International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

Gis Application in Water Resourse Management in Uzbekistan

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***Abstract:** In present time geoinformation systems are used to solve various problems in various spheres of economy. The difference of GIS from other information systems is that all GIS modeled objects have spatial link, that allows to analyze them in connection with other spatially determined objects. Besides, GIS cardinally differs from most other information systems with that all the information in them is visually presented as electronic maps, allowing users to acquire new knowledge. [3,4]*

The article presents recommendations on possibilities to create "mobile application" or model to design agricultural crop irrigation at field level with the use of GIS. [1,5] In order to realize the solution for this task they offer the use of existing data from previously conducted research in the republic. There is a certain experience in the republic in creating spatial and climatic database for operation of various scenario models in water management and development of irrigation maps for agricultural crops and irrigation rates with respect to time for chosen rates of irrigation. [1,5] GIS application is the new means in management of data distributed in time and space, and for development of imitation systems on the basis of obtained data. GIS supports various user applications, it is very flexible in searching, analyzing and using water resources.

***Keywords**: soil map and irrigation basin map, hydromodulus region, water discharge, irrigation schedule, water saving.*

I.INTRODUCTION

Nowadays GIS is a crucial factor in development process of innovation methods for solving water resource scarcity problems. Based on collection and analysis of environmental data GIS allows water resource management specialists to create more accurate water forecasting models. Thus, one of the basic functions of GIS is obtaining information on a site chosen from the map. For example, by pointing the cursor on an irrigated land on the map in computer screen, a detailed information can be obtained about water discharge, water demand and rate for a crop, irrigation schedules and etc.

While there is a deficit in water resources, water management organizations must provide water users with opportunity to estimate current water reserve condition, so that they could know how water distribution among water users is accomplished and provide information transparency. In order to solve such problem there came up a necessity to create "mobile application" with the use of GIS, so that all the information on water consumption in field can be obtained instantly with a click of a button on the phone.

After becoming an independent country Uzbekistan have set technical collaboration with international institutions in water resource management sphere. [7,8] In collaboration with international institutes IWMI, NITS MKVK, agencies USAID (USA) and CGIAR (European Union) various research work are done on improvement of water resource management in Uzbekistan. For instance, European Union Program "Sustainable management of water resources in rural areas of the Republic of Uzbekistan" is accomplished with the involvement of German society on international collaboration (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH), International Water Management Institute (IWMI), Council for Agricultural Research and Economics (CREA, Rome, Italy), Austrian Agency on environmental protection, Austria. [1,2]

The given program covers the use of land and water resources in six regions of the republic and gives the evaluation on their use and condition in present level. Recommendations have been developed on the improvement of land and water resource use with the modern GIS technology applications. The realization of the given project from 2010 to 2016 has taken place in six regions of the republic, Water Users Associations of three regions and in six Demo sites (Fig.1)

The materials of the project can serve as the basis to create a "mobile application".

Manuscript received on February 10, 2020.
Revised Manuscript received on February 20, 2020.
Manuscript published on March 30, 2020.

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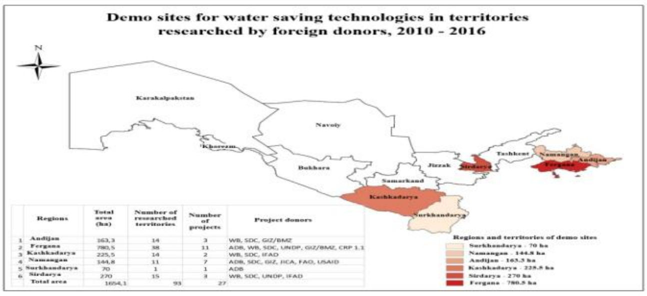

Figure 1. Demo sites of project "Sustainable management of water resources in rural areas of the Republic of Uzbekistan".

II. DATA AND METHODS

Materials from projects accomplished in the republic, science articles of local and foreign authors, internet materials on the subject were used in order to conduct the research. Study of science data was conducted with the use of comparative and system analysis method and logical approach.

