

GENERATION OF GEOSPATIAL INFORMATION FOR SUPPORT OF SUSTAINABLE FOREST MANAGEMENT IN RUSSIA

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Abstract

Geospatial data serves as a main information component to support the sustainable forest management. Forest statistical data in a table or text form is traditionally applied for strategic planning and forest recourse assessment by Russian forest administration. The statistical data prepared for management units in the regions is summarized within the framework of state forest register at the federal level. Up to now, the main disadvantage of forest register is the lack of cartographic support and visualization of statistical data. The simple map service for visualization of statistical record data as an atlas of interactive maps is now being developed.

Keywords: forest management, Web mapping, GIS, electronic atlas

INTRODUCTION

The Russian forest management effectiveness depends on the quality of planning and monitoring of the activities undertaken for the use, conservation, protection and reproduction of forests. The information basis for the effective forest management is the statistical data being collected in the State Forest Register. According to the Russian forest legislation, the State Forest Register is a "systematic set of documented information concerning both the forests, their use, conservation, protection, reproduction, and the basic territorial forest management units – forestries and forest parks". The State Forest Register is being conducted by the executive authorities and the local self-government organizations in all the regions of Russia, while the subordinate organizations of the Federal Forestry Agency of the Ministry of Natural Resources of the Russian Federation summarize the information for the whole country.

The collection and the synthesis of the State Forest Registry data array require significant budgetary costs, while at the same time there are restrictions on its open publication. According to the Government Order №1187-r of 07.10.2013, the data on the subjects of the Russian Federation consists of an open public information and the data on forestries and forest parks which is for official use only.

Until recently, there has been neither a spatial representation nor cartographic visualization of the State Forest Register data. To solve the problem, the compilation of the analytic maps in the GIS environment and the creation of a simple map service in the form of an electronic atlas based on these maps were implemented.

Our long-term studies [3,5,7,8] are aimed at demonstrating the benefits of using the spatial information for decision-making and the introduction of cartographic presentation of different data on Russian forests in forest management practices. The aim of our applied research is the development of a map service to provide access to the forest statistical data through a simple user interface by means of GIS tools and web technologies.

The main purpose of this service is to render visual presentation of statistical reports in the form of cartograms and orthodiagrams with spatial reference to the territorial management units, and thus to simplify the comparative analysis and spatial evaluation of activities in the use, conservation, protection and reproduction of forests. To realize this goal, the maps in the GIS software environment were created and the web interface for visualizing and delivering the maps to the end user was designed.

It is important for the user that the map service oriented to the visualization and to the publication of the State Forest Register data meet the following requirements:

- the maps should be reproducible on a variety of platforms and popular operating systems (OS) and should not require the installation of the special GIS software;
- the maps in the service should remain vector, should be made on a single basemap and preserve the projection and the coordinate system
- all the advantages of the maps created in GIS environment should be retained, e.g: the feasibility of the user's queries both to the space and to the attributive data for obtaining absolute and relative values of the data, the possibility of manipulating the layers, the metricity, and an ability of moving from a more detailed map to a less detailed one if changing the scale.
- the maps should be interactive and easy-to-use, i.e. contain controls and other tools used in web mapping.

The Web-GIS technology meets these requirements, since it combines the functionality of the GIS and the benefits of using the Web as a medium for the transmission of GIS functions to a wide audience [9].

MATERIALS AND METHODS

Our mapping service is the simplest Web application. It is essentially a client-server architecture in which the client is a web browser and the server is the user's local computer. The web browser is technically a client that implements the HTML specification and JavaScript, i.e., is able to access the folders on the local computer, where the maps, images, legends, texts, etc are placed, and to interpret and execute the code.

The mapping service consists of the following structural elements:

- The digital cartographic basis (base map) with the boundaries of the Russian Federation subjects and the boundaries of forestries and forest parks in the coordinate system WGS 1984
- Operational layers with State Forest Register data for subjects of the federation and their forestries being grouped by the federal districts.
- The web interface for the maps visualization and publishing, working with the layers and the implementation of the requests

An integral part of the map service are the maps based on the State Forest Register data, which are to be employed for the information support of the federal and regional levels of forest management. The atlas gives an idea about the resource base, the composition of the forests, quantitative and qualitative characteristics of the forests by the subjects of the federation and their forestries within the boundaries of the federal districts. In cartography, such maps are usually being referred to as the analytical type [2], and the map collection forms the information and reference atlas.

The reference type of the maps is determined by their designation for the analysis of spatial data and long-term planning in the field of use, protection and reproduction of the forests to assess the effectiveness of forest management in the Russian Federation regions. Statistical characteristics in the atlas mapping are traditionally displayed in the form of the cartograms and orthodiagrams. In this method of displaying the detailed cartographic base is not required [10].

Visualization of the State Forest Registry data was performed using the cartographic basis with a minimum of content elements:

- an administrative subdivision as the polygon layer of the subjects of Russian Federation and the polygon layer of territorial forest management units (forestries and forest parks);
- a layer of linear objects consisting of the state border line and the generalized coastline

The polygon layer of the forest management units consisting of forestries and forest parks has been created and is being regularly updated by us based on the open data sources.

