Role of Geoinformation Technology in Strengthening the Planning Process of Forestry Sector in India

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January, 2006

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By

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Thesis submitted to the International Institute for Geo-information Science and Earth Observation in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation, Specialisation: (fill in the name of the specialisation)

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Acknowledgements

I am extremely grateful to Dr. V.K. Dadhwal, Dean Indian Institute of Remote Sensing, Department of Space, Government of India, Dehradun and the Director, ITC, The Netherlands for their kind support and encouragement without which it would not have been possible for me to undertake this course. I am extremely thankful to the Government of Maharashtra for granting me permission to undergo this course. I sincerely thank the former Principal Chief Conservator of Forests Shri B.K. Singh, for his continuous support. I am extremely grateful to Shri J.N. Saxena, IFS, Principal Chief Conservator of Forests, Government of Maharashtra. I offer my sincere thanks to Shri Sarwesh Kumar, Chief Conservator of Forest, Dhule for his continuous support. I thank all the senior forest officers of the Maharashtra Forest Department for interactions and support on various accounts.

My sincere thanks are due to my supervisors Dr. Ir. L. G. J. (Luc) Boerboom, Assistant Professor, Department of Urban and Regional Planning and Geoinformation Management and Dr. Ir. R. A. (Rolf) de By, Associate Professor, Department of Geoinformation Processing for their continuous guidance and encouragement during the course component at ITC and thereafter during the project. I offer my gratitude to Ms Vandita Srivastava, Faculty, GID and Mr. P.L.N Raju, Head, Geoinformatics Division, IIRS without whom this study would not have been possible. My Course Coordinator, Dr. C. Jegannathan was always a big support during the course and I am extremely thankful to him. I would not forget the support offered by Shri Ram Mohan during the course. I specially thank all the faculty of GID for their deliberations. I am also extremely thankful to Ms. Dr. J.E. (Jantien) Stoter, Assistant Professor and Dr. G.C. (Gerrit) Huurneman, Assistant Professor / Program Director GFM for their support while at ITC. I offer my extremely sincere thanks to Dr. Alfred Stein and Dr. David Rossitier for their valuable inputs during the Mid Term evaluation and preliminary review respectively. I would like to thank all the staff of the ITC for their valuable support during the conduction of the course at ITC. The cooperation from the staff of Dish Hotel is unforgettable. My sincere thanks are due to the faculty and staff of the IIRS. My thanks are especially due to Shri S.C. Gupta, TSO, IIRS.

I would like to thank all my classmates (GID and HRA-Junior and Senior Batch) for being there always and being supportive. My sincere thanks are due to all the respondents of my questionnaires administered during the course of the research. I would also like to thank all those senior level planners and policy makers for giving me a chance to interview them. I would not like to miss an opportunity to thank Shri A.K. Upadhaya, Joint Director, Indira Gandhi National Forest Academy, Shri Anil Kumar, Director Forest Education and Shri Suresh Chandra, Principal, State Forest Service College, Dehardun for allowing classroom sessions for research purpose.

Thanks are due to Shri Sushil Banafar for helping me out with the report when I was handicapped due to an accident. I am thankful to Ms Shubhashree Das and Ms Sindhu Rathaur for their moral support.

Last but not the least I would like to thank my parents, my sister and my nephews Amol and Vaibhav for their kind support.

Date:
Place: Dehradun, India.

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Abstract

The role of Geoinformation technology in forestry planning and management has been explored. The current planning process has been observed to have drawbacks like delay in plan preparation, lack of data standards, insufficient use of available Geoinformation technology, absence of an integrated planning approach apart from being devoid of planning or policy guidelines, conducive to technological orientation. The present study attempts to analyze, strengthen, develop, evaluate, standardize, and establish the planning process of forestry sector in India to bring about its technological revitalization. Questionnaires, expert interviews and presentations were used for assessment of the current planning process and management. As a result of situation analysis of the current planning process, two existing planning processes namely, traditional and semi-technological were identified and the need for a third Geoinformation technology oriented process was felt. A framework for these three planning processes was laid down. Subsequently, exploration of technology potential in various areas of forestry planning and management was done along with indexing of accessibility of technologies for forest departments in the country. Data standards have been developed to make forestry databases capable of interoperability. An integrated Geoinformation technology oriented planning process for forestry sector (GITOPPFS) has been developed with the help of process models using AMBER technique, to reinforce the existing planning processes. To enhance quality of planning, a quality organization has been proposed and quality work instructions have been laid out. Workflows have been developed to enable the monitoring of the planning process with the help of business map developed. The three planning processes were compared using performance indicators like time, quality, costs and adaptability. Performance assessment of the GITOPPFS was done using the aforesaid indicators along with one more indicator, level of standardization. The comparison was done based on professional experience, expert opinion and reference to existing case studies. The GITOPPFS was analyzed to be the most optimal planning process. The research findings were finally condensed to evolve planning, implementation and policy guidelines. The study concludes making out a case for institutionalization of the GITOPPFS, benchmarking tremendous scope of Geoinformation technology applications in forestry sector.

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1. Introduction

1.1. Forestry- the Indian perspective

India has a flourishing history in the field of forestry, which over the years has evolved as a principal academic discipline. Forestry has affected the socio economic structure of the country due to its cross-sectoral nature. Processes have been developed in the country for the administration, planning and development of the forestry sector. To improve upon the existing interrelationships amongst various sectors with forestry, there is a need to integrate forestry development processes with the key concepts of administration, economics and social structure process of the nation.

Forestry planning in India has a considerably long history. The adoption of scientific forest management strategies like working plans, silvicultural systems, and '*sustained yield management principle'* was the preliminary step towards a better forest management system. Policy documents outline methodologies for the preparation of working plans, provision of initial training to field staff and establishment of training capacity and facility. An attempt was made to consolidate the process by providing legal categories resulted in improvement of growing stock and site conditions.

However, over time management and administrative problems have been identified, such as lack of structural changes in planning, institutionalization of management concepts, and adoption of stringent traditional practices as against a technology driven approach. Through the means of this study an attempt has been made at developing a synergistic approach towards forestry management and exploring possibilities of introduction of novel technological concepts at the administrative, human resource and policy making levels of the existing management structure.

1.2. Forestry resource in the country

The natural forest cover of the country, comprises, 16 major forest types, as per Champion and Seth classification (1968). The total area under forest cover in India has shown a constant trend and currently stands at 20.64 % (State of Forest Report, Forest Survey of India, 2003), of which moderately dense forests (40-70%) comprise of 10.32% (Table 2, Appendix I). Rate of deforestation has been reported to reduce from 1.3 m ha in 1970s to 129,000 ha during 1990-95. An increase in forest cover by 3.54 % over 15 years is not a very encouraging scenario when compared against the target of 33% set by the National Forest Policy, 1988. The per capita forestlands in India (0.06 ha) are amongst the lowest in the world as against average of 0.5 ha for developing countries and 0.64 ha for the world, due to exponential increase in population (Table 4, Appendix I).

The above scenario and state of the forests in India poses a serious challenge for foresters and the management. The depletion of natural forest cover due to excess and unsustainable removal resulted in spiraling-down effect, causing degradation of other natural resources, such as, land, air, water, watersheds and biodiversity. Thus, there is a need to strengthen the planning and forestry management processes with sustainable technological inputs funneled into the system. Principles of sustainability need to be addressed in the Indian context so as to achieve optimal socio-economic growth within the carrying capacity of the forested areas.

1.3. Existing policies and management strategies

The forests in India are managed under the direct control of the governments of states and union territories, but the central government has the sole discretion and jurisdictional powers. Three "National Forest Policies" (1894, 1952 and 1988) have been formulated over the years on the basis of five conceptual cornerstones:

(i) Evolution of a system of balanced and complimentary land-use.

(ii) The need for checking denudation, erosion and invasion of sea sands and sand dunes.

(iii) Establishment of tree lands for amelioration of physical and climatic conditions.

(iv) Catering to the progressively increasing need for grazing, small wood, agriculture implements and firewood.

(v) The needs for sustained supply of timber and other forest produce required for defense, communication and land-use.

The classification of forests according to the policy is as follows-

- Protection Forests
- National Forests
- Village Forests
- Tree-lands

The country has adopted various strategies of planning and management of protected areas, forests, national parks, wildlife sanctuaries etc. The major initiatives taken by the government have been briefly outlined below-

1.3.1. National Forestry Action Program (1999)

Some of the issues covered under the National Forestry Action Programme are sustainable forest management, ownership issues of forest resources, conservation measures, resource expansion, critical role of forestry research and technology development, awareness and technology dissemination, capacity-building, forest policy and legislation, improvements in planning. The priorities set by the government are indicators of an inclination of innovative technological interventions in the planning process.

1.3.2 National Working Plan Code of India

The "Working Plan" is one of the documents of prime importance to foresters and administrators of the country. The formulation of the Working Plan hence needs to be regularly overviewed and uniformity needs to be maintained amongst all Forest Departments of the country with respect to finalizing the document. The rules and procedure for writing, implementation and revision of plans were codified in Working Plan Code to ensure uniformity of approach in the country. These pertain to the managed forests in the country where resource use is allowed under an

approved Working Plan. A working plan is usually written for a division, which comprises ranges, rounds and beats in the descending order of hierarchy. These plans are revised every ten years. A Working Plan Officer is assigned the task of preparation of working plan.

1.3.3 Guide for Protected Areas and Managed Forests for India

As per the categories of the protected areas by International Union for Conservation of Nature (IUCN) two categories of protected areas exist in India, National Parks and Sanctuaries. For each of these a Management Plan is formulated for five to ten years. The need for separate guidelines emerged from the fact that management of protected areas is conservation oriented and not utilization oriented.

1.3.4 Eco-development and Joint Forest Management Planning guidelines

These plans are prepared to address issues related to people's participation in the planning process and its implementation. These might not always be separate plans but sub-plans, which might form a part of the working plan or a management plan as the case may be.

1.3.5 National Forestry Research Action Plan

The Indian Council of Forestry Research and Education, Ministry of Environment and Forest, Government of India has developed this plan. It identifies various areas of research and sets priorities. This document intends to address the research issues to guide the planning process for the field level and also guide the planners and policy makers in developing strategies. The action Plan accords high priority to applications of modern tools in assessments of forestry resource and monitoring change.

1.3.6 HRD Planning (Training, and Education)

There is no separate Human Resource Development Policy for the forestry sector. The National Training Policy developed by Department of Personnel and Training (DOPT), Govt. of India, serves as a guideline. The Indira Gandhi National Forest Academy, Dehradun caters to the training of Indian Forest Service, the highest service in the country. The Directorate of Forest Education caters to the training of the middle level executives. The states and the union territories impart training to the frontlines through various forestry training schools managed by the state governments.

Most of the above policies are potent in the light of traditional methods of forest management and therefore there is a need to address issues of technology development and implementation at all levels. The inclusion of technical aspects at the policy making level and its subsequent incorporation in the organizations shall prove to be a definite advantage. Capacity building in terms of infrastructure, training programs and skilled personnel needs to be addressed. Foresters are entrusted with the task of protection, conservation, management and propagation of forestry resources. The roles of foresters have changed drastically over time (Table 5, Appendix I). The multifarious roles of foresters and diversification of their roles in forest management has to be borne in mind while formulating principles of sustainable management.

1.4. The Geoinformatics context

Geoinformation technology is an emergent and fast-growing technology with immense potential to overcome hurdles related to the planning process. Geoinformation when coupled with conventional methods of ground validations can be a useful instrument of efficient planning.

High Resolution Satellite data are an extremely important source of producing large-scale maps especially in countries like India where use of Aerial Photographs is restricted due to high cost and security reasons. The Geoinformation technology may be extensively used for developing linkages through Information

and Communication Technology (ICT), which can lead to public awareness, thus enabling people's participation in the planning process. Intra and inter-organizational linkages are facilitated and better management systems can be developed. Change detection studies can be undertaken, facilitated by satellite data over a time scale. Change detection studies have been made use of, in the court of law as evidence.

The advantages of using Geoinformation technology are numerous, conversion of analogue spatial data into digital data, being one of the many. Digital data can facilitate effective and efficient handling and enhance the analytical capability of the database. It can also facilitate storage, retrieval and dissemination of datasets, which presently is a cumbersome task in forestry. Spatial and non-spatial data processing is more accurate and easier in the digital domain.

The most important area in spatial database generation for forestry resource management is generation of topographic information. The cumbersome task of dealing with contours and the restrictions imposed by the newly issued National Map Policy (2005) of the Survey of India is gradually facilitating the balance of convenience towards use of technologies like stereo satellite data, SAR Interferometry (e.g. ERS/RADARSAT/ SRTM data) and LIDAR. This will solve the problem of generating digital elevation maps using topographic sheets, which are restricted.

The strong database packages like Oracle and many others have the potential to make the exhaustive databases generated through forestry sector plans sharable and facilitate their storage, and retrieval. Enhancement in analytical capability and timely updating are some important advantages. The US Forest Service has developed a Forest Inventory and Analysis (FIA, 2001) Program, which standardizes data format, and data mining tools that allow the public to extract information to meet their individual requirements stemming from forestry resources. It would be possible to build such tools for Indian conditions.

There are software packages that enable system-modeling approach, which can be used to develop management scenarios, which can be of immense use in strengthening the planning process as per changing scenario. The ILWIS- Spatial Multi Criteria Evaluation Version has the potential to evaluate various scenarios using the decision tree approach. If all relevant spatial and non spatial data related to a selected ecosystem are available in the GIS domain, then it is possible to develop Ecological Status Models, which might be able to guide and strengthen the planning process. The software packages available may be of immense help in developing such models.

In Forestry and allied resource management, huge amount of spatial and non-spatial data is generated using traditional/ manual and semi technological methods. Traditional Methods – a process of plan preparation, which is completely manual involving exhaustive field surveys for generating spatial and non-spatial data. Semi-technological Methods – a plan preparation process, which consists of use of technology to the extent of generating forest cover/ landuse and forest density, maps using remotely sensed data. It also involves use of Geographical Information System to the extent of generating digital maps and use of computer for word processing. In the Geoinformation technology oriented planning process extensive use of technology in various processes of planning and management have been proposed. If a Geoinformation technology oriented planning process is to be adopted data standards are extremely essential and they would be required to be institutionalized.

So also, a forestry database can only be generated by taking into account various thematic data models like- Administrative Boundaries, Hydrology, Water/Wastewater, Land Parcels, Energy Facilities, Transportation, Environmental Facilities, Conservation / Biodiversity, Forestry, Defense and Base Map. If there is interagency consistency across these themes it might lead to enhanced usefulness of data, usefulness for legal issues and time productivity. It will also promote application development, focused analysis, resource optimization and will also help in concentrating on other high return activities

1.5. Processes chosen for research

Forest Department documents such as 1) Working Plan Process for Managed Forests and 2) Management Plan Process for Protected Areas and Managed Forests are considered as the background for the present research. The scope, content, levels, management strategies, approaches to various practices, extent of dissemination and use are some of the dimensions which shall be borne in mind while trying to enumerate the advantages of Geoinformation technology in the planning process.

Above said planning processes have a common framework but a different objective. The former deals with managed forests where extraction of resources is regulated and is more extraction oriented with emphasis on consumptive use. On the other hand the latter deals with protected areas where extraction is prohibited and there is more emphasis on conservation through non-consumptive use.

1.6. Overview of the Thesis

The thesis consists of six chapters; Chapter 1 is an introduction, explaining the evolution of the planning process and resource status in the country. It also describes the evolving role of foresters *vis a vis* the changing scenario. Chapter 2 entitled "Review of Literature" has reviewed the previous research carried out in applications of Geoinformation technology in management, planning and policy related issues. An attempt has been made to compile and analyze the research areas of Geoinformation technology in resource management. Chapter 3 outlines the research problem, motivation, objective and sub-objectives, research questions and details of the study area. Chapter 4 explains the methods used in the course of the study. The methods have been described as an overview followed by detailed description. Chapter 5, comprises Sub-Chapters, namely, Situation Analysis of Forest Management and Planning (5.1- Results of expert opinion and extended SWOT analysis have been presented), Technology- Potential and Accessibility in Forest Plans (5.2- Potential of technology in various areas of forest planning and management have been ascertained and accessibility of the forest departments to

these technologies have been indexed), Data Standards for Forestry Databases (5.3- Data Standards have been developed for various forest attributes and appropriate data standards have been chosen from the existing ones), Integrated Geoinformation Technology Oriented Process (5.4- Process models have been developed for various components of the proposed planning process, quality organization has been prescribed and a business map for the process has been laid out), Comparative Analysis of Planning Processes (5.5-The traditional, semi-technological and the proposed planning processes have been compared using various indicators), and Guidelines for planning and Policy (5.6- The research findings have been condensed to derive planning and policy guidelines). Each of these Sub Chapters contains the results and formulations elicited from the current study with respect to their objectives. The concluding chapter of the thesis is Chapter 6, which consists of concluding remarks and future scope of work.

2. Review of Literature

2.1. Geoinformation Technology Applications

Geoinformation is a technology that can cater to a wide range of applications such as natural resource management, infrastructure development, utility services, environment analysis, disaster management, good governance and legislation etc. The dimensions of Geoinformation are ever increasing and the need to integrate Geoinformation based applications with policy-making for a synergistic effect has been felt. Contextually speaking, Geoinformation may be used as a monitoring and assessment tool that includes all aspects of data acquisition, analysis and dissemination of a process. Geoinformation and other environmental observations assist in acquiring and processing such data for addressing a variety of key issues related to forests and natural resources management. The role of Geoinformation technology has been studied extensively over time by various research establishments and independent researchers across the globe. The status of research in this arena is yet to fully establish itself in the Indian sub-continent. However with increasing demands of public participation in various sectors, especially forestry, there is an immediate need to devise new planning processes that are holistically integrated with technological inputs. The role of spatial data infrastructure in policy development issues is becoming pivotal. A need for Geoinformation theory was felt in order to fill the lacuna between theoretical information science research and its applicability at the grass root level management processes. Geoinformation has a fragmentary and heterogeneous nature with respect to its applicability. The necessity of a Geoinformation theory was studied by Molenaar, (1999). He identified key problems associated with the definition of the context of Geoinformation, the evaluation and handling of data inaccuracies and the definition of curricula for courses to train new generations of Geoinformatics professionals. An attempt has been made in the following sections to outline in brief, the various research findings relevant to the objectives of this study.

2.2. Review of Research

A complete review of all available literature, howsoever desired, was outside the scope of this study. Therefore, an overview of most relevant literature, which was accessible, is being presented here.

In Nigeria Geoinformation technology and management has been used to improve the cadastral services system and enhance the planning processes (Akpoyoware 2003). Business improvement in terms of better estimation of current production cost, service cost, and cost control through geo-information has been done in Thailand (Cheuntragun, 2003). Elaborated guidelines for institutional arrangements of Geoinformation provider organizations to the government have been formulated in Ethiopia (Beshah, 2003). Robinson, (2003) attempted the development of a user-friendly operational plan for Land Information System. Researchers have explored the use of Unified Modelling Language (UML) in the development of mapping protocols, e.g, Topographic Mapping System (Kwon, 2002); Geo-spatial Data Distribution Strategies, (Acharya, 2004). A dynamic modelling of the core business owned by a Geoinformation organization has been elucidated by Sani, 1998. The methodology aims to define the performance measures of the Geoinformation production business to study how the process contributes to the business objectives of the organization. Gautam, (2003) has exhibited the potentials of Geoinformation technology in optimizing urban plan preparation through development of business processes for Simla, India.

Multi Criteria Evaluation (MCE) is being extensively used as a tool to evaluate management scenarios in order to decide an optimal management system and planning process. Spatial Multi Criteria Decision Analysis is a process that combines and transforms geographical data (the input) into a decision (an output). The role of GIS in spatial decision-making has been a topic of emerging interest in the scientific community and much research has been accomplished in this regard (Clarke, 1990; Kyem, 1994; Fedra, 1995; Carver et al., 1997). Policy analysis and conflict resolution has directly benefited by the inclusion of MCE techniques in the framework. Studies have been conducted in this regard, which were overviewed for the current study (French, 1998; Paruccini, 1994; Climaco, 1997).

Decision support systems (DSS) have played a prominent role in the implementation of forest management since the early 1980s (Reynolds et al., 2005). Computer based DSS has played a valuable role in evaluation, monitoring and planning of diverse processes ranging from governance and resource management to suitability assessments and urban economics. Lexer et al., (2005) have demonstrated the use of DSS in different phases of decision making such as the identification of current site stand conditions, owners expectations and preferences regarding a set of objectives and selection and evaluation of management alternatives. An exemplary result of DSS oriented research is the formulation of Sustainable Forestry (SUFOR) in Southern Sweden (Nihlgard, 2005). The evolution of complex models, which involve coupling of GIS to simpler logistic models, was explored about a decade back (Loague et al., 1989). With a shift towards decision processes in modeling from simple physical models to coupled models, the role of MCE became strategic (Carver et al., 1991; Eastman et al., 1993, Schmidt et al., 1994).

The combination of multi criteria evaluation methods and spatial analysis is referred to as Spatial Multi Criteria Evaluation (SMCE). Issues of sustainable forest management have been addressed at the pilot scale using a geographic information system-based spatial multi-criteria evaluation. This technique has been used for measuring sustainability of forest management. It involves integration and utilization of spatial and temporal data on diverse ecological, economic and social variables, while handling data and decision-rule uncertainty (Varma et al., 2000). Based on the results and participant evaluations, techniques such as this appear effective as decision support tools in conflict-prone areas (Sheppard, 2004).

Another important tool of process planning and management is the Strengths Weaknesses Opportunities Threats (SWOT) analysis. It is a framework for identification of Strengths, Weakness, Opportunities and Threats. A SWOT analysis is critical to the creation of any strategic plan and it usually begins with a scan of the external environment. Furthermore, SWOT analysis has proved to be an effective tool and has constituted a suitable baseline to diagnose current problems and to sketch future action lines (Terrados et al., 2005). Masozera et al., (2004) has effectively used SWOT in combination with an Analytical Hierarchy

Process (AHP) for assessing the suitability of community-based management in a Reserve Forest in Rwanda. An example of application of SWOT analysis in the establishment of key survival issues of an organization is a research initiative carried out by Robinson, 2000. Important environmental threats and opportunities have also been identified using SWOT. Based upon the review and available literature SWOT has been used as a technique to derive the key strengths and weakness of current management perspectives as part of the objectives of this study.

Workflows have been defined as "The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action according to a set of procedural rules" (Stader, 2003). Work Flow Management Systems can be built into an integrated GIS system to maintain inventories of environmental assets digitally. Such systems can be used for real time access to status of projects, control of production processes and activities etc. The success of applying workflow technologies to distributed GIS data production requires comprehensive understanding of the underlying production processes (Songnian, 2003).

The use of AMBER (Architectural Modeling Box for Enterprise Redesign) technique as an architectural modeling building- box for business processes has been well established. It looks upon business process from an external and an internal point of view. External viewpoint takes into consideration the business process as a whole with focus on externally observable behavior. The external viewpoint considers the business process as black box which only shows services provided to its environment. The internal viewpoint takes into consideration the internal composition of coherent sub entities and their assigned behaviors, which together constitute the external behavior. The AMBER language contains various constructs describing actions, causality relations, disabling interaction and hierarchical composition (Janssen, 1998). A number of researchers have studied model checking by use of AMBER. One of the notable studies is by Janssen et al., (1997) who have shown in their study that model checking can be made accessible to a large, not formally trained audience.

The concept of a Planning Support System (PSS) is increasingly being hailed as a major foundation of modeling. PSS couples analytic tools and computer simulation models with visual displays (Brail, 2001). Extensive research has given conclusive evidence that GIS is an integral part of a PSS. A scenario based, policy oriented PSS uses increasingly available GIS data to support community-based processes of collaborative planning and collective decision-making (Klosterman, 2001). A relevant study, outlining how optimization models are currently being made more informative through the presentation of results and are further being integrated within the structure, has been conducted for the USDA by Church et al., 2000. The means by which the technology could be used to model the phenomena of ecological significance is discussed. The benefits of a planning support system when integrated with GIS based quantitative models for long-term forest management planning has been reviewed by Naesset, (1997). Church et al., (1998) have studied the locational issues in forest management related to planning and its subsequent conjunction with GIS based process models.

New schools of thought such as Total Quality Management (TQM) and New Public Management have emerged as important tools of participatory forest management. It has become a challenge for decision-makers and evaluators. All participatory programmes are designed to be responsive to changing community needs. Systems-based evaluative processes allow for ongoing learning, correction, and adjustment by all parties concerned. In the Indian scenario, this requires major institutional reorientation at the policy level to ensure responsiveness to local demand, and to empower and enable communities to act (Narayan, 1993). As pointed out, the key questions managers face is what should be monitored and evaluated, and what processes should be utilised. The incorporation of TQM concepts for such strategic questions makes it a viable tool for administration. The Quality System is a network of administrative and technical procedures required to produce and deliver a product of specified quality standards (Feigenbaum, 1961).

2.3. Digital Data Standards

A review of the available data standards is very essential since it governs the results of any ensuing process. Once established, it is necessary to adopt and publish data standards. In the United States there are national data standards being developed by the government as a part of the National Spatial Data Infrastructure. Comparatively, in India, the initiative for establishment of a national level data standard was taken by National Spatial Data Infrastructure (NSDI) and the Department of Space, which is the current national focus. It is visualized as a network of databases consisting of the domain specific databases created and managed by various agencies like Survey of India, Geological Survey of India and a central database having metadata to be managed by NSDI secretariat. The other participating agencies are Natural Resources Data Management System, Office of the Registrar General of India, Forest Survey of India, National Atlas and Thematic Mapping Organization and National Natural Resources Management System, however not many scientific goals towards the development of a national data standard for forestry sector have been achieved as of now.

The development of database for forestry and allied resources to strengthen planning process is a key concern, since very few established data standards exist. The existing standards are the standalone ones of the forest department and other allied agencies. Gong et al., (2004) intensively dealt with issues related to technologies and standards on spatial data sharing. The differences in data content and sources have been divided into three types namely vector, image and topographic data. They have further elaborated on differences in spatial data types and software platforms. Further, basic methods to realize geospatial data sharing through data exchange mode, data direct access mode or data interoperability mode have been suggested. Schwind et al., (1999) have discussed creation of a consistent and standardized vegetation database for northwestern forest plan monitoring in California. Standards have been established for spatial layer development, thematic layer development, and vegetation classification scheme. Warbington et al., (2002) has emphasized requirements of remote sensing and geographic information system to meet the new forest service vegetation classification and mapping standards. The results give an insight into feasibility, cost effectiveness and accuracy of mapping standard attributes, including National Vegetation Classification System.

In India, standardization of GIS databases has been one of the most important activities of the Department of Space (DOS) towards establishing a National (Natural) Resources Information System (NRIS). The NRIS Node Design and Standards is the first national effort towards defining a content and design standard for GIS database activity in the year 2000. Although there are Meta data standards laid down for forestry and allied resources these are seldom followed. The latest in the line are the NNRMS Standards (2005) for EO Images, thematic and cartographic maps, GIS databases and spatial outputs.

The Strategy and Action Plan for NSDI has laid down a framework for establishment of data standards for various disciplines. The NSDI Metadata Standards Version 2.0, which is a compilation of set data standards, has considered the broad dominant forest types for establishing metadata standards. NSDI, 2003, has brought out the data exchange format NSDE Version 1.01. It has evolved a Digital Vector Data (DVD-3) format, which was earlier, designed as the National Standard Exchange Format for Survey of India digital cartographic vector data.

2.4. Management and Policy Issues

Some policy issues and management concepts were reviewed prior to undertaking the current research. Based upon the available literature and accessibility to policies of the government and different allied agencies, following observations were made and effort has been directed towards the critical analysis of the observations. This aided the planning and recommendation formulation of the current study. Singh, (1998) evolved a holistic management strategy for forest resources and also proposed management planning approach and suggested modifications in the Forest Working Plan formats. He also elaborated upon the need for review of the National Forest Policy. The Science and Technology Policy, 2003 aims at science and technology governance, optimal utilization of existing infrastructure and competence, human resource development, technology development, transfer and diffusion, technologies for mitigation and management of natural hazards and many other related issues. Processes of policy making have

been studied by (Leach and Stewart, 1982) in terms of detailed tools of analysis that can be used to assist the processes of policymaking. They elaborated the methods in which tools have been misused in the processes of policy making, and their roles. Majchrzak, (1984) has developed methods for policy research. The importance of modern geographic information systems technology has been highlighted, (Masser, 1998), which transformed spatial data handling capabilities in government functioning. The nature of relationship between GIS and governments has been explored through number of different conceptual positions with reference to experiences in Britain. Detailed research on spatial data infrastructure and policy development in Europe and the United States has been carried out (Loenen et al., 2004). The developments related to national spatial data infrastructure in the Netherlands has also been elaborated upon. Forest County Land Records Modernization Plan (1999-2004) of the USFS has been developed with the purpose of outlining a strategy for Forest County land records modernization development and the implementation of a geographic information system (GIS).

The Government of India has announced a new National Map Policy, separating the sensitive, security-related maps from the ones, which can be accessed, used and even modified by the public. Two new series of maps - Defence Series and Open Series - will be released, the latter involving even private agencies, after areas and points on maps that are "vulnerable" from security point of view are masked. The defence series maps (DSMs) would cater to the exclusive use of defence forces and authorised government departments. The defence ministry would determine the policy regarding the use of DSMs. The open series maps (OSMs) would be the responsibility of the Survey of India and department of science and technology. It would be available to the public and specific users for developmental planning, infrastructure and research community. This new map policy governs the developments related to NSDI.

3. Research Overview

3.1. Research Problem

The planning process of forestry sector in India is very complex. It consists of multifarious activities and involves generation of voluminous spatial and non-spatial data. Despite elaborate guidelines for planning, there is tremendous scope for improvement. There is a need for critical assessment of the current planning process and documents.

Some of the basic lacunae identified in the planning process are

- Extensive delay in plan preparation
- Long planning cycle
- Low precision and accuracy in data generation
- Non- existence of data standards for interagency coordination
- Inconsistency and incompatibility of plans at local, regional, state and national level
- Lack of data sharing
- Time consuming manual methods
- Lack of scientific dimension to plan preparation

The planning cycle of a working/ management plan is 10 years. It is pertinent to mention here that a plan prepared using manual processes takes around four years whereas using semi technological process the same can be achieved in about three to four years. The role of Geoinformation technology is underlined in the event that new plans are still under construction when the previous plan has expired. There is a glaring need for a shorter planning cycle to intensify management.

The planning process needs to be revitalized using Geoinformation technology. Geoinformation technology can efficiently address issues related to accuracy and

data standards. The scope of Geoinformation Technology in the planning process needs to be emphasized through comparison of various planning process scenarios to generate awareness about the advantages of Geoinformation technology amongst planners and policy makers.

There is a need to transform planning and implementation guidelines using a Geoinformation technology oriented process so that appropriate measures can be taken to adopt them into the mainstream of the national forestry sector policy and planning. The new planning process so developed will ensure optimal and sustainable use of resources for planning and improve efficiency and effectiveness in management of forestry and allied resources.

3.2. Motivation for the research

The major factors motivating the current study and strengthening the role of Geoinformation in the planning process are-

- Quality enhancement of the Working and Management Plans (Working Plans for Managed Forests and Management Plans for Protected Areas)
- Reduction of the temporal cycle of forestry plans
- Efficiency and effectiveness of the plans

Though the process of planning in the forestry sector has been an ever-evolving process, it has not yielded the desired results. It has not been able to fulfill its constitutional obligation to the desired extent. A sound planning process will be able to mobilize more funds from within and outside the country. There is need for planning process and implementation guidelines, which may act as a reference tool for policy makers, implementers and grass root level planners. This will generate awareness about the latest technology and its application in order to streamline the planning process for conservation and sustainable development of forestry, wildlife and allied resources. Consistent and standardized databases will prevent wastage of Government funds. Technology applications will help address trans-boundary problems, legal issues related to ownership and encroachment, data merging and compatibility, landscape level management and day-to-day administration and management of issues.

3.3. Objectives of the study

The primary objective of the study is to analyze, strengthen, develop, evaluate, standardize, and establish the forestry sector Planning Process from Geoinformation Technology perspective.

To establish clarity of the objective and define scientific boundaries as per the role of Geoinformation technology as a potential tool for management, the following five sub objectives were outlined for the study-

Sub Objectives

1. **To analyze the current planning process**

   A situation analysis of forest management in conjunction with planning process in the form of an extended SWOT to develop strategies for identifying areas of improvement and revitalisation.

2. **To strengthen the planning process using Geoinformation Technology**

   Listing of various activities involved in the planning process and resource management for analysing potential of various technologies and assessing accessibility of the forest department to such technologies.

3. **To standardize database generation for enabling interoperability and establishing guidelines for their incorporation in the planning process.**

   Identifying various issues for data standards, analysing the existing data standards, developing data standards for various forestry attributes at various scales, choice and adoption of appropriate data standards for allied resources and thematic and cartographic mapping standards from amongst the existing ones.

4. **To develop an integrated Geoinformation technology oriented planning approach.**

   To integrate all the identified technologies to synergise the planning process so that avenues of transformation from the existing approaches of planning to a new one which may prove beneficial can be explored.

5. **To develop and evaluate different planning processes to adjudge the optimal approach.**

   To compare traditional, semi-technological and proposed Geoinformation technology oriented planning processes using indicators like cost, time, quality, adaptability and level of standardization. This followed by performance assessment of the proposed process based on the indicators mentioned above for the activities, which are currently devoid of Geoinformation technology applications.

6. **To establish guidelines for plan preparation and implementation to steer the mainstream planning process and policy.**

   To develop a set of guidelines for plan preparation, which are compatible with the national mandate so that they can be, incorporated into the National Planning Documents and be of assistance in developing a Geoinformation Policy.

3.4. Research Questions

The current research aims to be able to answer the following questions at the end of the study-

1. Is the current plan preparation process conducive to the changing scenario, from extraction oriented to conservation oriented and traditional to technology oriented?

2. What are the probable areas where Geoinformation Technology can be applied?
3. What are the inconsistencies in data being currently generated?
4. Is it possible to develop and establish data standards to ensure data sharing at local, regional, state and national level? If yes, How?
5. Is it possible to adopt an integrated approach to technologically revitalize the planning process?
6. Is adoption of Geoinformation technology the ultimate answer or can reliance be placed on some traditional or semi traditional methods? If yes, which ones?
7. Is it possible to get realistic results by combining various planning components into a management scenario?
8. Is it possible to get realistic evaluation by comparing various planning process scenarios to ascertain the best possible approach? What further analysis would be required to assess performance of the so-called best/optimal approach?
9. What modifications would be required at the policy, administration and management level in order to adopt the new planning process?
10. What is the impact of Geoinformation Technology on the planning process?

3.5. Study Area

The study has been conducted at three different scales. The planning process of forestry sector has been studied at a national level. For the purpose of intensive study, a sample study area has been demarcated to study planning process in the states of Madhya Pradesh and Maharashtra. For the demonstration of the existing Ecological Status Models (Appendix-VII) in the Planning process, a still smaller area consisting of the Satpura National Park, Bori and the Pachmarhi Wildlife Sanctuaries (Satpura Protected Area Complex) has been used. Fig 3.1 illustrates all three scales of the study- national, regional and local levels.

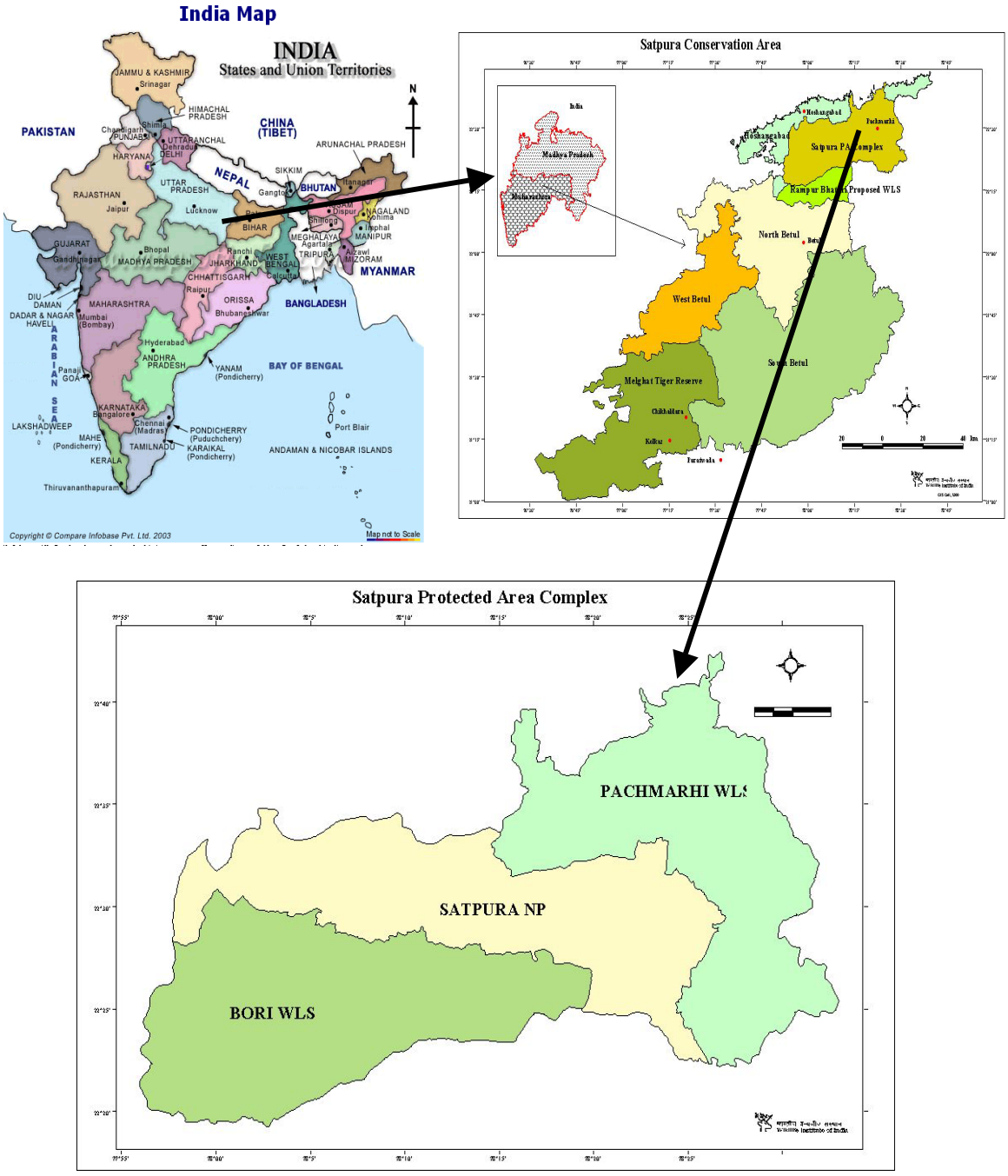


Figure 3.1. Study area showing three scales of the study

4. Methodology

4.1. Methodology Overview

The methodology followed in the study is a combination of applied management concepts in conjunction with Geoinformation techniques. The methodology has evolved from personal field experience, expert opinions, reference to case studies and intensive research on planning processes and Geoinformation tools applicable to the objectives addressed in the study.

The entire methodology spans over the following seven steps-

Step 1- Identification and analysis of the current planning process

Step 2- Assessment of Geoinformation technology for strengthening planning process

Step 3- Ascertainment of the existing two planning processes and components of the new Geoinformation technology oriented process

Step 4- Development of data standards and choice of appropriate data standards

Step 5- Development of Geoinformation technology oriented planning process

Step 6- Evaluation of different planning processes using stylized case studies

Step 7- Development of Guidelines for strengthening the planning process and its implementation

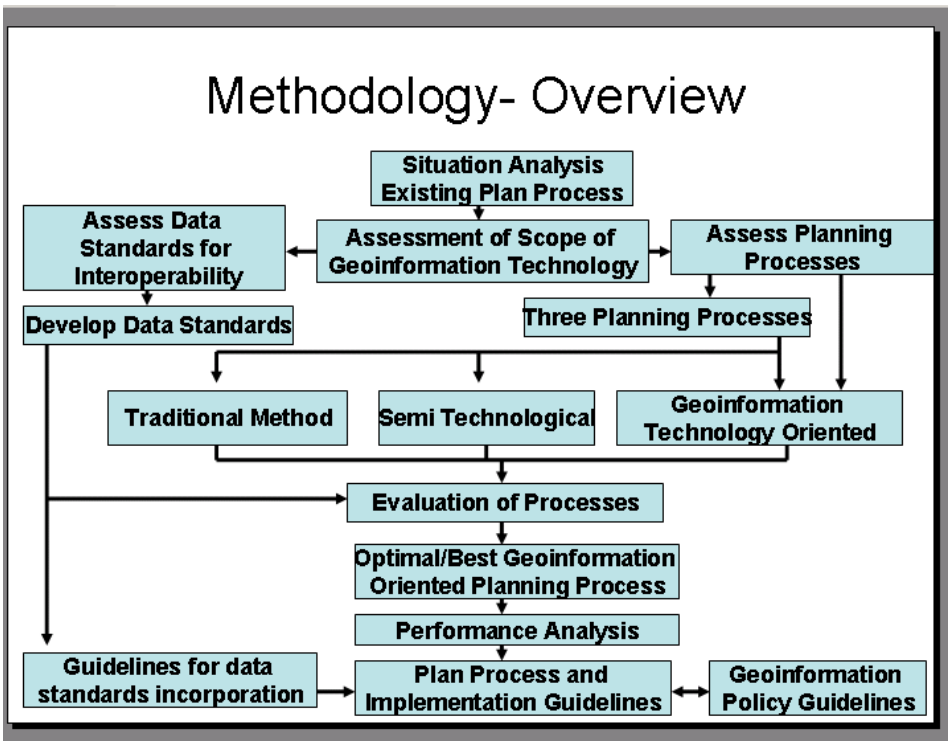


Figure 4.1. Methodology Overview

4.2. Detailed methodology description

Step 1 - Analysis of the current planning process

The current planning process was analyzed with the elicitations of opinions forwarded by various levels of forest department officials, spread out across the country. The three modes of opinion pooling were in the form of questionnaires, personal interviews and web resourced information exchange. The study was conducted at three different levels of information extraction. There were three levels of target groups based upon their exposure levels to Geoinformation technology. The exposure levels followed a gradient advancing from a low exposure level to a high exposure level. The major groups identified for distribution of the questionnaires consisted of retired senior forest policy makers, planners in service from forestry and other allied science, working plan and management planning officers, field executives, trainers, academicians, scientists

and leading personalities from non-governmental organizations. Accordingly three levels of questionnaires were prepared which were distributed to the following levels-

1. *First Level Questionnaire* to elicit response from senior level policy makers and planners with a high level of awareness of the technology available but with low exposure to the technology.
2. *Second Level Questionnaire* to elicit response from technocrats and senior planners and policy makers who have moderate exposure to the technology applications.
3. *Third Level* of questionnaires was and addressed to planners and policy makers with a high level of technology usage.

The questionnaires were distributed amongst 100 personnel, a sample size, considered appropriate and representative of the people involved in the entire planning process and working plan preparation at various administrative and ministerial levels. The questionnaire (Appendix II) covered various aspects of existing planning process and aimed at estimating the current status of Geoinformation in the process and identification of the potentials of incorporation of Geoinformation technology at suitable levels. The important aspects covered in the questionnaire were -

- Extent of Geoinformation technology perspective in planning and policy
- Emergent need of Geoinformation technology
- Planning documents, which need to be addressed
- Probable areas of technology use
- Current status of data standards and need of appropriate standards
- Scope of Geoinformation technology oriented process
- Anticipated planning and policy level changes

The second part of Step I is Situation Analysis of the current planning process to ascertain potential for application of Geoinformation tools. A situation analysis using **SWOT** (Strengths, Weaknesses, Opportunities, Threats) matrix was derived

for evolving strategy as an input to strategic plan. Analyzing opportunities and threats comprises the external assessment of the environment. Identification of opportunities in the current study focused on exploring potentials of Geoinformation technology in the process, while threats focused on issues like the nature of the management process, the status of availability of resources, response of the community towards wildlife conservation and levels of cooperation.

The results of the SWOT analysis have been used as a baseline scenario for future improvement, as well as gap analysis. Gap analysis comprises of the identification of the major gaps in the organization and has been used in the study as a tool to uplift the organization from its current capabilities to its desired future state. Thus, SWOT matrix has been used to develop best practices for the planning of processes for the forestry sector management. Appendix II, Table 2 outlines the matrix used to conduct SWOT. The responses from the interviews/ questionnaires were evaluated and results were tabulated, details of which have been discussed in the Results chapter. An extended SWOT was also deduced from a simultaneous combination of any three factors out of SWOT.

Step 2 Assessment of Geoinformation technologies for strengthening planning process

In this part of the methodology, various planning activities in forest working plans and management plans were identified and potential of various levels of technologies, and products such as Aerial photography, Low and high resolution satellite imagery, GIS, etc. were estimated to arrive at a consolidated *Technology Accessibility Index*. The Index represents the accessibility to technology by the forest department. The parameters considered for estimation of technology accessibility were-

- Costs
- Availability
- Know-how
- Infrastructure
- Human Resource capacity

The above parameters were ranked on an ascending scale of 0-5, 0 rated as "inaccessible". The sum of these ranks was then reclassified to arrive at the final "Technology Accessibility Index" which also ranges from 0-5 which were then converted into percentage. Table 4.1 shows the attributes corresponding to each rank of the Index-

Technology Accessibility Index	=	Reclassifed (Cost+Availability + Infrastructure + HR capacity Knowhow)

Table 4.1 Technology Potential Index attribute table

Technology Accessibility Index	Attribute
0 (20%)	Inaccessible
1 (20-40%)	Very Low Accessibility
2 (40-60%)	Low Accessibility
3 (40-60%)	Moderate Accessibility
4 (60-80%)	High Accessibility
5 (80-100%)	Very High Accessibility

The determination of Application Potential was based upon the relative scope of applying a particular type of scientific technology in any of the planning process activities. The potential was represented in the form of percentage.

