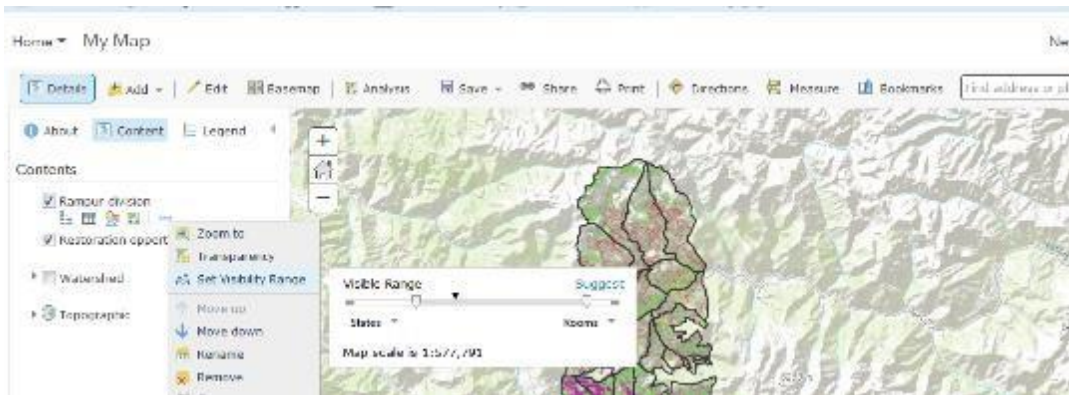
iv. After the customization, choose legend in the menu bar to view the legend information.



7. More customization under 'options':
  - i. Set layer transparency by adjusting the scroll bar as shown in the picture below.

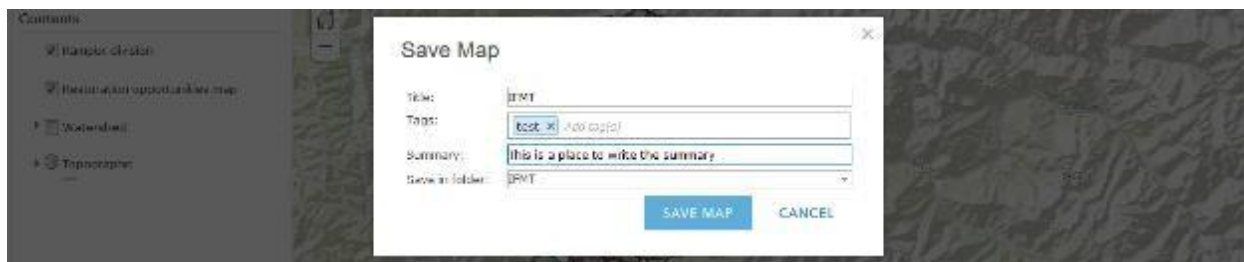


- ii. Use 'set visibility range' to view the layer up to a zoom level, beyond which the layer disappears. If the layer should appear at all zoom levels, pull the bars to both the extremes.



- iii. Use 'hide in legend' option, if the legend information of the layer shouldn't appear in the legend section.

8. After adding the required layers, use 'save' from the top menu bar to save the created map.



## Create Web Application

After creating web map, the web application can be created as follows:

1. Download the GFW MapBuilder files attached below. Unzip the configuration files (index.html, report.html and resources.js). These are the files that need to be hosted in the web server.



Mapbuilder.rar

2. Unzip the downloaded file and open the file - resources.js with Notepad++ (Notepad++ is available for download in the link - <https://notepad-plus-plus.org/download/v7.3.3.html> )
3. Following code customizations need to be made in resources.js file.

Edit/change the following to customize the code for general content of the page. Be sure to make changes between the quotes ( ' ' ).

- i. Title of the page - Line 17: title: 'Integrated Forest Management Toolbox-Beta Version',
- ii. Subtitle that goes in the page - Line 18: subtitle: 'Powered by World Resources Institute India and Foundation for Ecological Security',
- iii. Link of the logo – line 19: logourl: '[http://connectkaro.org/maptenure/IFMT-USAID-Horizontal\\_RGB\\_294.png](http://connectkaro.org/maptenure/IFMT-USAID-Horizontal_RGB_294.png)',
- iv. Link of the page that needs to be directed on click of the logo – line 20: logolinkurl: '<http://www.gfw-mapbuilder.org/>',
- v. Link any web page that shows in about section– line 21: aboutLinkUrl: '<http://www.gfw-mapbuilder.org/>',

### Customization of Tabs

Customize tabs as follows by editing the code in resources.js file. For all the customizations, be sure to make changes in code only between the single quotes ( ' ' ), unless specifically mentioned.

