Subsystem of Calculation and Prognostics of Flood Areas on Republic Bashkortostan Territory in Structure of Geoinformation System "FLOOD"

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Abstract[1]

The article describes the development of subsystem of calculation and prognostics of flood areas on Republic Bashkortostan territory in structure of geoinformation system "Flood".

1. Introduction

Spring tide is an annually repeated seasonal long term significant increase of river's water content, accompanied by rise of water level in river-bed and impoundment of floodplain – which comes as one of the main reasons of flooding. Consistency of snow melting in spring and water-supply in snow influence greatly upon the character of flood's forming and passage.

Owing to predominant snow feeding, the rivers of Republic Bashkortostan are remarkable for well-defined event of spring tide [1]. In Republic Bashkortostan spring tide often leads to unexpected consequences, characterized by significant property damage. It is due to more than thousands of rivers flow through republic's territory with total length about 20 square kilometers. During the period of spring tide almost all metropolises and over 30 republic districts locate in the area of potential flood.

Under these circumstances, it is necessary for the republic heads to have urgent information about submerged territory. Except for weather forecast, granted by Bashgidromet, this information is producing while comparing situations relying on water levels data obtained from hydro stations and previously generated maps of probable flood scales, based on algorithms of calculation and past flood maps. These modern maps can be defined more precisely using satellite imagery.

2. The Necessity of Development of Calculation and Prognostics of Flood Areas Subsystem

As a result the first line-up of automated decision-making support system of natural resources management and environment control has been developed for ministry of natural management, forestry and environment control, including subsystem of data ware of flood situation evolution control "GIS Flood". The purpose of its development is in operative support of Ministry's directorate and organization departments with full and reliable spatial information (reference and analytical) to carry anti flood actions out [2, 3].

The example of solution of flood situation evolution control data ware task is shown on figure 1. Information about water levels from hydrological stations (in this case "Ufa" station) is represented in three types: map, graphic and tabular format [4].

Proceedings of the 9th International Workshop on Computer Science and Information Technologies CSIT'2007, Ufa, Russia, 2007

However first system's line-up accomplishes only I&R tasks, which allow implementing search and location and important objects specification in two primary forms:

- Search and objects' location representation on map.
- Search and objects' attributive features representation, using their location on the map.

For this reason the developing second line-up of automated decision-making support system of natural resources management and environment control ought to allow calculation and prognostication of main indices, essential for flood situation control and management. Owing to it, the necessity of development of calculation and prognostics of flood areas subsystem, using data from hydro stations and digital maps had emerged.

The place of second line-up of automated decision-making support system of natural resources management and environment control in general system is shown on figure 2.

Calculation and prognostics of flood areas subsystem based on data from hydro stations and digital maps will be used by Ministry directorate and its organization departments for decision-making support to carry anti flood actions out on republic territory. This will allow:

- Guaranteeing operative calculation of geographic parameters of flood areas during the spring tide period.
- Ensuring operative information presentation in form, convenient for substantial analysis.

Calculation and prognostics of flood areas subsystem performs following functions:

- Acquisition of vector polygon of flood area by means of geospatial analysis, using prognostic and operative values of water levels.
- Comparative analysis of flood areas on current and preceding years.
- Generating report on under flooding objects of flood areas.
- Output to print of represented area of digital map.

Above-listed functions caused the choice of licensed software ArcGIS 9, including ArcSDE (an advanced spatial data server for managing geographic information in numerous relational database management systems) and geospatial analysis extension Spatial Analyst (for advanced vector and raster spatial modeling) as a basis for development.

It is advisable to realize the task of flood areas calculation in the following order:

- Data preparation for digital elevation model building.
- Digital elevation model building.
- Three-dimensional planes building using section lines, built on water height raising lines.
- Raster creation on basis of planes and flood area finding.

Flood areas calculation algorithm includes following stages, shown on figure 3.

Place of calculation and prognostics of flood areas subsystem with complying added command button in elaborated interface of GIS "Flood", representing navigation system for fulfilling different tasks, concerned with ministry of natural management, forestry and environment control, is shown on figure 4.

It is necessary to choose data source according for building flood areas to switch to flood areas calculation and prognostics subsystem. End user of this system will use data on scales 1:200 000 or satellite imagery for flood areas calculation and prognostics.