Step 3 - Ascertainment of the two existing planning processes and components of the new Geoinformation technology oriented process was done.

The planning processes, which are currently in existence, were determined and their flowcharts prepared, based upon which the new Geoinformation technology process was formulated.

- **Process 1**- Traditional Planning Process **(Fig 4.2)**
- **Process 2**- Semi-Technological Planning Process- **(Fig 4.3)**
- **Process 3**- Geoinformation Technology oriented Process **(Fig 4.4)**

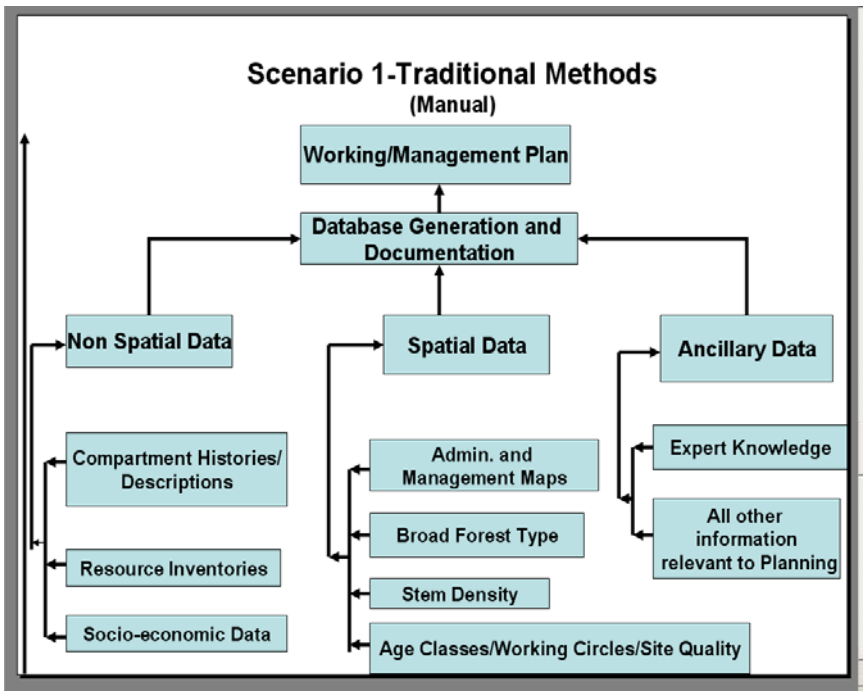


Figure 4.2- Traditional Planning Process

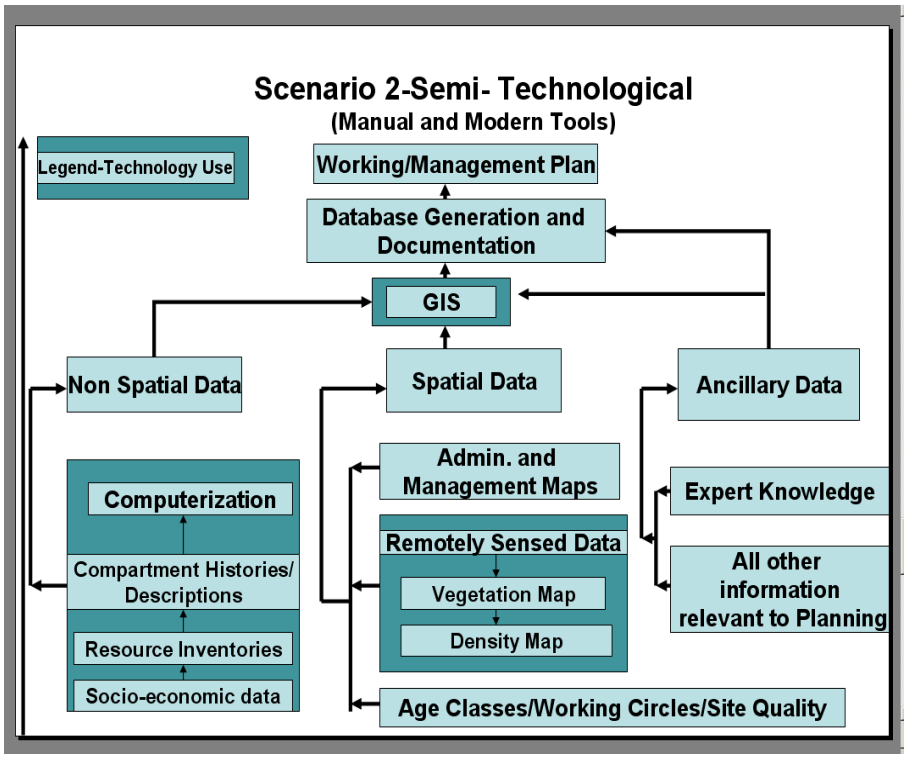


Figure 4.3 Semi Technological Planning Process

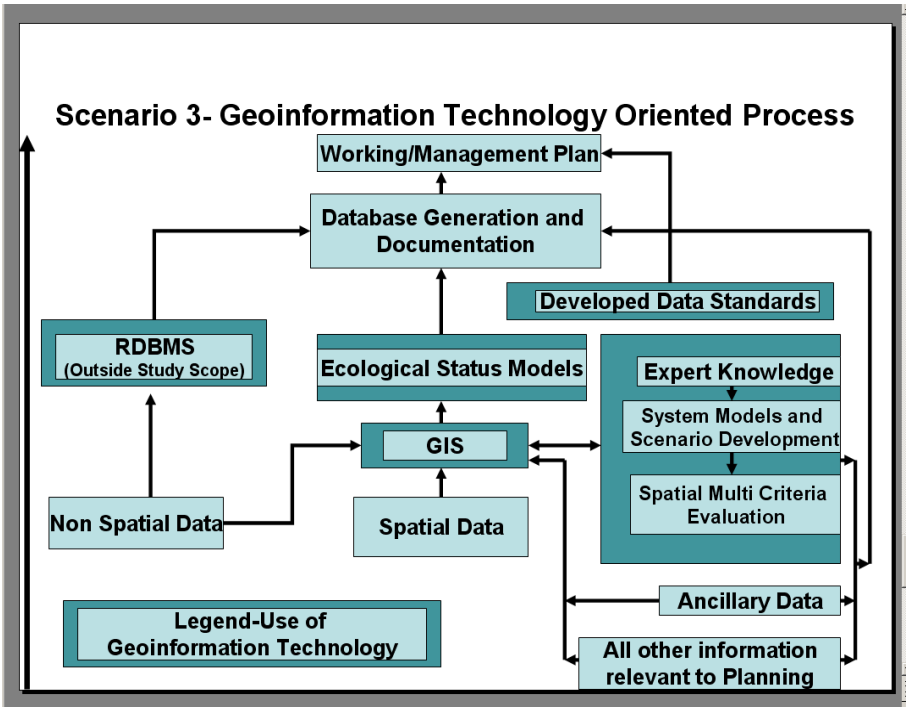


Figure 4.4 Geoinformation Technology Oriented Planning Process

Step 4 - Development of data standards and choice of appropriate data standards from amongst the existing ones.

Data standards developed, ensured data compatibility at local, regional, state and national level. The key consideration for the development of data standards was conformity to the availability of data, cost and time consumed. The existing data standards were reviewed and new data standards were prepared at local levels, which previously did not have data standards.

Step 5- Development of Geoinformation technology oriented planning process

The proposition of a new model has been motivated by the inadequacies of technological inputs in the existing models. The lack of scientific dimensions in the form of technology incorporation was identified as major fallout of the existing systems. Thus an attempt has been made to develop a new process model, which has more technology-oriented aspects. After reviewing various business process models, the AMBER (Architectural Modeling Box for Enterprise Redesign) technique was found appropriate for developing a new process.

Process Models were developed using the AMBER technique to elaborate upon all the processes and sub-processes of the Geoinformation technology oriented process. AMBER is a graphical language for the specification of business processes. Such a specification describes which actions are involved in the business process and the causal relations between these actions. In this technique, behavior is depicted by means of actions, interactions and attributes.

i. **Action**- is an abstraction of some activity in real world.
ii. **Interaction** is introduced into the model, where several sub entities cooperate to achieve ascertain outcome model.
iii. **Attributes**- Data (Information), Time, Probability and location are four essential characteristics of an activity, which are modeled as attributes.

Utility of Ecological Status Model was demonstrated to emphasize the use of Ecological Status models, which is an analysis-oriented integration as against the data- oriented compilations done presently. The main advantage of an analysis oriented integration lies in that it is a networking of various processes, each of which has undergone a specific desired level of analysis. The existing Erosion Status and Site suitability for soil conservation measures (process based-Morgan and Finney, MMF) Model, for a central Indian forest area, has been used for demonstration (Appendix VII).

A successful Total Quality Management (TQM) is useful in balancing realities of an organization and human resources development in achieving quality objectives. The TQM must understand and balance the skills needed to blend them together. While using TQM for the present study, care was taken that it should evolve from the organization's strategic plan and be based on stakeholder expectations. TQM as a technological change will not be successful unless cultural and political dimensions are attended to as well, hence care has been taken to propose elements of Quality control and Quality Check in the appropriate stages and levels of the organization.

The new process encompasses the following aspects of Total Quality Management that need to be followed while developing the plans.

i. Quality Manual – The inclusion of a Quality Manual has been prescribed in the organizational structure, which will describe the policy, structure and responsibilities of the organisation.

ii. Quality Procedure - It describes the processes the organisation needs to follow in order to ensure best practice to achieve success.

iii. Work Instructions - It describes sub processes in detail to answer one of the above.

Quality organization and Work Instructions have been developed for the forestry organization.

Step 6 - Assessment of different planning processes using stylized case studies

Performance assessment has been done by comparison with existing two processes using stylized case studies. The indicators of performance for comparison were as follows. Performance indicators help in improving organizational effectiveness.

a. Time
b. Quality
c. Costs
d. Adaptability
e. Level of standardization

After the identification of performance indicators, three processes were compared, traditional, semi-technological processes and Geoinformation-oriented process. The responses of the questionnaires were studied, expert opinion was gathered and the new planning process was placed before target groups in the form of presentations. Responses were critically evaluated and analyzed.

The optimal Planning Process was then ascertained based upon the above mentioned process. The detailed results of the performance assessment have been given in Chapter 5, sub-chapter 5.5.

Step 7 - Development of Guidelines for strengthening of planning process and its implementation addressing the following

The final objective was the formulation of guidelines for the planning process, which was accomplished by a clear analyzed understanding of the results obtained from the above steps.

The formulation of guidelines changes with the objectives of policy research efforts. The present study encompasses guidelines for planning process and implementation and policy at the central and state level using the findings based on the incorporation of GITTOPPFS. The basic steps included to evolve policy are as follows:

- Identification of the problem
- Identify key policy issues
- Review of legislation regarding policy issues
- Modifications towards organizational structure
- Stakeholder interviews
- Information synthesis

This study has been aimed at capacity building by enhancement of new planning processes documents for the Government of India. The formulation of Geoinformation policy is also a potential beneficiary from the study since stress has been laid on the role of Geoinformation in policy making, the infrastructure and resource needs and the capacity building through institutionalization of the process.

5. Research Findings

5.1. Situation Analysis of Forest Management and Planning in India

5.1.1 An abstract of Questionnaires / Interviews-

The sources of data for situation analysis were the responses of eighty experts/ planners/ officials whose responses were taken into consideration. An abstract of responses received for the major issues addressed in Questionnaires/ Interviews were as follows

a. Geoinformation Technology perspective in planning and policy.
   (Need for Planning and policy orientation to technology was felt by 90%)
b. Need of Geoinformation Technology.
   (Need was felt by 90% in tasks identified, but supported by strong ground component)
c. Planning Documents that need to be addressed.
   (Need for technological reinforcement was felt by 85%)
d. Probable areas of technology use.
   (Technological issues and avenues rightly identified - 80% felt so, others suggested more areas of applications)
e. Current status of data standards and need of appropriate standards.
   (Current Status: < 10 %, Strong need felt by 85% for appropriate data standards)
f. Need of Geoinformation technology oriented planning process.
   (Needs felt by 80%)
g. Planning and policy level changes anticipated.
   (Planning process improvement: 90%, Geoinformation policy: 60%, Geoinformation Law: 30%)

5.1.2. Situation Analysis using SWOT Matrix

Based upon the results of the questionnaires as described above external sources of interviews and review of current planning process, the SWOT analysis was performed after gathering the required data. The results of the SWOT analysis have been tabulated in Table 5.1.1 as per the traditional SWOT analysis matrix. This analysis gave an insight to the lacunae as well as the strengths of the current planning process that have been duly considered while preparing the third model based on the incorporation of Geoinformation tools.

The strengths and weaknesses of the organization were adjudged based on the SWOT matrix. One of the key strengths of the organization was found to be the enormous amount of experience in survey and management of the forests of the country. The Forest Services being hailed as a highly technical service is another key strength since it invites participation from manpower with high levels of intellect. The Service is backed by strong legislations. Conversely, the main weaknesses identified were attitudinal rigidity with little or no interoperability. The absence of trained manpower in newer technologies also is a major hindrance towards effective adoption of technological oriented processes in the planning.

One of the main opportunities identified were the inclination of the government policies to enhance capacity building and consequently build human resources capabilities. The coming up of a national level Information Technology Policy is also a step towards growth of the information technology as a discipline in the country. The easier availability of Geoinformation tools also follows this approach. Loss of large tracts of land on account of encroachments coupled with deforestation and administrative loopholes in the forestry sector have proven detrimental to the system since decades and have hence been an easy ad judgment to be a threat.

Based on the above S, W, O and T, separate analyses were carried out by a combination of two and three variables. Simultaneous consideration of two or more than two variables enabled the study to draw realistic conclusions towards enhancing the strengthening process of the forest management sector.

An extended SWOT was conducted on the basic SWOT matrix. Deductions were arrived at which formed a part of further analysis. An extended SWOT amongst "Strengths", "Weaknesses", or "Opportunities" concluded that establishment of communications and collaborations with national and international organizations are a key component to be addressed in the planning and management processes. Skills need to be developed at the national level using the capacity and level of skilled personnel available currently.

An analysis of S, W and T concluded that a planning process that integrates the analysis and technological innovations to form a combined approach is required to enhance the capabilities of the planning process. Such integration is imperative at both the Resource management as well as the Plan management levels.

Extended analysis of S, W, O and T brought a novel perspective of organizational alignment in tune with technology. It includes changes in the behavioral patterns, technology levels as well as planning process based protocols. The analysis also indicates need for extensive use of Geoinformation technology at various levels of planning and management.

The evaluation of the difference between the current position of the organization and the desired future can be made through gap analysis. As a result, the organization can develop specific strategies and allocate resources to close the gap, and achieve its desired state. Core deficiencies of the organization were thus identified from the complete SWOT analysis which have been listed below-

- Gap in the infrastructure of the organization
- Inadequacy of skilled manpower
- Lack of capacity building in terms of training
- Apathy towards acceptance of new technologies
- Legislative gaps for Geoinformation
- Unsystematic use of database generated

Table 5.1.1 Results of the SWOT and Extended SWOT analysis

Extended SWOT Analysis-Forest Management and Planning			
	Opportunities	**Threats**	**OT**
	1. Emergent National need of spatial data standardization (GSDI, NSDI, OGC) 2. Forest and environment are a national priority (NFAP, 1999) 3. Availability of and accessibility to Geoinformation tools and technology. 4. Adequate infrastructure and national expertise in Geoinformation Tech. for HRD in the country. 5. National intent to propagate Geoinformation Technology (Technology, IT Policy, NeGP) 6. National and international collaborations for sharing experiences, expertise and mobilization of funds (WB,UNEP, UNDP, FAO,USFS,USFWS etc) 7. International concern for India's mega diversity status 8. International funding. 9. Urgent National need for spatial and non-spatial database in digital domain for improved governance and management.	1. Victims of policy makers, public apathy and development agencies. 2. Loss of area on account of encroachments 3. De- notification of pristine wildlife/ forested areas for want of data to establish ecological importance of area 4. Forest management more administrative than scientific 5. Reduced faith and apathy of people towards forests, wildlife and allied resources 6. Disforestation for developmental activities 7. Indifferent attitude of policy makers. 8. Reduced or no revenue generation for the Government	

Strengths	SO Analysis	ST Analysis	SOT
1. One of the oldest and the most experienced department involved in surveying and management of forests and allied resources 2. Custodians of around 23.42% geographical area of the country 3. Forest Service is a highly technical service 4. A highly organized training process infrastructure for HRD. (IGNFA, FRI, ICFRE, DFE, SFTs) 5. Forest Department is a disciplined; resource concerned and dedicated force of personnel. 6. Down to earth approach in management. 7. Crisis Managers- Acumen to manage resources with modest funds and tremendous adversities. 8. Huge Human Resource 9. Strong Legislations	1. Use in-depth experience to gain leadership in standardization of spatial databases. 2. Initiate efforts for standardization of database at local level in tandem with national standards for ensuring Interoperability 3. Combine jurisdictional monopoly and national interest to establish credentials and create ground for generating funds 4. Blend scientific forest management and technocratic capability to develop human resource for maximum utilization of available technology. 5. Orient highly organized training process, infrastructure to tap national expertise in Geoinformation technology. 6. Encashment of traits to bring about attitudinal change and acceptability. 7. Use in house aptitude and attitude to sensitize forest and wildlife to gain international support. 8. Revitalize the planning process in light of national intent to propagate technology. 9. Encourage and sensitize technology organisations to invest in terms of time, money and expertise. 10. Use leadership in spatial domains for interoperability	1. Integrate traditionalism, experience, monopoly and available technology to develop alternative strategies 2. Use technocratic aptitude for effective technology use in legal issues 3. Extend use of technology in economic evaluation of forests and protected areas to strengthen counter argument against irrational development. 4. Incorporate technology to save time and costs through proper HRD 5. Use traditionalism, work culture, discipline, dedication and down to earth approach and technology to develop outreach programs. 6. Extensive use of Geoinformation technology for analysis oriented integrated planning convincing to policy makers 7. Develop alternative avenues for revenue generation using in-house capabilities and technology.	1. Geoinformation technology oriented HRD Programmes for addressing Attitude, Initiatives and Motivation 2. Leadership in geoinformation technology use in resource management and dissemination of spatial data products to sister concerns and allied departments.

Weaknesses	WO Analysis.	WT Analysis	WOT
1. Attitudinal rigidity to change and slow acceptability of modern tools and technology 2. Inadequate technologically oriented manpower. 3. Little or no interoperability in spatial data and inconsistent in database generation 4. Dilution of spatial scales (Intensive to Extensive-NWPC, 2004) 5. Gap between demand and supply of resources (Gap in Productivity = 2.7 to 3.7 cu m per ha per year) 6. Financial crunch and lack of funds (Ninth Plan-0.79%) 7. Weak monitoring of forest boundaries. 8. Inadequate/improper service conditions of staff. 9. Inadequate coordination amongst related planning organizations at various levels 10. Well established but technologically blunt planning process 11. No Geoinformation policy, law or formal arrangement in place 12. Inadequate infrastructure for law implementation 13. Apathy towards research and training amongst employees.	1. Encashment of national priority in generating resources for technology incorporation 2. Use Geoinformation technology to prevent dilution of scales and strengthen jurisdictional monitoring. 3. Optimum utilization of national expertise and intent towards technology propagation for HRD. 4. Fully utilize HR to make the planning process Geoinformation technology oriented 5. Strengthen financial position through international support 6. The national need of digital domain be seen as an opportunity to address own data needs 7. Welcome the national efforts of interoperability with open arms and contribute. 8. Strengthen law implementation through technology orientation. 9. Use technology to develop alternative sources of revenue to improve service conditions (especially Non Consumptive uses0 10. Encourage and sensitize technology developers and propagators to ensure percolation to grassroots level.	1. Analyze the threatened existence and accept change. 2. Prevent illegal area losses through technology oriented planning to support legal framework 3. Use interoperability to save resources for other priorities 4. Technology enabling in economic evaluation of forested landscapes (Economic Values of Protected Areas Guidelines for PA Managers-WCPA/IUCN) 5. Outreach activities through technology use 6. Transition of planning process from Data oriented compilation to Analysis Oriented Integration for gaining wider support and acceptability. 7. Strengthen existing policy through apt technology use 8. Incentives for technology and research inclined personnel 9. Enhance credibility using Geoinformation technology and use credulity to gain support.	1. Overcoming threats and addressing weaknesses through Security and Risk Management plans. 2. Evolving Quality Organization and establishing quality manual for achieving long term and sustainable conservation of resources.

SW	SWO	SWT	SWOT
	1. Establishing Communications, Linkages and Collaborations with National and International organizations 2. Knowledge and Skills Development for technology orientation using the national technological capacity available.	1. Geoinformation Technology Oriented Plan Management through Analysis Oriented Integration approach. 2. Geoinformation Technology Oriented Resource Management through the evolved process and planning and policy guidelines	1. Need for incorporation of geoinformatin technology in various aspects of planning and management in forestry sector. 2. Organizational Alignment (Technology, Organizational and Behavioral Innovation) through innovative and sustainable plans.

5.2. Technology- Potential and Accessibility in Forest Plans

The results of the estimation of Application potential and Technology Accessibility Index are presented in Table 5.2.1 Various tasks in forestry planning have been outlined, viz., basic processes such as forest type and density, stem density, site quality mapping and applied tasks such disease detection, forest fire mapping and the application potential of Geoinformation technology in these fields have been estimated. The classification of forest types and density classes is most accurate with the use of aerial photographs and hence this methodology has been attributed a high application potential of 80% but correspondingly the technology accessibility is low due to the high level of difficulty in procurement of such data. Hence the feasibility scale of technology shifts towards the medium and high-resolution satellite data.

Issues of legal implication such as encroachment mapping and change detection also play a vital role in the planning process; the role of Geoinformation has been evaluated in this context. The current study points out that there is a high potential of around 90% of the use of Geoinformation techniques while mapping encroachments within protected areas. High resolution satellite data, or PAN merged data with a high spatial resolution best fit the purpose. Change detection also constitutes an important issue for the concerned organizations. The change

detection can be conducted for blanks and also intra forest, i.e. within the forest. The scale of the study also is an important parameter to be considered. Satellite data of high resolution is more effective as a tool in this context but considering the cost benefit analysis of the study, moderate resolution data also remains a feasible option.

The avenues of Geoinformation as a tool for addressing preliminary stages of disaster management, such as the prevention of forest fires, is clearly reflected. Forest fire risk zonation studies and active forest fire mapping are two fields that have been thoroughly researched and methods have been established for the same. There is a requirement of integrating the deductions and recommendations from such research into the mainstream planning process so that fire risk can be effectively addressed. Fire risk zonation can enable planners to prepare against the event. There is a high level of Geoinformation application in such studies. Mapping of active fires is an advantage because it can create spatial histories of fire in a region. This database can be readily available to the future planning process and suggestions can be incorporated.

One of the major issues identified from the study is the low level of applicability of existing technological resource. Existing capabilities are not harnessed to full extent in scientific perspective. The current extent of use of GIS is limited to cartographic procedures and does not take into account the actual potential of GIS. Hence GIS and digital cartography has been attributed high ranks with respect to application potential as well as technology accessibility, but the overall realization of the potentials of the technology is minimal due to attitudinal problems of the organization. Spatial database creation is useful over a length of time only when there is repetitive update of the database with finer details.

The results also indicate a high application potential of Wireless Application Protocol (WAP) enabling to control crime rates and offences within the protected areas. WAP is a secure specification that allows users to access information instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smart phones and communicators. The application though, highly efficient

remains inaccessible to government departments due to very high initial investment in the introductory phase of the technology which is likely to experience a gradual decrease with time.

The application potential for regular information on the status of young plantations is an explored area due to which it is characterized by a poor cost-benefit analysis. The major areas that have been tried to cover as part of this study are as follows-

- Forest Type
- Forest Density
- (Blanks and Forest Non Forest)
- (Intra Forest)
- Soils Mapping (under forests
- Young Plantations
- Habitations/ Forest Villages/Settlements
- Forest Inventories
- Road Network
- Drainages and Water bodies
- Treatment Maps (Activity Execution Plan) Large Scale
- (Extensive areas + Major Diseases)
- Administrative / Management Maps
- Spatial Analysis and Integration
- Mesic sites etc
- Generation of Framework data
- Data sharing and interoperability
- Mapping Ecological Attributes for Wildlife
- Riparian zones, Sacred Grooves, Special habitats
- Fuel Moisture
- Encroachment Mapping
- Change Detection
- Change Detection
- Site Quality
- Age Classes
- (Below 5 years age)
- Stem Density
- Stock Mapping
- Real Time Data Collection
- Elevation/ Slope /Aspects
- Disease Detection
- 2 and ½ D
- Analysis
- Active Forest
- Fire Risk Mapping
- Planning Support Systems
- Forest Fires
- Data management, sharing and concurrent use
- Offence/Crime control and monitoring
- Fire Mapping

Table 5.2.1 Technology- Potential and Accessibility in Forest Plans

Tasks in Forestry Planning	Technology Products	Application Potential (%)										Technology Accessibility Index (Costs + Availability + Know-how + Infrastructure +HR Capacity)					
		10	20	30	40	50	60	70	80	90	100	0	1	2	3	4	5
Forest Type	R.S. Data Products •Aerial Photos								✓				✓				
	•Satellite Data (Moderate Resolution-MS)						✓									✓	
	•Satellite Data (High Resolution-MS)						✓								✓		
Encroachment Mapping	Satellite Data (High Resolution-PAN)									✓				✓			
Forest Density	RS Data •Aerial Photos								✓				✓				
	•Satellite Data (Moderate Resolution-MS)				✓											✓	
	•Satellite Data (High Resolution-MS)						✓								✓		
Change Detection (Blanks and Forest Non Forest)	RS Data Satellite Data (Moderate Resolution-MS)									✓						✓	
Change Detection (Intra Forest)	RS Data •Satellite Data (Moderate Resolution-MS)						✓									✓	
	•Satellite Data (High Resolution-MS								✓						✓		
Site Quality	RS Data + GIS (Indirect Inferences)		✓												✓		
Soils Mapping (under forests	RS Data + GIS •Aerial Photos						✓						✓				
	•Satellite Data (Moderate Resolution-MS)				✓											✓	

Tasks in Forestry Planning	Technology Products	Application Potential (%)										Technology Accessibility Index (Costs + Availability + Know-how + Infrastructure +HR Capacity)					
		10	20	30	40	50	60	70	80	90	100	0	1	2	3	4	5
	•Satellite Data (High Resolution-MS					✓									✓		
Age Classes	RS + GIS •Aerial Photos						✓						✓				
	•Satellite Data (High Resolution-MS)			✓											✓		
Young Plantations (Below 5 years age)	RS Data + GIS •Satellite Data (Moderate Resolution-MS)				✓											✓	
	•Satellite Data (High Resolution-MS)						✓							✓			
Habitations/ Forest Villages/Settlements	RS Data •Satellite Data (Moderate Resolution-MS)							✓								✓	
	•Satellite Data (High Resolution-MS)								✓						✓		
Stem Density	RS Data + GIS •Aerial Photos					✓							✓				
	•Satellite Data (High Resolution-PAN)					✓								✓			
Forest Inventories	RS Data + GIS •Aerial Photos							✓					✓				
	•Satellite Data (Moderate Resolution-MS)		✓													✓	
	•Satellite Data (High Resolution-MS)					✓									✓		
Stock Mapping	RS Data + GIS •Aerial Photos						✓						✓				
	•Satellite Data(Moderate Resolution-MS)		✓													✓	
	•Satellite Data(High Resolution-MS)			✓											✓		
Road Network	RS Data + GIS •Aerial Photos									✓			✓				
	•Satellite Data(High Resolution-PAN)								✓					✓			
Drainages and Water bodies	RS Data + GIS •Aerial Photos										✓		✓				

Tasks in Forestry Planning	Technology Products	Application Potential (%)										Technology Accessibility Index (Costs + Availability + Know-how + Infrastructure +HR Capacity)					
		10	20	30	40	50	60	70	80	90	100	0	1	2	3	4	5
	•Satellite Data (Moderate Resolution-MS)									✓						✓	
	•Satellite Data (High Resolution-MS)										✓				✓		
Elevation/ Slope /Aspects	SAR Interferometry/ Satellite Derived Elevation •SRTM (90 M)					✓											✓
	•SRTM (30 M) (Aster/ERS1/2)									✓					✓		
Treatment Maps (Activity Execution Plan) Large Scale	RS+GIS •Aerial Photos								✓				✓				
	•Satellite Data (Moderate Resolution-MS)				✓											✓	
	•Satellite Data (High Resolution-MS)						✓								✓		
	•HR-PAN								✓					✓			
Disease Detection (Extensive areas + Major Diseases)	RS+GIS •A. Photos (IR)						✓						✓				
	•Satellite Data (Moderate Resolution-MS)				✓											✓	
	•Satellite Data (High Resolution-MS)					✓									✓		
Administrative / Management Maps	Digital Maps •1:50,000					✓										✓	
	•1:25,000								✓					✓			
	•1:15,800										✓		✓				
	•(4": 1Mile)																
Spatial Analysis and Integration	GIS Digital Cartography										✓					✓	
	GIS								✓						✓		
Generation of Framework data	GPS									✓						✓	
	Lidar/ Laser									✓		✓					
	Framework Std.									✓				✓			
2 and ½ D Analysis	•Stereo Pair (APs)									✓			✓				
	•Stereo pairs HR Sat. Data								✓						✓		

Tasks in Forestry Planning	Technology Products	Application Potential (%)										Technology Accessibility Index (Costs + Availability + Know-how + Infrastructure +HR Capacity)					
		10	20	30	40	50	60	70	80	90	100	0	1	2	3	4	5
Real Time Data Collection	Mobile GIS and WAP									✓					✓		
Data sharing and interoperability	Web GIS/National GIS						✓							✓			
Data management, sharing and concurrent use	Geo-RDBMS									✓			✓				
Offence/Crime control and monitoring	WAP									✓				✓			
Mapping Ecological Attributes for Wildlife Riparian zones, Sacred Grooves, Special habitats/ Mesic sites etc	RS+GIS (Attribute specific resolution)							✓								✓	
Forest Fires Fuel Moisture	RS •NOOA-AVHRR (Composite NDVI Images)						✓							✓			
	•Shortwave IR or Hyper spectral data							✓				✓					
	•Thermal infrared							✓				✓					
	•Active Microwave						✓					✓					
Active Forest Fire Mapping	•Satellite Data (Moderate Resolution)								✓							✓	
Fire Risk Mapping	•RS+GIS								✓							✓	
Planning Support Systems	RS+GIS •Multi Criteria Evaluation									✓				✓			
	•Spatial Multi Criteria Evaluation									✓				✓			
	•Decision Support Systems								✓					✓			
	•Analytical tools +computer simulations+ Visualization									✓				✓			

5.3. Data Standards for Forestry Database.

For seamless access and exchange of Geoinformation, data standards are inevitable. These data standards have been established in two ways

i. Choosing appropriate data standards from the existing
ii. Developing new data standards wherever necessary.

As a result of the study data standards were developed for forest departments considering non-availability of such standards. Even though some agencies other than the forest departments have come up with some data standards for forestry but they are seldom followed and need much work at the local level. These standards were studied before arriving at the data standards

5.3.1. Key Issues

Data standards were developed and appropriately chosen from the existing ones. The Key issues, which were considered while choosing the appropriate standards and developing new standards wherever required, were, as follows:

- Scale
- Resolution
- Map Projection
- Error Tolerance
- Data Standards and conversion
- Content Standards
- Meta Data Standards

5.3.2. Existing Data Standards (referred for appropriate choice)

The data standards, which were studied to get an insight into existing data standards to make choice of appropriate standards possible, were as follows.

- National (Natural) Resources Information System (NRIS) Node Design and Standards, Indian Space Research Organization, Bangalore, 2001
- National Spatial Data Infrastructure (NSDI), India, Metadata Standards, 2002
- National Spatial Data Infrastructure (NSDI), India, Data Exchange Format, 2003 Version 1.01
- National (Natural) Resources Management System (NNRMS), National Standard for EO Images, Thematic and Cartographic maps, GIS database and spatial outputs, 2005.

Amongst these the most appropriate and elaborate standards were found to be those of the NNRMS data standards 2005. The NNRMS through a wide variety of user- driven projects has generated a rich base of map information for the country. The NNRMS standards cover standards for images, thematic and cartographic mapping, and seamless GIS database organization and outputs and quality certification, which appropriately comply with the needs, which will arise while generating forestry database. However the NSDI Data Exchange Format mentioned above will be followed wherever necessary. These have been evolved from the Digital Vector Data (DVD –30) format of the Survey of India for digital cartographic vector data, which earlier catered to point, line and polygon topology but now provides for inclusion of digital images acquired by satellites, digital elevation models and coded raster data.

5.3.3. Data Standards Developed

Based on the need of the forestry sector new data standards were developed -

- **Forest Type and Composition Attributes Standards**

  While developing these standards the classification scheme of Champion and Seth, 1968 for India was taken into consideration. This classification categorizes the Indian forests into six Major Groups, 16 Type Groups, 20 Sub Groups, which have then been further, classified into moderate 161 floristic compositions and 50 smaller sub floristic compositions and 13 minor local variant compositions (these includes general edaphic, seral and degraded stages).

It is proposed that the Major Groups will be mapped at the scale 1: 250,000(National Level), the Groups will be mapped at scale 1: 50,000 (State Level), the Sub Groups at a scale of 1: 25,000 scale (Forest Division Level), the moderate level floristic composition at scale of 1: 10,000 (Forest Range Level), and the sub floristic groups at 1: 4000 (Beat Level). At 1:4000 scale floristic groups pertaining to top canopy trees, second storey trees, bamboo, shrubs, herbs and grasses will be mapped through field surveys. At the scale of 1:2000 (Compartment Level), very specific forest type/ habitat components namely, climbers, epiphytes, and parasites will be mapped. However, the mapping scale and the attributes to be mapped will also depend on the objective and managerial preferences. The standards are as given in Appendix VI, Table 1 and 2.

- **Indicative Standards for Ecological Attributes-** These standards have been developed to cover the Non – Champion and Seth classes and important ecological attributes, vital to forest and wildlife management. Five mapping scales have been specified for each ecological attribute with independent coding. The attributes will be decided depending upon the management objective. The method will consist of use of moderate resolution remotely sensed data and fieldwork at the scales of 1:50,000 and 1:25,000. At the scale 1:10,000 high-resolution satellite data supported by extensive fieldwork will be used. Mapping of these attributes at 1:4000 and 1:2000 scales will be exclusively field based since it is a micro level mapping, eg., habitat elements or ecological elements which are difficult to map on large scale. The degree of fieldwork and use of remotely sensed data will largely depend on the ecological attribute being mapped. The standards are as given in Appendix VI, Table 3 and 4.

- **Structural Data Standards**- These pertain to mapping the structural attribute of crown and stem density. It is proposed that at the scale of 1:250,000 and 1:50,000, the crown density will be mapped using moderate resolution satellite data. At 1:25,000, and 1:10,000 scales, high-resolution

satellite data will be used. At the scale of 1:10,000 and 1:4000, stem density will also be mapped, but using field-based methods. The mapping depends upon the management objective, eg., if the stem density has to be mapped at numerous density classes, the mapping has to be done at a larger scale like 1:4000.The standards are as given in Appendix VI, Table 5 and 6.

- **Ground Cover data standards-** Since the use of remote sensing has serious limitations towards mapping of shrubs, herbs and grasses, these being in the under storey, field based surveys will be done for mapping the shrubs, herbs and grass cover at the scale of 1:10,000 and 1:4000 as specified in Appendix VI, Table 7.

- **Tree Size Classification Standards-** The tree size classes are determined in forestry by calculating the diameter (usually at breast height) of the tree of average basal area (Quadratic Mean Diameter) of the top storey trees that contribute to canopy closure, which is the tree cover as seen from the Bird's Eye view. Various QMD classes specified are seedlings, saplings, poles, small, medium, large, very large trees and giant trees. The standards are as given in Appendix VI, Table 8.

All the administrative units for forestry database have been prescribed in each table (Appendix VI, Table 9). They consist of Notified Forest Boundary, Circle, Division, Range and Beat. Standards for various territorial units have been described in Appendix VI, Table 10. The attribute standards for Management Units have been described in Appendix VI, Table 11. The existing standards proposed to be used for forest Working Plans and Management Plans are as given in Appendix VI, Table 12. Standards for all the legal categories at different scales have been described in Appendix VI, Table 13.

Table 5.3.1 List of Various Data Standards Developed and Chosen for Forestry Sector

Standards	Table
Forest Type and Composition Attribute Standards	1
Method and Scale for Forest Attribute Table	2
Indicative Standards for selected Ecological Attributes (Non Champion and Seth Classes)	3
Methods and Scale for Indicative Standards	4
Forest Density Classification Standards (Total Cover, Shrub Cover and Tree Canopy Cover)	5
Methods for crown and stem density classification	6
Shrub, Herbs and Grass Cover% (Method- Field Based)	7
Tree Size Classification	8
Attribute Table for Administrative Units (Forests)	9
Attribute Standards Territorial Forest Units	10
Attribute Standards for Management Units	11
Existing Standards proposed to be used for Forest Working/ Management Plans	12
Attribute Standards Legal Sub-division (Units)	13

5.4. Proposed Geoinformation Technology Oriented Planning Process for Forestry Sector(GITOPPFS)

5.4.1 Background- This sub-chapter is devoted to process modeling of the GITOPPFS for its optimisation by suggesting changes in technology at appropriate stages in the process along with resource optimisation introducing operations management techniques.

This chapter consist of two parts. The first part consists of proposing use of modern geonformation technologies to strengthen the existing planning process. The second part consists of realigning the organisation to accommodate the GITOPPFS and institutionalising it.

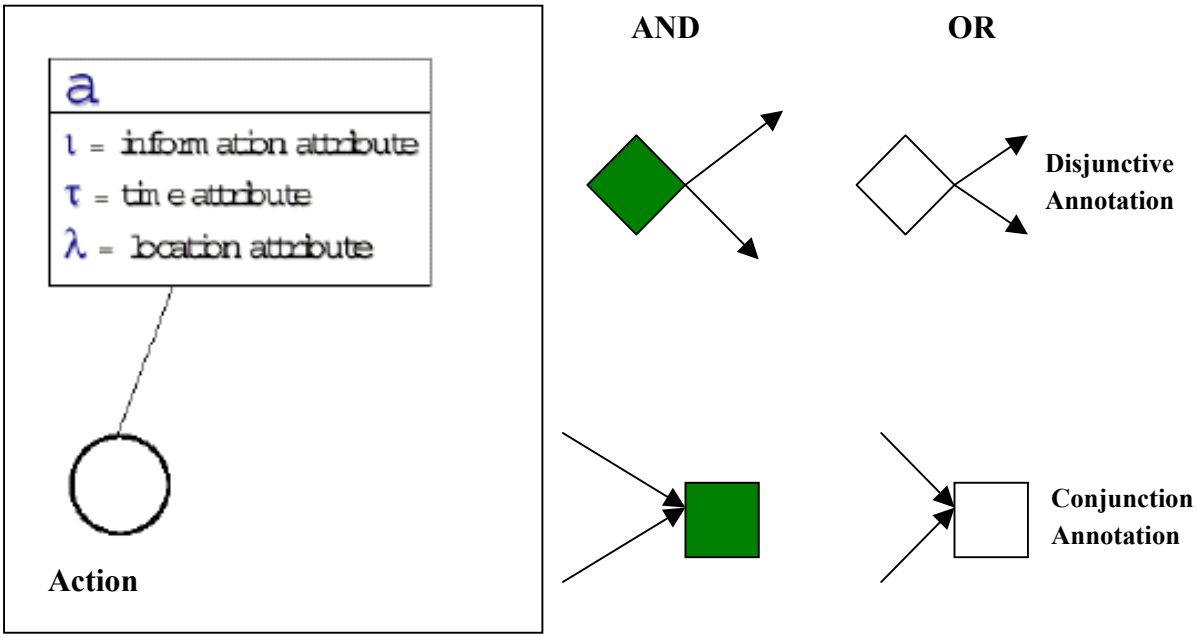
5.4.2 Process Modelling of GITOPPFS

Process- A pattern of closely related events (activities, actions) that take place to lead to a particular result and can be manifested in many different ways (Radwan et al., 2001). It may be structured, semi structured and structured. These processes need to be modeled to understand, diagnose and optimize to keep pace with the changing scenario on the technology front and application potential of such technologies in forestry.

5.4.3 Process Modelling

"An abstract representation of reality that includes much of the world's infinite details. The purpose of model is to reduce complexiety of understnding…. A phenomenon by elimniating the details that do not influence its relevant behaviour." (Curtis, Kellner, and Over, 1994 as quoted in OEEPE, Manual) The processes are modelled to design a new system, evaluation of existing system and finally to compare proposed alternatives for a particular system.

Some annotations and abbreviations used



- In the process models - Years/ months before means "before the expiry of the current Working/ Management Plan

Abbreviations-

1. **NTADD** National Technology and Applications Division
2. **NFDR** National Forestry Database Repository (Nodal Agency FSI)
3. **MOEF** Ministry of Environment and Forests
4. **GOI** Government of India
5. **SFDR** State Forestry Database Repository
6. **STADD** State Technology Applications and Development Division
7. **WPO** Working Plan Officer (for Managed Forest Plans)
8. **MPO** Management Plan Officer (for Protected Area)
9. **RFO WP** Range Forest Officer Working Plan
10. **RFOT** Range Forest Officer Territorial
11. **CFWP** Conservator of Forests Working Plan
12. **CF** Conservator of Forests
13. **FDRDC** Forestry Database Research and Development Center
14. **PCCF** Principal Chief Conservator of Forests
15. **CCF** Chief Conservator of Forests
16. **W/MPO** Working Plan Officer/ Management Plan Officer (Working Plan-for Mnaged Forests and Mngement Plan for Protected Area

In the beginning, the process model for the existing planning process has been illustrated from Initiation to the Final working plan. The process consists of sub processes from A to K. Some of the processes relevant to this study namely, A- Preparatory Works; B- Preliminary Working Plan Report Part I; C- Descriptive Field Work; D- Survey and Assessment of Natural Resources and E- Preparation of Maps by WPO have been further illustrated to the second level of abstraction.

The overall process model for the GITOPPFS been subsequently illustrated indicating the processes which have been modified and reinforced to incorporate applications of Geoinformation. Apart from proposing reinforcements in the above mentioned processes, new processes have been developed and incorporated, namely, U- Generation and Compilation of other non-spatial and ancillary data; V- Quality Control / Check; W- Entry in/ Interface with georelational database; X-

Integration and Analysis; Y- Building a Decision/ Planning Support System; Z- System Validation and Performance Evaluation.

The Proposed Plan Process consist of four levels of abstraction.There are 15 processes which have been spilt into 63 Sub processes at second level of abstraction, 82 Sub processes at third level of abstraction and 18 sub processes at fourth level of abstraction.The process model for the existing planning process has first been decsribed and then the proposed planning process has been described. The GITOPPFS has been illustrated in the following manner-

Actions have been described as short footnotes beneath each diagram for the convenience of the reader. Detailed descriptions follow in Table 5.4.1.

