DATABASES AND INFORMATION SYSTEM (IS) OF THE ARAL SEA BASIN STATES.

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1. Introduction

In arid zone conditions, water plays a vital role both in economy and social-ecological fields of CAR countries (Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan, Uzbekistan). Till 1991, water resource usage programs were formed on the basis of long-term development plans of the Ministry of Land Reclamation and Water Resources of the former USSR. These plans established priorities of water-economic activity in Amu-Darya and Syr-Darya river basins as for the single social-economic space within the limits of USSR and supported large investments in irrigation development. Intensive irrigation development during the last several ten years has caused a number of ecological problems, with the main problem of Aral sea.

The Aral sea basin is inland and covers approximately 690000 km^2. Aral sea is a final point of basin drains and waste dumps. Two largest Central Asian rivers - Amu-Darya and Syr-Darya - carry their water to the Aral sea. Direct dumping of industrial and municipal waste water into the rivers is the main reason of river headwater contamination. Main source of contamination in the middle and lower current is a collector-drainage water from the irrigated fields, which is increasingly concentrated with harmful salts and agricultural chemicals.

In connection to a population growth, intensive irrigation, and industry development, a supply of water to the Aral sea has been steadily declining. As a result, the Aral sea area decreased from 68000 km^2 in 1960 to 37000 km^2 in 1995 and its level declined by 16 m. In some places sea has receded from the former position of its coast line by 120 km. Sea water salinization increased 3 times. Because of drastic water quality deterioration, a threat for population's health has arisen, fish reserves and industries related to fish production processing have seriously suffered, and agricultural production efficiency has decreased.

Fundamentally new political and economical situation was created in the region after USSR collapsed and independent states were formed. Now, water economic activity of CAR countries in the Aral sea basin is implemented against a background of developing ecological crisis, in conditions of water resources deficit, various interests of states in the field of strategic directions of water policy and regional

water resources operating control.

Since the moment of acquisition of independence by the CAR states, there are no official channels of direct information interchange between the states, which is necessary for each of them to create operating and strategic plans of land and water resources development. Nevertheless, the CAR states leaders have basically reached an agreement to cooperate in the field of water resources management and water distribution. Also, the interstate organizations ICWC and BVOs continue activity on water regulation on the channels of Amu-Darya and Syr-Darya rivers and on non-conflicting solution of water distribution problems.

It is necessary to note, that despite sincere intentions to improve ecological situation in the region, the CAR countries have very limited resources and a whole number of unsolved immediate problems. Therefore, they could not solve above problems without financial and intellectual support from the World community. In this connection, five CAR states in 1992 has addressed the European Union for contribution on environment conditions improving, concentrating on the crisis causes, i.e. on water and land resources management in agricultural production systems.

On January 1994, the Heads of five states approved "Plan of actions on improving ecological situation in the region and its social-economic development". They approved "Program of specific actions on improving ecological conditions in the Aral sea basin" carried out both at the expense of own means and at the expense of means of foreign sponsors. This program was maintained by World Bank and European Union's TACIS program who has submitted funds to finance the WARMAP Project "Water Resources Management and Agricultural Production in the Central Asian Republics".

Originally, 9 subprojects within the limits of above program were planned to be fulfilled, however not all sponsors submitted their financial warranties, therefore studies under 7 subprojects were started during the preparatory phase (January - August 1995). During the main period (September 1995 - July 1997), international and local organizations' activity was focused on 6 following components:

- ◊ Preparation of priority normative and legal documents (interstate agreements);
- ◊ Creation of information system to solve priority problems of land and water resources management at the regional level, and development of regional communication network with specialized units;
- ◊ Analysis of water use and water resources management in the irrigation;
- ◊ Pilot projects on improving the maintenance and management of inter-economic canal systems, and perfecting the irrigation techniques and technologies;
- ◊ Water quality evaluation and management. Improving the quality of water used in agriculture;
- ◊ Pure water and health.

Only the activities related to creation of information system and database development within the scope of activities on Aral sea range of problems are reviewed in this report.

