INTEGRATED SYSTEM FOR MODELLING AND EVALUATION OF NATURAL-ECONOMIC RESOURCES IN THE KAZAKHSTAN PRIARALIE

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In September, 2002, at the World summit on steady development in Johannesburg, the European Union (EU) has officially declared the beginning of realization of the Global water initiative: " Water for a life - health, well-being, economic development and safety

The question of an estimation of the future, let even the confidant, always was important for planning strategy of perspective development for each state.

The important tool for such purpose are mathematical models Calculations on model can promote acceptance of more progressive decision better approaching to an overall objective.

One of main tasks in project INTAS ARAL SEA – 1072 became build of a kernel of the Integrated system for Kazakhstan Priaralie**.** And on the one side the main database incorporated in GIS should describe scale processes at a level of basin of Syrdarya , and with another – to correspond to needs of concrete region for an estimation both water, and soil resources.

Structure of regional system for Kazakhstan Priaralie.

The kernel – the integrator of system (fig. 1) is constructed on the basis of the final logic automatic device, (as the majority of problems of the project are well enough formalizable) and represents the standard console interface with 3D – a visual analyzer. At construction of system opportunities DirectX Software Developer Kit were widely used. The kernel of system created by Vladimir Krivenko in the ISOTOPE Association.

Derivative geoinformation system and its representative block interface it is constructed on the basis of MapInfo Professional and actively uses toolkit GEOLINK. This popular GIS is effective enough and accessible economically to the majority of potential users in Kazakhstan. The set of accompanying maps in format MapInfo Professional has been created. For example, maps of rice checks of Khazalinskiy and Kzylordinskiy arrays for 1963, 1987, 1998 both 2003 according to Kazgiprozem and to data of remote sounding.

The block naturally – scientific models includes base soil dynamic model, climatic model, model of a relief and can be added. Also the set of the special utilities intended for preparation of the information for modelling and construction of base model of a relief, and also the utility of calculation bonitification here enters.

The block socially – economic models includes analytical model of development of the Kazakhstan subpopulation and an infrastructure of region and can be added.

The derivative geoinformation system can display socio – economic scripts and parameters of an estimation of territory and can form a basis of classic visualization on time cuts of processes and the phenomena.

The background database consists of the survey maps caused in a mode 3D. The Basis for data of the system, containing the detailed information on territory, is divided on segments. The principle of segmentation allows to work on a personal computer of middle class. For a basis the usual text file. In general the system does not contain any complex for specialists components in development, except for the models working in the environment of mathematical package MATLAB and is compatible to any popular GIS – system. All initial data are entered in GIS environment.

In a general view work of system looks as follows:

The kernel of system is started. Originally the system loads an abstract landscape for guide for the user (Look a Fig. 2). In the bottom of the screen there is an information panel of a conclusion of parameters of the volumetric cursor – a sonde, geographical coordinates and height of a sonde on a surface within the limits of a survey map or a segment and distance from spacecraft up to a sonde. The user can freely move a probe on a surface of a map and move in space of model. Below a line of parameters of a sonde there is a line of parameters of a segment – its position on a survey map and base number for a call.

Following step – a call of the utility of creation of a primary matrix the button " Create Matrix Database " This program creates three matrixes of heights:

- matrix in the size 5000 x 5000 elements with step approximately 100 m
- matrix with step of 1000 m for maps of scale 1:1000000 (maps of pools, etc.)

- matrix with step approximately 5000 m for the survey maps loaded by system

All three primary matrixes have in each line number of an element, number of a segment and coordinates in a projection "longitude - latitude" in decimal degrees to within six signs after a comma. Then for point objects of matrices in GIS environment on preliminary created topographical maps or radar data the grid of heights is created and data from it are transferred on an initial matrix.

