rivertwin

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RIVERTWIN

A regional model for integrated water management in twinned river basins

Instrument: Specific Targeted Research Project (STREP)

Priority: Sustainable development, Global Change and Ecosystems

D12 – Thematic maps of DEM, soils, infrastructural and administrative GIS layers for the Chirchik basin

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Scientific Information Center of the Interstate commission of water coordination of Cnetral Asia

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PU	Public	X
PP	Restricted to other programme participants (including Commission Services)	
RE	Restricted to group specified by the consortium (including Commission Services)	
CO	Confidential, only for members of the consortium (including Commission Services)	

Description of the interface of the GIS and databases complex

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Contents:

1. Introduction

The DB interface has been developed in accordance with the requirements specified by the Terms of Reference. Development environment is Visual Basic Pro.

The main purpose of the user interface (as well as of another one) is to effectively integrate functional components into a single whole system and organize fulfilling functions so that user could draw all his attention to necessary analytical work, not programs, using which this work is done.

2. Basic principles and requirements to DB user interface

The DB user interface is a system of blocks (DB block, GIS block, forms for information input and output) designed for user servicing: input, adjustment, update and analysis of information available in the database, without need for deep knowledge of DB MS Access commands.

The user interface has been constructed, based on the following system principles: dialogue controlled by system, i.e. inflexible “rules of play” are established in working with system such as what functional components can be handled, what forms of information display can be used, what key parameters should be set to process any information object; mixed structure of dialogue that enables to simultaneously use a number of different elements of dialogue on the screen, edit data fields before input. In other words, user has an opportunity to work with the form until he presses appropriate button that means, for example, exit from the form and so on. Moreover, while developing a user interface, numerous requirements that are usually set to modern software products were fulfilled.
The “Rivertwin” DB interface adequately takes into account the basic requirements to the interface of modern software products, namely:

1. Commonality of main dialogue forms and data processing forms: appearance, sequence of data placing and display on the screen.

2. Naturalness of dialogue: conducting dialogue in native language (in our case it is Russian, later English as well). The procedure for information input is extremely approximated to that procedure, in which user generally processes information.

3. No redundancy (conciseness): input of minimum information necessary for fulfilling any function. One cannot input information, which can be formed automatically or which was inputted before. This enables to make the dialogue fast and simple, and reduce the number of possible errors. Broad use of icons (menu button) instead of text to mark frequently used functions. At the same time, if user does not understand destination of the icon, then he can see a brief text explanation of its destination beside it, having placed the mouse pointer on this icon.

4. User-friendly support: it gives an opportunity to receive general or context-dependent information (assistance), giving user reports on any events (actions), for example, lack of information on object for given key parameters in the table.

User interacts with the system on the basis of dialogue forms by using a keyboard and mouse. As a rule, using a keyboard, data are inputted and updated. Using a mouse, different elements of dialogue forms (functional buttons, selecting menu items, finding objects in GIS and so on) are selected and activated.

3. Components of databases and GIS and their linkage to the DB interface

Software: Access XP, ARC GIS, Visual Basic Net.

Main components of database (fig.3.1)
- surface water block,
- groundwater block,
- agricultural production block,
- climatic block,
- ecological block,
- socio-economic block.

Energy information is formed in sub-blocks, in the structure of surface water (hydropower) block and socio-economic block of the database (power system as a whole).

The objectives of the Project and principles of integrated processes modeling suppose certain requirements for generation of data, which can be taken into account through:
- standardizing data,
- creating a common coding system,
- logical compatibility of data in measurement range and units, information sources, types of objects – point, line, area (contour).

These are formed in DB as basic limiting data:
- trends of changes in population (socio-economic block),
- norms of water consumption with changes by development stages (agricultural production block),
- quality standards and ecological restrictions in part of requirements to river flows, reservoir operation modes, return flow disposal, as well as to conservation of ecosystems, prevention of pollution, and depletion of clean groundwater deposits (ecological block),
- potential productivity of water and land resources, planned limits to achieve it by development stages (agricultural production block),
- coefficients of planned flow use effectiveness that supposes minimizing technical and organizational losses by development stages (agricultural production block),
- planned trends of investments (socio-economic block).

Requirements to Geographic Information System (GIS) as applied to DB interface:
- Connection of created GIS layers by types of chosen objects,
- Establishment of relations between GIS layers and DB objects by borders (contours), lines and points.

Sources for creating GIS layers: topographic and thematic maps, satellite images.

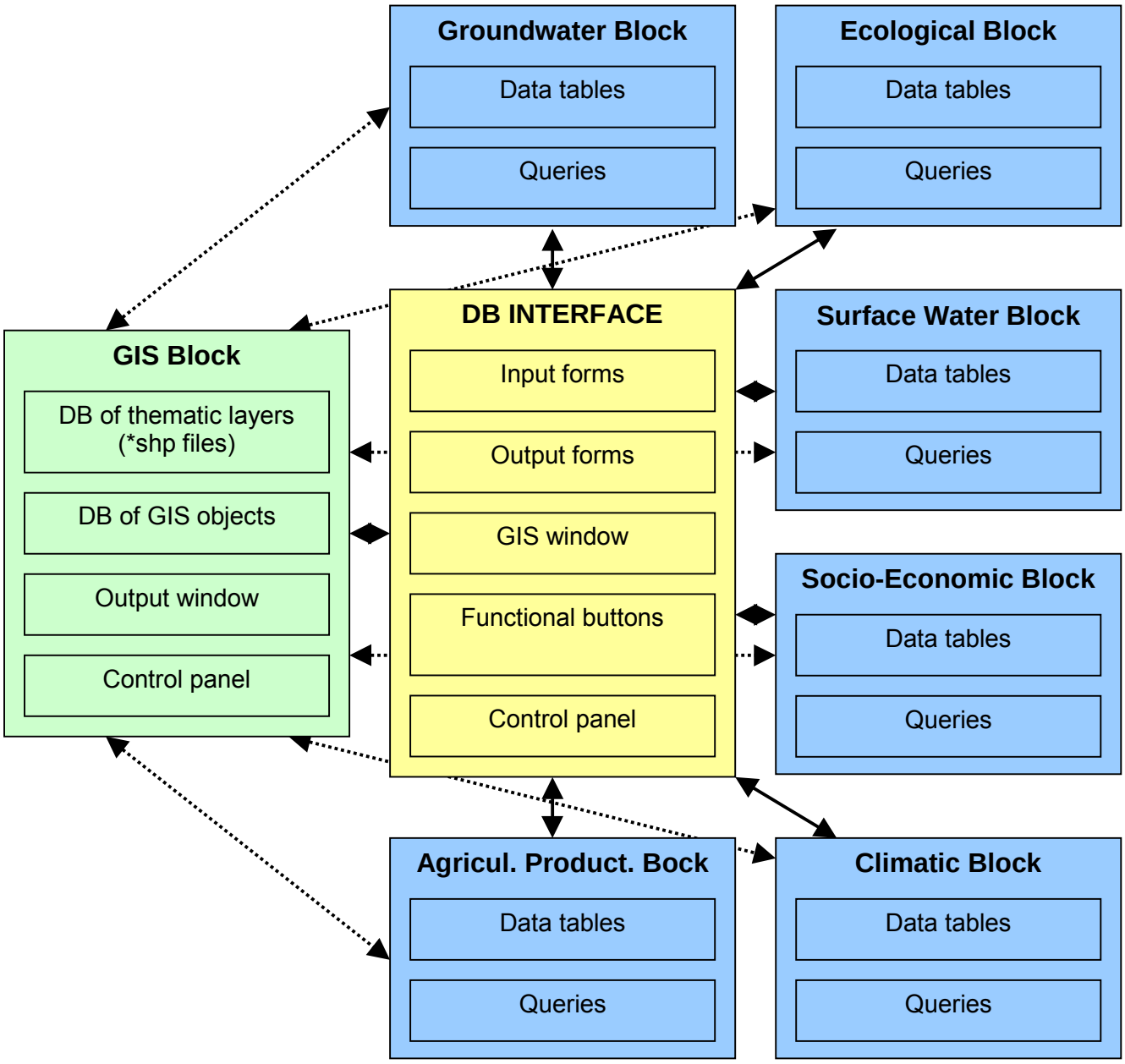

Fig.3.1. Scheme of linkage between the main blocks of interface in system

The development of each block in DB includes standard operations:

- Developing a structure of block (according to requirements of model complex and Project tasks),
- Indexing and coding objects, defining flows, logical and functional links,
- Preparing forms and tables of DB and connecting to the interface,
- Data gathering by information sources or as a result of special studies, their analyses,
- Data processing, populating DB with them,
- Developing modules for processing source information, calculating mid-term and output data with a view to prepare dataware for models, formulating analytical requests and repots.

The database on surface water (surface water block, including hydropower sub-block). The main information sources on surface water resources and their use – data:

- BWO “Syrdarya”,
- Ministry of Agriculture and Water Resources of Uzbekistan and Chirchik-Akhangaran Basin Administration of Irrigation Systems,
- Central Hydromet Service (hydrological bulletins), regional DB (SIC ICWC) and “AralConsult” (information on objects in Kazakhstan).