- Represents the components of the existing planning process
- Represents the second level of abstraction in the existing planning process
- Represents the modified and newly introduced components in the proposed GITOPPFS
- Represents the second level of abstraction in the proposed GITOPPFS
- Represents the third level of abstraction in the proposed GITTOPPFS
- Represents the fourth level of abstraction in the proposed GITTOPPFS

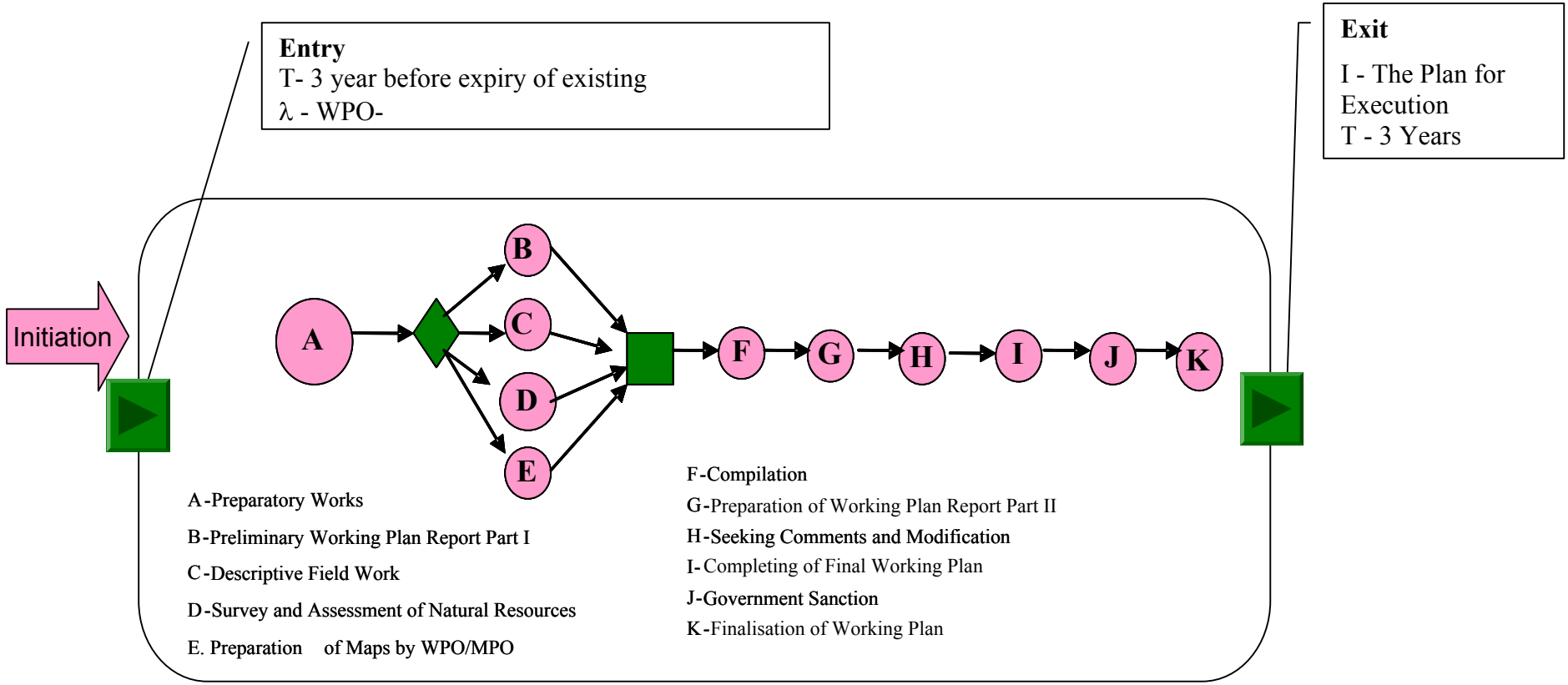


Figure 5.4.1 Overall Process (Existing Planning Process)

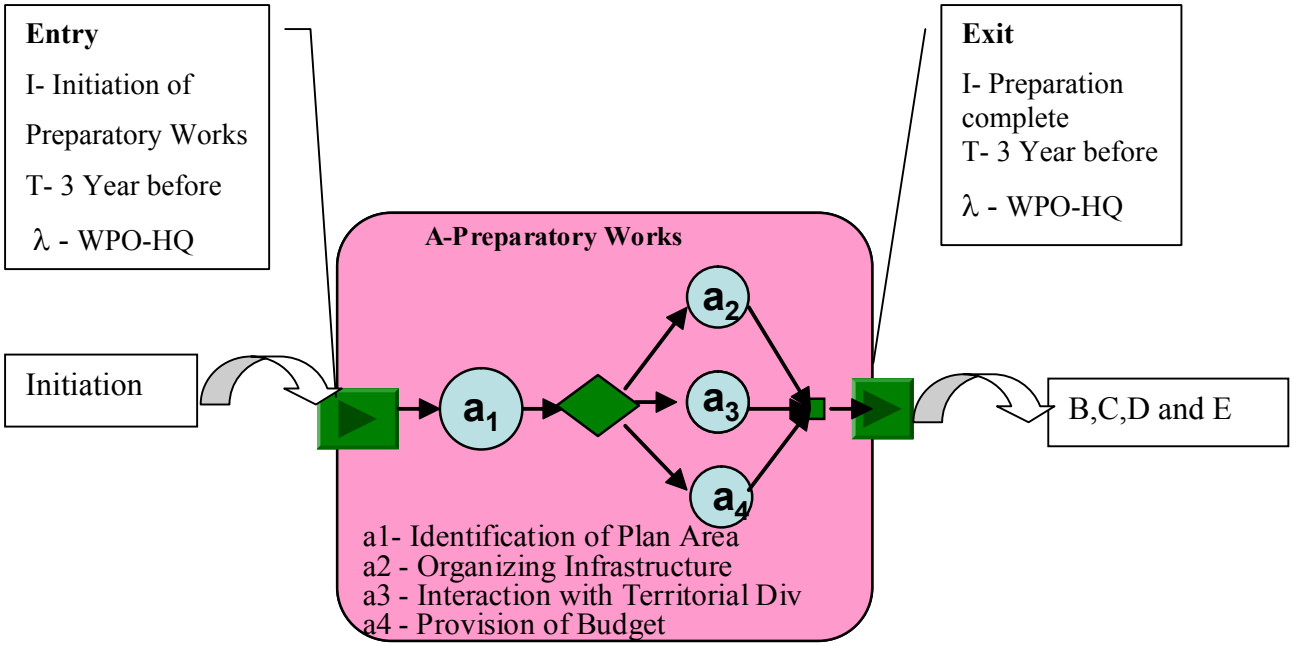


Figure 5.4.2 Preparatory Works

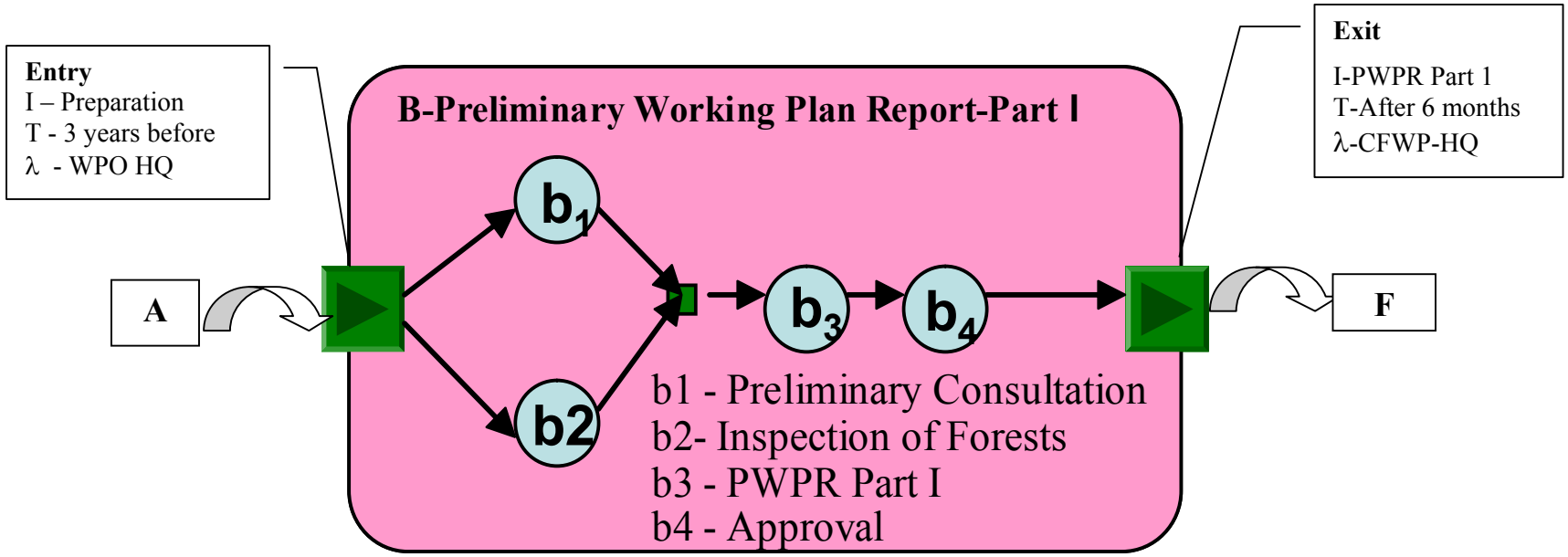


Figure 5.4.3 -Preliminary Working Plan Report –Part I

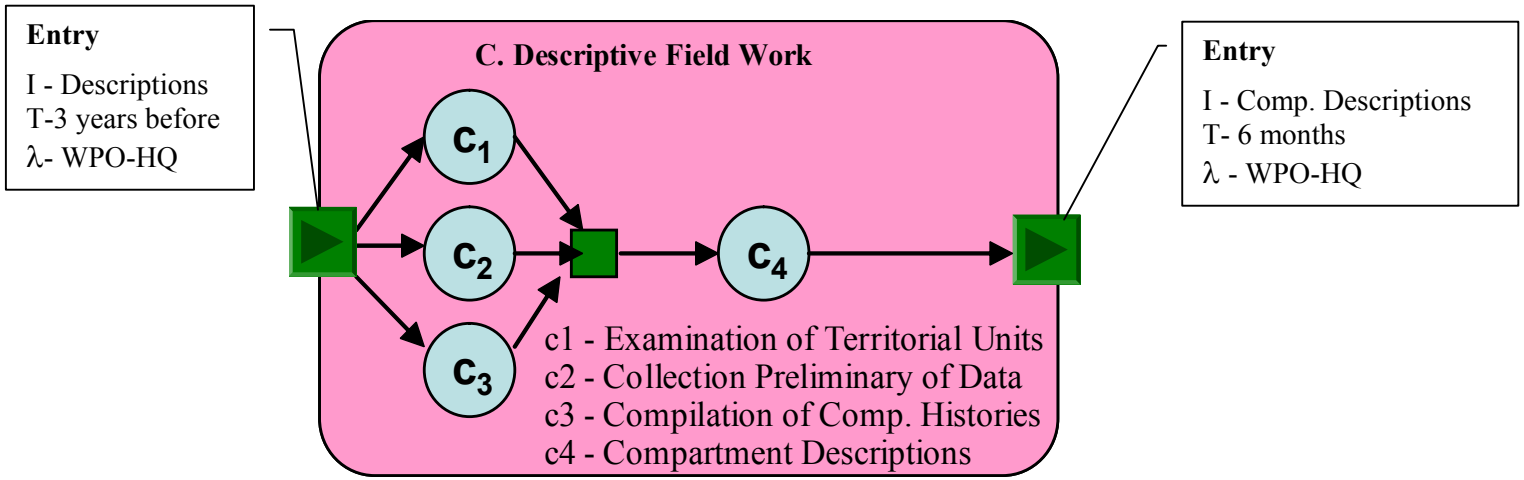


Figure 5.4.4 -Descriptive Field Work

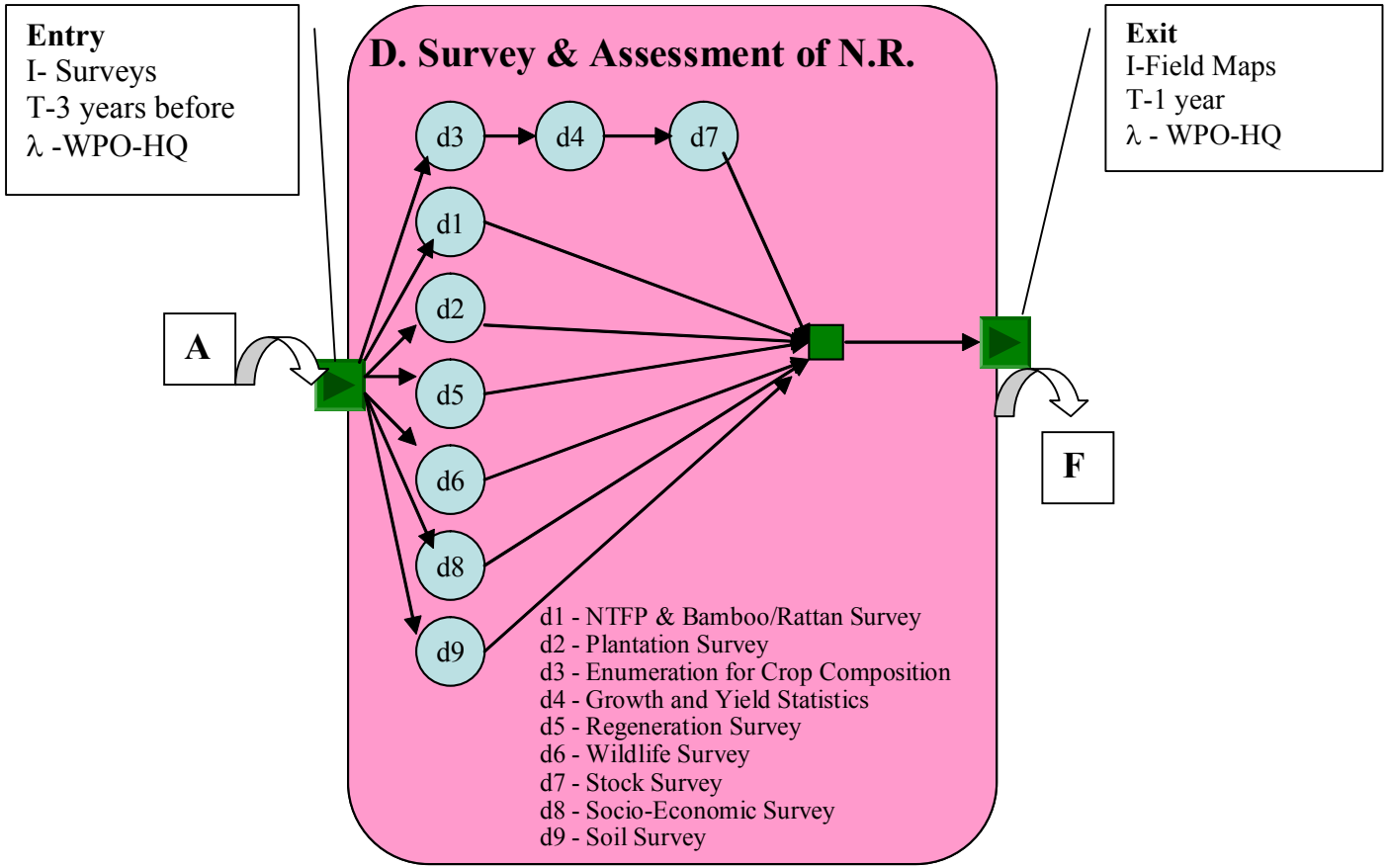


Figure 5.4.5 -Survey & Assessment of N.R.

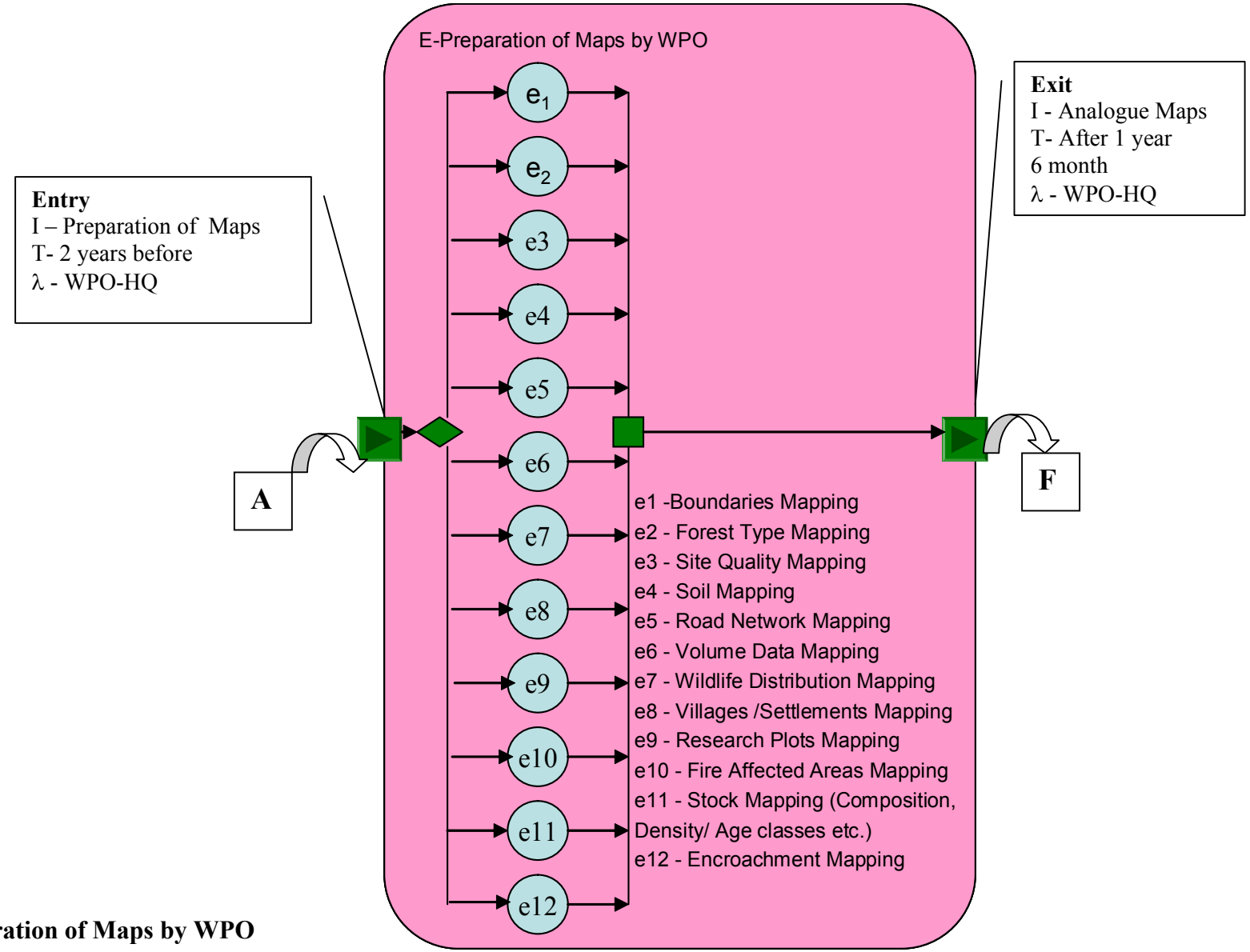


Figure 5.4.6 -Preparation of Maps by WPO

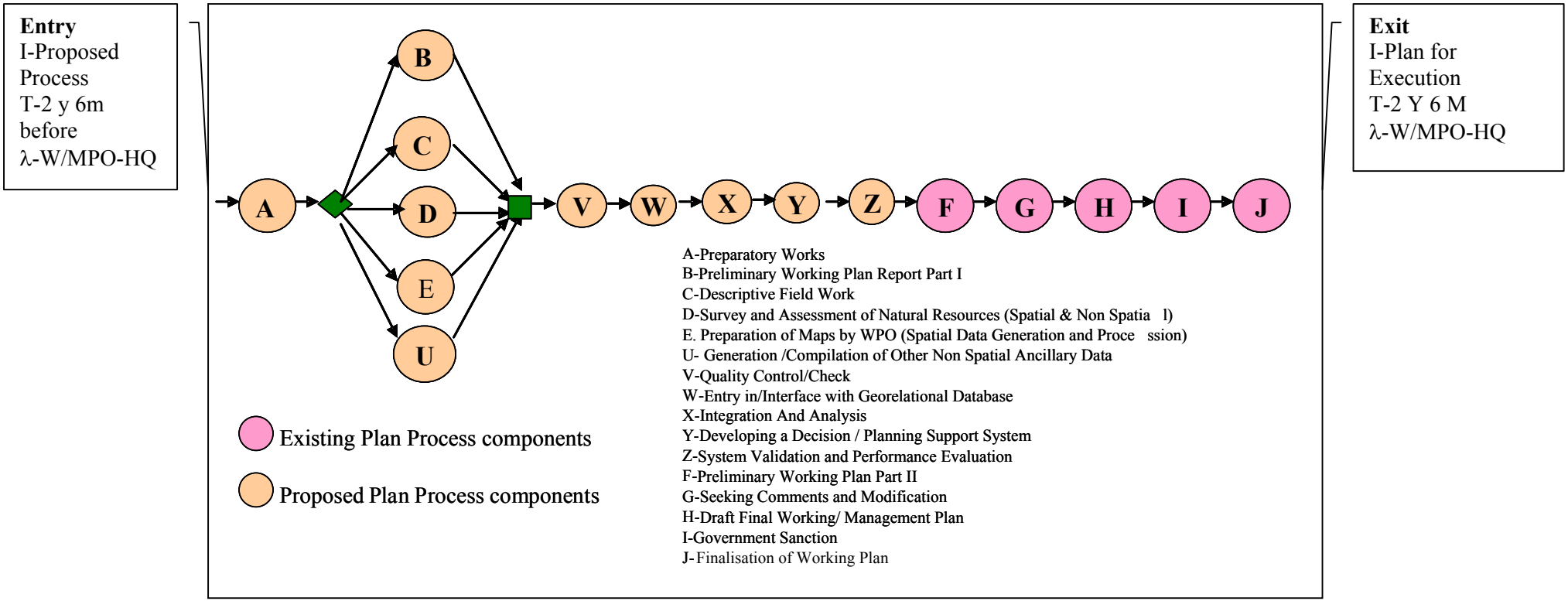


Figure 5.4.7 Proposed Geoinformation Technology Oriented Process for Forest Working/ Management Plans

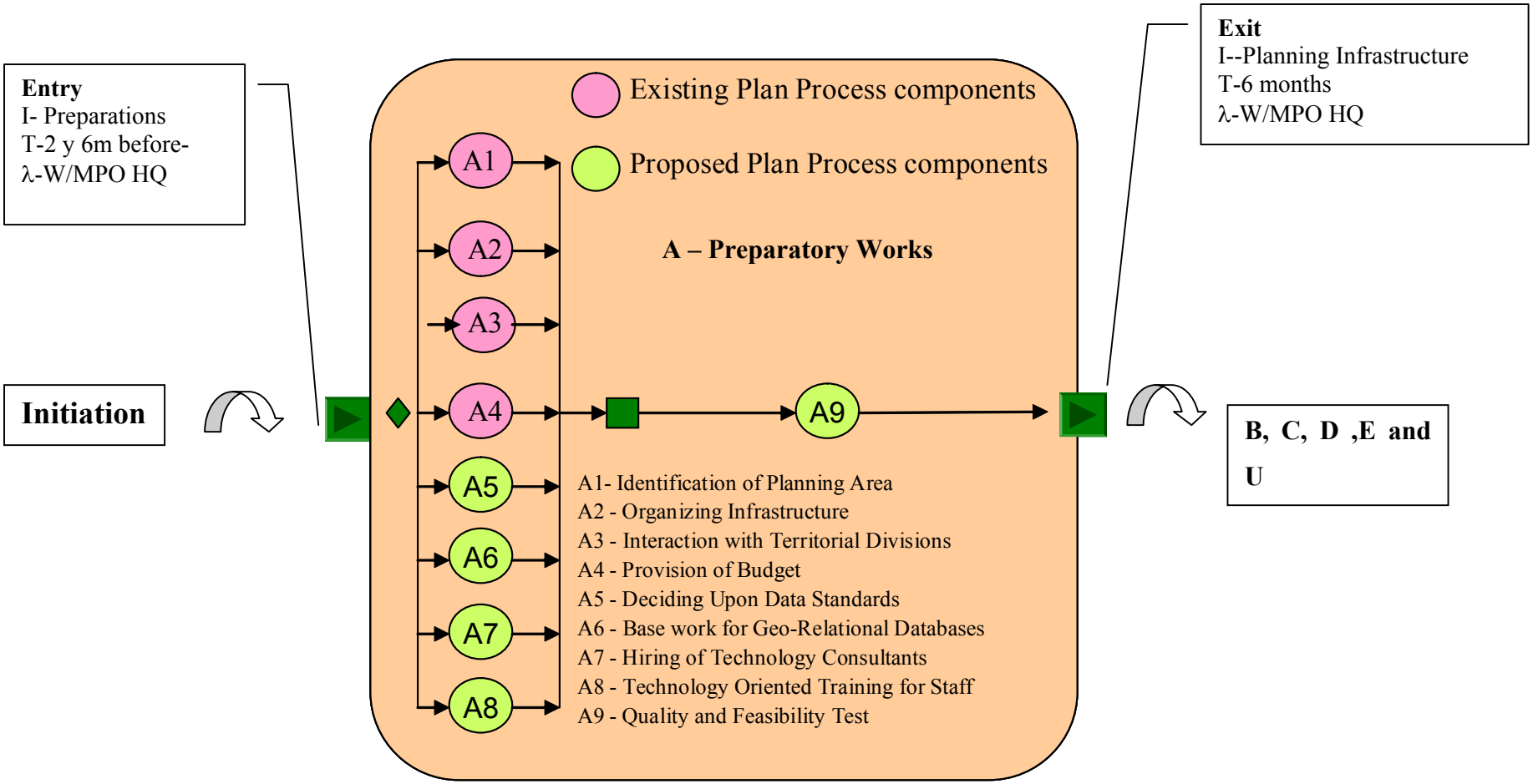


Figure 5.4.8 - Preparatory Works Proposed Process

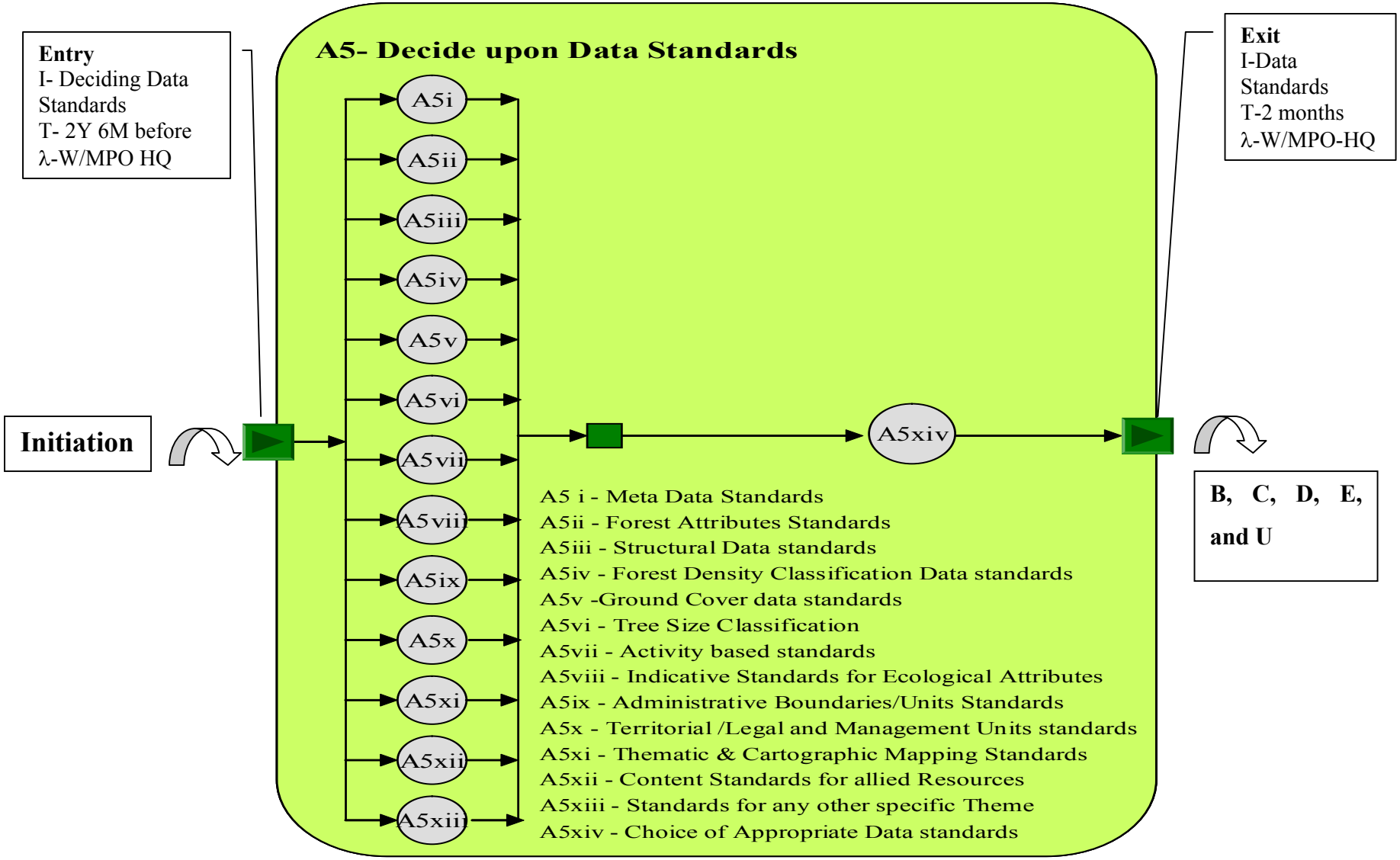


Figure 5.4.9 Decide upon Data Standards

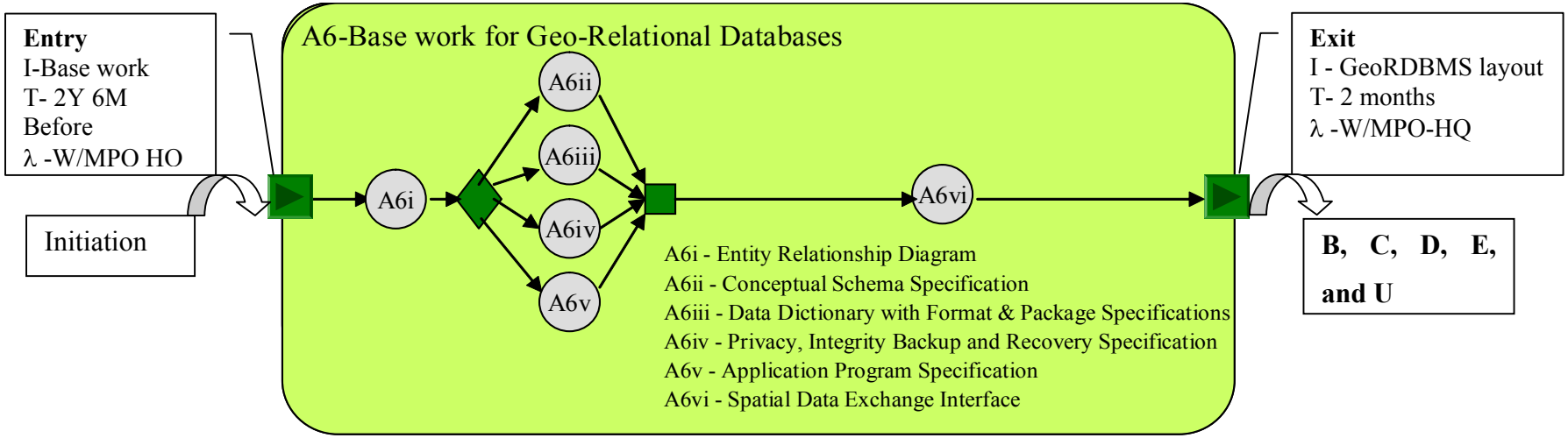


Figure 5.4.10. Base work for Geo-Relational Database

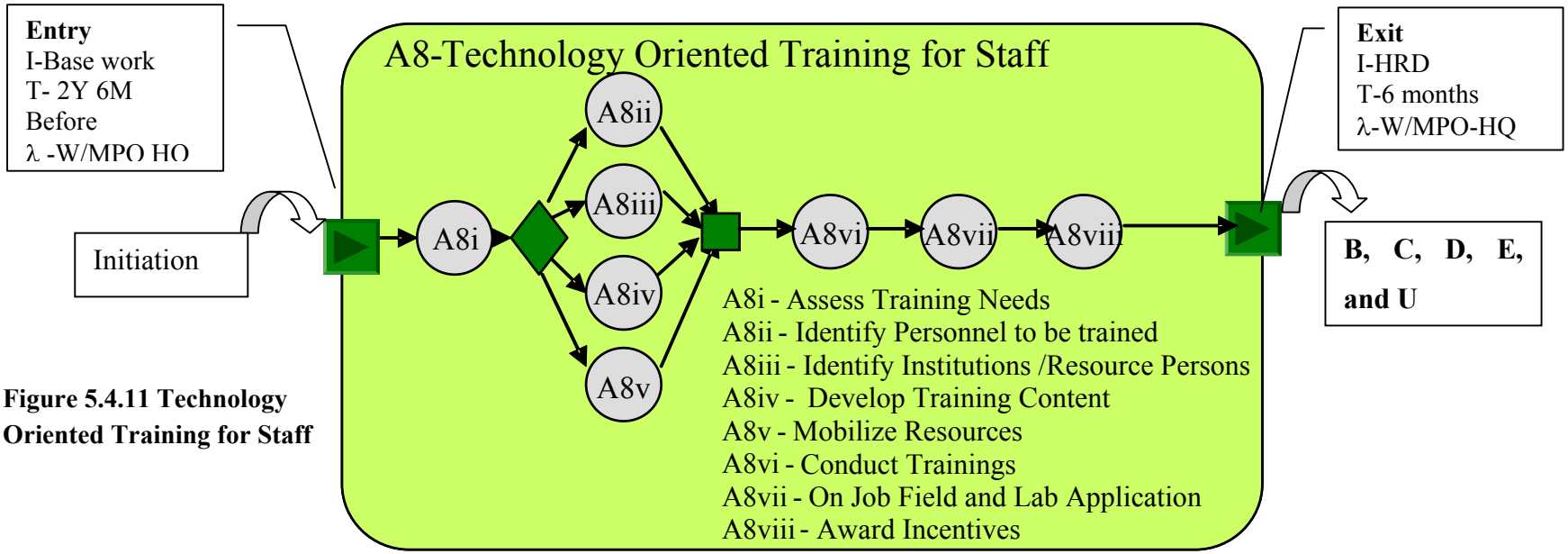


Figure 5.4.11 Technology Oriented Training for Staff

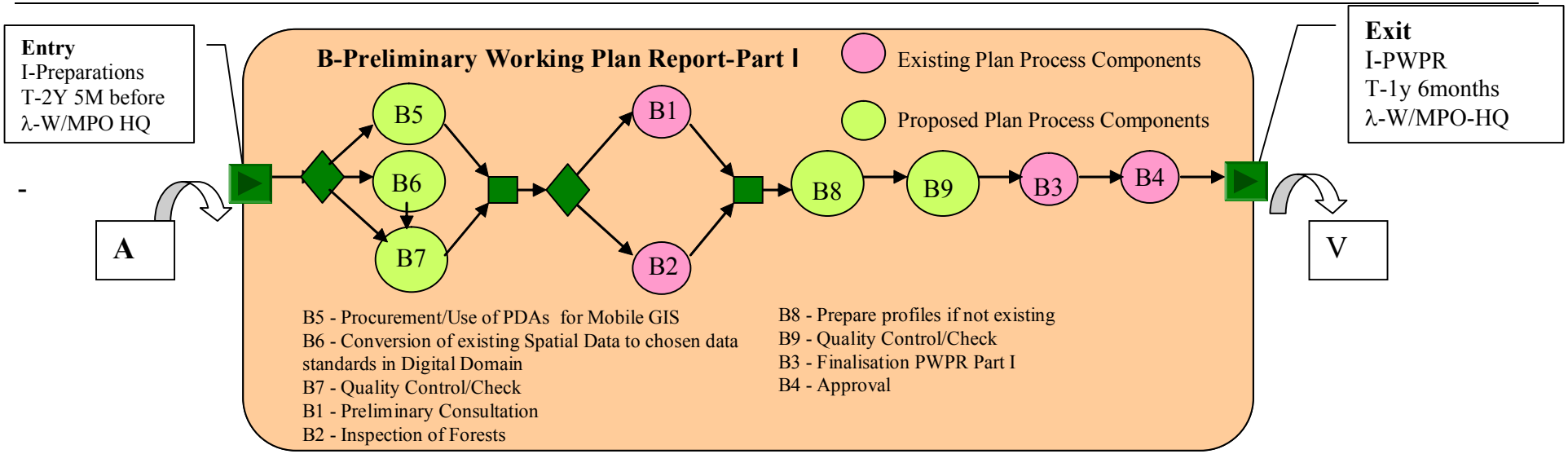


Figure 5.4.12 Preliminary Working Plan Report - Part

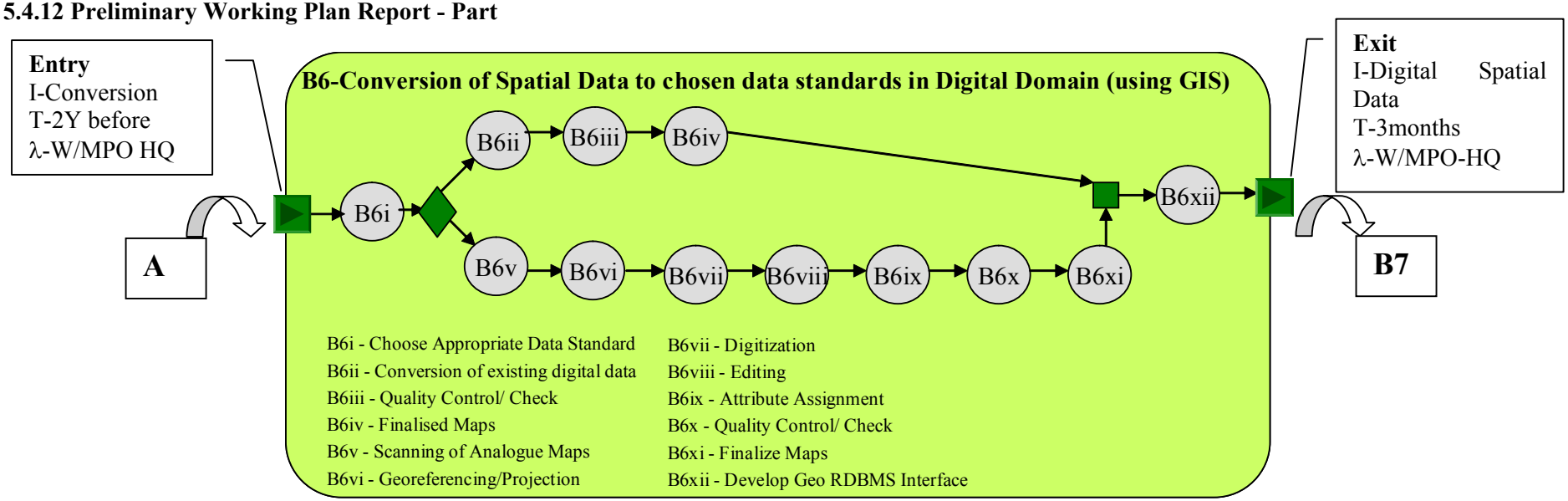


Figure 5.4.13- Conversion of Spatial Data to chosen data standards in Digital Domain

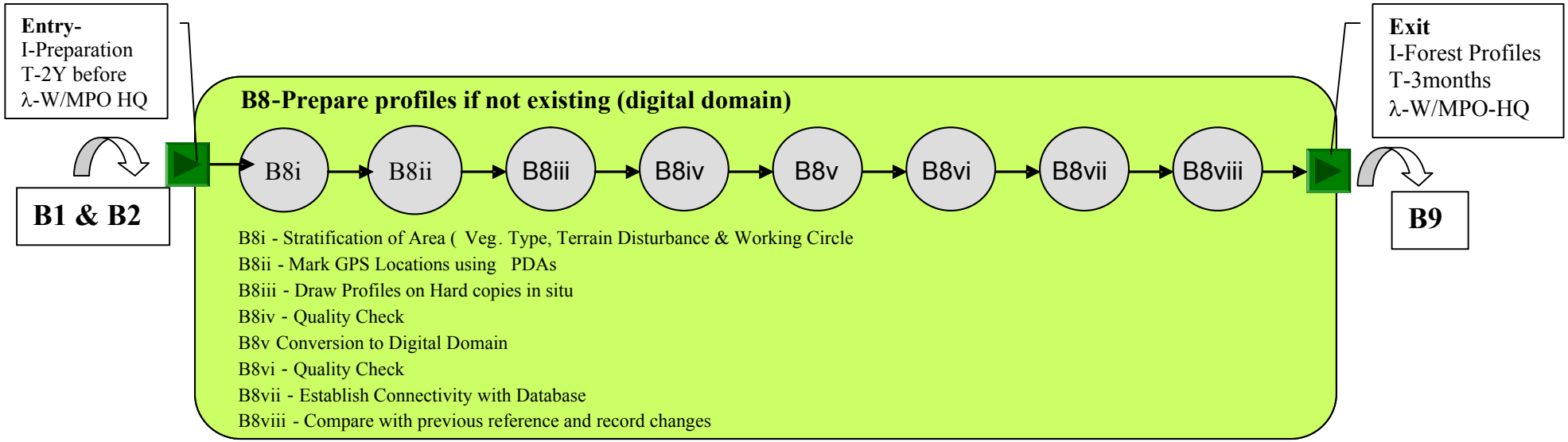


Figure 5.4.14 Prepare profiles if not existing (digital domain)

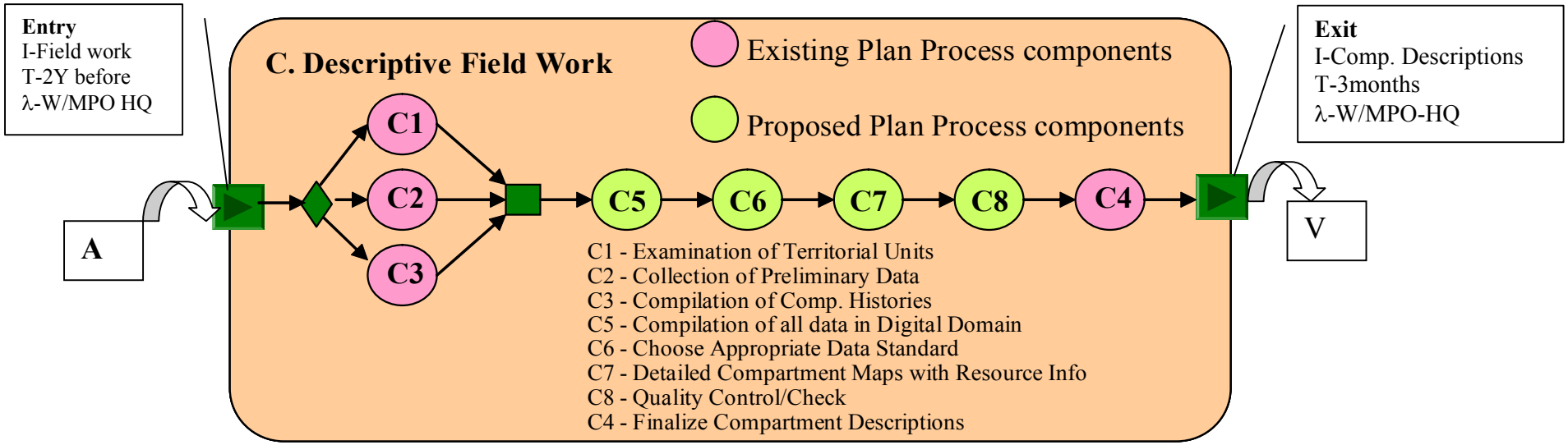


Figure 5.4.15- Descriptive Field Work

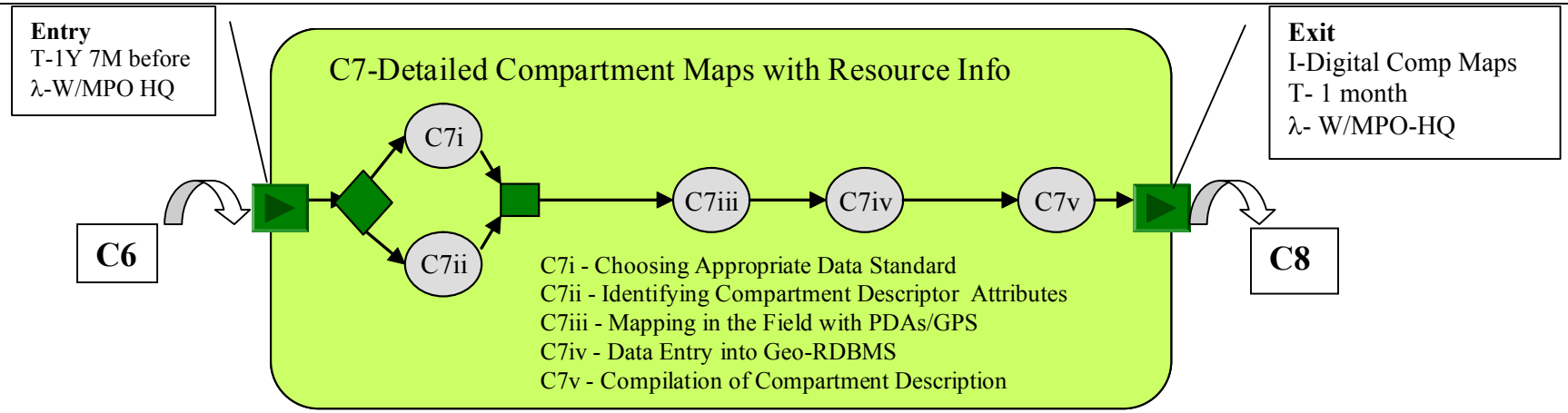


Figure 5.4.16 Detailed Compartment Maps with Resource Info

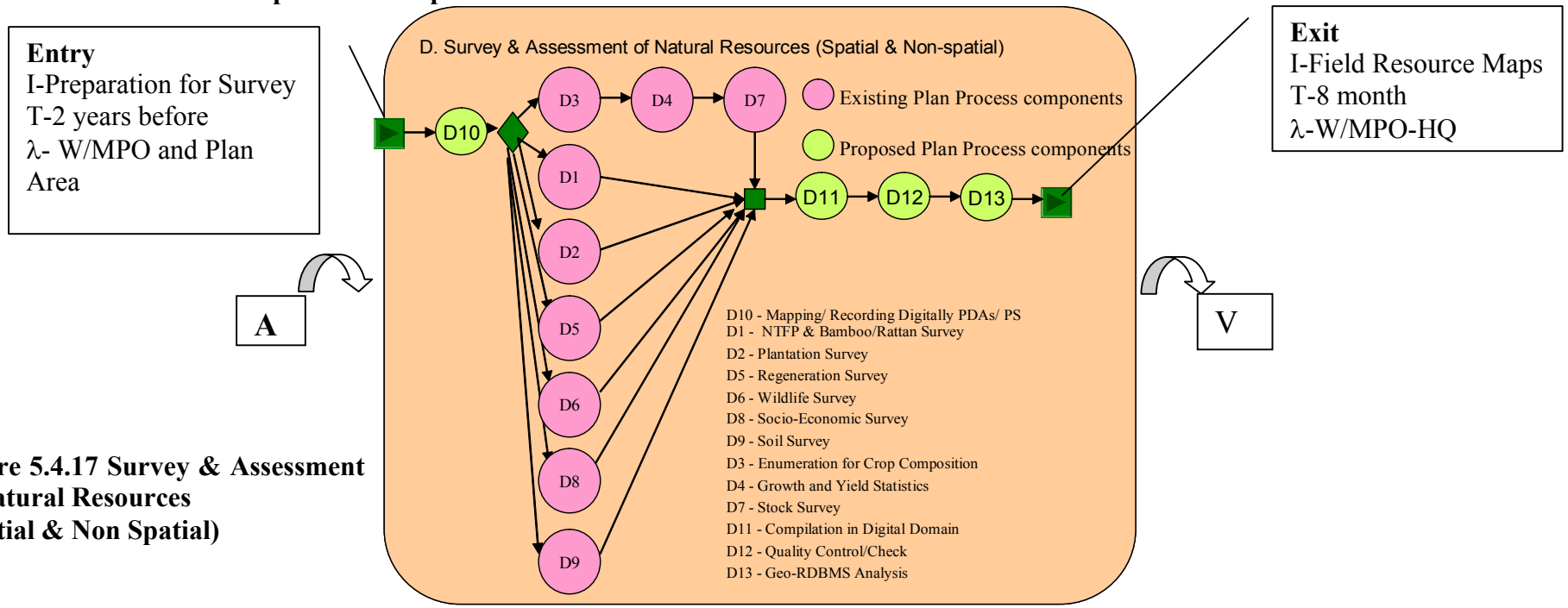


Figure 5.4.17 Survey & Assessment of Natural Resources (Spatial & Non Spatial)

