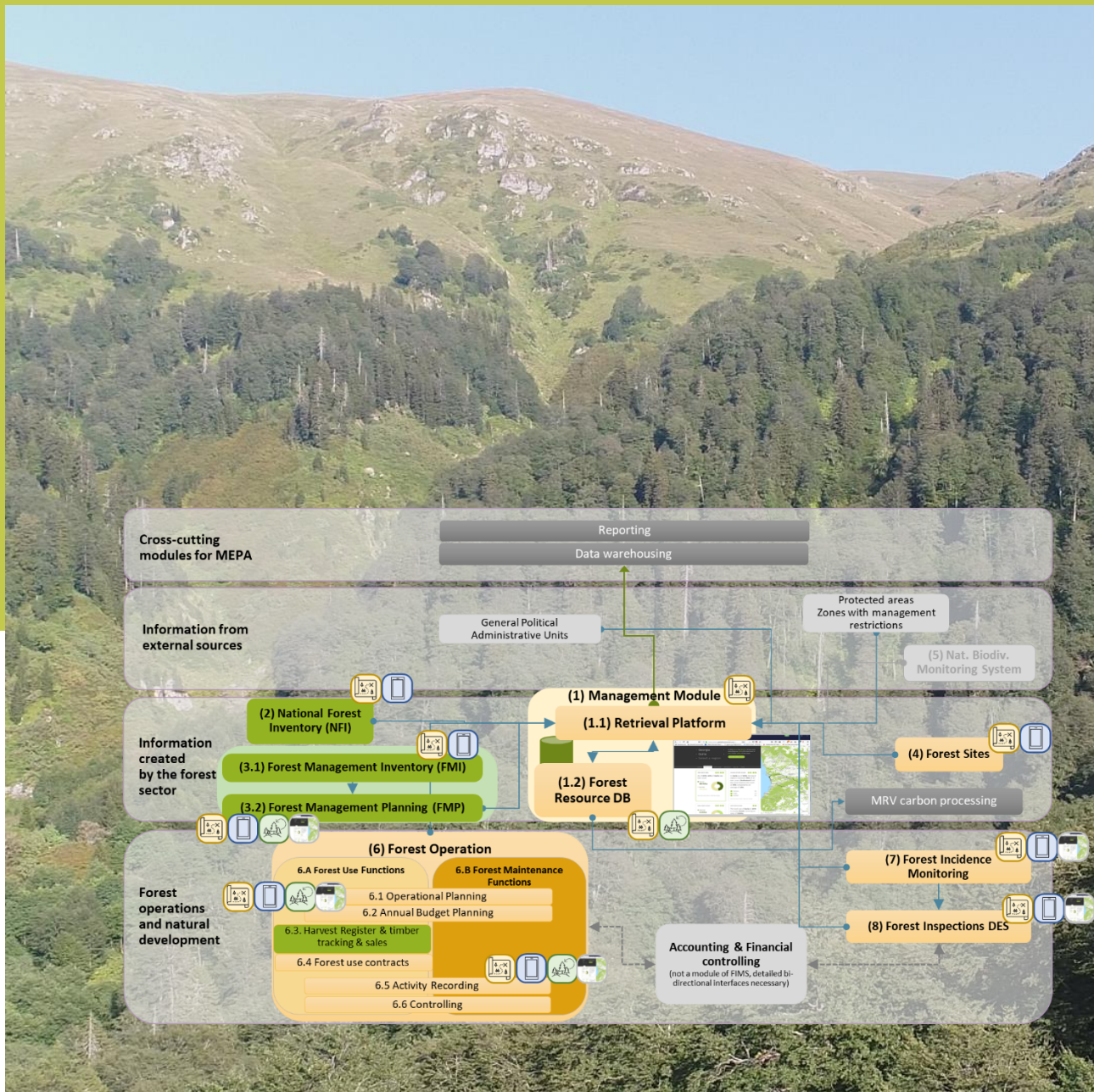


Forest Information and Monitoring System

- Stocktaking Report



**Support to the further Development of
Georgia's Forestry Information and Monitoring System (FIMS)
Technical Proposal - 81276643**

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Client

Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Date

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List of abbreviations

AFS	Adjara Forest Service
APA	Agency of Protected Areas
BFD	Biodiversity and Forest Policy Department, MEPA
DBMS	Database Management System
DES	Department of Environmental Supervision
DTM	Digital Terrain Model
FAO	Food and Agriculture Organization of the United Nations
FIMS	Forest Information and Monitoring System (for Georgia)
FMI	Forest Management Inventory
FMP	Forest Management Planning
FPS	Forest Policy Service, former name of the FPD
FPD	Forest Policy Department in the Biodiversity and Forestry division
GEF	Global Environment Facility
GFW	Global Forest Watch
GIS	Geographic Information System
GIZ	Gesellschaft für Internationale Zusammenarbeit GmbH
IS	Information System
MEPA	Ministry of Environment and Natural Resources Protection
NBMS	National Biodiversity Monitoring System
NFA	National Forest Agency
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NSDI	National Spatial Data Infrastructure
RS	Remote Sensing
TWG	Technical Working Group (FIMS-TWG)
WFS	Web feature service
WMS	Web map service

1. Executive Summary

This stocktaking report answers on the demand described in the project's terms as work package (WP-2) and shall provide early **overview on the status of the FIMS development**. It provides an understanding of the progress of the implementation of the existing FIMS modules and relevant achievements thereof, obstacles encountered, and lessons learned. It provides reflections on the capacities of the relevant stakeholders and institutional structures to support the implementation of the FIMS. Centrally, it compiles needs and demands regarding the FIMS design, the need for additional FIMS functions or structural changes, which subsequently allows to identify needs for updates, additional modules, interaction between modules and integration of modules into the overall FIMS. Based on this compilation, it should be possible to take the basic steps necessary to develop new modules and/or modify existing modules, as well as to prioritize and develop a schedule and work plan.

Finally, this stocktaking has not been completed in an early stage in this assignment, but it compiles the status in a moment, where the **decision on ABACO as sole developer** has been made. This changes the perspectives from the initial idea of a FIMS build from a number of different modules, developed or purchased by/from different companies towards a situation, in which the whole modular FIMS may be designed and developed in one package using the tools available from ABACO. Although this is definitely a more expensive solution, it has the advantage of a comprehensive integrated design, a standardization of tools and features and synergies. Special FIMS tools can be developed once and used in multiple modules.

Getting a full overview, proved to be more difficult than as several FIMS modules are under development in different phases. This ranges from "not yet planned" ((3.3) Forest Model Toolbox) to "draft concept exists" ((6 b) Forest operations – Maintenance) to just before "implementation" ((3.2.) FMP module). In this regard the stocktaking task was already mixed with tasks from the WP-3: "Specifying new FIMS modules and updating existing modules".

For the current status, an **overview of the FIMS system** and its modular structure was compiled (see Figure 1 below and chapter 3.3 for details), which has been several times adapted as a result of discussions and decisions triggered by the stocktaking interviews and meetings. A **catalogue of factsheets for each module** is presented in chapter 4 to 0. From this compilation a set of **FIMS tools** – technical tools relevant for several or nearly all FIMS modules could be defined and are described in chapter 3.4. Chapters 3.1 and 3.2 were added to define the **role and meaning of software modules, tools and graphical user interfaces** as it was a matter of intensive discussion during the stocktaking (see chapters 3.1 and 3.2).

The following Figure 1 gives an overview on the current **FIMS modular system** at the end of the stocktaking phase, more details can be found in chapter 4. The graph contains a system of IDs for each module, some of the bigger modules are divided into sub-modules

representing a specific bundle of features to provide support for a defined business process.

To highlight crosscutting technical **FIMS tools** relevant for many FIMS modules 4 different symbols have been used at each module. They represent (from left to right) the need for: WebGIS / Spatial DB (yellow); a Mobile App (blue); “Forest Model” Tools (green) and the integration of (1.1) Retrieval platform features (small screenshot).

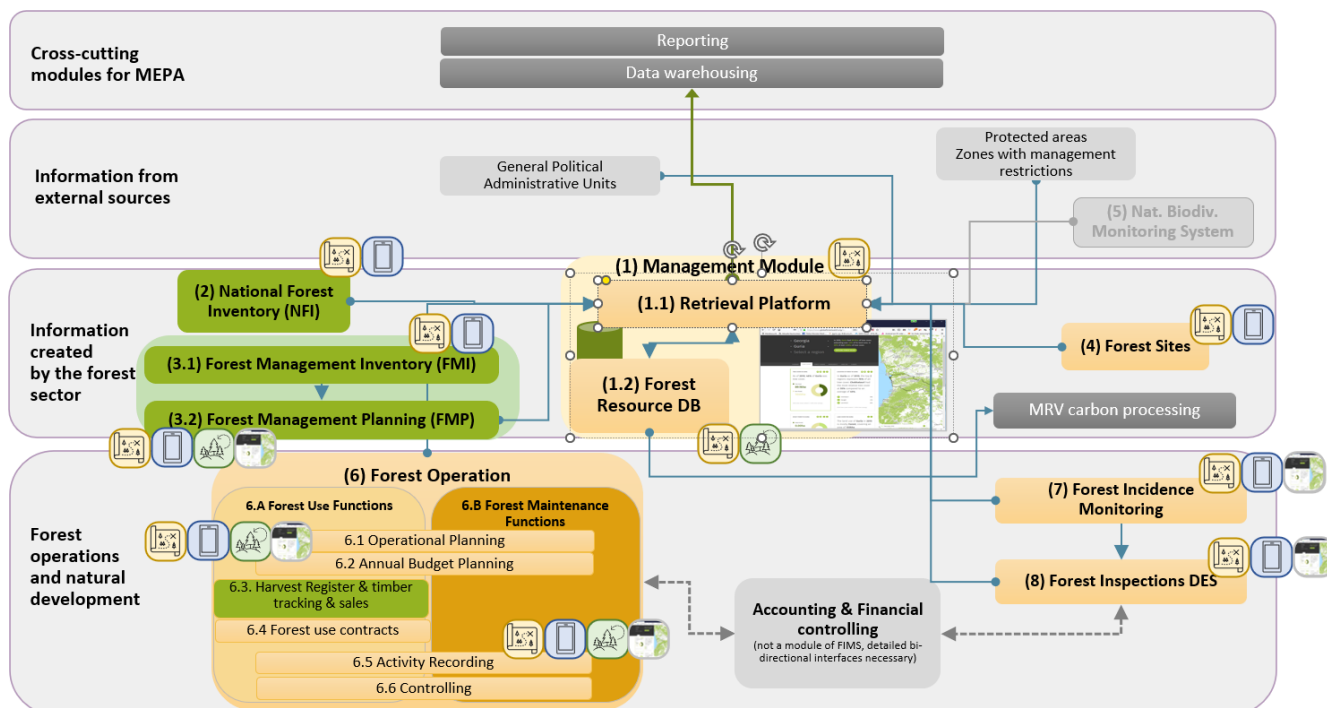


Figure 1: Current overview over the FIMS modules

(the symbols at each module represent (from left to right) the need for some FIMS tools: WebGIS / Spatial DB (yellow); a Mobile App (blue); (3.3) Forest Modelling Toolbox (green); (1.1) Retrieval platform features)

General recommendations for the **implementation of the FIMS** are highlighted in chapter 0, again as outcome of the interviews and discussions during the stocktaking. The chapter ends with an **estimation of a development time frame and developer resources** (chapter 5.3) required considering the status and the decision that ABACO is selected as sole developing company for most of the not completed FIMS modules.

This summary and the stocktaking report close with a list of recommendations for priority decisions and priority steps towards the planning, developing and implementation of the FIMS.

Recommended priority decisions

- Decide on the Setup for the organization of the software development (see chapter 5.2)
- For the (4) Forest Site Module the definition and development could be connected with the upcoming soil mapping project – supported by GIZ (for the fact sheet see chapter 4.4).

- (2) NFI Module: Thinking ahead the software Open Foris Calc is reaching its end of life and is not developed by FAO anymore. A migration of the data into the successor Open Foris Arian will be necessary for the next NFI. So far, no investigations have been made as to whether this software can be seamlessly integrated into the FIMS. Open Foris is not an interactive reporting system. If such a feature is needed: Can Open Foris SAIKU be used or another platform to present NFI results?
- Unique offers to develop a standardized format for the documentation of each module to be used by the TWG.
- The role of the Forest Atlas of Georgia (ESRI server) in the future needs to be clarified. Especially with regards to:
 - Who is developing and providing any update of the Atlas?
 - Should any new data from the FIMS be displayed in the Forest Atlas as well?
 - Why are license cost paid for two parallel platform techniques offering access to information on forests and forest management in Georgia?

Recommended priority steps

- Ensure that the TWG is meeting regularly and that it receives enough recognition for its importance to coordination between the different modules.
- Develop TORs for the FIMS-TWG, the related FIMS commissions and FIMS developer teams (see chapter 5.2).
- TWG: ABACO needs an “observer position” in the TWG. ABACO also needs to nominate developers for the different FIMS development teams.
- TWG: Prioritize the software concept document development for all the FIMS modules, which are not existing yet (see module descriptions in chapter 4 below). Only if an overview of the FIMS system on the level of a concept document exists, ABACO can plan the complete system layout and assess time and costs.
- TWG & ABACO: Discuss the FIMS modular structure as described in this document. Get a draft technical FIMS concept from ABACO including a cost- and time plan.
- BFD & GIZ: Development costs: Get a draft cost estimation for the ABACO-development based on the FIMS software concept documents and compare this to the available funds.
- TWG: Decide a priority order in which the FIMS modules shall be developed. Start with central FIMS tools (Spatial DBMS, mobile offline App, WebGIS) and the (1) Management module. Decide on priority features in case of budget restrictions. If budget cuts need to be discussed it is advised to keep the vision of the optimal and complete FIMS module in mind and to design cuts in such a way that predefined features may still be added at a later time to complete the originally planned feature set.
- Forest Model toolbox: high priority to define the components and start with developing a draft database structure (Unique can develop it).