III. RESEARCH RESULTS

Evaluation of Geoinformation System (GIS) application capabilities in the sphere of agricultural water use in the republic. GIS systems based on radio technologies, such as telemetric sensors, are among the main sources of information about Earth's atmosphere and environment. Remote sensing technologies together with wireless satellite systems, Global Positioning Systems (GPS) and GIS are helpful in finding new sources of fresh water. Nowadays various GIS application models are created in many countries in the field of agricultural water use. In the republic we have an experience in GIS application with the use of ISAREG and WINISAREG models to develop a design for agricultural crop irrigation on field level. ISAREG model is a non-distributed water balance model for designing agricultural crop irrigation on field level under optimal conditions or during water deficit.

WINISAREG is the version of the model for Windows, which contains two support programs, one is for corresponding input data on agricultural crop KCISA, the other is for designing the etalon evapotranspiration EVAP 56 with FAO Penman-Monteith method. Optimal irrigation rates are set by FAO 56 method (CROPWAT-8 program). Comparison of actual irrigation regime is compared with optimal irrigation rates.

GISAREG is a Geographical Information System (GIS), based on compilation of ISAREG and KCISA, developed for application in Aral Sea basin as a support for application of improved irrigation management in the area. Integration concerns creation of spatial and climatic database, functioning of models for various water management scenarios and development of irrigation maps for agricultural crops and irrigation rates depending on time with chosen aggregation regimes. Therefore, the resulting information on alternative irrigation schedules is spatially distributed and is used to identify methods, leading to water saving and providing salinification control.

Application examples of surface irrigation model in Uzbekistan are presented within the project "Sustainable management of water resources in rural areas of the Republic of Uzbekistan" (2010-2018), which is successfully tested in Central Asia. Project executors have described the use of WINISAREG. When design procedure is used within the scope of region, it becomes hard and slow, since large number of combinations for characteristics for fields and agricultural crops must be considered in the design. In spite of this, spatially distributed characteristics of input data, required by ISAREG and KCISA, make their integration with Geoinformation System (GIS) particularly attractive and useful. As a result, assuming that each field is homogeneous, there is a possibility to call up a model for each treated field, presented in the field section of GIS. Then, using the diversity of distinctive features the application scope of obtained results can be widened. It is the main technique, accepted in GISAREG, which is a GIS version for ISAREG model. GISAREG application was developed within the scope of the given project. The specific goals include design of distributed requirements for agricultural crop to irrigation, support information for farmers and managers, related with alternative techniques for design of water saving irrigation schedule and modeling the requirements, aggregated in the main joint points of irrigation system canals.

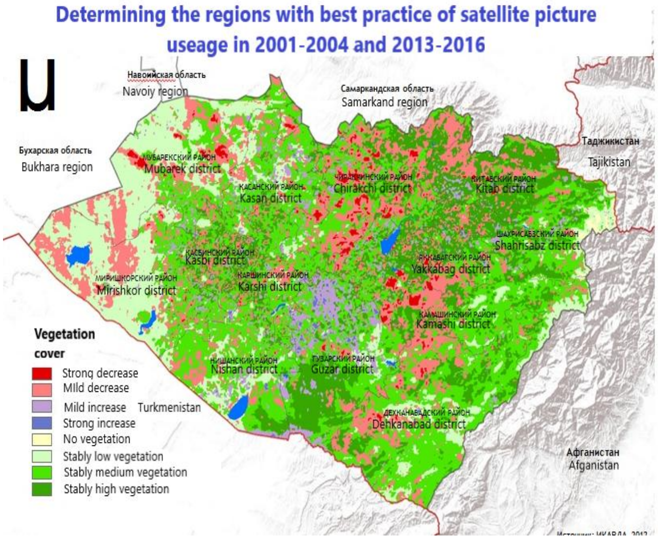

Figure 2. Land vegetation cover topographic map of Uzbekistan.

ISAREG model design irrigation schedules according to user determined options, such as: determination of irrigation schedule on maximal crop yield criteria, including allowable water stress and corresponding water limits, set during certain periods, evaluates the influence of the given schedule on crop yield and water use, checks model characteristics on the basis of soil humidity observation data and actual irrigation times and rates, carries out the design of water balance for irrigation of net field, including the use of frequency analysis of irrigation requirements with consideration of evaporation water loss.