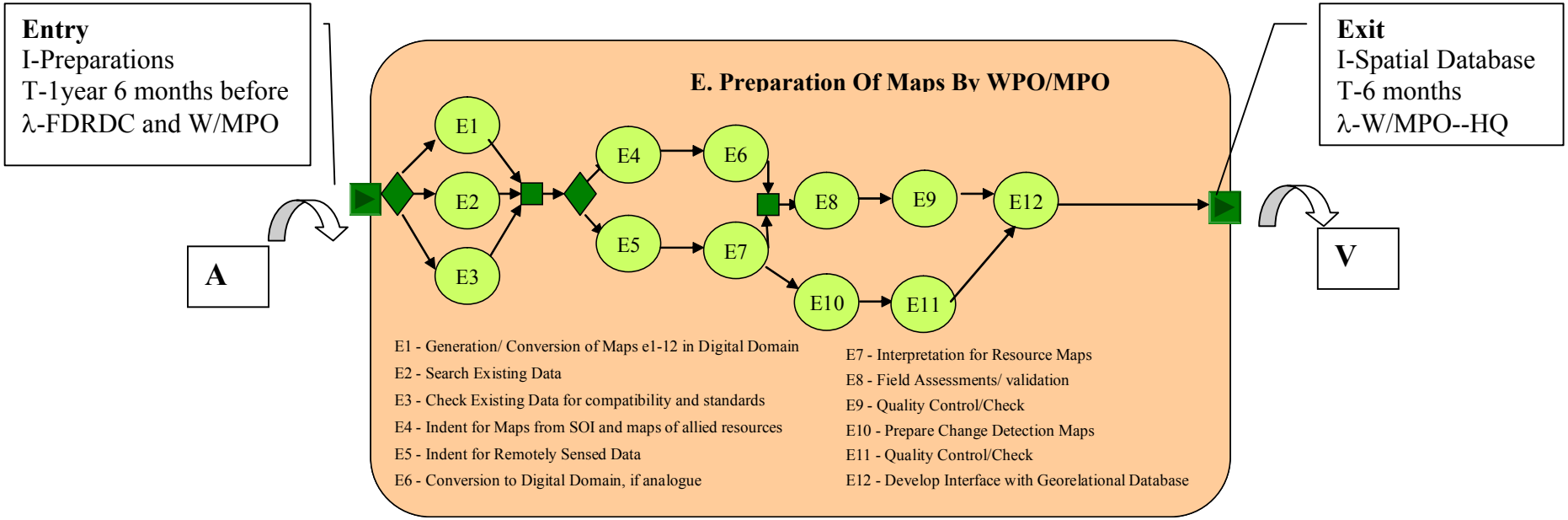


Figure 5.4.18. Preparation of Maps by WPO/MPO (Spatial Data Generation and Processing in GIS Domain)

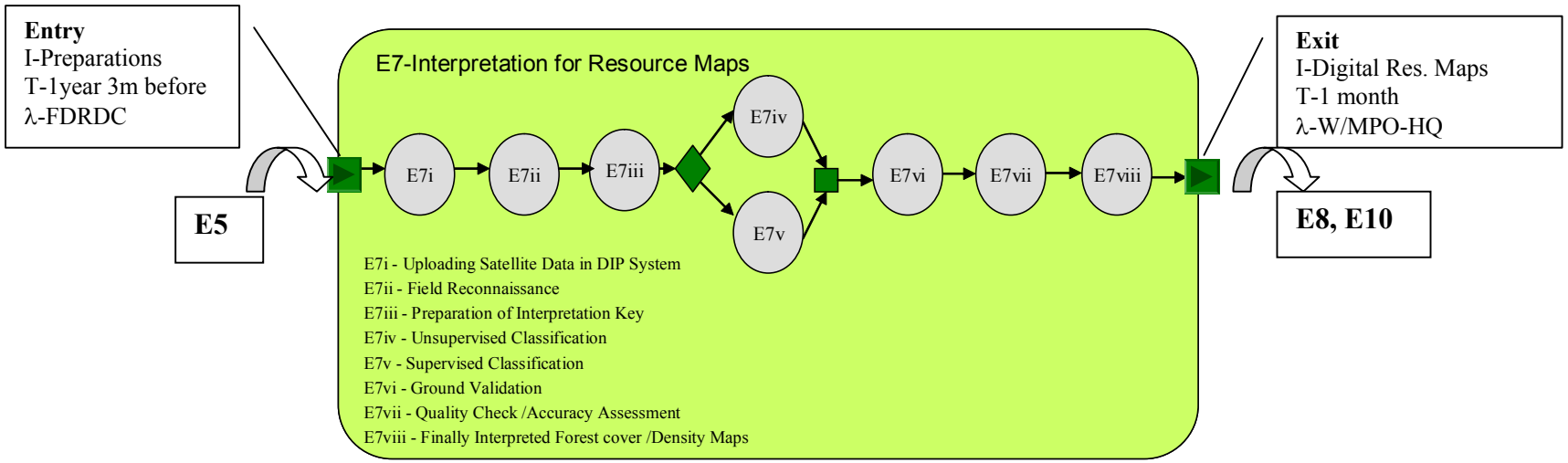


Figure 5.4.19- Interpretation for Resource Maps

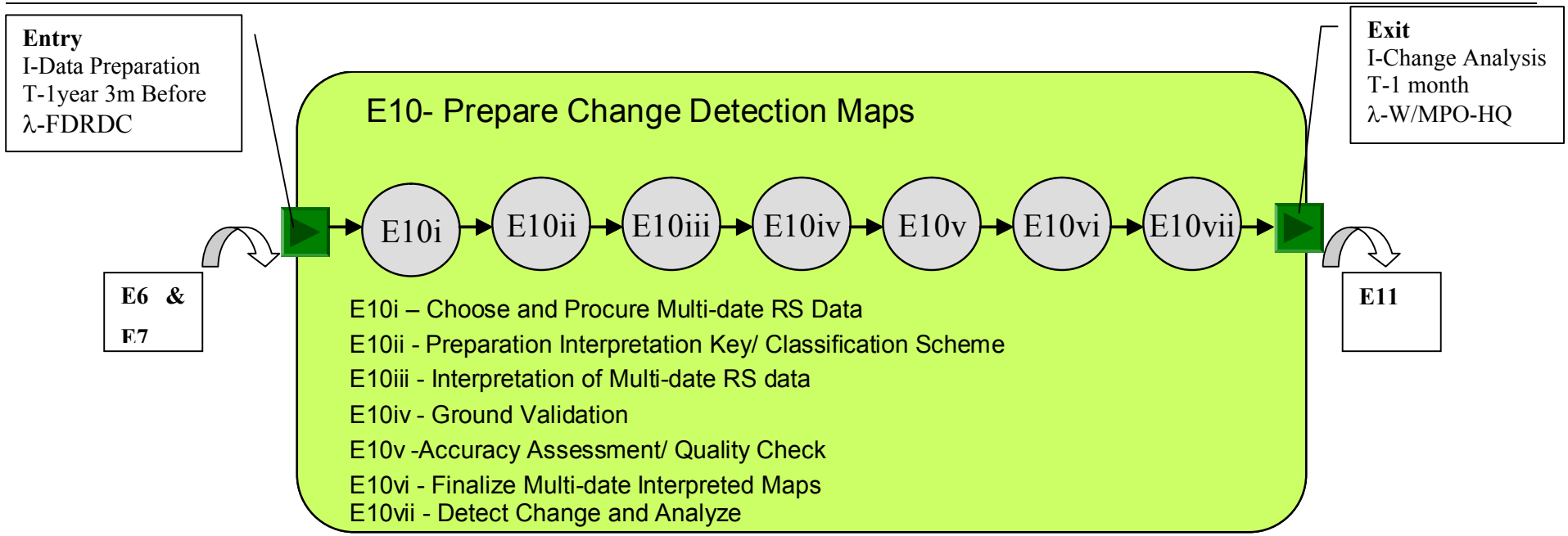


Figure 5.4.20 Prepare Change Detection Maps

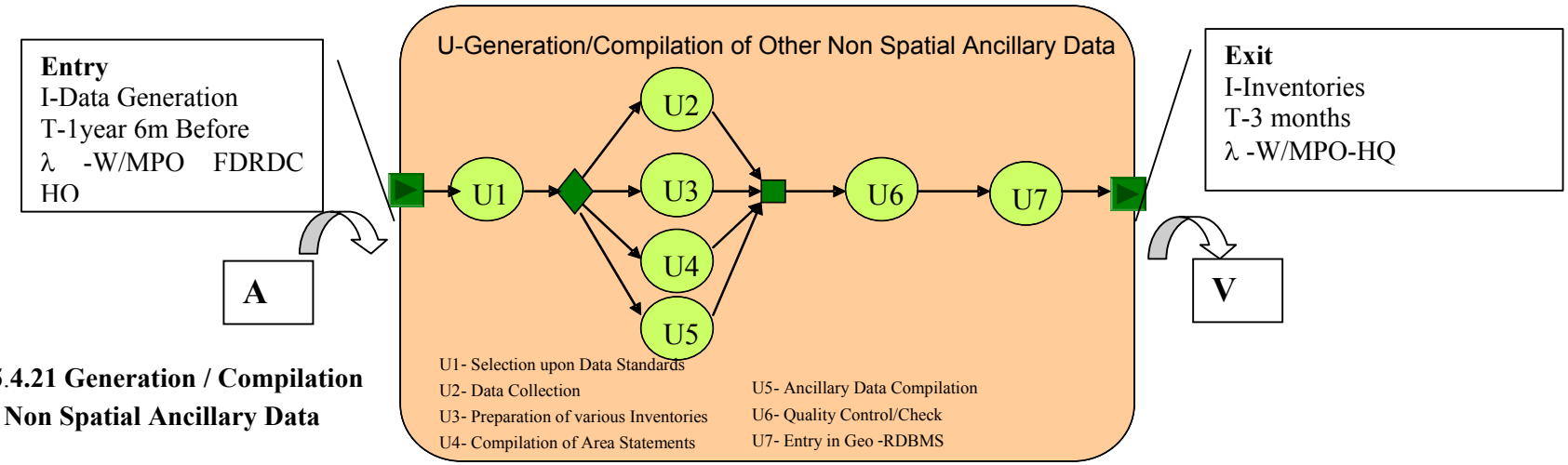


Figure 5.4.21 Generation / Compilation of other Non Spatial Ancillary Data

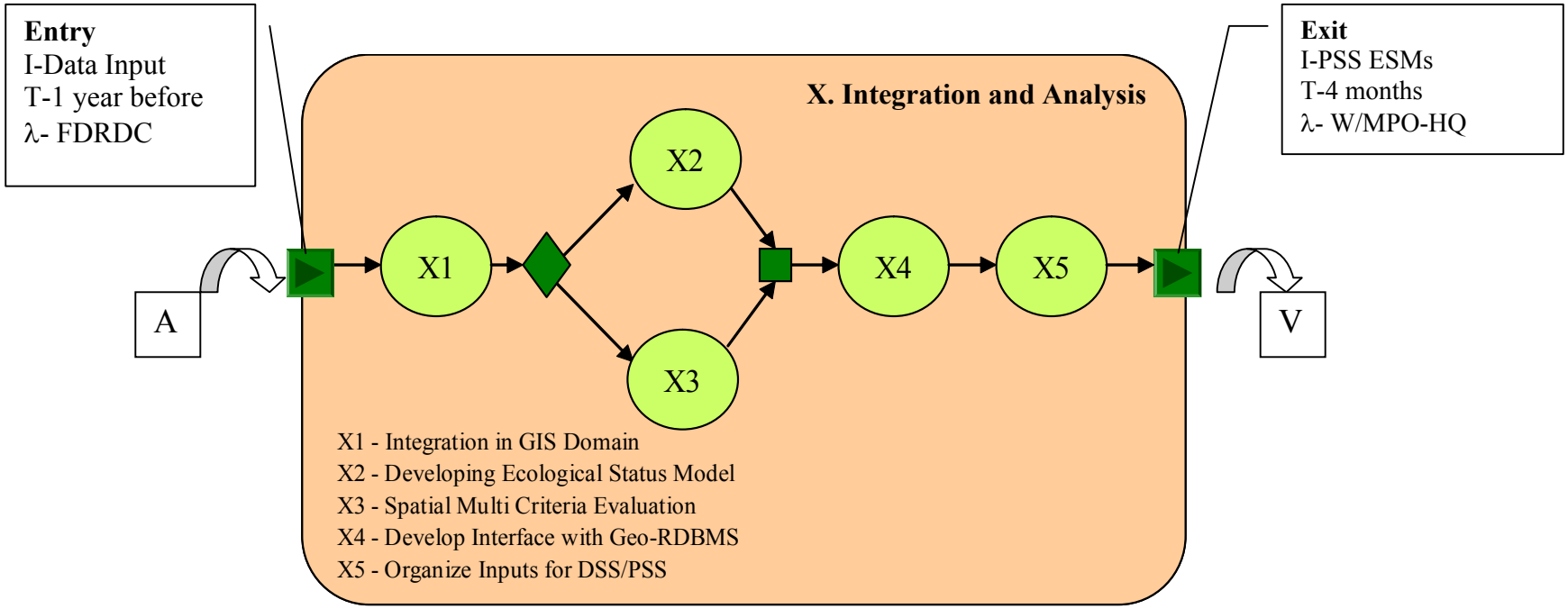


Figure 5.4.22-Integration and Analysis

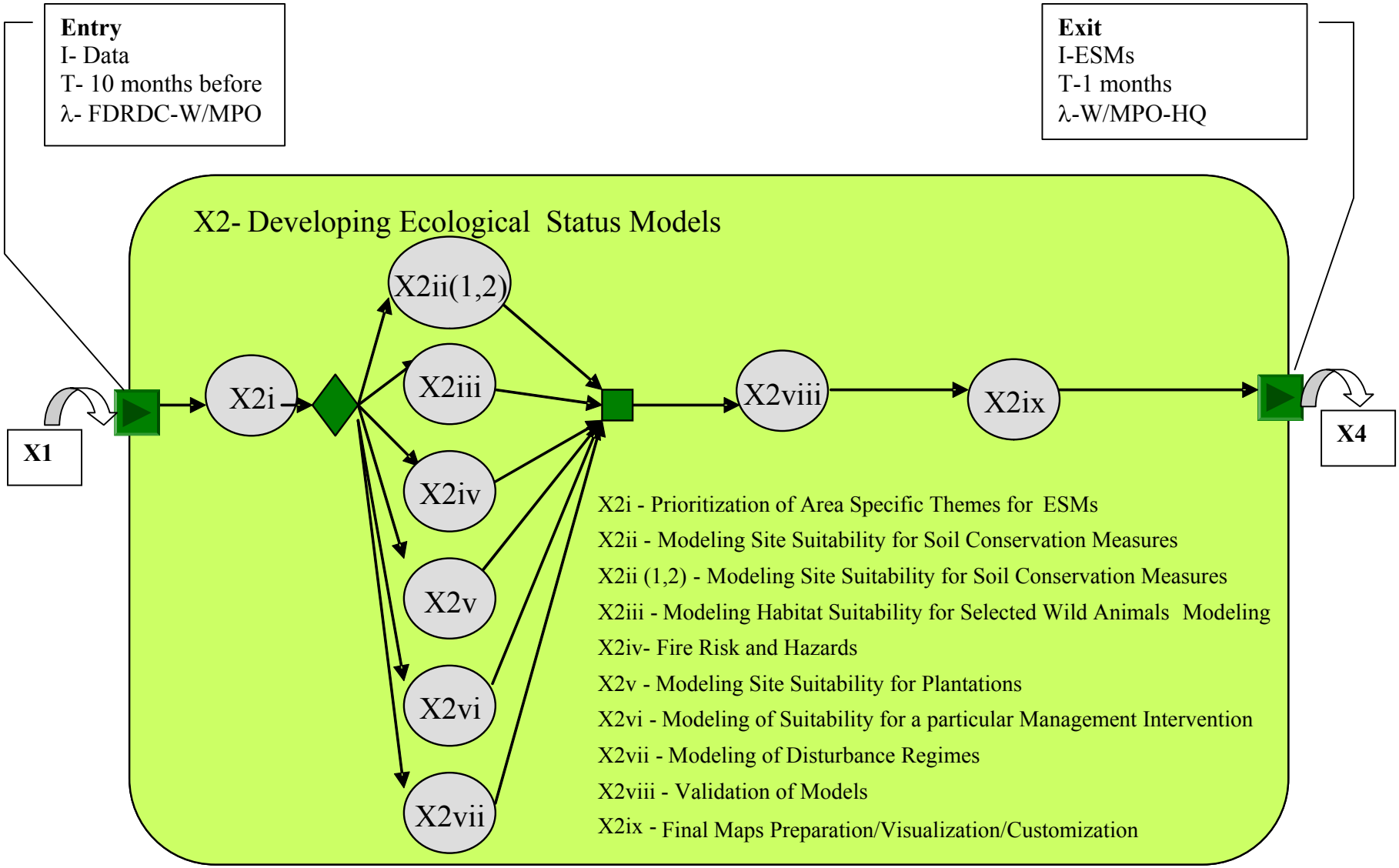


Figure 5.4.23-Developing Ecological Status Models

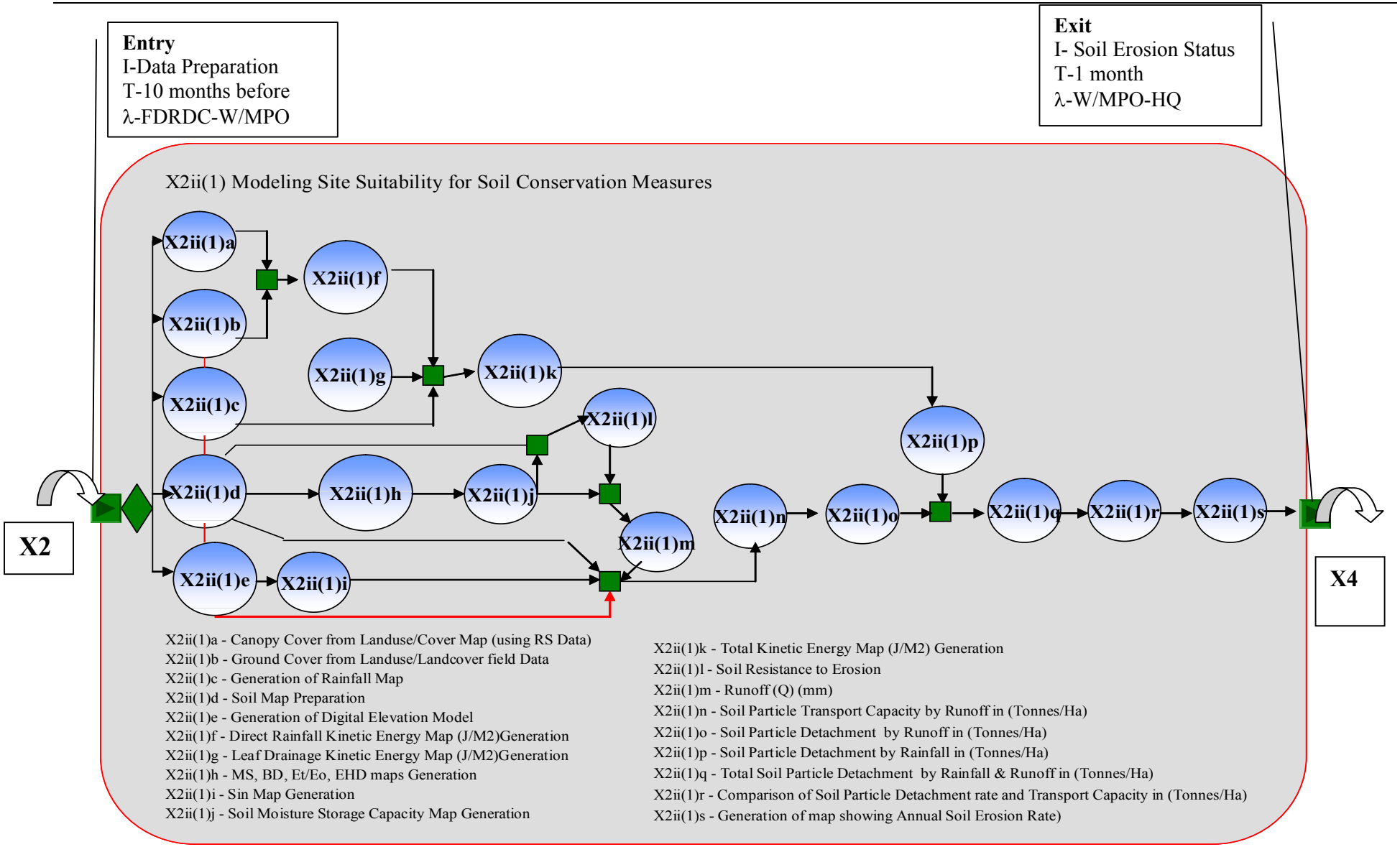


Figure 5.4.24 Modeling Site Suitability for Soil Conservation Measures(Models generated for BSP Protected Area Complex(existing)

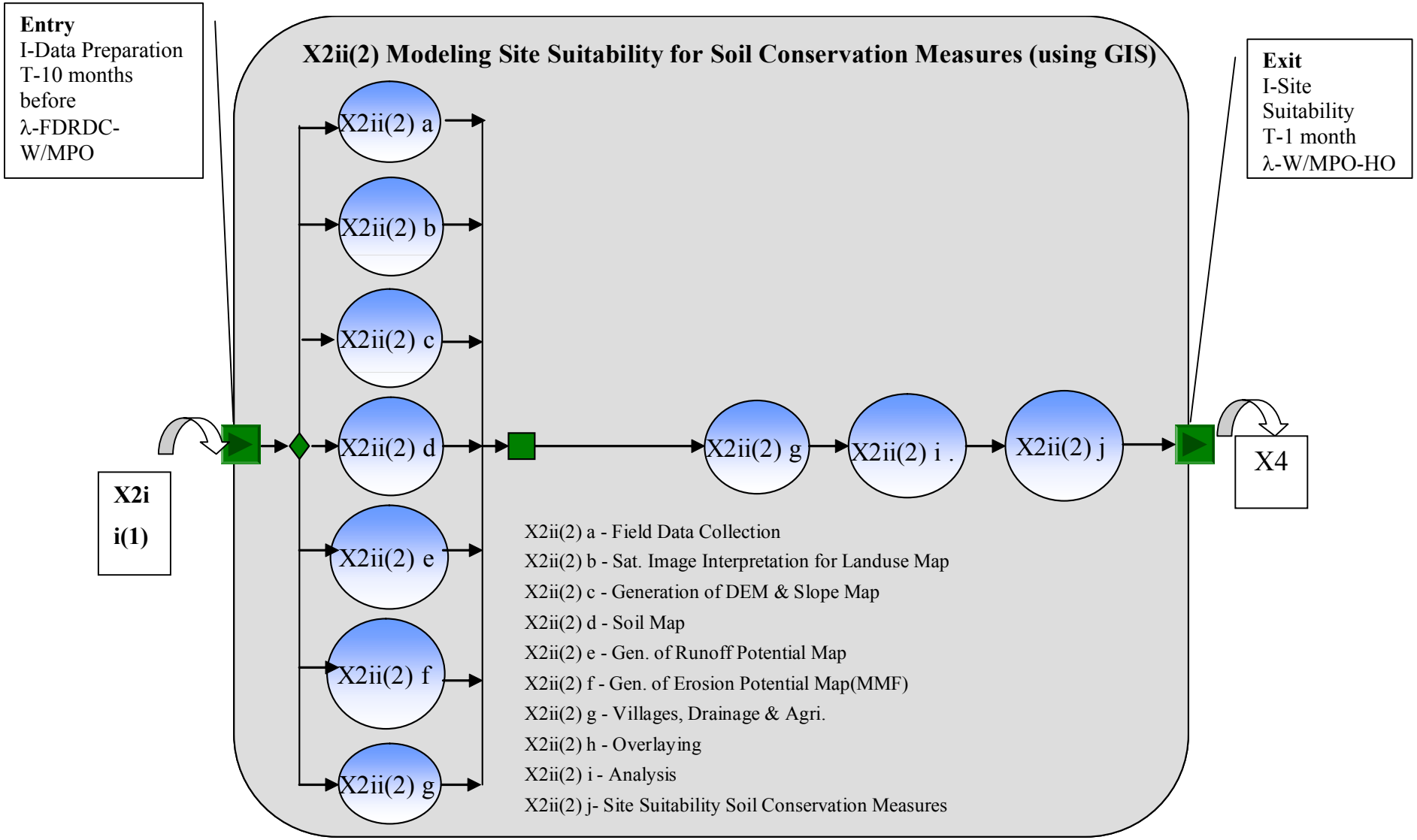


Figure 5.4.25- Modelling Site Suitability for Soil Conservation Measures(Models generated for BSP Protected Area Complex(existing) shown at Appendix VII)

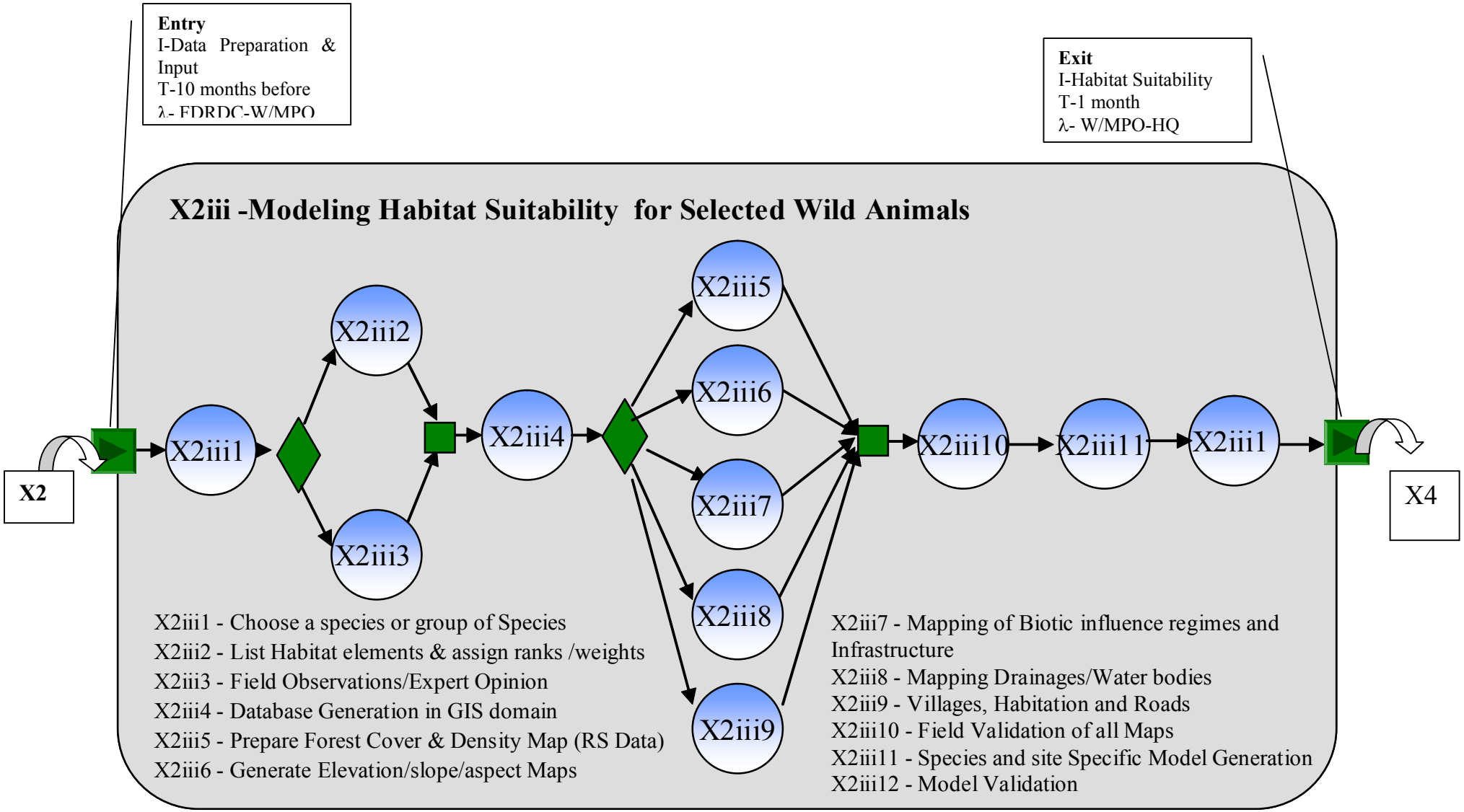


Figure 5.4.26 -Modeling Habitat Suitability for Selected Wild Animals

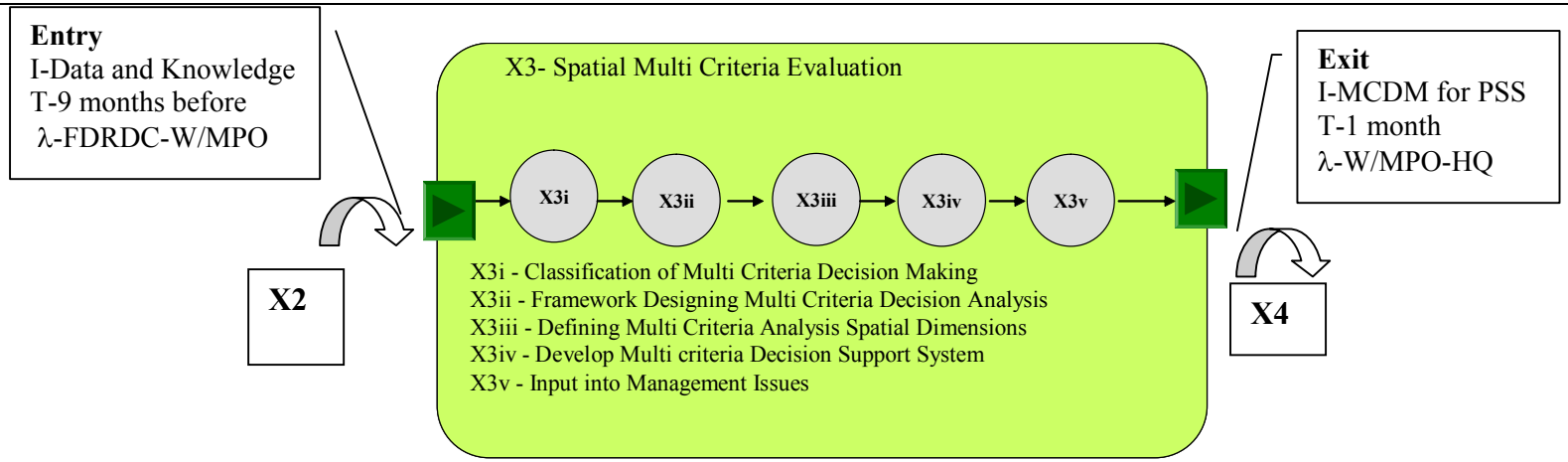


Figure 5.4.27- Spatial Multi Criteria Evaluation

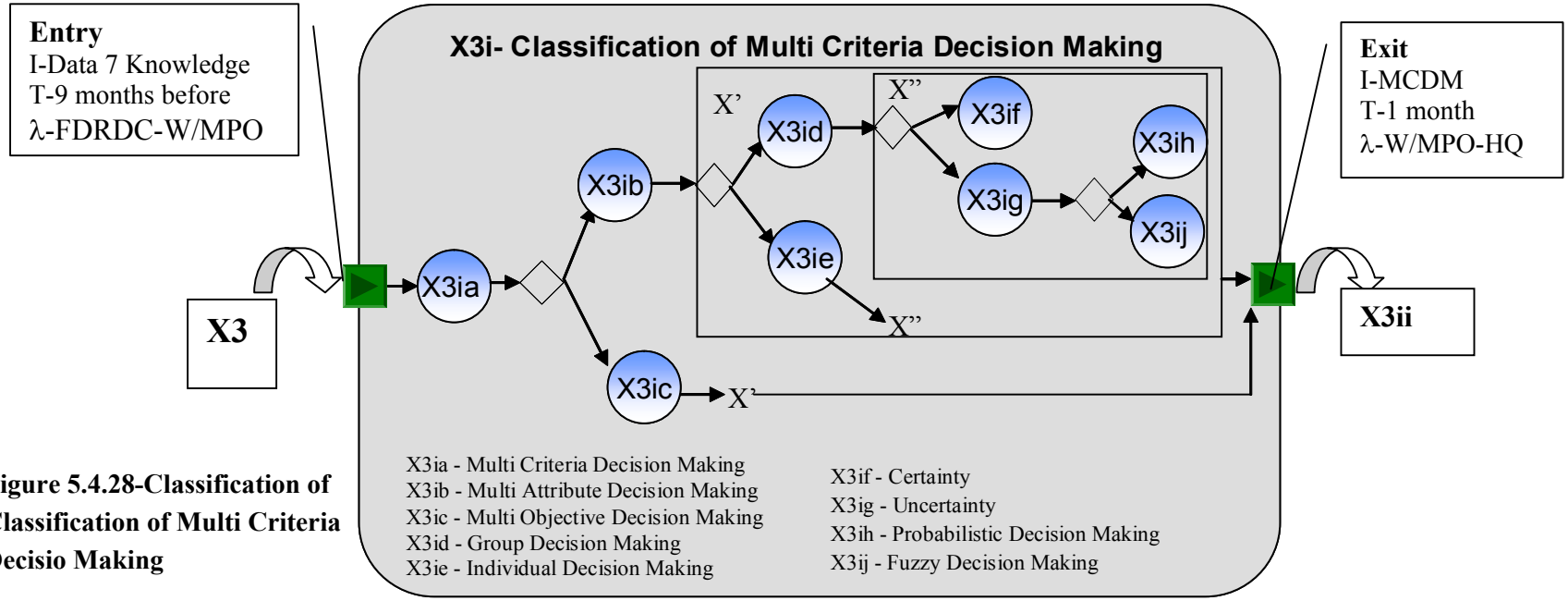


Figure 5.4.28-Classification of Classification of Multi Criteria Decisio Making

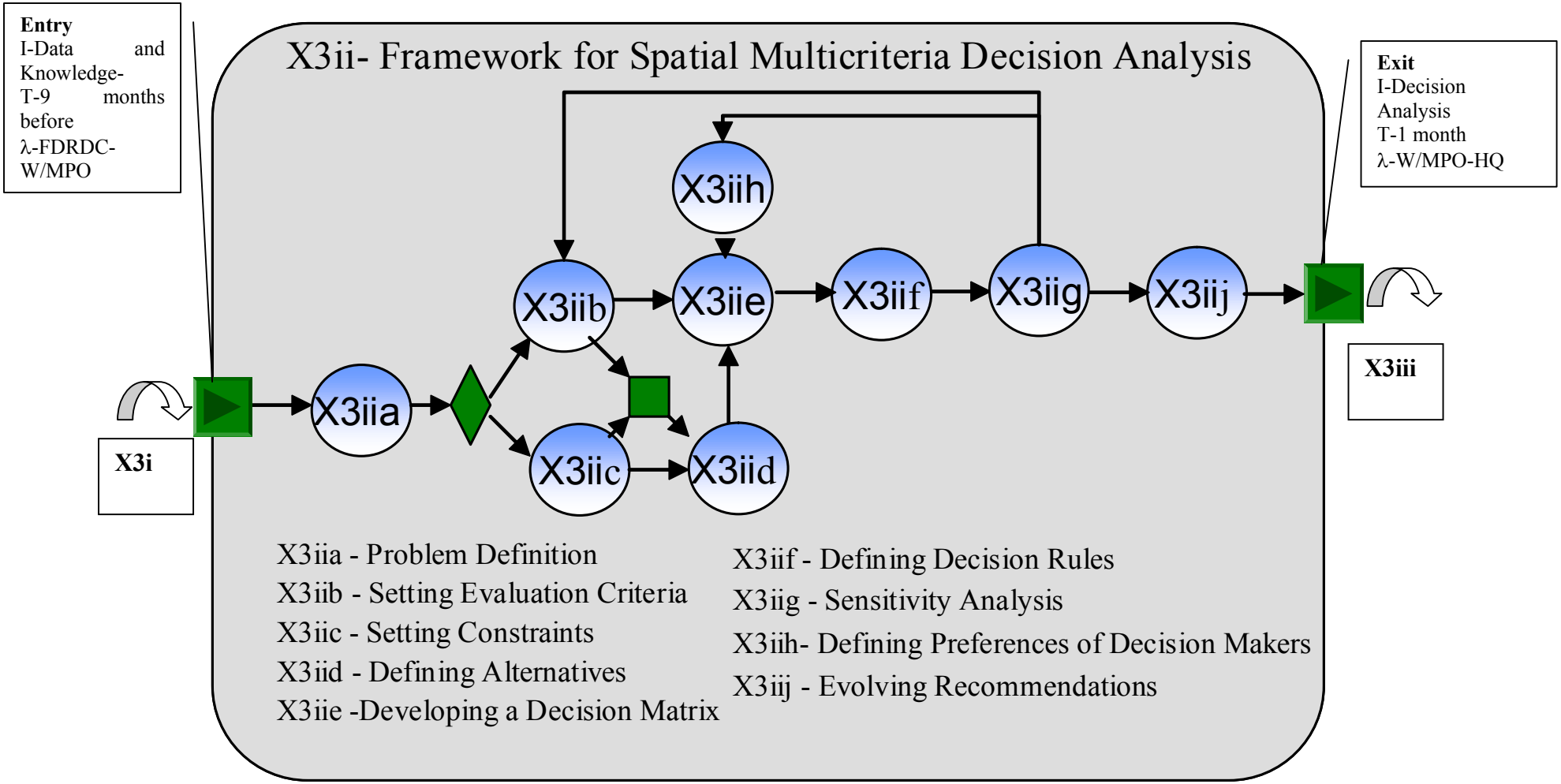


Figure 5.4.29- Framework for Spatial Multicriteria Decision Analysis

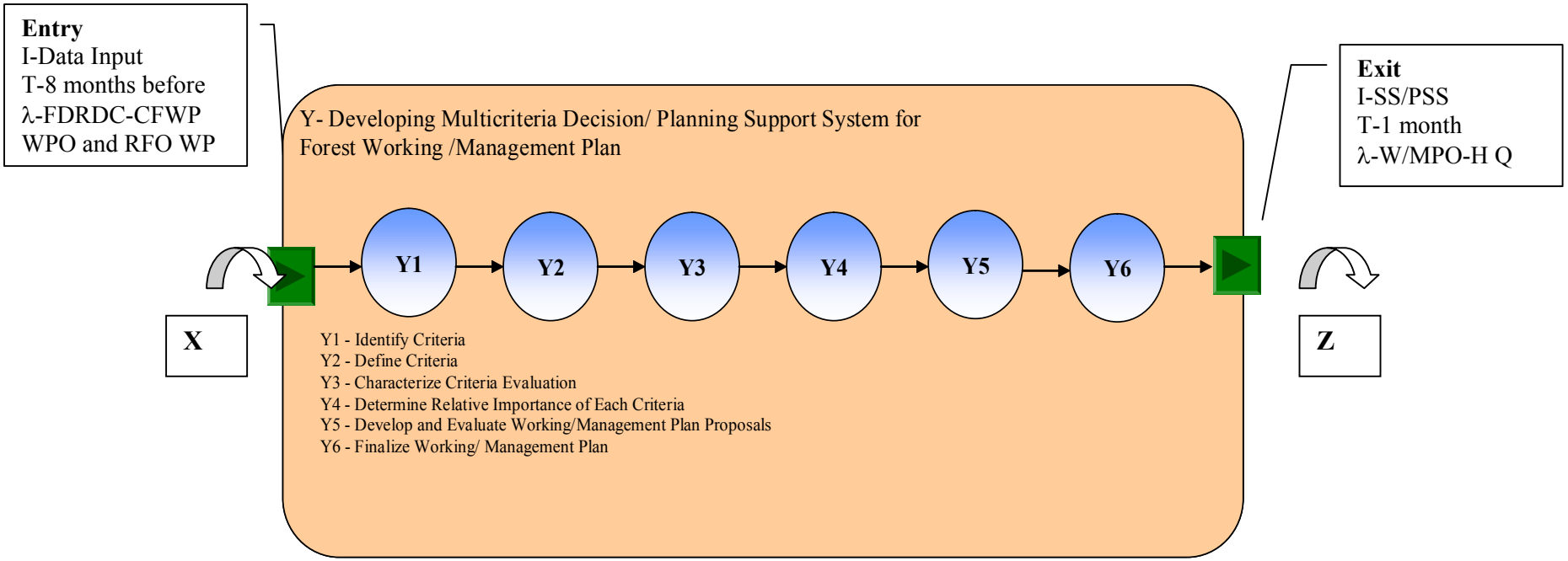


Figure 5.4.30. Developing Multicriteria Decision/ Planning Support System for Forest Working/ Management Plan

Table 5.4.1- Description of the Processes of Proposed Planning Process (GITOPPFS)

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
A- Preparatory Works	Involves organization of resources for plan preparation. (Figure 5.4.8)
A1- Identification of Area	The plan area is identified by Working Plan Organization in consultation with the Senior Territorial Officers and the consent from the Principal Chief Conservator of Forests. These are basically the areas where the working plan is due to expire in a period of two years.
A2-Organising Infrastructure	Organization of maps, survey equipment, vehicles and official logistics is done.
A3-Intercation with Territorial Division	It is the territorial divisions which will implement the plan hence interaction and inputs will be obtained from them
A4-Provision of Budget	Projecting the Budget forecast and making provision for sustained in flow of funds from the Government
A5- Deciding upon data standards	Since database is to be prepared in digital domain in GIS appropriate data standards will be chosen to maintain interoperability (Figure 5.4.9)
A5i-Meta Data Standards	The existing NRIS, 2001 and the NSDI meta data standards will be adopted.
A5ii- Forest Attributes Standards	The standards developed in this study will be used and the level of information generated will depend upon the scale and objective of the task being conducted.
A5iii- Structural Data Standards	The standards developed in this study will be used. These standards basically describe the structural attributes of the forests
A5iv Forest Density Classification	If remotely sensed data is used then it would be the crown density and if field based methods are used then it will be stem density as well. The level of

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
Data Standards	information will be scale specific. At larger scales field based survey techniques will be used. The standards developed will be used.
A5v Ground Cover data standards	The developed standards will be used. The data generation will be at large scale and using field based methods. This will help asses cover requirements of wild animals, assessment of regeneration and status of weed infestation
A5vi Tree Size Classification	The developed standards may be used and the Quadratic Mean Diameter can be assessed. This will be done to assess structure and composition of the forests in plan area
A5vii Activity based standards	The developed standards will be used. Since standards have already been specified for various attributes and scales, appropriate scale may be chosen as per objective of management
A5Viii-Indicative Standards for Ecological Attributes	Certain ecological attributes simple to map and of prime importance and which do not fall under the Champion and Seths's Classification will be mapped here. The choice will depend upon the manager. Mapping of ecological attributes is extremely essential for wildlife management.
A5ix Administrative Boundaries /Units Standards	The existing standards prescribed in the NNRMS, 2005 Data Standards will be used. This is to maintain transformation compatibility.(Appendix VI, Table 12)
A5x Territorial /Legal and Management Units Standards	These will be as specified in the newly developed standards.
A5xi Thematic & Cartographic Mapping Standards	The consultant, trained staff and the Surveyors of the department will be made aware of these standards to maintain the quality.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
A5xii Content Standards for allied Resources	The existing NNRMS, 2005 standards will be used for, soil, geology, hydro geomorphology, water resources maps etc Though all these are not being generated presently they are required to be generated for use in Ecological Status Models
A5xiii Standards for any other specific Theme	This is to address any spatial theme which the manager intends to map and has not been identified in the developed standards. These will be the themes which are localized and specific to the area
A5xiv Choice of Appropriate Data Standards	From amongst all the above standards appropriate standards will be chosen so that overall uniformity is maintained all over the state or Union Territory
A6-Base Work for Georelational data base	All the existing data-spatial and non-spatial will be examined and various parameters on which data is supposed to be collected and maintained will be decided. A Geo-Relational Database will ensure data security, easy updating, and concurrent sharing of data, optimum use of computational facility, efficient storage and retrieval, concurrent access to data and enhance planning efficiency. Maintenance of such a database will facilitate access of spatial and non spatial data by stakeholders. (Figure 5.4.10)
A6i-Entity Relationship Diagram	It is the conceptual layout of all the entities and their relationships.
A6ii-Conceptual Schema Specification	It is the description of the application area. It describes those things, which are intended to be modeled in the database. It will include list of the types of entity which are of interest, a list of relations between these entities and a list if integrity constraints which apply to these relation (Frost, 1984).