2. Role and place of information system and land & water resources databases in Aral Sea Problem Program realization.

It's obvious that program efficiency, cost justification, and profit stability from project realization is in many respects determined by:

- ◊ completeness and quality of information used as a basis for projects fulfilled within the Program limits;
- ◊ primary organization of reliable communication between system partners;
- ◊ creation of the interstate information system integrating existing independent structures that participate in program realization;
- ◊ step by step implementation of full-fledged monitoring systems on key directions using modern hardware and software base;
- ◊ solution of legal, political, financial, economical, organizational and methodical aspects of system functioning, openness and information availability.

Even though the large experience of various information systems creation has been accumulated in the world, a proposed system is unique in scale, number of purposes, and participants. Analysis of main stages and problems of information system creation in 1995-1997 period could be useful both for regional experts and for foreign organizations and experts who would like to take part in system's creation and maintenance.

Before the beginning of works under "Program of specific actions ..." the information on development, registration and use of land and water resources in the Aral sea basin was collected, processed and used by five countries of region separately. Inside these countries the information is distributed among various departments (Minvodhoz, Minselhoz, Gidromet, MinGeo, MinEnergo, Goskompriroda, BVO, Minzdrav, Ministry of Municipal Services, Geodesy and Cartography Administration). However, this data is difficult to get because of departmental barriers, or because this information is not available for public use (first due to the secrecy, and recently due to commercial reasons). There is a number of technical-only problems:

- ◊ Database creation, which was begun in above departments at the end of the 80's beginning of 90's within the limits of all-union programs, was only supported by special purpose financing and logistics of the Union's ministries and oriented on out-of-date type of mainframes of "ES Computer" series. These activities were mostly experimental and had no time to become a required element in daily activity of organizations. However, the mass replacement of mainframes with PCs concurrent in time with the USSR's collapse and subsequent break-up of traditional links between the states resulted in fast curtailing or full termination of these activities for the lack of specialized software for the PCs. In most cases, previously created databases on magnetic tapes and punched cards either remained unclaimed or were physically lost;
- ◊ Nowadays, regional organizations collected huge arrays of initial non-systematized data which

volume exceeds potential needs and technical capabilities of the information system many times. However, the main part of useful information is stored on paper medium not in computer databases.

- ◊ Information, obtained by various departments was not generalized in a single key and, as the corollary, contains many errors, discoordinations, back-up and over-detailed data. Large human and time resources are needed to search, coordinate and check data. It is necessary to note, that due to frequent and large-scale reorganization of ministries and departments during the transitive period, there is an actual threat of loss of collected information at all;
- ◊ In last years, the general economic recession resulted in serious deterioration of information infrastructure quality, reduction of observation points and parameters of observations, and consequently, in drop of qualitative and quantitative characteristics of information used in planning and water economic activity management.
- ◊ The information infrastructure of region does not meet modern specifications;
- ◊ Absence of solution of interstate and often of intrastate information interchange aggravates all these problems.
- ◊ Until recently, the main and well known source of water resources information about CAR countries was the information by Gidromet, member of the World Meteorology Organization. In this connection, foreign experts of World Bank and European Union supposed on pioneering stages of the Aral problem activities, that obtaining data from this department will allow to receive necessary information. The first activity stage that solved strictly departmental problems was carried out within the limits of Program 2.1 "Regional unified system of hydrometeorologic information, registration and forecast of water resources, and natural environment monitoring in the Aral sea basin (Gidromet services)". In 1995, the project 2b "Hydrometeorological observations" was carried out under the WARMAP Project. After completion of these activities, it became obvious that solution of the Aral sea problem requires information going beyond the limits of hydrometeorologic observations and only water-economic organizations of CAR countries obtain the complex of necessary information. It's notable, that information collected by the WARMAP Project on pioneering stages was not even included in the WARMIS databases and remained unclaimed.

3. Approaches in information system and databases development.

The first studies of the future Aral sea information system were made by SIC-ICWC, and later by the expert group of CAR countries during the preparation of requirement specification under the World Bank's project 2.2 "Regional unified information system of water resources registration and use, and hydroecological monitoring". The following project purposes were declared:

- ◊ Creation of computer databases on water resources use and hydroecological monitoring national on national and regional levels on the basis of existing organizational structures of the CAR states;
- ◊ Creation of open information system for access to the processed authentic information on the basis of these databases. Use of information system in complex with economic-mathematical models of evaluation, forecast and decision making on water resources use and improving their quality in region;
- ◊ Creation of unified system of water resources registration and hydroecological monitoring conducting. Strengthening and modernizing of available services that collect data;
- ◊ Supplying of operating information and data to all projects of the "Program of specific actions on improving ecological conditions in the Aral sea basin".