- TWG: Define the organizational setup and start software requirement development for each FIMS module (exception (2) NFI module).
- TWG: The central (1) Management module with its sub-modules (1.1) Retrieval platform and (1.2) Forest Resource DB should get early attention as the other modules can build onto it. This is now easier with the central role of ABACO.
- TWG: Knowledge gaps regarding the interactions of modules should be identified and closed between the coordinators of the respective modules. The connections between modules should be regarded from the earliest possible stage of the modules to avoid isolated solutions.

2. Background / Introduction

2.1. The FIMS support

This stocktaking report is one delivery for the work package 2 of this assignment, which aims to give support to the further development and successful implementation of the FIMS, covering four years of the total seven for the GCF project. Concrete objectives are as follows:

- Extending / updating the FIMS system (incl. designing new modules, updating existing modules, module integration) to cover Georgia's information needs for the forest sector.
- Supporting the integration of FIMS into legal and institutional frameworks to ensure relevant data is fed into FIMS and FIMS is used as resource for decision-making.
- Ensuring the necessary capacity of stakeholders operating or interacting with FIMS elements (e.g., local data collection, using FIMS data)
- Ensuring the software development / IT-based implementation of FIMS modules / updates to modules (which will happen under other projects) is in line with the functional design developed under this project.
- Ensuring the necessary alignment with other relevant activities conducted in parallel, e.g., UNDP-funded Land use, land use change and forestry (LULUCF) Measurement, reporting and verification (MRV) system, GIZ-funded development of forestry MRV system.

The forestry MRV system is required for Georgia's forests and for the GCF project to monitor and report on the results and impacts of the forest sector reform. It is also needed for monitoring and reporting on progress regarding Greenhouse Gas (GHG) emission reduction targets specified in Georgia's Nationally Determined Contributions (NDCs). The forestry MRV relies on the data collected and created in the FIMS. Specific FIMS modules shall be provided but are developed under a parallel assignment.

Regarding the demand of the objectives above, the assignment is organized into six work packages (WP):

- WP-1: Kick-off
- WP-2: Stocktaking on progress with the implementation of FIMS so far and national needs with regard to FIMS2
- WP-3: Specifying new FIMS modules and updating existing modules. If needed, advise on FIMS structure.
- WP-4: Provide flexible technical support and capacity development related to FIMS
- WP-5: Support the integration of FIMS into institutional structures and processes, including systems / platforms of MEPA (existing as well as under development)
- WP-6: Development of a long-term implementation roadmap for FIMS

2.2. Work Package 2 – Stocktaking

Aims of the stocktaking task

- Understand the progress with the implementation of the existing FIMS modules and relevant achievements thereof, barriers encountered, and lessons learned.
- Understand the capacities of the relevant stakeholders and institutional structures to support the implementation of the FIMS.
- Understand Georgia's needs/demands regarding the FIMS design. In addition, we will analyze the demand to support forest landscape restoration activities and monitoring.
- Considering the results of a) - c), understand the need for additional FIMS functions or structural changes. Subsequently identify needs for updates, additional modules, interaction between modules and integration of modules into the overall FIMS.
- Basic steps necessary to elaborate the new modules and or amendment of existing modules.

Approach and activities

- Stocktaking mission: Set of workshops with the FIMS-TWG, divided by the different FIMS modules adding the relevant future users (institutions) and software developers.
- Analyze the existing FIMS modules and modules under development in meetings with the software developers ("local experts" as addressed in ToR under WP 3).
- Analyze the existing/planned IT policy and infrastructure of MEPA. Consider software development options and capacities, module interoperability, central data retrieval and the central report platform.
- Draft, present and discuss suggestions for an updated FIMS-concept.
- Update of the project work plan based on development priorities as base for the work on WP 3 and WP 5 and the activities of the FIMS-TWG.
- With the FIMS-TWG clarify the standard operation procedure (SOP) for the FIMS planning and implementation cycle as base for the FIMS implementation plan.

Outputs and deliverables

- Stocktaking report including updated work plan and implementation plan.

2.3. Planned FIMS-structure based on TORs - 2021

The ToR contains a list of software modules, which shall be integrated and centrally retrieved by all institutions and users and form the future FIMS.

Table 1: Overview of FIMS modules, demands and remaining needs at the time of the drafting of the ToRs

Module	Status	Further needs & demands for consideration
(1) Central data management module (aligned with MEPA's ABACO platform?)	Planned	Support for update of vision document required – update of “FLUIDS idea”. Development of functional specifications, programming and integration into FIMS needed. Consideration of necessary functional and logical interrelationship among modules
(2) National Forest Inventory (NFI) module	Programming concluded	Integration with central data management system of MEPA needed
(3) Forest management inventory & Forest management planning module (FMI – FMP)	Status? Programming concluded	Improvements & Amendments needed such as: Evaluating the work of the program and develop recommendations, especially in the area of operation; Identifying possible gaps and standardization; Supporting the development of FMI integration needs and specifications into module; Mobile data collection; Integration into FIMS needed. Integration of the “forest model functionalities”
(4) “Site map” module (combines soil and forest data; forest productivity)	Planned	Support for vision document required; Functional specifications, programming and integration into FIMS needed.
(5) National Biodiversity Monitoring System	Status ??	To be interlinked
(6 a) Forest operation module - Forest use functions	Under development	Vision document available; Improvements & Amendments needed: Improve timber tracking system; Integration into central data management system of MEPA. Functional specifications, programming and integration into FIMS needed. Integration of the “forest model functionalities” Considering the interaction with the forest industry to help better understand national and international market demands.
(6 b) Forest operation module - Forest maintenance functions	Under development	Vision document available; Development of functional specifications needed, programming and integration into FIMS needed. Integration of the “forest model functionalities”
(7) Forest incidence monitoring module	Under development	Improvements & Amendments needed such as: Adding additional functionality, considering international experience; Possible connection to remote sensing; assessing the need to mirror further forest incidences like fires and pests collected under the forest operations module. Interfaces to different databases needed (e.g., on licenses, protected areas, assigned cutting areas, etc.). Integration into FIMS needed.

Module	Status	Further needs & demands for consideration
Carbon processing module (allows calculating changes in carbon stocks achieved)	Planned	To be developed under the MRV project and support tender: Support for vision document required; Development of functional specifications needed; Programming and integration into FIMS needed

The figure illustrates the modular FIMS system and flags the development status of each above-mentioned module as reported in the ToR and known at start of the stocktaking phase.

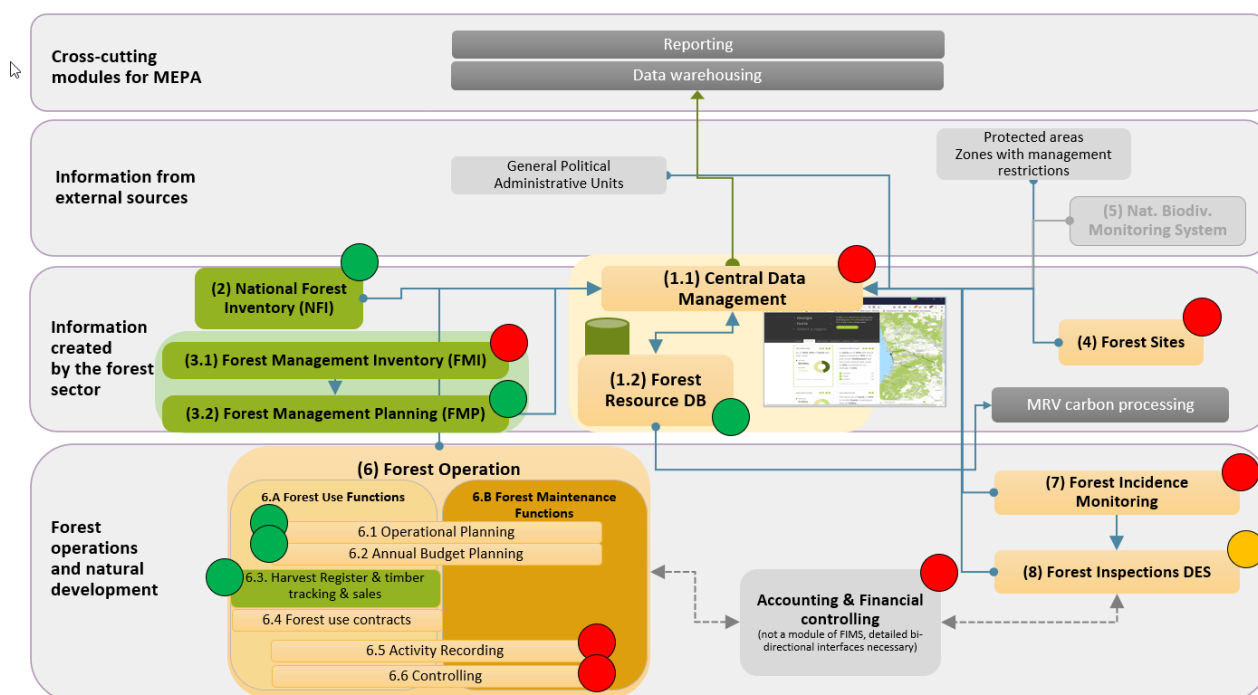


Figure 2: Illustration of the FIMS module structure at start of the stocktaking phase - highlighting the status of development

(red: planned or unclear status; orange: under development; green: programming concluded)

Especially the large and complex module (6) Forest operations needs to be split up in sub-modules covering the annual work cycle of forest operations from annual planning to activity recording and finally financial and impact controlling. Here it was already visible at start of the phase, that the sub-modules are in very different development stages.

3. FIMS-Overview

3.1. Excuse: What constitutes a module in the context of the FIMS?

The FIMS software shall support all users in the forestry sector in their daily work. The daily work for each of the institution or department can be split into business processes like “create the annual plan for NFA office xy” or “develop a forest management plan” or “create the annual contribution of MEPA BFD to the national MRV reporting”.

In each business process one or more organizational units are involved and mostly one is responsible. The responsible institution is related with the biggest part of the information creation in the process or with the final decision making based on the information compiled. For the definition of a FIMS module the business process and the main user is relevant. In the process of developing any kind of information system the analysis of the business processes is the first and basic step.

Roles, objectives and tasks for state institutions, responsible for forest management and administration are defined within the forestry related legislative framework (laws, regulations, strategies). For management purposes, these tasks can be easily interpreted and described as business processes.

Business processes are structured as a logical chain of work steps aiming to produce services to achieve business goals. They are influenced by the specific organizational framework within every institution. Business processes deal with answering the following questions regarding a business goal:

- What needs to be done?
- What input is necessary?
- What tools, information, staff or materials are necessary?
- What is the output?

Having this in mind, a FIMS must create and provide the support for the information and data flow along the business processes. The possibilities of digitalization need to be recognized and it may be beneficial to revise the businesses processes as future digital business processes. A FIMS is an essential tool to run the business, manage information, communicate, and support decision making. Therefore, prior to the development of a FIMS structure, the according business processes should be examined and consequently, the FIMS structure should reflect them respectively.

In result the FIMS module structure is influenced by the main user and owner of a FIMS module and a certain number of business processes related with them.

3.2. Excuse: Understanding the Distinction: Module - Tool - Graphical User Interface (GUI)

A clear distinction between a FIMS module, a FIMS tool and the FIMS user-interface, through which interactions with the module happen, helps minimize misconception about the development process and its sequence.

As we discussed the **module**-based design above, we need to separate it from technical tools. We can define the **FIMS tools** as technical features of the FIMS, which can be used in several modules. One example is, that for any Forestry related information system a spatial database management system (Geo-database) able to store geo-location of data (stands, compartments, forest roads, harvesting areas) is needed. Another technical tool is the use of Web-GIS for all FIMS modules, as the user should have the ability to see data from the database as map embedded in a web-application (example "Forest Atlas"). A third example is the collection of tools combined to form the "Forest Modelling Toolbox" (see chapter 4.3.3).

A **Graphical User Interface (GUI)** is the visual interface that users use to access a software application (what they see of the program). A GUI provides a visual representation of the software or application, allowing users to input commands, view information, and receive feedback through menus, forms, and other visual interactive elements. The primary purpose of a GUI is to provide an intuitive and user-friendly way for users to communicate with the software or application.

In the context of the FIMS, a single piece of software should be developed that flexibly serves as a GUI for all modules: the **(1.1) Retrieval platform**. It consists of menu, where the user can select the different FIMS modules. When starting one of the FIMS modules, the user gets a more specific menu allowing to start with those business processes, which are purpose of the module. The user at the same time gets access to tables, graphs and maps (via a Web-GIS window). As it is planned now, that one company - ABACO – will develop most of the FIMS modules (except for the NFI module) this platform can be developed a single time. Subsequently only minor adaptations are required for each module and the specific needs of their users. This will ensure consistency across the FIMS-applications and looking forward allows for easier adaptations of how users interact with all modules.

While the GUI is the user-facing part of a system, the module itself refers to the underlying architecture and organization of the software and databases. It can be thought of as a specialized unit, each of them being responsible for a set of specific tasks that can be mapped to one process (e.g. FMP). The modules are the backbone of the software, managing data storage, processing, and executing the logic behind the scenes.

In the FIMS, a module can have a GUI (and most modules do), but this is not per se required e.g., the (3.3) Forest Modelling Toolbox will provide calculation outputs for other modules but will not be interacted with directly via a GUI.

Hence, when designing a module, the primary task is to understand and conceptualize the work-processes executed from the users of a specific module. The key task is to translate these processes into a more technical description for the developers. How the GUI of a module is designed is defined in a later stage of the development process.