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
A6iii-Data Dictionary with Format & Package Specifications	Data Dictionary is the description of all data items, which are to be processed in the system. It allows the designer to record properties of data items namely- synonyms, definitions, type (e.g. string, integer, real), format, access constraints, relationship to other data items, source and usage. The next step in the specification of the end user interface is to determine how groups of data items should be packaged for input to and output from the system (Frost, 1984).
A6iv-Privacy, Integrity, Backup and Recovery Specification	The design of the privacy sub system involves decisions related to how users/uses are to be identified, how access rights are stored and what actions should be taken when an attempt for unauthorized access is made. Integrity is the property as to which extent the database is an accurate model of part of the universe. Back up means maintaining a copy of the whole database, which can be retrieved if something goes wrong with the original data. The Recovery Sub System involves decision concerning how often dumps should be taken, how big the locked units and transactions should be and what information should be recorded on the journal file (Frost, 1984) Note: Such Geo-relational Databases will be required to be maintained at all Working Plan Offices and these will have linkages with the territorial forest divisions. Whenever any intermittent planning is required such as preparing tourism plans, Fire Management Plans, Eco development Plans, Joint

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
	Forest Management Plans, Annual Plan of Operations, etc. the stored data may be accessed and plans can be prepared
A6v- Application Program Specification	The actual generation of input/output packages is carried out by the programs commonly known as application programs
A6vi-Spatial Data Exchange Interface	This will ensure interface of Geographical Data with robust database software e.g. ARC SDE
A7- Hiring of Technology Consultants	Since Geoinformation technology oriented planning process is to be adopted, external consultants will be hired to advice and build in- house capacity
A8-Technology Oriented Training for Staff	The Working Plan and the Territorial Staff both will be given short term hands on training. A few of them will be trained for longer duration based on existing level of competence and depending upon situation. (Figure 5.4.11)
A8i-Assess Training Needs	Training Needs Assessment will be based on prescriptions in the Geoinformation Technology Oriented Process
A8ii- Identify Personnel to be trained	Inventory of technical in- house experts at all levels and external experts will be prepared.
A8iii-Identify Institutions /Resource Persons	Inventory preparation and assessment of institutions within the district, state and country or abroad is essential. This will also include mobilization of resources for training inputs.
A8iv-Develop Training Content	Training Content will be carefully prepared and will be intensive. The task may be accorded to the faculty of State Forestry Training Institutions/national institutions
A8v-Mobilize Resources	This means mobilization of resources for successful conduction of training. External funding wherever necessary may be mobilized

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
A8vi-Conduct Trainings	The frontline staff involved will be trained in State Forestry Training Schools and middle level executives at National Forestry institutes and specialized trainings at IIRS and FSI
A8vii-On Job Field and Lab Application	This will be done by mobile training units which will be established for each circle comprising of highly trained fieldsman and professionals.
A8viii-Award Incentives	A trained personnel deserves to be rewarded appropriately, hence an incentive and award scheme is required to be made operational
A9-Quality and Feasibility Test	There will be a quality check as regards training inputs and performance in training. Feasibility of achieving success in various tasks using technology will be also tested during trainings, based on success and failure case studies
B-Preliminary Working Plan Report-Part I	The current process has been reinforced using processes B5-B9 for quality enhancement. The map generation task here pertains to digitization of existing maps of the previous plan. The new maps will be generated for the final new plan. This is to save time and make use of time available (Figure 5.4.12).
B5-Procurement/Use of Personal Digital Assistant for Mobile GIS	Personal Digital Assistants, help in collection of real-time data in the field itself. The map of the area being surveyed can be accessed and phenomenon under investigation can be marked. It is as good as taking the office or lab to the field as far as mapping is concerned.
B6-Conversion of existing Spatial Data to chosen data standards in Digital Domain	First all the themes for which maps are to be generated will be identified. Then existing database will be examined. All the relevant existing analogue (hard copy) maps will be converted to digital domain using the chosen standards. If digital maps exist they will be transformed to desired standards. New maps will be prepared if required. (Figure 5.4.13)

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
B6i Choose Appropriate Data Standard	This will be done choosing from amongst the developed or existing standards
B6ii Conversion of existing digital data	Presently in around 80% cases of plan preparation analogue maps are used. It is proposed to change this trend. Conversion of digital maps pertaining to site quality, stock maps, Working circle, Age classes, Forest Types, density and other field maps to desired standard.
B6iii Quality Control/Check	Quality related to accuracy will be ensured
B6iv Finalized Maps	Finalize and build linkages with Geo RDBMS
B6v Scanning of Analogue Maps	All the maps mentioned in B6ii will be generated. Apart from these maps pertaining to drainage, DEM, Soil, Geology, water resources, habitations, communication network, Regeneration, plantations etc.
B6vi Georeferencing and Projection	Coordinates will be assigned and appropriate projection will be chosen (e.g UTM WGS 84, Polyconic Everest or Geographic Lat Long) It is advisable to generate data in geographic lat long so that, later on, it can be brought to a desired projection
B6vii Digitization	The scanned maps can be kept in the background in any of the GIS software package so that on screen digitization of desired themes can be done
B6viii Editing	This pertains to getting rid of digitization errors.
B6ix Attribute Assignment	Assigning labels of a particular theme. For example, in case of a vegetation map the polygons are required to be labeled or a vector layer of road has to be labeled according to the class of road.
B6x Quality Control/Check	Positional accuracy and errors will be handled.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
B6xi Finalize Maps	Finalized maps will form a part of the Geo Relational Database
B6xii Develop linkage with Geo-RDBMS Interface	This will enable access to spatial database from any terminal in the organization
B7- Quality Control/Check	A strict Quality check for cartographic and classification accuracy will be done
B1-Preliminary Consultation	The Working Plan Conservator will seek notes on current working plan from the Territorial Conservator of Forests and Divisional Forest Officer six months in advance and asses the performance of the existing plan.
B2 - Inspection of Forests	All the territorial units will be examined on ground and the general condition of forest will e inspected
B8-Prepare profiles if not existing	Profiles of forests under various management prescriptions are a very good indicator of what a particular management intervention has resulted into. These profiles are not being maintained presently. With the use of digital cameras this will be very much possible. If not, profiles may be hand- drawn. The comparison of previous plan profiles and the current one can be a good indicator of performance of a particular management system. (Figure 5.4.14)
B8i Stratification of Area (Veg. Type, Terrain Disturbance &Working Circle)	The profiles will differ based on strata parameters identified. Therefore horizontal stratification of the area needs to be done.
B8ii Mark GPS Locations using PDAs	Using PDAS the area for which the profile has been drawn or photographed can be mapped
B8iii Draw Profiles on Hard copies in situ	Foresters are trained in profile drawing, thus these drawings will be made on hard copies and then converted to digital format OR Digital Cameras can be used to photograph profile

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
B8iv Quality Check	More than one profile will be drawn for particular strata and few of the good ones will be retained in the database
B8v-Conversion to Digital Domain	The profiles may then be converted to digital domain using software packages available and then they can be linked to the GIS database
B8vi- Quality Check	Compatibility with chosen data standards will be ensured and positional accuracy check will be carried out
B8vii - Establish Connectivity with Database	The generated profiles will be made interactive with the database
B8viii - Compare with previous reference and record changes	The profiles developed currently will be compared to those of the previous plans. Since this practice is not followed presently the first round of profiles may be developed.
B9-Quality Control/Check	The entire database will be subjected to a quality check
B3-Finalisation PWPR Part I	The draft PWPR I is deliberated upon in a meeting chaired by the PCCF
B4-Approval	The Committee so appointed by the Government approves the First PWPR
C. Descriptive Field Work	This basically pertains to documentation related to compartments, which are the basic management units. The process presently being followed has been reinforced using processes C5 to C8 mentioned below. The processes C1 to C3 will run parallel. (Figure 5.4.15)
C1 Examination of Territorial Units	The plan area will be inspected and area, blocks, compartments and sub compartments boundaries will be ascertained. This may be done using PDAs. Rights and Concessions to villages will be ascertained. In some cases sub compartments may be created to facilitate management.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
C2 Collection of Preliminary Data	Fieldwork is carried out to collect data pertaining to boundaries, aspects, slopes, drainage, rock, soil and humus, general composition of the over wood, specie, density, undergrowth-climbers weeds, grasses, regeneration. Working Circles and Periodic Block and areas needing special treatment. Extensive use of GPS and PDAs can be done here.
C3 Compilation of Comp. Histories and Descriptions	The compartment Histories of the past for each compartment will be compiled.
C5-Compilation of all data in Digital Domain	The data collected will be converted to digital domain and digital maps may be prepared in GIS. Presently the data is generated in analogue form. A change over to digital is required. The scales adopted will be as per the developed standards.
C6-Choose Appropriate Data Standard	The newly developed data standards will be referred to.
C7-Detailed Compartment Maps with Resource Info	This map generation will be done at 1:4000 or 1: 2000 depending upon targeted information.(Figure 5.4.16)
C7i-Choosing Appropriate Data Standard	C7i and C7ii will be carried out parallel
C7ii- Identifying Compartment Descriptor Attributes	The compartment history forms will be used to select descriptor attributes as specified in present Working Plan Code. In case of management plans the compartment description form in the management planning guidelines will be used.
C7iii-Mapping in the Field with PDAs/GPS	The mapping of compartment level attributes can be done using PDAs and GPS. Extensive Field work will be carried out to record all the attribute information mentioned earlier
C7iv-Data Entry into Geo-RDBMS	Data compilation will be done in the database

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
C7v-Compilation of Compartment Description	This will be necessarily done in digital domain and the analogue copies will be kept as original record.
C8- Quality Control/Check	Accuracy, representation and conversion parameters will be ascertained.
C4-Finalize Compartment Descriptions	The compartment descriptions and spatial data pertaining to compartments will be finalized and stored in the Geo-Relational Data base.
D. Survey & Assessment Of Natural Resources (Spatial & Non-Spatial)	Presently, in most of the cases the data collection, compilation and representation is done manually. Now it is recommended that it be done in digital domain entirely. This entire process has been reinforced using steps D10 to D13. Detailed survey for mapping the attributes will be carried out using PDAs and GPS as per standards developed. All resource survey D1 to D9 will be done simultaneously. The procedure will be the same as being done presently but spatial and non-spatial data will be stored digitally under standards specified for the task. The processes D4-D9 are consecutive processes. (Figure 5.4.17)
D10 Mapping/ Recording Digitally PDAs/GPS	This data will be collected along with collection of data for compartment descriptions to save time and effort.
D1-NTFP & Bamboo/Rattan Survey	Large Scale survey will be done to map them.
D2-Plantation Survey	Since most of the middle and old aged plantations are not distinctly identifiable on satellite images, field surveys are recommended.
D5-Regeneration Survey	This is one of the most important processes therefore regeneration status will be assessed through exhaustive field sampling and using PDAs
D6-Wildlife Survey	This will be done using direct and indirect evidences. The direct ones include census through direct sighting comparative occurrence indices. The indirect ones consist of presence absence indices, densities arrived at through indirect evidences.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
D8- Socio-Economic Survey	Data will be collected on various socio economic parameters. Especially the one which are not covered by population census data and of direct relevance to forestry.
D9-Soil Survey	The stem analysis will be done for site quality assessments. But for soil maps the local soil department data will be used if the requirement is large scale. Otherwise, National Bureau of Soil Sciences and Land Use Planning (NBSS-LUP) will be used.
D3-Enumeration for Crop Composition	These enumerations will continue to be done as per the sampling technique and design used by the Working Plan Divisions. The processes D3, D4 and D7 are consecutive processes
D4-Growth and Yield Statistics	All the activities will be conducted through field based surveys but results will be compiled digitally. Digital Maps will be the prepared in GIS as specified in E (existing Process).
D7-Stock Survey	The area will be sampled at grid of 600 x 600 mts and plots of 60x 60 m will be marked at grid crossing. Total enumeration will be done in these plots. In the lower left corner of the plot regeneration data will be recorded
D11- Compilation in Digital Domain	This will be done as per data standards specified.
D12-Quality Control/Check	Quality Checks will be done as per laid down procedures.
D13-Geo-RDBMS Analysis	Entry and analysis for area statistics will be done in the data base
E. Preparation Of Maps By WPO/MPO	Spatial Data Generation and Processing will be done in GIS Domain. Presently, in 80 % cases this task is done manually and analogue maps are prepared. This trend needs to be reversed by generating data in digital domain. (Figure 5.4.18)

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
E1-Generation/ Conversion of Maps e1-12 in Digital Domain	All resource maps are needed to be generated in digital domain. The maps referred to in the original process **e1-e12** (as shown in the existing process, will all be generated in the proposed process) and other maps required in addition will be generated.
E2-Search Existing Data	Existing data inventory will be prepared and status will be ascertained for conversion to digital
E3- Check existing Data for compatibility and standards	The checking pertains to data standards followed and required to be followed both.
E4-Indent for Maps from SOI and maps of allied resources	Inventories of what exists and what is required will be prepared and indents will be placed with SOI. This needs to be done keeping in view the new map policy
E5-Indent for Remotely Sensed Data	This indent will be placed with the National Remote Sensing Agency, a premier and the only agency dealing in remotely sensed data products. The objective of work, season and spatial resolution should be kept in mind while indenting the data. The opinion of trained expert be sought here.
E6-Conversion to Digital Domain, if analogue	This needs to be done following the existing and developed standards documented.
E7-Interpretation for Resource Maps	The satellite data will be interpreted to generate resource maps, either digitally or visually. In case of visual conversion will be done into digital form. (Figure 5.4.19)
E7i Uploading Satellite Data in DIP System	Uploading and data preparation works pertaining to georeferencing, resampling and projection will be done.
E7ii Field Reconnaissance	Field work will be carried out to collect info for interpretation
E7iii Preparation of Interpretation Key	Interpretation key will be prepared using all elements of interpretation

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
E7iv Unsupervised Classification	This will be done in Digital Image Processing System. The method is well laid out and the software may be referred along with expert assistance.
E7v Supervised Classification	Training sets will be given to train the computer to recognize signature for a particular class intended to be classified. The interpreter exercises control over classification. Expert help needs to be taken here.
E7vi Ground Validation	Classified output will be verified on ground
E7vii Quality Check /Accuracy Assessment	Accuracy Assessments will be done
E7viii Finally Interpreted Forest cover /Density Maps	The forest type and density maps depicting various categories as specified in data standards will be generated.
E8-Field Assessments/ validation	Ground validation of all maps will be done to confirm ground reality.
E9-Quality Control/Check	Accuracy estimation in case of satellite data interpretation will be done.
E10-Prepare Change Detection Maps	Satellite data provides the facility of multi-date coverage. Hence depending upon objective, maps for change detection analysis may also be generated to provide insight for management. (Figure 5.4.20)
E10i- Choose and Procure Multi-date RS Data	This will depend upon what change is to be mapped.
E10ii- Preparation Interpretation Key/Classification Scheme	It needs to be ensured that the classification scheme is the same for the multi- date data.
E10iii- Interpretation Of Multi-date RS data	Interpretation/ classification will be done using digital or visual interpretation technique. The output of visual interpretation will be digitized
E10iv-Ground Validation	Ground validation will be done using GPS to ascertain correctness.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
E10v-Accuracy Assessment /Quality Check	Quality checks will be done at various levels specified in quality organization.
E10vi-Finalize Multi-date Interpreted Maps	Mid course corrections will be incorporate.
E10vii-Detect Change and Analyze	Change table generated by the software package will be analyzed
E11-Quality Control/Check	Accuracy Assessment and ground validation will be done.
E12- Develop Interface with Georelational Database	The data will be linked with the Georelational database
U-Generation/ Compilation Of Other Non Spatial Ancillary Data	All the secondary and ancillary data pertaining to resources, infrastructure, socio-economy will be entered into the Geo-Relational Database (Figure 5.4.21)
U1-Decide upon Data Standards	These will be followed for data collection and map generation
U2-Data Collection	Computer compatible formats will be used for data collection along with PDAs/GPS
U3-Preparation of various Inventories	Inventories related to forestry and socioeconomic resources will be prepared
U4-Compilation of Area Statements	Area statements will be generated in MS WORD/EXCEL
U5-Ancillary Data Compilation	It will be compiled in a similar manner as elaborated above.
U6-Quality Control/Check	Authenticity/ positional/ factual/ data accuracy checks
U7-Entry in Geo-RDBMS	This will done by computer technicians.
V-Quality Control/Check	Quality checks will be done as per the quality manual at various levels of organization.
W-Entry In/Interface With Georelational Database	The entire database generated for the plan is required to be a part of the Geo-RDBMS Frame work

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
X-Integration And Analysis	Once all the data is generated as per standards in the digital domain, analysis oriented integration may be done to derive more analytical meaning out of the data for better resource management. (Figure 5.4.22)
X1-Integration in GIS Domain	This will be done using the overlays option in GIS.
X2-Developing Ecological Status Models	Presently all the spatial data and non-spatial data generated are compiled into the Working/ Management Plan. Instead, if analysis oriented integration is carried out it will be more useful for management. Site suitability for soil conservation measures, species-specific wildlife habitat suitableness, areas suitable for plantation/ felling, fire risk zonation are some of the day-to-day issues in Forest Management. The Ecological Status in terms of these may be ascertained by generating such models. Theses models can be developed in GIS Domain. (Figure 5.4.23)
X2i Identify/Prioritize Area Specific Themes for ESMs	This involves decision on what to model and prioritization of themes and areas as well
X2ii (1,2) Modeling Site Suitability for Soil Conservation Measures	All the maps generated may be used to generate soil erosion map. Consideration of additional parameters will help in identifying areas suitable for a specific soil conservation measure. (Figure 5.4.24, 5.4.25 and Appendix VII)
X2iii Modeling Habitat Suitability for Selected Wild Animals	If the habitat parameters for a species are known, using all the digital spatial data, habitat modeling can be done to ascertain areas of varying degrees of suitability. Detailed methodology is as shown in (Figure 5.4.26)
X2iv Modeling Fire Risk and Hazards	It is possible to generate a fire risk map to plan for fire management in advance and maintain preparedness.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
X2v Modeling Site Suitability for Plantations	Depending upon which type of plantation is to be raised and by ascertaining the site requirements for undertaking such a plantation, areas suitable for plantations may be identified in GIS Domain
X2vi Modeling of Suitability for a particular Management Intervention	Any issue for which spatial attributes exist in GIS domain and if parameters related to the issue in question are documented, models may be developed to plan any management intervention
X2vii Modeling of Disturbance Regimes	Biotic disturbances of various natures can be assessed based on the inputs available. Biotic disturbances from various sources can be mapped and an accumulated biotic regimes model/map may be generated.
X2viii Validation of Models	All such models developed should be validated an tested in ground for reliability and accuracy before applying them to device management strategy.
X2ix Final Maps /Visualization/ Customization	Proper visualizations and customizations can be developed for better perception of managers and operationalization, using software packages like Visual Basic
X3-Spatial Multi Criteria Evaluation	"It is a process that combines and transforms spatial and aspatial data (input) into a resultant decision (output) The two important considerations are (i) the GIS capabilities related to data acquisition, storage, retrieval and manipulation and analysis.(ii) the MCDM capabilities for aggregating the geographical data and the decision makers preferences into one-dimensional values of alternative decision" (Carver, 1991; Jankowski, 1995). Based on all the data generated and depending upon emergent issues in forest management "Spatial Multi

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
	Criteria Evaluation" can be done. Issues like deciding upon a particular management intervention can be analyzed. (Figure 5.4.27)
X3i Classification of Multi Criteria Decision Making	MCDM can be classified based on major components of multicriteria decision analysis The three dichotomies are (i) Multi Objective versus Multi Attribute (ii) individual versus group decision problems and (iii) decisions under certainty and uncertainty (Malczewski, 1999) (Figure 5.4.28)
X3ia-Multi Criteria Decision Making	All the attribute data necessary will be organized for inputs.
X3ib-Multi Attribute Decision Making	Requires that choices be made amongst alternatives described by attributes. Attributes are properties of elements of a real world system (e.g. geographic system
X3ic-Multi Objective Decision Making	It recognizes that attributes of alternatives are often just means to higher ends, that is the decision makers objectives.
X3id-Group Decision Making	Most of the planning and management decisions in the forest department are taken as a group
X3ie-Individual Decision Making	As regards site specific application of prescription laid down in the working plan the decisions may be individual
X3if-Certainty	This depends upon the amount of information (knowledge) about the decision situation that is available to the decision makers and analysts. If the decision maker has perfect knowledge of the decision environment, then it is a decision under certainty OR
X3ig-Uncertainty	Decision under Uncertainty
X3ih-Probabilistic	Probabilistic decision has a stochastic character. They are handled by probability theory and statistics. The outcome is either true or false.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
X3ij Fuzzy	In situation where the event itself is ambiguous, the outcome may be given by a quantity other than true (one) or false (zero). Ambiguity can be structured as the degree to which an event more or less belongs to a class. (Malczewski, 1999)
X3ii ***Framework for Spatial Multi Criteria Decision Analysis***	It consists of three phases (i) Intelligent Phase in GIS (II) Design Phase in MCDM and (iii) Choice Phase in MCDM and GIS (Malczewski, 1999) (Figure 5.4.29)
X3iia Problem Definition	A decision is to be taken on spatial problem. The gap between the desired state and the one existing a decision maker expects is called as a problem. e.g. Construction of a road through a ecologically sensitive forested area. The decision to be taken is whether the road is to be allowed/ If yes, then how would it be the least damaging.
X3iib Setting Evaluation Criteria	1. For this a comprehensive objective/s which will address all concerns is set. e.g. The road should be the least damaging and disturbing. 2. Then measures/ attributes for achieving these objectives will be considered. e.g. Potential Wildlife Habitats of endangered species, water bodies, salt licks, breeding sites (all these should be there on spatial scales.
X3iic Setting Constraints	This basically consists of what cannot be allowed Road passing through potential habitats Passing through or close to water bodies At least 1 km away from breeding sites Not passing along salt lick areas.
X3iid Defining Alternatives	These are alternative courses of action amongst which the decision maker has to choose. Diversion of the road so that it does not pass through the ecologically sensitive area.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
	Fly-over Use GIS to come out with the least disturbing road alignment
X3iie Developing a Decision Matrix	A decision matrix will be developed including constraints and alternatives.
X3iif Defining Decision Rules	The map layers pertaining to the criteria and judgments are integrated to provide overall assessment of alternatives. Methods like simple additive weighing, value/utility function method etc. may be used
X3iig Sensitivity Analysis	It is an exploratory process by which the decision makers achieve a deeper understanding of the problem. It helps to understand how decision elements interact while the most preferred alternative is chosen and what are the sources of disagreement among decision makers.
X3iih Defining Preferences of Decision Makers	This involves defining criteria of different importance to decision makers. Evaluation of each criteria is done by assigning weights. A number of procedures related to criteria weighing based on the judgments of decision maker are as follows- ranking, rating, pairwise comparison and trade off analysis
X3iij Evolving Recommendations	The end result is the recommendation as to how the road would finally be constructed or otherwise.
X3iii Defining Multi Criteria Analysis Spatial Dimensions	Geographic Information System has become an important tool for decision support in problems with spatial dimensions. It involves an integration of geographic information system (GIS) and other analytical tools for spatial decision making.
X3iv Develop Multicriteria Decision Support System	Conceptual Framework- The ultimate goal is to determine what if anything should be done to the area of land in order to provide the greatest utility to the Government (owner). This involves identifying all the physical, social, economic and environmental criteria relating to a particular site. Planners and Managers

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
	can work with stakeholders to develop sketches, or potential scenarios for development or management interventions. These sketches may include physical plans economic or social policies to give effect to a particular management intervention. (Macdonald and Faber, 1999)
X3v Input into Management Issues	Thus management interventions needed may be planned.
X4 - Develop Interface with Geo-RDBMS	All the database generated for plans will be stored in the Geo relational Database. The GIS will bear an interface with the database foe accessing spatial data
X5 - Organize Inputs for DSS/PSS	A systematic list of inputs to DSS and various information attributes will be prepared.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
Y-Developing A Decision / Planning Support System For Forest Working /Management Plan	Planning Support Systems are very useful for planning and management purpose. PSS has been defined as a "fully integrated, flexible, and "user- friendly" system that allows the user to (1) select the appropriate analysis or forecasting tool which helps users identify the most appropriate methodologies and tools for doing a particular task (2) links the appropriate analytic or projection model to the required local, regional or national information stored or accessed through the PSS (3) run the appropriate models to determine the implications and alternative policy choices and assumptions for present and future and(4) instantaneously view the results graphically in the form of Charts, maps and interactive video displays". (Klosterman, 2001) Such Forestry Planning and Management System may be developed as planning support. This may be developed using the data generated for the Working/Management Plan. When ever decisions are to be taken related to various issues, the PSS can be used .The PSS would be an add on system to the Plan (Figure 5.4.30)
Z-System Validation And Performance Evaluation	Once a system is developed it can be tested for its validity and tested in the real world situations.
F-Preliminary Working Plan Part II	The PWPR II is an exhaustive document, which is as good as the final plan.
G-Seeking Comments And Modification	This will be done through presentations and demonstrations of the plan through the database generated. The potential of the Planning Support System will also be made to the State Government.
H-Draft Working/ Management Plan	This is the Final Draft, which will be sent to the Government of India. WPO will make extensive interactive deliberations.

Process & Sub-processes at various levels of abstraction	Description of the processes in the proposed process
I-Government Sanction	Government Sanction will be obtained as per rules
J-Final Working Plan	The Final Plan will be sent to the Territorial Divisions for implementation.

5.4.4 Optimization of Planning Process and Operations Management

So as to achieve the objective of implementation of the Geoinformation technology oriented planning process, the following two have been adopted-

a. Geoinformation Technology Oriented Organizational Frame work and
b. Optimization of Operations Management

a. Geoinformation Technology Oriented Organizational Frame work

There exists a well-organized infrastructure for forestry planning administration and management in the country. Since the central and the state governments both are involved in planning, the Geoinformation technology oriented planning process has been proposed at both levels. At the Government of India level, the Forest Survey of India (FSI) manages forestry database at the National Forest Database Management Center, at the head quarter in Dehradun. This data pertains to the mapping of the national forest cover on a biannual basis. A National Forestry Database Repository (NFDR) is proposed at the national level, which will maintain the forestry database pertaining to data generated by the states and UTs. It will work in close interaction with the State Forestry Database Repository managed by the state. Apart from this it is proposed that a National Technology Application Development Division be established at the Ministry of Environment and Forest, Government of India New Delhi. This will serve as a link between the ministry officials and the NFDR and the State Technology and Applications Divisions.

At the state level modifications in the structure have been proposed at two levels. Establishment of the Forestry Database Research and Development Center (FDRDC) at the Deputy Conservator of Forest (a level at which actual plans are prepared) and the State Technology Application and Development Division and the

State Forestry Database Repository at the level of the Principal Chief Conservator of Forests in state head quarters (a level at which the scrutiny and initial approval of plans takes place). These will work in coordination with their national counterparts.

These modifications proposed, in the national and state forestry planning framework will ensure proper implementation of the proposed Geoinformation technology oriented planning process. These changes have been proposed so as to monitor technology incorporation in the planning process, ascertain areas of weaknesses and providing for strict quality control of the proposed planning process.

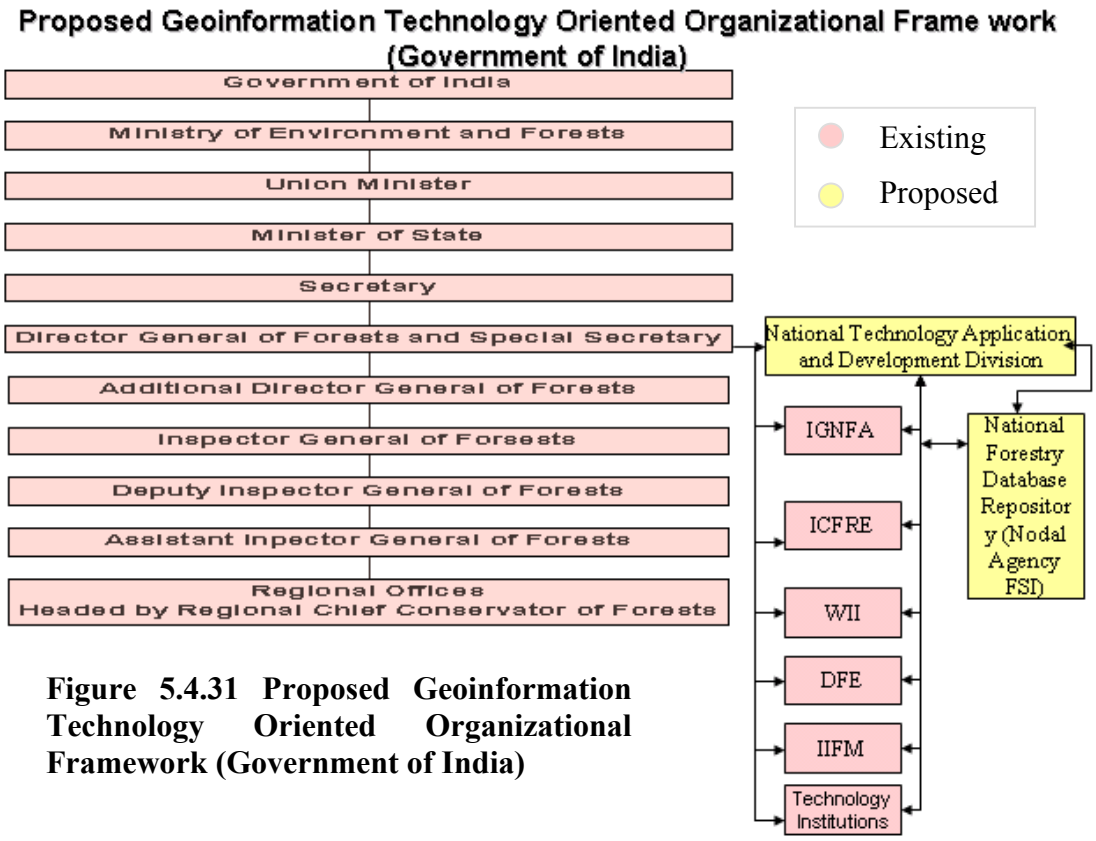


Figure 5.4.31 Proposed Geoinformation Technology Oriented Organizational Framework (Government of India)

IGNFA - Indira Gandhi National Forest Academy

ICFRE - Indian Council of Forestry Research and Education

WII - Wildlife Institute of India

DFE - Directorate of Forest Education

IIFM - Indian Institute of Forest Management

FSI - Forest Survey of India

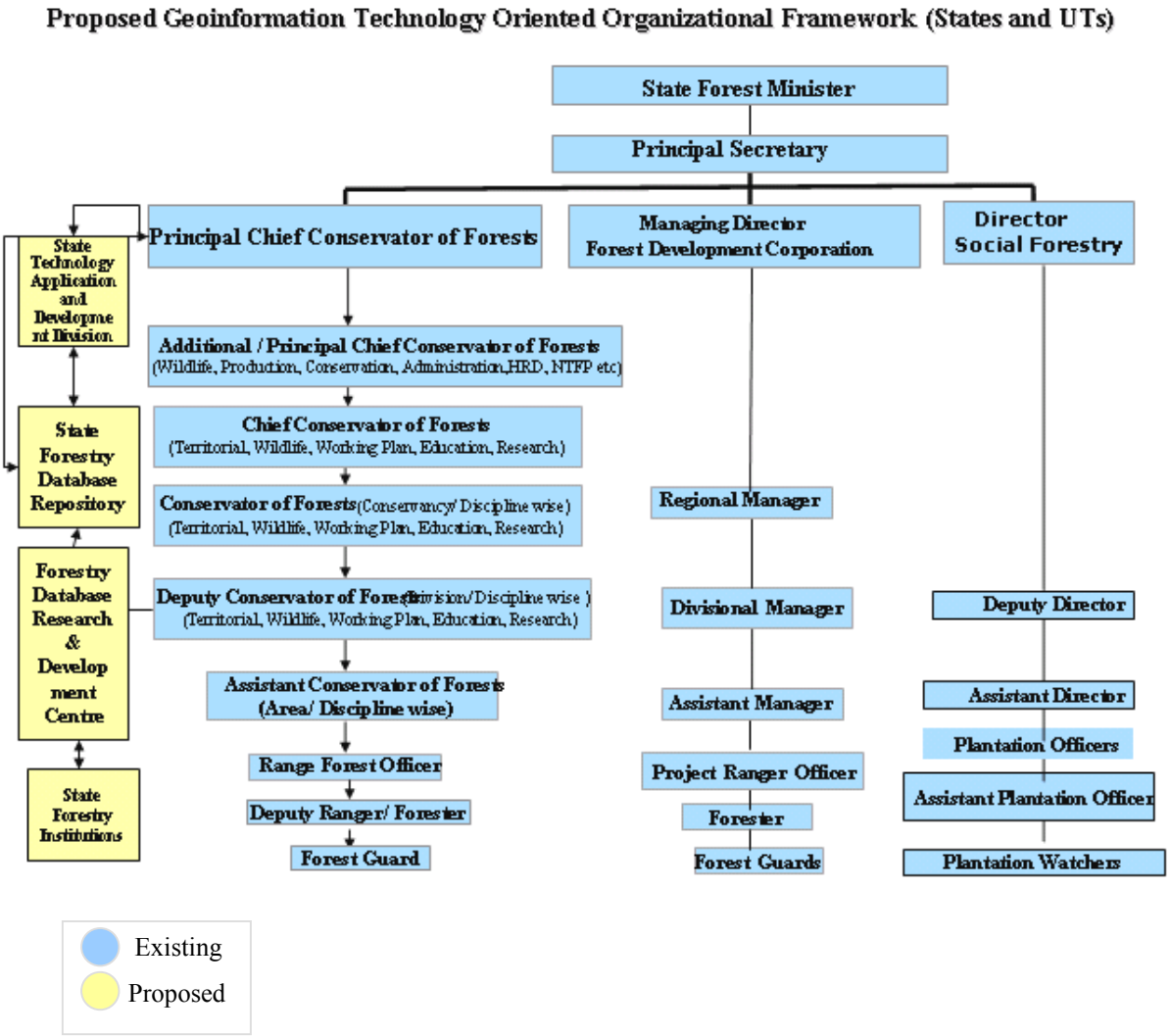


Figure 5.4.32 Proposed Geoinformation Technology Oriented Organizational Framework (State and Union Territory Government)

5.4.5 Optimization of Operations Management

There are various techniques for operations management namely, **Performance Modeling** in order to assess criteria specific effectiveness and efficiency. To suit the changing requirements of the proposed Geoinformation technology oriented process there is a need to reorganize the functional and structural components of the system through **Organizational Modeling**. In order to satisfy stakeholders and beneficiaries a continuous improvement in processes is essential. Implementing an appropriate **Quality Management System** ensures such a continuous improvement. **Workflow Management** is essential for reduction in plan production time, ensures consistent

and proper monitoring and optimum utilization of resources. A **Quality Manual** describes the policy, structure and responsibilities of the organisation and the **Quality Procedure** describes the processes organisation to ensure best practice to achieve success. **Quality Work Instructions** describe sub processes in detail related to quality in detail.

i. Quality Model- Presently no formal quality model exists for the forest departments and forestry sector in general. Total Quality Management principle has been used because it best suits the requirement in this context. Quality is a basic business strategy which provides goods and services that completely satisfy both internal and external customer by meeting their implicit and explicit expectation. Total Quality Management (TQM) represents a style of management aimed at achieving long-term success through linkages between quality and customer satisfaction. It is a management environment, which focuses on continuous improvement of work processes. TQM means the involvement of the whole organisation in the process of quality improvement. In line with the principles of Total Quality Management the following are proposed-

- **Quality Policy**- The forest departments are one of the oldest and experienced departments committed to quality and is the custodian of some of the vitally important natural resources. It caters to many stakeholders and beneficiaries in a tangible and an intangible manner.
- **Quality System**- A quality system in which quality manuals, quality procedures, work instructions, departmental production procedures and departmental structure and job descriptions are meticulously documented, has been proposed.
- **Quality Organisation** – The organisation proposed has quality checks at various levels of planning and management to control the quality of the planning process. The quality organisation is synchronous with the organisational structure of the forest departments of the states and Union Territories except for structural changes proposed to accommodate the proposed Geoinformation technology oriented planning process. The Forestry Database Research and Development Centre at the Working Plan Division level and the Technology Application and Development Division at the state level are two such structural changes proposed. The Advisory

Committee of external experts at the state government and central government level will have members from outside the organisation to ensure unbiased scrutiny and evaluation. The National Forestry Database Repository and the National Technology Application and Development Division will exercise quality control at the Government of India Level (**Figure 5.4.33)**

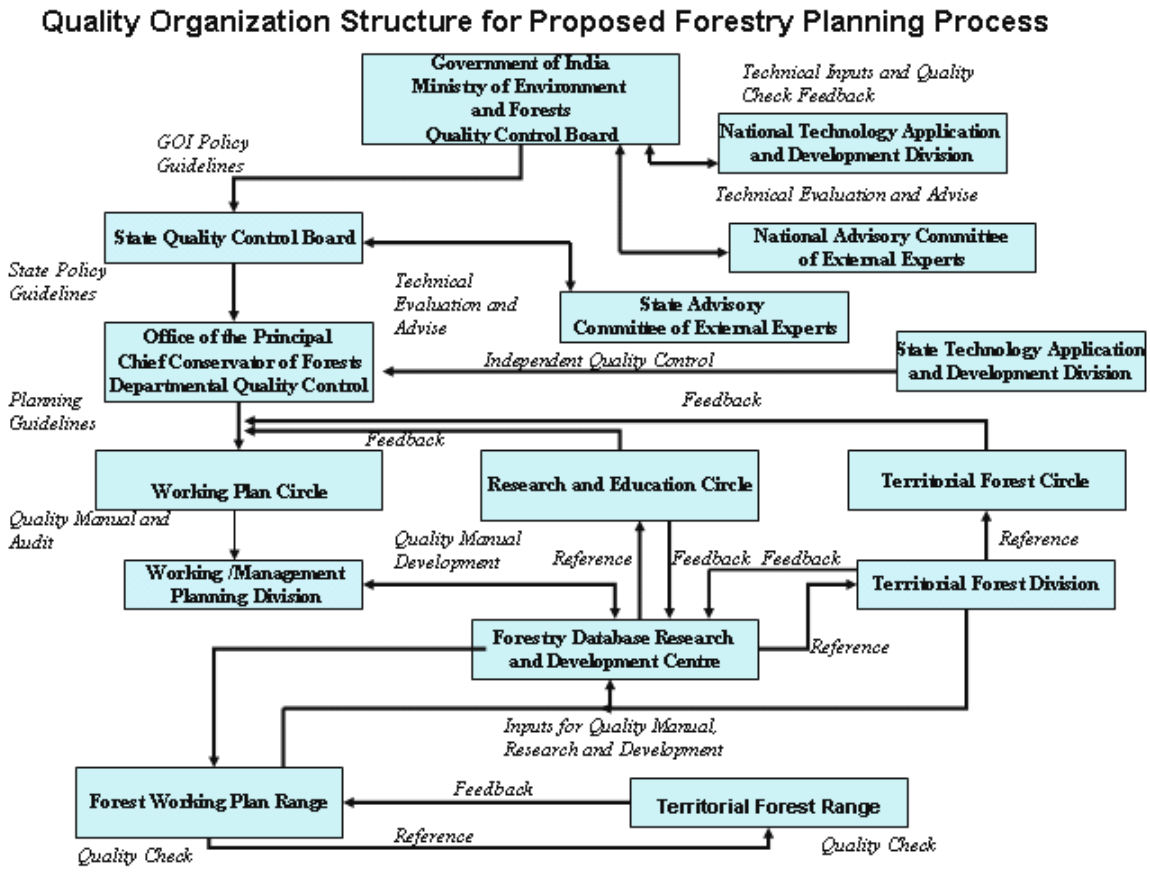


Fig 5.4.33 Quality Organisation Structure for the Proposed Geoinformation Technology Planning Process

The proposed quality model involves function assignment to various functionaries of the forestry planning organization at different levels of hierarchy. They will be involved with the task of quality assurance apart from the regular functions they carry out in the organization.

Quality Control Board, Government of India- The Secretary, Ministry of Environment and Forests will head the board. The Director General of Forests and Special Secretary, all the Additional Director General of Forests and the Deputy Inspector General of Forests involved in planning, research and education shall be the members. The Deputy Inspector General of Forests, Policy and Planning will be

the Member Secretary. The Regional Chief Conservators of Forests shall also be members in the committee. The Secretary of the Central Empowerment Committee on Environment constituted by the Supreme Court of India will also be a member.

The board will examine the Working Plans and the Management Plans for quality in terms of economic viability, consonance with the National Forestry Policy and National Forestry Action Programs, ecological sustainability, and compliance with the prevailing environmental laws of the central government.

National Advisory Committee of the External Experts- The committee will consist of members from other associated ministries namely Rural Development, Science and Technology, Department of Space and Ministry of Law and Heads of two reputed Non -Government Organizations of national stature. The Chairman, Central Empowerment Committee, shall act as the Chairman and Secretary of the Committee. This committee will examine the quality of plans from their respective perspective to address a broader spectrum of related issues.

National Technology Application and Development Division- Apart from carrying out the function of technology applications and development in forestry and allied resources it will offer technical guidance to the Government of India related to plans submitted for approval.

State Government Quality Control Board- The Principal Secretary (Forests) of the States/ Union Territory will be the Chairman of the Board. The Principal Chief Conservator of the State/ Union Territory will be the Member Secretary and the Joint Secretaries in the State Forest Ministries (in case of Union Territories, Official nominated by Government of India). This board will examine the plans from qualitative aspects of the state forest and environment policies and ascertain compliance to and consonance with law, rules and guidelines. It will also take into consideration the opinion of state level Committee of External Experts.

State Advisory Committee of External Experts- The Committee will consist of members from other associated state ministries namely Rural Development, Science

and Technology, Department of Space and Ministry of Law, two representative of forest/ environment departments from Universities and heads of two reputed Non-Government Organizations of state stature. A renowned authority in the discipline of environment and forests will be appointed as a Chairman by the state government and a Chief Conservator of Forests (Policy and Planning) will be the Member Secretary. This committee will conduct an independent examination of the working and management plans.

Departmental Quality Control Board (Office of the Principal Chief Conservator of Forests)- The Working and Management Plans will be thoroughly examined by the departmental quality control team appointed by the Principal Chief Conservator of Forests. The Additional Principal Chief Conservator of Forests or any other equivalent officer dealing in policy and planning shall be the Chairman and the Conservator (Working Plan) will be the Member Secretary. The other members shall be Chief Conservator of Forests (Research, Education, Wildlife, Development and Production). This board will seek an independent opinion from the technology application and development division related to accuracy of database, data standards followed and all the aspects related to technology use and its results. This board will also examine various prescriptions made to check their validity in terms of sound principles of forest management. This board will also examine the impact of GI Technology on the plan preparation process to strengthen future use.

State Technology Application and Development Division- This division will directly monitor all the Plans being submitted to the Office of the Principal Chief Conservator of Forests from technology perspectives. It will ensure the accuracy of the Spatial and Non-Spatial data included in the Plan and validate the planning support systems developed on the Plan. It will help the Principal Chief Conservator of Forests in proper decision making based on the analysis of the data.

Working Plan Circle- A circle is headed by the officer of the rank of Chief Conservator of Forests/ Conservator of Forests. This specialized unit will be responsible for preparing a detailed quality manual for the organization and subsequent updates of the manual in view of policies and guidelines being issued from the superior offices and boards and interaction and feedback from forestry

database research and development centre. The most important inputs shall be given by the Working/ Management Plan Officer. Apart from this it will also seek feedback related to quality control measures from research, education and territorial circles.

Working / Management Planning Division- All the field inputs and conversion of data into digital domain by the database research and development centre will be checked by the Working/ Management Plan Officer (W/MPO) before incorporating it into the plan and doing any further analysis. The W/MPO is the official directly responsible for the preparation of the Plan. He will exercise the most vital quality control check. He will also be responsible for preparation of the quality manual.(A Working Plan is for the Managed Forests and the Management Plan is for Protected Areas)

Forestry Database Research and Development Centre- This will be headed by an officer of the rank of Deputy Conservator of Forests. This centre will be responsible for generating Spatial and Non-Spatial data using modern tool in Geoinformation Technology. It will strictly follow the process models prescribed. This centre will receive field information and feedback from the field Range Officers of all the forest divisions concerned. The centre will also make references to the territorial Deputy Conservator of Forests to get inputs related to accuracy

Forest Working Plan Range- It shall be responsible for checking the quality of the data collected by the frontline staff (Foresters and Forest Guards). This range will also make a reference to the territorial forest range for ascertaining the correctness of the data and will receive continuous feedback on the quality checks done.

Territorial Forest Range- This range is the custodian of the forest resources for which the Plan is being made. It will exercise a strict quality check on the data being collected.

Quality Work Instructions- These elaborate upon the allocation of duties, functionaries responsible for each activity, time of action, location of the performance and the method of doing the activity to ensure quality performance.

