E3S Web of Conferences **443**, 01001 (2023) https://doi.org/10.1051/e3sconf/202344301001
ETESD-II 2023

Integration of forestry management tasks at the forestry level

Vladimir Mavzovin[1]*, Nikolay* Klevanskiy[2*], *Dmitry* Shakirzyanov[3], *Ekaterina* Miroshikhina[4], and *Venera* Yumagulova[4]

[1]National Research Moscow State Construction University, Moscow, Russia
[2]Saratov State University of Genetics, Biotechnology and Engineering named after N.I. Vavilov, Saratov, Russia
[3]Ukhta State Technical University, Ukhta, Komi Republic, Russia
[4]Kazan Federal University, Kazan, Russia

Abstract. The article is devoted to the problems of forestry management. Integration of control tasks is proposed on the basis of a single database containing geometric, cartographic and taxation information. The integrated information system is focused on meeting the needs of forestry management at the forestry level. The system must have a user interface with tools for using forest resources. The functional model of the integrated system project is represented by diagrams of different levels and made it possible to identify the main approaches to creating the system. Functional modeling also showed the need to develop and include editors of forest plot boundaries into the proposed integrated system with the ability to visualize them; a layout of the proposed integrated system. To edit the boundary vertices of forest taxation units, a hierarchical decomposition has been proposed, which consists of sequential fragmentation of large areas into smaller areas.

1 Introduction

Most of the complexities of forestry management are largely determined by information problems [1, 2]. Integration of management objectives, including geographic information systems (GIS) data, increases the assurance that the needs of all individuals associated with forestry are met through common and shared access to objective information [3]. The history of GIS development shows that forestry was among the first industries to use geographic information technologies to create cartographic databases [4].

The new forest management instructions [5] maintain the continuity of the hierarchy of inclusion of forest areas. "When designing forest districts, forest parks, their boundaries are established, the territories of forest districts, forest parks are divided into subdivisions of forest district, and a block network is determined. When forest taxation is carried out, the territory of each forest district is divided into primary forestry accounting units - forest compartment".

* Corresponding author: nklevansky@yandex.ru

A mandatory condition for carrying out continuous forest management is the annual (or current) updating of departmental banks of taxation data created on personal computers during the basic forest management [5].

The next stage of forest management was the development of technologies for creating taxation databases (DBs) based on cartographic information [6]. Technologies created for forest management cannot be directly introduced into forestry to create plans, coordinate schedules, and make important decisions on the use of forest resources. The problem is that: forest management technologies and forestry technologies put forward different requirements for the level of training of the personnel using them. A large amount of graphic and text data generated in the process of forest management work (lists of division of forests according to their intended purpose, forest management tablets, plans for forest plantations, aerial and satellite images, sets of taxation cards for each forest area) is necessary for further work in the forest industry. This state of affairs is similar to the situation in industry that developed during the period of intensive development and implementation of computer-aided design systems [7]. The solution was the development of integrated control systems based on design databases [8], in which the central place is given to geometric models of the designed objects.

Eliminating the problem for the forestry industry is possible by developing an integrated forest management information system at the forestry level based on geometric models of forest areas [12]. The system should be based on a database, including cartographic, taxation, organizational and management information [9]. The initial stage of development involves designing a system, including a forestry database scheme with means for entering spatial information, which is a necessary element for the formation of cartographic databases of forest management and the subsequent expansion of the database scheme for entering taxation indicators of forest areas, generating plans, cutting schedules, and contracts.

The purpose of the work is to present the results of designing an integrated forestry management system at the forestry level.

2 Design of an integrated forestry management system

To design an integrated forestry management system at the forestry level, functional modeling was used, called by the developer Structured Analysis and Design Technique (SADT) [10]. The US Department of Defense's Integrated Computer Aided Manufacturing (ICAM) program has recognized the usefulness of SADT. This led to the publication of part of SADT in 1981, called IDEF0 (Icam DEFinition), as a federal standard for software development. The latest edition of the IDEF0 standard was released in December 1993. Modeling using the IDEF0 methodology is recommended for use by the State Standard of the Russian Federation. Later, the SADT methodology became a tool for the structural analysis of systems of medium complexity [11].

