



Forest Policy Report

SFI/2022

Analytical report on status quo of the NFI field software

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Kyiv, February 2022



About the Project “Sustainable Forestry Implementation” (SFI)

The project “Technical Support to Forest Policy Development and National Forest Inventory Implementation” (SFI) is a project established in the framework of the Bilateral Cooperation Program (BCP) of the Federal Ministry of Food and Agriculture of Germany (BMEL) with the Ministry of Environment and Natural Resources of Ukraine (MENR). It is a continuation of activities started in the forest sector within the German-Ukrainian Agriculture Policy Dialogue (APD) forestry component.

The Project is implemented based on an agreement between GFA Group, the general authorized executor of BMEL, and SFRA since October 2021. On behalf of GFA Group, the executing agencies - Unique land use GmbH and IAK Agrar Consulting GmbH - are in charge of the implementation jointly with SFRA.

The project aims to support sustainable forest management planning in Ukraine and has a working focus on the results in the Forest Policy and National Forest Inventory.

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Disclaimer

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Some tasks realised in software (18-22, 24) were not described in the report as author mobilised to Armed Forces of Ukraine.

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1. Describe the status quo of NFI field software development and implementation in 2021

The SmallForest mobile application was developed in 2020 and is actively used to keep records of changes in the forest fund by forest users. The available functionality allows for the prompt input of information on a separate taxation allotment and its distribution (exchange) among employees of the same enterprise, as well as orientation on the ground using available forest maps. The actual number of users is more than 3 thousand with 1.6 thousand maps of individual forestries available.

For the NFI in 2021, the list of SmallForest indicators to be collected in accordance with the NFI requirements was expanded, and the procedure for exchanging NFI information with a separate server was separated. The functionality of the existing programme was modified to achieve this goal. For example, the algorithms for building the "Technological map of logging area development" were used to display objects and map the inventory plot.

The SmallForest application implements a mechanism for exchanging information between users, which was also used for NFI and allowed for operational control of the work. The application implements 7 levels of user rights for operational accounting of changes in the forest fund by forest users and 4 levels for NFI, namely:

1. Users with the ability to upload information about a separate inventory plot without the ability to change the information in it.
2. Identical set of user rights 1 with the ability to change the status of a separate section.
3. Field inventory groups without the ability to upload information about a separate inventory plot.
4. Field control inventory groups.

2. Analysis of the reasons for refusing the Field-Map software

The Field-Map software was used to conduct regional forest inventory in Sumy and Ivano-Frankivsk administrative regions in 2010-2015. Also, the functionality of this software product was analysed to solve the tasks assigned for the NFI in 2021. In the course of using this product, a number of advantages and disadvantages of the existing functionality and a number of other circumstances were identified, which forced the search for an alternative. In my opinion, the main reasons for refusing to use Field-Map software are as follows:

- The existence of bureaucratic procedures for approval and independent evaluation of the purchase of software and devices;
- Lack of certain functionalities of this software when conducting control re-measurements, control of information transmission;
- Difficulty in use;

- The high cost of devices for collecting information (tablets) compared to devices running on the Android operating system.

3. Description of the current approach to local field software development

During the fieldwork, multiple field visits were made to assess the convenience and correctness of using the field software. A mechanism for updating the software functionality on mobile devices was developed by downloading and installing the appropriate application file on the device without changing the existing collected data. The update procedure was carried out by the relevant operators in the field. Certain functionalities were refined in the course of the work. For example, the functionality of selecting "Candidates for model trees randomly" was not very successful from a practical point of view. Some of the trees that were proposed as potential model trees did not fully represent the taxonomic characteristics of a particular thickness level. In some cases, these trees had a lower crown in the forest canopy, and there were other factors that prevented the full use of this functionality.

Based on the results of consultations with the direct executors of the work, a display of the list of tree numbers included in the corresponding thickness level was added. Similarly, an analysis of the user experience when filling in the information was also carried out. If there were rational ideas for optimising the work, the functionality was added (for example) to automatically fill in the "Mark presence" field when measuring trees, as this indicator is marked as "True" only for 3-5 trees. When entering information about an individual tree in the trial area, this indicator is automatically marked as "False", while checking for the presence of "True" values for all trees in the trial area, during the control of information, which allows avoiding not filling in this indicator.

