N.K. VAKHONIN

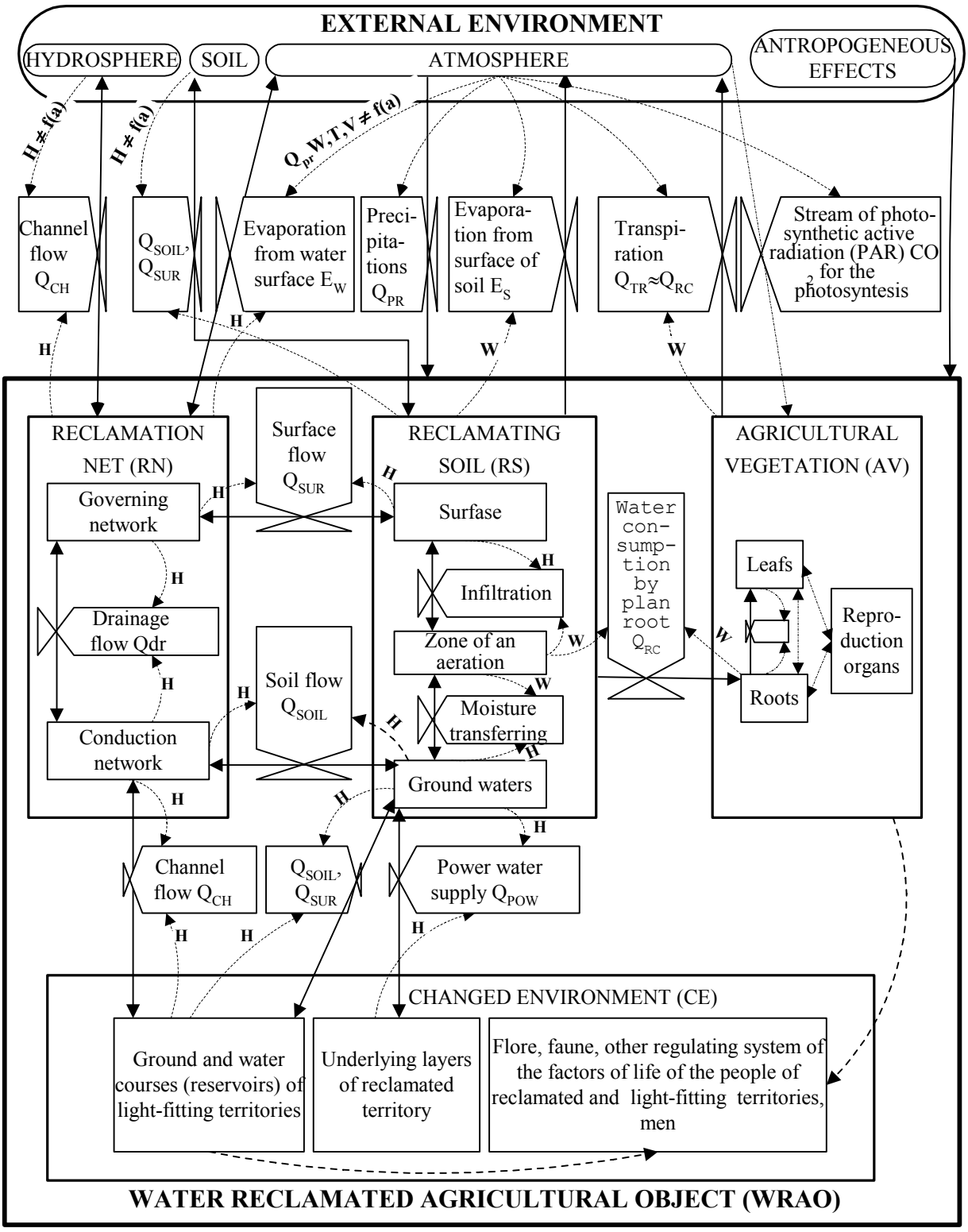
BELARUS, INSTITUT OF HYDRORECLAMATION

OF NATONAL ACADEMY OF SCIENCE.