The working layers contain the State Forest Registry data grouped by the regions (subjects) and forestries as parts of the subjects, being visualized on the maps by the user.

A set of interface tools in the web browser provides the user with the following capabilities:

- to publish and to visualize the maps based on the State Forest Register data;
- to navigate and to switch between atlas sections, subsections and maps on various subjects;
- to connect or to disconnect individual working layers
- to display maps in different scales without any quality loss, because the vector graphics is being scaled
- to view maps and data of the State Forest Register for forest areas and regions of Russia in table or chart form;
- to generate inquiries on the selection of a spatial object (or a forest region), or the object with the specified quantitative characteristics and to obtain the information on the selected object
- to build charts directly on web maps using the "Query" tool;
- to get the object coordinates
- to print maps and attribute information

The atlas uses the Dojo library and AJAX technology to improve communication with the user, to give interactivity to the HTML-pages and to animate the charts. These tools can be installed on the local computer or loaded from the Web. Cartographic base and working layers form the mapping service content, being implemented as an electronic atlas.

RESULTS AND DISCUSSION

Our electronic atlas contains systematized, inter-related and mutually complementary maps, which is consistent with the standard requirements of [2,10]. According to the electronic atlases typification [2], the atlas we have created can be identified as a combined one. It combines the functions of the viewer intended only for visual examination (browsing), and interactive functions, which provide content management features. Namely, it is possible to load separate working layers, to implement requests for spatial and attribute data, to scale the map and to carry out measurements and print the map from the screen if necessary.

The atlas contains four thematic sections: forests and forest resources; the use of forests; conservation and protection of forests; forest reproduction. Atlas sections are hierarchical and contain sub-sections with detailed description of the forest resources and forest management. During the design phase the subjects and legends of more than 90 maps in each of the two levels of spatial mapping (by the regions and by the forestries) have been agreed with the potential users - forest management specialists. The structure and hierarchical subordination of the mapping levels and map subjects by sections are shown in Figure 1.