4. Description of all approaches that are currently being implemented to avoid data entry errors

At this stage, the indicators are checked for completeness. The user can perform the procedure of checking the entered information at any time, regardless of the amount of work performed on this site. If the entered data is available during the control, the "Bonitet Class" and "Prevailing Breed" are automatically determined.

The control also includes verification of information on compliance with the correctness of tree measurements, diameters and distances. In case of measurement of a tree diameter that does not meet the condition, the user is informed about it. For convenience, individual elements are displayed on the software form and are displayed automatically when entering information.

Measured model trees are also subject to verification. If there is an incorrect selection of model trees, information about the error is displayed.

5. Evaluation of the use of the QA software developed initially in R-programme

The developed software allows comparing the data obtained from the field and control groups. In general, the developed algorithm allows to calculate the accuracy of determination of indicators by field inventory groups and generate the corresponding "Comparative Statement". At this stage of the work, the mechanisms for transferring and storing information have undergone significant changes, which makes it impossible to use this software for quality control.

6. Development of suggestions and recommendations for improving the field software (based on the experience of 2021)

According to the available feedback from the direct executors of the work (field teams), the existing software functionality fulfils all the necessary current user needs. Therefore, at this stage, no significant changes in the design of software forms and data entry algorithms are expected.

In my opinion, it is necessary to work out a consistent algorithm for data entry when mapping parts (in some cases, the division is not correct), because a clear sequence of data entry is required to perform polygonisation. It is also advisable to limit the input of information about the diameter of the tree, as this indicator is filled in based on the input of its circumference. At present, the algorithm responsible for checking the correctness of the selection of model trees works with the calculation of the minimum number of trees of the predominant species in the amount of 5 trees. In some cases, the available number of trees in the test area does not allow to satisfy this condition and as a result, the user receives a message about a possible error.

It is also necessary to refine the change of the data storage directory, because the current mechanism for saving a backup copy of data on the phone is triggered after entering or changing 10 indicators, which leads to the accumulation of a significant number of files in one directory. If there are too many files, it can lead to technical failures or slow down the application.

7. Suggestions for the operating system

Currently, the most common operating systems used on servers are Windows Server, Ubuntu Server, CentOS. When reviewing the available operating systems for mobile data collection terminals, the most common are Windows, Dos, Android, and IOS. In my opinion, in the context of digital development, Windows operating systems (OS) are significantly losing competition with Android for data collection terminals. The Windows mobile OS, which was quite popular until 2010 and is still quite common today, has been withdrawn from support and development. The new alternative Windows Phone was also not

widely used and was withdrawn from support in 2019. The practical application of Windows 10 for data collection terminals causes a number of complications, as software developers often face problems with the use of on-screen keyboards for data entry, etc.

Therefore, for data collection terminals, it is optimal to use the Android operating system, given the availability of a large number of devices. For the server operating system, it is advisable to use Windows Server or other operating systems based on the Linux kernel.

8. Proposals for the format of field and server databases

When using the Android operating system in data collection terminals, it is advisable to use a SQLite database, given their high performance on mobile devices. Any database management system can be used for the server database. Given the widespread use and ease of use, it is advisable to use SQL server or Mysql server.

9. Suggestions for enhanced measures to avoid data entry

The existing functionality for checking the correctness and restrictions for user input needs to be improved. First of all, the following restrictions and checks should be added:

- When entering information, encourage the user to fill in information about the "Time of relocation", "Time of transition" and "Date of commencement of work". When filling in other indicators, display a message about the priority of filling them in;
- Check the correctness of the entered location coordinates;
- Limit the field "Dominant species", as this indicator is filled in automatically based on the description of the layer;
- Add a check for the origin of the main breed and land category.