The contents of basic information:

- technical data on facilities (waterworks facilities, hydro power plants): flow capacity, relationship between water levels and discharges,
- coefficients of efficiency: design and actual, on irrigation systems, main canals, irrigation network within irrigation zones, hydro power plants,
- average ten-day and average monthly data (1980, 1985, 1990, 1995, 1998-2003) on water discharges at alignments of gauging stations, hydro power plants, side inflow, water withdrawal and return water (collector-drainage flow, sewage), amounts of flows, which are transferred between Chirchik and Akhangaran basins, Uzbekistan and Kazakhstan according to the adopted planning units,
- structure of water consumption in absolute and relative values: agriculture (irrigated farming, agricultural water supply, fish-breeding, applying to irrigation zones and fow formation zones), drinking water supply and municipal services, industrial water supply, heat and power engineering (applying to point objects).

Gathered information of regional database (hydrological series up to 1998) is used as well. Based on data of surface water block, the major part of dataware for HM, its hydropower block and surface water block, a part of dataware for the model of irrigation zones - local water resources and flow formation block of the ecological model are formed.

The database on ecology (ecological block) includes indicators for 1980, 1985, 1990, 1995, 1998-2003:

- ecological state of natural landscapes, agro-landscapes and industrial zones,
- characteristics for sources of anthropogenic load of ecosystems in flow formation and use zones,
- indicators of quality of river and groundwater, return flow from collector-drainage network, and sewage from industrial and municipal enterprises, marking out physical-chemical characteristics, water salinity, and main ions, biogenic elements, organic pollutants, heavy metals.

Main information sources:

- Central Office for Hydrometeorology at the Cabinet of Ministers of Uzbekistan (Glavgidromet): recording and controlling over quality of surface water,
- Central Office for Geology and Mineralogy of Uzbekistan: recording and controlling over quality of groundwater,
- State Specialized Inspection for Analytical Control: recording and controlling over industrial wastewater,
- Hydro geologic meliorative expedition at the Ministry of Agriculture and Water Resources of Uzbekistan: recording and controlling over quality of return collector-drainage water,
- Organs of Sanitation and Epidemiologic Service at the Ministry of Health of Uzbekistan: control over quality of water sources for drinking and cultural-domestic purposes,

- Tashkent Province Committee for Nature Conservation,
- State Concern “Uzbekbalyk”.

The following main indicators of water quality were adopted:
- Physical-chemical (pH, T, dissolved oxygen, suspended matters),
- Salinity and main ions
  - Ca^{2+},
  - Mg^{2+},
  - $Na^{+}+ K^{+}$,
  - HCO_3^{-},
  - SO_4^{2-},
  - CL^{-};
- Biogenic elements
  - compounds of nitrogen
  - ammonium
  - nitrites
  - nitrates
  - phosphates
  - organic matters
  - chemical oxygen demand
  - biological oxygen demand
- Heavy metals (chrome, copper, lead, mercury, nickel, zinc) and iron,
- Organic pollutants (phenols, oil products, synthetic surfactants, pesticides).

Based on data of the ecological block, the major part of dataware for the ecological model, including flow formation block, is formed.

“Groundwater ” Database (groundwater block) includes the following basic information:
- network of groundwater sources, applying to groundwater consumers: irrigated zones, points of water supply and industrial water use objects, with characteristics on flow capacity, applying to surface water resources,
- retrospective data on groundwater availability (supplies, their dynamics) and use (water amount, quality, water supply regime) per network of sources and consumers of groundwater.

“Agricultural Production” Database (agricultural production block) includes the following main information:
- areas under crops with marking out irrigated, non-irrigated lands, small holdings, per crop, with indication of dates for sowing, harvesting, crop capacity, gross yields, with breakdown to components of industrial crops, grain crops,
- data on the state of livestock breeding: livestock heads and produce,
- data on agro-economics,
- data on soil characteristics.

Basic information sources:
- Ministry of Agriculture and Water Resources of Uzbekistan and Chirchik-Akhangaran Basin Administration of Irrigation Systems,
- State Committee on Land of Uzbekistan,
- Regional CAREWIB DB (SIC ICWC).

Preliminary data structure:

- Total area: area under crops; forests; roads, canals, buildings; settlements and towns; area of protected strips of rivers and water bodies; spacing of irrigated lands; gross and net irrigated area; rain-fed lands.
- Irrigated lands: lands resources (arable lands, multi-year plants, fallow lands, hay-fields, pastures, agricultural lands on small holdings, other lands); agricultural production on irrigated lands (areas under crops, crop productivity, gross yields); specific water consumption; distribution of irrigated lands by groundwater levels; distribution of irrigated lands by groundwater salinity; distribution of irrigated lands by soil salinity; distribution of irrigated lands by sol fertility class; area provided with drainage; drainage module.
- Rain-fed lands: agricultural production on rain-fed lands (areas under crops, crop productivity, gross yields).
- Sowing time of crops grown on irrigated and rain-fed lands.
- Vegetation period of crops grown on irrigated and rain-fed lands.
- Forms of economic activities on irrigated and rain-fed lands: average area attached to farms.
- Livestock breeding: livestock heads (cattle, sheep and goats, poultry); produce of livestock breeding (meat in live weight, meat in dead weight, milk, eggs).
- Costs to produce crops per item: total; machinery; labor resources; seeds; fertilizers; fuels and lubricants; miscellaneous; administrative; amortization.

Based on data of the block, a part of dataware for the irrigation zone model is formed.

"Socio-Economic" Database (socio-economic block and its energy sub-block) includes:
- data on water consumption volume and norms (water supply, disposal) for objects of municipal services, industry and heat-and-power engineering, designated in the models as point objects, applying to the structure of the HM and surface water block of DB,
- socio-economic parameters per district, linked with irrigation zones.

Preliminary data structure:
- Demography: population (by the end of year), urban, birth rate, death rate, life expectancy, internal population migration, external population migration, family structure.
- Economy: GDP, sectoral structure of GDP, export percentage in GDP, import percentage in GDP,
- Production volume: crop production, livestock breeding, fish-breeding, poultry farming, silkworm breeding, secondary production,
- Prices for agricultural products (purchasing, market): crop production, livestock breeding, fish-breeding, poultry farming, silkworm breeding, secondary production,
- Costs per unit of output,
- Power engineering: cost, cost of 1 ton of coal, cost of 1 m^3 of gas, electric power consumption (agriculture), electric power consumption (industry), electric power output - hydro power plants, heat power plants; required water supply for heat power plants, return, norm of water supply per unit of produced electric power,
- Employment: (average annual) labor resources, economically active population, employed in economy, structure of employed population per economic sector,
- Investments: amount of investments, foreign investments, private investments, sectoral structure of investments, required investments in agriculture, real investments in agriculture, assignments to water service,
- Living standards: population income, income per capita, GDP per capita (real and by purchasing-power parity), population expenditures,

- Industry: output volume, industrial production growth rate, structure of industrial production, per separate object as water consumer (according to adopted planning units): required water supply, return, cycle; norms of water use for production of a unit,
- Municipal services: per separate object as water consumer (according to adopted planning units): required water supply, disposal, norms of supply per person,
- Fish industry: average cost of fish, requirements to water resources, per separate object (ponds): required water consumption,
- Food: food consumption in accordance with basket, medical norms of food consumption,
- Recreation and tourism: number of boarding houses and rest zones, number of people visiting rest zones, average cost of 1 day, requirements to water and natural resources.

Based on data of the blocks, a part of dataware for the socio-economic model and energy block of the socio-economic model is formed.

Database on climate (climatic block). Basic information is presented on parameters: temperature, precipitation, evaporation, relative humidity, prepared per climatic zone, applying to weather stations, irrigation zones, reclamation zones, flow formation zones, reservoirs. Based on data of the blocks, a part of dataware for the surface water block of the HM, irrigation zone model and socio-economic model is formed.

Out of information from the Chirchik-Akhangaran Basin Administration of Irrigation Systems, the following data (preliminary list) are used for populating DB blocks and modeling:

- data on water discharges over river gauging stations, per ten-day period;
- data on planned (limits) and actual discharges to canals, per ten-day period;
- data on groundwater use, with indication of source and water consumer: water supply, irrigated farming and others, applying to districts or separate towns, industrial centers,
- data on side inflow to rivers and canals: inflow from creeks, inflow from canals, collector-drainage sewage, municipal and industrial sewage,
- data on discharges transferred between Chirchik and Akhangaran sub-basins, per ten-day period,
- data on inflow, outflow and volume of water in reservoirs, per ten-day period,
- data on required discharges passed through hydro power plants,
- data ob water consumption structure: irrigated farming, agricultural water supply, fish industry and others, applying to irrigation systems, districts, main canals,
- data on water withdrawal (water discharges) from surface sources for non-agricultural sectors: towns, industrial systems, heat-and-power engineering,
- data on groundwater use, with indication of source and water consumer: water supply, irrigated farming and others, applying to districts or separate towns, industrial centers,
- data on salinity of river, irrigation water and wastewater, per ten-day period,
- data on land resources and reclamation condition of lands: geographic area, arable lands, irrigated lands, non-irrigated lands, cultivated lands (crop pattern), personal plots, drained lands, level and salinity of groundwater, drainage module, per district and irrigation system, for the last 5 years,

- data on forms of economic activities: structure and number of water users (shirkat farms, private farms, dekhkan farms), applying to districts and irrigation systems, their characteristics (area of lands, required water consumption),
- ecological indicators of surface water and groundwater quality (hydrochemistry, biological parameters),
- efficiency: main canals, irrigation systems (average per system),
- data on hydraulic structures: assemblies of control over water allocation: flow capacity, relationship between water level and discharges,
- economic indicators: volumes of production (livestock heads, agricultural products, fish catch), crop yields, prices (tariffs) for agricultural products, water supply, irrigation system maintenance costs, production costs, annual costs of water organizations, water productivity (irrigation water, industrial water, drinking water),
- Linear circuits and maps with covers: digital surface map, administrative districts, settlements, roads, industrial centers, hydro power plants, heat power plants, reservoirs, water network (river, irrigation, escape, with marking out irrigation systems), irrigated lands, non-irrigated lands, soil cover and vegetation, rain-fed lands, pastures, groundwater sources (water withdrawal), water protection zones, recreation zones.