3.3. Overview on FIMS-modules – at the end of the stocktaking phase

In the following graph the FIMS related modules are presented in an overview. The graph contains a system of IDs for each module, some of the bigger modules are divided into sub-modules representing a specific bundle of features to provide support for a defined business process.

To highlight crosscutting technical tools relevant for many FIMS modules 4 different symbols have been used at each module. They represent (from left to right) the need for: WebGIS / Spatial DB (yellow); a Mobile App (blue); "Forest Model" Tools (green) and the integration of (1.1) Retrieval platform features (small screenshot).

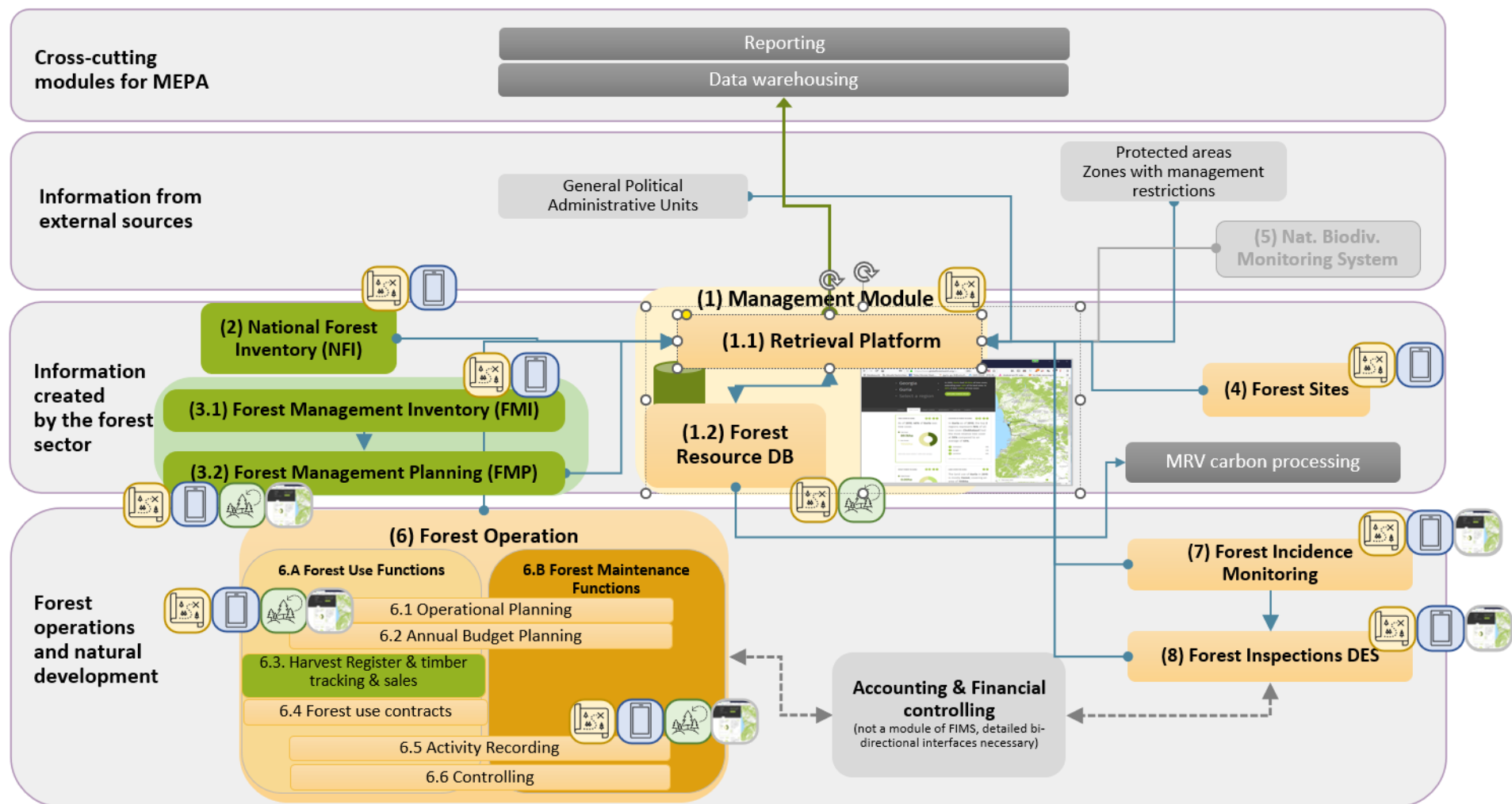


Figure 3: Current overview over the FIMS modules

(the symbols at each module represent (from left to right) the need for some FIMS tools: WebGIS / Spatial DB (yellow); a Mobile App (blue); (3.3) Forest Modelling Toolbox (green); (1.1) Retrieval platform features

3.4. Mobile Solutions and WebGIS

Figure 3 in chapter 3.3 presents an overview about the modules of the FIMS also highlighting cross cutting technical FIMS tools relevant for many modules. Four different cross cutting technical tools have been identified, these are: 1) a WebGIS / Spatial DB, 2) a Mobile App, 3) the “Forest Model” Toolbox, and 4 (1.1) Retrieval Platform. The Forest Model Toolbox is described in detail below (see 4.3.3), as is the module (1.1) Retrieval Platform (see 4.1.1). Therefore, the focus of this section are the two other cross cutting FIMS tools.

3.4.1. WebGIS & spatial databases

Nearly all objects we deal with in forestry have a spatial aspect. Whether stands are managed, forest roads are built, soil conditions are mapped, or nature protection zones need to be considered. Spatial data are created in Inventories from the position of single trees to locations of timber piles, areas for harvest or areas for land lease. In consequence, a FIMS not considering a DBMS, which can handle spatial data like points, lines or polygons is not an option nowadays. The standard DBMS selected by the MEPA IT Team – MS SQL is capable to manage spatial data, other DBMS are PostgreSQL/PostGIS or Oracle. As FIMS modules shall be developed as web-based applications, WebGIS tools are the necessary

GUI to edit, show and retrieve spatial data in a map format. In the

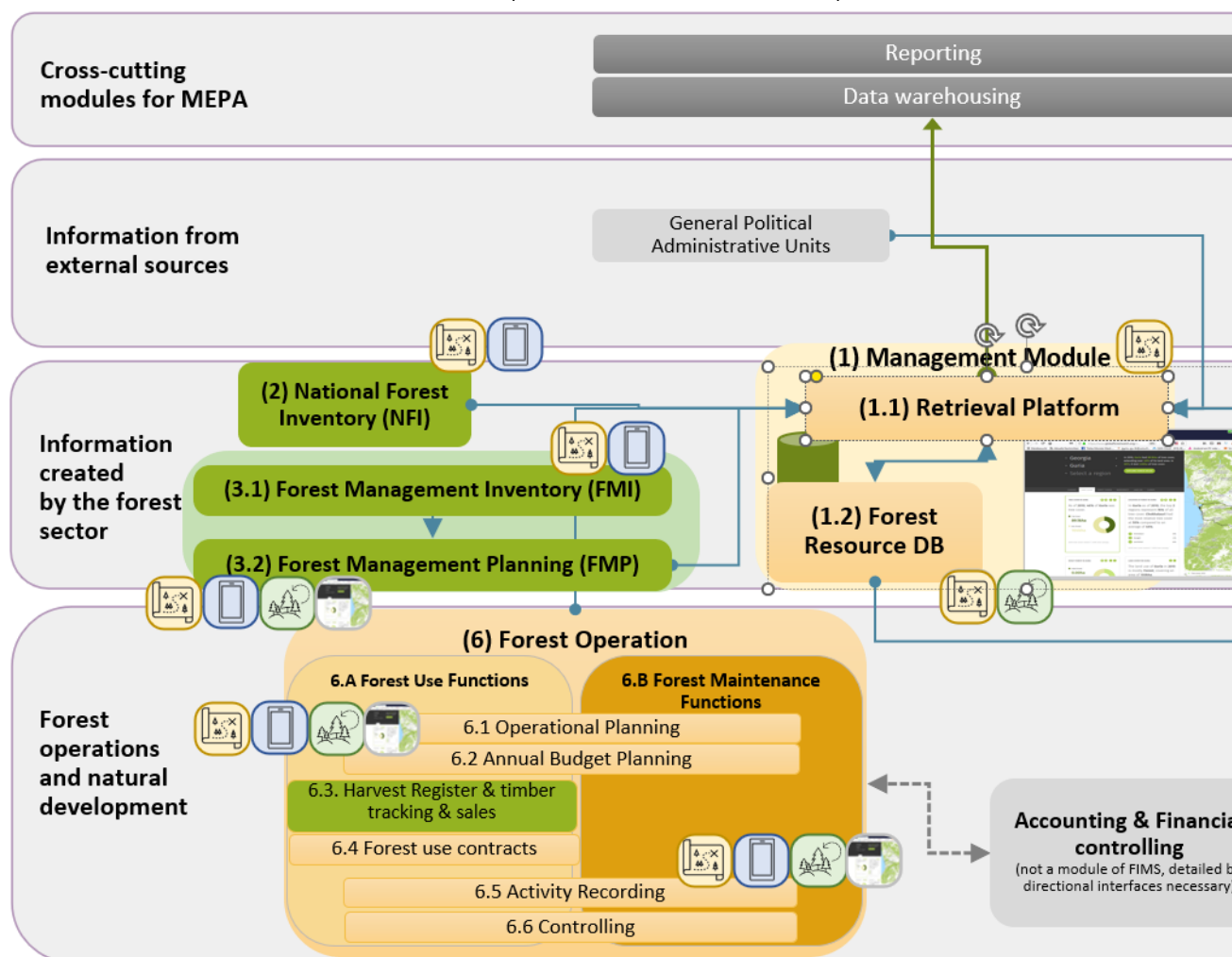


Figure 3 all modules are marked, where spatial databases and WebGIS technique should be used.

3.4.2. Mobile Solutions

Data creation, data collection as for many work processes in the forestry sector are happening in the forest. To optimally support these business processes and decision-making FIMS information should be available in the forest. The NFI, the FMI, the FMP, operations planning, and implementation can be optimally supported using mobile applications. At the moment only the NFI and the planned module for Forest Inspection of DES are considering the advantages and cost efficiency of mobile solutions. Mobile solutions can integrate spatial data via WebGIS tools and allow navigation and spatial data collection via GPS in the field. For the work in forests offline functionality is a must.

In Figure 3 all modules are marked, where mobile solutions should be considered.

3.5. Showcases for workflows with the FIMS module structure

The discussion about FIMS, facing a complex software structure, high investments, and operational costs, leads to questions about the positive effects and impacts on decision-making and daily workflows.

To illustrate the impact and effects of a complex and costly FIMS, several show cases from different business processes were described in the FIMS concept from 2017. Hereafter these showcases are updated to highlight how the different modules will interact with each other and along the process steps to conduct a specific task. These showcases shall also highlight the need to combine data – mostly spatially – from many different sources to allow quick and efficient reactions on the wide range of tasks in forest management and forest administration.

In the chapters below for each task the traditional approach and the new solution using the FIMS is explained step by step. In addition, for the new solution a table with these steps and involved modules is displayed.

3.5.1. Showcase: Inventory data collection

Task: Tree data must be measured in several sample plots per stand to derive numerical values of tree species and stand structure (N, basal area, volume, quality, and density).

Traditional approach:

- Subjective location of sample plots; Measurement of diameter and a sub-sample of heights; no documentation of tree and plot data; manual data aggregation; manual data input in FMP software without plausibility checks.

New solution: FMI software combined with the FMP software

- Objective GPS controlled and documented sample plot layout; statistical analysis of precision possible; mobile data collection including plausibility checks in the forest; full tree data storage for analysis on higher level (biodiversity, structural diversity, tree quality, growth and yield); repeated measurements after 10 years allow deriving high precision change information and increment data; automatic import of plot and tree data to the FMP software; automatic calculation of all tree species data in the traditional stand description.

Table 2: involvement of FIMS-modules in the new solution

Work step	Involved module
objective GPS controlled and documented sample plot layout	(3.1) Forest management Inventory
statistical analysis of precision possible	(3.1) Forest management Inventory
mobile data collection including plausibility checks in the forest	(3.1) Mobile data collection app for FMI
full tree data storage for analysis on higher level (biodiversity, structural diversity, tree quality, growth and yield)	(1.2) Forest resource DB stores all relevant data
repeated measurements after 10 years allow deriving high precision change information and increment data	(1.2) Forest resource DB stores all relevant data
automatic calculation of all tree species data in the traditional stand description	(3.2) Forest management planning module

Effects and benefits:

- More information, higher data quality.
- Higher costs for inventory field work but almost no data input costs.
- Overall time savings by using mobile data collection (up to 30%)

3.5.2. Showcase: FMP planning support

Task: During the FMP process, each stand must be described and evaluated. It is to decide upon a set of optimal measures for stand development to fulfil multiple economic and environmental services.

Traditional approach:

- Stand boundaries are mapped in a desktop GIS, based on old forest maps and actual aerial images; stand boundaries are not fitting to the digital cadaster.
- During the field work a paper map is used with the old topographic map in the background; Many spatial data layers are not available such as forest site map, forest function map; data on the utilization of the previous period and the previous strategic decision for this stand; paper forms for data collection are used.
- Decision on measures – especially yield planning - are mainly made back in the office.

New solutions – supported by FMP software:

- The easy accessibility and the smart overview of all information layers relevant for forest management decision form a key challenge for software systems supporting the planning process. As most of the information is location-based and spatial-explicit, it can be retrieved using a GIS. This is especially valid for the new ecological information compiled in the FIMS.