The main frame of a map's window ("View"), displays digital map of locality, consisted of following layers: territorial subjects of Russian Federation, republic's districts, settlements, elevation numbers, roads, railroads, horizontals, hydrography (rivers, lakes, streams, bogs), vegetation and flood area itself (fig.5).

The structure of interface of flood areas calculation and prognostics subsystem is organized in the following way. Subsystem fulfills two types of task – immediate calculation and prognostics of flood areas while river flowing and comparative analysis of built flood areas.

In task of calculation the input parameters are:

- River, upon which the flood area will be built.
- Level of river's detail – certain area of river or political district of republic with all rivers on it's territory or chosen river as a whole.
- Prognostic or operative data on water level from Bashgidromet hydro stations (it is possible to specify definite data interval in case of operative data).

In task of analysis a work with already built flood areas is implied, where input parameters include political district of Republic Bashkortostan and specified data, and as output come map with detailed legend and report on flood areas.

Accordingly, after choosing all of the essential parameters one can build a flood area for each section line of a river. In case demonstrated on figure 6, the input data were Belaya river, prognostic data from hydro stations of Bashgidromet and area of river – Yumaguzino settlement.

As a result besides building flood area on certain territory, a report is being generated on number of under flooding settlements, inhabitants, situated in flood area and total flood area (fig.7).