Regional coordinatory organization SIC-ICWC and Institute "Turkmengiprovodhoz" offered two different approaches to information system creation:

I. In SIC-ICWC's version it was planned to create an information system with ideology, based upon the following principles:

- ◊ IS must consist of three main components: a geographical information system, environment monitoring system and managing information system;
- ◊ IS contains at least 5 hierarchical levels (basin - republic - area - region - field). Environment monitoring is implemented on the lowest layer, then information is transmitted upwards, being transformed into databases pursuant to the requirements of each hierarchical level. Databases are expanded on each level with the information from different branches of industry (that is, there are horizontal links besides vertical), and its integration is carried out both by administrative and water economic division of region's territory;
- ◊ System will unite three interstate centers (SIC ICWC, BVO "Amu-Darya", BVO "Syr-Darya", decision-making directing bodies, national centers, organizations of Minvodhoz and other branch water using organizations. On the information level system will include Gidromet services of CAR countries with their observation stations.
- ◊ System will work with distributed (on the territory of 5 states and hierarchical levels) databases. Databases' output parameters will be used in variant calculations of water and land resources management for every country and the Aral basin as a whole, and in information output to republic authorities, ICWC, and ICAS about resource availability and use. Regime observation processing and evaluation of existing ecological conditions of environment is conducted within the framework of monitoring. On the first phase "environment" means surface and underground waters (volume and quality), land resources, land efficiency and related ecological aspects;

- In organizational point of view it was supposed that SIC-ICWC, as a regional center, would create the information system kernel within itself, where financial and material resources are concentrated. All information flows are gathered here, they are analyzed, managing decisions are made, and functions of coordination and data updating are carried out. Then, data is distributed by SIC to authorities, water user organizations and national centers of CAR countries. Nevertheless, assuming the system to be the open developing structure, it was planned that any partners (suppliers of initial information) potentially can be directly connected to the information system "kernel";

Analysis of proposed IS variant allows to conclude the following:

- The structure of IS, when its "kernel" is localized in one country and one organization, is wrongful in conditions of independent states and is obviously in contradiction with established principles of the Aral sea problem agreement on equivalent possession of information and access to it, and independence in decision making;
- The attempt to build the IS on the basis of organizational-technical forms and methods of information system development that existed in former USSR during the introduction of global MISs, mixing of information and administrative purposes resulted in excessive complication and confusion of information and management flows structure.

Talking about technical and financial aspects of realization of this kind of structure, it's necessary to note that distributed management information system of such scale:

- Will have a cost greater than the cost of local information systems by several orders, will require more expensive (to carry out control and management functions) equipment, software, maintenance service and respective highly-professional staff;
- Should be based upon the broad network of high-speed communication lines, which are actually absent in all CAR countries. Widely available computer networks based on satellite and fiber-optical cable communication are still "in embryo". Condition, quality and capabilities of regular and dedicated telephone lines allow to organize the reliable operation of e-mail and BBS only;
- With planned equipment nomenclature and upon closing of all information flows on one server, the IS most likely will not be viable. Even the approximate evaluation of information volume that will circulate within the system, number of participants who will potentially work with the system simultaneously, allows to suppose that the central server of SIC-ICWC will constantly stay in condition of the information collapse;

Amongst other serious disadvantages of proposed IS variant, the following should be noted:

- The scope of problems of this IS is not clearly defined, and nomenclature, scale and terms of management object creation are unknown at all. Unequivocally, it is only possible to say that the technical equipping level of information survey points of potential control and

management objects is extremely primitive and does not allow to use them in monitoring information systems structure. Obviously, the task of re-equipment of the whole survey and measurement network, even during the 5-10 years, absolutely unreal. By the time when information blocks and management objects of this IS will be reasonably outlined, the hardware-software base in such quickly developing field as computer technologies will change several times. "The system kernel", which is supposed to be build first, will become outdated many times before the system will be put into operation.