Table-5.4.2 Quality Work Instructions for Geoinformation Technology Oriented Planning Process (Refer Fig. 5.4.33)

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
1.	**A- Preparatory Works Proposed Process**	WPO /MPO	Working Plan Division Headquarters	2 Y 6M years before the expiry of the existing Plan *(6 months)*	
2.	A1- Identification of Planning Area	WPO /MPO	Working Plan Division Headquarters	2 Y 6M years before the expiry of the existing Plan *(1 month)*	In consultation with CF Working Plan and PCCF
3.	A2 - Organizing Infrastructure	WPO/MPO	-do-	-do- *(6 month)*	Using Government Resources
4.	A3 - Interaction with Territorial Divisions	-do-	-do-	-do- *(1 month)*	By organizing field visits and meeting
5.	A4 - Provision of Budget	PCCF	State Headquarters	Ensuing financial year	From State Government
6.	A5 - Deciding Upon Data Standards	WPO/ MPO	WP Headquarters	2 Y 5M before the expiry of the existing Plan *(1 month)*	In consultation with Forestry Database Research and Development Centre , SFDR, NTADD, STADD NFDR and FDRDC
7.	A6 - Base work for Geo-Relational Databases	DCF of Forestry Database Research and Development Centre	State Headquarters	-do- *(2 months)*	In consultation with NTADD, NFDR, SFDR (Nodal Agency FSI) and STADD
8.	A7 - Hiring of Technology Consultants	CF (WP)	District HQ	-do- *(4 months)*	Through approved Government Process
9.	A8 - Technology Oriented Training for Staff	CF Education	National and State Training Institutes	-do- *(6 months)*	Training procedures followed at IGNFA and DFE
10.	A9 - Quality and Feasibility Test	CF Education and Heads of the training institute concerned	Training Institutes	-do- *(1 month)*	Examination, presentations and case study assessments

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
11.	B- Preliminary Working Plan Report - Part I	WPO/MPO	WP-HQ	2 Y before….. *(6 months)*	Compilation and analysis of results and findings
12.	B5 - Procurement/Use of PDAs for Mobile GIS	WPO/MPO	WP-HQ	2 Y 6 M before … *(4 months)*	Through open tendering
13.	B6- Conversion of Spatial Data to chosen data standards in Digital Domain	Forestry Database Research and Development Center	WP-HQ	2 Year before… *(3 month)*	In consultation with STADD
14.	B7 - Quality Control/Check	WP-TADD	WP-HQ	1Y 10M before…	Meetings and deliberations with NFDR
15.	B1 – Preliminary Consultation	CFWP	CFWP-HQ	2 Year before …	Presentations, Deliberations
16.	B2 – Inspection of Forests	WPO/MPO and DCF, Territorial	Plan Area	2 Year before…. *(1 month)*	Profile examinations/ drawings use of PDAs
17.	B8- Prepare profiles if not existing (digital domain)	WP-RFO	Plan Area	-do- *(3 months)*	Using digital camera/hand drawings/ PDAs
18.	B9 - Quality Control/Check	WPO/MPO	WP-HQ	1Y 9M before…	Field Verification
19.	B3 – PWPR Part I	WPO/MPO	WP-HQ	1Y 7M before….	Hard Copies and CDs
20.	B4 - Approval	PCCF, Regional CCF and GOI	State HQ/ New Delhi	1Y 6M	Deliberations in meetings
21.	C- Descriptive Field Work	WPO/MPO and field staff	Plan Area	2 Year before… (6months)	Under guidance of CFW
22.	C1 - Examination of Territorial Units	RFO-WP and T	Plan Area	2 Year before…	In consultation with frontline staff
23.	C2 - Collection of Preliminary Data	-do-	-do-	-do-	-do-
24.	C3 - Compilation of Comp. Histories	-do-	-do-	-do-	-do-
25.	C4 – Finalize Compartment Descriptions	-do-	-do-	1Y 8M before..	-do-
26.	C5 - Compilation of all data in Digital Domain	FDRDC	WP-HQ	1Y 6M before…	Digitization/s canning/ formats compilation

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
27.	C6 - Choose Appropriate Data Standard	FDRDC	State-HQ	1Y 8M before…	In consultation with STADD
28.	C7- Detailed Compartment Maps with Resource Info	FDRDC and RFO-WP	WP-HQ	1Y 7M before… *(1month)*	Using GIS
29.	C8 - Quality Control/Check	WPO	WP-HQ	1 Y 6M before…	Field Checks
30.	D. Survey& Assessment of Natural Resources (Spatial & Not Spatial Data)	FDRDC, RFO-WP RFO-T andW/MPO	Plan Area	2 Year before… *(8 Months*	Field and GIS lab work
31.	D10 - Mapping/ Recording Digitally PDAs/GPS	RF-WP and T	Plan Area	2 Year before… *(8 Months)*	PDAs/GPS/Field Survey Equipment (Extensive Field work and Sampling
32.	D3 - Enumeration for Crop Composition	-do-	-do-	-do- *(5 months)*	-do-
33.	D4 - Growth and Yield Statistics	-do-	-do-	-do- *(5 months)*	-do-
34.	D7 - Stock Survey	-do-	-do-	-do- *(5 months)*	-do-
35.	D1 - NTFP & Bamboo/Rattan Survey	-do-	-do-	-do- *(5 months)*	-do-
36.	D2 - PlantationSurvey	-do-	-do-	-do- *(5 months)*	-do-
37.	D5 - Regeneration Survey	-do-	-do-	-do- *(5 months)*	-do-
38.	D6 - Wildlife Survey	-do-	-do-	-do- *(5 months)*	-do-
39.	D8 - Socio-Economic Survey	-do-	-do-	-do- *(5 months)*	-do-
40.	D9 - Soil Survey	Soil Survey Department	Plan Area	-do- *(5 months)*	
41.	D11 - Compilation in Digital Domain	FDRDC	WP-HQ	1Y 6M *(2 months)*	In consultation with STADD and SFDR
42.	D12- Quality Control/Check	WP-FDRDC	WP-HQ	1 Y 5 M before… 15 days	-do-

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
43.	D13-Geo-RDBMS Analysis	FDRDC	WP-HQ	I Y 4 M *(2 months)*	In consultation with STADD and SFDR
44.	E. Preparation of Maps by WPO/MPO (Spatial Data Generation and Processing in GIS Domain)	FDRDC	WP-HQ	1Y 6M before to be completed in six months	Remote Sensing and GIS
45.	E1 - Generation/Conversion of Maps e1-12 in Digital Domain	-do-	-do-	-do-	GIS
46.	E2 - Search Existing Data	RFOs -WP	WP-HQ	1Y 5M Year before… *(15days)*	Manual and using computers
47.	E3 – Check Existing Data for compatibility and tandards	FDRDC	WP-HQ	1Y 3M (15 days	Compare with data standards
48.	E4 - Indent for Maps from SOI and maps of allied resources	FDRDC	Dehardun	1Y 5M Year before…	Through Official indent
49.	E5 - Indent for Remotely Sensed Data	FDRDC	NRSA, Hyderabad	-do-	Through Official indent in consultation with WPO/MPO
50.	E6 - Conversion (of indented maps) Digital Domain, if analogue	FDRDC	WP-HQ	IY before… *(15 days)*	Scanning/Digitization-GIS
51.	E7- Interpretation for Resource Maps	FDRDC and RFO-WP and T	WP-HQ	1Y 3M *(1 month)*	Digital Image Processing/ Visual Interpretation
52.	E8 - Field Assessments and validation	RFO-WP and T	Plan Area	1Y 3.5M (7days)	Use of GPS/PDAs
53.	E9 - Quality Control/Check	WPO/MPO and TADD	WP-HQ	1Y 3.75 M	Classification Accuracy/Field verifications.
54.	E10- Prepare Change Detection Maps	FDRDC and RFO-WP and T	WP-HQ	Activity parallel to Sr.no.51	Digital Image Processing/ Visual Interpretation

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
55.	E11 - Quality Control/Check	WPO/MPO and TADD	WP-HQ	Activity parallel to Sr.no.52	Verify data standards compatibility, accuracy etc.
56.	E12 - Develop Interface with Georelational Database	FDRDC	WP-HQ	1Y 1M before…	Through spatial data exchange (SDE) interface
57.	U. Generation / Compilation of other Non Spatial Ancillary Data	RFO-WPO/MPO FDRDC	Plan Area	IY 6M before… *(3 months)*	Field survey
58.	U1- Decide upon Data Standards	FDRDC	WP-HQ	IY 6M before… *(15 Days)*	In consultation with WPO and STADD ,SFDR and NFDR and NTADD
59.	U2- Data Collection	RFO -WP	Plan Area	IY 5M before… (15 days)	Field Survey
60.	U3- Preparation of various Inventories	-do-	-do-	IY 4M before… *(1 month)*	Computers
61.	U4- Compilation of Area Statement	FDRDC	WP-HQ	-do-	Computers
62.	U5- Ancillary Data Compilation	RFO -WP	Plan Area	1Y 3M before… *(15 days)*	Various Government Offices
63.	U6- Quality Control/Check	FDRDC	WP-HQ	1Y 2M before… *(1 week)*	In consultation with WPO CFWP and STADD and SFDR
64.	U7- Entry in Geo-RDBMS	FDRDC	WP-HQ	1Y before…	In consultation with WPO and STADD and SFDR
65.	V. Quality Control/Check	CFW/WPO/ STADD NTADD, and NFDR	CFWP HQ and PCCF HQ	10 months before..	Spatial data check and validation of work prescriptions proposed in the plan.
66.	W. Entry in/Interface with Georelational Database	SFDR and STADD	WPO HQ	10 months before…	Using in house and external technicians

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
67.	X-Integration and Analysis	FDRDC	WP-HQ	1Y before… (*4Months)*	In consultation with WPO and STADD and SFDR
68.	X1 - Integration in GIS Domain	-do-	-do-	11 M before…	In consultation with WPO and TADD, SFDR and NFDR
69.	X2-Developing Ecological Status Models			10 M before… *(1 month)*	In consultation with WPO DCF (T) and STADD and SFDR(Frontline staff)
70.	X3- Spatial Multi Criteria Evaluation	FDRDC , W/MPO and RFO WP	-do-	9M before… *(1month*)	
71.	X4- Develop Interface with Geo-RDBMS	FDRDC , W/PO and RFO WP	-do-	9.5M before… *(15 days)*	-do-
72.	X5- Organize Inputs for DSS/PSS	FDRDC , W/PO and RFO WP	-do-	9 M before… *(1 month)*	-do-
73.	Y. Developing Multicriteria Decision/ Plnning Support System for Forest Working/ Management Plan	FDRDC ,CFWP WPO and RFO WP	-do-	8 M before… *(1 month)*	In consultation with WPO CFWP and TADD and SFDR(inputs from CF Research, Education and Training and Territorial)
74.	F-Preliminary Working Plan Part II	WPO/MPO	WP-HQ	6 M before ….	In consultation with WPO CFWP and
75.	G-Seeking Comments and Modification	PCCF and Regional CCF	Respective HQs	4M Before…	In consultation with STADD, SFDR and State Advisory Committee
76.	H-Final Draft Working Plan	MOEF and PCCF and Regional CCF	Respective HQs	3M Before…	In consultation with STADD, NFDR,NTADD and National Advisory Committee of External Experts

S.N.	Activities/Tasks	By Whom	Place/Where	When	How
77.	I-Government Sanction	MOEF(GOI) and State Government	Respective HQs	1 M Before ….	Overall Consultations, deliberations and meetings
78.	J-Final Working Plan Implementation	Territorial Division, Forest Development Corporations for Implementa-tion	Respective HQs	Initiate implementation on expiry of the existing plan	Implementa-tion Guidelines

5.4.6 Workflow Management- "Workflow Management is the automated coordination, control and communication of work both of the people and computers, in context of business process, through the execution of software in a network of computers whose order of execution is controlled by computerized representation of the business process."(Joosen, 1994).

Once the GITOPPFS has been put to implementation and organizational database has been established the workflow management as shown in Figure 5.4.34 which depicts the business map will be adopted. The workflow management will help reduce the time taken in plan preparation since controlling and assigning of various activities in the process will be well defined, which in turn will minimize the transfer time of the plan from one stage to another. This is a sample for the overall process but each smallest process can be shown in this manner. It will help spot out problems and suggest for remedial measures by prescribing structure of responsibilities, accountability, decision- making and mitigation strategy for bottlenecks in the process.

The workflow starts with the Government requesting the PCCF of the State concerned. In this case the PCCF is the performer, He will send a request to the CFWP. In this secondary workflow the PCCF is the customer and the CFWP the performer. Thus, as shown in business process various activities will be performed till the Final Working Plan is approved at the Government level. The initial process where the Government requested the PCCF, is the primary workflow and the rest are secondary workflows. The workflow where the WPO is the performer and where the

matter is referred to FDRDC, the subsequent workflow becomes a tertiary one. Such workflows are very useful to monitor the entire planning process and its implementation as well.

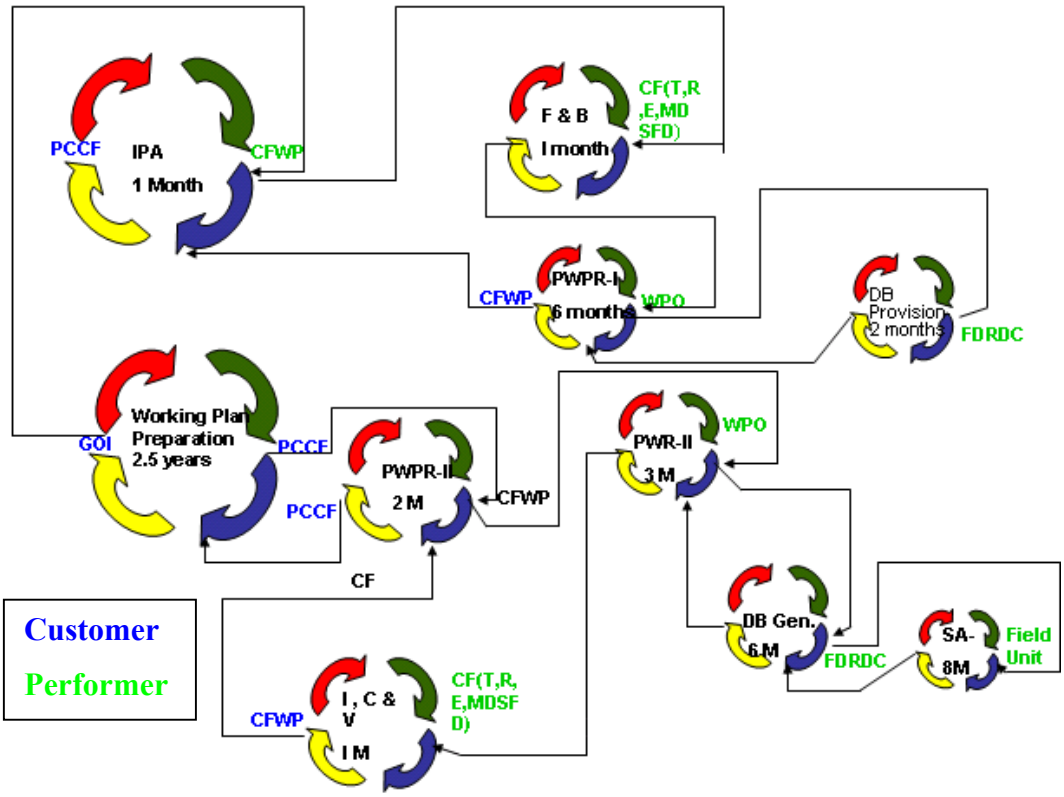


Figure 5.4.34 Business Map of Forestry Planning Process in India

Abbreviations-

PCCF - Principal Chief Conservator of Forests

CFWP- Conservator of Forest Working Plans

CF(T,R,E,FDC &SFD)-Conservator of Forests(Territorial, Research, Education, Forest Development Corporation, Social Forestry)

WPO- Working Plan Officer

FDRDC- Forestry Database Research and Development Center

F&B – Feedback and Briefing

PWPR-I Preliminary Working Plan-I

PWPR-II- Preliminary Working Plan-II

Final WP- Final Working Plan

DB Gen.- Database

DB Provision- Database Provision

IPA-Identification of Plan Area

IC&V – Interaction, Communication & Verification

5.4.7 Concluding Remarks for GITOPPFS

Data Oriented compilation to Analysis Oriented Integration

Figure 5.4.35 shows us a data oriented compilation. It encompasses a compilation of spatial and non-spatial data and ancillary data to the working plan. This process is currently being practiced. The main drawback of the process is that it does not encompass analysis of the data, thus there is no networking of the process. Also, the scope of interoperability of the data is limited since the database is not linked to a RDBMS.

Figure 5.4.36 shows the typical framework of the proposed GITOPPFS based database integration. Each step in the process is based on an analyzed integration and linked to the consecutive step. Thus there will be a networking of the various steps in the process. Various tools for analysis will be applied for situation analysis, ESM analysis, data standards analysis etc. that are networked to the entire database. Knowledge layer forms the base of the entire system. The use of the RDBMS ensure interoperability in the entire system so as to enable data sharing and data reference in relation to time scale.

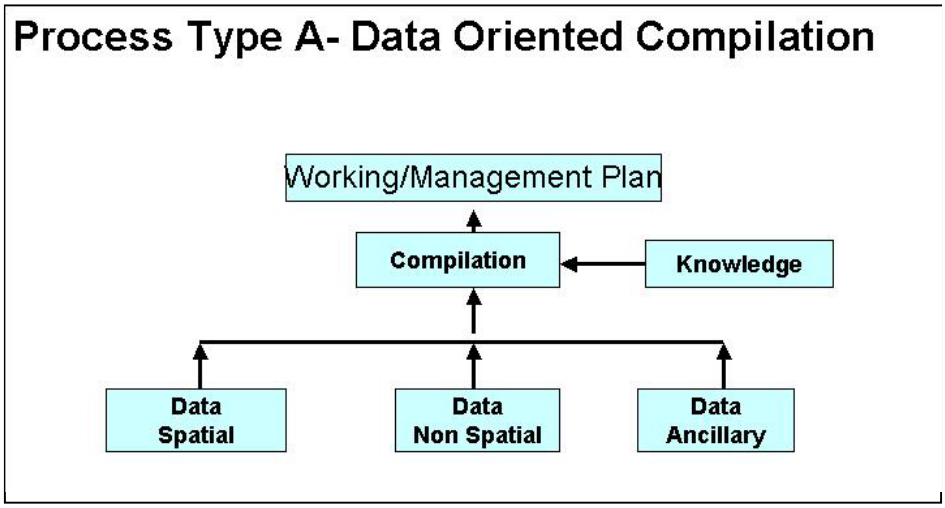


Figure 5.4.35 Existing process of data oriented compilation

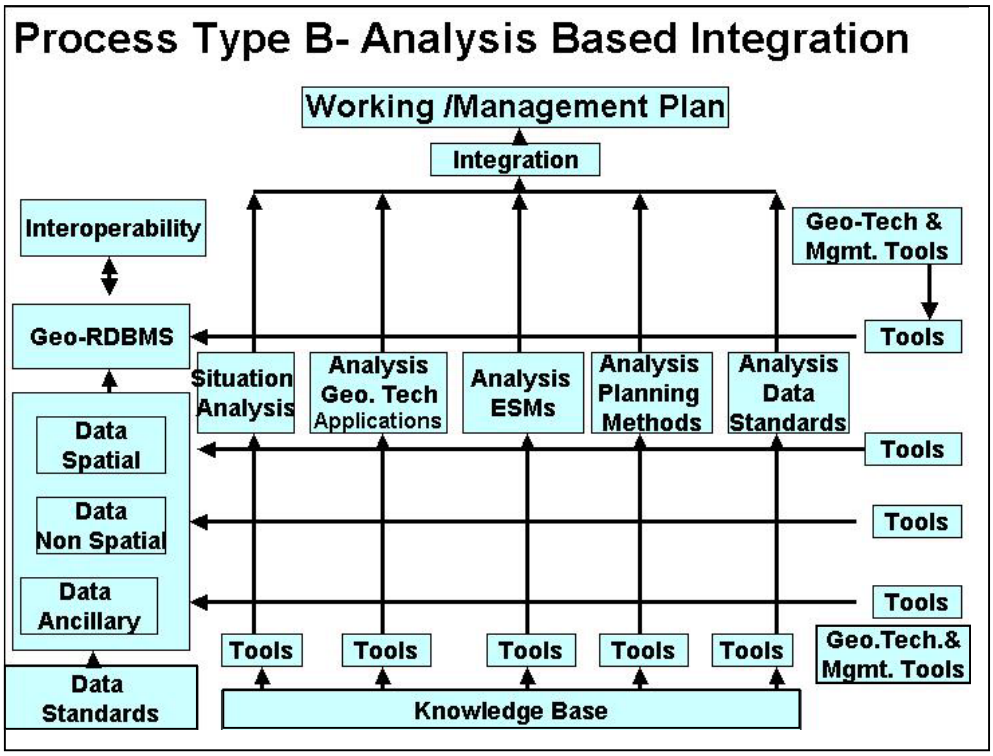


Figure 5.4.36 Proposed GITOPPES based Analysis based Integration

5.5. Comparative Analysis of Planning Process

5.5.1 Comparative analysis of processes is usually done, essentiality in terms of efficiency, quality, effectiveness and sustainability. The most potent methodology followed to draw a comparison between existing and recommended processes is by defining a set of indicators/ parameters which are common to the sets of processes, identifying a suitable scale of measurement, and eventually arriving at a comparison matrix. The matrix would reflect upon the relative advantages and disadvantages of a particular process. Such an activity aims at achieving the final goal of developing a sustainable planning process for forestry sector by integration of current practices with novel methods. Some commonly used performance parameters are based on quality, time, stakeholder satisfaction, in house capacity building, sustainability, vulnerability etc. as listed below.

Efficiency

1. Time for Plan Preparation
2. Cost involved in Plan preparation
3. Level of standardization (data standards followed, content level and presentation)

Quality

1. Level of analytical integration
2. Plan revision and updating frequency
3. Accuracy in generating spatial data.

Effectiveness

1. Number of deviation proposals
2. Precision in plan prescriptions addressing field level issues
3. Ecological viability
4. Stake holder satisfaction

Sustainability

1. Focus on realization of the objectives and not just on outputs
2. Emphasis on management rather the administration
3. Capability for formulation and evaluation as a continuous process.
4. Flexibility of continual re-planning on the basis of formative periodic evaluation.

Out of the above, the parameters demarcated in the context of the current study is to draw a realistic comparative analysis of the three planning processes, viz. Technological, Semi-technological and GITOPPFS were as follows:

- Time
- Cost
- Quality
- Adaptability

The three processes were evaluated for a set of common activities. The scale used for the study was a five- point scale; ranging from very high to very low

performance. Table 5.5.1 shows the comparisons. The following annotations have been used to represent different levels of performance, +++ (very high); ++ (high); + (moderate); - (low); -- (very low). These have been assessed based on personal experience, expert opinions, review of Working Plans and Management Plans, reference to case studies and examination of both the existing and proposed planning processes.

Table 5.5.1 Comparison of three Planning Processes

Activity	Planning Processes			
	Traditional	Semi-Technological	Proposed GITOPPFS	Comparison Criteria (Performance Level)
Preparatory Works				
	-	-	+	Time
	++	++	-	Cost
	++	+	++	Quality
	++	+	-	Adaptability
Preliminary Working Plan Report Part I				
	++	++	++	Time
	+	+	-	Cost
	-	+	++	Quality
	++	+	-	Adaptability
Descriptive Field Work				
	+	-	++	Time
	++	+	+	Cost
	+	-	+++	Quality
	++	+	+	Adaptability
Survey and Assessment of Natural Resources (Spatial & Non Spatial				
	-	+	+++	Time
	+	-	--	Cost
	-	-	++	Quality
	+++	+	+	Adaptability
Preparation of Maps by WPO (Spatial Data Generation and Procession)				
	--	+	+++	Time
	-	+	++	Cost
	-	+	++	Quality
	++	+	+	Adaptability

Activity	Planning Processes			
	Traditional	Semi-Technological	Proposed GITOPPFS	Comparison Criteria (Performance Level)
Generation /Compilation of Other Non Spatial Ancillary Data				
	+	+	+++	Time
	+	+	++	Cost
	+	++	+++	Quality
	+	+	++	Adaptability

The traditional and semi technological processes were found to have a low performance with respect to time for the activity of preparatory works, while GITOPPFS has been evaluated to take lesser time and high quality, hence is more beneficial than the former technologies. However, the cost benefits against GITOPPFS are lesser since it proves to be a costlier tecchnological input than the rest. Superior levels of quality are expected in the technological and the new process.Adaptibility of GITOPPFS is rated the lowest amongst the three. It refers to the overall adaptibility of the process to the organization. The reason for the low level of adaptibility is due to the unavailibility of the superior infrastructure.

The preparation of the Preliminary Working Plan Report Part I can be facilitated to reach superior levels in terms of quality and time. The major issues where the new proposed method has major drawbacks are those of cost and adaptibility. The economic feasibility of the two processes in current use is considered to be high. There is an increase in the level of information generated or quality when GITOPPFS is used.

Field work can be directly benefited from the use of the new technology. Cost and adaptability issues are equivalent to the semi technological process. The use of PDAs and mobile GPS for the field work will reduce the time substantially and increase the quality.

The time scale for the survey and use of natural resources by GITOPPFS can be considerably reduced. Preparation of the maps will also be enhanced with respect to the time and quality of the database creation. Non- spatial data generation and compilation will also be regularised by the use of geoiformation.

5.5.2 Performance Assessment of the GITOPPFS

Performance measures have been limited to those that relate to strategic organizational goals and objectives, and that provide timely, relevant, and concise information for use by decision-makers at all levels to assess the progress toward achieving predetermined goals. These measures shall produce information on the efficiency with which resources are transformed into goods and services, on how well results compare to a program's intended purpose, and on the effectiveness of organizational activities. Performance measurement is a tool with which the overall feasibility of the process is assessed.

An independent performance assessment of GITOPPFS has been done because most of the activities proposed, do not exist in the prevailing two planning processes. The advantages of applicability of GITOPPFS have been tabulated in Table 5.5.2.The scale of performance of the GITOPPFS has been devised on a three point percentage graduation, of “High”, “Moderate” and “Low”. The assessment has been made on the basis of personal opinion and experience, review of currently existing processes, individual interactions through interviews/ questionaires and expert opinion sought during presentations of GITOPPFS to groups of departmental experts, Decision makers, top forest officers, consisting of (69 individuals in classrooms and 20 individual responses) representing almost all State Forest Departments in India. The parameters found to be relevant to the scope of the current study are Time, Cost, Level of Standardization, Quality, and Adaptability.

Table 5.5.2 Performance Assessment of the GITOPPFS

S.N.	Changes proposed	Time	Cost	Level of Standardiza -tion	Quality	Adaptability
	A- Preparatory Works Proposed Process					
1.	A5 - Deciding Upon Data Standards	L	L	H	H	M
2.	A6 - Base work for Geo-Relational Databases	M	M	H	H	L
3.	A7 - Hiring of Technology Consultants	-	M	-	H	M
4.	A8 - Technology Oriented Training for Staff	M	M	M	H	M
5.	A9 - Quality and Feasibility Test	L	L	M	H	-

S.N.	Changes proposed	Time	Cost	Level of Standardiza -tion	Quality	Adaptability
	B- Preliminary Working Plan Report - Part I					
6.	B5 - Procurement/Use of PDAs for Mobile GIS	H	L	H	H	M
7.	B6- Conversion of Spatial Data to chosen data standards in Digital Domain	M	L	H	H	L
8.	B7 - Quality Control/Check	H	M	H	H	-
9.	B8- Prepare profiles if not existing (digital domain)	L	L	H	H	L
10.	B9 - Quality Control/Check	H	M	H	H	-
	C- Descriptive Field Work					
11.	C5 - Compilation of all data in Digital Domain	M	L	H	H	L
12.	C6 - Choose Appropriate Data Standard	M	M	H	H	L
13.	C7- DetailedCompartment Maps with Resource Info	M	M	H	H	L
14.	C8 - Quality Control/Check	M	L	H	H	-
	D. Survey& Assessment of Natural Resources (Spatial & Not Spatial Data)					
15.	D10 - Mapping/Recording Digitally PDAs/GPS	H	M	H	H	M
16.	D11 - Compilation in Digital Domain	M	L	H	H	L
17.	D12- Quality Control/Check	L	L	H	H	-
18.	D13-Geo-RDBMS Analysis	H	M	H	H	L
	E. Preparation of Maps by WPO/MPO (Spatial Data Generation and Processing in GIS Domain)					
19.	E1 -Generation/Conversion of Maps e1-12 in Digital Domain	M	L	H	H	L
20.	E2 - Search Existing Data	M	M	-	L	-
21.	E3 – Check Existing Data for compatibility and Standards	M	M	M	M	-
22.	E4 - Indent for Maps from SOI and maps of allied resources	-	-	-	-	-
23.	E5 - Indent for Remotely Sensed Data	-	-	-	-	-
24.	E6 - Conversion (of indented maps) Digital Domain, if analogue	M	M	H	H	L

S.N.	Changes proposed	Time	Cost	Level of Standardiza -tion	Quality	Adaptability
25.	E7- Interpretation for Resource Maps	H	L	M	H	M
26.	E8 - Field Assessments and validation	M	M	M	H	H
27.	E9 - Quality Control/Check	-	-	-	-	-
28.	E10- Prepare Change Detection Maps	M	H	M	H	L
29.	E11 - Quality Control/Check	-	-	-	-	-
30.	E12 - Develop Interface with Georelational Database	M	L	H	H	L
	U. Generation / Compilation of other Non Spatial Ancillary Data					
31.	U1- Decide upon Data Standards	H	M	H	H	M
32.	U2- Data Collection	-	-	-	-	-
33.	U3- Preparation of various Inventories	-	-	-	-	-
34.	U4- Compilation of Area Statements	H	M	H	H	M
35.	U5- Ancillary Data Compilation	H	M	H	H	M
36.	U6- Quality Control/Check	-		H	H	M
37.	U7- Entry in Geo-RDBMS	H	M	H	H	L
38.	**V. Quality Control/Check**	-	-	H	H	-
39.	**W. Entry in/Interface with Georelational Database**	L	M	H	H	L
	X-Integration and Analysis					
40.	X1 - Integration in GIS Domain	L	L	H	H	L
41.	X2-Developing Ecological Status Models	H	H	H	H	L
42.	X3- Spatial Multi Criteria Evaluation	M	M	H	H	L
43.	X4- Develop Interface with Geo-RDBMS	M	M	H	H	L
44.	X5- Organize Inputs for DSS/PSS	-	-	-	-	-
45.	**Y. Developing Multicriteria Decision/ PAlnning Support System for Forest Working/ Management Plan**	H	H	H	H	M

Note: H (high, > 60%); M (moderate, 30-60%); L (low, <30%)

- Overall assessment: **Time**- High, **Cost**- Moderate, **Quality**- Very High, **Level of Standardization**- Very High, **Adaptability**- Low.

5.6. Planning and Policy Guidelines

To enforce the proposed GITOPPFS and to institutionalize it into the forestry sector elaborate guidelines are required at planning and policy level. While proposing the guidelines the outcome of the Extended SWOT Analysis has been taken into account. The response of the target groups pertaining to planning and policy level changes has also been duly considered. The planning process guidelines proposed based on this research are listed below and summarized forest policy recommendations subsequently.

5.6.1 Planning Process guidelines

Technology oriented plan preparation

The expert opinions sought in the study, point towards the need of Geoinformation technology in planning and management of forests. So also the results of presenting the outcome of this study to senior level experts indicate 80 % acceptability of the GITOPPFS amongst planners and policymakers. The proposed GITOPPFS has a preference over the prevailing traditional and semi technological planning process, hence a case for its adoption is made out. In order to institutionalize the proposed process orientation of human resource to technology is essential.

Working Plan and Management Plan Officers suggest that technology orientation trainings to various national and international institutions is essential. Quantum of training needs shall be assessed so as to identify the areas where training is required.

a. Provision of technology oriented infrastructure-

The proposed GITOPPFS would be exhausting on the resources in the initial phase of introduction and adoption. It will start yielding the benefits only in due course whereby it will result into optimization of resources use. In order to make it happen the following steps are suggested based on research findings:

- Forestry and allied resources need to be mapped digitally with the support of required hardware and software pacakges until range level
- Data standards should be strictly followed to ensure interoperability. The Forestry Database Research and Development (FDRDC)

proposed to be established at the division level will coordinate and ensure that data standards are propagated and followed in the right perspective

- This study has identified many areas, which are still unexplored as far as application technology is concerned. Infrastructure commensurate to requirement needs to be provided. New areas of technology potential identified should be brought into practice. For example – use of PDAS can be popularized to get the badly needed accurate field ecological data. Modern survey equipment to generate frame work data would be extremely essential
- The GIPTOPPFS has been elaborately described in the form of process models. These may be extensively used to generate better analysis for management. These process models are easy to conceive and simple to deal with. But the supporting infrastructure to make generation of these models successful need to be made available by the Government.

b. Provision of skilled manpower to assist in plan preparation-

The proposed GITOPPFS would need specialized personnel power highly skilled in various disciplines of Geoinformation technology applications. This specialization shall come through specialized training and reinforcing the existing human resource with specialized personnel into various facets of planning.

It needs to be ensured that "Proper men are at proper places." Portfolios of the staff/ official being posted in planning divisions should be scrutinized to ascertain caliber.

The Government needs to be careful about a general misconception that application of Geoinformation technology would enable reduction in number of personnel being deployed for various tasks. This will never happen in forestry. The specialized personnel trained in field disciplines are equally essential and extensive application of technology cannot be a replacement for them.

c. Flexibility to opt for external consultants-

The proposed GITOPPFS would bring in numerous new facilities and establishments, which will be new to the department. Therefore, it would not be possible to build up in- house capacity immediately. Engagement of external consultants would be extremely essential

d. Practical Technology Demonstrations-

The GITOPPFS has come out with extensive areas of applications of Geoinformation technology in forestry planning and management such as spatial and non spatial data generation, model making, Decision Support Systems etc Most of these have been tried or done on smaller areas as pilot studies or projects. The potential of the technology established and explored in these studies needs to be demonstrated to planners. The technology developers are required to come forward with as many application case studies as possible to address various issues in consultation with planners and field managers. The Government will have to ensure that just buying technology will not serve the purpose but developing competency through practical learning, will be equally important.

e. Adoption of Data Standards while preparing Forest Plans

The GITOPPFS has come out with elaborate data standards for forestry databases and has identified data standards, which might be chosen for allied resources. Data standards help to integrate the data and exchange seamlessly for fast plan preparation. This is a significant step towards establishing interoperability for sharing and integration of geospatial data and Geo-processing Resources. This will save Government resources from being wasted and optimum utilization of resources will be ensured. This can be a step towards Indian initiative of NSDI.

One of the most important contributions of data standards is facilitation in establishing spatial data as evidence in court of law. It is an important instrument in strengthening the environmental laws

f. Process standardization, quality organization and Organizational Plan

The GITOPPFS has developed several process models, elaborating various plan preparation processes in detail, which will be a guiding factor to the forest planner and policy maker while formulating plans. The plan process thus can be standardized so as to be uniform all over the country.

In order to maintain quality in planning at all levels in the hierarchy of the forestry sector the GITTOPPFS has proposed quality organization. Essential steps towards establishment of component sections for quality organization need to be taken. The Business Map developed can be further disintegrated into various component processes by experienced planers to further refine the monitoring processes for plan preparation and implementation both. As such the proposed process has brought down the planning preparation time by 6 months and it is a considerable saving of Government resources in terms of time and money.

5.6.2 Plan implementation Guidelines

a. Link Planning With Decision-making- The proposed GITOPPFS has illustrated elaborate steps that will help decision makers in plan implementation. This potential shall be explored fully.

b. Develop Skills for Strategic Technology Applications Planning- This will be done through trainings and short courses organized by various institutions

c. Allow Adequate Time and Budget - When it comes to incorporating technology in management at a large scale the expenditure incurred on purchases and installations is very high. This often serves as initial bottleneck in getting technology into the mainstream due to budget constraints. It is important to note that in the long run it results into resource savings because it is not a recurring expenditure. Some add-ons may be required from time to time. Allocation of resources needs to be sustainable for technology to become sustainable. Implementation of GITOPPFS needs to be done on the sound principles of Geoinformation Project Management

such as logical Framework, Work Breakdown Structures, establishment of new facilities, management and monitoring protocols, risk management etc. A detailed Gantt chart needs to be prepared for all activities and fund allocation needs to be done in advance so that the budget is provided for and committed in advance.

d. Establish Technology Action Teams (Territorial Division) for Implementation - This is an in- house activity but an important one. Forest departments need to explore and tap the talent available within the department, train them further as per training needs assessment and form Technology Action Teams for trouble shooting, further development and maintenance of infrastructure. These may work in tandem with the territorial forest divisions where the GITOPPFS is to be implemented.

Action Teams can be monitored by seeking answers to following questions:

- What is the progress?
- What are examples of recent improvements?
- What problems are being encountering?
- What is being done to resolve these problems?
- What are the change areas to smoothen technology transfer?

e. Documentation - The forest management in this country derives heavily from the British legacy of documentation. Documentation at field and laboratory levels is very important. With advent of information technology and modern aids, documentation has never been as simple as it is now. Work Breakdown Structures may be used to describe and document processes. Ecological notes jotted in the field can be transformed and analyzed in the laboratories to develop insight into management. Documentation at each level of implementation will help develop better plans in future.

Depending on the context, it can be as simple as a notebook, or as complex as a computerized database. Records are means to monitor progress and problems, and a way to report them within an organization. It should be ensured that each action team has a useful record-keeping system, and that this system is periodically updated for adaptability and relevance

The metadata will take care of proper documentation in the process of digital databases. Therefore metadata standards should be followed.

5.6.3 Organizational Alignment (Technology, Organizational and Behavioral Innovation) through innovative and sustainable plans.

To accommodate GITOPPFS into the existing structure of planning of forestry sector, organizational alignment is essential. This alignment is required at five levels –

Central Government- At the Central Government level there shall be a National Technology Applications and Development Division, which will ensure efficient applications of technology in forestry and allied issues and issue guidelines from time to time. It will also act as a link between the technology sector and the planners. The National Forestry Database Repository shall be responsible for maintenance of database at the national level, which is required for planning from time to time

State Level- There shall be a State Applications and Development Division, which will assist the state level planners especially the Principal Chief Conservator of Forests. The State Forestry Database Repository shall maintain a state level database of forestry and allied issues. This division shall function as a guiding factor for planners and policy makers at the state level.

District Division Level

The actual plans are made at this level and this is the level, which forms a link between the field executives and plan implementers. The Forestry Database Research and Development Center, proposed to be established, will be the coordinating component of the forest department which will be responsible for generation and conversion of spatial data, training field executives (Deputy Conservator of Forest, Assistant Conservators and Range Forest Officers). This center will be responsible for technology orientation at this level. This training will be basically to train middle level executives in handling various software packages, remote sensing data interpretation, applications of various, data conversion techniques, awareness towards data standards and quality control.

Taluk Level- (Range Level)- The range head quarter will be used as a training facility. The staff from the FDRDC will train the frontline staff. The Training Team will go up till the round level to impart training. The training will basically consist of handling Global Positioning System, Personal Digital Assistants, visual interpretation of satellite data, ground validation techniques, large scale resource surveys, generating database.

All these establishments at various levels shall bear the responsibility of generating awareness towards technology to bring about attitudinal change and come out of the "technology not for me syndrome".

5.6.4 Policy Guidelines

Policy guidelines are required both at the level of the Central and the State. Policy is basically the role of power in the interaction between knowledge maker and the policy maker. (Majchrzak, 1994). In India as far as the forestry sector is concerned the Central policies are a driving force for the policies that are formulated at the State level.

1. Policy Guidelines at Central Government

a. While developing GITOPPFS an expert opinion has been sought from various levels of planners and policymakers. An inherent consensus and rich experience of a cross section of people who matter, has gone into it. The vital needs highlighted by the National Forest Policy such as conservation of forests, regenerating degraded forest blanks, increasing of forest areas to one third of geographical area etc are effectively addressed by Geoinformation technology and how it can be made part of forest sector has been brought out by this research. On the other hand, provisions laid down in the National Forest Policy 1988 and the National Forestry Program, 1999 are required to be made specific and conducive for technology incorporation in planning and forest management. Currently technology just finds a brief mention. The policies should focus more on technology use in different facets of management.

b. The Planning documents of the Government of India, namely the National Working Plan Code and the Management Planning Guidelines need to be oriented towards technology use to accommodate technology applications in various areas. This may be facilitated if the proposed GITOPPFS is made an integral part of the aforesaid planning documents. If it is not immediately possible to do so, at least it should be given a status of an associated planning document and in due course the Planning Codes can be revised.

c. There is a need for laying ground for a Geoinformation Policy with specific provisions for environmental and forestry related issues. Unless Government issues any guidelines it becomes very difficult for individual planners to become innovative in planning. Planners are usually reluctant to go for new technology because they feel their decisions might misfire and that they will be held responsible. If guidelines are in place, planners feel that they are appropriately backed. The questionnaire survey strongly indicates that planners and policy makers appreciate technology and that they feel that Geoinformation Policy will be very significant step conducive for applications in forestry. As regards data standards are concerned, all such organization, which does not follow them, should not be granted Government funds for functioning unless they do so. The Government should make data standards mandatory.

d. There is enough edge to the technology environment in the country, but the organizations involved in the propagation of technology need to be proactive. There needs to be a thrust outreach program. Passive trainings imparted to a few personnel are not going to make much difference. The technology environment in the country, though it is conducive, has not been able to make a dent as far as institutionalization of technology into forestry sector is concerned.

e. The States should be directed to spend certain amount of budget on technology applications so that more and more of it percolate down to the desired level.

f. All the Government of India organizations dealing in technology related issues need to come to a common platform to device means for enhanced

applications in forestry. The Ministry of Environment and Forests, Government of India can play a significant role of coordination.

g. The GITOPPFS may be used to reinforce the planning documents of the Government so that it assimilates down to the plan making level uniformly over the entire country.
h. The states may be issued a directive to prepare plans and implement plans in totality and create technology environment wherever it does not exist.
i. The multi faceted GITOPPFS should be used in decision making at the Government of India policymaking level.

2. Policy Guidelines at State Level

Forestry being a subject directly under the control of states they have a major role to play. The states are required to bring about an extensive technological renovation in planning and management of forests. The states may have to come out with a policy on the following lines.

- There should be compulsion on use of technology wherever possible and to ensure this accountability framework should be laid down.
- Enough funds should be kept earmarked and these should be strictly monitored to ensure appropriate utilization.
- The associated plans developed along with the Forest Plans namely Eco- tourism plan, Joint Forest Management Plan etc. should make full use of technology analogous to the database generated by GITOPPFS.
- Guidelines may be issued to the concerned department to institutionalize the GITOPPFS.
- Forest department which has a history of generating spatial data should be made a nodal agency to generate spatial data which will be usable by other departments like rural development, revenue, horticulture, water resources, agriculture and other allied departments. The data can be marketed to generate revenue.
- The data generated may also be supplied on costs to private entrepreneurs who need it. This will generate revenue for the state government.

- The capability of the GITOPPFS to give effect to Multi Criteria Decision Making and Planning Support Systems may be popularized to make decision making an unbiased affair based on facts.
- The capabilities of generating Ecological Status Models using the GITOPPFS find utility in planning for developmental activities. Thus this may be popularized with other departments.
- GITOPPS will be able to assist in economic evaluation of natural ecosystem, hence this potential needs to be cashed and embarked upon to counter irrational development at the cost of natural ecosystems
- The GITOPPFS has potential tools to handle conflict situations, which can be, strengthen the implementation and enforcement of environmental laws.
- The components of Quality Organization proposed by GITOPPFS at the state and the division level should be immediately established.
- The data standards developed need to be made effective through a Government notification and the standards need to published in the Gazette.

6. Conclusions

The main objective of research study consisted of technological revitalization of forest planning process by analyzing the existing planning process and coming out with strategy to overcome various difficulties and to address the lacunae. SWOT analysis, identification of technology potential in various aspects of planning and management, development of process models, use of workflows, user feedback through questionnaires and prescribing data standard requirements, followed by development of planning and policy guidelines was attempted.

a. Sub-objectives achieved, seeking answers to the research questions:

1. **Is the current plan preparation process conducive to the changing scenario, from extraction oriented to conservation oriented and traditional to technology oriented?**

   The study has come out with a detailed situation analysis of forestry planning and management in India in the form of Extended SWOT Matrix. Expert opinions sought through administration of questionnaires, presentations made and interviews, significantly helped in carrying out the situation analysis and review of the current planning process. The lacunae observed in the existing processes were

   1. Delay in plan preparation
   2. Lack of data standards
   3. Lack of digital databases
   4. Extremely field intensive, resulting in loss of resources.
   5. Scope for enhancement of quality.

The Extended SWOT could be condensed to come out with following analysis

a. Need for incorporation of Geoinformation technology in various aspects of planning and management in forestry sector.

b. Organizational Alignment (Technology, Organizational and Behavioral Innovation) through innovative and sustainable plans.

2. What are the probable areas where Geoinformation Technology can be applied?

The study has identified various areas in forestry planning and management from the perspective of applications of Geoinformation technology and its potential and accessibility of these technologies for the forest department

Some major advantages of using Geoinformation technology noticed were-

a. Reduction in time dedicated to surveys and assessments.
b. Quality enhancement in field work.
c. Digital outputs which are easy to access modify, retrieve and maintain.
d. Accuracies in generating framework data.
e. Possibility of large scale automated surveys
f. Facilitated automated mapping.

3. What are the inconsistencies in data being currently generated?

In the present Planning Process, the whole work is done in bits and pieces. There is no mechanism to integrate. Traditional approach is based on manual methods.

Some of the major inconsistencies noticed in generation of data in the traditional approach were as follows-

a. Scale discrepancies leading to ownership and legal conflicts with other Government departments and private owners.
b. Incompatibility in databases of administratively distinct adjoining forest divisions.
c. Difficulties in detecting encroachments.
d. Lack of analytical capability of the database.
e. Little or no interoperability in databases
f. Lack of data sharing.

4. Is it possible to develop and establish data standards to ensure data sharing at local, regional, state and national level? If yes, How?

The study has come up with data standards for forestry sector in India. The expert opinions obtained through various means mentioned earlier and review of some of the standards developed by other non-forestry organizations made it possible to identify themes for which data standards are required. For such themes data standards were developed.

The data standards developed were-

- Attribute Standards - Administrative Units- Forests
- Attribute Standards- Territorial Forest Units
- Attribute Standards- Legal Sub-division (Units)
- Attribute Standards - Management Units
- Forest Type and composition attribute Standards
- Indicative Standards for selected Ecological Attributes (Non Champion and Seth Classes)
- Structural (Density) Classification of Forests
- Shrub, herbs and Grass Cover%
- Tree Size Classification Standards
- Existing Standards proposed to be used for Forest Working/ Management Plans

5. Is it possible to adopt an integrated approach to technologically revitalize the planning process?

The study has come out with a definite conclusion proposing an integrated planning approach. Planning in a piecemeal manner, as being done presently might help in achieving success in terms of completing the activities or tasks but not the objectives. One of the significant findings of the study is a transformation from the planning approach being used presently "Data Oriented Compilation" to "Analysis Oriented Integration." which is proposed

6. Is adoption of Geoinformation technology the ultimate answer or can reliance be placed on some traditional or semi traditional methods? If yes, which ones?

The Study has come out with a detailed Geoinformation Technology Oriented Planning Process (GITOPPFS) in the form of process models. Quality organization and Quality Work Instructions have been brought out to facilitate quality enhancement in planning. The GITTOPPFS has taken into consideration the merits of the existing two planning processes, since technology may not necessarily have answers for all facets of forest planning and management. In such cases technology reinforcement has been proposed for strengthening.

The adoption of the proposed process is expected

- To reduce time consumed in plan preparation.
- To enhance qualitative aspects of plans.
- To assist planners in decision making.
- To improve overall resource management at the field level.
- To monitor plan implementation process
- To optimize planning and management.