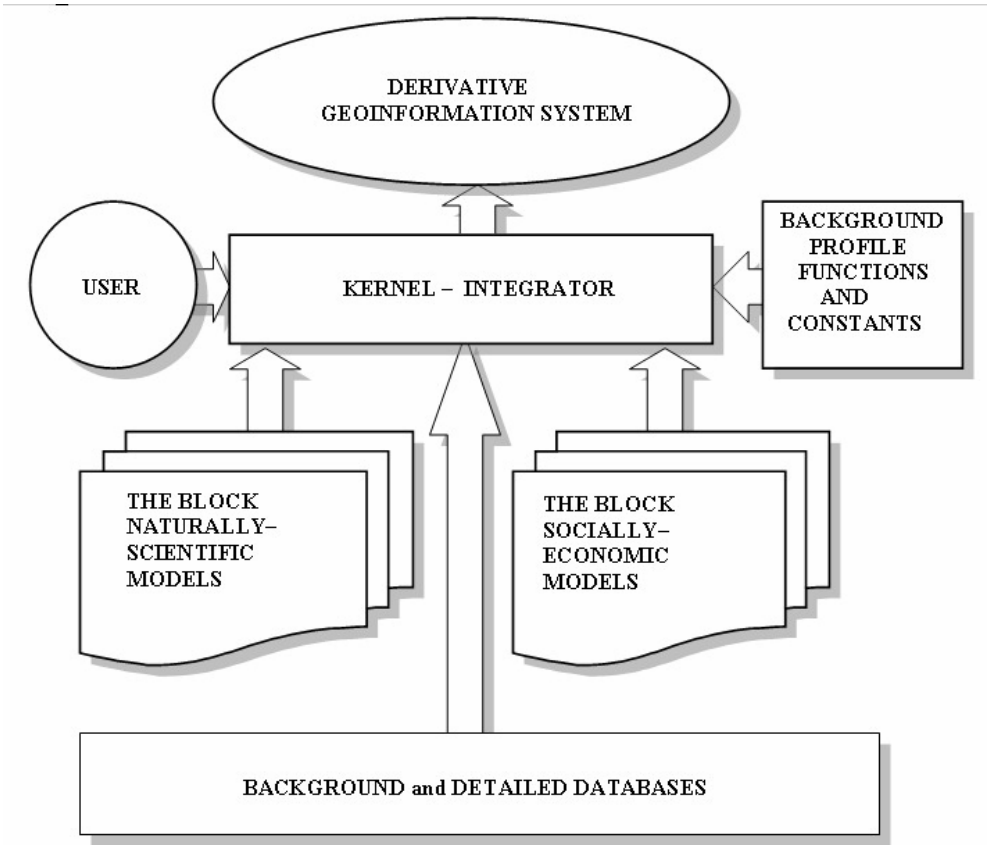

Figure 1. Block scheme of system.

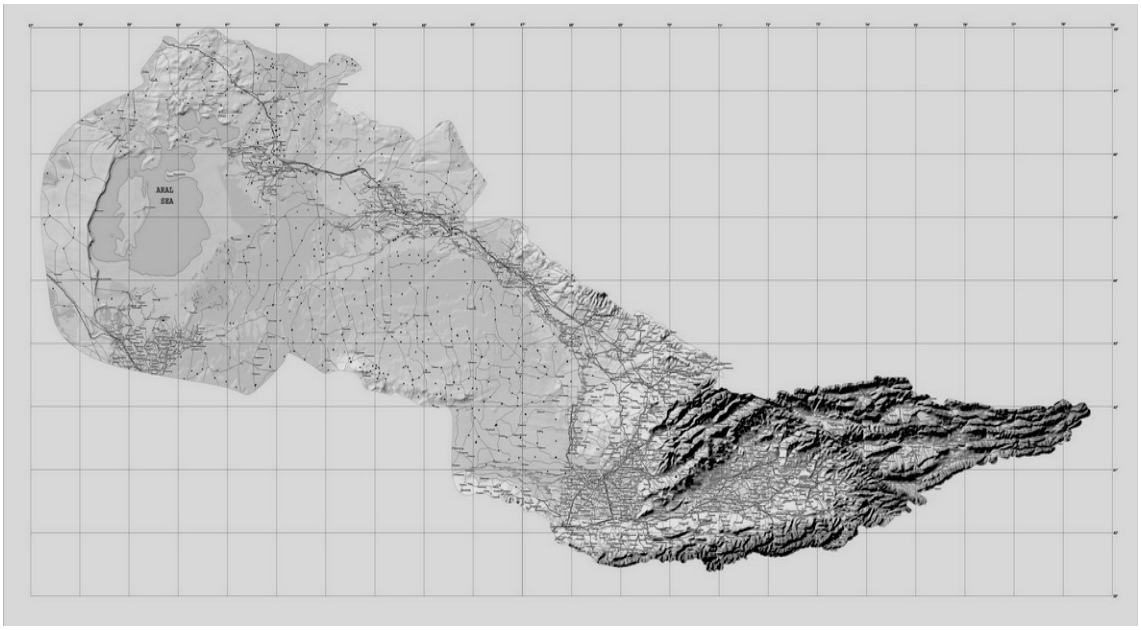

Figure 2. Example of use of a topographical map on the basis of digital model 1km This map is in derivative GIS and contains the previous information about detailed territories of the project, soil profiles and levels of Aral Sea in it vector model.

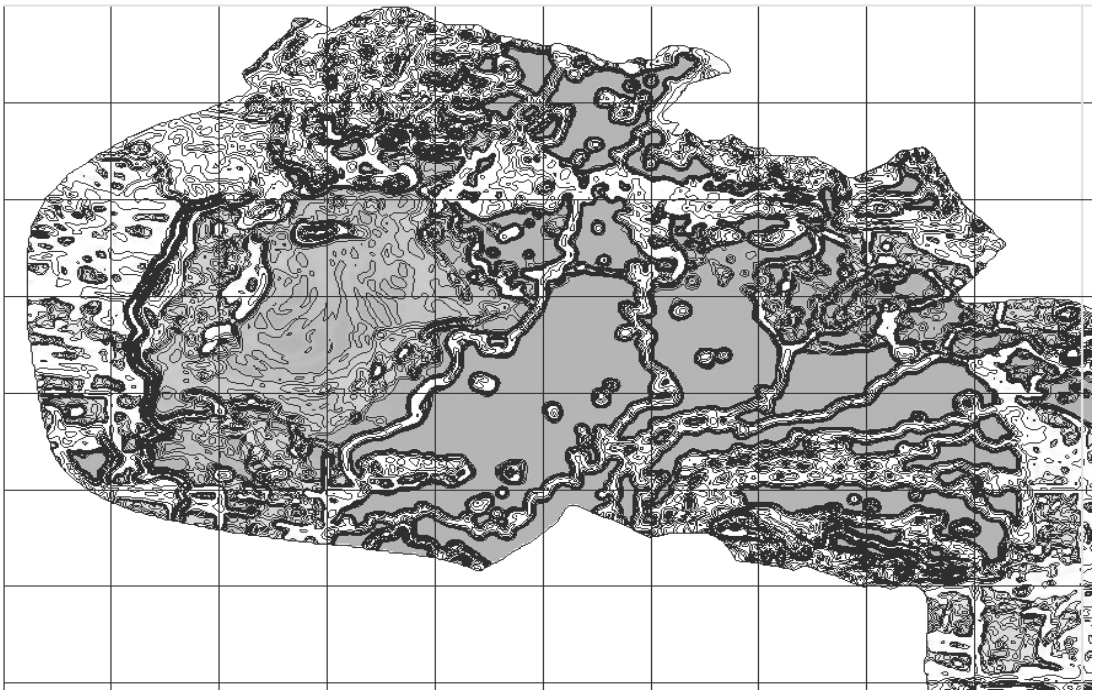

Figure 3. Example of use of a basis digital model 1km. Map of morphometry structures - angles of slopes. Are well visible radial structures of ancient delta of the Syrdarya river and terrace of the ancient Sea. We use for this Space Shuttle radar data.