1. The first tab includes the narrative section, where an intro about the project/tool could be provided. Goto line 27 to enter your text: narrative: '<p>Write your narrative here<p>', This involves html coding. The html tag in the sample code here (<p>\_ \_ \_ <p>) starts and ends the paragraph. A suggested link [here](#) for more html tags that could be of use like italicize/bold the text, adding links, adding images and making a list.
2. The second tab, showing various layers, has three menu sections with respective layers. First menu: line no. 131 to 217 signifies the code for the menu.
3. Provide the title for menu-1 in line 134:en: 'Potential Working Plan Prescriptions'
4. Order number of the menu in the tab can be changed here; Replace the order number as 1,2 or 3 as there are 3 menu sections that can be rearranged – goto line 132: order: 1,
5. Line 136-147 denotes the code snippet for a single layer.

```
{
  order: 8,
  id: 'RRB',
```

```

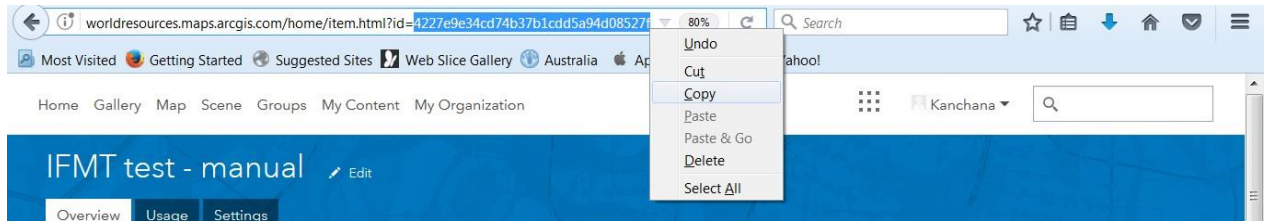
    type: 'dynamic',
url: 'http://gis-staging.forest-atlas.org/server/rest/services/ind/Rampur_data/MapServer',
    //technicalName: 'intact_forest_landscapes_change',
layerIds: [1],
    label: {
en: 'Rampur Range Boundary'
    },
    visible:true
}

```

There are seven other instances of this code snippet in the menu. These lines can be replicated when there are more layers to add.

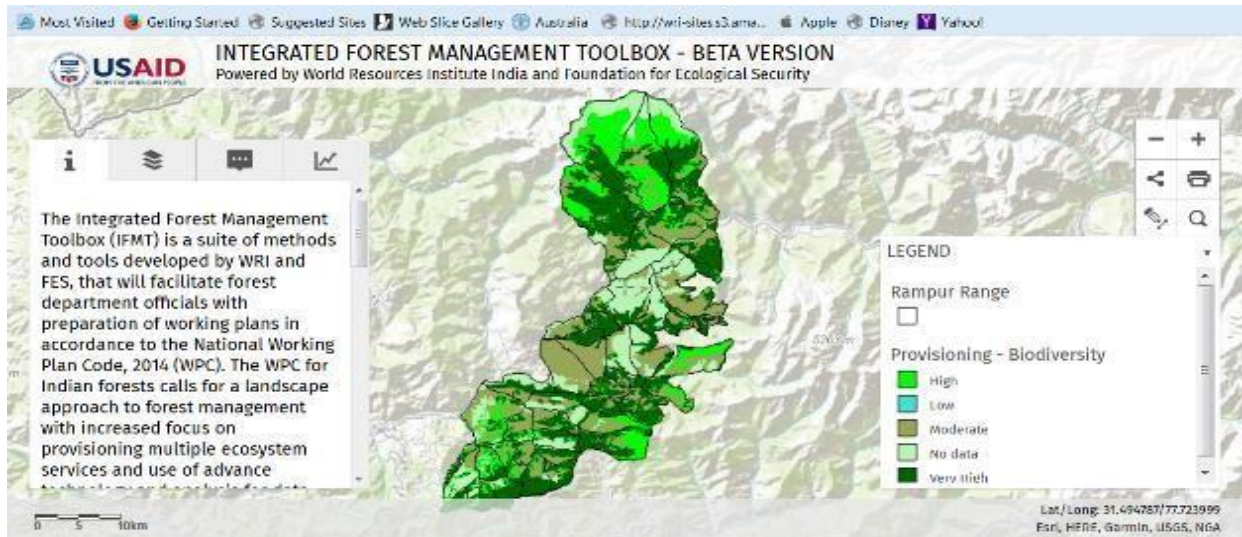
6. Order of the layer in the menu; change the number as per the order in which the layer should be displayed in MapBuilder – line 137: `order: 8`,
7. Provide a unique id for the layer. Unique ID for the layer must be unique across the whole app; the unique id can be anything – for eg: RRB for Rampur range boundary – line 138: `id: 'RRB'`,
8. Place url of the ESRI map services that are hosted in the server – line 141: `url: 'http://gis-staging.forest-atlas.org/server/rest/services/ind/Rampur_data/MapServer'`,
9. Identify and place the layer ids; replace the number inside the bracket [] – line 142: `layerIds: [1]`,
10. Enter the title of the layer to be displayed in the MapBuilder – line 144: `en: 'Rampur Range Boundary'`
11. Line 146: `visible:true` implies that the layer will be visible on opening the web application. Replace 'true' with 'false' to turn off the layer when the web application starts up.
12. Likewise, customize the code snippet between the lines 148-217 for other layers in the menu.
13. To add more layers, replicate the code (copy the code from point iii above and paste it in resources.js file) in line 273 after the closing braces '}' that closes the previous function. Make sure to insert a comma (,) after the closing braces '}'.
14. Second menu in layers tab: lines 16, 55 and 125-129 represents the code for menu-2. The second menu here is ecosystem services priorities which comes from web map.