INFLUENCE OF AGRICULTURAL RECLAMATION OF WETLANDS ON RIVERS AND ITS CATCHMENT.

Rivers in Republic Belarus are pertain to basin of two seas: Black and Baltic. In Belarus most deep influence on river catchments exert realized hydroreclamation. Its undertaking was caused by need of the increase to productivities of the agriculturalplants for the reason improvements of the ensuring the population product feeding. Need for realization undertaking the land reclamations was caused that Belarus is found in humid zone with the result that in natural condition marsh and weat land formed beside 8 mln.ha. In this connection the main type of the land reclamations in Republic Belarus is drainage by open network of channels and drainage with additional devices for moistening at shallow periods. As a result of land reclamations, riverbed networks thickness on catchment increased from 2-5 m/ha to 40-50 m/ha, riverbeds are deepened and straightened, the type of lands from marshes and weat lands changes to agricultural fields. Herewith in separate low-lying region of the Republic, in particular, on Polesie, percentage of reclamated river catchments area reaches 50% and more. At present from the 20 mln.ha of general area of Belarus, 9 mln.ha are used as agricultural land, from which 3 mln.ha reclamated (15% whole territory). Thereby land reclamation in Belarus is a greatest spatial influence on rivers watersheds. As a result of changes, caused by catchment reclamation,together with the increasing of the agricultural plants productivity and accordingly improvement of the economy of agro-enterprises in connection with presence of complex transitive intercoupling chains between water dynamic processes in different subsystems (Fig.1) hydrological mode changes as well as other connected with it modes on watershed.

For study ecological-economical consequence of the influence to land reclamations on rivers and their catchments permanent establishment was organized in Polesie by Byelorusian Institute of the land reclamation, on which during thirty years is realized synchronous monitoring beside 100 different factors of: water mode (the discharge and water level in rivers and channels on 5 waterplots; the precipitation, level of ground water and pressure horizons on120 bore holes, soil moisture, evaporation, infiltration on 90 vaporizers etc. on catchment); temperature mode of air



- systems (subsystems) - capacities characterized by a level;

- decision functions; - external environment (hypersystem "nature");

- material streams (water and also transfering by it heat, nutritious units, chemical units etc.);

- streams of PAR, CO_2, assimilatings of plants; - streams of the information;

H(W) - variables such as level (level of water (humidity)) in an appropriate subsystem; Q - variables such as stream; W_{AIR}, T, V - humidity, temperature of an air, speed of a wind; a - alternatives (variants of a structure, changing parameters, managements) in WRAO.

Fig.1. The scheme (Forester's diagram symbols)of water dynamics processings interaction on reclamated for agricultural using river basin.

and soil,other agrometeorologic features, agricultural productivities and other features on 4 agro-waterbalance plots; chemical contamination of riverbed and soil water on two compared catchments on the total area 50 ths.ha. One of the catchments: r. Yaselda (the basin Black sea) reclamated and is in agricultural use. Another located beside catchment r. Narev (the basin of Baltic sea) is found in natural conditions - a marshes and wood National park "Belovezhskaya Pushcha".

For keeping monitoring data, the realization of the comparative analysis quantitative and qualitative factors of the condition of the rivers and its catchments, forecast of their change and taking the optimum decisions on integrated management of lands and water resource on catchment, is designed automated information system.

For sufficing to the requirement of effectiveness (exceeding of the incomes from exacter acceptance of solutions on its basis above costs on it realization), the hydrological monitoring should answer the requirement of universality: to be information security for the maximum large number of soluble problems: estimations,forecasting, to taken decisions optimization for designing the creation, reconstruction and usage of different systems on watershed (hydromelioration, fish facilities, water transport etc.) with necessity of coordination their often inconsistent interests, at decision of problems on different hierarchical level of generality (interstate, interbranch, in limits of branch, for a catchment, for separate object). From above-stated follows, that the data of hydrological monitoring are necessary for usage on a fuzzy set of the tasks (models) of a various type, each of which has its own requirements to a data structure. Task's shaping of a data structure in these conditions is completely unproductive, as reduces in necessity of a multiple gang of the same data calculated in hundreds of thousands and millions of figures, but with various modification of their structure necessary for each concrete model. For the data storage of the invariantly rather soluble tasks with realization of their single entering and with the following possibility of the shaping concrete subset of necessary structure required for different solved problems the information system is designed (Fig.2).