Out of information available at BWO “Syrdarya”, the following information on objects controlled by the BWO for the years 1998-2004 is used to populate the DB:

- data on actual head water intakes and limits, per ten-day period, for 3-4 years typical by water availability;
- data on water discharges over river gauging stations, per ten-day period, for years typical by water availability;
- data on side inflow for years typical by water availability;
- inflow, outflow and volume of water in reservoirs, selectively for the last 6 years;
- selected data from available findings on river water salinity.

4. The key parameters of information provision

1. Hydrological and water-management information, energy sector

- River runoff and its salinity,
- Discharge from canals into rivers and idle discharge,
- Discharge into rivers and reservoirs from collectors (from irrigated land, with reference to PZ and irrigation systems), household and domestic waste discharge (cities, villages), industrial wastes, salinity of waste discharges,
- Transfer flow at PZ boundaries – main canals and collectors (points of water transfer),
- Withdrawals from rivers and reservoirs,
- Reservoir operation regimes – water level, water volume and salinity at the beginning and the end of month, inflow, withdrawal and releases from reservoirs,
- Groundwater – usable groundwater resources, groundwater inflow and outflow, discharge, filtration losses in rivers and reservoirs, abstraction from groundwater sources per user,
- Water distribution:
  - Uzbekistan – total, including from: Chirchik, Akhangaran, small rivers (Ugam, Aktash, Aksakata),
  - Kyrgyzstan (Chatkal River),

- Kazakhstan (VDK, etc.),
- Uzbekistan's irrigation systems (Tashkent main canal, "Bozsu" system, "Parkent-Karasu" system, "Akhangaran-Dalverzin" system) – irrigated farming, agricultural water supply, fishery,
- Urban and industrial centers (Tashkent, Chirchik, Yangiyul, Almalyk, Angren) – household-drinking needs, industry (Chirchik chemical plant, Almalyk industrial system, Angren coal open-pit mine),
- Internal use (with reference to irrigation systems): groundwater, CDW.

- HEPS parameters: gross and net storage volume of reservoirs, highest controlled water surface, maximum water surface, water head in HEPS under the highest controlled water surface and dead-storage level, HEPS capacity, installed power.
- Limitations:
  - Recreation demand – minimum level of Charvak reservoir drawdown (summer, winter),
  - Limitations for Charvak reservoir regarding seismicity – filling below the set level,
  - Limitations for Charvak reservoir regarding non-admission of dust storms – drawing off not below the set level,
  - Environmental demand for runoff: minimum flow along Chirchik river downstream of Charvak reservoir.
- Heat-power engineering – operation parameters and requirements of State rayon power stations.

2. Land resources and their use

- Land fund (arable land, perennial plants, fallow land, hayfields, pastures, agricultural land, other lands),
- Irrigated areas – total, including sources: river intake (transboundary flow, main rivers), sai, springs, wells, collector-drainage water (CDW),
- Area under drainage, drainage modulus,
- Distribution of areas per soil salinity, groundwater level and salinity, index of soil quality,
- Cropped area, including non-irrigated, cropping patterns and crop yields,
- Agricultural production in irrigated and dry lands (seeding dates, cultivation dates, gross harvest).

3. Ecology

- Water quality:
  - Physical and chemical characteristics,
  - Salinity and main ions,
  - Biogenic elements,
  - Organic matter,
  - Heavy metals.

- Parameters of ecological hydroecosystem assessment,
- Parameters of ecological landscape (natural, agricultural) assessment,
- Parameters of anthropogenic load on ecosystems and evaluation of load consequences (irrigated agriculture, livestock, fishery, industrial and municipal enterprises, etc.).

4. Socio-economic parameters

- Operational costs and net cost:
  - Costs of crop production per variety: total; machinery; labor costs; seeds; fertilizer; fuel; other; administration; depreciation charges,
- Water and agricultural output prices
  - Purchasing and market prices of agricultural output,
- Productivity:
  - Irrigation water per irrigation system,
  - Industrial water use (per plant),
  - Household and drinking water use,
- Demographic and macro-economic indicators
  - Population trends, including urban, working population, occupied in economy and agriculture,
  - Industrial production volume,
  - Agricultural production volume,
  - Investments,
  - GDP, industrial and agricultural shares,
  - Population income,
- Water use norms – for crops, household and drinking water supply,
- Production volumes:
  - agriculture,
  - fishery,
  - livestock,
  - output of livestock farming,
  - allied industries,
  - power sector, including hydropower,
  - industry,
- Recreation and tourism

5. Climate data
- Temperature, precipitation, evaporation, relative humidity (per weather station).

4. Appendix

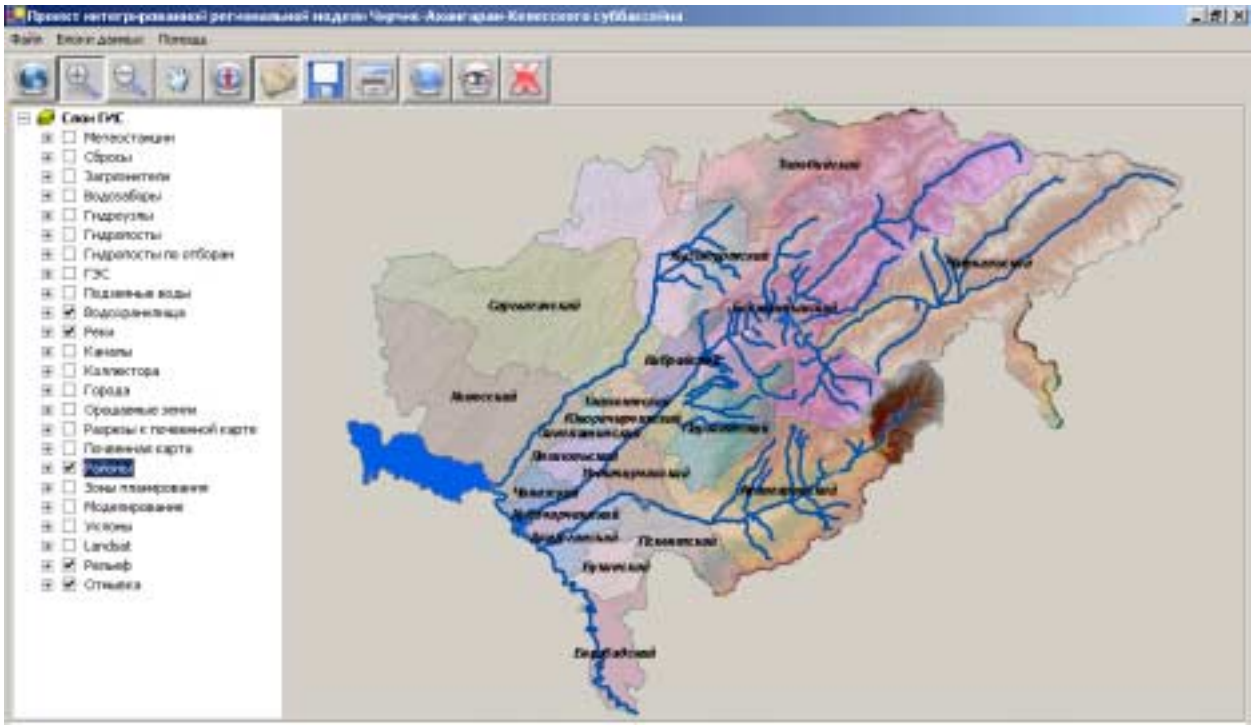

Fig. 4.1. Main form window of RIVERTWIN DB's interface, with active GIS layers – river network (rivers, canals, reservoirs), division into rayons