10. Suggestions for the implementation of GIS for mapping sample plots and their parts

Mapping of parts in the existing software is performed on the basis of the "Direct geodetic problem" and the "Inverse geodetic problem". When performing the mapping operation, the user needs to divide a circular test area by a line that includes the intersections of its boundary at the beginning of the line and at the end.

The existing software functionality, in the case of division into three or more parts, may not work correctly due to the lack of "Rules" for the order of information input in such cases. As a result, the user may randomly enter information that is difficult to process. It is advisable to test these cases and improve the algorithm or develop clear rules for entering information in such cases.

11. Recommendations for field computers and equipment

In accordance with the Procedure for conducting the national forest inventory of Ukraine, the work performed must ensure proper accuracy of the indicators. Both modern electronic devices for determining azimuths (angles) and conventional mechanical devices can be used to map trees on the site, as the error in determining this indicator should not exceed 20°. To determine the distance and height of a tree, it is advisable to use laser or ultrasonic rangefinders. When using the TruPulse 200B laser rangefinder, it is also necessary to take into account the advantage of the ability to determine horizontal angles (azimuths) on the ground. A significant disadvantage is its use in forests with significant underlay and undergrowth. The use of conventional tape measures to determine the distance to a tree significantly reduces the productivity of field crews. Therefore, the use of tape measures is possible only in cases of rangefinder breakdown.

The experience of previous inventory work has shown a fairly high efficiency of using the Vertex ultrasonic height meter, which allows you to take measurements in the presence of dense undergrowth or underbrush.

Conventional GPS receivers can be used to determine the coordinates of the centre of the inventory plot with an acceptable accuracy of ± 20 m.

In previous years, mobile tablets of considerable size were used to enter information. The use of a large device in the field requires additional costs. The main reason for using a large screen was the need to accommodate a large number of indicators for input. Currently, it is difficult to find a user of a large mobile device. Most not only mobile applications but also websites are adapted for small screens. Therefore, it is advisable to use conventional mobile devices that have basic protection against dust and moisture. The small size of the terminal will allow it to be used more conveniently in the field and to combine data entry with other operations (measurements, etc.).

12. Implementation of software proposals and documentation

Suggestions for improving the software usually arise from the direct performers of the work, because the daily work allows you to fully assess the individual functional need. The best way to get suggestions for software improvements is to hold discussions about the necessary changes among all the people involved in the work. Sometimes, the proposed changes to the software may facilitate the work of certain groups of performers at the expense of others. This is usually due to the subjectivity of the assessment. For example, the exchange of information should be carried out no later than one week, which in some cases creates difficulties for field teams, and at the same time, late exchange of information does not allow for timely verification of the entered information and pointing out possible errors, and in case of loss of the data collection terminal, this information will not be recoverable.

In order to receive rational suggestions, it is necessary to first consult on the use of certain software mines. The collected proposals should be discussed at a technical meeting between all employees in case of significant changes in the software. It is also advisable to develop detailed instructions on how to enter information and the functionality of existing software to avoid developing existing software solutions for functionality.

13. Create the structure of the field database based on the lists of parameters from the Order for conducting the NFI

Currently, the field database stores information in a structured format only until it is exchanged with the central server.

The structure of the database and key fields of the relevant tables is created using software directly on the mobile device. To prevent modification of the information in the database, it is protected by appropriate authorisation tools. The relevant attribute tables are populated by receiving information from the central server by means of "Full Exchange" through the SmallForest application.

14. Prepare lists of database attributes

The list of attribute tables in the database is identical to the existing predefined directories in accordance with the work to be performed.

15. List by attribute to be entered to avoid/minimise data entry errors

The attribute tables used for data entry have one key field "ID", which is responsible for the uniqueness of the indicator record, and two fields "I1", "I2", which are used in case of dependence of directories. For example, the selection of the "Type of land" depends on the value of the "Group of land". In the case of a small number of indicators in the reference book, the relationship between them is implemented at the software level. The key to entering information is to determine the availability of the plot and land group. For forest plots, a full-fledged collection of information on relief, species, etc. is performed, which is implemented in the control function.