- Soon the planner will have access to the following geo-data layers, on a mobile device (ruggedized tablet), which he can combine in a comfortable and fast way using his retrieval platform:
 - Forest Site Map (including tree species suitability and productivity; Potential Natural Forest Vegetation)
 - Layers related to nature conservation such as protected areas or range data of rare and endangered species
 - Erosion or landslide risk maps
 - Accessibility map – terrain data and road network
 - Forest function map
 - Background maps: Topographic features such as waters, buildings, and other land use classes etc.
- Moreover, the planner needs direct access to the standard forest maps – now in digital format
 - Forest stand map
 - Forest operation map (results of harvest and other silvicultural activities)
- The planner can now read and interpret several information layers at the same time for a certain stand in his spatial context.
- In the traditional approach, for the task to describe a forest stand and the following derivation of optimal measures, it is necessary to open several analogue maps, open printed tables and documents one after another. Every time the location "stand" had to be searched for. The number of documents, yield tables, maps, guidelines often led to the situation that most of this information was not at hand, not in the forest and also not at the desk. Decision making was shifted in time and space, thus from the best moment – on site and in the forest stand – to desk days or even weeks later. Moreover, for the data extraction and input in a stand description form or for the selection of management activities in the planning process a manual data input is needed. Both are time consuming and error prone.
- In contrast a GIS based user interface as in a mobile app allows to keep the location of the stand fixed and open the related information layers very fast.

Table 3: Showcases for work-flows including the FIMS-module structure

Work step	Involved module
The easy accessibility and the smart overview of all information layers relevant for forest management decision form a key challenge for software systems supporting the planning process.	(3.2) Forest Management Planning via the (1.1) Retrieval platform
Soon the planner will have access to many different geo-data layers on a mobile device	3.2 Forest management Planning; (4) Forest Sites; (1.2) Forest Resource DB via (1.1) Retrieval platform
Moreover, the planner needs direct access to the standard forest maps – now in digital format - Forest stand map - Forest operation map (results of harvest and other activities)	(1.2) Forest Resource DB
The planner can now read and interpret several information layers at the same time for a certain stand in his spatial context.	(3.2) Forest Management Planning (FMP)
In contrast a GIS based user interface as in ABACO allows to keep the location of the stand fixed and open the related information layers very fast.	(3.2) Forest Management Planning (FMP) via its mobile app interface

Effects and benefits:

- More information for decision-making is easily accessible, higher data quality.
- Same costs for better and more precise decisions.

3.5.3. Showcase: Reporting on Criteria & Indicators of Sustainable Forest Management

Task: The MEPA BFD shall develop a report on Criteria & Indicators of Sustainable Forest Management – here criteria 1 – to be provided in a 5-years rhythm. Criteria 1 asks for the quantitative and qualitative development and preservation of forests as a natural resource.

1. Criteria 1

- 1.1 Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles.
- 1.2 Forest area - Area of forest and other wooded land, classified by forest type and by availability for wood supply, and share of forest and other wooded land in total land area.
- 1.3 Growing stock - Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply.

- 1.4 Age structure and/or diameter distribution - Age structure and/or diameter distribution of forest and other wooded land, classified by availability for wood supply.
- 1.5 Forest carbon - Carbon stock and carbon stock changes in forest biomass, forest soils and in harvested wood products.

Traditional approach:

- Forest area: Statistical data of forest fund area; updates and actualizations are not monitored; no full matching with new digital cadaster; no actual overview of the forest area of the country; data is not available in digital format in a FIMS.
- Growing stock - classified by forest type: Statistical data derived from a mix of older sources; known deviation from reality needs to be ignored, as precise data cannot be retrieved; forest types not flexible defined to meet different international reporting schemes; yield planned exist only partially for the entire forest area.
- Age structure and/or diameter distribution: Age roughly estimated per stand, only available where FMP exists. Complicated access as stored in paper documents of single FMP, no central database; diameter distribution not available as sample plot data is not stored in the traditional inventory process.
- Forest carbon - Carbon stock and carbon stock changes in forest biomass, forest soils and in harvested wood products: Carbon stock information is not available from traditional FMP; no data on forest soil biomass as no site map is available; only 20% of harvested wood products are traditionally registered; an automatic calculation model to evaluate wood products is not available.

New solutions – based on the NFI database and the Forest register:

- Forest area: Forest area is available in the (1.2) Forest Resource Database; Any classification can be calculated via intersection with other spatial layers via (1.1) Retrieval platform.
- Growing stock: Data available from two different sources: (2) NFI database and from (1.2) Forest Resource Database; The software stores all available FMPs; Stand data is actualized via (6) Forest Operations Module and simulation of the annual growth; Software allows to group data by any types of forest or mix of grouping schemes (example: volume and increment in "Beech forests" by different forest function zones).
- Age structure and/or diameter distribution: Age and diameter distribution available from either (2) NFI Module or (1.2) Forest Resource Database.
- Forest carbon - Carbon stock and carbon stock changes in forest biomass, forest soils and eventually also in harvested wood products: Carbon stock information available from (2) NFI module or (1.2) Forest Resource Database; data on forest soil biomass available from (4) Forest Site Module; Information on harvested wood products from data stored in (6.3) Harvesting Register and can be evaluated via a calculation model.

Table 4: Showcases for work-flows including the FIMS-module structure

Work step	Involved module
Forest area: Forest area of the country	(1.2) Forest Resource DB
Growing stock	(2) National Forest inventory; (1.2) Forest Resource DB
Age structure and/or diameter distribution	(2) National Forest inventory; (1.2) Forest Resource DB
Forest carbon - Carbon stock and carbon stock changes in forest biomass, forest soils and in harvested wood products	(4) Forest Site Module; (6.3) Harvesting Register; (1.2) Forest resource DB

Effects and benefits:

- Drastic improvement of data quality and completeness
- Cost savings: Several weeks (traditional method) versus a few hours (new solution)

4. Status of FIMS Modules and recommendations for design and development

4.1. (1) Management module

4.1.1. (1.1) Retrieval platform

Business processes

The Retrieval platform acts as a central provisioning and retrieval infrastructure across the different modules. It allows (spatial) queries of all data from the decentralized modules (2) - (8) that are relevant for the functioning of other modules. While (1.1) is required for data exchange, the data itself is held in (1.2) and integrated via the web-GIS tool.

The FIMS concept follows the idea that each institution or department of the forest sector, which is creating and updating information, shall manage the information based on its own special software module (e.g. NFI Module, Forest Operation Module). The related modular databases are also under ownership of each institution. The Retrieval Platform combines information from different sources / software systems and makes all of them available via a web-GIS-portal. The Retrieval Platform technology also allows offering relevant forest information to a wider public via the web-GIS-portal.

Within the proposed FIMS different user groups will have different access rights according to modules and databases, allowing them the fulfillment of their daily work and decision-making via one general user-interface build as a web-GIS-portal using a general spatial analytical potential and monitoring functionalities. It is foreseen as the central access and data retrieval point for all user groups, combining all relevant spatial and tabular data, spatial analytics and access to the different software modules.

Features and tools

- Data on that platform is provided via standardized interfaces between the spatial databases of the different FIMS modules especially from the (1.2) Forest Resource Database or via WFS or WMS. Like in a "spatial data warehouse" information from different FIMS software modules can be combined and analyzed not only via visual interpretation but also using spatial analytics.
- Geodata management required (spatial DB).
- User access rights management, allowing a fine-grained provisioning of data depending on their access rights (ranging from other modules to data available to the public)

Users

- Owner/Main users: MEPA BFD
- Users: NFA, APA, AFS, DES
- Other users with (limited) access: Gov. Bodies, Public

Most relevant data interfaces

- As the Retrieval Platform is the integrative platform for data access and retrieval there are data interfaces to all modules necessary.

Examples of similar software applications

- Platform technique of ABACO GROUP
 - <https://www.abacofarmer.com/en/>

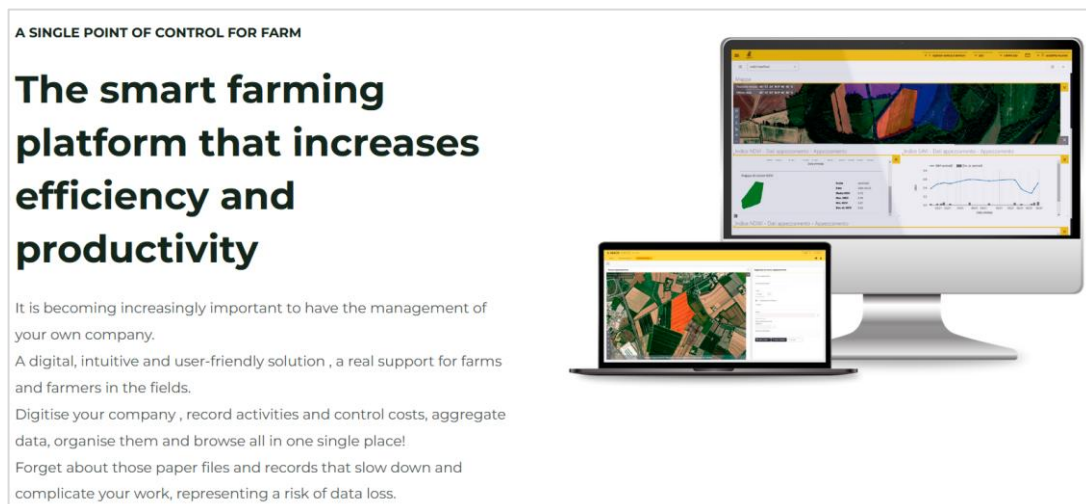


Figure 4 User interface – platform example: Abaco Farmer

- Platform technique of Global Forest Watch
 - Interactive World Forest Map & Tree Cover Change Data | GFW (globalforest-watch.org)

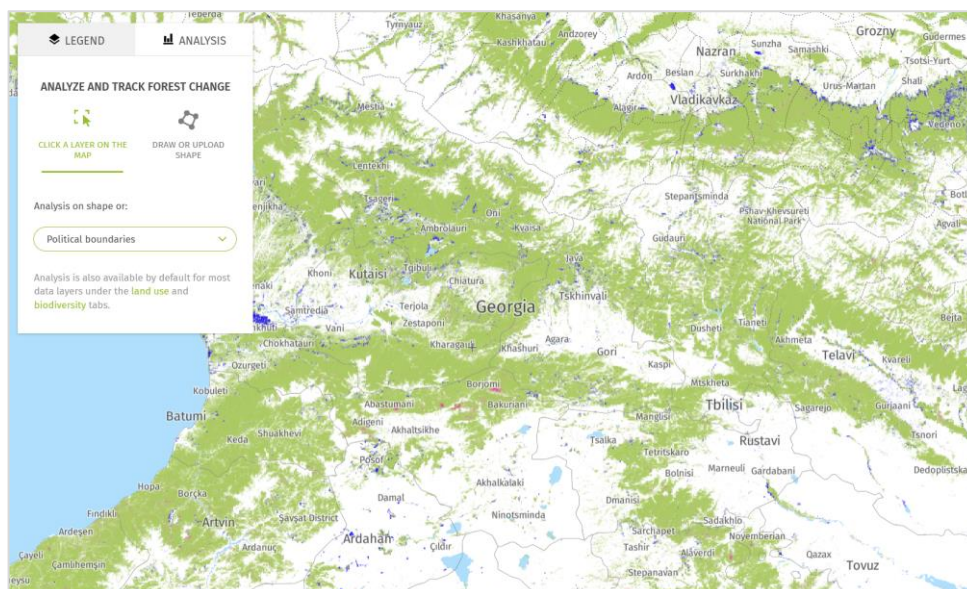


Figure 5 User interface – platform example: Global Forest Watch

Status of development

- Planned
- Existing technologies in MEPA are available like those already developed by ABACO, but technical suitability and costs to be clarified.
- Development of functional specifications, programming and integration into FIMS needed.
- Consideration of necessary functional and logical interrelationship among modules.

Further comments

- The Retrieval Platform is a core tool and needs a higher priority as it influences tools, interface techniques or other technical standards of other FIMS modules.

4.1.2. (1.2) Forest Resource Database

Business processes

The Forest Resource Database (ex "Forest Register") is part of the central Management module of the FIMS holding all data describing forest resources and infrastructure. This is the location where the forest and the forest structure are described using forest stands as their core forest management unit. A regular update is maintained by Forest Management Plans and features to simulate annual growth and changes induced by forest operations (harvesting, re afforestation etc.).

Features and tools

The database structure and main functions are very similar to the one of the (3.2) FMP Module. A Forest Resource Database module can be derived from the partly completed (3.2) FMP module. To ensure the proper functionality of the module, the following features should be included:

- Relational spatial database of the core forest management entities: forest compartments and stands, forest roads and other infrastructure.
- Data import from forest management plans including secure overwriting of outdated stand and management units.
- Data check, data aggregation and (spatial) analysis.
- Actualization of stands triggered by activity records from (6.5) Activity recording sub-module and (7) Incidence Monitoring module:
- Continuous actualization triggered by all forest operations changing the structure of forest stands (harvesting, thinning, planting) or incidences (fire, storm, pests)
- Geodata management required (spatial DB)

Users

- Owner/Main users: MEPA BFD
- Users: NFA/APA/AFS – all management bodies; DES – for inspection
- Other users with (limited) access: Gov. Bodies, Public

Access is provided via the (1.1) Retrieval platform

Most relevant data interfaces

(3.2) Forest Management Planning (FMP) – uploading forest management plans once project is completed.

(6.4) Activity records – send trigger with data allowing to update forest stand information (timber harvesting, regeneration, fencing)

Examples of similar software applications

- „Datenspeicher Wald“ - Software for Forest Management planning and Central forest database updated from Forest Operations
 - Powerpoint: [DSW2-eyecatcher KWF_GEO.pptx](#)

Status of development

- Planned, can be derived from basic DB structures of the (3.2) FMP module.
- Most obvious adaptations are:
 - Features like “annual growth” and “actualization of stands” triggered by activity records – as described above - are not existing in most of the known software products on the market.
 - Add objects like forest roads, bridges, business yards, offices (assets)
 - Switch to a spatial database.