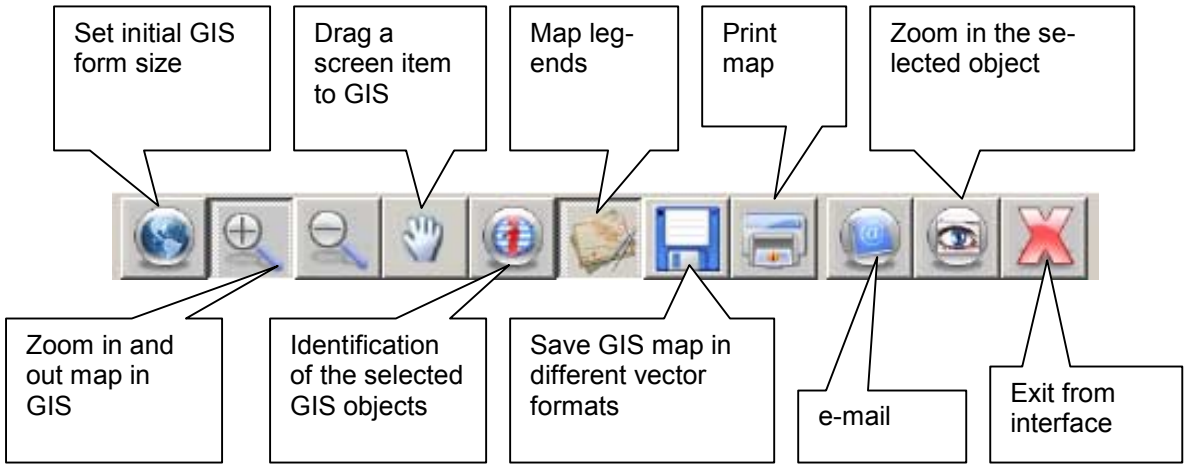

Fig. 4.2. Control panel buttons

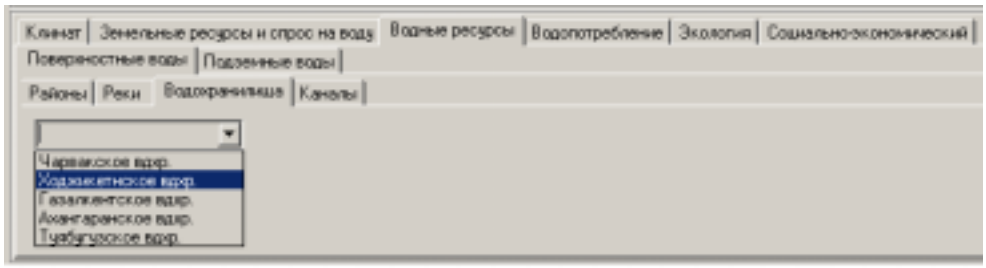

Fig. 4.3. Object control panel

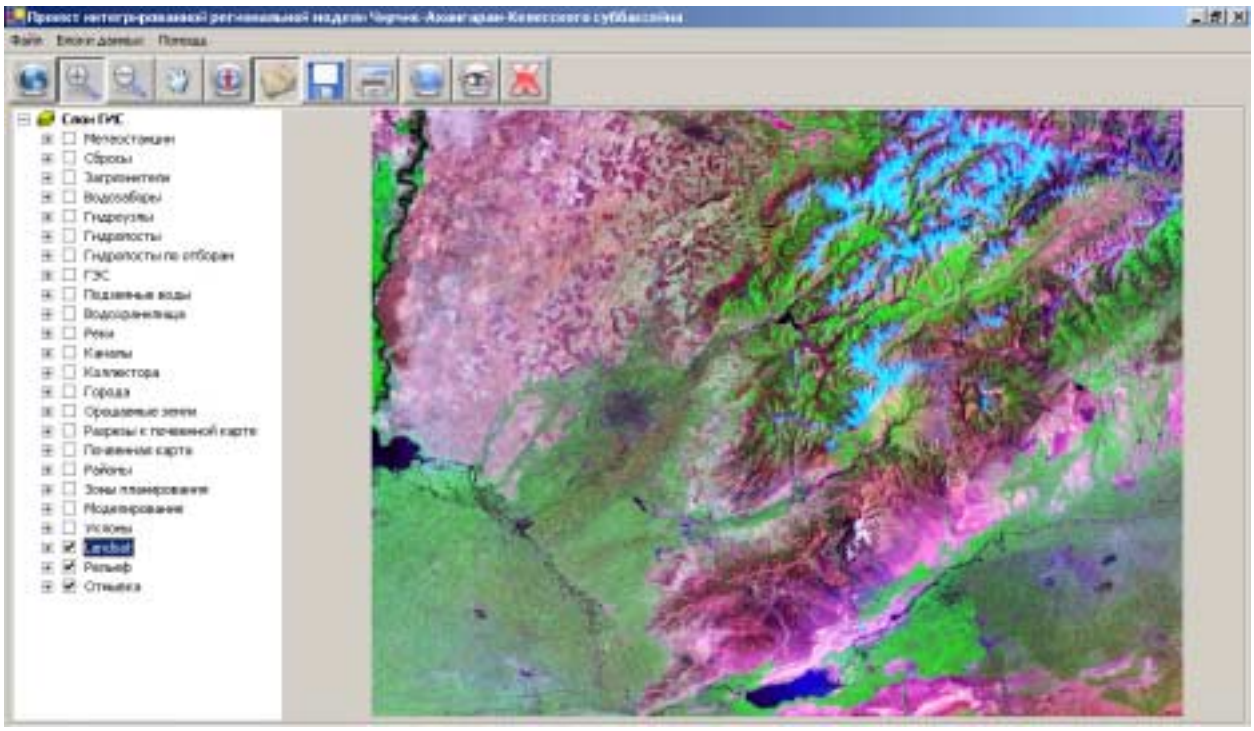

Fig. 4.4. Activation of Landsat image in GIS form window

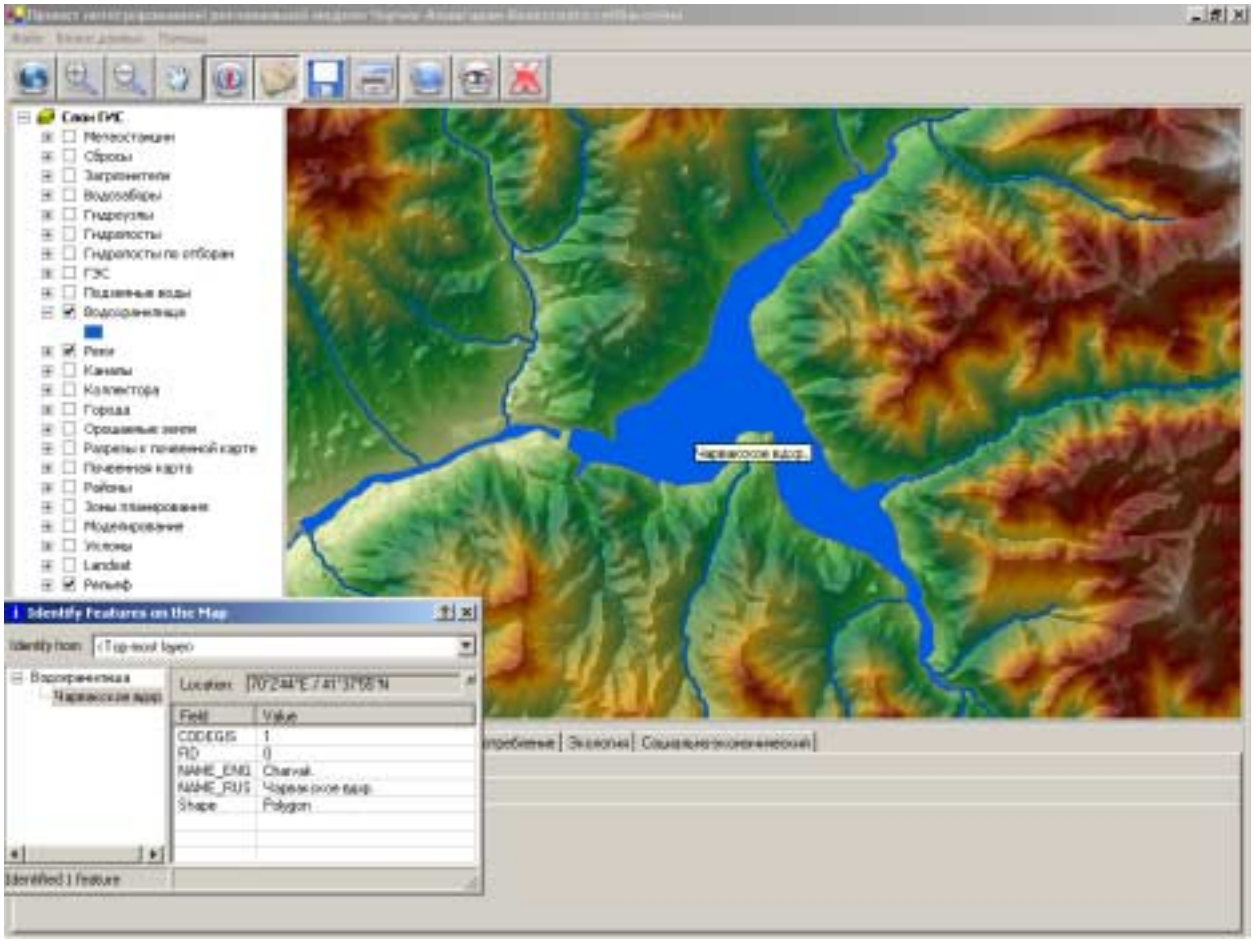

Fig. 4.5. Zooming in the selected object, with maximum GIS window size, brief information about the object