3 Research methodology

The basis of the IDEF0 methodology is a graphical language for describing processes. A model in IDEF0 notation is a set of hierarchically ordered and interconnected diagrams (Figure 1).

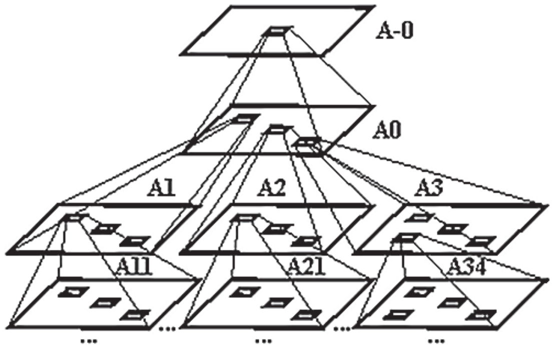

Fig. 1. Hierarchical decomposition scheme in SADT.

The model contains context diagrams and decomposition diagrams. Each model must have two context diagrams. Context diagram A-0, being the top of the tree structure of diagrams (Figure 1), shows the purpose of the system (main function) and its interaction with the external environment. After detailing the main function of the A-0 diagram, the functions of the context diagram A0 are determined. Next, the functions of the A0 diagram are divided into subfunctions until the required level of detail of the modeled system is achieved. Diagrams that describe each part of a system are called decomposition diagrams. After decomposition, subject matter experts analyze the correspondence of real processes to the created diagrams. After eliminating the found inconsistencies, further detailing of the processes is carried out.

The IDEF0 methodology uses a simple graphical modeling notation. The main components of the model are diagrams that display system functions in the form of rectangles (functional blocks), as well as connections between functions and the external environment through arrows. The use of two graphic primitives allows you to quickly connect and activate the customer's activities in describing business processes using a visual graphic language.

The choice of AllFusion Process Modeler 7 (BPwin) as a design tool was based on the fact that it is based on generally accepted modeling technologies such as IDEF0 and SADT. With AllFusion Process Modeler 7 (BPwin) you can produce detailed documentation of all aspects of business processes. That is, the necessary actions, methods for their implementation and control over the required resources, as well as visualization of the information received.

4 Research results and discussion

Figures 2, 3 show context diagrams A-0 and A0 of the functional model of the integrated system.

Diagram A-0 requires some explanation. The choice of the developer of the future integrated system (IS) as the person whose point of view will be represented in the functional model was determined by the need to obtain such a solution, which should be discussed with experts in the field of forestry management. The inclusion of IS as a supporting mechanism was driven by the need to identify a set of IS functions and their modular organization.