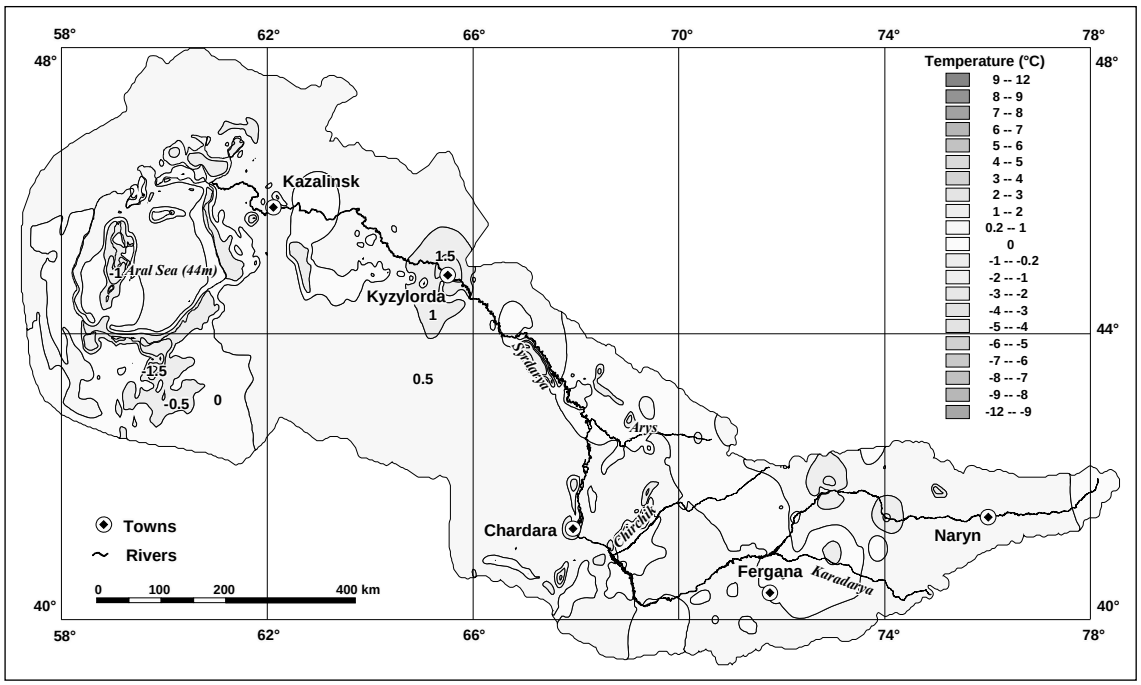

Figure 6. Changing of annual air temperature (C°) between 1985 and 1965.

During performance of the project in the ISOTOPE Association two basic grids of heights – one for all territory of a river basin of Syrdarya with step of 1000 m and the second with step nearby 100м for detailed territory have been created. The detailed territory got out according to primary climatic modelling for pool by criteria of the greatest changes for the period.

For work of climatic model and definition of correct parameters of the soil maps created under space images, it is necessary to count morphological parameters of a relief: the elementary area of a surface, a corner of a bias and an azimuth of its orientation. For this purpose by the corresponding button the utility "Compute Ma-

trix" also is started. Parameters pay off by Evans – Young method well-known technique when parameters of surrounding points are considered.