◊ From the viewpoint of reliability and security of databases and system itself, as well as the quality of information service, the centralization of system life-support on one server and absence of database backup in national centers of other countries is technically unacceptable;

As noted above, the CAR countries have very limited resources and a number of unsolved immediate problems, so the development in "information direction" was curtailed almost in all fields, but military-space, defense, power, oil and gas, banking and some other areas. It is improbable for international sponsoring organizations to seriously consider perspectives of investing multimillion resources into unpromising and little profitable business;

II. The IS version of "Turkmengiprovodhoz" Institute supposed that at the given stage:

◊ management problems, which were previously planned to be studied under World Bank's Sub-Project 7 "Management information system of water resources in Amu-Darya and Syr-Darya river basin", as well as monitoring problems should be carried beyond the framework of Program 2.2 and creation of IS;

◊ basis of ICWC's Information System should consist (besides SIC-ICWC) of five technically, functionally and organizationally equal independent information systems, basing on local area networks and databases of national centers, who own national database and carry out their creation, management and updating;

◊ organization of national ISs and databases should allow for their independent use and creation of LANs and other databases on their basis, depending on particular tasks of each national center;

◊ unity of information system should be provided by maintenance of identical specialized databases (among others) in each information center not by creation of distributed databases being closed on one server. These databases are formed by granting parts of national databases to other participating countries using agreed list of information of mutual interest. This will provide all participants will equal access to necessary information on the basis of unified (compatible) standards and formats of transmitted operating and reference information databases.

In our opinion, such approach to possible information system structure better corresponds to realities of transition period in independent states and will require sufficiently smaller financial, technical and human resources.

Speaking of priorities in information system development and technical aspects of its creation, the "Turkmengiprovodhoz" Institute considered the following necessary to proceed from:

- ◊ First of all, it is necessary to organize a normal information exchange between national centers, coordinators and program sponsors on the basis of e-mail and BBS.
- ◊ It is expedient to provide national and regional centers with access to distributed databases and international communications through the Internet. Both problems "of information direction" should be isolated into a separate subprogram, as they were not obviously stipulated by one of the 7 World Bank's subprojects;
- ◊ Following the realization of separate programs, it is necessary to develop material base of national and regional centers, creating necessary conditions for functioning of workgroups and creative groups;
- ◊ Structure of each national information system may be formed variously, depending on acquired experience, internal needs and peculiarities of each country. Requirements of nomenclature, structure, input and output data formats identity, as well as of periodicity of information updating should only apply to the exchange part the information, necessary to create the regional database.

Therefore, in our opinion, a reasonable compromise between a desirable software-hardware level of work and information system support, degree of preparedness of existing communication and other infrastructures, capabilities of local organizations, as well as financial resources, allocated for realization of this Program's Project, should be made.

In our opinion, the most optimum solution would be to submit studies of information system within the limits of the Aral problem to the international tender. Design and realization of the IS will be carried out by specialized foreign companies with participation of local experts of national centers. For them, a participation in such activity would be an invaluable professional school.

After several meetings of CAR experts, a compromise version of Requirement Specification "Databases of SIC-ICWC and information system management" was prepared. It proposed that all fundamental aspects would be additionally studied by a special workgroup, however these works were not started due to the lack of funding.

4. Information system and WARMIS databases.

In 1995, under proposal of the World Bank and European Union, it was decided to begin activities on creation of the upper (regional) level of IS, and organizations of five states have started to prepare

respective databases on land and water resources use. The initial version of WARMIS-1 information system concept was prepared by the WARMAP Project experts. However, an attempt to mechanically transfer western approaches to database design disregarding the realities of a region, in combination with presentation orientation of requested information, as well as unclear understanding of purposes and problems that are to be solved by this IS and databases, made this version of little use. In this relation, in February 1996, experts of SIC-ICWC and Institute "Turkmengiprovodhoz" prepared a first turn concept of WARMIS-2 IS and proposals of its design, which were put in the base of WARMAP Program's Project 2 after agreement with other CAR countries. In accordance with concept, the IS should including the following three components on pioneering stage of its development:

- ◊ Text databases in MS Access software environment;
- ◊ Geographical Information Systems (GIS) on the basis of PC ArcInfo-ArcView, with relevant graphic databases;
- ◊ Support tools of information exchange.