15. Provide the title of second menu between single quotes ( ' ') – line 55: `webmapMenuName: 'Analysis for Ecosystem Services'`,
16. Third menu in layers tab: line 237 to 253 signifies the code for menu-3. Changing the code snippet is similar to point b above. The code snippet in point from earlier can be replicated here as well, to include more layers.
17. Provide order number of the menu by changing the number; order number would be 3 for the menu to appear third in the tab – line 238: `order: 3`,
18. Provide a unique id for the layer; the unique id can be anything – for eg: DRO for draft restoration opportunities – line 244: `id: 'DRO'`, Place url of the ESRI map services that are hosted in the server – line 246: `url: 'http://gis-staging.forest-atlas.org/server/rest/services/ind/Rampur_data/MapServer'`,
19. Identify and place the layer ids; replace the number inside the bracket [ ] – line 248: `layerIds: [1]`,
20. Enter the title of the layer to be displayed in the MapBuilder – line 250: `en: 'Rampur Range Boundary'`

Once the changes are done, save the resources.js file. Open downloaded index.html file in a browser to visualize the changes offline. Host the downloaded three files – index.html, report.html and updated resources.js in a web server. This makes the application go online. Get the web link from server to visualize the application from anywhere.



## ANNEX - 3

# INDICATIVE LIST OF LAYERS IN GEOSPATIAL DATABASE

Indicative list of layers in the Spatial Database in GIS

S.N.	Layers in the Spatial Database	Possible source(s)
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*	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 Image/ASTER DEM
15	Nurseries*	Maps in the division / department/GPS
16	High resolution satellite imagery*	NRSC
17	Forest cover*	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

# ANNEX - 4

## ADDING LAYERS IN GFW MAPBUILDER

### Host data layers in a server

This section is about hosting necessary data in the required format. Prepare the layers in GIS tool and host them in the server. ARCGIS server or any GIS server could be used to host the data.

The web map forms one of the menu; designed in GFW MapBuilder as second menu. Web map provides the choice to input data hosted in a server or import shape file in zipped format from desktop or add any existing layers or atlas from ARCGIS online. Shape files added in web map can be customized through ARCGIS online account (Refer Section II in ‘Steps to create a web map and web application in GFW MapBuilder’ of preparatory phase). The web services supported by web map are as follows.