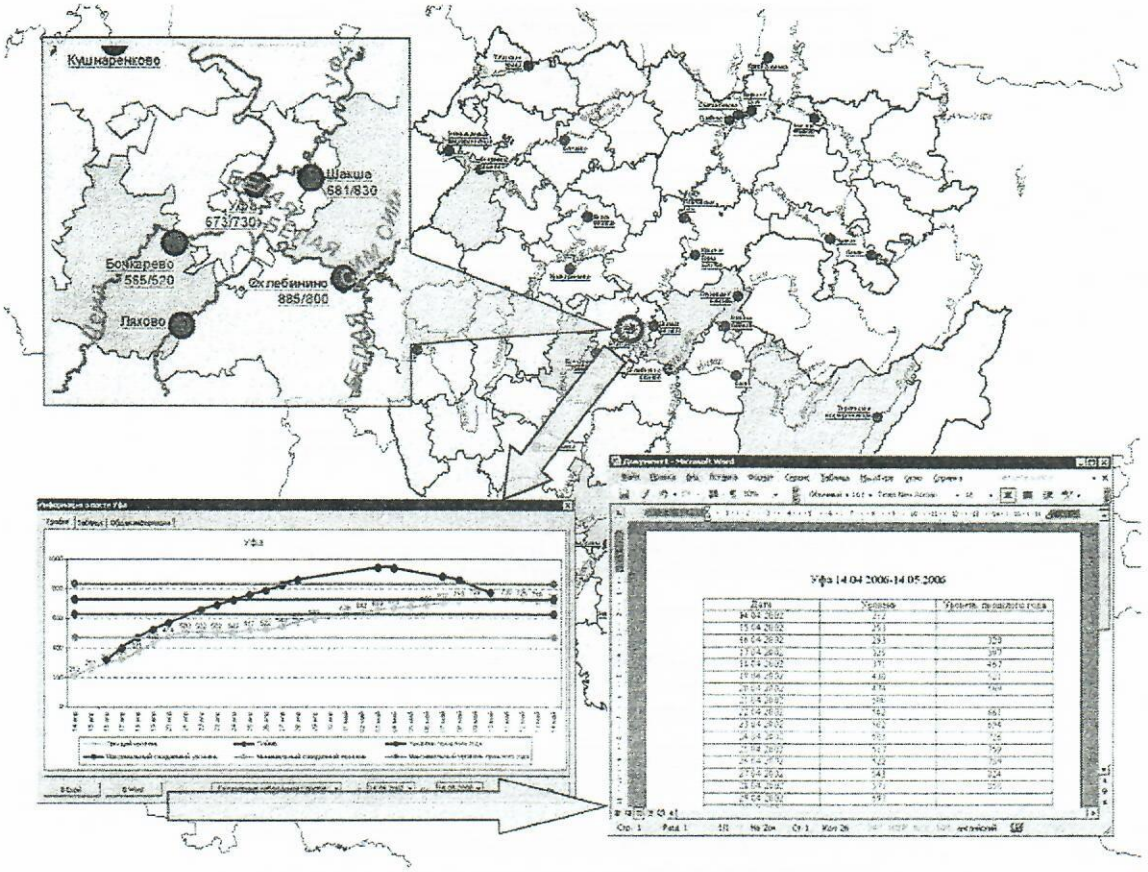

Figure 1. Information's Presentation in Map, Graphic and Tabular Formats

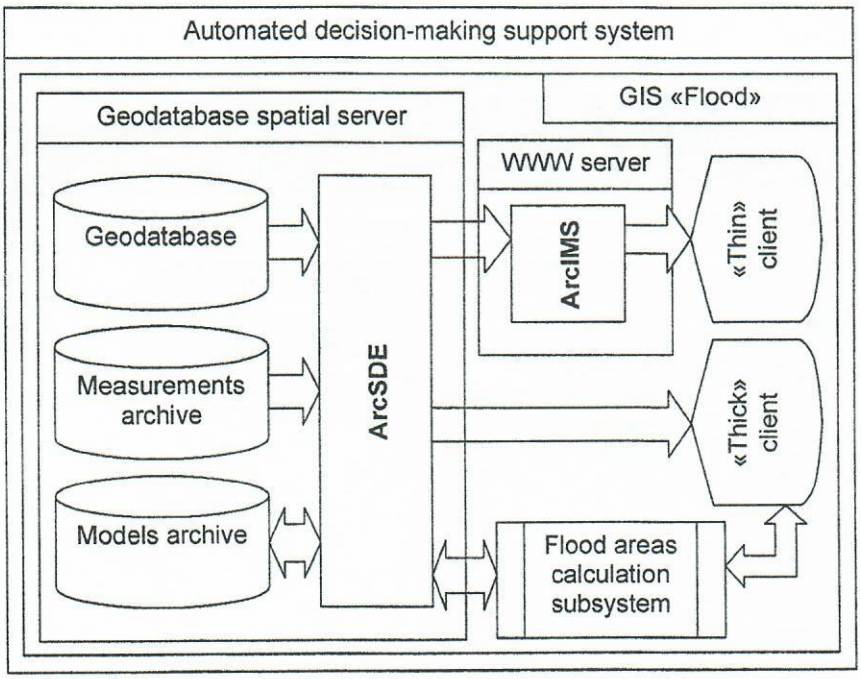

Figure 2. The Place of Second Line-up of Automated Decision-Making Support System of Natural Resources Management and Environment Control in General System