A number of problems, for which this information system is created, was formulated in the WARMIS concept. Is also defined that databases and technologies providing the following features should be created at the given stage of its development:

- ◊ storage, accumulation and browsing of reference and operating information on water, land and natural-climatic resources of a region, as well as related information of technical, ecological and social-economic type;
- ◊ information exchange between all participants of projects on WARMIS IS database creation;
- ◊ obtaining of initial information for the wide range of imitative and optimization models that are needed to solve problems of water resources operating control and the CAR countries' water strategy planning, and for the purposes of local staff training.

In relation to variety and large content of information that will be contained and processed in GIS, it should be prepared as separate layers, generated by theme characteristic:

- ◊ administrative boundaries of republics, areas, regions;
- ◊ systems of main rivers, reservoirs, waterpower plants, hydrometric stations, outlets from main rivers to irrigation systems, municipal-household and industrial consumers, collector and drainage water dumps into the rivers;
- ◊ irrigation and drainage systems, with irrigated areas and hydromodular regions;
- ◊ maps of underground water deposits;
- ◊ maps of occurrence depths of ground water and its mineralization;
- ◊ soil maps (bonitet (land-use-capability class), type, degree of soil salinity content, etc.)

According to the purposes and tasks of IS, the databases should consist of two blocks:

- ◊ regional information;
- ◊ national information;

The first block - central WARMIS kernel - is created on the basis of information collected by national centers and other organizations of CAR countries and having the regional interest on mutually agreed:

- ◊ purposes and tasks;
- ◊ nomenclature of parameters needed to reach them;
- ◊ lists of natural water sources, water economic objects and systems, hydraulic engineering objects;
- ◊ formats of input and output forms, information structure;
- ◊ time basis (periodicity of information collecting and updating).

Structure, information contents and other parameters of databases, contained in the second block, are not strictly regulated and determined by every national center independently, proceeding from their needs.

Taking into account problems with searching and preparation of required information in "the Concept ...", a special significance was given to necessity of a very precise statement of every problem and coordination of requirements on information volume and nomenclature for WARMIS with conditions of a problem and available financial resources.

The WARMAP Project has agreed to support development and functioning of the central WARMIS kernel in all national and regional centers.

For the period of February, 1996 to June, 1997, experts of the WARMAP Project, specialists of SIC-ICWC and national workgroups have developed a structure and prepared a computer implementation in Microsoft Access programming environment of an experimental sample of WARMIS-2 databases. National workgroups have carried out the collecting and typing in of input data for their countries for the period of 1986-95 for the following blocks:

- ◊ Help information (administrative-territorial division of a region, irrigation and economic zones, etc.);
- ◊ Operating information (monthly or annually generalized):
  - Water resources (including sub-blocks - surface, underground, collector-drainage waters and its reuse, reservoirs);
  - Climatic data;
  - Land resources;
  - Economic figures on planning zones;
  - Quality of water resources;
  - Industrial and power use of water resources.

Each of these sub-bases contains a number of tables that are inter-coordinated through a system of codes with the base of 2TPVodhoz coding system. This system has been used to describe administrative and hydraulic infrastructure in all regional water economic organizations for many years. Hereinafter, it is necessary to develop simpler and more effective coding system for the IS.

A set of queries and reports is implemented as a program for every sub-base. This allows to integrate, group and extract information from the base according to requirements of users, as well as to output this information as "hard copies" in habitual form of reports and references.

The WARMIS databases have a convenient interface, implemented by means of Access, that allows to work both with separate blocks and with a complex.

From the point of view of a practical realization of WARMIS concept, a preparation of simple analytical modules that work with information contained in WARMIS databases was started. Two program modules that are now in testing phase were developed with the forces of national workgroups:

- ◊ Module of water and salt balance of a river and/or reservoir segment;
- ◊ Module of water and salt balance of a planning zone.

Besides testing in national centers, a collecting of additional information, specific to various water economic zones or objects, is required to practically use these modules.