In an association from characteristic time of proceeding all indexes used at decision making are divided on processes: unguided entering actions $\xi(t)$, controls $U(t)$, variable of condition $Z(t)$, output actions $y(t)$ and supposed constant, but actually also evolutive, onlu with large characteristic from time to time courses system parameters governed P and not governed N. For example, for hydroreclamative systems it: $\xi(t)$ - meteorological factors and hydrological regime

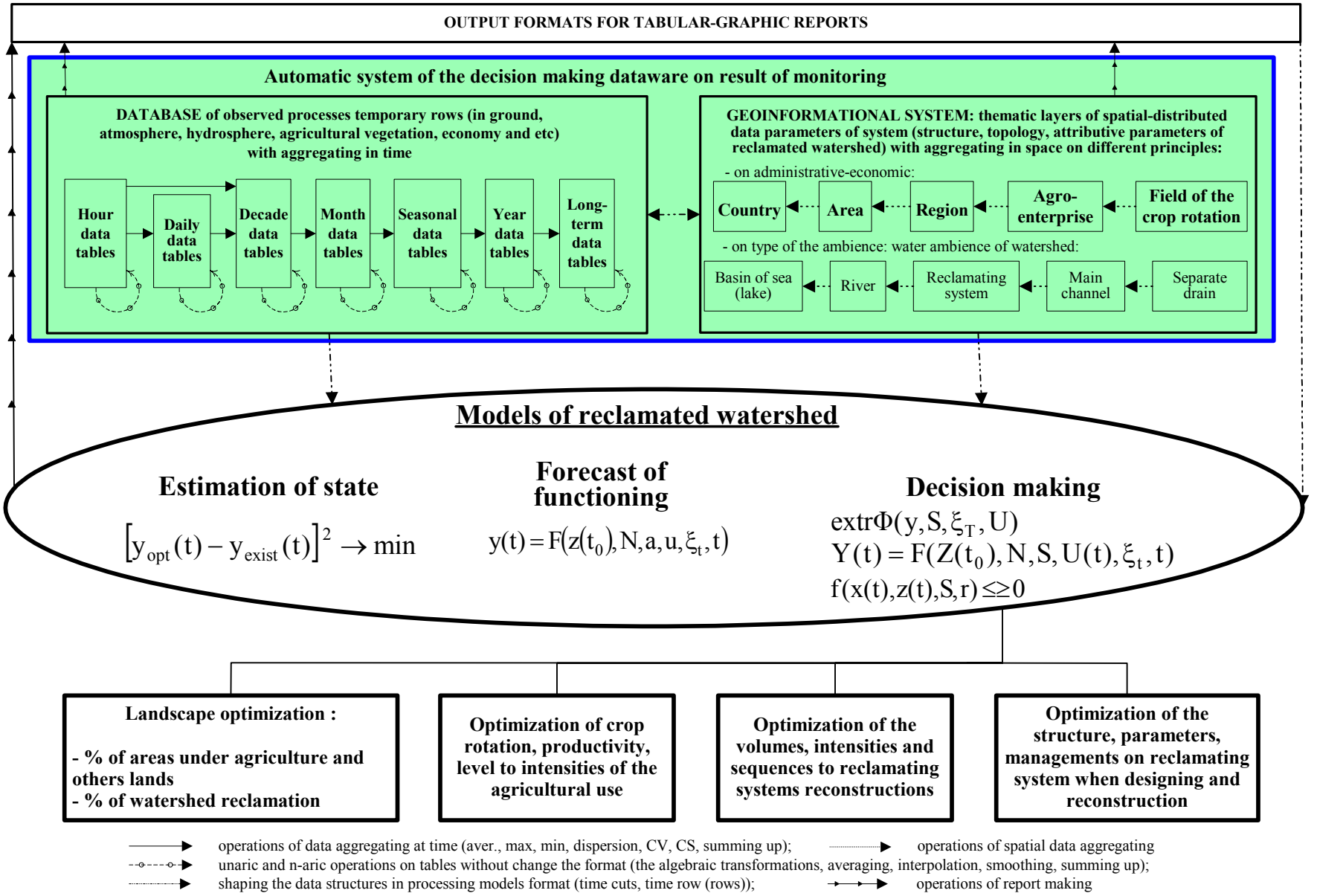


Fig. 2. Information system of spatial-temporal monitoring for estimation, forecast and decision making on reclamated river watersheds

of intaking rivers: u(t) - expenditures of waters which are pumped out by the pump, z(t) - levels, expenditures, evaporation in channels and ground, y(t) - formed crop of agricultural cultures and indexes of the environment condition, P - parameters of channels, drains, N - factors of a filtration, water returning, roughness of channels etc.

Herewith aside from that these factors change at time, they also are spatial distributed on watershed area.

In this connection designed information system includes two components: database(DB) of time series of monitoring processes and geoinformation system (GIS) for keeping spatial distributed parameter.

The DB is realized on the base of the DataBase Management System (DBMS) Interbase and optimized on monitoring data keeping, realized with usual frequency for hydrological and meteorological factors - a hour and daily periodicity. The aplication for work with database realized on client-server technology on Delphi.

Data entering in database is realized by filling the standard annual table for each separate hour of observations (Fig.3) with possibility of tabular and graphic visualization.

Aside from direct data entering in main database there is realized possibility of the remote entering in computer right in place of the undertaking the monitoring. Data entering is realized through specially created application for the remote entering or through Excel table, data translation from which in main database is realized by means of designed converter. Converters are also written for data translation in database from the station of automatic record observed parameter of the SEBA company.

The set of the procedures is realized for processing the measured factors and preparing of data structures required for different statistical, deterministic, neuro-net models. The most important operations with annual tables are: aggregating source data of term measurements consecutively till to daily, decade, month and etc. meanings (Fig.2) with calculation of statistician (maximum, minimum, average, dispersion, amount), annual tables algebraic transformations, summation with growing steps, averaging on n-days, approximation by different functions, interpolation for recovering the missed observations, as well as between-tables operations.