7. **Is it possible to get realistic results by combining various planning components into a management scenario?**
8. **Is it possible to get realistic evaluation by comparing various planning process scenarios to ascertain the best possible approach? What further analysis would be required to assess performance of the so-called best/optimal approach?**

Three planning processes were compared. The comparison was carried out using certain performance indicators and using stylized case studies. The features common to traditional, Semi technological and GITOPPFS were compared together. The performance assessment of newly proposed processes was done using a performance scale. This comparison gives an overview to the planners and policy makers as to why GITOPPS should be adopted. The study makes out case for GITOPPFS as an optimal planning process.

9. **What modifications would be required at the policy, administration and management level in order to adopt the new planning process?**

The research findings of the study were very significant in developing forestry planning, implementation and policy guidelines. These guidelines may prove helpful in revision of the existing Government planning documents and in laying down a framework for developing a Geoinformation Policy or Law.

The guidelines proposed are focused on following issues-

- Institutionalization of the GITOPPFS.
- Technology oriented human resource development.
- Development of technology oriented infrastructure.
- Modifications in organizational structure of the department at the state and central level.

10. What is the impact of Geoinformation Technology on the planning process?

The study through its various research findings indicates that a GITOPPFS approach in plan preparation and implementation is possible. Such an approach will enhance planning capability with reference to quality, efficiency, effectivity and sustainability and thus help develop sustainable plans. The study establishes a case for adoption of Geoinformation technology by planners and policymakers.

The Geoinformation Technology Impact, for following indicators, in terms of performance level has been found to be-

Time- High
Cost- Moderate
Quality- Very High
Level of Standardization- Very High
Adaptability- Low

b. Future Scope of Work:

The future avenues of research which originate from this study are as follows-

1. A project of plan preparation using GITOPPFS for a particular forest division might be taken up to establish credentials.
2. A Forestry Information System may be developed.
3. An Operations Management research in furtherance of the present results may be taken up.
4. A GITOPPFS training content may be developed to device tailor-made courses for the forest departments of states and Union Territories

List of Abbreviations

CCF	-	Chief Conservator of Forests
CF	-	Conservator of Forests
CFWP	-	Conservator of Forests Working Plan
DB Gen.	-	Database
DB Provision	-	Database Provision
DFE	-	Directorate of Forest Education
F&B	-	Feedback and Briefing
FCWFG	-	Flouristic Composition with Flouristic Groups
FDRDC	-	Forestry Database Research and Development Center
FSI	-	Forest Survey of India
GITOPPFS	-	Geoinformation Technology Oriented Planning Process for Forestry Sector
GOI	-	Government of India
ICFRE	-	Indian Council OF Forestry Research and Education
IC&V	-	Interaction, Communication & Verification
IGNFA	-	Indira Gandhi National Forest Academy
IIFM	-	Indian Institute of Forest Management
MOEF	-	Ministry of Environment and Forests
MPO	-	Management Plan Officer (for Protected Area)
MPO	-	Management Planning Officer Area
NFDR	-	National Forestry Database Repository (Nodal Agency FSI)
NTADD	-	National Technology and Application Division
PA	-	Protected
PCCF	-	Principal Chief Conservator of Forests
RFOT	-	Range Forest Officer Territorial
RFO	-	WP Range Forest Officer Working Plan
SFDR	-	State Forestry Database Repository
STADD	-	State Technology Applications and Development Division
W/MPO	-	Working Plan Officer/ Management Plan Officer (Working Plan for Mnaged Forests and Management Plan for Protected Area
WII	-	Wildlife Institute of India
WMP	-	Wildlife Management Plan
WPO	-	Working Plan Officer (for Managed Forest Plans)

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Glossary

Annual Plan of Operations- A layout of prescriptions and operations undertaken in a forest division for a particular year.

Beat- A territorial charge primarily protective in scope; subdivision of Range; usually the charge of the Forest Guard or Forester.

Blocks- (a) A main territorial division of forests, generally bounded by natural features and bearing a local proper name.

Circle- A territorial area of forests under the control of a Conservator of Forests.

Compartment- A territorial unit of a forest permanently defined for the purposes of administration, description and record.

Compartment History- record of all events effecting the forestry of an individual compartment.

Division- It is an administrative forest unit under the control of a Divisional Forest Officer/ Deputy Conservator of Forests.

Eco development Plans- These are basically sub plans or special plans associated with the working plan aimed at carrying out eco-developmental activities concerning the local people.

Forest Management- The practical application of the scientific, technical and economic principles of forestry.

Forest Organization- The systematic sub division and arrangement of forest areas with a view to regular management: sometimes extended to include staff, plant etc.

Forest Range- An executive unit, usually the charge of a forest ranger.

Forest Type- A category of forest defined generally with references to its geographical location, climate and edaphic features, composition and condition.

Growing Stock- The sum (by number or volume) of all the tree growing in the forest or a specific part of the forest.

Habitat Components A simplest or a relatively complex entity regarded as a part, of an area or type of environment in which an organism or biological population normally lives or occurs (Thomas 1979).

Joint Forest Management Plans- This is a sub-plan or a special plan which elaborates on prescriptions related to participatory forest management.

Managed Forests- All categories of forests excluding protected areas managed for multiple use.

Management Prescription- Prescriptions elaborated in the Working Plan or a Management Plan

Old Growth- A stand that is past full maturity and showing decadence: the last stage in forest succession (Thomas 1979)

Plan Area- The area that has been identified to prepare a Working Plan or Management Plan.

Profiles of forests- Profiles elevation drawings of a section of forests that depict the structure of the forests

Protected Areas-These consist of areas own by the state and dedicated to the conservation of scenery and natural and historic objects of national significance and to the conservation of wild animals and plants by such means as to leave them unimpaired for the enjoyment of the present and the future generation. These consist of National Parks and Sanctuaries that are IUCN Protected Area Categories.

Regeneration Surveys- A survey for assessment of established and unestablished regeneration generally by sample enumeration.

Round- An area under the jurisdiction of a Forester or a Deputy Ranger.

Silivculture- The art and science of cultivating forest crops

Site Quality- A measure of the relative productive capacity of a site for a particular species. The top height as it varies with age is generally the basis of classification.

Sub compartments- A subdivision of a compartment generally of a temporary nature, differentiated for special description and treatment (preferably designated by a,b,c…).

Taluka- A recognized revenue sub-division of the district which is a sub -district level administrative unit headed by a an Executive Magistrate

Territorial forest divisions- Divisions which actually manage the forests and involved with the actual execution of the working plan.

Volume Table- It is designed to cover the whole range and dimensions of species.

Working Circle-A forest area (forming the whole or part of the Working Plan area) organized with the particular object and under one silivicultural system and one set of Working Plan prescriptions. In certain circumstances working circles may overlap.

Working Plan-A written scheme of pf management aiming at continuity of policy and action and controlling the treatment of forests. It is an instrument of forest management.

Yield- The volume or number of stems that can be removed annually or periodically, or the area over which fellings my pass annually or periodically, consistent with the attainment of the objects of management.

Appendix I - Forestry Scenario in India and elsewhere

Table 1. Forest area in last five decades(in million hectares)

Year	Recorded Forest Area*	Forest Area as Landuse**
1951	71.80 (21.84 %)	40.48 (14.24 %)
1961	68.96 (20.98 %)	54.19 (18.09 %)
1971	74.83 (22.76 %)	63.77 (21.03 %)
1981	75.00 (22.82 %)	67.47 (22.19 %)
1991	77.00 (23.42 %)	67.87 (22.24 %)

*Source: Ministry of Environment and Forests, Govt. of India

**Source: Ministry of Agriculture

Figures in parenthesis are percentage of geographic area/reported area

Table-2: Forest Cover and Density Classification

Forest Area by Crown density		
Class	**Area (km^2)**	**Percentage of Total Geographical Area**
Forest Cover		
Very Dense forests >70%	51,285	1.56
Moderately forests 40-70%	339,279	10.32
Open Forests 10-40%	287,769	8,76
Total Forest Cover	**678,333**	**20.64**
Non Forest Cover		
Scrub<10%	40,269	1.23
Non Forest	2,568,661	78.13
Total Geographic Area	**3,287,263**	**100**

Sources: (State of Forest Report, Forest Survey of India, 2003)

Table-3 Forest cover as estimated by the FSI from 1987 to 2003 (sq km)

Assessment Cycle	Year of Publication of State of Forest Report	Forest Cover	% of Geographical Area
First	1987	640,819	19.49
Second	1989	638,804	19.43
Third	1991	639.364	19.45
Fourth	1993	639,386	19.45
Fifth	1995	638,879	19.43
Sixth	1997	633,397	19.27
Seventh	1999	637,293	19.39
Eighth	2001	675,538	20.55
Ninth	2003	757,009	23.03

Table-4 Forest cover and per capita availability in different regions/ countries

Region/ Country	Percentage of Forest cover to land area (1995)	Per capita forest (ha)
World	26.6	0.64
Asia	16.4	0.1
Africa	17.7	0.7
Europe	41.3	1.3
China	14.3	0.1
Pakistan	2.3	0.01
Nepal	33.7	0.2
Bangladesh	7.8	0.02
Sri Lanka	27.8	0.1
Indonesia	60.6	0.6
Malaysia	47.1	0.8
Philippines	22.7	0.1
Japan	66.8	0.2
USA	23.2	0.8
India	15.7	0.06

Source: State of World Forests FAO (1999)

Appendix-II

Questionnaire for Research Purpose

I. Objective of the Questionnaire -

The objective is to elicit response as to need of Geoinformation Technology in revitalizing the Planning Process of Forestry sector in India so that management of forestry and allied resources is facilitated and improved. The response would be helpful in the M.Sc. Dissertation of Mr. Shivaji Chavan, (Forest Officer from Maharashtra Forest Service) titled "**Role of Geoinformation Technology in Strengthening the Planning Process of Forestry Sector in India".** The M.SC. Program is a collaborative project of the Indian Institute of Remote Sensing, Department of Space, Government of India and the ITC, Netherlands

II. The Project Objective and Sub- Objectives are-

Objective

To analyze, strengthen, develop, evaluate, standardize, and establish the forestry sector Planning Process from Geoinformation Technology perspective.

Sub Objectives

1. To analyze the current planning process.
2. To strengthen the planning process using Geoinformation Technology
3. To develop an integrated Geoinformation technology oriented planning approach.
4. To develop and evaluate different planning processes to adjudge the optimal approach.
5. To standardize database generation for enabling interoperability and establishing guidelines for their incorporation in the planning process.
6. To establish guidelines for plan preparation and implementation to steer the mainstream planning process and policy.

(The Planning Process intended to be addressed is the Working Plan Code for Managed Forests and Management Planning Guidelines for Protected Areas)

III. Questionnaires are also intended to be administered to the following Target Groups (with appropriate modifications, if required)

a) Retired Senior forest planners and policy makers
b) Serving Policy makers and Planners related to forestry and allied resources.
c) Working Plan and Management Planning Officers.
d) Field Executives
e) Trainers
f) Academicians/ Scientists
g) Non Government Organizations

IV. The Questionnaire

1. Name-

2. **Address Professional-**

_____

_____

3. Telephone Nos. -

a. Office - _____

b. Residence - _____

c. Cell - _____

4. Disciplines involved in, while serving as a Forest Officer/Civil Service Officer-

(Please tick the relevant discipline)

a. Forest Planner ☐

b. Policy Maker ☐

c. Trainer ☐

d. Academician ☐

e. Scientist ☐

f. Technocrat ☐

g. Field Executive ☐

h. Consultant ☐

i. Politician ☐

Note: Before proceeding on to answering further questions kindly have a look at some Geoinformation Technologies and tools available for Technological revitalization of the Planning Process for better management of the forestry and allied resources. Kindly tick the one with which you have got chance to be associated with.

a. Remote Sensing ☐

b. Geographical Information System ☐

c. Global Positioning System ☐

d. Geo Relational Database Management Systems ☐

e. Web GIS ☐

f. Mobile GIS for real time data collection ☐

g. Use of SRTM data for ☐

h. Use of LiDAR Technology ☐

Generation of topographic maps

I. Wireless Application Protocol ☐

j. Use of Internet Facility ☐

k. Geoinformation ☐

l. Management Tools ☐

You may kindly add other relevant technologies and tools if you feel so.

_____

_____

5. Do you think that the current planning process of forestry is conducive to the changing scenario in the light of advanced technology available?

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

_____

_____

6. If you think that considerable amount of technology needs to be brought into the planning process, which of the following planning documents you think are required to be dealt with (Please prioritize by writing no. in box)

a. National Working Plan Code for Managed Forests ☐

b. Guidelines for Management Plans for Protected Areas. ☐

c. Eco-development Planning Guidelines. ☐

d. Eco tourism Plans ☐

e. Joint Forest Management Plans. ☐

7. Do you think that the following Policy Documents adequately address the Issues related to incorporation of Geoinformation Technology for forestry and allied resources management?

a. National Forest Policy

b. National Forestry Action Program

c. National Wildlife Action Plan

d. National Training Policy

Options		**Percentile**									
		10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can’t say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

8. Do you thing that the current planning processes vide various planning documents addresses the issues raised in the National Forestry Action Program?

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

9. (a) Do the planning documents address the technology use issues to an appropriate extent? (Reference to National Working Plan Code and Management Planning Guidelines) Please tick the relevant reaction.

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

_____

_____

(b) If No, which are the probable areas where modern tools mentioned earlier can be of use to facilitate planning and execution of plans? (Please prioritize by writing number in the box against the probable areas)

a. Surveying and resource assessment ☐

b. Generation of spatial data (Mapping) ☐

c. Storage, retrieval and maintenance ☐

d. Process evaluation of spatial and non-spatial data ☐

e. Collection of data for management ☐

f. Dealing with encroachment ☐

g. Analyzing changes in distribution of forestry and allied resources ☐

10 (a) Since spatial databases are now intended to be maintained in computers/digital domain, do you feel that currently any spatial data standards compatible at local, state, regional and national level, exist in the forest department? Is there any amount of "Interoperability"

Interoperability of Geospatial Data has been introduced early in the 1990s as a solution for sharing and integration of geospatial data and Geoprocessing Resources.

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

_____

_____

(b) If no, do you feel that there is an emergent need for spatial data standards (addressing interoperability issues) with compatibility at local, regional, state and national level? Interoperability is intended to save Government resources from being wasted and to ensure optimum utilization of resources.

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes, urgent need											
b. Yes, but can be gradually brought in through proper planning and policy											
c. Useful but can wait											
d. Mixed reaction											
e. No											
f. Can't say											

Please substantiate, with reference to your response.

(c). Are there any current data standards being followed in the Forest Survey of India?

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes											
b. To a considerable extent											
c. To a limited extent											
d. Mixed reaction											
e. No											
f. Can't say											

Please substantiate, with reference to your response

(d) Are these data standards compatible with the standards set forth by the National Spatial Data Infrastructure?

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

(e) Kindly enlist the constraints in maintaining compatibility with the NSDI standards?

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

(f) Is it possible to develop spatial data standards for the Forestry Databases to ensure Interoperability at local, regional, state and national level?

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. To a considerable extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. To a limited extent	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

_____

_____

(g) If your answer to (f) is positive kindly enlist the probable efforts required in order to bring Interoperability.

_____

_____

_____

_____

_____

11. **(a) This Project proposal has identified two prevailing planning processes as far as preparation of Working Plans for managed forests and Management Plans for Protected Areas. These are the**

i. **Traditional Approach-** (where very little or no use of modern technology is done) and

ii **Semi Technological Approach-** Where modern tools and technology are used in certain aspects of plan preparation. The use of technology is to varying degrees.

Do you think that there can be additional approaches than the one mentioned above?

Options		**Percentile**									
		10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
a. Yes	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(b) If yes please kindly elaborate as to what approach would be the best as per your opinion

_____

_____

_____

_____

_____

12. **This project intends to develop a third approach, which would be "Geoinformation Technology Oriented". Do you feel that with the availability of technology for which the Government has spent lot of funds, such planning approach is required and will lead to optimization of resources?**

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Urgently necessary											
b. Necessary											
c. Required but can wait											
d. Mixed reaction											
e. No											
f. Can't say											

Please substantiate if you intend to provide additional information

_____

_____

13. **Forest Department is one of the oldest departments and is custodian of large amount of geographical data. It shares boundaries with many other landuses and situations of constraints are common. A major part of the onus of protecting and conserving the environment lies with forest departments of states and Union Territories. Under these circumstances do you feel that there should be a Geoinformation Policy in place, which will avoid duplication of data generation and optimize the resource use by the Government?**

Options		Percentile									
		10	20	30	40	50	60	70	80	90	100
a. Urgently necessary	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. Necessary	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. Required but can wait	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. Mixed reaction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. No	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. Can't say	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please substantiate, with reference to your response.

_____

_____

14. If, in your opinion, there has not been enough incorporation of modern tools and technology in management of forests, wildlife and allied resources, its planning and policy making, what might be the probable reasons? Please choose from amongst the following options. Please prioritize the options you feel relevant in your opinion, by writing serial nos. 1,2.. etc (that is the most responsible factor is numbered 1 and so on) in the boxes.

a. Inadequate inclination ☐

b. Lack of skilled manpower ☐

c. Attitudinal rigidity to accept change ☐

d. Lack of awareness as regards technology available ☐

e. Dearth or crunch of funds ☐

f. Doubts about reliability of modern tools available (May kindly refer those mentioned earlier in the questionnaire) ☐

g. Traditionalism and regimentation ☐

h. Problems related to recognition of talent available within the department ☐

i. Technology not required ☐

j. Problems related to service conditions ☐

k. Inadequate technology training infrastructure within the MOEF and State Forest Ministries ☐

l. Inadequate technology environment and infrastructure in the country to cater to training needs. ☐

15. Do you think that the issues, amongst the above, which you feel might be responsible for inadequate technology incorporation might be addressed through the following(Please prioritize by writing numbers in the boxes):

a. Technology Oriented Planning Process and Management and Implementation strategy. ☐

b. Geoinformation Policy for generation, sharing and dissemination of spatial data in digital domain ☐

c. Geoinformation Law ☐

16. Kindly offer your comments on the results of the Sub Objectives presented:

1. **To analyze the current planning process.**
   (SWOT Analysis)

2. **To strengthen the planning process using Geoinformation Technology**
   (Technology Potential and Accessibility)

3. **To develop an integrated Geoinformation technology oriented planning approach.**
   (The Geoinformation Technology Oriented Process Developed)
   (Technology Potential and Accessibility)

4. **To standardize database generation for enabling interoperability and establishing guidelines for their incorporation in the planning process.**

   (Key Issues Data Standards Developed so far)

5. **To develop** and **evaluate different planning processes to adjudge the optimal approach**

(Key Issues for comparison of the Planning Processes)

6. **To establish guidelines for plan preparation and implementation to steer the mainstream planning process and policy.**

(Key Issues for Policy and Plan formulation)

17- The following space is provided for reaction to other issues which might not have been covered by the aforesaid questions.

Concluding Note- The reactions of the target groups is going to be of prime importance in developing a Technology Oriented Planning Process. Once the approach is developed another questionnaire will be administered to seek valuable suggestions and for performance evaluation. This will be of immense help in developing Planning and Policy Formulation Guidelines. The author/ researcher sincerely thanks all those who spared their valuable time. There contribution will be duly acknowledged.

About the researcher- I am a forest officer from the Maharashtra Forest Service currently undertaking an M.Sc. Course, at the Indian Institute of Remote Sensing. I have experience of working in the Maharshtra Forest Department in various capacities. I have been on the Government of India deputation with the Wildlife Institute of India and the Directorate of Forest Education. I have been on central deputation for around nine years. I have some 13 years experience in application of modern tools and technology in forestry, wildlife and allied resources.

I sincerely thank you for your precious response.

Shivaji Chavan

Note: This questionnaire will be collected personally. If not so may please dispatch it or deliver to the following address:
Address for correspondence-

S.G.Chavan,
Geoinformatics Division
Indian Institute of Remote Sensing,
4 Kalidas Road,
Hathi Barkala,
Dehradun. 248001
Uttranachal
Phone No. 91-135-2774513
Cell Phone- 91+ 9897274565
Email- shivachavan@yahoo.com
shivachavan@iirs.gov.in
shivachavan13198@itc.nl

Appendix III

a. List of Experts Consulted (Individual Consultation)

Mode of Consultation-Questionnaire (initial stage)

Administration/email/Interview

S. No	Name	Designation
1.	Shri Anil Kumar, IFS	Director Forest Education, Government of India, Dehradun
2.	Shri S.P. Kulshreshtha	Technical Director, NIC, presently with the Indira Gandhi National Forest Academy, Dehradun
3.	Dr. S.P. Singh, IFS	Secretary, Indian Council of Forestry Research and Education, Dehradun
4.	Shri Arindom Tomar, IFS	Associate Professor, Indira Gandhi National Forest Academy
5.	Shri T.C. Nautiyal, IFS	Registrar, Forest Research Institute, Dehradun
6.	Shri A. Agrawal, IFS	Faculty, State Forest Service College, Government of India, Dehradun
7	Shri P.R. Sinha	Director Wildlife Institute of India, Government of India Dehradun.
8	Dr. P.K. Mathur	Head, Landscape Management Division, Wildlife Institute of India, Dehradun.
9.	Dr A.J.T. Johnsingh	Dean, Wildlife Institute of India, Dehradun
10	Dr. Y.V. Jhala	Scientist "SF" Wildlife Institute of India
11.	Dr A.K. Gupta, IFS	Chief Conservator of Forests and Head Wildlife Population Ecology Division, WII, Dehradun
12	Dr. M.S. Rana	Librarian and Documentation Officer, Wildlife Institute of India
13	Dr. Vinod Rishi	Director, Indira Gandhi National Forest Academy
14	Dr. A.K.Upadhyaya	Joint Director, Indira Gandhi National; Forest Academy
15	Dr. S.S. Negi	Director, Forest Research Institute, Dehradun
16	Dr. A.K. Saxena	Joint Director, Forest Survey of India, Dehradun
17	Mr. R.V. Singh	Retd. President, Forest Research Institute and Colleges, Dehradun
18.	Dr Shashi Kumar	Deputy Director General (Research), ICFRE, Dehradun
19	Ms. Neeta Hooda	Head, Climate Change, FRI, Dehradun
20.	Dr. Jha	Head, Regional Remote Sensing Centre, Dehradun
21	Dr A.K. Tiwari	Faculty Forestry, Regional Remote Sensing Center, Dehradun

S. No	Name	Designation
22	Mr. K.K. Das	Faculty, IIRS, Dehradun
23	Mr. Paramjeet Singh	Conservator of Forests Dehradun
24	Mr. D.V.S. Khati	Chief Conservator of Forest Planning, Policy and Finance
25	Mr. P.K. Pant	Conservator of Forests, Technology Development, Uttaranchal Forest Department
26	Mr. Ramesh Chandra Sharma	Divisional Forest Officer, Karnaprayag
27	Ms. Bharti Joshi	Associate Professor, IGNFA, Dehradun
28	Shri Yogesh Singh	Registrar, Forest Research Institute, Dehradun
29	Shri M.M. Pant	Director, IGNFA, Retired
30.	Shri B.K.Singh	Principal Chief Conservator of Forests, Mahrashtra
31	Shri Ravi Wankhede	Deputy Director Melghat Tiger Reserve, Mahrashtra
32	Shri Sunil Banubakode	DFO and Publicity Officer, Forest Department, Government of Maharsahtra
33	Shri Ravi Singh	Secretary General, WWF, India
34	Shri B. Muzumdar	Principal Chief Conservator of Forests(Wildlife) Maharashtra
35	Shri P.K. Sen	PCCF, Bihar(Retd.) Director Project Tiger, WWF, India
36	Shri Arindran	Head, Indira Gandhi Conservation Monitoring Center, WWF
37	Shri RPS Katwal	Additional Director General of Forests, Ministry of Environment and Forests (MOEF), GOI, New Delhi
38	Dr. Anmol Kumar	Deputy Inspector General, Wildlife
39	Shri J.V. Sharma	Deputy Inspector General,(MOEF,GOI) Policy and Law
40	Shri A.K.Goyal,	Deputy Inspector General,(MOEF,GOI) Research and Training
41	Shri Dinesh Kumar Tyagi	Deputy Special Commissioner, Maharshtra Sadan
42	Shri Nitin Kakodkar	Field Director, Melghat Tger Reserve
43	Shri Bhoop Singh	Director, NRDMS, Department of Science and Technology, New Delhi
44	Brig. Shiv Kumar	Director, NSDI Secretariat, New Delhi
45	Dr.(Mrs) Vandana Sharma	Senior Technical Director, Head Remote Sensing and GIS, National Informatics Center
46	Shri James Kurian	Director, NSDI, DST, New Delhi
47	Shri Sanjay Gehlot	Information and Technology, NIC, New Delhi
48	Shri S.P. Karthikeyan	Scientist “SD” Remote Sensing and GIS,

S. No	Name	Designation
		NIC, Delhi
49	Shri K.K. Gupta	Superintending Surveyor, NSDI, Secretariat, New Delhi
50	Shri O.P. Ghaba	Deputy Director, DST, New Delhi (Ex. Forest Survey of India
51	Shri Bardekar	Conservator of Forest, Chandrapur, Maharsahtra
52	Dr. V.B.Mathur	Head, Remote Sensing and GIS AND Protected Area Network, Wildlife Institute of India.
53	Shri D.M. Shukla	Chief Conservator of Forests, Andaman and Nicobar
54	Shri Ajit Kumar Srivastava	Conservator of Forest Working Plan, Jabalpur, Govt. of Madhya Pradesh
56	Shri H.S. Pabla	Chief Conservator of Forests Policy and Technology, Govt. of Mahya Prdesh
57	Shri Okhandiar	Conservator of Forests, Govt. of Madhya Pradesh
58	Shri Sanjay Srivastava	Conservator of Forests, Govt. of Tamil Nadu
59	Dr. Sudhashu Gupta	Director, Gulf of Munnar National Park, Govt. of Tamil Nadu
60	Shri V.B.Sawarkar	Director, Wildlife Institute of India, Dehradun (Retd.)
61	Shri H.S.Panwar	Director, Wildlife Institute of India, Dehradun (Retd.)
62	Shri D.N. Singh	Director, Delhi Zoo, New Delhi
63	Shri Avinash Pathe	Wildlife Institute of India, Dehradun
64	Shri Sushil Sharma	Divisional Manager, Forest Department, Jammu and Kashmir.
65	Shri Suresh Chandra	Principal, State Forest Service College, Dehradun
66	Shri P.R.Patil	Range Forest Officer, Government of Mahrashtra
67	Shri Ashtekar	Joint Secretary, Ministry of Forest, Govt. of Maharashtra
68	Dr. S.H. Patil	Field Director, Tadoba, Tiger Reserve, Chandrapur, Maharashtra
69	Shri S.P. Thakre	Deputy Conservator of Forests, Wardha, Maharshtra
70	Shri Ajay Lal	Assistant Director General, Indian Council of Forestry Research and Education
71	Shri S.S. Notey	Range Forest Officer, Office of the Principal Chief Conservator of Forests, Nagpur
72	Shri M.S. Malik	Conservator of Forests, Haryana Forest Department
73	Dr. Arun Kumar	Director In-charge, Zoological Survey of

S. No	Name	Designation
		India, Dehradun
74	Dr. A.K. Pathak	Scientist, Botanical Survey of India
75	Shri Omkar Singh	Conservator of Forests, New Delhi, Delhi Government
76	Shri S.R. Reddy	Divisional Manager, Forest Development Corporation, Govt. of Uttar Pradesh
77	Shri Santosh Gupta	Divisional Forest Officer, Govt. of Uttranchal
78	Shri G.S. Pandey	Director, Rajaji National Park, Dehrdun
79	Shri Sameer Sinha	Director, Valley of Flowers, Uttranchal
80	Shri S.P. Rayal	Forest Registrar, Head Engineering Cell, Forest Research Institute, Dehradun, India

b. Classroom Sessions and feedback on GITOPPFS and Policy Guidelines

(i)Participants of "Training of Trainers" Course from 4.10.2005 to 7.10.2005 organized at the State Forest Service College, Government of India, Ministry of Environment and Forests, Dehradun.

S. N.	Name of participant	Official address	Home address
1	Yesu Ratnam, Principal	A&N., Islands, A&N Forest Training School	Community Health Centre Bamboo Flat South Andman, Port Blair
2	N.K. Baruah, ACF	Superientendent, Assam Forest Guards' School, Makum, P.O. Makum, Dist, Tinsukia, Assam	Bishnunagar, P.O. Rupai siding dist, Tinsukia, Assam
3	Bashir Ahmad Wani	KFT School Chitternar Bandipur, Kashmir	Gulwanpora, P/O Haiderpora Pin- 190 014 The/Distt Budgam, J&K
4	Kamlesh Pandey, Director	Director, Forester Training School, Hajaribag, Jharkhand	Vill. Barahi , P.O. Akorhigola, Distt-Rohtas, Bihar
5	Keshav Shankar Naik, Dy Conservator of Forests	K.S. Naik, Dy. Conservator of Forest, O.E.C.F &b JFPM, Gungergatti Training Institute, Dharwar 580 000, DHARWAR, Karnataka ☎Ph- 9448629377	K.S. Naik, Dy Conservator of Forests, Near Kalarudreshwar Temple, Gidda road, Kajubag, Karwar, Karnataka ☎ Ph- 08382, 226986

S. N.	Name of participant	Official address	Home address
6	D.V. Ramesh, ACF	Forest Training centre Tattihalla, Via. Ambika Nagar ☎ 08284-267851, Haliyal (Taluk), Karnataka	Forest Training centre Tattihalla, Via. Ambika Nagar ☎ 08284-267851, Haliyal (Tq), Karnataka
7	C. Rajendran, ACF	Principal, Kerala Forest School, Arippa, Chozhiyakode, P.O. Trivendrum (Dt.) ☎ 0474-2442354 Mob. 94447979171	TRA/B-33, Thattinakom, Nalanchira, P.O. Trivendrum. ☎0471- 254 3333 Mob. 9447344090
8	S.G. Raoot, Principal	Principal, MFRC, Upper Plateau, Chikhaldara, Dist Amravati (MS) ☎ 07220, 220230, 220246 (R)	Principal, MFRC, Chikhaldara, Dist Amravati (MS) ☎220246
9	Kalaskar A.S., Director	Forest Guard Training School Jalna Dist. Jalna, (MS) ☎ 02482-231527 e-mail: fgtsjalna_jln @sancharnet.in	c/O Adv. shri S.K. Kalaskar, Station Rd. Nandura Distt.- Buldana (MS)
10	N.N.Janbandhu, Principal	Pirncipal C.F.R.C. Chandrapur Mul Road ☎ 255519	Pirncipal C.F.R.C. Mul Road Chandrapur- 252013
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Appendix IV

Table 5. Changing Role of Foresters in India

Time span	Role of a Forester
1875-1880	**Foresters as Surveyors and adventurers**
1880-1900	**Forester as adventurer, naturalist and anthropologist.**
1900-1925	**Forester 50% Engineer 50% Silviculturist,** • Exploitation for Roads, Railways and Buildings. • Cutting back useless trees
1925-1950	**Forester as a Researcher** • Regeneration of Forests and documentation • Naturally and artificially, Plantations. • Inception of compartment histories. • Developing Management Practices • Utilisation Research • Survey of in-accessible forests in Assam and Andaman. • Uses Seasoning and Preservation of Timber • Manufacture of Paper and Processing of Minor Forest product
1950-1975	**Forester as a anthropologist, magistrate, Policeman, Engineer, and conservationist** • Person with green hands • Knowledge of silviculture, genetics, ecology, soils, plant introduction
1975-1990	**Forester as a Tree Grower** • Managing forests along with plantation • Introduction of fast growing species • Taking of extensive areas for plantation for achieving 33% target • Revision and preparation of new working plans • Introduction of silvicultural systems
1990- 2005	**Forester as a Protectionist, Conservationist, Policeman, Lawyer, Administrator, Manager, Executive and Technocrat.** • Prioritization of Forest Protection • Adoption of newer concepts of Conservation • Effective legislation and its implementation • Strong Protection measures • Joint Forest Management and Eco-development • Landscape Management • Modernization of Office Procedure
2005 onwards	**As technocrat and all the above as well** • Adoption of modern tools and technology to cater to the increasing challenges • A technocratic vision • Technological updating through capacity building

Appendix V- Framework for Extended SWOT Analysis

Constraints	Opportunities	Threats	O/T
Strengths	Set of actions to make use of strengths to take advantage of opportunities Exploit	Set of actions to use the strengths to counter the threats Attack	S/O/T Exploit and Attack
Weaknesses	Set of actions to minimize weaknesses and make use of opportunities Explore	Set of actions to remove weaknesses in front of threats Avoid	W/O/T Explore what to avoid
S/W	S/W/O Explore what to exploit	S/W/T Avoid areas requiring attack	S/W/O/T Strong Competitive Advantage

Appendix VI – Data Standards Developed through the present Study

Standards	Table
Forest Type and Composition Attribute Standards	1
Method and Scale for Forest Attribute Table	2
Indicative Standards for selected Ecological Attributes (Non Champion and Seth Classes)	3
Methods and Scale for Indicative Standards	4
Forest Density Classification Standards (Total Cover, Shrub Cover and Tree Canopy Cover)	5
Methods for crown and stem density classification	6
Shrub, Herbs and Grass Cover% (Method- Field Based)	7
Tree Size Classification	8
Attribute Table for Administrative Units (Forests)	9
Attribute Standards Territorial Forest Units	10
Attribute Standards for Management Units	11
Existing Standards proposed to be used for Forest Working/ Management Plans	12
Attribute Standards Legal Sub-division (Units)	13

Table 1. Forest Type and Composition Attribute Standards

	250000 L1 National Level	**Code**	**50000 L2 State Level**	**Code**	**25000 L3 Division Level**	**Code**	**10000 L4 Range Level**	**Code**	**4000 Beat Level**	**Code**	**4000 Beat Level**	**Code**	**2000 Compartment Level**
CS I	Moist Tropical Forests	CSI_1	Tropical Wet Evergreen Forests	CSI_1_1A	Southern Tropical wet evergreen Forests	CSI_1_1A_C_1	Giant Evergreen Forests			*CSI_1_1A_C_1_(A,B,C-1….n in I, II, IIa, III,IVa and IVb as applicable mentioned as FCWFG)	**I-**Top Canopy Trees **II-** Second Storey Trees **IIa-** Bamboo **III-** Srubs **IVa-** Herbs **IV-** Grasses **(As by CS,1968individually for all categories below with appropriate codes)**	CSI_1_1A_C1_FCWFG_Cl. CSI_1_1A_C1_FCWFG_Ep. CSI_1_1A_C1_FCWFG_Par. **(As by CS,1968individually for all categories below with appropriate codes)**	V Epi. Parasites (As by CS, 1968 individually for all categories below)
						CSI_1_	Andaman's			CSI_1_			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						1A_C_2	Tropical Evergreen Forests			1A_C_2 _FCWFG			
						CSI_1_ 1A_E_1	Andaman's Moist Deciduous Forests			CSI_1_ 1A_E_1 _FCWFG			
						CSI_1_ 1A_C_3	Southern Hilltop Tropical Evergreen Forests			CSI_1_ 1A_C_3 _FCWFG			
						CSI_1_ 1A_C_4	West Coast Tropical Evergreen Forests			CSI_1_ 1A_C_4 _FCWFG			
				CSI_1_1B	Northern Tropical wet evergreen Forests	CSI_2_ 1B_C_1	Assam Valley Tropical Evergreen Forests*(Dipterocarpus)*			CSI_2_ 1B_C_1_ FCWFG			
						CSI_1_ 1B_C_2	Upper Assam Valley Tropical Evergreen Forests	CSI_1_1B _C2(a)	Kayea Forest	CSI_2_ 1B_C2(a)_ FCWFG			
								CSI_1_1B _C2(b)	Mesua Forest	CSI_2_ 1B_C2(b) _FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						CSI_1_1B_C_3	Chachar Tropical Evergreen Forests			CSI_2_1B_C2__FCWFG			
				CSI_1_1O	General Edaphic and Seral Types of wet evergreen forests	CSI_1_1O_E_1	Cane Brakes						
						CSI_1_1O_E2	Wet Bamboo Brakes						
						CSI_1_3O_2S_1	Pioneer Euphorbiaceaeous Scrub						
		CSI_2	Tropical Semi Evergreen Forests	CSI_2_2A	Southern Tropical semi-evergreen forests	CSI_2_2A_C_1	Andaman's Semi Evergreen Forests			CSI_2_2A_C_1__FCWFG			
						CSI_2_2A_C_2	West Coast Semi Evergreen Forests			CSI_2_2A_C_2_FCWFG			
						CSI_2_2A_C_3	Tiruneveli Semi Evergreen Forests			CSI_2_2A_C_3_FCWFG			
						CSI_2_2A_2S_1	West Coast Secondary Semi Evergreen Dipterocarpus			CSI_2_2A_2ES$_1$_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
							Forests						
				CSI_2_2B	Northern Tropical Semi-evergreen forests	CSI_2_2B_C1	Assam Valley Semi Evergreen Forests	CSI_2_2B_C_1(1a)	Assam alluvial Plains Semi-Evergreen Forest	CSI_2_2B_C_1(1a)_FCWFG			
								CSI_2_2B_C_1(1b)	Eastern Sub-montane semi evergreen Forest	CSI_2_2B_C_1(1b)_FCWFG			
						CSI_2_2B_1S1	Sub Himalayan Light Alluvial Semi – Evergreen Forests			*CSI_2_2B_1S1__FCWFG			
						CSI_2_2B_1S2	Syzyzium Parkland						
						CSI_2_2B_2S1	Pioneer Euphobiaceaeous Scrub						
						CSI_2_2B_2S2	Eastern Alluvial Secondary Semi-Evergreen Forests			CSI_2_2B_2S2_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						CSI_2_2B_2S_3	Sub Himalayan Secondary Wet Mixed Forests			CSI_2_2B_2S3__FCWFG			
						CSI_2_2B_C2	Chachar Semi-Evergreen Forests			CSI_2_2B_C2_FCWFG			
						CSI_2_2B_C3	Orissa Semi-Evergreen Forests			CSI_2_2B_C3_FCWFG			
				CSI_2_2E	General Edaphic and Seral Stages of Semi evergreen forests	CSI_2_2E_E_1	Cane Brakes			CSI_2_2E_E_1_FCWFG			
						CSI_2_2E_E_2	Wet Bamboo Brakes			CSI_2_2E_E_2_FCWFG			
						CSI_2_2E_E_3	Moist Bamboo Brakes			CSI_2_2E_E_3_FCWFG			
						CSI_2_2E_E_4	Lateritic Semi-Evergreen Forests			CSI_2_2E_E_4_FCWFG			
						CSI_2_2E_2S_1	Secondary Moist Bamboo Brakes						