- i. ArcGIS server web service
- ii. WMS OGC web service
- iii. WMTS OGC web service
- iv. WFS OGC web service
- v. Tile layer
- vi. KML file
- vii. GeoRSS file
- viii. CSV file
- ix. Bing basemap

Web application (Web app) will form the other two menu sections of the toolbox. The layers for web app must be hosted in a server. Supported data layers include:

- i. Tiled service
- ii. Webtiled service
- iii. ESRI image
- iv. ESRI dynamic map service
- v. ESRI feature service
- vi. ESRI graphic service

### Host the layers in GFW MapBuilder

The three steps below are explained in the order of the menu sections in GFW MapBuilder.



1. Menu 1– Preparation and data collection:
  - i. Open the file - resources.js from the downloaded MapBuilder folder. Customize the tab as follows by editing the code in resources.js file. For all the customizations, be sure to make changes in code only between the single quotes ( ' '), unless specifically mentioned.
  - ii. Line no. 131 to 217 signifies the code for menu 1.
  - iii. Line 136-147 denotes the code snippet for a single layer.

```

      {
          order: 8,
          id: 'RRB',
          type: 'dynamic',
          url: 'http://gis-staging.forest-
atlas.org/server/rest/services/ind/Rampur_data/MapServer',
          //technicalName: 'intact_forest_landscapes_change',
          layerIds: [1],
          label: {
              en: 'Rampur Range Boundary'
          },
          visible:true
      }
  
```

2. There are seven other instances of this code snippet in the menu. These lines can be replicated when there are more layers to add.
3. Order of the layer in the menu; change the number as per the order in which the layer should be displayed in MapBuilder – line 137: `order: 8`,
4. Provide a unique id for the layer. Unique ID for the layer must be unique across the whole app; the unique id can be anything – for example: RRB for Rampur range boundary – line 138: `id: 'RRB'`,
5. Place url of the ESRI map services that are hosted in the server. Look at the previous section for supported web services in web app. Line 141: `url: 'http://gis-staging.forest-atlas.org/server/rest/services/ind/Rampur_data/MapServer'`,
6. Identify and place the layer ids; replace the number inside the bracket [ ] – line 142: `layerIds: [1]`,
7. Enter the title of the layer to be displayed in the MapBuilder – line 144: `en: 'Rampur Range Boundary'`
8. Line 146: `visible:true` implies that the layer will be visible on opening the web application. Replace 'true' with 'false' to turn off the layer when the web application starts up.
9. Likewise, customize the code snippet between the lines 148-217 for other layers in the menu.

10. To add more layers, replicate the code (copy the code from point iii above and paste it in resources.js file) in line 273 after the closing braces '}' that closes the previous function. Make sure to insert a comma (,) after the closing braces '}'.
11. Menu 2 - Analysis for ecosystem services: Data for the menu can be customized in the web map. Input the collected data in web map either by importing shape file or web service. Refer to section II in 'Steps to create a web map and web application in GFW MapBuilder' to customize the fields, name and styling. Data arriving from tools like FDK, CLART need to be added here.
12. Menu 3 – Potential forest management activities: Open the file - resources.js from the downloaded MapBuilder folder. Customize the tab as follows by editing the code in resources.js file. For all the customizations, be sure to make changes in code only between the single quotes ( ' '), unless specifically mentioned.
  - i. Line 237 to 253 signifies the code for menu-3. Customizing the code snippet is similar to point 1 above. The code snippet in point 1.ii can be replicated here as well, to include more layers.
  - ii. Provide order number of the menu by changing the number; order number would be 3 for the menu to appear third in the tab – line 238: `order: 3,`
  - iii. Provide a unique id for the layer; the unique id can be anything – for example: DRO for draft restoration opportunities – line 244: `id: 'DRO',`
  - iv. Place url of the ESRI map services that are hosted in the server – line 246: `url: 'http://gis-staging.forest-atlas.org/server/rest/services/ind/Rampur_data/MapServer',`
  - v. Identify and place the layer ids; replace the number inside the bracket [] – line 248: `layerIds: [1],`
  - vi. Enter the title of the layer to be displayed in the MapBuilder – line 250: `en: 'Rampur Range Boundary'`