4.2. (2) National Forest Inventory Module (NFI)

Business processes

The National Forest Inventory is an internal core information creation process. A software solution is needed for data collection, data aggregation, data analysis and reporting. The smallest unit for which statistical sound data can be provided following the developed design for the National Forest Inventory are forest types and tree species (groups) within a region, a district or even within a certain forest function zone.

Features

- Relational spatial database for point sampling
- Data check, data aggregation and analysis, sample error calculation
- Reporting: Reports all relevant data (tables and maps)
- Mobile data collection App including plausibility checks and GPS navigation
- Integration of all functions of the sub-module (3.3) Forest Modelling Toolbox

Users

- Owner/Main users: MEPA BFD – NFMS unit (not established yet)
- Users: NFA, APA, AFS
- Other users with (limited) access: DES, Gov. Bodies, Public
- Access is provided via the (1.1) Retrieval platform

Most relevant data interfaces

- (1.2) Forest resource DB – upload of copies of views showing NFI results to be retrieved via (1.1) Retrieval platform

Examples of similar software applications

- Open Foris Arena Website
 - <https://openforis.org/solutions/arena/>

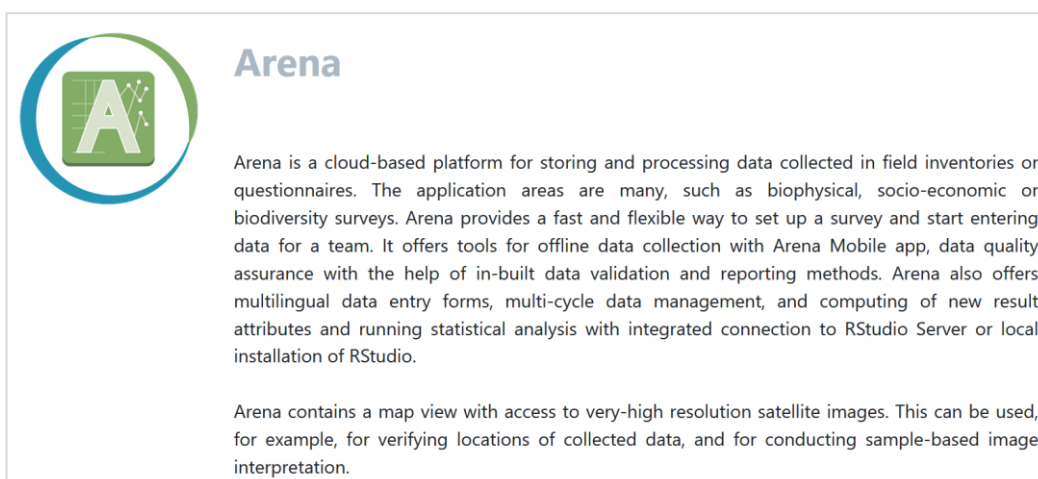


Figure 6 Open Foris Arena – Introduction from the website

- Open Foris Arena Web-Application
 - <https://www.openforis-arena.org/app/home/>
- Open Foris Arena Mobile-App (field data collection)
 - https://play.google.com/store/apps/details?id=org.openforis.arena&hl=en_US
- Handbook (V.1.4; 19.03.2024)
 - <https://docs.google.com/document/d/1GWerrExvbdT5oOOI-wdKE9pptK4pVbQxwtgaSNPasmKA/view>

Status of development

- Open Foris of FAO established and used for the first NFI.
 - NFI team has delivered a first report; the software for data collection, processing, analysis, and reporting is functioning (with very minor tasks remaining to be completed).
 - Clarifications needed:
 - The Open Foris Calc software cannot not be used as an interactive reporting system. If such a feature is needed: 1.2) Forest Resource DB could be used to store pre-defined NFI results as alternative to the SAIKU reporting tool embedded in Open Foris.
- Integration of the (3.3) Forest Modelling Toolbox not discussed and developed.

4.3. (3) Forest Management Inventory & Forest Management Planning module (FMI-FMP)

4.3.1. (3.1) Forest Management Inventory (FMI)

Business processes

ForestEye (2017) has defined the purpose of the FMI as part of the Forest management planning business process like follows: "FMI are to provide scientifically sound and technically meaningful data and information to support planning and decision processes within the forest district where the FMI takes place" (ForestEye 2017). The FMI is an inherent part of the Forest Management Planning process: "Quantitative and qualitative assessment of forest resources for production" (Article 26, Forest Code).

The Forest Management Inventory is an internal information creation process. The FMI module allows data collection, data aggregation and data analysis for a point sampling inventory. It has an interface to feed stand and strata data into the (3.2) FMP module.

Features

- Relational spatial database for point sampling
- Mobile App for data collection including plausibility checks required (safes 30% of time and costs)
- Data check, data aggregation and analysis, sample error calculation
- Reporting
- Geodata management required (spatial DB) features (MSSQL or Postgres/PostGIS) and a web-GIS tool

Users

- Owner/Main users: Management bodies responsible for FMP: NFA / APA / AFS
- Users: see 3.2) FMP module as data are reported within a Forest Management Plan
- Other users with (limited) access: see 3.2) FMP module as data are reported within a Forest Management Plan

Most relevant data interfaces

- (3.2) Forest Management Planning – providing updated sampling inventory-data for the taxation of stand in the FMP process.

Status of development

- For the meanwhile 3 pilots for the FMI process Open Foris has been used.

- The automatic data aggregation for the stand level (taxation) is not yet developed. The FMI and FMP databases are not connected.
- Option to integrate the FMI data collection and Stand level data collection in a mobile and GI-containing application need to be evaluated as a mobile app is targeted for both sub-modules (3.1) FMI and (3.2) FMP.

4.3.2. (3.2) Forest Management Planning (FMP)

Business processes

The Forest Management Planning is an internal information creation process providing regular (10 years cycle) updates on forest status and future planned activities. The FMP module is used to define and update stand data and forest maps. These feed back into the 1.2) Forest Resource DB to complete the actual picture of the forest resources of an enterprise or an administration entity. Typically, the smallest management unit is a forest stand (litter) inside a forest district. The FMP is updated every 10 years.

The purpose is to support the development of Forest Management Plans in all steps:

- Phase 1: Analysis of the forest structure (Status)
- Phase 2: Evaluation of the past period (10 years period)
- Phase 3: Definition of planned measures for the next 10-years period
 - Forest stands: Harvest, tending, thinning, regeneration, reforestation
 - Non forest: Afforestation, agriculture, grazing rights, non-timber production rights
 - Roads: Building & maintenance

Features

- Relational spatial database for stands (litter), including Geodata management features (MSSQL or Postgres/PostGIS) and a WebGIS tool
- Mobile App for stand description and planning required (saves 30% of time and costs)
- Data check, data aggregation and analysis (i.e. DBH classes per tree species by stand or stratum)
- Integration of all functions of the sub-module (3.3) Forest Modelling Toolbox
- Planning:
 - Group and filter stands by strata
 - Calculate and present model-based yield indicators (increment, yield table etc.)
 - Support comparison of model-based yield planning and stand based yield planning
- Reporting:

- Status of forest by forest types, species, age class, DBH distribution, stocking density, volume and others
- Activity records from the last period
- Target – actual comparison
- Planned measures by forest type for harvesting, reafforestation, roads, NTFP and other plans.

Users

- Owner/Main users: Management bodies responsible for FMP: NFA / APA / AFS
- Users: MEPA BFD, NFA / APA / AFS - via upload of FMPs to (1.2) Forest Resource DB
- Other users with (limited) access: Gov. Bodies, Public - via upload of FMPs to (1.2) Forest Resource DB

Most relevant data interfaces

(3.1) Forest Management Inventory (FMI) – retrieving up to date information on the stand level for planning

(3.3) Forest Modelling Toolbox – evaluating the effect of different interventions and intensities based on forest growth predictions

(1.2) Forest Resource DB – results of the FMP modules are used to update respective data from previous management plans

Status of development

- Programming is partly concluded, but improvements and amendments are needed:
 - Switch to spatial DB, integration of a Web-GIS tool needed.
 - Development of integration of the sub-module 3.1) FMI and the sub-module 3.3) Forest-Modelling Tools required.
 - Mobile data collection app not yet developed.
- Issues remain to be solved: in the test case of Akhmeta the link with spatial file-based data requires a lot of manual work.

4.3.3. (3.3) Forest Modelling Toolbox

Business processes

The Forest Modelling Toolbox is a collection of tools/functions to simulate growth and development of forests, simulate management interventions and allow to evaluate economic impacts of the simulation runs.

It can be defined as toolbox as some elements and features can be used in the context of different FIMS modules.

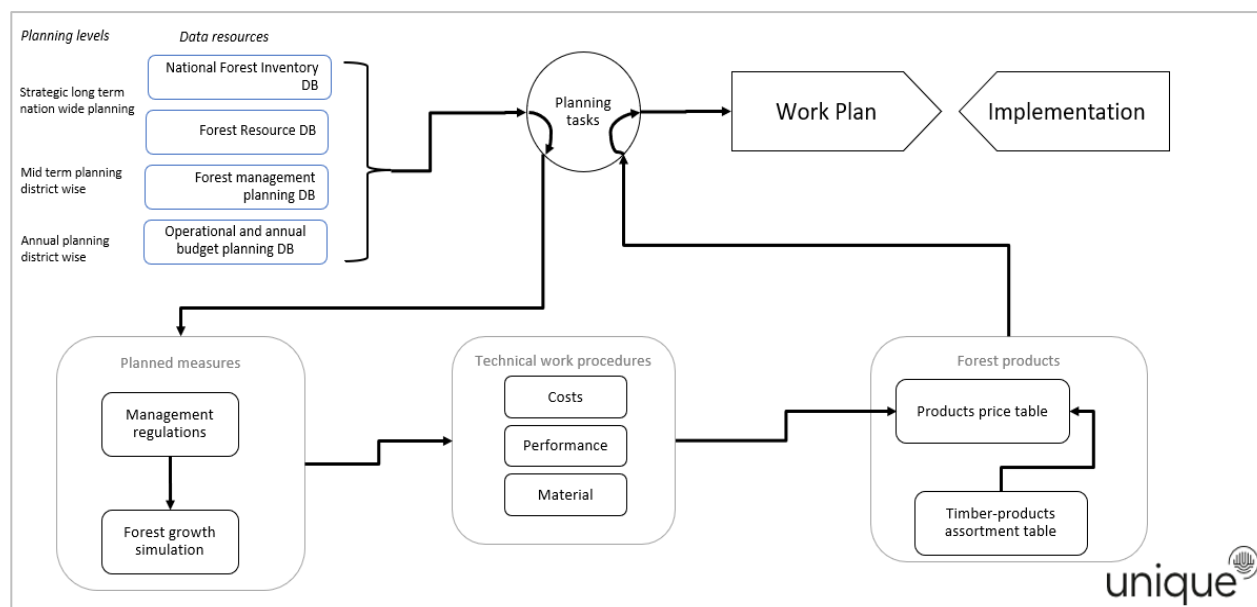


Figure 7: Schema of the Forest Modelling Toolbox

The full set of tools are necessary for the (3.2) Forest Management Planning module or the (2.) NFI module. A complete national forest management plan and simulation of the forests could be provided if the toolbox is linked to the NFI database.

The tools for “technical work procedures” like plan costs by measures tables or the tools for “forest products” like a timber assortment table or function can be used for the 6) Forest operations module – specially to derive an annual plan (6.1) Operational plan, (6.2) Annual Budget plan one-to-one.

Features

Set of tools plugged on different forest database NFI, FMP, Forest Resource DB (see upper left in figure 2)

- Forest Growth Simulator
 - Simulation of annual growth by using increment data per tree species to update stand information annually and updating of age information.
 - Simulation of management interventions (regeneration or thinning or final harvesting)

- Forest Management regulations: in a digital format describing rules for the application of certain interventions and intensities (forest type x: Between 17-18 m of mean height apply selective thinning and remove 20% of the volume).
- Technical work procedures tool: List of typical technical work procedures combined with: Tables or functions for costs per unit for all kind of measures; tables and functions defining performance of work per output unit (m³/h skidding, m³/h felling and delimbing etc.); Tables of material inputs per work procedure (oak seedlings / ha etc.).
- Forest product tool: Assortment tables or functions allowing to calculate assortments based on tree species, height and DBH and an estimate of quality classes of each assortment. Table of prices per assortment – including features to update it from timber sales statistics.

Users

- Owner/Main users: MEPA BFD
- Users: NFA / APA / AFS – indirectly used via the respective modules
- Other users with (limited) access: - -

Most relevant data interfaces

- 1.2) Forest Resource DB
- 2) National forest inventory module
- 3.2) Forest Management Planning module
- 6.1) Operational plan, 6.2) Annual Budget plan

Status of development

- Conceptual work about the modeling toolbox has started but is not yet concluded
- The so-called "Forest Model" as MS Excel developed for the GCF project proposal has been and can be used as kind of template.
- Module itself not yet under active development

4.4. (4) Forest Sites Module

Business processes

The Forest Site Module is foreseen as a tool to develop “forest site maps”. The mapping of forest sites (soil, climate, productivity, and risks) is an internal information creation process applying a multi-source mapping procedure using external and internal sources. The mapping comprises collection, processing, and analytical steps to derive a “forest site map”. The results are information layer – a map – showing soil, climate and integrates it to a tree species suitability map. The system should be climate sensitive as site conditions are changing (too) fast under climate change.

Features

- Spatial database application
- Spatial analytical scripts / models to derive site classifications for a combination of climate and soil attributes relevant for tree and forest growth conditions.

Users

- Owner/Main users: MEPA BFD - NFMS team (not yet established)
- Users: NFA, APA, AFS, DES
- Other users with (limited) access: Gov. Bodies, Public

Access via the 1.1) Retrieval platform

Most relevant data interfaces

- 1.1) Retrieval platform
- 3.2) Forest Management Planning (FMP)

Status of development

- Not yet under development, not yet on the radar of any organization, receives little priority
- Definition and development could be connected with the upcoming soil mapping project – supported by GIZ.