Hereafter, it is proposed to develop a number of simple analytical modules (first of all "the Economic analysis" and "Water-power engineering") that will allow users to use WARMIS databases more effectively. (Large optimization and simulation models, needed to support perspective and operating decision-making on water resources management in the Aral sea basin, will be developed within the framework of Project 1.1 "To develop a general strategy of water division, rational use and protection of the Aral sea basin water resources").

The Geographical Information System is at development stage. With regional group forces, the following separate blocks (theme coverages) were created:

- ◊ administrative boundaries of republics, areas, regions;
- ◊ planning, irrigation, economic and climatic zones;
- ◊ reservoirs, natural lakes, large rivers, canals and their nodes (points of inflow or drainage water dumps);
- ◊ irrigated territories (satellite shots).

Elements of theme coverages are coordinated with the information stored in WARMIS text databases by a coding system. The GIS's basis are official topographical maps with a scale of 1:500000 in Gauss-Kruger projection, issued in the middle 80's. "No scale" map sketches, based on topographical map geometry, were used to depict those water elements that were not shown on official maps.

It was planned that national workgroups will do digitization of specialized theme maps (soil, salinity, ground water levels, etc.), however, due to a long delay with GIS-equipment delivery, this works are not carried out yet.

Nevertheless, works on above blocks are continuing to be done, because every block should be somehow expanded with a number of figures and tables for full-fledged use of collected information.

Since the activities on regional level databases are not yet completed, the bases are not yet given beyond the limits of a developer circle (the WARMAP project, SIC-ICWC, national centers). At the

present time, there are two main points of view on a problem of WARMIS database information accessibility:

- ◊ The WARMAP project experts think that all information should be open and available (with allowance for database safety requirements) and may be used without any limitations, because the activity was carried out under financial support of international organizations;
- ◊ In opinion of official representatives of Minvodhoz and majority of local experts-developers, the access to information should be differentiated and partially limited because of the following reasons:
  - Most of the CAR countries somewhat limit the access to information because of the national security reasons, established by corresponding governmental structures;
  - Part of the information might be closed upon demand of governmental or private companies for "trade secret" reasons;
  - Database and algorithms are considered as the objects of intelligent property in some CAR countries, thus they are protected by applicable copyright legislation;
  - costs of water economic organizations of a region incurred upon obtaining the required information, creation, support and updating of database, sufficiently exceed the amount of donor aid from the side of international organizations. Taking into account a critical financial condition of water economic branch of CAR countries during the transition period, a statement of question of providing part of the information to external users for fee is quite lawful.

At present, taking into account the gravity of problem of exchange of information, collected in the WARMIS databases, an agreement, regulating the procedure of information use by all states and organizations that took part in database filling, is being developed.

Information about the progress of works under projects within the framework of Aral Sea problem is published in "Bulletins of SIC-ICWC" and "the Aral Herald" published by EC ICAS. The most complete information on the projects is contained in national and regional reports, as well as in reports of the WARMAP Project.

On further stages of activity, it is proposed to make the first steps to coordination of regional system with national databases, which will develop according to the principle of a four-level hierarchy: region - oblast (water economic zone) - rayon (irrigation region) - farms.

As it was noted above, a research on water use and farm management was conducted in 1996-97 in all 5 CAR countries under the framework of Sub-Project WUFMAS. WUFMAS was perfected on the basis of representative farms, characterizing a certain natural-economic zone with the purpose of obtaining authentic information on use of seeds, fertilizers, chemicals, machinery, irrigation water, labor and farm management techniques and their interrelationship with production of agricultural products. Analysis of field research materials will allow to realistically evaluate the situation that arose in agriculture and develop

the recommendations on improving use of land and water resources, agricultural production factors. These activity gives an extremely valuable material for future development prognosis and feasibility reports both for pilot projects and for real projects of irrigated agriculture perfection. At present time, an experimental version of database is prepared in Access programming environment. Information obtained during research was recorded in the database.

It is supposed that WUFMAS Sub-Project will allow to fill up the lowest layer of the information system.