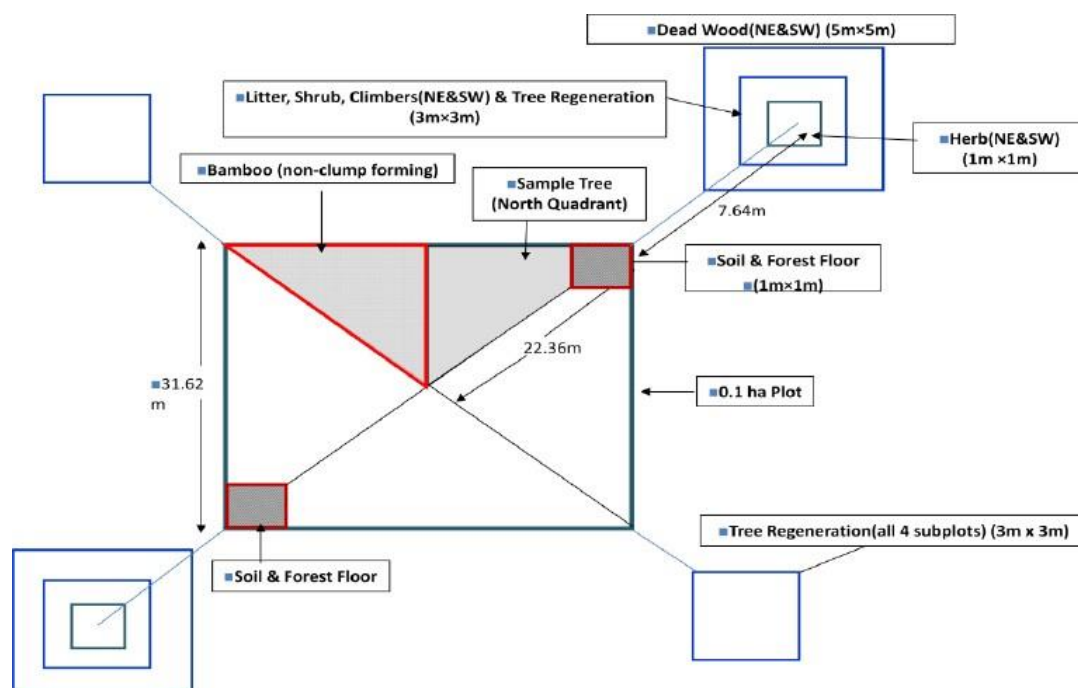
Once the changes are done, save the resources.js file. Open downloaded index.html file from the windows file explorer. This opens the application in a web browser, to visualize GFW MapBuilder offline. Host the three downloaded files, index.html, report.html and updated resources.js in a web server. This makes the application go online. Get the web link from server to visualize the application from anywhere.

## ANNEX - 5

# GUIDELINES FOR FILLING OF FDK FORMS

For plot enumeration, after reaching the sampling plot, the center of the grid, a square plot of 0.1 ha (main plot) should be laid out by measuring 22.36 m horizontal distance that is, half of the diagonal in all the four directions at 45° in north-east, at 135° in south-east, at 225° in south-west, and at 315° in north-west corners of the plot from true north. Nested quadrates of size 3mX3m and 1mX1m should be laid out at 30 meters from the center of the central plot in all four directions along diagonals in non-hilly area and along trails in hilly areas for the enumeration of shrubs (including regeneration status) and herbs/grasses respectively. Selected grids must contain one central plot of 0.1 ha (31.62m X 31.62m). An example of this is given in Fig A 1.

**Figure A1 Plot configuration of main plot and sub-plots**



Guidelines on filling out particular forms are given below.

- i. Plot approach form: Team is recommended to fill the form once every 30 minutes right from the onset of their journey towards every sampling plots. For adding more species to the ocular assessment, the surveyor can use the option after entering the details of one species. Once the species information is complete, move to other options.
- ii. Plot description form: The team should fill the form once they reach the sample plot.

- iii. Plot enumeration - trees\_and\_non\_clump\_bamboo: The form should be filled during plot enumeration. The data on each and every tree above 10 cm GBH and grown non-clump bamboos should be entered. The data on each observation (tree or bamboo) should be entered separately.
- iv. Plot enumeration - Bamboo: This form should be used for enumeration of bamboo clumps from the main plot.
- v. Plot enumeration - Shrubs and Plot enumeration - Herbs: These forms are to be used for enumeration of shrubs, climbers and herb from all the sub plots. Forms are separately available for North East, South East, North West, and South West Plots. One should complete data entry of one subplot and move to the next one.
- vi. Village information - PRA: The form is to be filled during a PRA. We suggest the team to run through the form and create discussion for answering questions in the form. Separate notes also should be kept for further correction of the data.
- vii. Household information: Provisions for documentation of necessary socio-economic status of the households and also the household dependency on the forest resources are provided in the form. It also has provisions to document the occurrence and intensity of Human Wildlife Conflict.