4.5. (5) National Biodiversity Monitoring System (NBMS) – not part of the FIMS any more

It was decided by BFD that the National Biodiversity Monitoring System is not going to be part of the FIMS. Given the spatial coverage (the entire Georgian territory and territorial waters) and then range of monitored fields (forests being a sub-part of them) it makes sense to handle the NBMS separately.

Therefore, the NBMS is not discussed at length here.

Nevertheless, it has been discussed that most of the data relevant for the NBMS can be retrieved from the NFI-data and in the future from the module (1) Central-DB and (6) Forest Operations. An interface for data retrieval or the direct calculation of the indicators within the FIMS should be developed.

4.6. (6) Forest Operations Module

Overview on Forest Operations sub-modules

Forest Operations happens on an annual or daily level. It comprises the annual planning, implementation, inspection, recording and controlling of all management activities in the forest enterprises. It is an internal management process at management institutions (NFA, APA, AFS) using the results of Forest Management Plans stored and regularly updated in the (1.2) Forest Resource DB.

The Forest Operations Module can be split into several sub-modules, the purpose of the module is to support all operational management steps on an annual base:

- (6.1) Operational planning (stand level, harvesting areas)
- (6.2) Annual Budget Planning
- (6.3) Harvest register & timber tracking (including sales)
- (6.4) Forest use contracts and licenses
- (6.5) Activity recording (recording all other activities)
- (6.6) Controlling

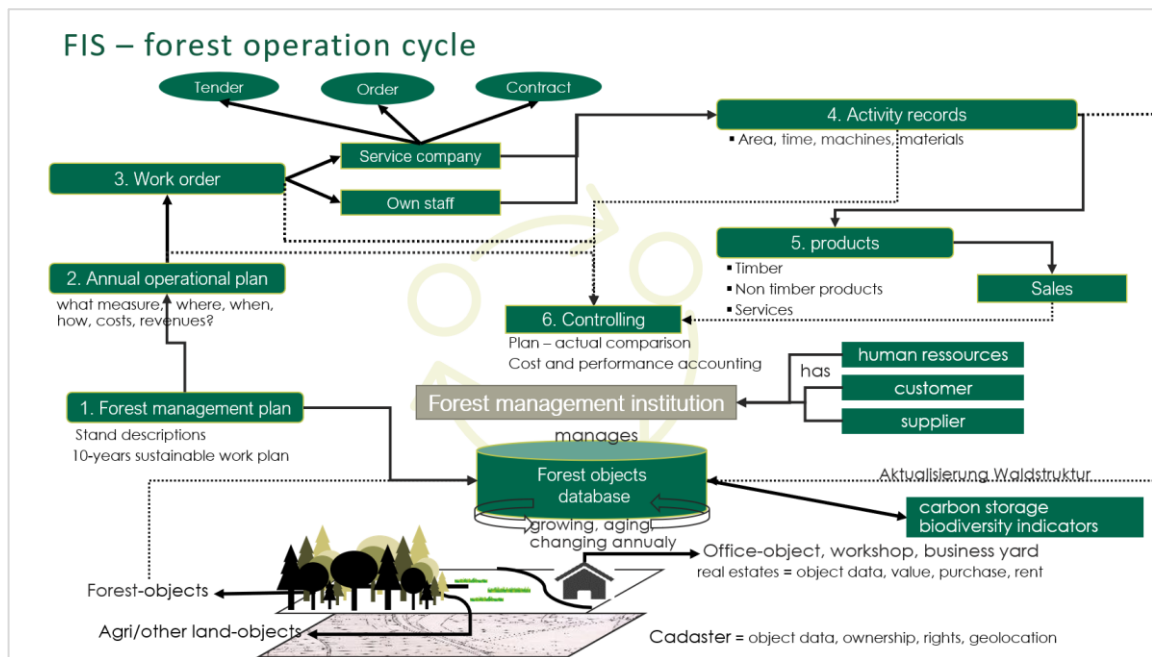


Figure 8 Schema of a typical forest operation cycle

4.6.1. (6.1) Operational Planning (stand level, harvesting areas)

Business processes

The Operational Planning breaks down the mid-term planning of 10 years from (3.2) Forest Management Planning into annual steps that should be realized. They are converted into specific operational steps comprising information on who is responsible for carrying out a specific task, when, with which technique, which personal, material, and financial resources. The activities are spatially explicit broken down to the litter level (harvesting, tending, planting...), operations on forest roads (repair, maintenance), other managed areas (meadows).

The following steps of an operational planning, which accounts for the production of wood and other products, are necessary:

1. Map cutting area
2. Get stand data
3. Mark and measure DBH of trees
4. Select harvest technique
5. Plan skidding / tractor roads
6. Calculate assortments
7. Calculate revenues
8. Calculate costs

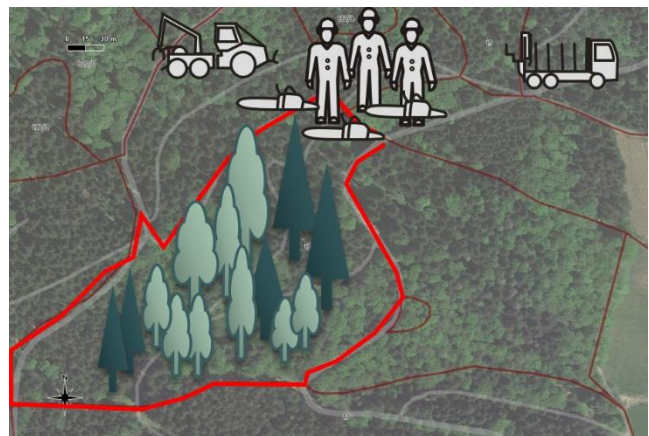


Figure 9 Forest use – timber and other products steps

Features

- Geodata management required (spatial DB)
- Mobile App required for
 - Delineating and/or marking the areas with interventions
 - Selection and quantification of measures
- Output
 - Catalogue of interventions with resources
 - Operational plan of (harvest) measures and timber sales (NFA, APA)
 - Operational plan of all other measures in a forest stand (planting, weeding, tending)

Users

- Owner/Main users: Forest management institutions (NFA, APA, AFS) - departments of forest use and maintenance
- Users: BFD / DES (for inspection tasks) / NFA / APA / AFS
- Other users with (limited) access: external service providers

Most relevant data interfaces

(1.2) Forest Resource DB – selection of due measures from Forest Management Plans

(3.3) Forest Modelling Toolbox – Forest Management Regulations; Technical Work Procedures tool; Forest Product tool.

All other sub-modules of (6) Forest Operations – (6.1) serves as foundation of most other sub-modules of (6)

Status of development

- Concept documents exists, but not yet discussed in the FIMS-TWG, current issue to get it into a fine-concept.
- Not yet under development.

4.6.2. (6.2) Annual Budget Planning

Business processes

The Annual budget plan aggregates all planned measures from (6.1) Operational Planning and develops a central annual budget plan (costs, earnings, investments) and an annual action plan for a forest management institution.

Features

- Aggregation of measures from the (6.1) Operational Plan on regional units or groups of measures to derive a planning base for state budget and enterprise level economic planning and controlling.
- Calculation of annual allowable cut based on (6.1) Operational Plan data and mid-term plans stored in the (1.2) Forest resource DB. Option to correct (6.1) Operational plans in an iterative process.
- Geodata management required (spatial DB)

Users

- Owner/Main users: Forest management institutions (NFA, APA, AFS) - departments of forest use and maintenance
- Users: BFD / NFA / APA / AFS
- Other users with (limited) access: - - -

Most relevant data interfaces

(6.1) Operational Planning - base for aggregation of individual measures

(3.3) Forest Modelling Toolbox – evaluating cost, performance and material requirements of different interventions and intensities.

Status of development

- Not yet under development
- Concept documents exists, current issue to get it into a fine-concept
- Recommendation to check if the Annual Planning software developed for Adjara FS can be used in minimum as a template.

4.6.3. (6.3) Harvest Register & Timber Tracking & Sales

Business processes

In the forest use departments and regional offices of the forest management institutions the oldest software system is in place based on a demand defined in the (former) forest code (Art. 50, paragraph 5): "The forest management body develops an "Electronic System of Timber Resources" to register forest use, its movement and primary processing activities." However, the software system does not cover all relevant business processes yet and was updated recently to cover the business yards as a new entity. The web-based software had been programmed by the Ministry of Finance and is hosted there. The NFA forest use departments are responsible for the management activities covered by the software. For the control of timber transport, the DES is involved and has access to the system.

Features and tools

- Registration and management of harvesting measures (cutting areas)
- Issuing of timber logging tickets (commercial, social, main, special cuts); Issuing of Logging Tickets (firewood); Issuing of certificate of origin.
- For harvesting operations implemented by the management institutions:
 - Management of harvesting machines (skidder, cable yarder, trucks)
 - Management of forest worker (staff management, time recording)
- Timber tracking (Barcode-system)
- Timber sales and timber sales statistics
- Business yards (use def. from reg. 221) – functions to register timber and management of timber to and from the new business yards
- Geodata management required (spatial DB) and Web-GIS
- Mobile App required for:
 - Timber data recording during harvest operations
 - Timber recording prior to loading & tracking (Barcode-system)
 - Issuing of certificates of origin

Users

- Owner/Main users: NFA / APA / AFA – forest use departments
- Users: NFA / APA / AFA and DES (inspections)
- Other users with (limited) access: BFD

Most relevant data interfaces

(6.1) Operational Planning – base for selection of harvesting measures to be implemented

(6.5) Activity recording (recording all other activities) – adds information on completed measures to the activity records.

(6.6) Controlling – adds data on timber produced, transport and sales to the controlling process.

Data interface to Accounting & Financial controlling system.

Example of similar applications

here for the business processes – timber harvest and sales:

- AFRY – smart forest manager
 - <https://afry.com/en/service/afry-smart-forestry-manager>
- Trimble – CFHarvest (also known as Woodforce):
 - <https://forestry.trimble.com/solutions/cfharvest/>
 - <https://youtu.be/dBnf5uMcsGQ?si=uXJFERi1S8jCrhL8>



Figure 10 CFHarvest main functions as presented in the company's website

Status of development

- "Log e tracking system" and the auctioning system are operational and well adopted; integration of "business yards" nearly completed.
- Plans to add timber tracking from sawmill to final product sales (incl. App and bar-coding-system): No concept yet.
- Integration into the other Forest Operation sub-modules (6.1 – 6.6) not yet conceptualized.
- Switch to spatial DB, Web-GIS and mobile solution not yet implemented.

4.6.4. (6.4) Forest use contracts and licenses

Business processes

A steady task outside of the annual forest operations cycle is the sale and management, inspection and control of **forest use contracts and licenses**.

These are the necessary process steps for the establishing and maintenance of (6.4) Forest use contracts:

1. Request from farmer:

- use category
- location
- client data

2. get object data (meadow) from (1.1) forest database

3. prepare contract document:

- start / end
- define fees

4. Control of use (in the field)

5. Input to the annual operational plan & budget plan

6. Control payments

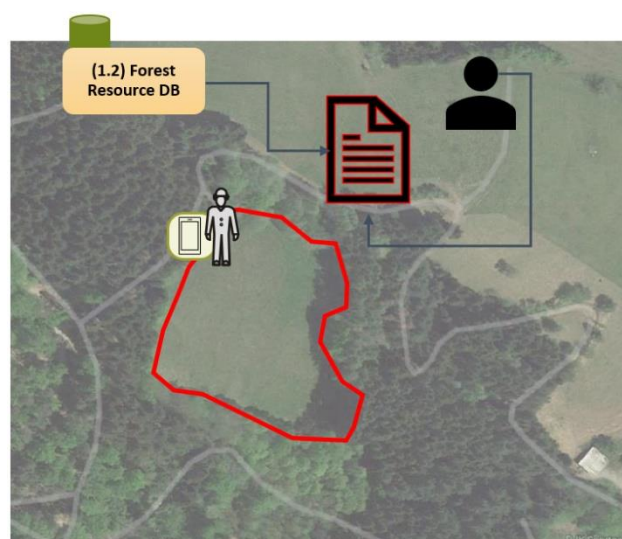


Figure 11 Illustration of the steps to establish a forest use contract

Features

- Selection and import of cadaster data.
- Selection and import of forest data (compartments, stands, stand information).
- Link to electronic auction platform.
- Export invoices to Financial Accounting software.
- Geodata management required (spatial DB).
- Mobile App useful.

Users

- Owner/Main users: NFA / APA / AFA – forest use departments
- Users: NFA / APA / AFA and DES (inspections)
- Other users with (limited) access: BFD

Most relevant data interfaces

- (1.2) Forest resource database – selection of areas under management for use contracts and licenses
- Data interface to Accounting & Financial controlling system

Status of development

- Draft concept document exists in NFA, but not yet discussed in the FIMS-TWG.
- Not yet under development.

4.6.5. (6.5) Activity Recording

Business processes

The Activity Recording is used to record all harvesting and non-harvesting activities: such as maintenance (e.g., planting, weeding, tending), road construction or maintenance and other works. These activities (unless unforeseen) are retrieved from the (6.1) Annual Operational Plan. For each activity it is recorded who, when and with what resources it was executed. The recording starts once a concrete measure is selected to be implemented and is completed after completion. The record answers directly on the measure planned and allows a continuous controlling as target - actual comparison. In a final step all activities changing the forest stands (harvesting, re-forestation), other managed areas (meadow) or forest roads (repair, maintenance) shall be registered in the (1.2) Forest resource DB. Thus, an update of the forest structure of the respective stands and objects will be documented.

The activity recording is used in forest use measures as for any forest maintenance measures. The features and tools can be applied in both types of departments.