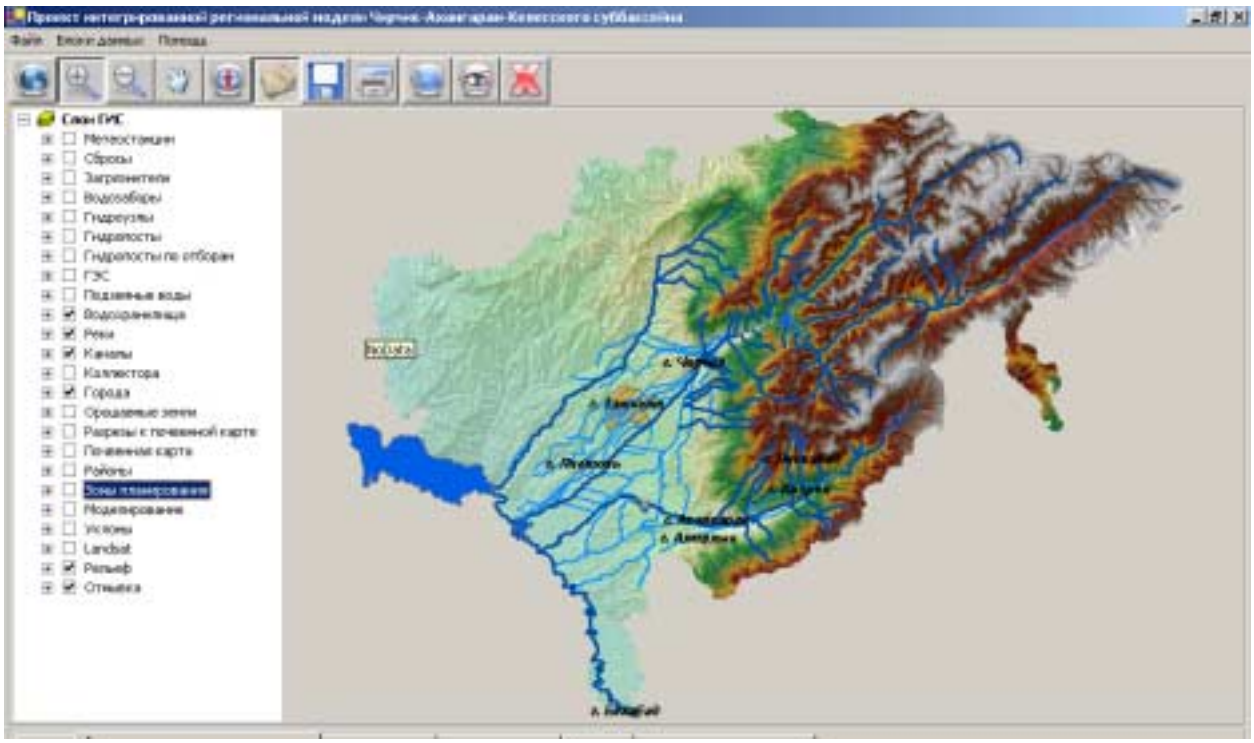

Fig. 4.6. Activation of GIS layers – river network, settlements

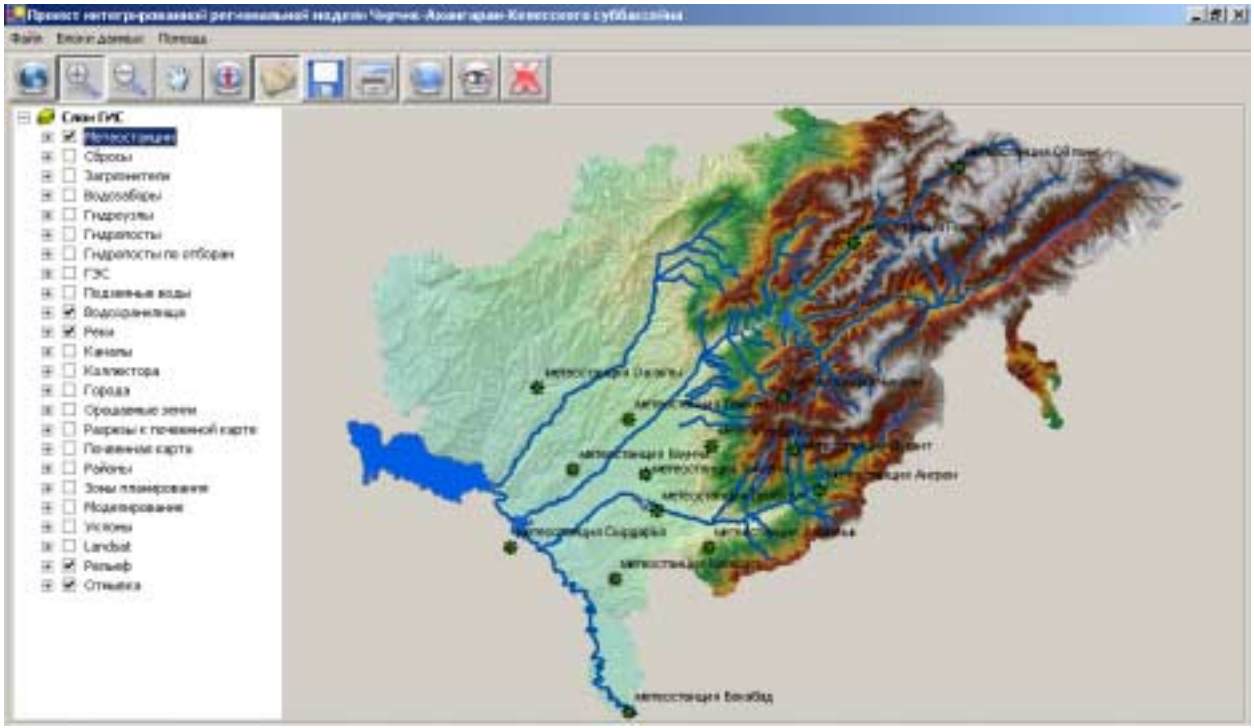

Fig. 4.7. Activation of GIS layers – river network, weather stations

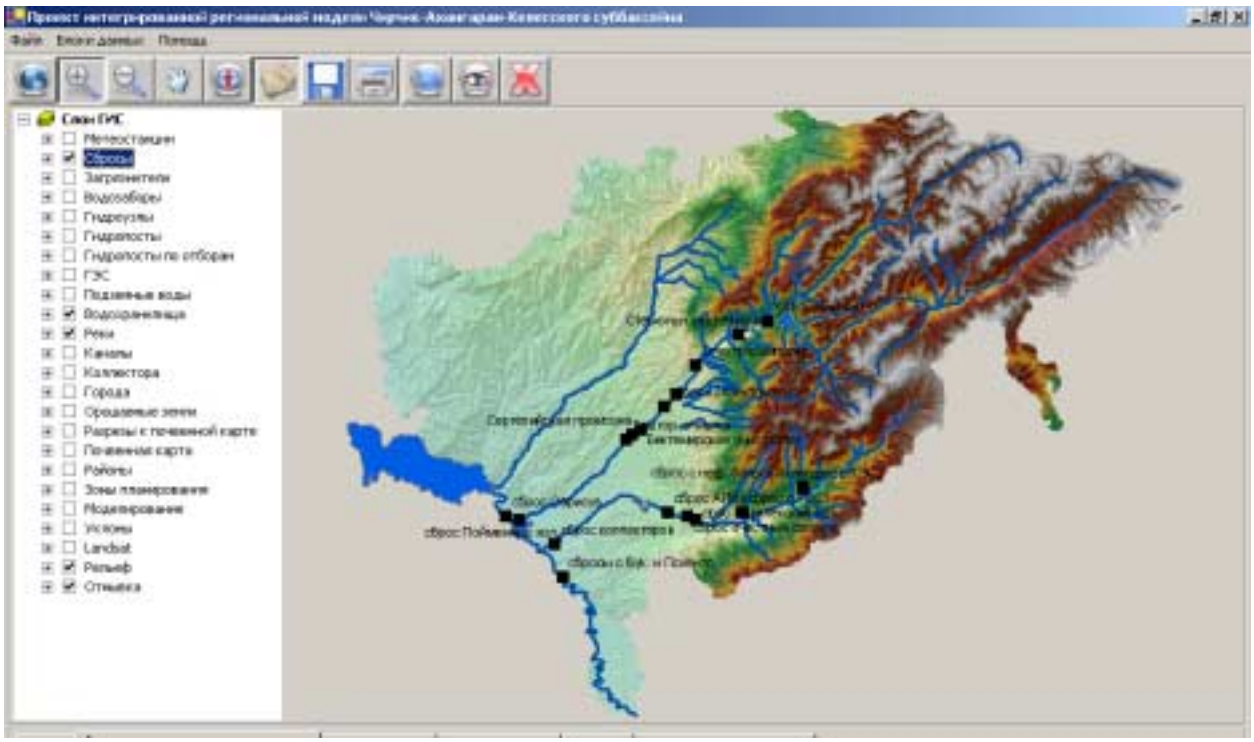

Fig. 4.8. Activation of GIS layers – river network, discharge points