16. Develop a diagram of the field database of links between database attributes

The existing functionality of the SmallForest application does not provide for the classic recording of information in the database. The entered data is saved in a file format. The peculiarity of saving is the availability of all information in the case of using the directory,

which makes it impossible to "modify" records in case of accidental changes in the directory code.

```
<DoctupName> The plot is accessible and passable </DoctupName> <DoctupName1> </DoctupName1><DoctupId>100</DoctupId><DoctupI1>0</DoctupI1><DoctupI2>0</DoctupI2>
```

Due to this storage format, the information is stored in the database as a single binary data record "Blob" and is stored only until the "successful data exchange" is completed.

The connections between the attribute tables are implemented at the software level, which allows for full or partial selection of information for visualisation by the user.

17. Create a structure and develop a draft documentation for the server database

The existing information structure for collecting and transmitting information involves a server database that stores field data in a file format and contains a set of reference tables that ensures the synchronisation of reference data between mobile devices. To analyse the information available in file format, it is advisable to develop a separate database and import and export data, due to the predefined structure of the software.

Developing an analytical database, it is necessary to take into account the amount of information, which, according to preliminary estimates, can be up to 1.5 GB. Information that allows you to process information on a separate personal computer. The use of a local database, as opposed to a server database, will significantly increase the speed of information processing and ensure the availability of a significant number of backup copies of data.

Developing the structure of the database for analysis, the most rational use should be made of the existing structure of information storage available in file format, namely:

- <anyType xsi:type="Invent_Objekat">
- <anyType xsi:type="Uhastok">
- <anyType xsi:type="Uhastok_Vpliv">
- <anyType xsi:type="Uhastok_Jarus">
- <anyType xsi:type="Uhastok_PidlisokA">
- <anyType xsi:type="Uhastok_Roslunu">
- <anyType xsi:type="Uhastok_Gruntuu">
- <anyType xsi:type="Uhastok_GruntuuPofil">
- <anyType xsi:type="DerevalnPoba">
- <anyType xsi:type="DerevalnPoba_DerevPochtt">
- <anyType xsi:type="Pni">

- <anyType xsi:type="Pni_PenGnil">
- <anyType xsi:type="Laman">
- <anyType xsi:type="Ponovlenna1">
- <anyType xsi:type="Ponovlenna1_Ponov_Xarak">
- <anyType xsi:type="Ponovlenna1_Ponov_Xarak_Pochkodgenna_Ponovlena">
- <anyType xsi:type="Mitki">
- <anyType xsi:type="Mitki_Geomet">

18. Develop a diagram of the relationships between the attributes of the server database

19. Describe the structure of the database (provide information about the database tables, including a detailed description of all attributes, key fields, etc.)

20. Develop proposals for data transfer between the field database and the server database

21. Develop proposals for data transfer between the field database and the server database

22. Propose an administrative procedure for data transfer

Data transmission must be controlled by the central server administrator, as otherwise it is impossible to analyse the collected data. It is not possible to exchange information with the central server every day due to the lack of Internet coverage in certain areas. Therefore, it is advisable to conduct weekly monitoring of information received from field teams and to respond promptly in case of delayed completion of this operation.

23. Propose technological operations for data transfer

The primary task of transferring information between mobile devices and the central server is to identify the device. Given the potentially large number of terminals used and exchanging information with the central server, there are risks of unauthorised access

to data. It is effective to create a unique identifier by the device itself and transfer the data to the central server to activate a separate terminal.

When performing information exchange, you should divide the data sets into those received from the server and those transmitted to the server. The main information that is transmitted to the central server is the collected data on a particular inventory site. Each terminal must also provide data for its authentication. When data is received from the central server, it can be divided into two sets. The first one includes a set of "operational" information that needs to be updated every time. For example, such data includes information on the status of a particular section. Also, a separate set is often supplemented or modified. The second set should include classifiers (reference data), as changes usually do not occur for a long time.

24. Propose a software approach for data control by the data team that checks the up-loaded data from the teams (checking procedures and data visualisation on the dash-board)