# ANNEX - 6

## BIODIVERSITY ASSESSMENT

### Calculations for Biodiversity

The National Working Plan Code recommends important biodiversity indices to be measured and monitored. IFMT provides for analyzing two criteria: biodiversity index and Importance Value Index (IVI).

1. The calculation of biodiversity index will use the plot enumeration data for trees, shrubs and herbs collected from the plot enumeration form mentioned in Annex II of the National Working Plan code and collected using the FDK. Shannon- Winner index is the measure of species diversity among different plant communities.

$$\text{Shannon Index (H)} = - \sum_{i=1}^s p_i \ln p_i$$

Where  $p_i = n/N$ , where  $n$  is number of individuals of a species and  $N$  is total number of individuals of all the species in the sampled plot.

2. Calculation of IVI will use data on Species numbers, density, Diameter at Breast Height (DBH) and height.

$$D_s = \frac{\text{Total number of individuals of a species}}{\text{Total area of quadrats studied}}$$

$$F_s(\%) = \frac{\text{Number of quadrats in which a species occurs}}{\text{Total number of quadrats studied}} \times 100$$

$$RD_s = \frac{\text{Density (D}_s\text{) of a species}}{\text{Total density of all species}} \times 100$$

$$RF_s = \frac{\text{Frequency (F}_s\text{) of a species}}{\text{Sum of frequencies of all species}} \times 100$$

$$RBAF_s = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

$$IVI_s = RD_s + RF_s + RBAF_s$$

Where  $D_s$  is the density of a species,  $F_s$  is frequency of species,  $RD_s$  is the relative density,  $RF_s$  is relative frequency and  $RBAF_s$  is relative coverage for a species.

## Annex - 7

# RESULT INTERPRETATION FOR CLART

Recommended Treatment Code	Recommended Treatment Type	Recharge Potentiality	Slope	Land Use/Land Cover
1	Good Recharge Area	Very High (5), High (4)	3%-5% (2), 5%-7% (3)	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11)
2	Moderate Recharge Area	Moderate (3)	0%-3% (1), 3%-5 % (2), 5%-7% (3)	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11)
3	Surface water Harvesting Area	Low (2), Very Low (1)	0%-3% (1), 3%-5% (2)	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11)
4	Regeneration Area	1,2,3,4,5	5%-7% (3), 7%-10% (4), 10%-15% (5), 15%-20% (6)	Frost land, Barren Land, Scrubland, Other wasteland

## ANNEX - 8

# DEVELOPMENT OF WORKING PLAN

Chapter	Title/ sub-title from Working Plan (NWPC 2014, 21)	Output from IFMT
Executive summary		
1	Introduction – vision statement, goals and objectives of management, expected outcome, abstract of working plan prescriptions	Phase 1 – The vision statement, goals and objectives of forest management are prepared along with input from stakeholders at the inception workshop.  Phase 2 – Forest management activities identified in phase-2 will provide basis for the working plan prescription
Part-I Summary of facts on which proposals are made		
1.2, 1.3, 1.4	Configuration of ground, geology, rock and soil, climatic parameters	Phase 1 – The FRO and FDK provide bio-physical and climatic parameters along with GIS maps
2	Maintenance/increase in the extent of forest and tree cover	
2.5	Threats to the forest	Phase -1: At the inception workshop, stakeholders provide information on threats to forests
2.7	Tree cover outside forest area	Phase – 1: FDK assists in assessment of growing stock  IFMT – The toolbox provides a landscape approach for identifying potential for forestry outside forests
3	Maintenance, conservation and enhancement of biodiversity	
3.1, 3.2, 3.8	Forest composition and distribution, plant species diversity	Phase – 1: Field data from FDK on biodiversity
4	Maintenance and enhancement of forest health and vitality	
4.1, 4.4, 4.8	Status of regeneration, area protected from grazing, forest degradation and its drivers.	Phase-1: Field data from FDK on biodiversity, village and household level data.  Inception workshop – information on forest degradation and its drivers
6	Maintenance and enhancement of forest resource productivity	
6.1 to 6.6	Growing stock of wood, growing stock of bamboo, increment in volume of identified timber species, efforts	Phase-1: FDK assists in collecting details of growing stock