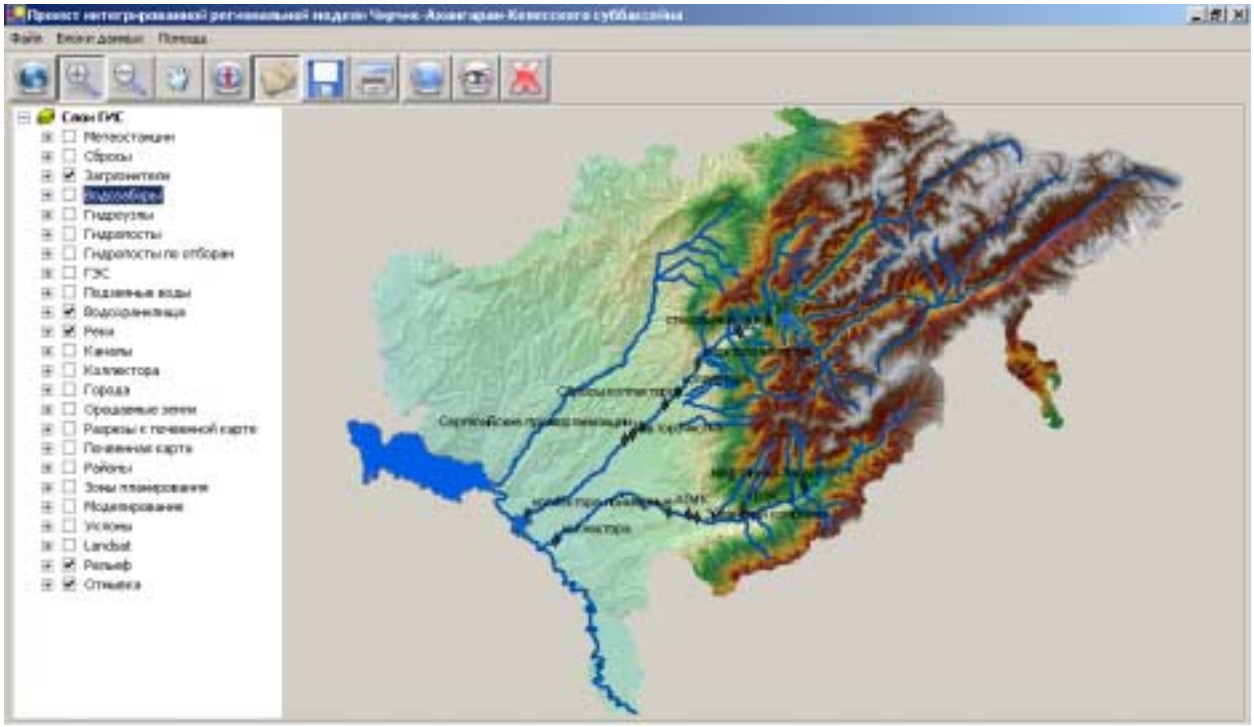

Fig. 4.9. Activation of GIS layers – river network, pollutants

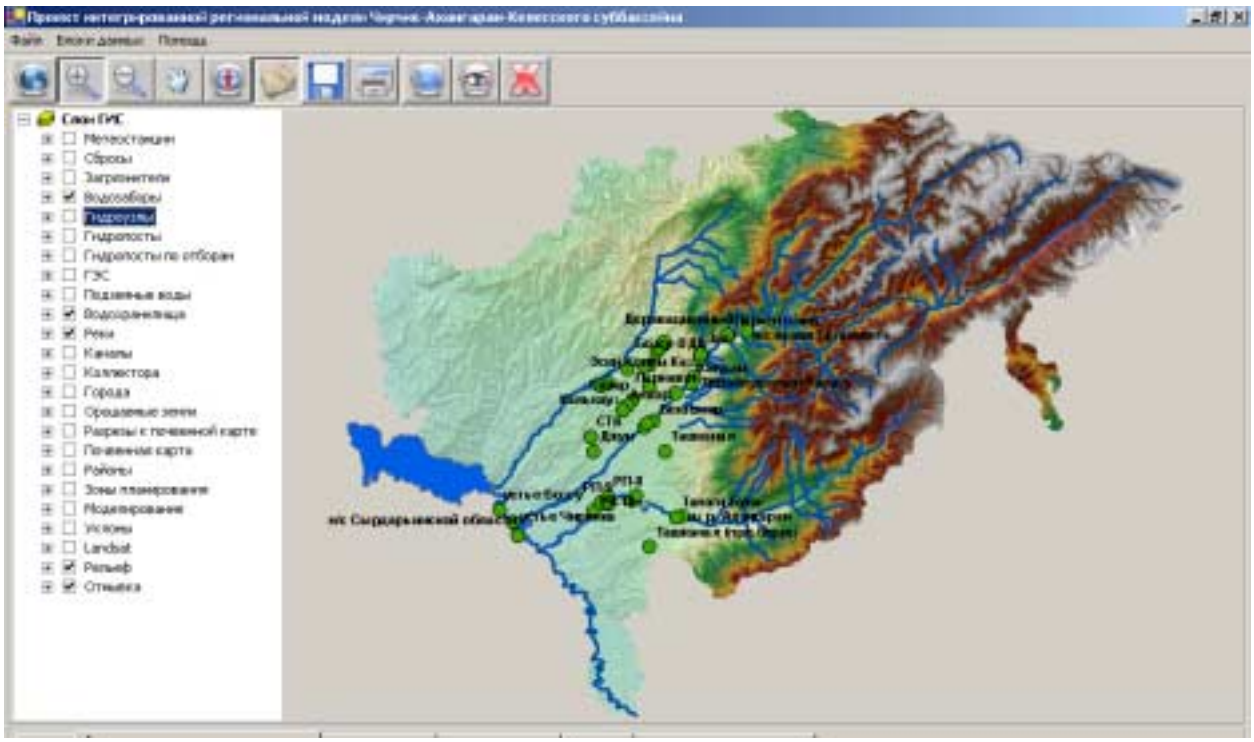

Fig. 4.10. Activation of GIS layers – river network, water intake points

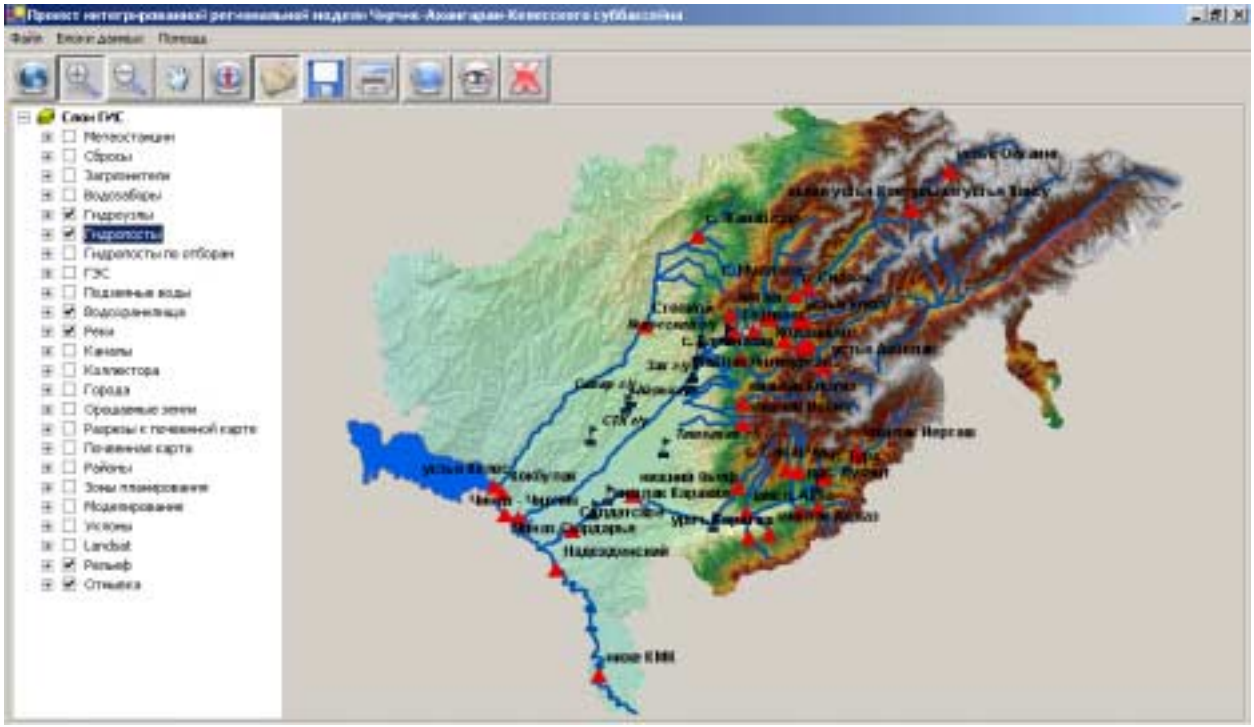

Fig. 4.11. Activation of GIS layers – river network, waterworks facilities, gauging stations