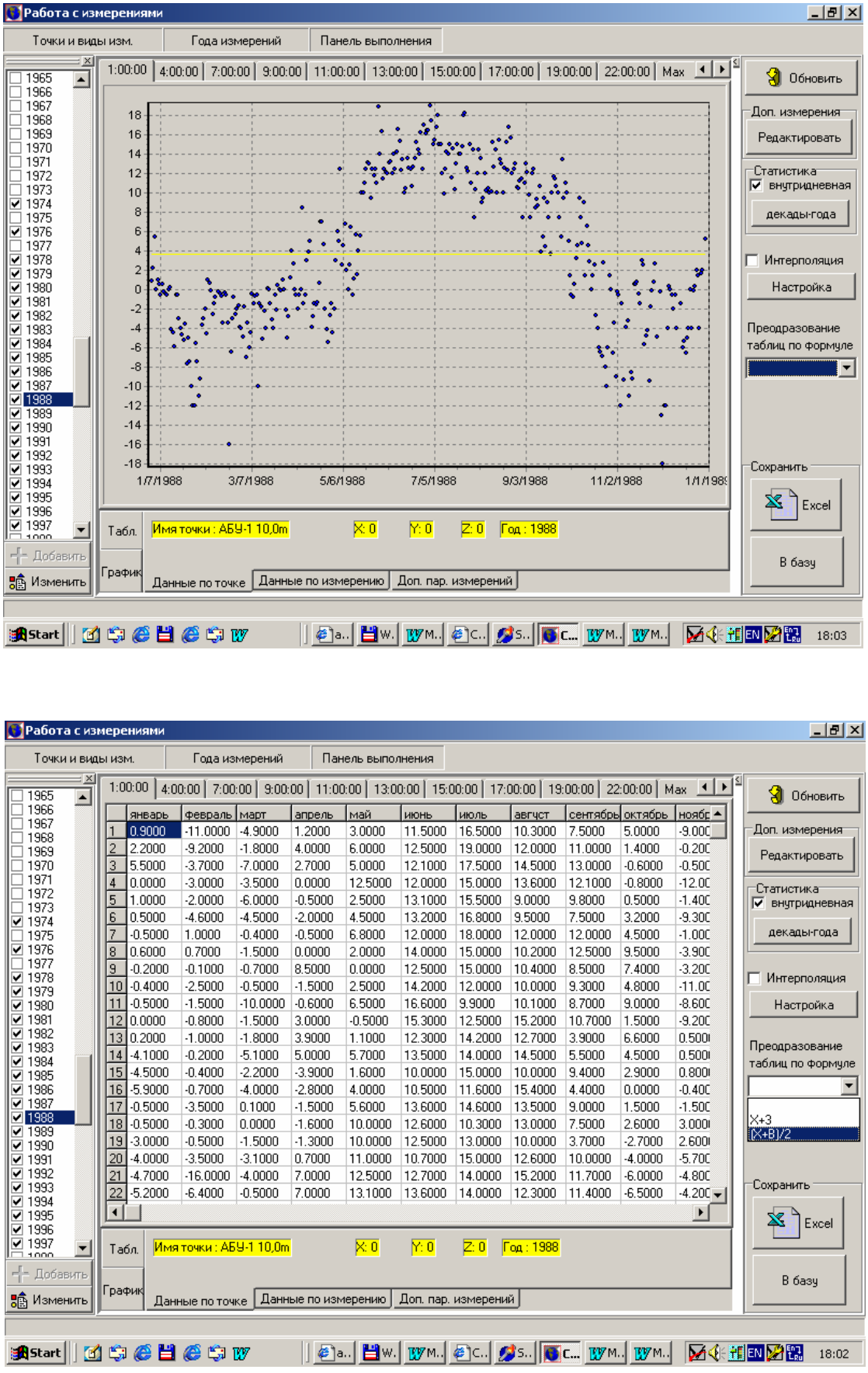


Fig.3.Database window for working with annual monitoring data on graphic and table shapes

There are also realized possibilities of data structures forming for different type models and generations of different type tabular and graphic reports on temporary rows.

The second component of the information system intended for keeping of the factors with greater typical times of their change (the relief, ground water-physical parameters, channel morphometric parameters of rivers etc.) is the information system (GIS). Considering particularities of the solved problems as GIS is used 2D-geoinformation system ArcView. Many additional utilities increasing functionality for considering problems decision is written for it.

In database there are kept names of observations types with possibility of their grouping in classes and point's names in which they are realized. Main arrays to information are presented by measurements results on corresponding time moments. Information on structure and parameters of reclamated watershed (channels, ground, vegetation) got by overland methods and from data of distance sound is kept in GIS in the form of thematic layers.

Between database and GIS is realized interface providing possibility of data exchange between them that allows to use processing procedures available in both components. In particular "temporary cuts" can be formed in database on observations of a certain factor on given date on all necessary points, on the grounds of which can be realized its zoning by GIS facilities.

Created spatial-time information system is the dataware for multicriterial, multifactor ecologic-economic estimation and decision making on watershed. On results of 30-year monitoring on compared watersheds of rivers Yaselda and Narev in database is collected several million measuring data of the different factors and are created many groups of GIS thematic layers.

Results of the comparative analysis perennial data on the most important ecologic-economic factor of studying watersheds are presented in table 1. The analysis of monitoring data shows that as a result of reclamating system construction firm reduction a ground water level (GWL) occurs on drained part of watershed. Unlike non-drained marsh, on which average perennial GWL are on ground surfaces, on drained watershed their average perennial depth is 1,1 m. On adjoining territory influence of land reclamations on GWL gradually fades away and on distance 2-3 km practically are not noted. GWL falling down brings to increasing the aeration zone and to reduction of ground moisture till to value favourable for agricultural plants growing. This provides growth of productivities of the main agricultural plants on reclamated lands.