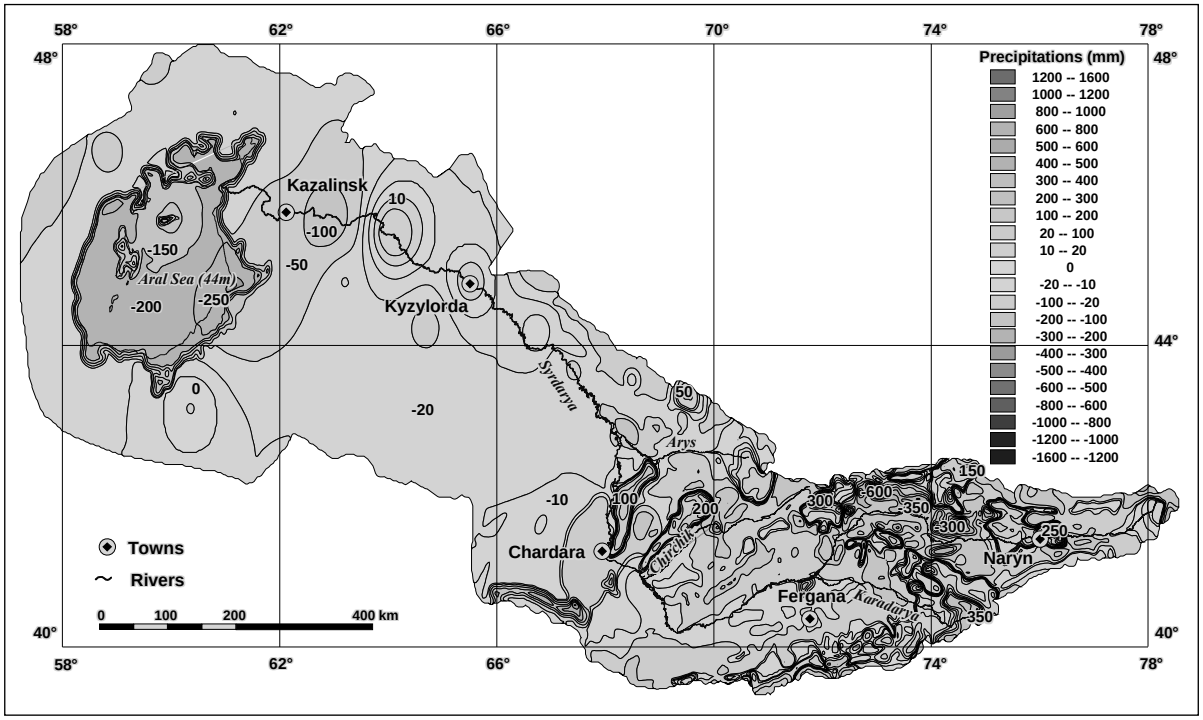

Figure 7. Changing of annual precipitations (mm) between 1985 and 1965.

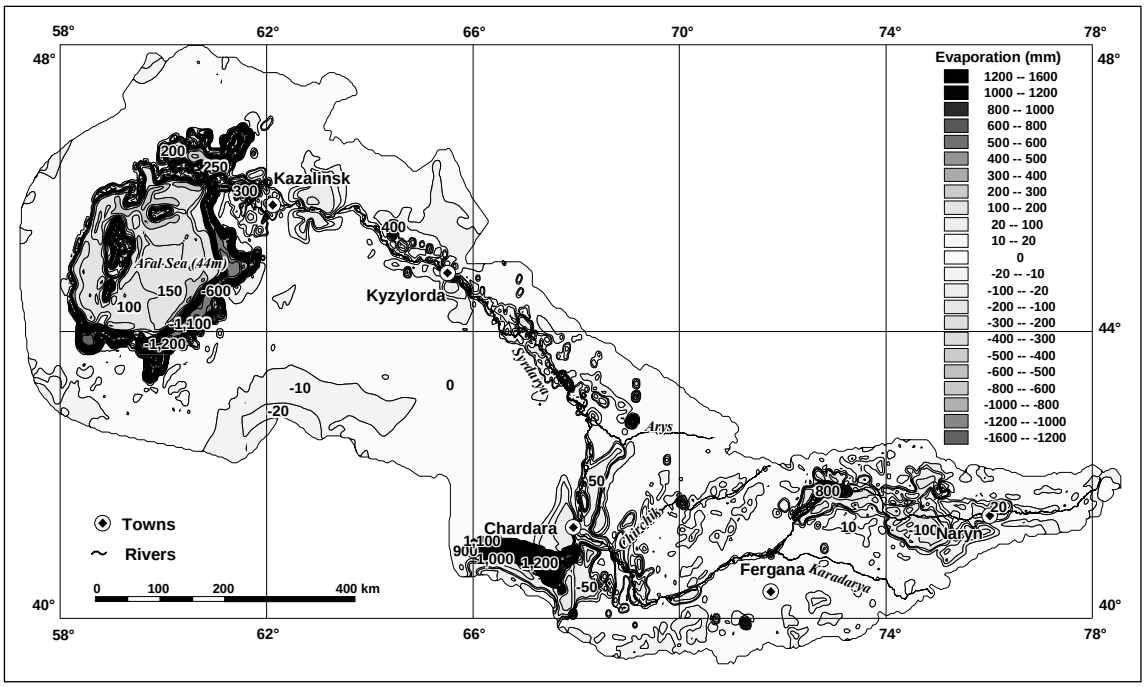

Figure 8. Changing of annual evaporation (mm) between 1985 and 1965.

For work of climatic model and definition of correct parameters of the soil maps created under space images, it is necessary to count morphological parameters of a relief: the elementary area of a surface, a corner of a bias and an azimuth of its orientation. For this purpose by the corresponding button the utility "Compute Matrix" also is started. Parameters pay off by Evans – Young method well-known technique when parameters of surrounding points are considered.