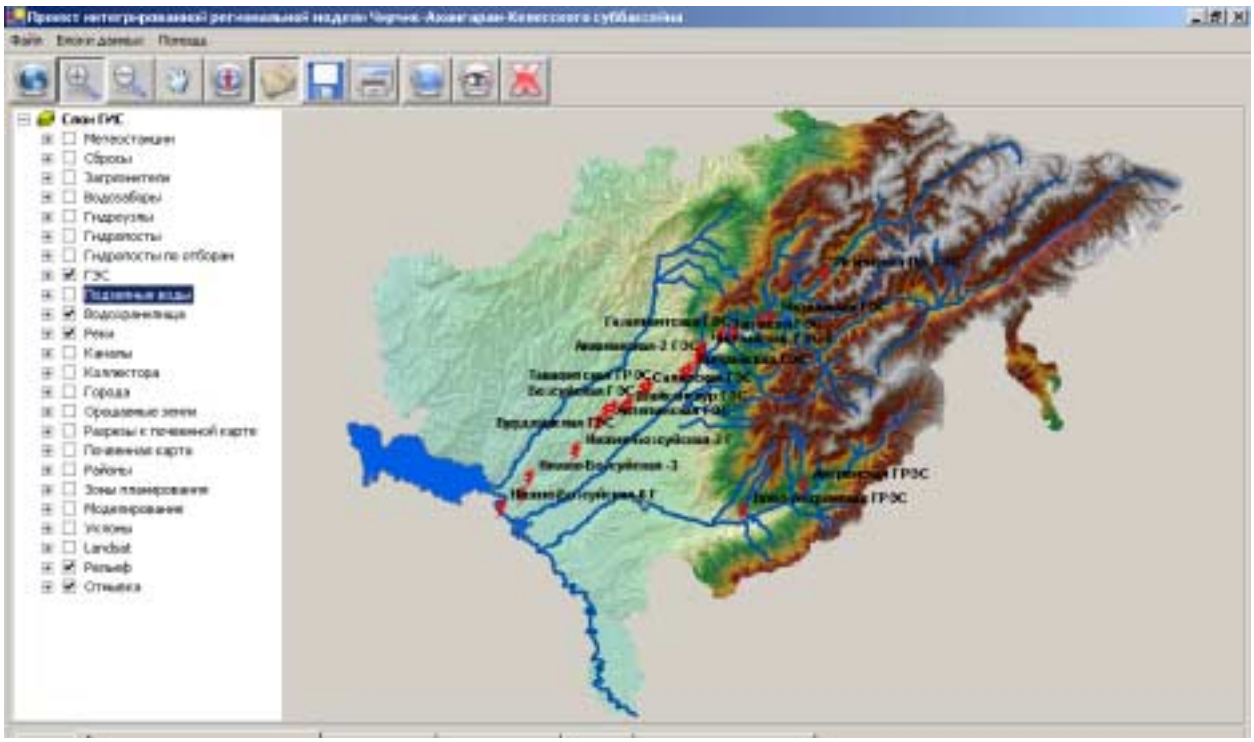

Fig. 4.12. Activation of GIS layers – river network, HEPS

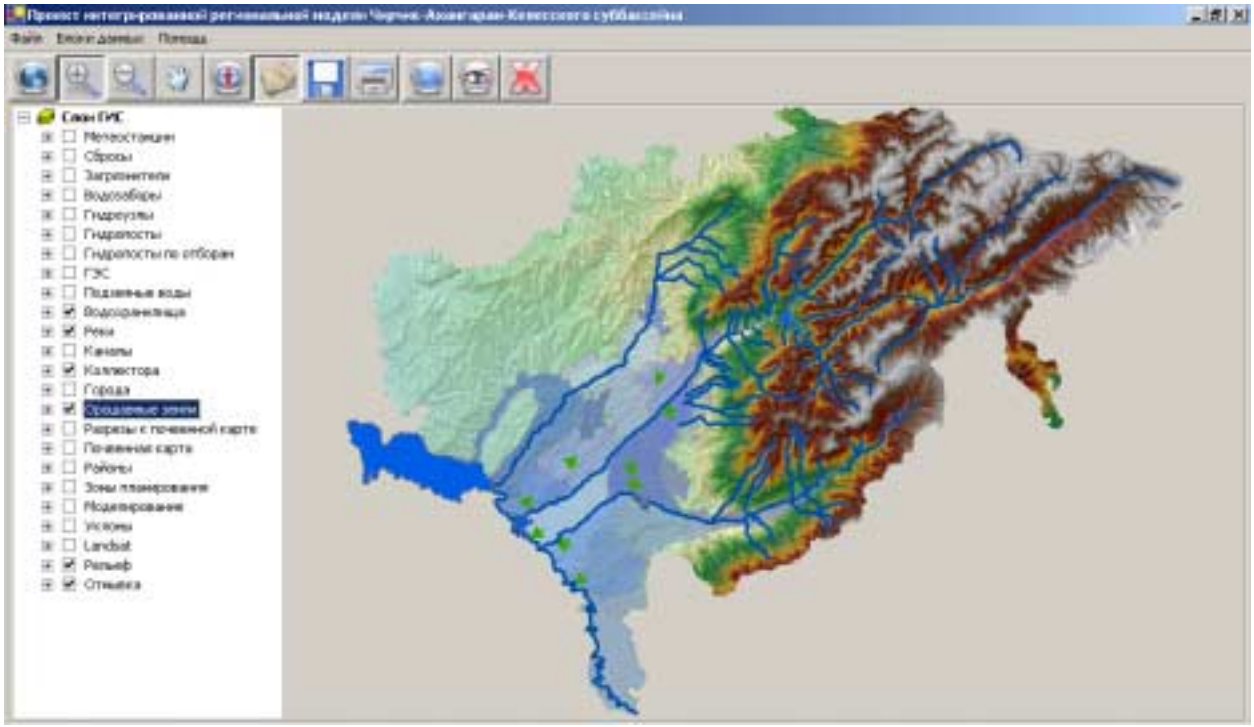

Fig. 4.13. Activation of GIS layers – river network, irrigated lands

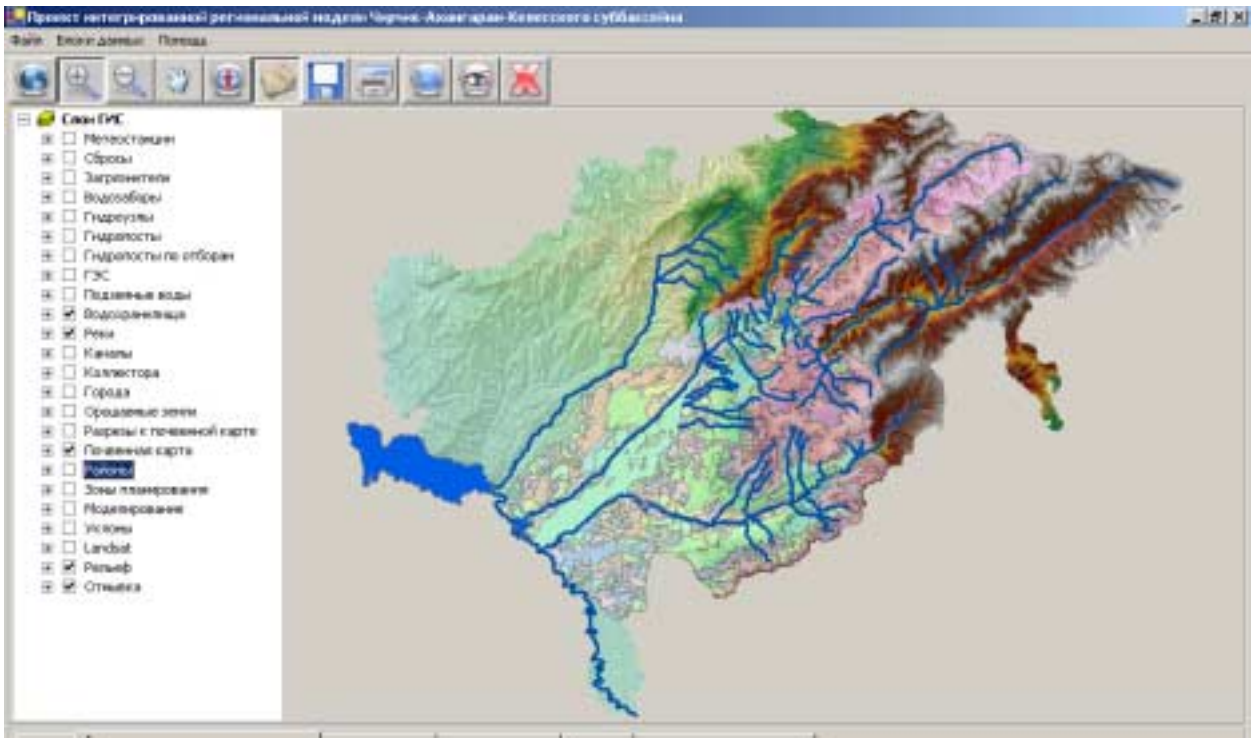

Fig. 4.14. Activation of GIS layers – river network, soil map

Fig. 4.15. Menu – climate.

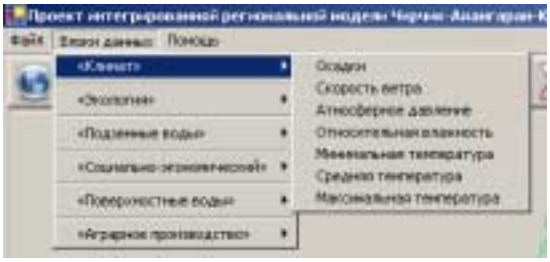

Fig. 4.16. Menu – Ecology.

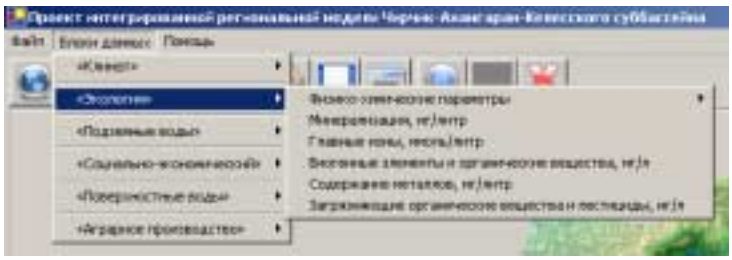

Fig. 4.17. Menu – Ecology, physical and chemical parameters.

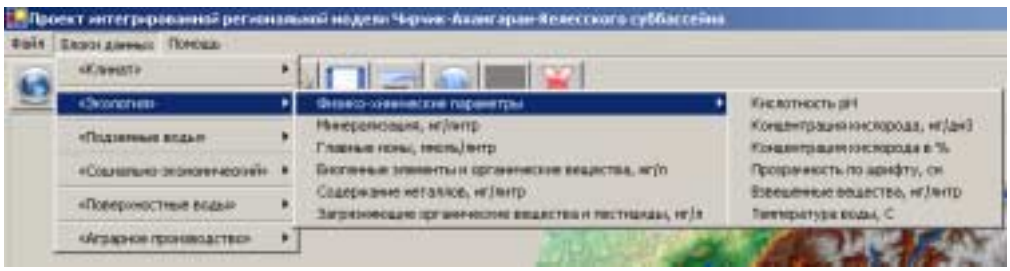

Fig. 4.18. Menu – groundwater, water use.