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
		CSI_3	Tropical Moist Deciduous forests	CSI_3_3A	Andaman's Moist Deciduous Forests	CSI_3_3A_C_1	Andamans Moist Deciduous Forests			CSI_3_3A_C_1_FCWFG			
						CSI_3_3A_2S_1	Andamans Secondary Moist Forests			CSI_3_3A_2S_1_FCWFG			
				CSI_3_3B	South Indian Moist Deciduous Forests	CSI_3_3B_C_1	Moist Teak Bearing Forests	CSI_3_3B_C_1(1a)	Very Moist Teak Forest	CSI_3_3B_C_1(1a)_FCWFG			
								CSI_3_3B_C_1(1b)	Moist Teak Forest	CSI_3_3B_C_1(1b)_FCWFG			
								CSI_3_3B_C_1(1c)	Slightly Moist Teak Forest	CSI_3_3B_C_1(1c)_FCWFG			
						CSI_3_3B_C_2	Southern Moist Mixed Deciduous Forests			CSI_3_3B_C_2_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						CSI_3_3B_2S_1	Southern Secondary Moist Mixed Deciduous Forests			CSI_3_3B_2S_1_FCWFG			
				CSI_3_3C	North Indian Moist Deciduous Forests	CSI_3_3C_C_1	Very Moist Sal-bearing Forests	CSI_3_3C_C_1_1a(i)	East Himalayan Sal	CSI_3_3C_C_1_1a(i) FCWFG			
								CSI_3_3C_C_1_1a(ii)	Khasi Hill Sal	CSI_3_3C_C_1_1a(ii) FCWFG			
								CSI_3_3C_C_1_1b(i)	East Himalayan Upper *Bhabhar* Sal	CSI_3_3C_C_1_1b(i) FCWFG			
								CSI_3_3C_C_1_1b(ii)	East Himalayan Lower *Bhabhar* Sal	CSI_3_3C_C_1_1b(ii) FCWFG			
								CSI_3_3C_C_1_1c	Eastern *Terai* Sal Forest	CSI_3_3C_C_1_1c FCWFG			
								CSI_3_3C_C_1_1d	Peninsular	CSI_3_3C_C_1_			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
									(coastal) Sal Forest	1d FCWFG			
						CSI_3_3C_C_2	Moist Sal-bearing Forests	CSI_3_3C_C_2_2a	Moist Shiwalik Sal	CSI_3_3C_C_2_2a FCWFG			
								CSI_3_3C_C_2_2b(i)	*Bhabhar* Dun Sal	CSI_3_3C_C_2_2b(i) FCWFG			
								CSI_3_3C_C_2_2b(ii)	*Damar* Sal	CSI_3_3C_C_2_2b(ii) FCWFG			
								CSI_3_3C_C_2_2c	Moist *Terai* Sal	CSI_3_3C_C_2_2c FCWFG			
								CSI_3_3C_C_2_2d(i)	Western Light Alluvium Plains Sal	CSI_3_3C_C_2_2d(i) FCWFG			
								CSI_3_3C_C_2_2d(ii)	App. *Chander* Sal	CSI_3_3C_C_2_2d(ii) FCWFG			
								CSI_3_3C_C_2_2d(iii)	Eastern Heavy Alluviu	CSI_3_3C_C_2_2d(iii)			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
									m Sal	FCWFG			
								CSI_3_3C_C_2_2d(iv)	App. Kamrup Sal	CSI_3_3C_C_2_2d(iv) FCWFG			
								CSI_3_3C_C_2_2e(i)	Moist Peninsular High Sal Forest	CSI_3_3C_C_2_2e(i) FCWFG			
								CSI_3_3C_C_2_2e(ii)	Moist Peninsular Low Sal Forest	CSI_3_3C_C_2_2e(ii) FCWFG			
								CSI_3_3C_C_2_2e(iii)	Moist Peninsular Valley Sal Forest	CSI_3_3C_C_2_2e(ii) FCWFG			
						CSI_3_3C_DS_1	Moist Sal Savannah			CSI_3_3C_DS_1_FCWFG			
						CSI_3_3C_C3	Moist Mixed Deciduous(without sal)	CSI_3_3C_C3_3a	West Gangetic Moist Mixed Deciduo	CSI_3_3C_C_3_3a FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
									us Forest				
								CSI_3_3C_C_3_3b	East Himalayan Moist Deciduous Forest	CSI_3_3C_C_3_3b FCWFG			
						CSI_3_3C_2S_1	Northern secondary moist mixed Deciduous Forest			CSI_3_3C_2S_1_FCWFG			
						CSI_3_3C_2S_2	(Secondary Euphorbeaceous Scrub)			CSI_3_3C_2S_2 FCWFG			
				CSI_3_3E	General Edaphic and seral types of moist deciduous	CSI_3_3E_E_1	*Terminalia tomentosa* Forest			CSI_3_3E_E_1_FCWFG			
						CSI_3_3E_IS_1	Low alluvial Savannah Woodland(*Salmalia-Albizzia)*			CSI_3_3E_IS_1 FCWFG			
						CSI_3_3E_1S_2	Eastern Hollock Forest(*Terminalia*	CSI_3_3E_1S_2_2a	*Terminali Largerostroemi*	CSI_3_3E_1S_2_2a_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
							myriocarpa)		*a*				
								CSI_3_3E_1S_2_2b	*Terminalia-Duabanga*	CSI_3_3E_1S_2_2b_FCWFG			
						CSI_3_3E_2S_2	(Dry Bamboo Brakes)						
		CSI_4	Littoral and Swamp Forests	CSI_4_4A	Littoral Forests	CSI_4_4A_L_1	Littoral Forest			CSI_4_4A_L_1 FCWFG			
				CSI_4_4B	Tidal Swamp Forests	CSI_4_4B_TS_1	Mangrove Scrub			CSI_4_4A_TS_1_FCWFG			
						CSI_4_4B_TS_2	Mangrove Forest			CSI_4_4A_TS_2_FCWFG			
						CSI_4_4A_TS_3	Salt Water Mixed Forest(*Heriteria*)			CSI_4_4A_TS_3_FCWFG			
						CSI_4_4B_TS_4	Brackish Water Mixed Forests(Heriteria)			CSI_4_4A_TS_4_FCWFG			
						CSI_4_4B_E_1	Palm Swamp			CSI_4_4A_E_1_FCWFG			
				CSI_4_4	Tropical Fresh	CSI_4_	*Myristica*			CSI_4_			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
				C	Water swamp forests	4C_FS$_1$	Swamp Forest			4C_FS$_1$_FCWFG			
						CSI_4_4C_FS$_2$	Sub Montane Hill Valley Swamp Forest			CSI_4_4C_FS$_2$_FCWFG			
						CSI_4_4C_FS$_3$	Creeper Swamp Forest			CSI_4_4C_FS$_3$_FCWFG			
				CSI_4_4D	Tropical savannah swamp forests	CSI_4_4D_SS$_1$	Eastern Seasonal Swamp Forest			CS_4_4D_SS$_1$_FCWFG			
						CSI_4_4D_SS$_2$	*Barringtonoia* Swap Forest			CS_4_4D_SS$_2$_FCWFG			
						CS_4_4D_SS$_3$	*Syzyzium cumini* Swamp Low Forest			CS_4_4D_SS$_3$_FCWFG			
						CSI_4_4D_SS$_4$	Eastern Seasonal Swamp Low Forest*(Cephalanthus)*			CS_4_4D_SS$_4$_FCWFG			
						CSI_4_4D_SS$_5$	Eastern *Dillenia* Swamp Forest			CS_4_4D_SS$_5$_FCWF			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
										G			
						CS_4_4D_2S_1	(*Syzyzium* Parkland)			CS_4_4D_2S_1_FCWFG			
						CSI_4_4D_2S_2	(Eastern Wet Alluvial Grassland)			CS_4_4D_2S_2_FCWFG			
				CSI_4_4E	Tropical Riparian Fringing Forests	CSI_4_4E_RS_1	Riparian Fringing Forest			CSI_4_4E_RS_1_FCWFG			
CSII	Dry Tropical Forests	CSII_5	Tropical Dry Deciduous Forests	CSII_5_5A	Southern Tropical Dry Deciduous Forests	CSII_5_5A_C_1	Dry Teak-bearing Forest	CSII_5_5A_C_1_Ia	Very Dry Teak Forest	CSII_5_5A_C_1_2a_FCWFG			
								CSII_5_5A_C_1_Ib	Dry Teak Forest	CSII_5_5A_C_1_2b_FCWFG			
						CSII_5_5A_C_2	Dry Red Sanders bearing Forest			CSII_5_5A_C_2_FCWFG			
						CSII_5_5A_C_3	Southern Dry Mixed Deciduous Forest			CSII_5_5A_C_3_FCWFG			
				CSII_5_5B	Northern Tropical Dry Deciduous	CSII_5_5B_C_1	Dry Sal-bearing Forest	CSII_5_5B_C_1_1a	Dry Shiwalik Sal	CSII_5_5B_C_1_1a_FC			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
					Forests				Forest	WFG			
								CSII_5_5B_C_1_1b	Dry Plains Sal Forest	CSII_5_5B_C_1_1b_FCWFG			
								CSII_5_5B_C_1_1c	Dry Peninsular Sal Forest	CSII_5_5B_C_1_1c_FCWFG			
						CSII_5_5B_C_2	Northern Dry Mixed Deciduous Forest			CSII_5_5B_C_2_FCWFG			
				CSII_5_5D	Degradation stages of Dry Deciduous Fores ts	CSII_5_5D_DS_1	Dry Deciduous Scrub			CSII_5_5D_DS_1_FCWFG			
						CSII_5_5D_DS_2	Dry Savannah Forest			CSII_5_5D_DS_2_FCWFG			
						CSII_5_5D_DS_3	*(Euphorbia* Scrub)			CSII_5_5D_DS_3_FCWFG			
						CSII_5_5D_DS_4	(Dry Grasslands)			CSII_5_5D_DS_4_FCWFG			
				CSII_5_5E	General Edaphic Types	CSII_5_5E_E_1	*Anogeissus pendula* Forest			CSII_5_5E_E_1_			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
					of Dry Deciduous Forests					FCWFG			
						CSII_5_5E_DS$_1$	*Anogeissus pendula* Scrub			CSII_5_5E_DS$_1$_FCWFG			
						CSII_5_5E_E$_2$	*Boswellia* Forest			CSII_5_5E_E$_2$_FCWFG			
						CSII_5_5E_E$_3$	Babul Forest			CSII_5_5E_E$_3$_FCWFG			
						CSII_5_5E_E$_4$	*Hardwickia* Forest			CSII_5_5E_E$_4$_FCWFG			
								CSII_5_5E_E$_5$	*Butea* Forest	CSII_5_5E_E$_5$_FCWFG			
								CSII_5_5E_E$_6$	*Aegle* Forest	CSII_5_5E_E$_6$_FCWFG			
						CSII_5_5E_E$_7$	Laterite Thorn Forest			CSII_5_5E_E$_7$_FCWFG			
						CSII_5_5E_E$_8$	Saline_Alkaline Scrub Savannah	CSII_5_5E_E$_8$_8a	Phoenix Savannah	CSII_5_5E_E$_8$_8a_FCWFG			
								CSII_5_5E_E$_8$_8b	Babul Savanah	CSII_5_5E_E$_8$_			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
										8b_FCWFG			
								CSII_5_5E_E_8_8c	*Salvadora-Tamarix* Scrub	CSII_5_5E_E_8_8c_FCWFG			
						CSII_5_5E_E_9	Dry Bamboo Brakes						
						CSII_5_5S	General Seral Types of Dry Deciduous Forests	CSII_5_5S_1S_1	Dry Tropical Riverine Forests	CSII_5_5S_1S_1 FCWFG			
								CSII_5_5S_1S_2	Khair-Sissoo Forest	CSII_5_5S_1S_2 FCWFG			
								CSII_5_5S_1S_3	Inundation Babul Forest				
								CSII_5_5S_2S_1	Secondary Dry Deciduous Forest	CSII_5_5S_2S_1 FCWFG			
		CSII_6	Tropical Thorn Forests	CSII_6_6A	Southern Tropical Thorn Forests	CSII_6_6A_C_1	Southern Thorn Forest			CSII_6_6A_C_1 FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						CSII_6_6A_C_2	Karnataka Umbrella Thorn Forest			CSII_6_6A_C_2_FCWFG			
						CSII_6_6A_DS_1	Southern Thorn Scrub			CSII_6_6A_DS_1_FCWFG			
						CSII_6_6A_DS_2	Southern *Euphorbia* Scrub			CSII_6_6A_DS_2_FCWFG			
				CS_II_6_6B	Northern Tropical Thorn Forests	CS_II_6_6B_C_1	Desert Thorn Forest			CS_II_6_6B_C_1_FCWFG			
						CS_II_6_6B_C_2	Ravine Thorn Forest			CS_II_6_6B_C2_FCWFG			
						CS_II_6_6B_DS_1	Zizyphus Scrub			CS_II_6_6B_DS_1_FCWFG			
						CS_II_6_6B_DS_2	Tropical *Euphorbia* Scrub			CS_II_6_6B_DS_2_FCWFG			
				CS_II_6_6EDS	General Edaphic,	CS_II_6_6ED	*Euphorbia* Scrub			CS_II_6_6EDS_			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
					degraded and seral types of thorn forests	S_E_1				E_1_ FCWFG			
						CS_II_ 6_6EDS_E_2	*Acacia Senegal* Forest			CS_II_6 _6EDS_ E_2_ FCWFG			
						CS_II_ 6_6EDS_E_3	*Rann* Saline Thorn Forest			CS_II_6 _6EDS_ E3_ FCWFG			
						CS_II_ 6_6EDS_E4	*Salvadora* Forest			CS_II_6 _6EDS_ E4_ FCWFG			
						CS_II_ 6_6EDS_DS_1	*Acacia auriculata* Forest			CS_II_6 _6EDS_ DS_1_ FCWFG			
						CS_II_ 6_6EDS_1S_1	Desert Dune Scrub			CS_II_6 _6EDS_ 1S1_ FCWFG			
		CSII_7	Tropical Dry Evergreen Forests	CSII_7_C 1	Tropical Dry Evergreen Forests	CSII_7 _C1	Tropical Dry Evergreen Forests			CSII_7_ C_1_ FCWFG			
				CSII_7_ DS1	Tropical Dry Evrgreen Scrub	CSII_7 _DS1	Tropical Dry Evrgreen Scrub			CSII_7_ DS_1_ FCWFG			
CSIII	Monta	CSIII_8	Sub	CSIII_8_	Southern sub-	CSIII_8	Nilgiri Sub-			CSIII_8			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
	ne Sub Tropical Forests		Tropical Broad leaved Hill Forests	8A	Tropical Broadleaved Hill Forests	_8A_C_1	Tropical Hill Forest			_8A_C_1 _ FCWFG			
						CSIII_8 _8A_D S_1	Southern Indian Sub-Tropical Hill Savannah			CSIII_8 _8A_D S1_ FCWFG			
						CSIII_8 _8A_E_1	Reed brakes (*Ochlandra*)			CSIII_8 _8A_E1 _ FCWFG			
						CSIII_8 _8A_C_2	Western Sub-Tropical Hill Forest			CSIII_8 _8A_C_2 _ FCWFG			
						CSIII_8 _8A_C_3	Central Indian Sub-Tropical Hill Forest			CSIII_8 _8A_C3 _ FCWFG			
						CSIII_8 _8A_D S	Degradation Stages of Southern Sub-Tropical Broad-leaved hill Forest			CSIII_8 _8A_D S_ FCWFG			
				CSIII_8_ 8B_	Northern sub-Tropical broadleaved Hill Forests	CSIII_8 _8B_C_1	East Himalayan Sub-Tropical Wet Hill			CSIII_8 _8B_C1 _ FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
							Forest						
						CSIII_8_8B_C_2	Khasi Sub-Tropical Wet Hill Forest			CSIII_8_8B_C_2_FCWFG			
						CSIII_8_8B_2S_1	Assam Sub-Tropical Pine Forest			CSIII_8_8B_2S_1_FCWFG			
						CSIII_8_8B_DS_1	Assam Sub-Tropical Hill Savannah Woodland			CSIII_8_8B_DS_1_FCWFG			
		CSIII_9	Sub Tropical Pine Forests	CSIII_9	Sub-Tropical Pine Forests	CSIII_9_C_1	Himalayan Sub-Tropical Pine Forest	CSIII_9_C_1_1a	Lower or Siwalik Chir Pine Forest	CSIII_9_C_1_1a_FCWFG			
								CSIII_9_C_1_1b	Upper or Himalayan Chir Pine	CSIII_9_C_1_1b_FCWFG			
						CSIII_9_DS_1	Himalayan Sub-Tropical Scrub			CSIII_9_DS_1_FCWFG			
						CSIII_9_DS_2	Sub-Tropical *Euphorbia* Scrub			CSIII_9_DS_2_FCWFG			
						CSIII_9	Assam Sub-			CSIII_9			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						_C_2	Tropical Pine Forest			_C_2_ FCWFG			
						CSIII_9 _DS3	Assam Sub-Tropical Pine Savannah			CSIII_9 _DS_3_ FCWFG			
		CSIII_10	Sub Tropical Dry Evergreen Forests	CSIII_10	Sub Tropical Dry Evergreen Forests	CSIII_1 0_C_1	Sub Tropical Dry Evergreen Forest	CSIII_10_ C_1_1a	*Oleo cuspida* Scrub Forest	CSIII_1 0_C_1_1a _ FCWFG			
								CSIII_10_ C_1_1b	*Acacia modesta* Scrub Forest	CSIII_1 0_C_1_1 b_ FCWFG			
						CSIII_1 0_DS_1	Dodonea Scrub			CSIII_1 0_DS1_ FCWFG			
CSIV	Montane Temperate Forests	CSIV_1 1	Montane Wet Temperate Forests	CSIV_11 _11A	Southern Montane Wet Temperate Forests	CSIV_1 1_11A_ C_1	Southern Montane Wet Temperate Forest			CSIV_1 1_11A_ C_1_ FCWFG			
						CSIV_1 1_11A_ DS_1	Southern Montane Wet Scrub			CSIV_1 1_11A_ DS_1_FC WFG			
						CSIV_1 1_11A_ DS_2	Southern Montane Wet Grassland			CSIV_1 1_11A_ DS2_ FCWFG			
				CSIV_11	NorthernMont	CSIV_1	East	CSIV_11	Laurace	CSIV_1			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
				_11B	ane Wet Temperate Forests	1_11B_C_1	Himalayan Wet Temperate Forest	_11B_C_1_1a	ous Forest	1_11B_C_1_1a_FCWFG			
								CSIV_11_11B_C_1_1b	*Buk* Oak Forest	CSIV_11_11B_C_1_1b_FCWFG			
								CSIV_11_11B_C_1_1c	High Level Oak Forest	CSIV_11_11B_C_1_1c_FCWFG			
						CSIV_11_11B_C_2	Naga Hills Wet Temperate Forest			CSIV_11_11B_C_2_FCWFG			
		CSIV_12	Himalayan Moist Temperate Forests	CSIV_12	Himalayan Moist Temperate Forest	CSIV_12_C_1	Lower Western Himalayan Temperate Forest	CSIV_12_C_1_1a	Ban Oak Forest (*Quercus incana*)	CSIV_12_C_1_1a_FCWFG			
								CSIV_12_C_1_1b	*Moru* Oak (*Quercus dilatata*)	CSIV_12_C_1_1b_FCWFG			
						CSIV_12_DS_1	Oak Scrub	CSIV_12_DS_1_1c	Moist Deodar Forest(*Cedrus*)	CSIV_12_DS_1_1c_FCWFG			
								CSIV_12	Western	CSIV_1			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
								_DS_1_1d	Mixed Coniferous Forest(spruce, blue pine, silver fir)	2_DS_1_1d_FCWFG			
								CSIV_12_DS_1_1e	Moist Temperate Deciduous Forest	CSIV_12_DS_1_1e_FCWFG			
								CSIV_12_DS_1_1f	Low Level Blue Pine Forest (*Pinus wallichiana*)	CSIV_12_DS_1_1f_FCWFG			
						CSIV_12_DS_2	Himalayan Temperate Secondary Scrub			CSIV_12_DS2_FCWFG			
						CSIV_12_C_2	Upper West Himalayan Temperate Forest	CSIV_12_C_2_2a	*Kharsu Oak* Forest (*Quercu*	CSIV_12_C_2_2a_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
									s semicarpifolia)				
								CSIV_12_C_2_2b	West Himalayan upper Oak_Fir Forest	CSIV_12_C_2_2b_FCWFG			
								CSIV_12_C_2_2c	Moist Temperate Deciduous	CSIV_12_C_2_2c_FCWFG			
						CSIV_12_C_3	East Himalayan Moist Temperate Forest	CSIV_12_C_3_3a	East Himalayan Mixed Coniferous Forest	CSIV_12_C_3_3a_FCWFG			
								CSIV_12_C_3_3b	*Abies delavayi* Forest	CSIV_12_C_3_3b_FCWFG			
				CSIV_12_12DS	Degraded Stages of Himalayan Moist Temperate Forests	CSIV_12_12DS_DS_1	Montane Bamboo Brakes			CSIV_12_12DS_DS_1_FCWFG			
						CSIV_1	Himalayan			CSIV_1			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						2_12DS_DS_2	Temperate Parkland			2_12DS_DS_2_FCWFG			
						CSIV_12_12DS_DS_3	Himalayan Temperate Pastures			CSIV_12_12DS_DS_2_FCWFG			
						CSIV_12_12E	General Edaphic and Seral Types Of Himalayan Moist Forests	CSIV_12_12E_E_1	Cypress Forest	CSIV_12_12E_E_1_FCWFG			
								CSIV_12_12E_1S_1	Alder Forest	CSIV_12_12E_1S_1_FCWFG			
								CSIV_12_12E_1S_2	Riverine Blue Pine Forest	CSIV_12_12E_1S_2_FCWFG			
								CSIV_12_12E_2S_1	Low Level Blue Pine Forest	CSIV_12_12E_2S1_FCWFG			
		CSIV_13	Himalayan Dry Temperate Forests	CSIV_13_(i)	Western Types	CSIV_13_(i)_C_1	Dry Broad Leaved and Conifers(*Quercus ilex-Pinus gerardiana)*			CSIV_13_(i)_C_1_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						CSIV_13_(i)_C_2	Dry Temperate Coniferous Forest	CSIV_13_(i)_C_2_2a	*Neoza* Pine Forest (*Pinus gerardiana*)	CSIV_13_(i)_C_2_2a_FCWFG			
								CSIV_13_(i)_C_2_2b	Dry Deodar Forest	CSIV_13_(i)_C_2_2b_FCWFG			
						CSIV_13_(i)_DS_1	*Pohu* Scrub			CSIV_13_(i)_DS_1_FCWFG			
						CSIV_13_(i)_DS_2	Dry Temperate Scrub			CSIV_13_(i)_DS2_FCWFG			
						CSIV_13_(i)_C_3	West Himalayan Dry Temperate Deciduous Forest			CSIV_13_(i)_C_3_FCWFG			
						CSIV_13_(i)_C_4	West Himalayan High-Level Dry Blue Pine Forest(*Pinus wallichiana*)			CSIV_13_(i)_C_4_FCWFG			
						CSIV_1	West			CSIV_1			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
						3_(i)_C_5	Himalayan Dry Juniper Forest			3_(i)_C_5_FCWFG			
				CSIV_13_(ii)	Eastern Types	CSIV_13_(i)_C_6	East Himalayan Dry Juniper Forest			CSIV_13_(i)_C_6_FCWFG			
						CSIV_13_(i)_E_1	Larch Forest(*L. griffithiana*)			CSIV_13_(i)_E_1_FCWFG			
						CSIV_13_(i)_C_7	East Himalayan Dry Juniper_Birch Forest(*Juniper wallichiana)*			CSIV_13_(i)_C7_FCWFG			
						CSIV_13_13S	General Seral Types of dry temperate Forests	CSIV_13_13S_$1S_1$	*Hippophae_Myriscaria* Scrub	CSIV_13_13S_$1S_1$_FCWFG			
								CSIV_13_13S_$1S_2$	*Populus_Salix* Forest	CSIV_13_13S_$1S_2$_FCWFG			
						CSIV_13_13S_$1S_3$	Western High Level Dry Pine	CSIV_13_13S_$1S_3$	Western High Level Dry	CSIV_13_13S_1S3_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
									Pine				
CSV	Sub Alpine Forests	CSV_14	Sub Alpine Forests	CSV_14	Sub Alpine Forests	CSV_14_C_1	West Himalayan Subalpine birch_Fir Forest	CSV_14_C_1_1a	West Himalayan Sub-Alpine Fir Forest	CSV_14_C_1_FCWFG			
								CSV_14_C_1_1b	West Himalayan Sub-Alpine Birch_Fir Forest	CSV_14_C_1_1b_FCWFG			
						CSV_14_C_2	East Himalayan Subalpine birch_Fir Forest			CSV_14_C_3_FCWFG			
				CSV_14_14DS	Seral and Degraded Types of Sub-Alpine Forests	CSV_14_14DS_1S_1	*Hippophae_Myriscaria*Brakes			CSV_14_14DS_1S_1_FCWFG			
						CSV_14_14DS_1S_2	Deciduous Sub-alpine Scrub			CSV_14_14DS_1S_2_FCWFG			
						CSV_14_14DS_2S_1	Sub-alpine Blue Pine(Pinus wallichiana			CSV_14_14DS_2S_1_FCWFG			

	250000 L1 National Level	Code	50000 L2 State Level	Code	25000 L3 Division Level	Code	10000 L4 Range Level	Code	4000 Beat Level	Code	4000 Beat Level	Code	2000 Compartment Level
							Forest)						
						CSV_14_14DS_DS_1	Sub-alpine Pastures			CSV_14_14DS_DS_1_FCWFG			
CSVI	Alpine Scrub	CSVI_15	Moist Alpine Scrub	CSVI_15	Moist Alpine Scrub	CSVI_15_C_1	Birch _Rhododendron Scrub Forest			CSVI_15_C_1_FCWFG			
						CSVI_15_C_2	Deciduous Alpine Scrub			CSVI_15_C_2_FCWFG			
						CSVI_15_E_1	Dwarf Rhododendron Scrub			CSVI_15_E_1_FCWFG			
						CSVI_15_E_2	Dwarf Juniper Scrub			CSVI_15_E_2_FCWFG			
						CSVI_15_C_3	Alpine Pastures			CSVI_15_C3_FCWFG			
		CSVI_16	Dry Alpine Scrub	CSVI_16	Dry Alpine Scrub	CSVI_16_C_1	Dry Alpine Scrub			CSVI_16_C_1_FCWFG			
						CSVI_16_E_1	Dwarf Juniper Scrub			CSVI_16_E1_FCWFG			

Table 2 gives methods and corresponding scale of mapping to be used for Table 1

Table 2. Method and Scale for Forest Attribute Table

Method	Scale
Classification of moderate resolution satellite data and ground work	1: 250,000 1:50,000
Classification of High resolution satellite data and ground work	1:25,000 1:10,000
Ground work	1:4000 1:2000

Table 3 gives indicative Standards for selected Ecological Attributes (Non Champion and Seth Classes)

Table 3. Indicative Standards for selected Ecological Attributes (Non Champion and Seth Classes)

		Codes at Multiple Scales				
	Other, non-Champion and Seth types	**1:50000**	**1:25000**	**1:10000**	**1:4000**	**1:2000**
1	Major Species plantations (100 yrs old;)	NCS11	NCS12	NCS13	NCS124	NCS125
2	Extensive plantation of teak, shisham, and eucalyptus	NCS21	NCS22	NCS23	NCS24	NCS25
3	Young jhum (<10 yrs;)	NCS31	NCS32	NCS33	NCS34	NCS35

		Codes at Multiple Scales				
	Other, non-Champion and Seth types	**1:50000**	**1:25000**	**1:10000**	**1:4000**	**1:2000**
4	Middle jhum (10-20 yrs)	NCS41	NCS42	NCS43	NCS44	NCS45
5	Old jhum (>20 yrs)	NCS51	NCS52	NCS53	NCS54	NCS55
6	Trophic category		NCS62	NCS63	NCS64	
7	Habitat elements/substrates		NCS72	NCS73		
8	Habitat elements of biotic origin (special habitats)		NCS82	NCS83		
9	Snags			NCS93	NCS94	NCS95
10	Snag recruits (dying trees, live trees with dead portions)			NCS103	NCS104	NCS105
11	Hollow trees, chimney trees (living or dead)			NCS113	NCS114	NCS115
12	Tree cavities (natural or created)			NCS123	NCS124	NCS125
13	Individual Large old trees (living)			NCS133	NCS134	NCS135
14	Trees with fluting boles and buttresses			NCS143	NCS144	NCS145
15	Down wood			NCS153	NCS154	NCS155
16	Litter and duff layers			NCS163	NCS164	NCS165
17	Stagnant Litter in streams			NCS173	NCS174	NCS175
18	Lianas			NCS183	NCS184	NCS185

		Codes at Multiple Scales				
	Other, non-Champion and Seth types	**1:50000**	**1:25000**	**1:10000**	**1:4000**	**1:2000**
19	Individual Fruit bearing trees			NCS203	NCS204	NCS205
20	Epiphyte bearing patches				NCS214	NCS215
21	Habitat elements of geomorphic origin	NCS221	NCS222	NCS223		
22	Cliffs, talus, and ledges		NCS232	NCS233		
23	Caves			NCS243	NCS245	
24	Overhangs			NCS253	NCS254	
25	Dens (existing burrows dug by animals)				NCS264	NCS265
26	Sheet rocks	NCS271	NCS272	NCS273		
27	Large boulder aggregates	NCS281	NCS282	NCS283		
28	Rock outcrops	NCS291	NCS292	NCS293		
29	Sandy banks and sand spits	NCS301	NCS302	NCS303		
30	Salt licks (exposed mineral soils)				NCS314	NCS315
31	Earth cuttings		NCS322	NCS323		
32	Man-made (anthropogenic) structures				NCS334	NCS335
33	Additional / other (specify)					
	Structural stage					

		Codes at Multiple Scales				
	Other, non-Champion and Seth types	**1:50000**	**1:25000**	**1:10000**	**1:4000**	**1:2000**
34	Early stage(Young)		NCS352	NCS353		
35	Mid stage(Middle)		NCS362	NCS363		
36	Late stage(Old)		NCS372	NCS373		
37	Old-growth stage - unmanaged		NCS382	NCS383		
38	Other – unmanaged		NCS392	NCS393	NCS394	NCS395
39	Key ecological functions(Spatial)			NCS403	NCS404	NCS405
40	Sensitivity to anthropogenic disturbance(Spatially Distributed)		NCS412	NCS413		

Table 4 gives methods and corresponding scale of mapping to be used for Table 3

Table 4. Methods and Scale for Indicative Standards above

Method	Scale
Classification of moderate resolution satellite data and ground work	1: 250,000 1:50,000
Classification of High resolution satellite data and ground work	1:25,000 1:10,000
Ground work	1:4000 1:2000

Table 5. Forest Density Classification Standards (Total Cover, Shrub Cover and Tree Canopy Cover)

Crown Density using satellite data and field work								Crown and Stem Density through field survey			
Code	**250000 L1 National**	**Code**	**50000 L2 State**	**Code**	**25000 L3 Division**	**Code**	**10000 L4 Range**	**Code**	**10000**	**Code**	**4000 (Specialized Local needs) Beat**
FSI1	Very Dense Forest>70%	SFD1	Very Dense Forest>70%	SFD1/I	80-100%	SFD1/I/A	90-100%	SFD1/I/AS	90-100%	SFD1/I/AS/i	95.5-100%
FSI2	Moderately Dense Forest 40-69.9%	SFD2	Moderately Dense Forest 40-70%	SFD2/II	60-79.9%	SFD2/II/B	80-89.9%	SFD2/II/BS	80-89.9%	SFDI/II/AS/ii	90-95.5%
FSI3	Open Forest 10-39.9%	SFD3	Open Forest 10-40%	SFD3/III	30-59.9%	SFD3/III/C	70-79.9%	SFD3/III/CS	70-79.9%	SFD2/II/BS/i	85-89.9%
FSI4	Scrub <10%	SFD4	Scrub <10%	SFD4/IV	10-29.9%	SFD4/IV/D	60-69.9%	SFD4/IV/DS	60-69.9%	SFD2/II/BS/ii	80-84.9%
				SFD5/V	<10%	SFD5/V/E	50-59.9%	SFD5/V/ES	50-59.9%	SFD3/III/CS/i	75-79.9%
						SFD6/VI/F	40-49.9	SFD6/VI/FS	40-49.9	SFD3/III/CS/ii	70-74.9%
						SFD7/VII/G	30-39.9	SFD7/VII/GS	30-39.9	SFD4/IV/DS/i	65-69.9%
						SFD8/VIII/H	20-29.9%	SFD8/VIII/HS	20-29.9%	SFD4/IV/DS/ii	60-64.9%
						SFD9/IIX/I	10-19.9	SFD9/IIX/IS	10-19.9	SFD5/V/ES/i	55-59.95
						SFD10/X/J	<10%	SFD10/X/JS	<10%	SFD5/V/ES/ii	50-54.9%
										SFD6/VI/FS/i	45-49.9%
										SFD6/VI/FS/ii	40-44.9%

Crown Density using satellite data and field work								Crown and Stem Density through field survey			
Code	**250000 L1 National**	**Code**	**50000 L2 State**	**Code**	**25000 L3 Division**	**Code**	**10000 L4 Range**	**Code**	**10000**	**Code**	**4000 (Specialized Local needs) Beat**
										SFD7/VII /GS/i	35-39.9%
										SFD7/VII /GS/ii	30-34.9%
										SFD8/VII I/HS/i	25-29.9%
										SFD8/VII I/HS/ii	20-24.9%
										SFD9/IIX /IS/i	15-19.9%
										SFD9/IIX /IS/ii	10-14.9%
										SFD10/X/ JS/i	5-9.9%
										SFD10/X/ JS/ii	<5%

Table 6 gives methods and corresponding scale of mapping to be used for Table 5

Table 6. Methods for crown and stem density classification

Method	Scale
Classification of moderate resolution satellite data and ground work for crown density	1: 250,000 1:50,000
Classification of High resolution satellite data and ground work for crown density	1:25,000 1:10,000
Classification using ground work for crown and stem density	1:4000 1:2000

Table 7. Shrub, Herbs and Grass Cover% (Method- Field Based)

Code	1:10000 Range	Code	1:4000 (Specialized Local needs-Species composition) Beat
SFD1/I/A (S,H or G)	90-100%	SFD1/I/A/i(S,H or G)	95.5-100%
SFD2/II/B (S,H or G)	80-89.9%	SFDI/II/A/ii(S,H or G)	90-95.5%
SFD3/III/C (S,H or G)	70-79.9%	SFD2/II/B/i(S,H or G)	85-89.9%
SFD4/IV/D (S,H or G)	60-69.9%	SFD2/II/B/ii(S,H or G)	80-84.9%
SFD5/V/E (S,H or G)	50-59.9%	SFD3/III/C/i(S,H or G)	75-79.9%
SFD6/VI/F (S,H or G)	40-49.9	SFD3/III/C/ii(S,H or G)	70-74.9%
SFD7/VII/G (S,H or G)	30-39.9	SFD4/IV/D/i(S,H or G)	65-69.9%
SFD8/VIII/H (S,H or G)	20-29.9%	SFD4/IV/D/ii(S,H or G)	60-64.9%
SFD9/IIX/I (S,H or G)	10-19.9	SFD5/V/E/i(S,H or G)	55-59.95
SFD10/X/J (S,H or G)	<10%	SFD5/V/E/ii(S,H or G)	50-54.9%
		SFD6/VI/F/i(S,H or G)	45-49.9%
		SFD6/VI/F/ii(S,H or G)	40-44.9%
		SFD7/VII/G/i(S,H or G)	35-39.9%
		SFD7/VII/G/ii(S,H or G)	30-34.9%
		SFD8/VIII/H/i(S,H or G)	25-29.9%
		SFD8/VIII/H/ii(S,H or G)	20-24.9%
		SFD9/IIX/I/i(S,H or G)	15-19.9%
		SFD9/IIX/I/ii(S,H or G)	10-14.9%

Code	1:10000 Range	Code	1:4000 (Specialized Local needs-Species composition) Beat
		SFD10/X/J/i(S,H or G)	5-9.9%
		SFD10/X/J/ii(S,H or G)	<5%

Table 8. Tree Size Classification

Class	Definition	Description
Seedlings	0-0.9 inches(2.286 cm)QMD	Tree size class is determined by calculating the diameter (usually at breast height) of the tree of average basal area (quadratic mean diameter or qmd) of the top storey trees that contribute to canopy closure, tree cover as seen from a birds eye view
Saplings	1-4.9 inches (12.446 cm) QMD	
Poles	5 – 9.9 inches(25.146 cm) QMD	
Small	10-19.9 inches(50.546 cm) QMD	
Medium	20-29.9 inches(75.946 cm) QMD	
Large	30-39.9 inches(101.346 cm) QMD	
Very Large	40-49.9 inches(126.746 cm) QMD	
Giant	50+ inches(127 cm) QMD	

Table 9. Attribute Table for Administrative Units (Forests)

Layer code	Scale	Theme code	Description	Remarks
Forest 250 KSFD	250,000	01	Notified Forest Boundary	RF/PF/COM. FOREST/VILLAGE will be common in all layers at all scales.

Forest 50 KSFD	50,000	01	Notified Forest Boundary	
		02	Circle	
		03	Division	
		04	Range	
		05	Beat	
Forest 25 KSFD	25,000	01	Notified Forest Boundary	
		02	Circle	
		03	Division	
		04	Range	
		05	Beat	
Forest 10 KSFD	10,000	01	Notified Forest Boundary	
		02	Circle	
		03	Division	
		04	Range	
		05	Beat	
Forest 4 KSFD-REV	4000	01	Notified Forest Boundary	Only forest areas adjoining to revenue boundaries(1km width on either side of the boundary)
Forest 2 KSFD-MUN	2000	01	Notified Forest Boundary	Only forest areas adjoining to urban municipal limits(1 km width on either side of the boundary)

Table 10. Attribute Standards Territorial Forest Units

Layer code	Scale	Theme code	Attribute of territorial unit	Remarks
TU50SFD	50,000	TU1	Block	
		TU1-1	Compartment	
		TU1-2	Sub Compartment	
TU25SFD	25,000	TU2	Block	

		TU2-1	Compartment	
		TU2-2	Sub Compartment	
TU10SFD	10,000	TU3	Block	
		TU3-1	Compartment	
		TU3-2	Sub Compartment	
TU4SFD	4000	TU4	Block	
		TU4-1	Compartment	
		TU4-2	Sub Compartment	
TU2SFD	2000	TU5	Block	
		TU5-1	Compartment	
		TU5-2	Sub Compartment	

Table 11 Attribute Standards for Management Units

Layer Code	Scale	Theme Code	Attribute of Management Units	Remarks
MU50KSFD	50,000	MU1	Working Circle	
		MU2	Compartment	
		MU3	Sub-Compartment	
MU25KSFD	25,000	MU4	Working Circle	

Layer Code	Scale	Theme Code	Attribute of Management Units	Remarks
		MU5	Compartment	
		MU6	Sub-Compartment	
		MU7	Cutting Section	
		MU8	Felling Series	
		MU9	Working Circle	
		MU10	Periodic Blocks	
		MU11	Coupes	
MU10KSFD	10,000	MU12	Working Circle	
		MU13	Compartment	
		MU14	Sub-Compartment	
		MU15	Cutting Section	
		MU16	Felling Series	
		MU17	Working Circle	
		MU18	Periodic Blocks	
		MU19	Coupes	
LU4KSFD	4000	MU20	Working Circle	
		MU21	Compartment	
		MU22	Sub-Compartment	
		MU23	Cutting Section	
		MU24	Felling Series	
		MU25	Working Circle	
		MU26	Periodic Blocks	
		MU27	Coupes	
LU2KSFD	2000	MU28	Working Circle	
		MU29	Compartment	

Layer Code	Scale	Theme Code	Attribute of Management Units	Remarks
		MU30	Sub-Compartment	
		MU31	Cutting Section	
		MU32	Felling Series	
		MU33	Working Circle	
		MU34	Periodic Blocks	
		MU35	Coupes	

Table 12 Existing Standards proposed to be used for Forest Working/ Management Plans

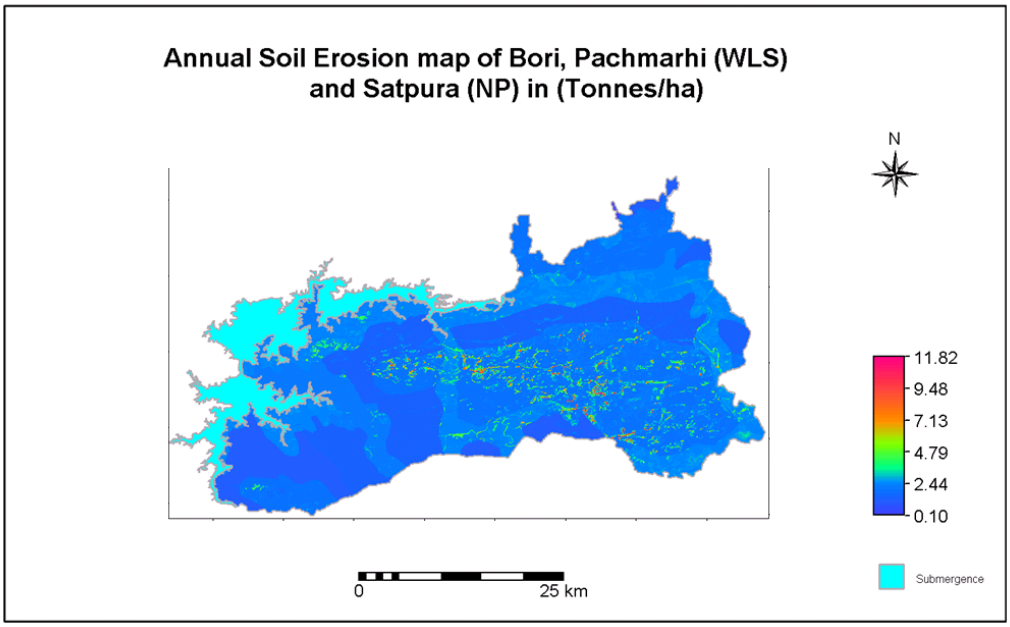
S.No.	Theme/Attribute	Table and Standards Reference
1	Administrative Boundaries,	Table 6.2.1(NNRMS, 2005)
2.	Canals	Table 6.2.2(NNRMS, 2005)
3.	Command Area Boundaries	Table 6.2.3(NNRMS, 2005)
4.	Drainage and Streams	Table 6.2.4(NNRMS, 2005)
5.	Railways	Table 6.2.5(NNRMS, 2005)
6.	Roads	Table 6.2.7(NNRMS, 2005)
7.	Settlements and villages	Table 6.2.8(NNRMS, 2005)
8.	Special forest boundaries	Table 6.2.9(NNRMS, 2005)
9.	Coastal Wetlands	Table 6.2.11(NNRMS, 2005)
10.	Geomorphology	Table 6.2.12(NNRMS, 2005)
11.	Glaciers	Table 6.2.13(NNRMS, 2005)
12	Land degradation	Table 6.2.14(NNRMS, 2005)
13.	Landuse/ Landover	Table 6.2.16 and 17(NNRMS, 2005)
14.	Cadastral Information	Table 6.2.19(N(NNRMS, 2005)NRMS, 2005)
15	Physiographic	Table 6.2.20(NNRMS, 2005)
16	Road 10k	Table 6.2.21(NNRMS, 2005)
17	Large Scale Base Map Poly	Table 6.2.22(NNRMS, 2005)
18	Large Scale Base amp- Line	Table 6.2.23(NNRMS, 2005)
19	Soil Map	Table 6.2.26(NNRMS, 2005)
20	Meta Data Standards	Table 7.1-NNRMS Meta Data Content-(NNRMA, 2005
21	Image Standards, Thematic/ Cartographic Standards, GIS Database Standards, Output standards and Accuracy Standards for outputs	Table 5.1 NNRMS Standards-Parameters and Values (NNRMS, 2005)

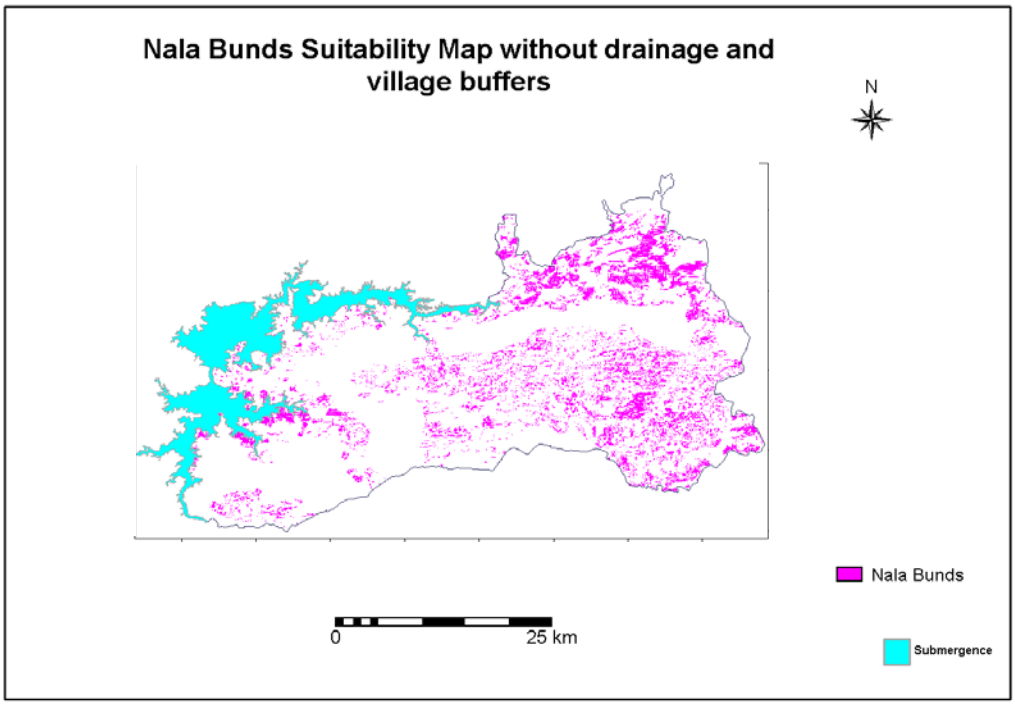
Table 13. Attribute Standards Legal Sub-division (Units)

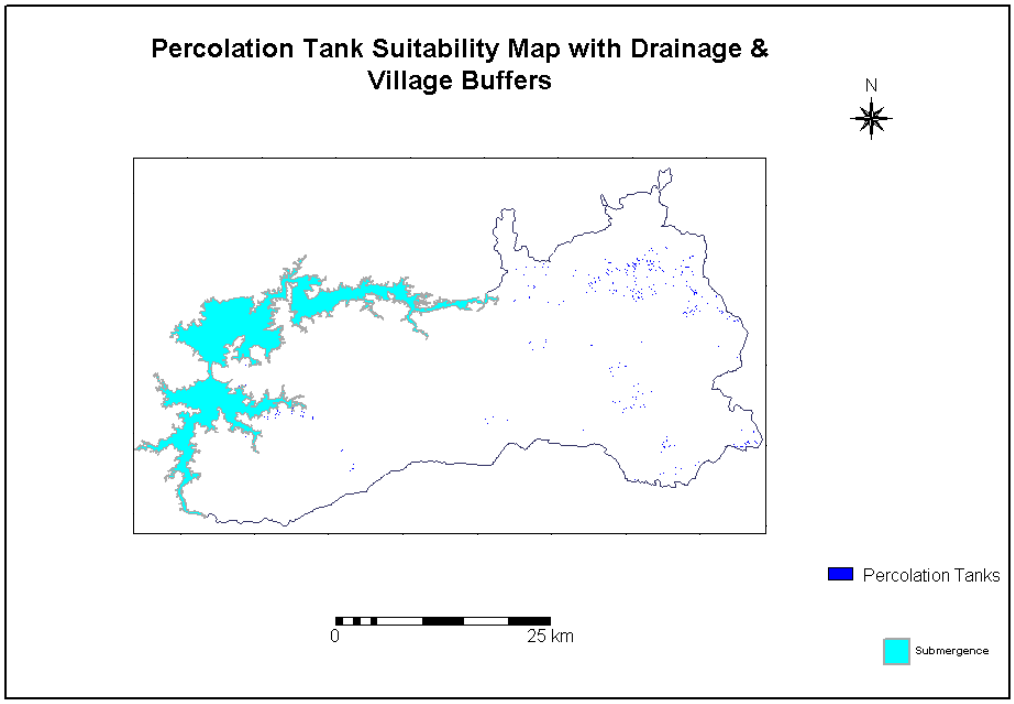
	Scale	Code	Attribute of Legal Sub-division	Remarks
LU50KSFD	50,000	LU1	Reserve Forests	
		LU2	Protected Forests	
		LU3	Village Forests	
		LU4	Private Forests	
		LU5-1,2,3,…	Others (As defined by the Supreme Court)	
LU25KSFD	25,000	LU6	Reserve Forests	
		LU7	Protected Forests	
		LU8	Village Forests	
		LU9	Private Forests	
		LU10-1,2,3,…	Others (As defined by the Supreme Court)	
LU10KSFD	10,000	LU11	Reserve Forests	
		LU12	Protected Forests	
		LU13	Village Forests	
		LU14	Private Forests	
		LU15-1,2,3,…	Others (As defined by the Supreme Court)	
LU4KSFD	4000	LU16	Reserve Forests	
		LU17	Protected Forests	
		LU18	Village Forests	
		LU19	Private Forests	
		LU20-1,2,3,…	Others (As defined by the Supreme Court)	
LU2KSFD	2000	LU21	Reserve Forests	
		LU22	Protected Forests	
		LU23	Village Forests	
		LU24	Private Forests	
		LU25-1,2,3,…	Others (As defined by the Supreme Court)	

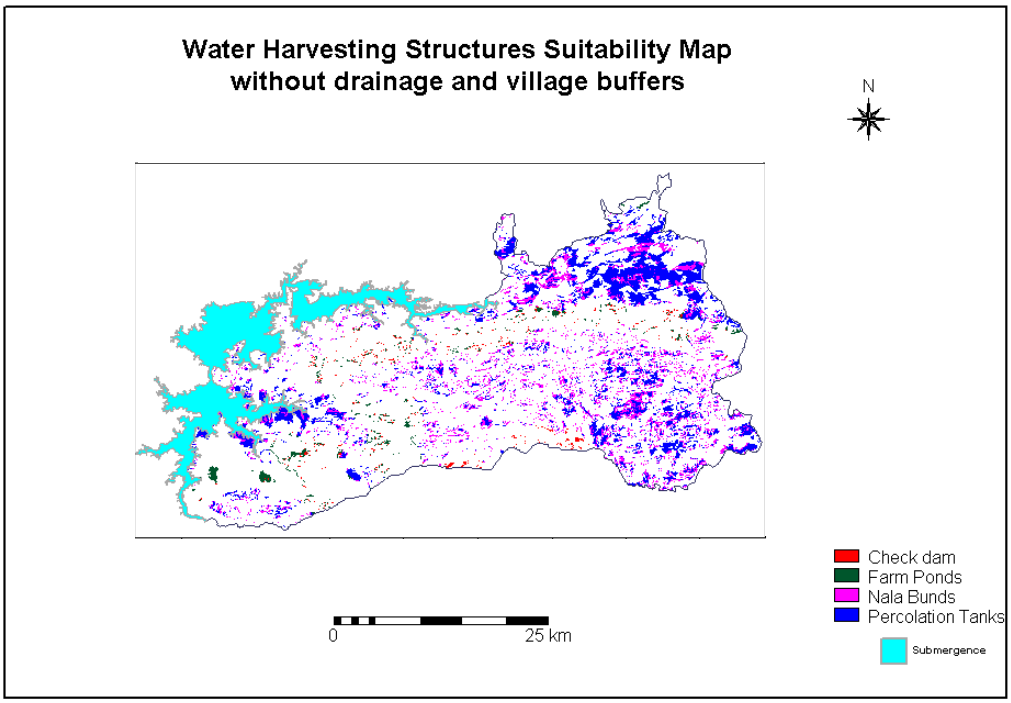
Appendix VII - Demonstration of Ecological Status Models-(Figure 3.1, Fig, 5.4.24 and Figure 5.4.23)

As indicated, earlier Ecological Status Models (ESMs) are very important in devising management prescriptions. The present example, demonstrates that instead of using soil map, drainage map and other resource maps independently if these are combined into ESMs with other associated data, they can be more informative for the management. Soil erosion status and suitability of areas for various soil conservation measures can thus be identified. Thus, better insights can developed in proposing management intervention in the Working Plans and Management Plans. The following illustrations pertain to the Bori Satpura and Pachmari Protected Area Complex in central India.






Percolation Tank Suitability Map with Drainage & Village Buffers
N
Percolation Tanks
0
25 km
Submergence


Water Harvesting Structures Suitability Map without drainage and village buffers
N
Check dam
Farm Ponds
Nala Bunds
Percolation Tanks
0
25 km
Submergence