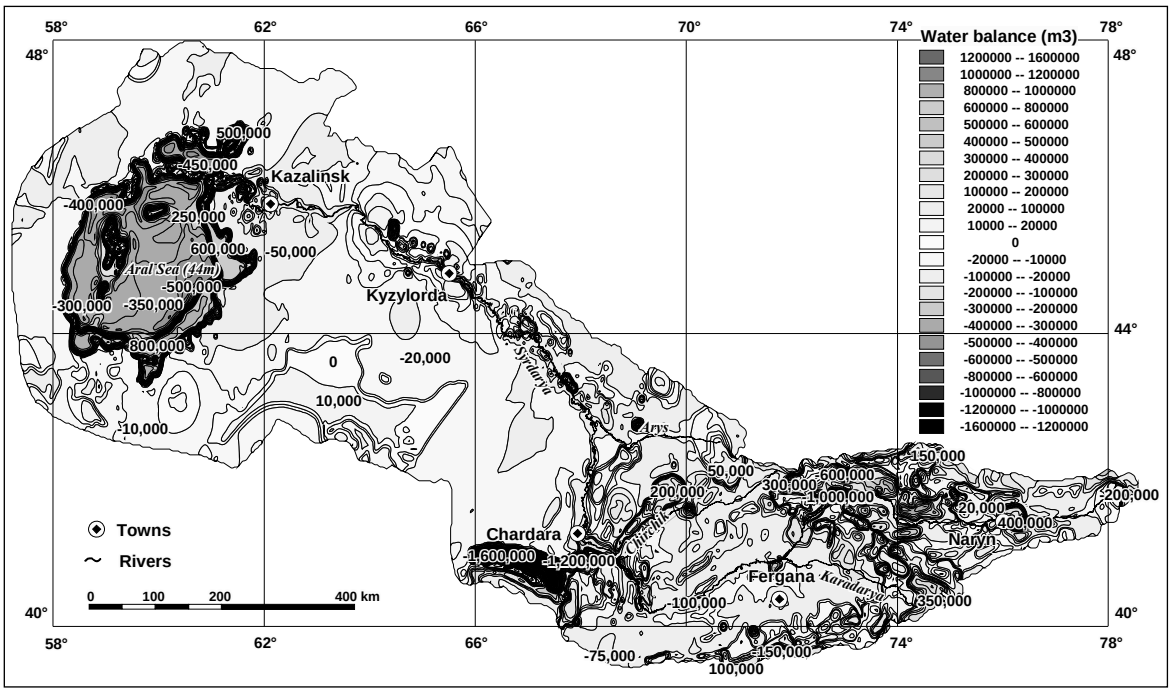

Figure 9. Changing of annual water balance (m3) between 1985 and 1965.

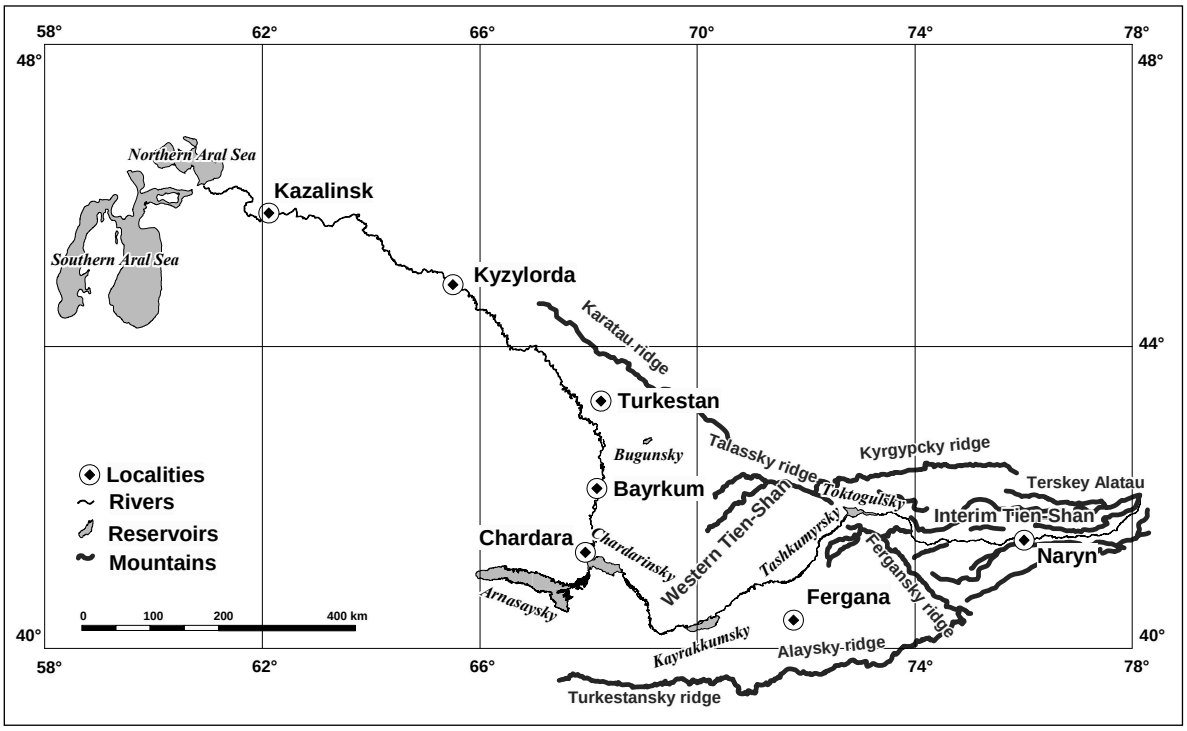

Figure 10. Map of water reservoirs of Syrdarya river basin.

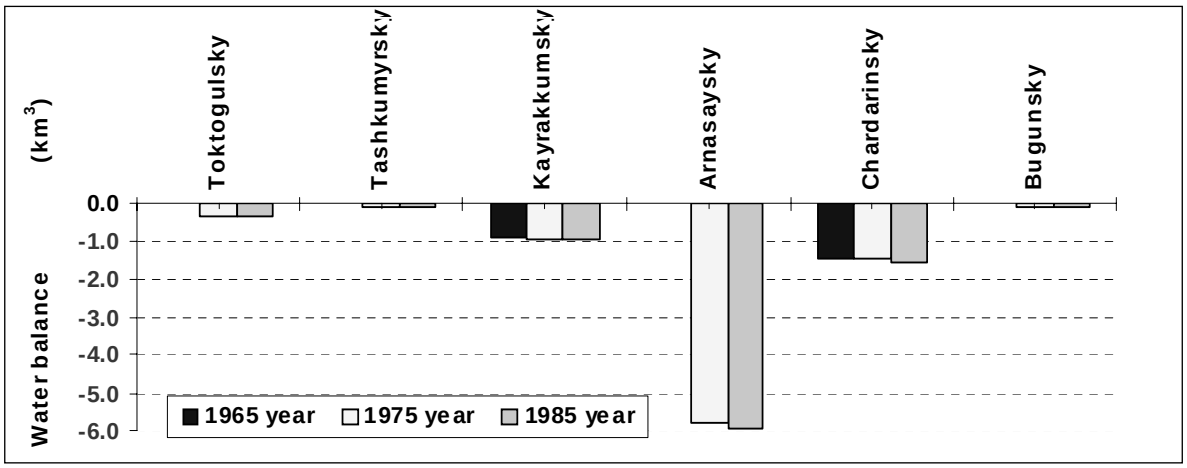

Figure 11. Water balance of more large reservoirs of Syrdarya River basin on three decades 1960-1990.