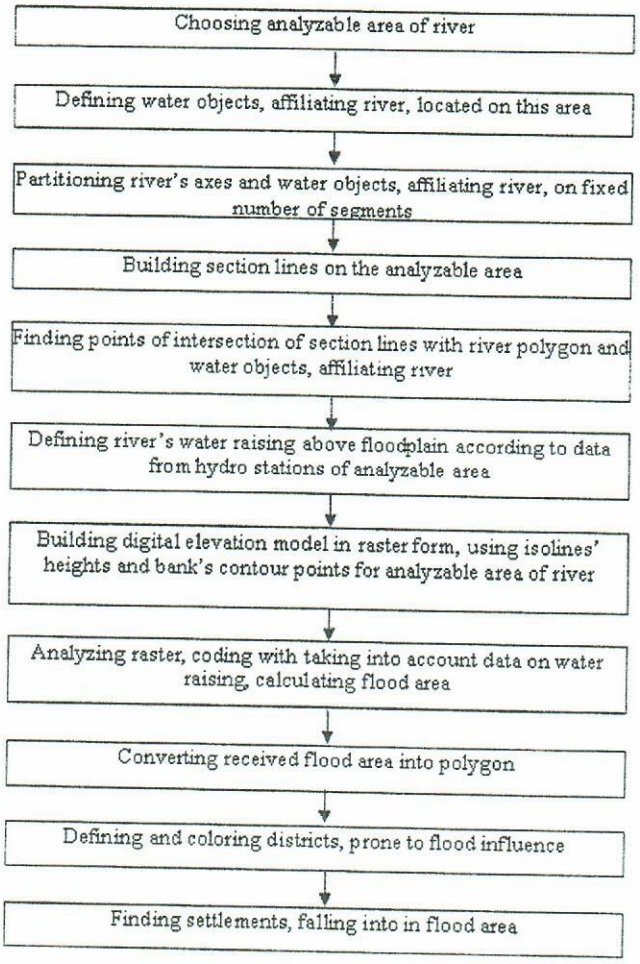

Figure 3. Flood Areas Calculation Algorithm

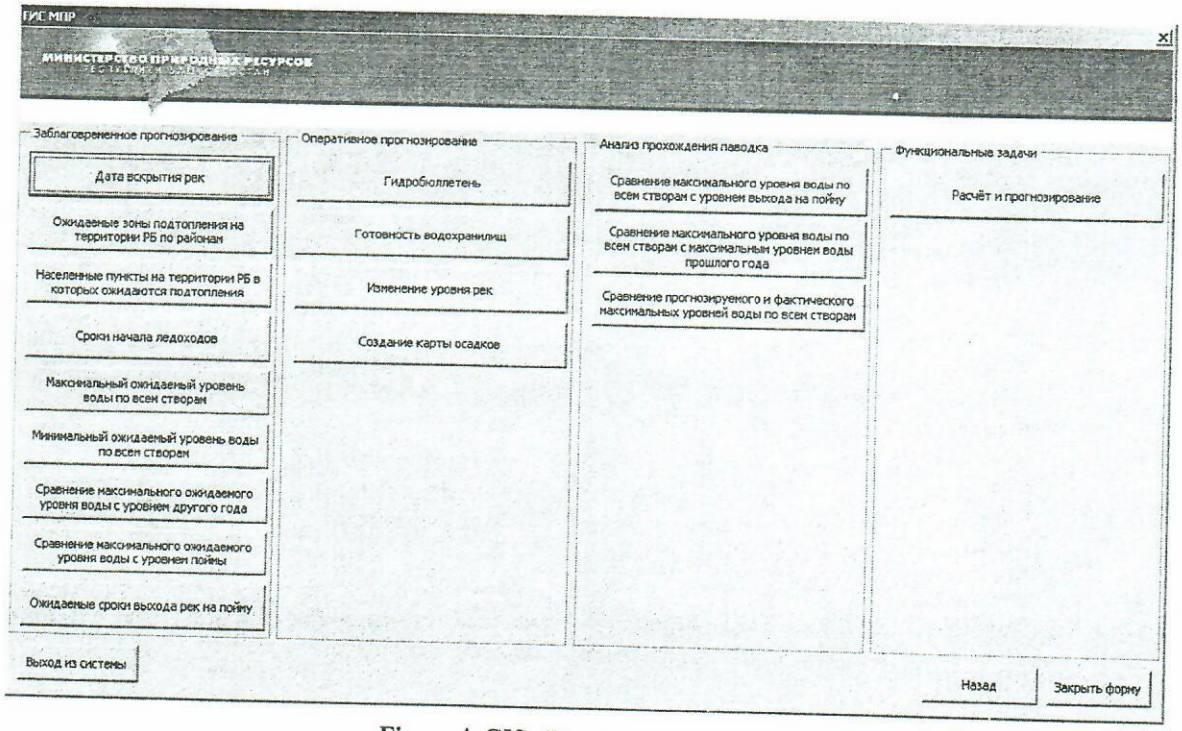

Figure 4. GIS «Flood» User Interface

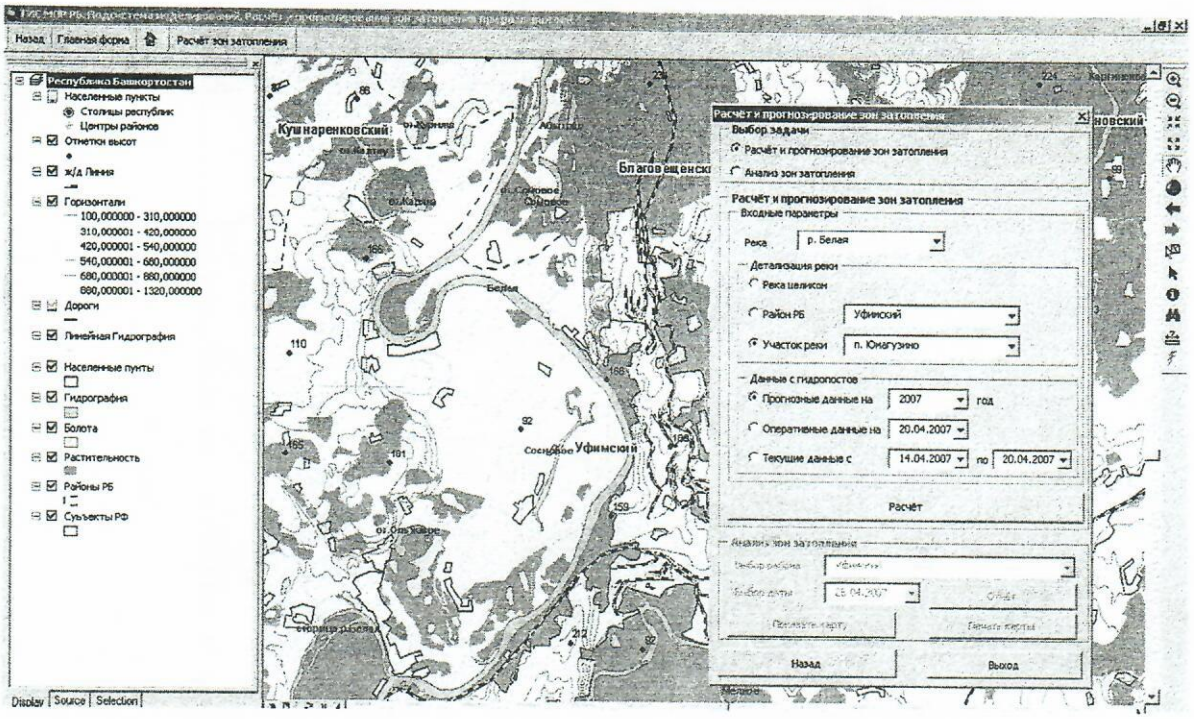

Figure 5. Flood Areas Calculation and Prognostics Subsystem User Interface

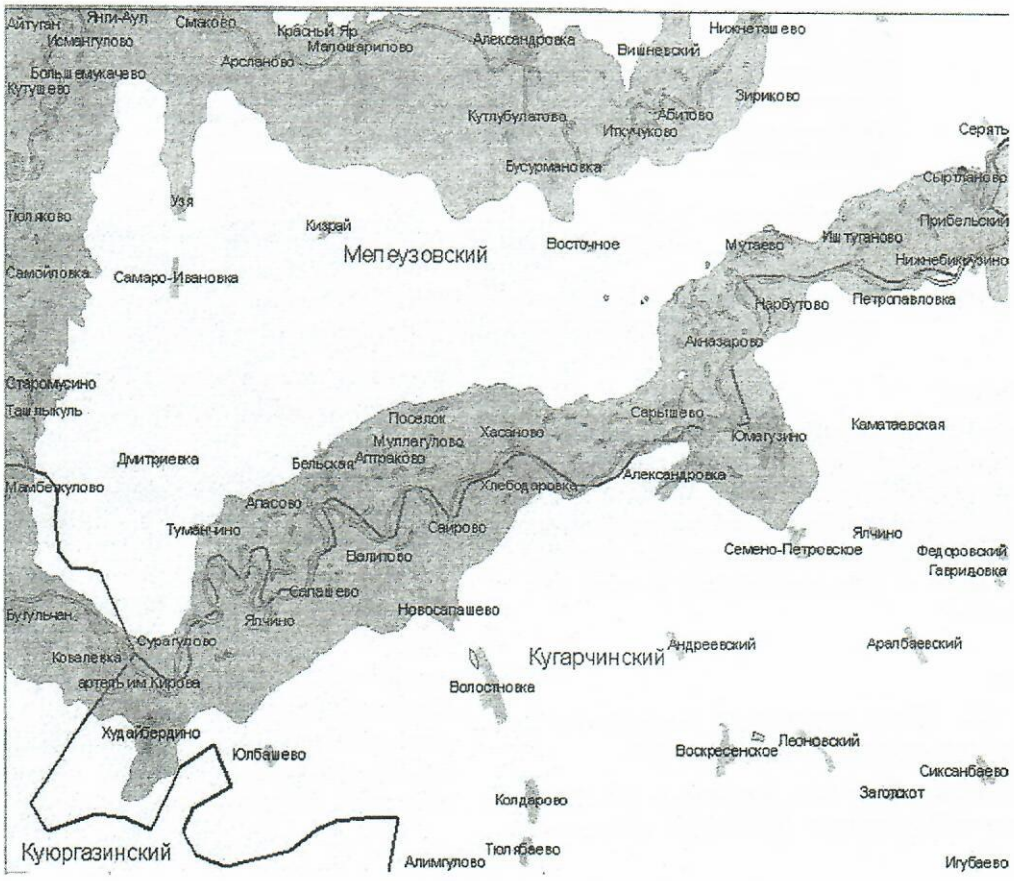