Lack of financial assets of WARMAP Project did not allow to begin a solution of problems with communication (e-mail, BBS, Internet) between sub-project participants. It had a negative effect on terms of works fulfillment and its effectiveness. We suppose, that the problem of communication direction should be solved first of all in order to proceed with activities on IS in the period of 1998-1999. The main problem for the national center of Turkmenistan is that because of absence of full-functioning computer network providers operating on the territories of NIS (Newly Independent States) countries, it is necessary to obtain financial assets both to set up the Internet server in "Turkmengiprovodhoz" Institute, and to cover the current costs (lease of channel, traffic payment), that Institute does not have. Nevertheless, creation of such server should have big perspectives, as it will allow:

- ◊ on one hand, to meet requirements of the Ministry of Melioration and Water Resources of Turkmenistan,
- ◊ on the other, to create hereinafter a commercial server on its basis, that will process the international information traffic.

Apparently, the most realistic variant is fulfillment of these works in the framework of one of the projects, financed by international sponsors. It is necessary to note, that activity allowing to lay a foundation for creation and development of computer networks is heavily conducted in Turkmenistan during the last 2-3 years:

- ◊ digital telephone exchanges are put into operation in the capital and in all provincial centers;
- ◊ part of the TAE project (trans-Asian-European fiber-optical communication line Shanghai-Frankfurt) is carried out on the territory of Turkmenistan. The line will pass through the territory of 20 states. National segments are already connected on Turkmen-Uzbek border and it is planned to connect it on the border with Iran at the end of 1997.
- ◊ State communication company "Turkmentelecom" will start to create a national network Internet/Turkmenistan ("tm" domain) in 1998. The network will have an access to international networks through a land station of space communication network "Intelsat". It is planned to use a channel with the bandwidth of 128 Kb/s. The most probable ISP will be an American Corporation MCI.

Several more years will pass prior to beginning of TAE maintenance, what will allow to accomplish respective design and scientific studies of information direction by that time, that are necessary

at a new qualitative level both for water economy of Turkmenistan, and for the state as a whole. It is necessary to note, that creation of computer monitoring systems of large irrigation and collector-drainage systems in conditions of Central Asian region is a challenge, taking into account their scope and ramified a morphological structure.

It is indicative that the first project of this kind for the Karakum canal, fulfilled by an English-Turkish group "Gibb-Temelsu" in 1995-97 at the expense of Japanese grant, was declared unsatisfactory and cannot be a basis for creation of information systems of such class.

Undoubtedly, a practical realization of the regional information system, its equipment with a complete set of water, economic, land data, creation of the ecological block, coordination with a complex of mathematical models, studying of other information system's hierarchical stages will take more than one year.

It is necessary to recognize, that this problem cannot be solved only by forces of the region's governmental organizations and should become a task not only for the following phase of WARMAP in 1998-99, but for other programs of EC, international sponsors and programs as well. To give an example, a basin information system of Nil river, which is rather simple in morphological structure (it covers main river flow and branched delta), was created during the period of 6 years and cost 18 million dollars. Information system in Mexico, which is planned to be created, is evaluated to cost 370 million dollars.

Abbreviations and Acronyms

BBS	-	Bulletin Board System
BVO	-	ICWC's Interstate Management Organizations
CAR	-	Central Asian Republics
EC ICAS	-	Executive Committee of the Interstate Council for Addressing the Aral Sea Crisis
Gidromet	-	Department of Hydrometeorology, Cabinet of Ministers
GIS	-	Geographic Information System
Goskompriroda	-	State Nature Protection Committee
ICAS	-	Interstate Council for Addressing the Aral Sea Crisis
ICWC	-	Interstate Commission for Water Coordination
IS	-	Information System
MinEnergo	-	Ministry of Energy
MinGeo	-	Ministry of Geology
Minselhoz	-	Ministry of Agriculture
Minvodhoz	-	Ministry of Land Reclamation and Water Resources
Minzdrav	-	Ministry of Health Protection
MIS	-	Management Information System
SIC-ICWC	-	Scientific Information Center of ICWC
WARMAP	-	EU TACIS Project "Water resources management and agricultural production in Central Asian Republics"
WARMIS	-	Subproject of WAPMAP "Water Resources Management Information System"
WUFMAS	-	Subproject of WARMAP for Water Use and Farm Management research