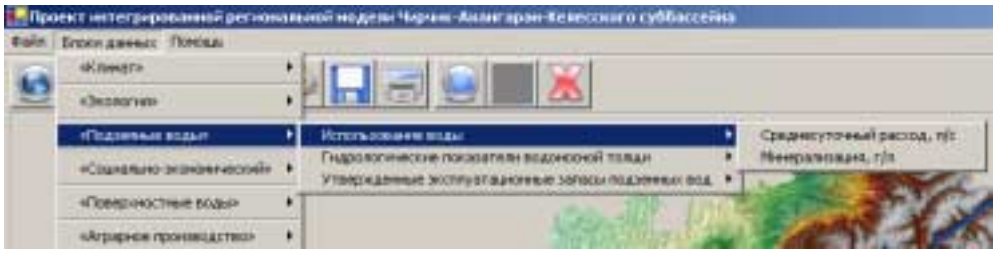

Fig. 4.19. Menu – groundwater, hydrological parameters of aquifer.

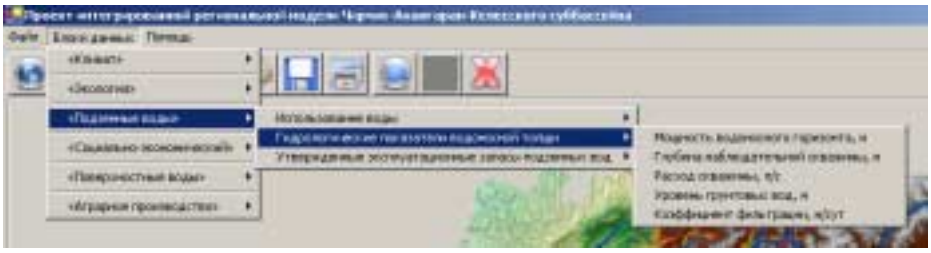

Fig. 4.20. Menu – groundwater, fixed usable groundwater resources.

Fig. 4.21. Menu – socio-economic.

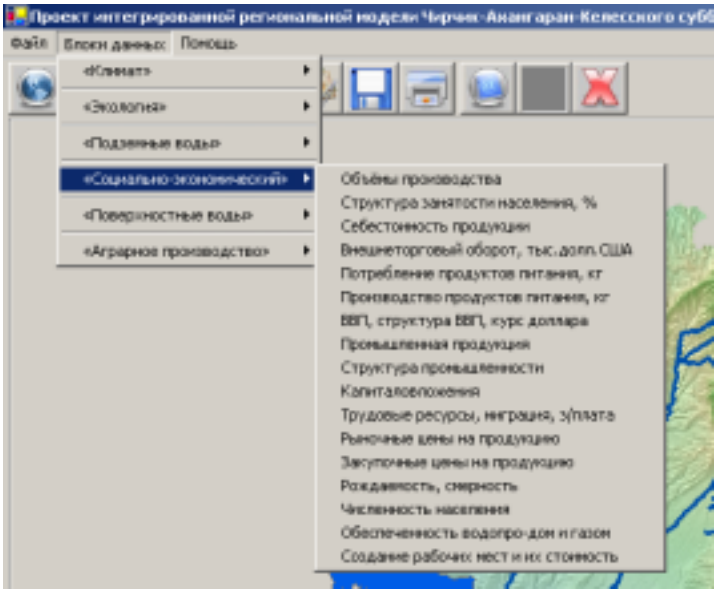

Fig. 4.22. Menu – surface water, water consumption.

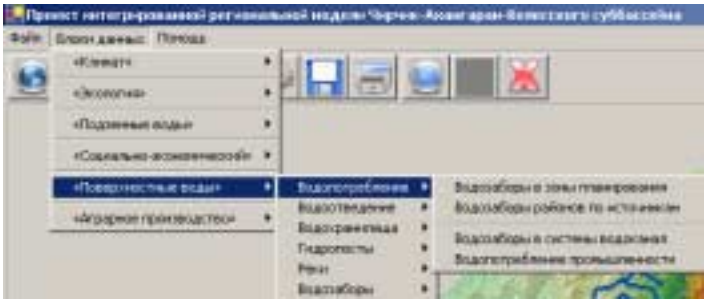

Fig. 4.23. Menu – surface water, water disposal.

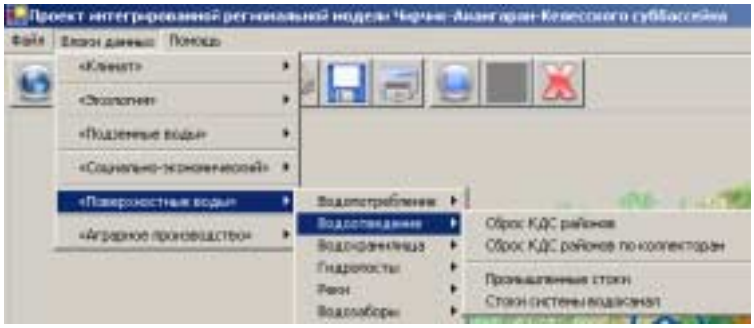

Fig. 4.24. Menu – surface water, reservoirs.

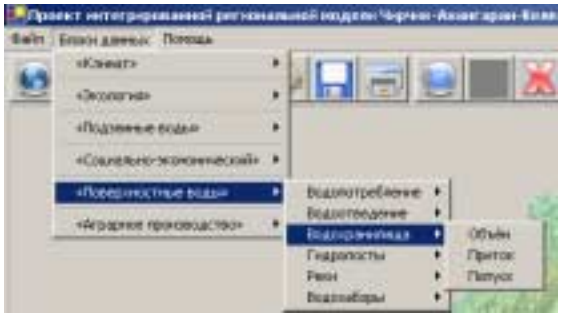

Fig. 4.25. Menu – surface water, gauging stations.

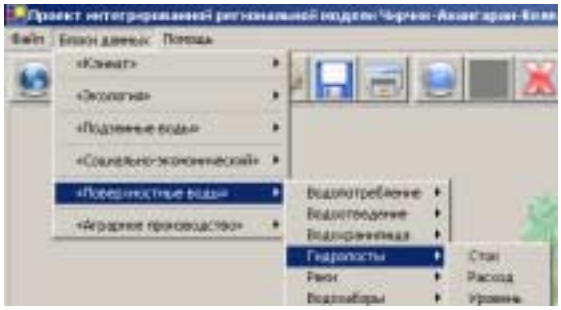

Fig. 4.26. Menu – surface water, rivers.

Fig. 4.27. Menu – surface water, water intake points.

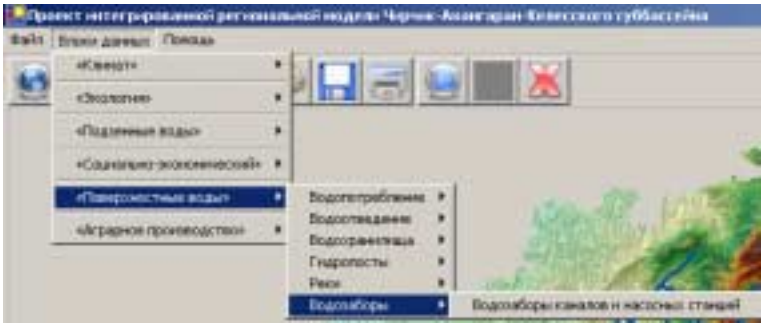

Fig. 4.28. Menu – agricultural production, land resources.

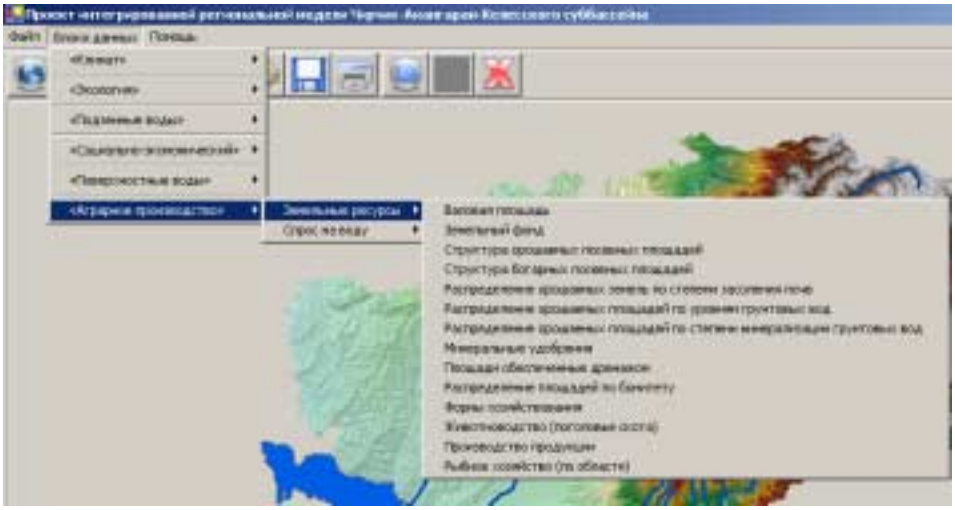

Fig. 4.29. Menu – agricultural production, water demand.

Fig. 4.30. Menu – agricultural production, water demand, reference information.