For seventieth years total losses of water store conditioned of evaporation for all large reservoirs were equal *-8.70 km3/year* and water losses from Kayrakkumsky, Arnasaysky and Chardarinsky reservoirs was equal *-8.17 km3/year* or *94.97 %* from total value. For eightieth years common water losses of same reservoirs were equal *-8.97 km3/year*, water losses from Kayrakkumsky, Arnasaysky and Chardarinsky reservoirs were equal *-8.46 km3/year* or *94.28 %* from total value. Losses of water resources from only one Arnasaysky reservoir have made accordingly:

for the seventieth years *-5.76 km3/year* or *66.20 %* from total amount;

for the eightieth years - *-5.94 km3/year* or *66.29 %* from total amount.

Following stage – prepared under space images and ground data soil maps (Konstantin Pachikin, Olga Yerokhina, Institute of Soil science KZ), "are put on" digital model of a relief by means of GIS and thus data for work of climatic model are prepared.

The climatic model developed by Jury Grechanichenko (Institute of Geography KZ), has no in the given configuration of executed files and be executed in the environment of mathematical package MATLAB. Result of work of model – maps of temperature modes, maps of modes of humidifying, etc., in conformity with properties of a spreading surface, type of a relief and data of ground meteorological stations.

During debugging system in the ISOTOPE Association climatic parameters for 1987 and 2003 have been computing.

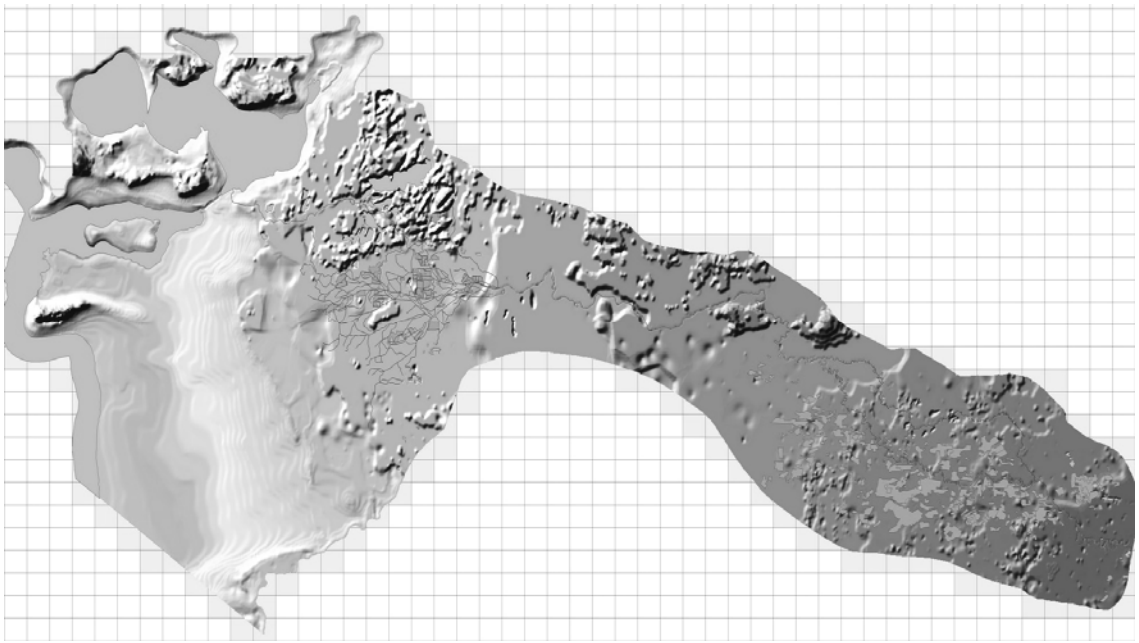

Figure 4. Digital model of a relief of 100 m and survey map (water area of Aral sea for 2003 is shown.