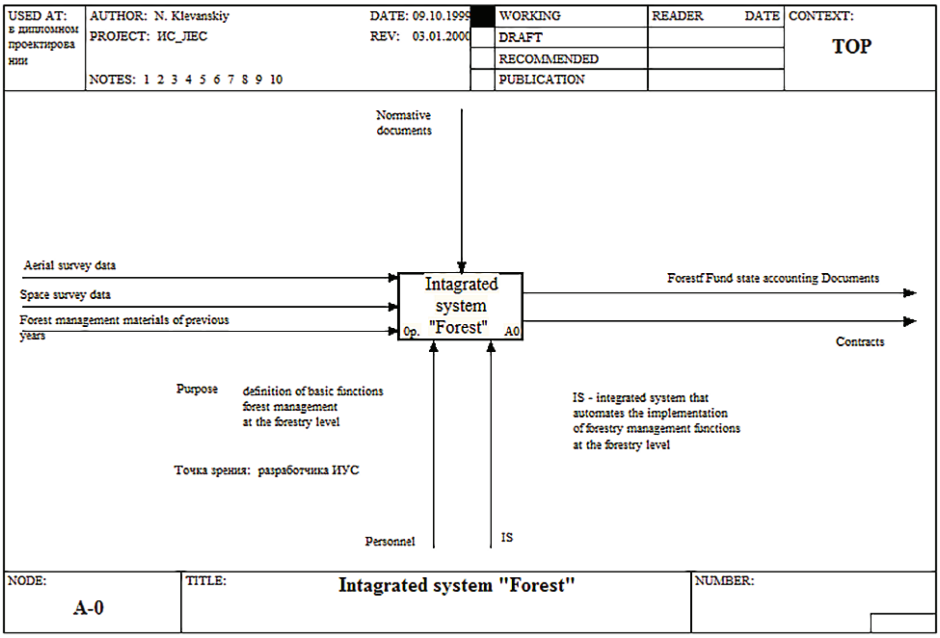

Fig. 2. Context diagram A-0 of an integrated system.

Diagram A0 (Figure 3) represents four modules of the future IC. The first module, "Working with geometric objects," involves working with the geometric characteristics of forest areas of various types.

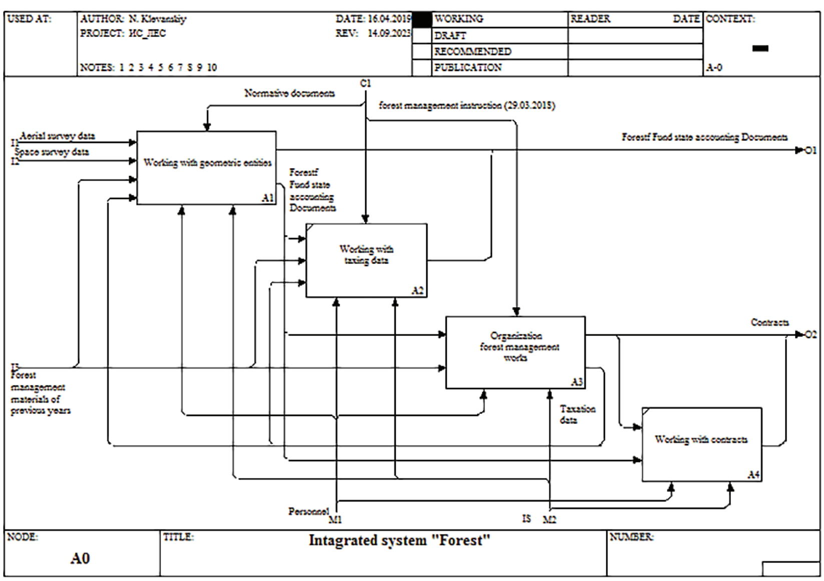

Fig. 3. Context diagram A0 of an integrated system.

Figures 4, 5 present the functional specifications of the two main business processes of the integrated system project.