Features

- Geodata management required (spatial DB).
- Mobile App to register activities and results in the field.
- For maintenance measures implemented by the management institutions:
 - Management of fleet and machines (e.g., trucks, bulldozers)
 - Management of forest worker (staff management, time recording)
- Preparation of invoice and salary data for to Financial Accounting system.
- Link to (1.2) Forest resource database allowing to trigger the update of stand level or any changes on objects in the forest resource database.

Users

- Owner/Main users: Forest management institutions (NFA, APA, AFS) - departments of forest use and departments of maintenance or controlling units
- Users: NFA, APA, AFA, DES, external service providers
- Other users with (limited) access: - - -

Most relevant data interfaces

(6.1) Operational planning (stand level, harvesting areas) – link to the planned measures, which are finally recorded here after implementation.

(6.3) Harvest register & timber tracking (including sales) – records from completed harvesting measures.

(6.6) Controlling

Status of development

- Draft concept documents exist and planned as part of the "maintenance module" only.
- Not yet under development.

4.6.6. (6.6) Controlling

Business processes

Financial data and activity recordings must be continuously compared with the operational plan (continuous controlling as target - actual comparison). What was done, where, when, by whom, for what costs, with what impact and revenues? These are questions to be answered by the controlling units of all forest managing bodies and finally partly also by the MEPA BFD.

Features

- Geodata management required (spatial DB).
- Dashboard including Web-GIS.
- Bidirectional data interface to the financial accounting system.

One option for a future technical solution, the controlling sub-module can be a part of the financial accounting system as software products integrating controlling are existing.

Users

- Owner/Main users: Forest management institutions (NFA, APA, AFS) - departments of forest use and departments of maintenance or controlling units.
- Users: NFA / APA / AFS – management level
- Other users with (limited) access: - - -

Most relevant data interfaces

(6.1) Operational planning

(6.2) Annual Budget Planning

(6.3) Harvest register & timber tracking (including sales)

(6.4) Forest use contracts and licenses

(6.5) Activity recording (recording all other activities)

Financial accounting system

Status of development

- No concept yet and not yet under development.

4.7. (7) Forest Incident Monitoring Module

Business processes

The Forest Incident Monitoring module is part of the internal information creation process of the forest sector. Its purpose is the recording of all incidental changes (unplanned changes manmade or due to natural causes) in forest area and structure. Incidences are all UNPLANNED changes to the forest structure. They can be caused by biotic or non-biotic disturbances and pests or caused by human activities. In the last case we have an overlap with the DES field of work. Most cases without human direct influences are insect pests, fungus infections, drought, storm, snow, fire. Caused by humans are illegal harvesting, but also grazing damages or fire.

The recording of incidences shall allow a continuous updating of forest structural data. It is combined with an alert system, which mobilizes responsible forest managers to react and to plan and implement restoration measures (e.g., planting of a fire damaged area). Sources of information are monitoring by staff on the ground (forest engineers of APA, NFA, AFS, but also DES should be able to record manmade incidences as illegal logging or manmade forest fires). An alert function might allow inputs from a wide public. Remote sensing services can be embedded to detect incidences (pests, fires, illegal harvesting).

Features

- Recording of incidences in relation with forest objects (stands, roads etc.)
- Mobile App required to record inspections in the field and to record and describe incidences. Offline functionality is a must for all field-apps. This applies also to base-maps for orientation in the field. For all incidents, appropriate questionnaires/forms should be developed for recording with incident-specific parameters + additional info/comments field.
- Geodata management required (spatial DB), a Web-GIS tool would allow to use RS-based services (automated fire, pest, forest cover change monitoring)

Users

- Owner/Main users: Forest management institutions (NFA, APA, AFS) - departments of forest maintenance
- Users: DES – as part of the inspection tasks
- Other users with (limited) access: Public (an alert system for citizens to report violations or incidences)

Most relevant data interfaces

(1.2) Forest Resource DB – contextual data on damaged forest stand or other objects to be available as background data for the incident records

(6.1) Forest Operations – notifying (6) forest operations about recorded incidences (fires, flood damage on roads) can change their operational planning. The incident records are sent and taken over to the forest operations module (record and spatial data of incidence area). They are shown with damage description and location. The Forest Maintenance departments shall be able to plan restoration measures based on that records.

(8) Forest Inspections DES – If illegal logging is accidentally found by local forest officers, a notification can be pushed to (8) Forest Inspections module for inspection by DES

Examples of similar software applications

- Wald-Wiki – damage recording system
 - [WALD-WIKI Reporting System \(wald-wiki-meldesystem.de\)](http://wald-wiki-meldesystem.de)
- North-Rhine Westfalia – Germany – Webportal with incidence records and forest risk information
 - [Waldinfo.NRW 2.61.0](http://waldinfo.nrw)

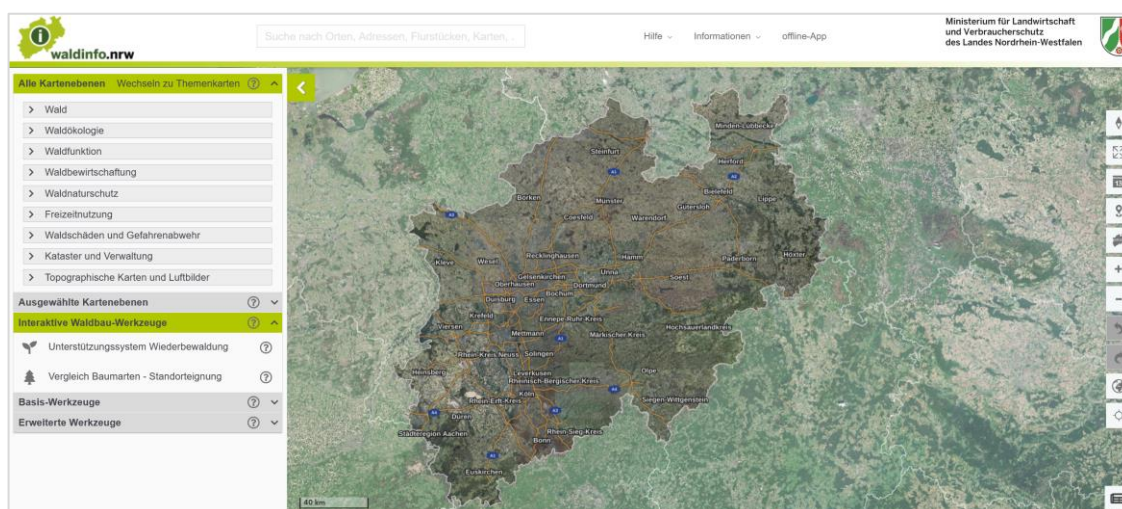


Figure 12 WaldInfo.nrw user interface of the web-portal

- Article – compiling existing incidence and forest pest recording software
- [Forest protection apps: What's already out there, what's missing? \(waldwissen.net\)](http://waldwissen.net) – in German language (in your browser: right-click and start translation)

Status of development

- No concept developed yet.

Further Remarks

It could be efficiently combined as a “multipurpose monitoring” with nature and environmental protection monitoring activities and software systems.

Excurs: Automated alert systems

Remote-sensing derived spatial data on fires and deforestation can play a role in automated incidence detection. Two layers, one for deforestation and one for fires can be integrated into the FIMS. They then generate automated incidences, which are flagged as non-human observations. After human plausibility checks they can be inspected on the ground

Automated fire-alerts:

- VIIRS active fires data (VNP14IMG1) is a fire monitoring product to FIRMS (Fire Information for Resource Management System) provided by NASA, it is updated *daily* and available at a global scale free of charge. It has a resolution of 375m and is therefore only suitable for detecting larger fires.

Automated deforestation alerts:

- Global Forest Watch (GFW) Data (unfortunately outside of the (sub)tropics only available on an annual base, instead of near-real-time. Hansen, M. C., et. al. 2013. “High-Resolution Global Maps of 21st-Century Forest Cover Change.” *Science* 342 (15 November): 850–53. At 30 m resolution could be utilized.
- Both datasets are updated once a year showing deforestation trends of the last (and previous) years. They could then be used in a verification-campaign or checked opportunistically alongside other inspections.

4.8. (8) Forest Inspection Module (DES)

Business processes

DES is tasked with a catalogue of inspection tasks along all activities related with forest management:

- Control of FMPs
 - In controlling these plans, a management body is given priority in how to plan and manage measures. DES checks only fragmentarily (in specific inspection area) and even that is checking only for incidents and illegal activities.
- Control of annually planned measures
- Control of running operations (implementation, marking, forest-waste leftovers, ...)
- Control of logging trucks
 - The document confirming the origin is indicated in the waybill.
- Control of delivered timber at a sawmill.
- Control of delivered timber at a business yard.
- Detection and description of all illegal man-made activities and calculation of fines (damage calculation)

Given the nature of these tasks, DES' inspection module must operate on the entire territory of Georgia, not only in forests. That implies that all necessary spatial datasets need to be accessible for DES inspectors including as example the administrative units of the forest management bodies.

Features

- Geodata management required (spatial DB).
- Inspection mission management:
 - Planning and conducting different types of inspection missions in the field, distributed across different teams.
 - Automated calculation of damages and resulting penalty sums based on collected field data.
- Mobile App
 - All data for their work must be available in the app and offline (e.g. FMPs, protected areas, aerial images, stand data). The app should resemble the typical workflow of DES-inspections and makes it unnecessary to handle paper. Checklists for each inspection case guiding what data need to be collected, data for all planned inspection tours and each inspection case are available – imported from the desktop solution in the office. For each planned tour and inspection case and object, all relevant data to be recorded can be handed in or taken over from secondary data (like forest stand data or managing entity and responsible person etc.)

- Detailed information about relevant topics (guidelines, laws), which are uploaded as basic background information for each inspection case as HTML or PDF files.
- GIS-functionalities allowing access to (1.2) Forest resource DB, (6.1) Operational Plans, (6.3) Harvest Register, (6.4) Forest use contracts, (6.5) Activity Recording and as still relevant for a certain period: Licenses for timber production (see under (6.4)) and the respective FMPs (see under 1.2)
- Calculation functionalities, such as: DBH calculation from the diameter of the wooden stump of a logged tree, Volume of woodpiles on the road, on trucks and in business-yards
- Data interface to the DES Financial Accounting system. It is a similar data interface as described for the Forest Management Bodies. Fines are calculated and send to legal entities, which lead to actions in the accounting system of DES.

Users

- Owner/Main users: DES
- Users: /
- Other users with (limited) access: Forest Management institutions (NFA, APA, AFS) and BFD, Public (A process for citizens to report violations)

Most relevant data interfaces

(1.2) Forest Resource DB - contextual data on forest stands or other objects (read-write)

(6) all submodules of Forest Operation – retrieving planned and current and completed activities for inspection (read)

(7) Forest Incidence monitoring module – men-made incidences that are recorded on behalf of DES can be further registered as inspection result and damage calculation (read)

Status of development

- Development of a mobile app is under development by MEPA-IT.
- Completion of the module is of high priority to DES.
- The new module structure presented here means that the concept and software need to be revised and adapted.

4.9. Interaction of modules and user groups

This chapter describes the interrelations between the user groups regarding the different FIMS modules mainly forced by cooperation needs between different institutions or departments in specific business processes or information needs provided by data created by other business processor or institutions. The Table 1 shows the main user / owner as well as all other user groups, working with the specific FIMS module or getting information from the module regularly.

Table 1: Module ownership/main users and other users

Module	Owner/Main users	Other users
(1) Management module		
(1.1) Central Data Management module	MEPA BFD	MEPA BFD, NFA, APA, AFS, DES
(1.2) Forest Resource Database	MEPA BFD	MEPA BFD, NFA, APA, AFS, DES
(2) National Forest Inventory Module (NFI)	MEPA BFD – future NFI & NFMS unit	NFA, APA, AFS, DES
(3) Forest Management Inventory & Forest Management Planning module (FMI-FMP)		
(3.1) Forest Management Inventory (FMI)	NFA, APA, AFS – Inventory departments	
(3.2) Forest Management Planning (FMP)	NFA, APA, AFS – Inventory departments	
(4) Forest Sites Module	MEPA BFD – future NFI & NFMS team	NFA, APA, AFS
(6) Forest Operations Module		
(6.1) Operational planning	NFA, APA, AFS - departments of forest use and maintenance	MEPA BFD, DES, NFA, APA, AFS
(6.2) Annual Budget Planning	NFA, APA, AFS - departments of forest use and maintenance	BFD, NFA, APA, AFS
(6.3) Harvest register & timber tracking (including sales)	NFA, APA, AFS - departments of forest use	NFA, APA, AFS, DES
(6.4) Forest use contracts and licenses	NFA, APA, AFS - departments of forest use	NFA, APA, AFS, DES
(6.5) Activity recording (recording all other activities)	NFA, APA, AFS - departments of forest use and departments of maintenance	NFA, APA, AFS, DES, external service providers
(6.6) Controlling	NFA, APA, AFS – controlling	NFA, APA, AFS –

Module	Owner/Main users	Other users
	units	Management
(7) Forest Incidence Monitoring Module	NFA, APA, AFS - departments of forest maintenance	MEPA BFD, DES, NFA, APA, AFS
(8) Forest Inspection Module (DES)	DES	MEPA BFD

5. Implementation

This chapter presents the implementation proposal to set up the FIMS. With the establishment of a FIMS technical working group where all relevant institutions are participating, a powerful and effective structure has been formed to guide and manage the implementation process.

5.1. Approach

For the implementation of information technology in any kind of organization three phases and related work steps as illustrated in the following figure should be considered. These three phases concern: a planning or preparation phase, the actual implementation phase and an update and improvement phase. The implementation ends the very day the new product is used. However, the third phase is a reminder that the organization has to build up sustainable institutional and organizational structures to run and maintain the system continuously (see Figure 13).