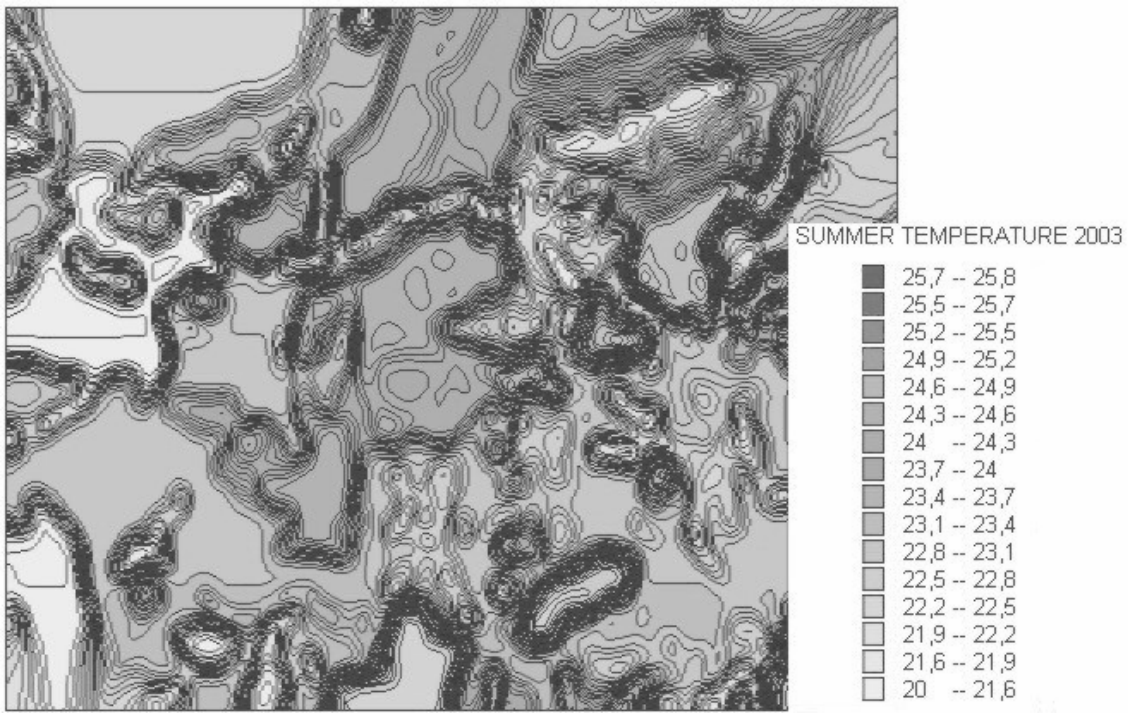

Figure 5. Fragment of a map of a temperature mode. Delta of Syrdarya River, a part of Khazalinsk irrigation system. Real step of model 0.1 ^{0}C. Grid 100 m.

Further it is necessary to compute dynamics of investigated territory for the period. By means of GIS maps of differences of temperatures easily pay off. Has more difficultly put is with a soil cover. For investigated territory the Institute of Soil science had been created a database of morphogenetic and physical - chemical soil properties and a classical appraisal scale on the basis of this database and to actually soil maps.

Figure 6. Map of dynamics of territory. Grey color – not changed territories, light – positive, dark color – degradation (it is well visible a dried bottom at the left below).

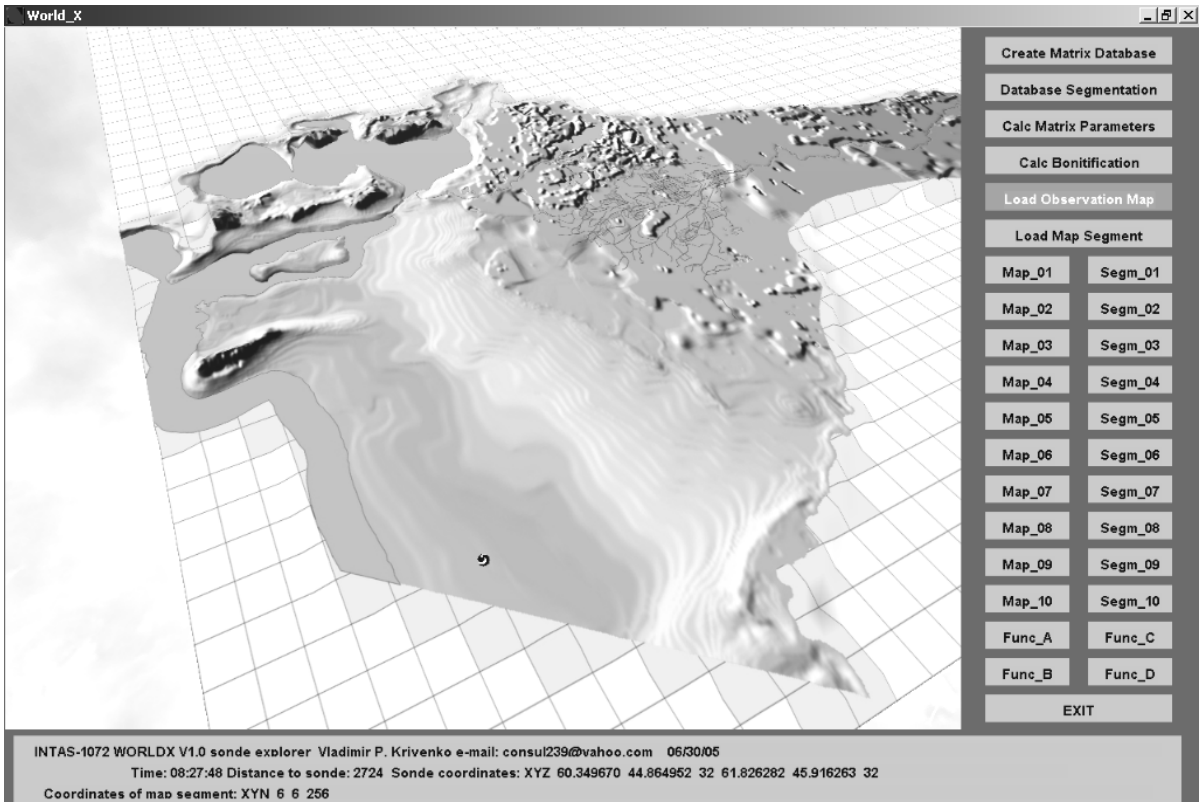

Figure 7. Survey map of Priaralie loaded into system.