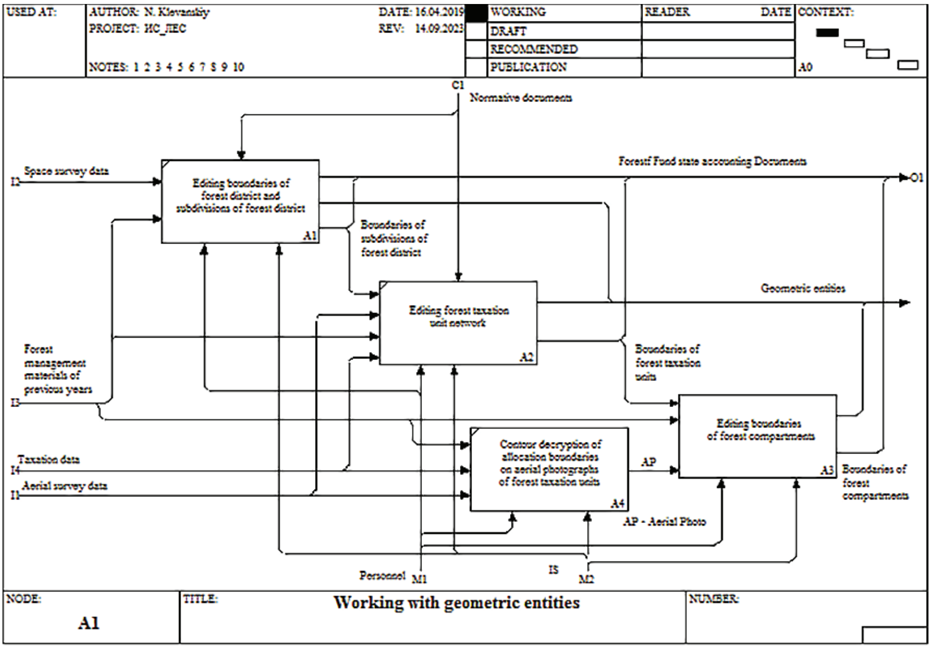

Fig. 4. Diagram of working with geometric object data.

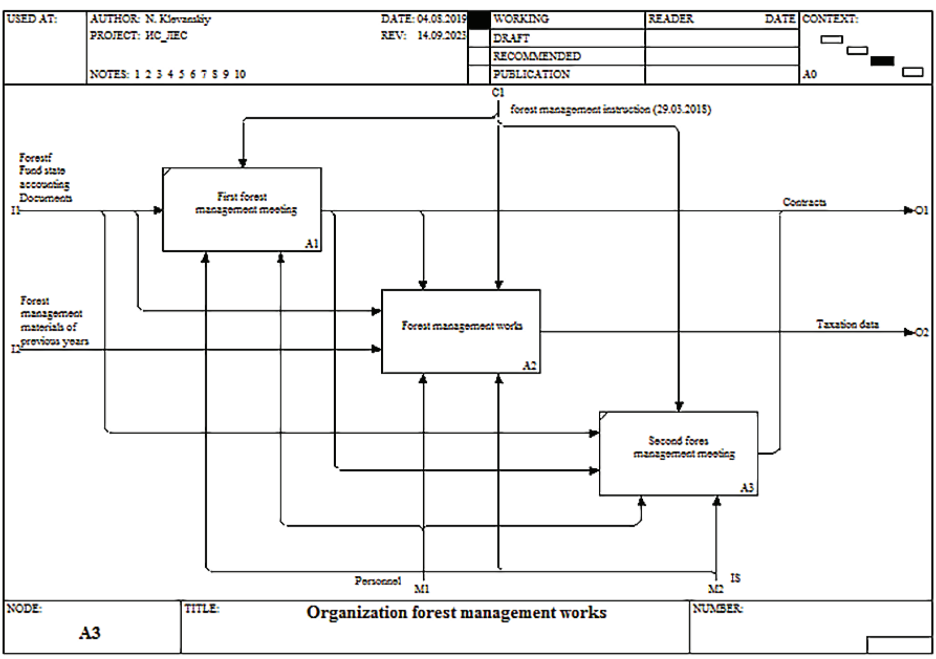

Fig. 5. Diagram of the organization of forest management work.

Figure 6 shows the detail of block A2 of diagram A3, and Figure 7 – detailing of block A2 of diagram A1.