Figure 6. Flood Area on Belaya River's Territory

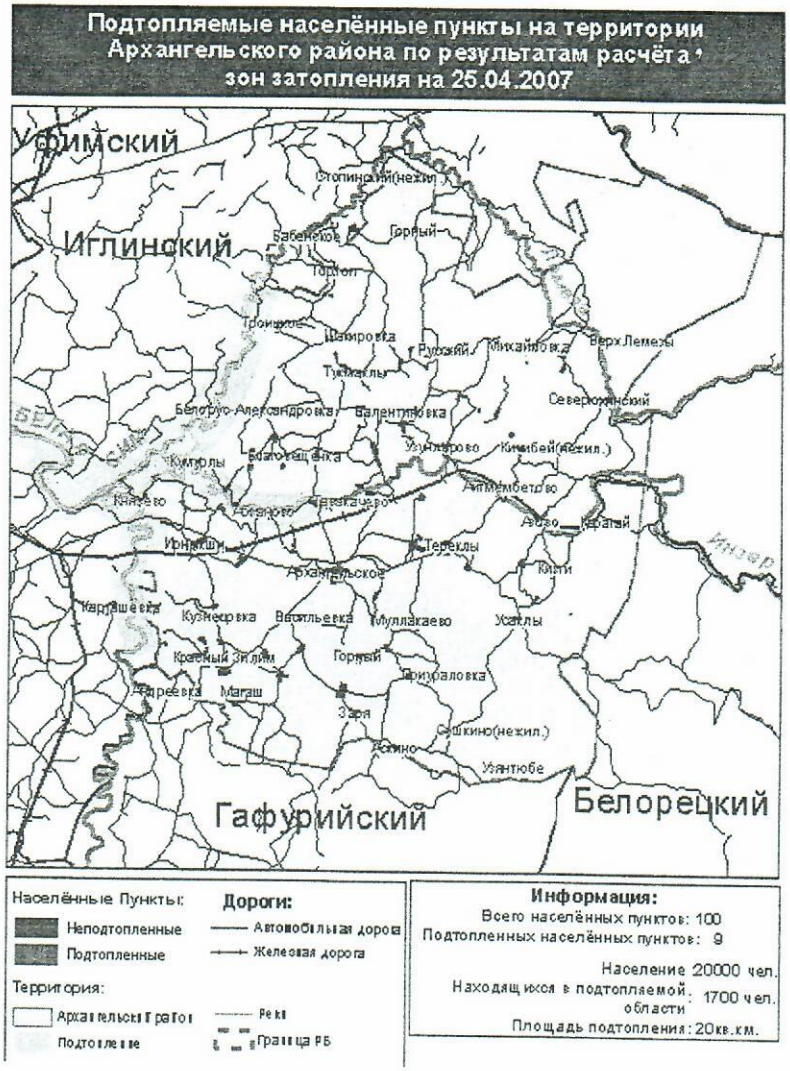

Figure 7. Report, Containing Information about under Flooding Settlements on Concrete District Territory, was Generated by Resulted Flood Area Calculation on Target Data

3. Conclusion

As a consequence of this subsystem's functioning it is possible to build flood areas on chosen water objects (rivers) using prognostic and operative data from hydro stations of Bashgidromet. Besides there is an opportunity of analysis of built flood areas on different time intervals, map representation of these areas (output to print) and report generation.

References

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