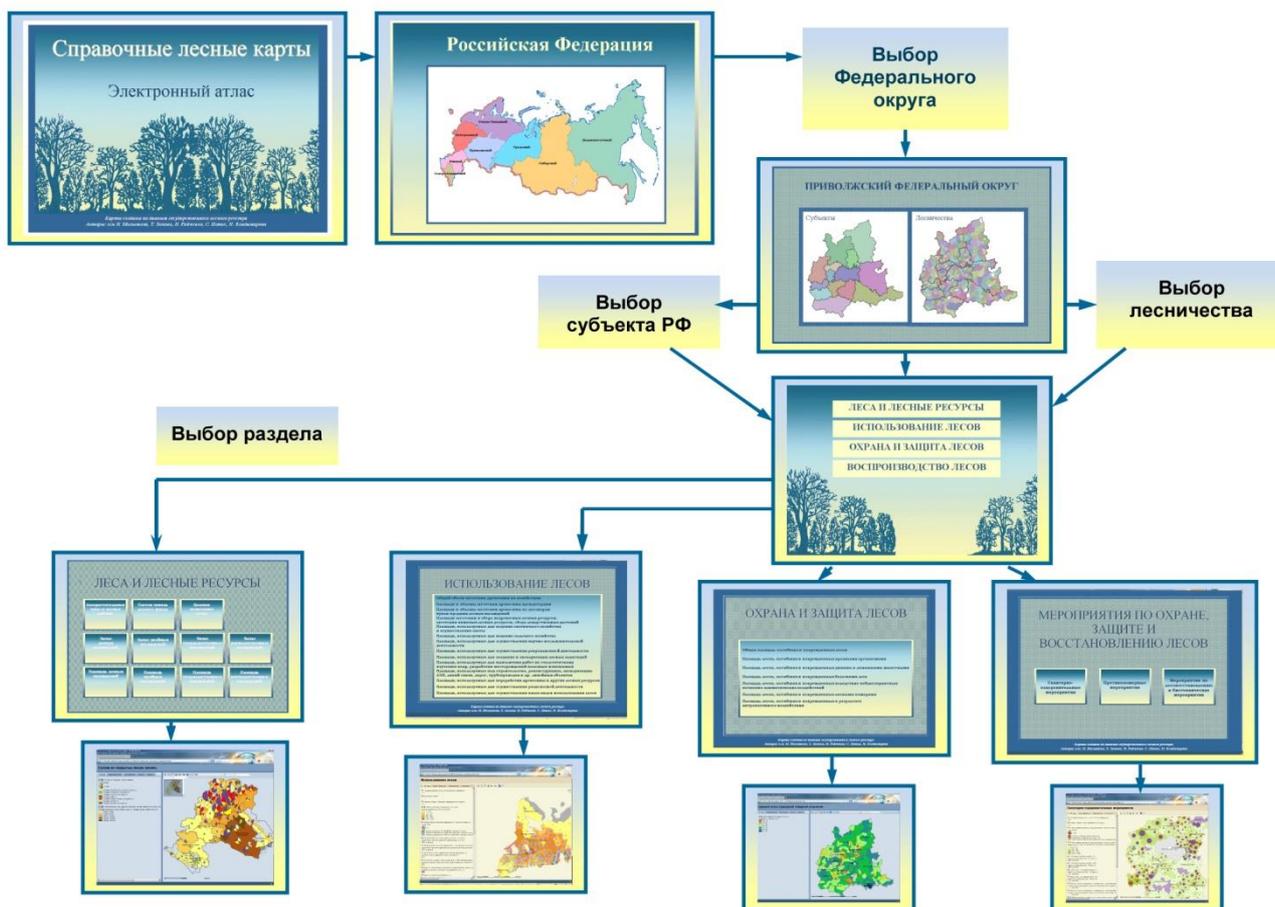


Figure 1. The structure and hierarchical subordination of the mapping levels and map subjects by sections

Our experimental work on the mapping service preparation included the creation of maps in ArcGis 10 and the export of the frames by means of a special extension for ArcGis called Mappetizer 11.2 and previously tested by us [7,10]. The software was purchased from the developer, a Uismedia company (Germany) [<http://www.uismedia.de/mappetizer/en/index.html>]. The Mappetizer was selected due to its usability for the creation of a browser-based application, the possibility of building maps and chart animation, and also due to the fact that published forest data do not require frequent updates. The export result is simple folders with a set of files that can be uploaded to the web and stored on the server or on the local computer.

All visible layers on the map are preserved when exporting, including the different geometry classes (polygonal, linear and point) stored in the geodatabase, shape-files, symbols and characters, as well as the map titles and accompanying inscriptions. In addition, it is important that the connection between the stored spatial and attribute information in the geodatabase is preserved. The software allows converting vector data of the frame to the SVG format.

The SVG is a user-friendly format due to its simplicity in creating web-GIS applications and no need in purchasing special software, as well as to high quality of graphical representation (including spatial), and integration with HTML-documents. The disadvantage of the format is a fairly rapid increase of the size of the SVG-file for the objects of complex geometric shapes and, consequently, decreasing the speed of page loading to the user [<https://ru.wikipedia.org/wiki/SVG>]. SVG-format is preferable for the publishing of the simple maps containing the statistical characteristics in the form of the charts [1] with minimum of content elements, and compiled on the simple cartographic basis, like the maps of our e-atlas.

Our atlas includes maps in SVG format, XML documents, JavaScript files to dynamically create the HTML web pages, offline files for interactive pages (the images in JPG format), cascaded CSS style sheets and XSL style sheets for recreating the layout and appearance of the text embedded in the HTML-pages. From the user side the atlas represents the HTML-pages collection hierarchically arranged in accordance with the logic and consistency of forests information, namely resource potential of the territory, forest use, preservation, protection and reproduction.

The user loads the pages sequentially in a predetermined scenario, leafing through them as through ordinary web pages of the Internet site in web browser. Our map service works in all popular web browsers supporting vector data in the SVG-format, such as Internet Explorer, Mozilla Firefox, Google Chrome, Opera. However, the most stable browser to work with the SVG format is the Mozilla Firefox, which has an internal (native) format support. This is the preferable browser to manage the atlas maps and the whole service.

Today our atlas includes maps of all the Russian regions and the territorial forest management units (forestries and forest parks), which are grouped within Federal Districts. Statistical data in the atlas are presented mainly in the form of a circular structure diagrams, as this method is best suited for the display of variation range and the structural subordination of the original data. Users often deal with the need in obtaining specific numerical values, that are displayed on the pie or bar charts.

ArcGIS visual tools have limitations in terms of sector chart signatures in the form of callouts that clutter the field map. Web Mapping tools made using the Mappetizer addon allow charts to be animated. When the user hovers over a chart sector the quantitative data is dynamically loaded popping up specific numerical values. That's why the map is not overloaded with lots of numbers, such as timber volume or forest area. These figures, taking into account the vast areas of Russian forests and timber volumes, are commonly expressed in million m³ or million ha respectively.

Our electronic atlas can be downloaded to a local computer or a server, and it is suitable for publishing maps on the Web. We emphasize that because of the regime restrictions, only a part of maps and statistical information is open for publication, namely, the State Forest Register data for the Russian regions.

CONCLUSION

The proposed approach to the work with industry statistical information through a simple map service in a Web browser gives us an opportunity to publish forest registry information and receive reference data without installing an expensive GIS software on the server or on the local computer. The forest administrative employees though not having any GIS experience can easily learn how to manipulate atlas maps' content and how to gain the reference forest data from the database. There is also no need for personnel to use GIS-based "cloud" technologies, such as ArcGIS Online, which, because of data confidentiality, may not be welcomed or even be not allowed to comply with corporate security policies. Modern users want the Web applications to be as simple, as quick, and as easy to learn and use as an ordinary Web page [9]. Our work is an example of such simple-to-learn and -use browser application.

The cartographic service will promote the involvement of the geospatial data into decision support of forest management with an objective to enhance the Russian forests administration at regional and federal levels.

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