	towards enhancement of forest productivity through quality plantation activities, carbon stock, carbon mitigation and sequestration.	estimation, growing stock of bamboo, and increment of identified tree species.  Phase-1: Inception workshop – stocktaking of past forest management activities.  Phase-2: Analysis of FDK data for carbon sequestration – assists in estimation of biomass.
7	Optimization of forest resource utilization	
7.2, 7.4, 7.5, 7.8	Recorded removal of fuelwood, recorded removal of locally important NTFPs including MAPs, demand and supply of important non-timber forest produce, and removal of fodder.	Phase-1: FDK forms related to household and village survey assist in collecting information on demand for NTFP, fuelwood and fodder
8	Maintenance and enhancement of social, economic, cultural and spiritual benefits	
8.10	Dependency of local people on NTFPs	Phase-1 FDK assists in collecting demand for NTFP
11	Past systems of management	
11.2	Past system of management and their results	Phase-1 Inception workshop – the workshop will facilitate in gathering data on past management practices and their results.
Pat II: Future Management		
1	Basis of proposals	
1.1	Objectives of management – dynamics of forests, forest and water, forest and biodiversity, climate and forests, socio-economic considerations	Phase -2: Analysis for ecosystem services provides maps for biodiversity conservation, water resource management, carbon sequestration and provisioning of fuelwood, fodder and NTFPs
1.2	Method of treatment to be adopted	Phase -2: Map of forest management activity developed with stakeholder, provides an account of interventions that can be implemented in different areas.

# REFERENCES

ArcGIS online; account available at <https://www.arcgis.com/home/createaccount.html>

FRI (2014). *National Working Plan Code-2014*. Forest Research Institute, Indian Council of Forestry Research and Education, Dehradun.

FSI (2015). *State of Forest Report 2015*. Forest Survey of India, Ministry of Environment, Forest and Climate Change Government of India, Dehradun. Available at file:///C:/Users/wri10/Downloads/isfr-2015-forest-cover.pdf.

GoI (1952). *National Forest Policy*. Government of India, New Delhi.

GoI (1988). *National Forest Policy*. Government of India, New Delhi.

IUCN and WRI (2014). A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level. Working Paper (Road-test edition). Gland, Switzerland: IUCN. 125pp. Available at [https://www.iucn.org/downloads/roam\\_handbook\\_lowres\\_web.pdf](https://www.iucn.org/downloads/roam_handbook_lowres_web.pdf).

Lakhchaura, Prakash. *Use of Volume/ Allometric Equations in National Biomass Estimation*. Indian Forester, [S.l.], p. 31-35, Jan. 2016. ISSN 2321-094X. Available at: <http://www.indianforester.co.in/index.php/indianforester/article/view/87157>

Ministry of Environment and Forests. 2009, *Asia-Pacific Forestry Sector Outlook Study II: India Country Report*. Working Paper No.APFSOS II/WP/2009/06. Bangkok: FAO pp 78. Available at <http://www.fao.org/docrep/014/am251e/am251e00.pdf>.

MoEFCC. (2015). "National Mission for a Green India (GIM)" retrieved on July 26, 2017, from <http://www.envfor.nic.in/major-initiatives/national-mission-green-india-gim>.

Reddy, C.S., Jha, C.S., Diwakar, P.G. & Dadhwal, V.K. 2015. *Nationwide classification of forest types of India using remote sensing and GIS. Environmental Monitoring and Assessment* DOI: 10.1007/s10661-015-4990-8. Available at [https://nrsc.gov.in/Forest\\_Types](https://nrsc.gov.in/Forest_Types)

Stanturf, John A., Promode Kant, Jens-Peter Barnekow Lilles, Stephanie Mansourian, Michael Kleine, Lars Graudal, and Palle Madsen. 2015. *Forest Landscape Restoration as a Key Component of Climate Change Mitigation and Adaptation*. Vol. 34. IUFRO World Series. International Union of Forest Research Organizations (IUFRO).

TERI, 2015, *Green Growth and Forestry in India*. New Delhi: The Energy and Resources Institute. 12 pp available at <http://www.teriin.org/projects/green/pdf/National-Forestry.pdf>



JAVHARI KM

**U.S. Agency for International Development**

1300 Pennsylvania Avenue, NW

Washington, DC 20523

Tel: (202) 712-0000

Fax: (202) 216-3524

[www.usaid.gov](http://www.usaid.gov)