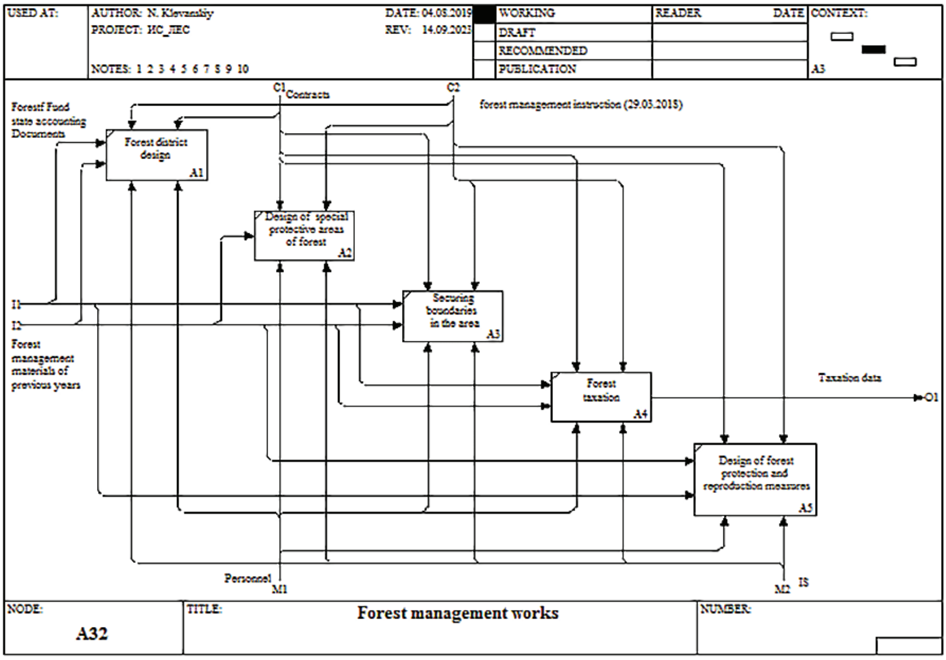

Fig. 6. Diagram of forest management work.

The lack of information about the boundary vertices of the sections complicated the detailing of block A3 of diagram A1 [13]. To edit the boundary vertices of the divisions, a sequential fragmentation of the area of the block into sections of smaller area was proposed in order to model the boundary vertices of the divisions in sections of 1x1 m (Figure 7).

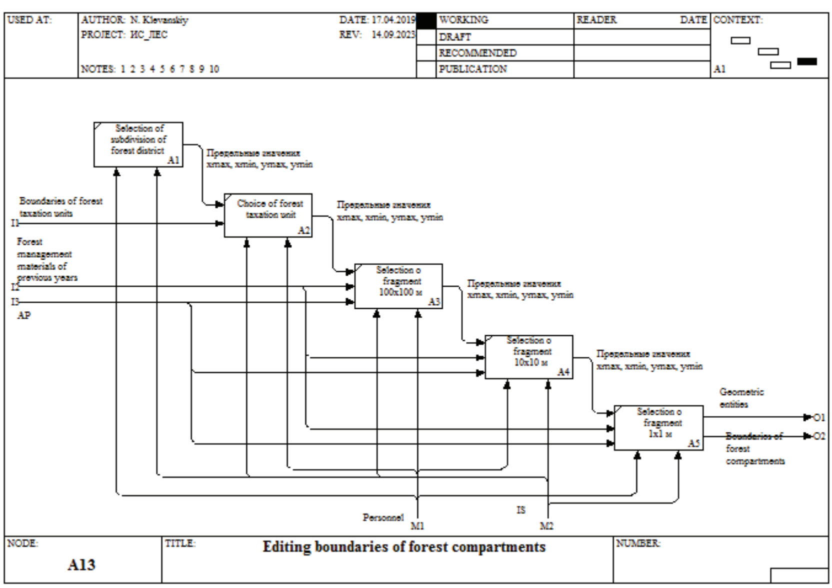

Fig. 7. Diagram for editing department boundaries.

The developed database diagram (Figure 8) of the integrated system layout [14] contains the following tables:

- PLOT - general information about forest areas of the forestry - designation, type of area (1 - forestry, 2 - district forestry, 3 - block, 4 - taxation division), number of characteristic points of the area's contour, area of the area.
- PLOT_PLOT – information about hierarchical relationships between forest areas of the forestry.
- POINT – information about the coordinates of characteristic points of forest areas.
- PLOT_ POINT – topological information about the contours of forest areas.
- FORESTER – information about the forest rangers of the relevant forest areas.
- TAXATION – information on the taxation indicators of allotments.
- CONTRACTOR – information about forest management contractors in forestry.
- CONTRACT – information on contracts for forest management work in forestry.

Thus, the database tables contain all the information about the geometry of the forest areas of the forest district, data on the indicators of taxation of the plots; data on contracts for forest management. Using data models, it is possible to visualize and calculate the areas of forest areas of a forestry.