Table 1.

Comparison of water catchment area

	Narev	*Yaselda*
The hydrological characteristics		
Precipitation, mm	***606***	***595***
Evaporation, mm	434 (75% from precipitation)	460 (60% from precipitation)
River flow, mm	162 (56% - surface flow)	186 (5% - surface flow)
Qmax, l/s/km^2	43	22
Overflow from lower layer, mm	10	60
Underground water level, cm	near surface	107
		(Adjacent territory: 0.1km - 79cm; 1km - 38cm; 3km - 5-9cm)
Soil humidity, %	85-100	65-80
The microclimatic characteristics		
Air humidity at the height of 2m:(bog / adjacent territory):		
Absolute, mbar	12.4/12.2	12.7/12.9
Relative, %	79/77	82/82
Crop capacity of agricultural plants, t/ha		
Winter rye	1.9	2.6
Barley	2.3	3.1
Potatoes	19.2	19.8
Grass from bogs	0.6	7.0

Concentration of main ions in channels, mg/l										
Chemical substances	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	NH_4^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	NO_3^{-}	PO_4^{3-}
Narev	50.3	9.0	0.7	3.0	0.4	160.7	6.1	11	0.49	0.1
Yaselda	68.8	11.6	1.3	4.3	0.3	180.4	11.8	11.9	0.55	0.1

The reliable difference in value of the precipitation on compared watersheds is not noted.

In connection with GWL falling down the physical evaporation is lowered, but in connection with growing of the productivity transpiration increases. At period of the initial throw of ground water store the observable increasing the runnoff river-waterreceiver occurs. But hereinafter annual sewer from reclamated watershed insignificantly exceeds the sewer from non-reclamated. However occurs the sharp redistribution the canal sewer and its components within year. In connection with formation big accumulating capacity the surface sewer from reclamated watershed does not exceed 5% from total then on non-reclamated watershed he forms more 50%. As a result on reclamated watershed fall down the river extreme expenses at period of spring high water at snow melting.In particular accounting sewer of the spring high water maximum of 10% supplies, to which calculation parameter of reclamated object is conducted (the channel depth and distances between drains) decreases on 15%. Considering this, possible economy of the facilities to account of the works amount reduction at silting channels reconstruction.

It is also installed that as a result of channels snowdrift in winter at few years at period of the spring high water because of uneasiness of the riverbed maximum discharge approach several days later maximum level of water.

On the contrary at shallow periods minimum river discharge with reclamated watershed grow to account of the increasing of ground water component of runnoff.

Increasing the items of the water balance expenditure on reclamated watershed with more low GWL is compensated the by feed increasing of recharge from lower pressure horizons.

The change of ground water mode changes its heat capacity in consequence the average temperature falls and its daily contrast increases.

The moisture reduction of reclamated ground enlarges the probability of wind erosion, and the absence of the surface runnoff reduces the risk of water erosion. With reduction of moisture and as a result of perennial agricultural use the organic peat ground thickness decreasing occurs. This is the most undesirable process on reclamated watershed, since after full peat ground thickness decreasing the sand emerge on surface, having small water capacity and low fertility.

As a result of fertilization of reclamated agricultural lands,the main ion concentration grows in ground water and in river runnoff accordingly. In river Yaselda average perennial total concentration in 1,2 times above than in being in natural state river Narev. However it is necessary to note that these values remains within permitted concentration and do not prevent the successful fish breeding in located below adrift water reservoir "Selec".

It is obvious that all aforesaid changes, caused by land reclamation, have a different estimation with standpoint of the different branches of the management, different type of flora and fauna, different expert incoordination of the criteria and preferences.

However as a whole it is possible to draw the conclusion that land reclamation brings about speedup of the water rotation. Herewith watershed natural system in accordance with Le Shatelie principle is steady to reclamative influences, which are extinguished in connection with presence of the large number of the negative feedbacks in water dynamic processes in different ambience.