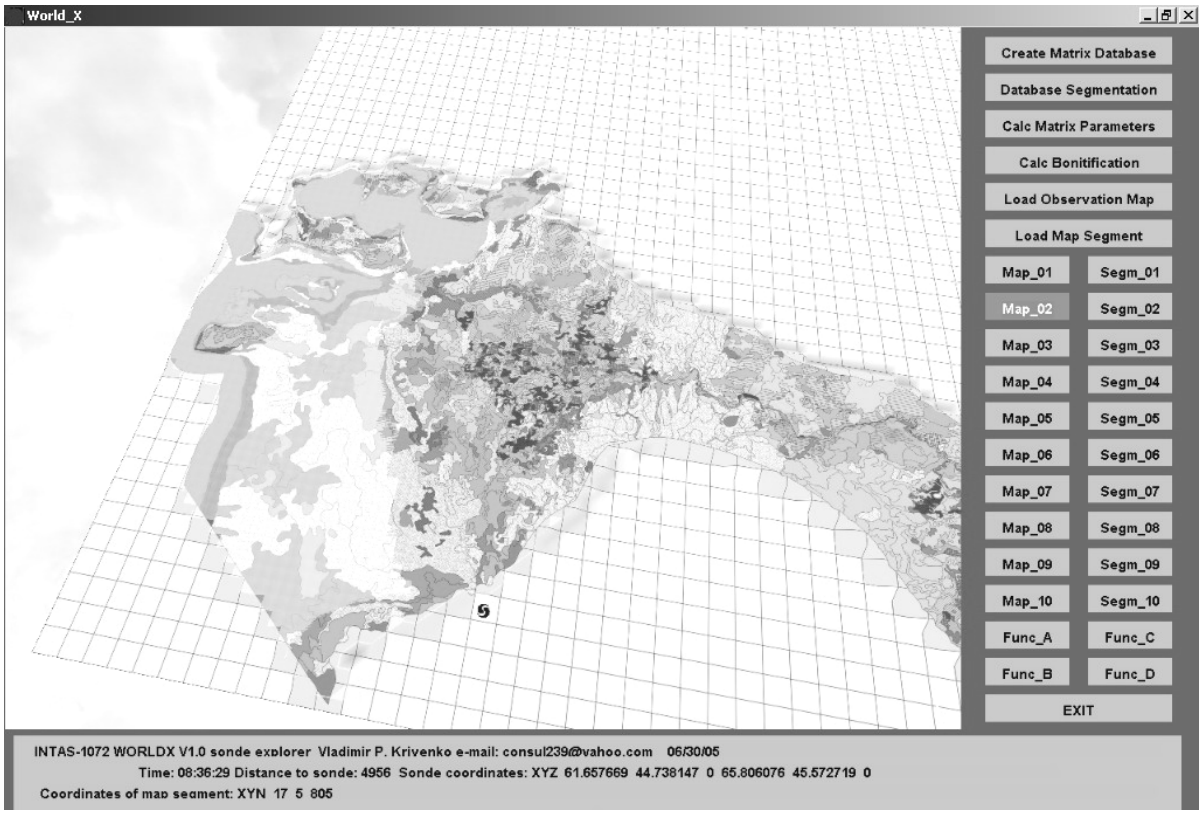

Figure 8. Soil map of Priaralie 2003 loaded into system. The water level of 45 meters is shown.

On the basis of this scale Vladimir Krivenko had been created the synthetic estimated scale and general vector map by a method of mutual crossing. The scale has the concrete not approximated values of points corresponding physical parameters of ground and the point "0" for a water table in it is changed on 1. It is made for an estimation of presence of a water table.

Thus, the basic block of the utility of appraisal numbers contains the program for an estimation of territory as on soil databases with various appraisal numbers scales, and on non-standard scales, including water resources.

The estimation is conducted according to indexes of the first, second and third components of soils and their percentage.

After calculation on each database for the period means, has been created a general vector map by a method of mutual crossing. It provides decomposition of data and allows to place a difference of parameters in a free column of a database.

Result of this operation is the map of relative dynamics of territory.

Zero values in it – stable ground or water tables, not to changes, negative values correspond to degradation. Certainly, at such estimation much depends on accuracy and quality of soil maps, surf water maps, climatic maps and databases.

Now, having climatic data and data on dynamics of a soil cover, the expert – the landowner can quite state a real economic estimation of territory. Having an estimation as on natural complexes of territory and results and scripts classical social – economic model can make better decisions on management of region. The economic model also is developed for mathematical package MATLAB by Jury Grechanichenko (Institute of Geography) and can use both the given estimations of territory, and standard data of Statistical Committee of Republic of Kazakhstan.

Quite really to create a corresponding detailed database on water resources, to add detailed data about a crop rotation at a level of separate facilities and will receive an estimation of territory at a level of separate commercial structures. Well-known, that both Khazalinskiy and Kyzylordinskiy irrigation system have low efficiency and greater losses due to bad quality of channels.

If to eliminate these lacks, to establish gauges and executive mechanisms with remote control and to automate process of an irrigation, the system can be used as means of scheduling and monitoring of an irrigating fields in a real time mode.

For effective introduction of such system additional innovational project INTAS is required. The direct communication with the consumer and its help in filling base by more detailed data in this case should be provided. Interdictions on use given KazHydroMet the scientific organizations also should be taken off. For today of the price for these data in Kazakhstan are unreasonably high. Full version of system can be constructed and use for any territory at condition of presence of enough of the data.

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Резюме

***Кривенко В., Пачикин К., Гречаниченко Ю.*. Интегрированная система для моделирования и оценки природно-экономических ресурсов для Казахстанского Приаралья.**

В статье приводится краткий обзор интегрированной системы моделирования для Казахстанского Приаралья, разработанной в рамках проекта INTAS – 1072.