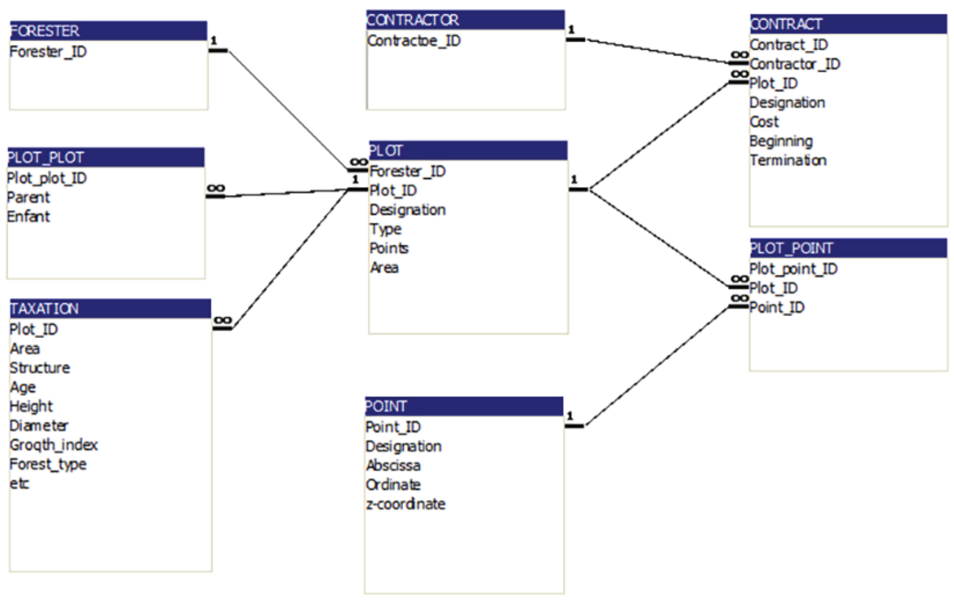

Fig. 8. Integrated system layout database diagram.

5 Conclusion

In conclusion, the following results should be noted:

- functional modeling of an integrated forestry management system was carried out at the forestry level;
- a database scheme has been developed that fully takes into account the information needs for solving forestry management problems.

The results obtained require professional discussion, especially the proposed method for establishing the boundaries of forest taxation units.

References

1. A.I. Chermnykh, G.A. Godovalov, Advances in modern science **10**, 85-89 (2018)
2. L.V. Abramova, P.A. Feklistov, *Improving the efficiency of forest management using information technology* (Northern (Arctic) Federal University named after. M.V. Lomonosov, Arkhangelsk, 2015)
3. A.S. Tikhonov, V.F. Kovyazin, *Forestry: Textbook* (Lan Publishing House, St. Petersburg, 2017)
4. V.I. Sukhikh, *Aerospace methods in forestry and landscape construction* (MarSTU, Yoshkar-Ola, 2005)
5. Forest management instructions (approved by order of the Russian Ministry of Natural Resources dated March 29, 2018 No. 122. registered with the Russian Ministry of Justice on April 20, 2018 No. 50859)
6. L.N. Vashchuk, Forest taxation and forest management **1 (47)**, 27-30 (2017)
7. J. Encarnaccio, E. Schlechtendal, *Computer-aided design. Basic concepts and system architecture* (Radio and Communications, Moscow, 1986)
8. D. Khorafas, S. Legg, *Design databases* (Mechanical Engineering, Moscow, 1990)
9. V.I. Sukhikh, Forestry **5**, 2-5 (2002)
10. D. Ross, *Structural analysis (SA): a language for conveying understanding. Requirements and specifications in program development.* Translation from English (Moscow, 1984)
11. David Mark, Clement McGowan, *Methodology of structural analysis and design*, translated from English (Moscow, 1993)
12. N.N. Klevanskiy, M.A. Kozachenko, Yu.V. Kozachenko, V.S. Mavzovin, Advances in modern science **2**, 13-18 (2020)
13. I.V. Tolkach, O.S. Bakur, Proceedings of BSTU. Forestry **1**, 58-61 (2011)
14. N. Klevanskiy, Journal of Advanced Research in Technical Science **20**, 70-82 (2020)