To ensure the efficiency of the process, every phase should start with a kick-off meeting including all involved stakeholders. Moreover, training components should be considered as an integral part of each phase guaranteeing the sustainability and functionality of the FIMS. In order to be able to integrate running modifications and adaptation steps, testing and fixing steps are necessary to be planned within the workflow.

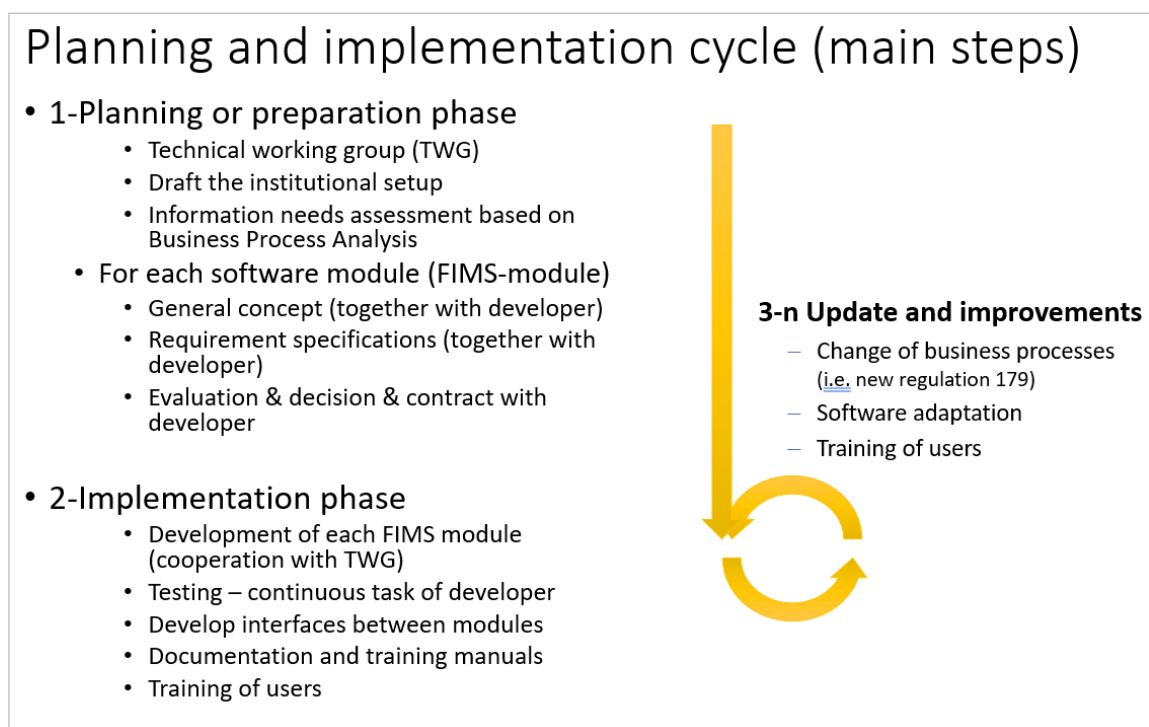


Figure 13: FIMS implementation process

Source: unique

For all these main steps, it is crucial to ensure the feeling of ownership and thus the sustainability of each FIMS module through the early participation of the future main user / owner. Having an outside expert circle only defining the features will lead to massive acceptance problems among the users.

5.2. Organization of the software development process

In Figure 14 below the organization of the software development process is exemplified for one single module: in the example it is the forest management planning (FMP) module.

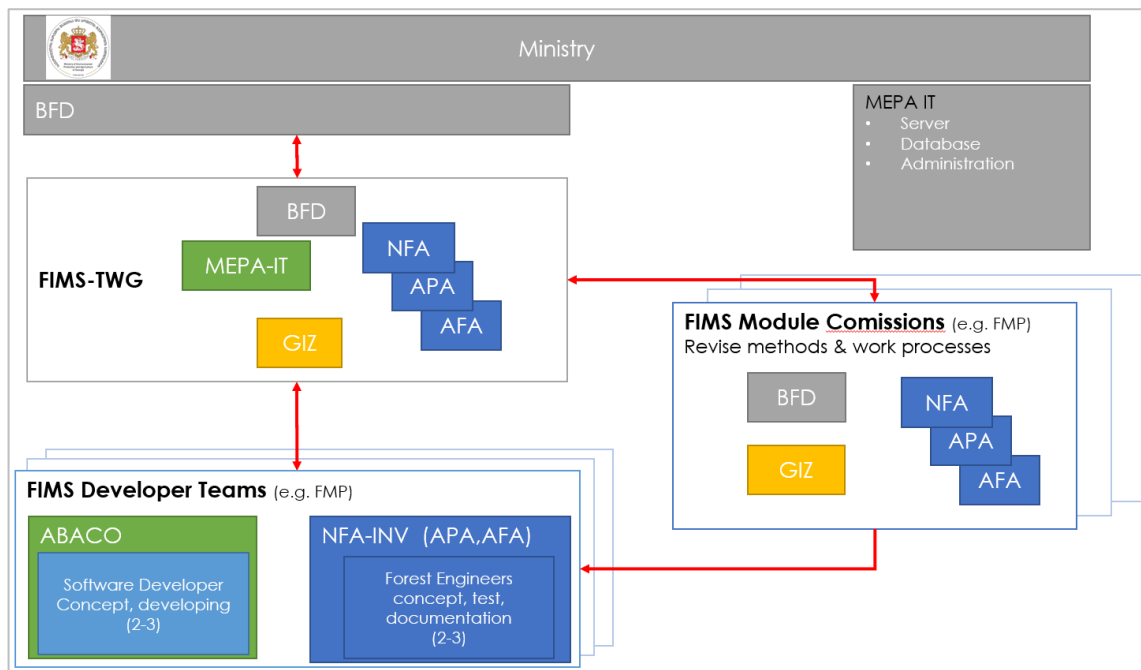


Figure 14: Organization of the software development process; example for the FMP-FMI modules

Source: unique

FIMS-TWG

The FIMS-technical working group is constituted of stakeholders (among others, NFA, APA, AFA), GIZ, the MEPA-IT team and members of the BFD. Together they have an overview of all modules as well as their integration into the FIMS. The goal of the FIMS-TWG is to jointly coordinate the module's development. As ABACO is selected as the main developer of FIMS, we propose to include one Abaco expert in the TWG.

FIMS Module Commissions

For each module, a commission, consisting of a subset of relevant members from the FIMS-TWG (representatives from the TWG and main user/owner of this specific module) is created. The commission is giving feedback to the developers of the respective FIMS-module

securing that all related business processes are described and implemented by the FIMS Developer Team.

FIMS Developer Teams

The development of each FIMS-module is carried out by a small group thereby minimizing organizational efforts. This group consists of 2-3 software developers from ABACO together with 2-3 main user/owner of the module. They collaborate closely throughout the development process to ensure that the final module meets the needs of the users.

5.3. Assessment of the development time frame and human resources

Unique had been asked to estimate the timeframe and required human resources for the module developments. A first estimation was conducted in November 2022. Based on the status quo and considering the status of the FIMS development in 2023 and the fact that ABACO has been selected as developing company, we adapted the estimation for this report (see Table 5).

Table 5: Estimated development time and number of developers and testers for the FIMS-modules

Module	Status	Estimation of completeness	Est. N of development month	Est. N of developers/testers
(1) Management module (1a) Central data management module	Planned	50% assuming – existing ABACO tools are suitable	12 months	2 / 1
(1) Management module (1 b) Central forest resource database	Planned	40% as partly same structure as FMP module	8 months	2 / 1
Central FIMS tools to be developed for all modules:				
Spatial database (DBMS)	Planned	60%, ABACO's ORACLE Spatial DB can be directly used for all FIMS modules. DB design and general structure.	2 months	2 / 1
WebGIS integration into all web-applications	Planned	60%; ABACO has a WebGIS component. Adaptation to the FIMS needs.	2 months	1 / 1
Mobile web-applications being able to work offline with (geo)data	Planned	10%; Mobile platform for most of the modules, web-GUI but adapted to work on tablets, including Web-GIS; synchronization with central databases of each module (selection of a suitable toolbox needed and possible)	6 months	3 / 2
Forest Model Toolbox	Planned	0%; To be embedded in module 1b, 3 b and 6 a, b	4 months	2 / 1

Module	Status	Estimation of completeness	Est. N of development month	Est. N of developers/testers
(2) National Forest Inventory (NFI) module	Program-ming con-cluded	90% done 10% open to report on the Central data management module	2 months	1 / 1
(3 a) Forest management inventory	Under de-velopment	70% Open Foris could be used, but not a sustainable solution. Switch to Open Foris Arena. Interface to the FMP module missing.	2 months	1 / 1
(3 b) Forest management planning module (FMI – FMP)	Under de-velopment	70% - re-structuring: spatial database, mobile data collection and FMI interface	2 months	2 / 1
(4) "Site map" module (combines soil and forest data; forest productivity)	Planned	0% not much to be developed. Once a "project" leads to the first map, the processing scripts can be used for repeated actions. Effort is embedding resulting layers in (1 a)	1 months	1 / 1
(6 a) Forest operation module - Forest use functions	Under de-velopment	50% - restructuring: spatial database, mobile data collection; improving E-timber tracking features; embedding Forest Model Toolbox; adding costs management, machine management and work force management.	10 months	2 / 1
(6 b) Forest operation module - Forest maintenance functions	Under de-velopment	0% fast if done after forest use and using synergies from overlaps in features. See above!	6 months	2 / 1
(7) Forest incidence monitoring module	Under de-velopment	0% not complicated if overlaps with (8) are used	4 months	2 / 1
(8) DES Inspection module	Under de-velopment	60% - restructuring needed: Spatial data-base.	6 months	2 / 1

All estimates need to be seen as rough estimates assuming developers with a experience and knowledge of the selected tools and DBMS as well as familiar with land management questions can be nominated. On the one hand ABACO has no central expertise in forestry related topics, on the other hand they work close to land management processes and do so with a lot of expertise.

6. Recommendations

The recommendations and proposed next steps have been revised reacting to the decision of MEPA to select ABACO as sole developer of most of the FIMS modules.

We see advantages and disadvantages in this decision.

Advantages are:

- One integrated FIMS structure and one basic DB structure for all FIMS modules,
- FIMS tools like mobile Apps, WebGIS or the Forest Modeling Toolbox are developed one time and used in several modules.
- Similar technical solutions and tools for similar business processes like reporting features.
- Look and feel and handling similar in all FIMS modules.

Disadvantages are:

- No competition, no retrieval for market solutions.
- International company, the development tasks and the budget might not support the Georgian IT sector.
- Costs: Daily rates are higher compared to developers from Georgian companies.
- To rely on one team of developers at ABACO might be a restriction in parallel development needs.
- ABACO has references for most of the technical tools – as far as we could assess it – however, there is a lack of forestry related references. This can only be compensated by constant cooperation with the main user/owner of the FIMS modules and the TWG.

6.1. Recommended priority decisions

- Decide on the Setup for the organization of the software development (see chapter 5.2)
- For the (4) Forest Site Module the definition and development could be connected with the upcoming soil mapping project – supported by GIZ.
- (2) NFI Module: Thinking ahead the software Open Foris Calc is reaching its end of life and is not developed by FAO anymore. A migration of the data into the successor Open Foris Arian will be necessary for the next NFI. So far, no investigations have been made as to whether this software can be seamlessly integrated into the FIMS. Open Foris is not an interactive reporting system. If such a feature is needed: Can Open Foris SAIKU be used or another platform to present NFI results?

- Unique offers to develop a standardized format for the documentation of each module to be used by the TWG.
- The role of the Forest Atlas of Georgia (ESRI server) in the future needs to be clarified. Especially with regards to:
 - Who is developing and providing any update of the Atlas?
 - Should any new data from the FIMS be displayed in the Forest Atlas as well?
 - Why are license cost paid for two parallel platform techniques offering access to information on forests and forest management in Georgia?

6.2. Recommended priority steps

- Ensure that the TWG is meeting regularly and that it receives enough recognition for its importance to coordination between the different modules.
- Develop TORs for the FIMS-TWG, the related FIMS commissions and FIMS developer teams (see chapter 5.2).
- TWG: ABACO needs an “observer position” in the TWG. ABACO also needs to nominate developers for the different FIMS development teams.
- TWG: Prioritize the software concept document development for all the FIMS modules, which are not existing yet (see module descriptions in chapter 4 above). Only if an overview of the FIMS system on the level of a concept document exists, ABACO can plan the complete system layout and assess time and costs.
- TWG & ABACO: Discuss the FIMS modular structure as described in this document. Get a draft technical FIMS concept from ABACO including a cost- and time plan.
- BFD & GIZ: Development costs: Get a draft cost estimation for the ABACO-development based on the FIMS software concept documents and compare this to the available funds.
- TWG: Decide a priority order in which the FIMS modules shall be developed. Start with central FIMS tools (Spatial DBMS, mobile offline App, WebGIS) and the (1) Management module. Decide on priority features in case of budget restrictions. If budget cuts need to be discussed it is advised to keep the vision of the optimal and complete FIMS module in mind and to design cuts in such a way that predefined features may still be added at a later time to complete the originally planned feature set.
- Forest Model toolbox: high priority to define the components and start with developing a draft database structure (Unique can develop it).
- TWG: Define the organizational setup and start software requirement development for each FIMS module (exception (2) NFI module).
- TWG: The central (1) Management module with its sub-modules (1.1) Retrieval platform and (1.2) Forest Resource DB should get early attention as the other modules can build onto it. This is now easier with the central role of ABACO.

- TWG: Knowledge gaps regarding the interactions of modules should be identified and closed between the coordinators of the respective modules. The connections between modules should be regarded from the earliest possible stage of the modules to avoid isolated solutions.