Retrieval Number: F7714038620/2020©BEIESP
DOI:10.35940/ijrte.F7714.038620
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

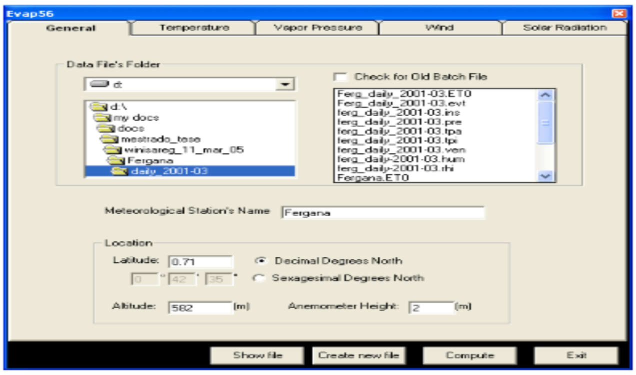

Figure 3. Main menu for calculating E T_c

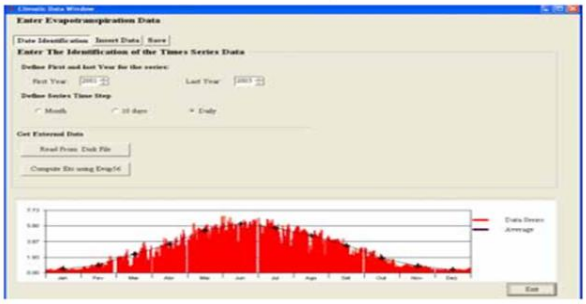

Figure 4. Window for inserting data and familiarizing with calculated E Tc

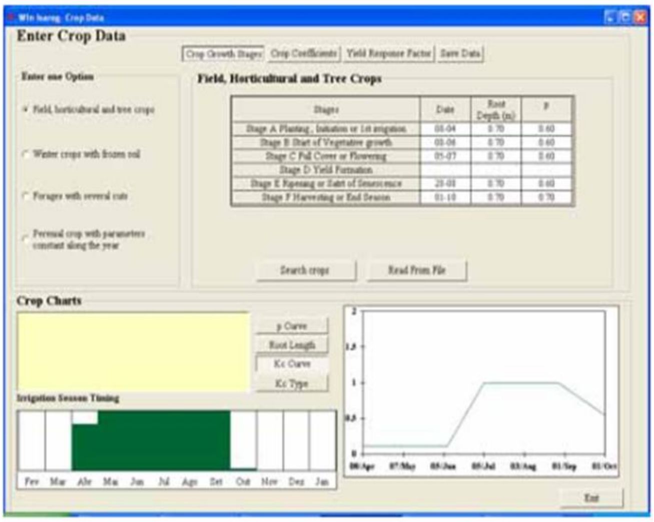

Figure 5. WINISAREG interface for agricultural crop data.

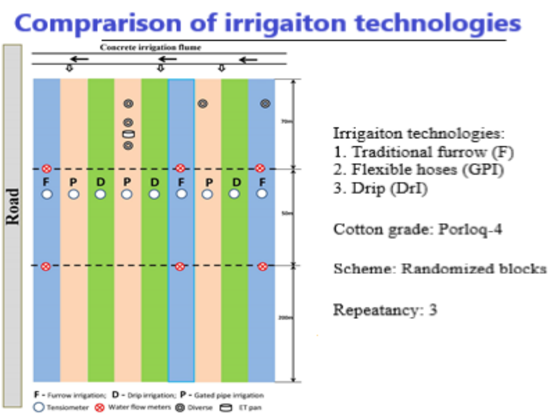

Figure 6. Comparative analysis of irrigation technologies.

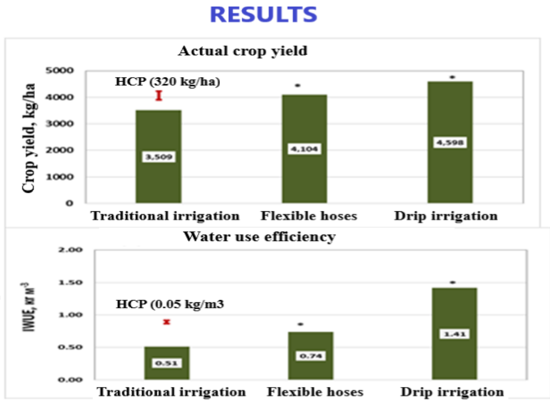

Figure 7. Results obtained with GIS application.

IV. RESULTS AND DISCUSSION

When using information systems for irrigation purposes it is possible to obtain actual, accurate and complex information about irrigation infrastructure objects [1-7]. Geoinformation system allows to keep record of water resources, register property rights and relations, carry out information exchange of data with government organizations [8].

The information system will include software programs, technical means, cartographic database and information exchange canals. The article gives short description of developed information system, which includes data necessary for project development and modeling processes, related with agricultural crop irrigation.

The system structure and its development process consists of three steps:

step 1 – development of topology for the territory under study; step 2 – monitoring, required for regular replenishment of information; step 3 – building GIS and database for models and decision making systems.

GIS for water resource management is built by water and land resource management hierarchy and water use objects related with them, and also by the level of formation and use of water resources.

GIS allows to carry out control of corresponding factors of main four levels of hierarchy of the existing water management:

Level 1 – Farmlands, including separate fields;
Level 2 – Water users association (WUA);
Level 3 – Innerfarm irrigation network;
Level 4 – Interfarm irrigation network.

Each level contains corresponding database, intended for centralized storage and management of interrelated data complex, which adequately reflects the condition of objects of given level and relations between them.

When used in water resource management field, various subsystem types may be included in information system:

• cartographic subsystem: standard geoinformation operations with spatial objects, service cartographic operations, operations on technical record objects, data management, determination of the length of irrigation network and factors, characterizing the condition of separate fields, factors of agricultural production in irrigated fields, factors of technical level of innerfarm irrigation network;

• record subsystem: database includes all the main parameters for functioning of the existing water users' associations. Factors of financial provision of operational expenses of collector and drainage network, even water supply by farm groups (vegetation, inter vegetation periods) are used as the main factors;
• technical record subsystem: factors by irrigated and drained areas, factors reflecting the condition and dynamics of reclamation condition of irrigated fields and technical means in typical farmlands and etc.
The main function of database is to assist on production of estimates for the efficiency of existing WUA operation (farm groups) and justification of the efficiency of newly created WUA;

• modeling subsystem: formation of regions for irrigation network cutoff and providing the analysis for their optimization; operative formation of actual cutoff regions;
• monitoring subsystem: providing global (reviewing the main information), local (reviewing fundamental schemes) and detailed (reviewing each element and technical specification) control;
• administrative subsystem: introducing user lists, managing user records;
• maintenance subsystem: integrated inspection of irrigation networks and water intake, control structures, formation of water use plans, presentation of records for accomplished works.
• modeling subsystem for water supply volumes: database includes all the main parameters for functioning of water management organizations (systems). The main factors are those reflecting water intake volumes from irrigation sources for each administrative unit and main canal, factors defining water supply volumes to irrigation (required water supply volumes, allocated limits, actual volumes) for each administrative unit and water source, technical efficiency coefficients and volumes lost due to organization, factors defining financial and economic activity of water management systems for each structural subdivision.

If the mobile application is loaded main menu appears on screen, as well as Menu, from which the other blocks can be started. The Main menu defines the farmland (irrigated field borders), for which water distribution parameters must be designed. Menu options are given below in a table form:

Table 1 Database Option Menu:

Submenu	Options
Selecting land from GPS	Connecting by coordinates using Arc Catalogue
Determining the structure of irrigation system	Discharge charts on hydropost. Irrigation charts for fields. Inflow to contour
Hydromodule regions	
Established irrigation rates	Discharge in canals. Comparative
Measuring devices	charts "Quota/Plan".
Model design	Comparative charts
Climatic and hydraulic data	"Actual/Quota/Plan". Discharge
Graphs	records for hydropost
Start design	Mathematical model, designing
Manuals:	water supply plan to fields
Methods and recommendations	CROPWAT
Instructions for users by systems	ISAREG
Selecting database (by year)	GISAREG

V.CONCLUSIONS

The use of GIS capabilities (with the use of mobile application) allows to apply them to solve various tasks, related with water resources:
1. Providing users with real, complex technical and spatial information on water use at field level;
2. Keeping record of database on forecasting and discharge of water in irrigation network, on water needs and setting irrigation time for agricultural crops;
3. Keeping record of consumed water, amount and quality of irrigation.
4. Record each canal and their parameters into database;
5. Determine set of parameters for each irrigated field. Information, determined for experimental field is passed over to a mathematical model to design a plan. At the exit the designed plan is passed over to database and presented to GIS user.
6. Download the mobile application into smartphone.

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