

UDC 504.064.36:574

D. Abiyeva, V. Bensman

The «Ecoserv. ICE-S» LLP

### **Generation and plans for development of system of ecological and demographic survey and radiation monitoring of rural communities in the Republic of Kazakhstan**

**Abstract.** The article contains description of objectives in designing technical and functional architecture of the information system, created for the field and laboratory data processing by ecological and demographic projects inspection and radiation monitoring of rural communities the Republic of Kazakhstan. The system development program includes the information-based analysis and geographic information subsystem development.

**Keywords:** ecological and demographic survey, radiation monitoring, rural community, information system, geospatial data.

Since 2008 the ECOSERVICE-S company by the order of the Ministry of Environmental Protection of the Republic of Kazakhstan deals with ecological and demographic survey (EDS) and radiation monitoring (RM) of the rural communities (RC).

The EDS of the RC project objectives are concentrated on ecological and demographic inspection of rural communities and projection of rural communities passports as a basis for decision-making in administrative issues aimed at improvement of living conditions of the rural community.

The RM of the RC project objectives are focused on radiation monitoring and data accessing, disclosing the radiation situation of the rural community territories for managerial decision-making and projection of the radiation sanitary passports.

In the frameworks of the aforementioned projects the company has to collect process and analyze a big data content, as well as specific data.

In 2010 the first series of the information system of ecological and demographic survey and radiation monitoring of rural communities was developed and

introduced (hereinafter referred to as the IS EDS and RM RC or the System).

The system has been constructed to provide methodical/systematic maintenance of the aforesaid projects and solve the following problems:

- improvement of quality of information loading by the projects;
- decrease of time for data processing and data analysis, estimation and preparation of reported data, both for special data interfacing and geographic information systems/programs analysis;
- information reservation in EDS of RC and RM in the unified data base allows to find out general disposition in initiation of ecological problems and planning nature-conservative measures.

The IS EDS and RM RC has been developed on the basis of the following principles:

- application of the unified open industrial standards;
- scalability;
- structure modularity, ensuring maximal flexibility that allows to use the existing typical decision-making and to dynamically develop the system according to changing requirements.

**1. Technical architecture of the system.** The

IS EDS and RM RC implies the client-server multifunctional system. The system components are:

- a workstation of the user, organized in the WEB browser;
- application server (webserver);
- database server.

The internal computer network, Internet shall be used as a communication facility between subsystems. The Transfer Control Protocol/Internet Protocol TCP/IP, Internet protocol stack shall be used as a track protocol of networking and internetworking.

The Apache Tomcat shall be used as a self-contained web-server, lightweight application server and server content. The PostgreSQL has been chosen as a database server that is a free alternative to the commercial database management system DBMS of the enterprise level having compatibility with the ArcGIS.

To develop and perform applications of the IS EDS and RM RC, the Java platform J2EE shall be used to create the enterprise level applications that also denotes programming language. The use of the Java platform shall ensure flexibility in selection of the application architecture, applied decision-making, self-sufficiency from a certain software supplier/vendor and is the best applicability to the specific architectural requirements. The software programs, designed in this language, are operated in different operation systems without code changing and recompiling.

The Apache Wicket, a framework for designing web applications, a public code product that shall be used for development of the IS EDS and RM RC. The main focus made on the Wicket projection oriented for rapid application development with the complicated user interface.

## **2. Functional architecture of the system.**

The system architecture is based on principles of complex systems construction and represents the integrated set of modules with specific functional directivity.

The first stage of the IS EDS and RM RC consists of 6 basic modules.

- The Module «Administrative and Territorial Objects Classifier (ATOC)» shall serve to display

and edit the hierarchical tree of communities of the Republic of Kazakhstan. The ATOS code shall be used as a unique key output data interface of the System and geographic information system GIS, the project data of the EDS and RM RC.

- The Module «Field Data» shall serve to register and account the field investigations data system by the EDS RC and RM RC projects.

- The Module «Sample Analysis Results» shall serve to input and analyze results of the laboratory samples research.

- The Module «Regulatory, Reference and Methodical information» shall serve to register level of standardized contamination of water, soil, vegetables, safety standards, document registration that are the motive for standardization.

- The Module «Reporting» shall serve to prepare reports on the basis of data, kept in the System.

- The Module «Administration» shall serve for access control to information resources of the System according to user permissions, as well as registration of user activity.

- A functional list of the Module «Administrative and Territorial Objects Classifier (ATOC)»:

- The Function «Display of ATOC». The ATOC shall be displayed as a hierarchical tree (Republic, district, region, RC, LD (country/rural or other community).

- The Function «Addition or editing of the ATOC object». The Function shall serve to register the object missing in the ATOC at the moment of loading into the System or editing the ATOC when renaming or converting/transcoding. Before entering the ATOC coding it is necessary to check accuracy of entering codes of regional object, district by the type of the object.

- The Function «Deleting and restoring of the ATOC objects». The function shall serve to delete officially non-existing objects in the ATOC tree and restoring mistakenly deleted objects of the ATOC.

- The Function «Search of the ATOC object». This Function shall assist to find an object in the ATOC tree by its name or by the ATOC code.

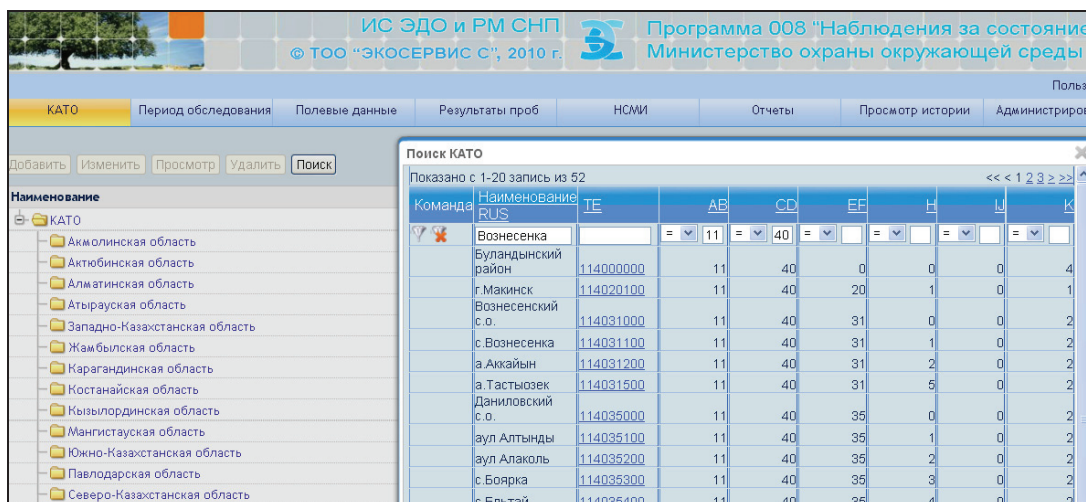


Figure 1 – The search of objects in the ATOC tree

The Field Data Module consists of 7 sub-modules, four of them are general for the EDS of RC and RM of RC projects.

The Field Party Recording sub-module shall serve to input parties that conduct field investigations into the information system.

The General Data Log sub-module shall serve to register in the system of common data by the RC and rural/country community, data by types of man's impact, statistical and other data associated with conditions of the rural community, obtained by analyzing statistical and stock data.

The Records of Ecological Inspection sub-module shall serve to register data about inspection of ecological situation of RC. The functional list of the Records of Ecological Inspection sub-module:

- The Description of housing stock situation function.
- The Description of roads function.
- The Description of living conditions function.
- The Description of public objects function.
- The Description of economic objects function.
- The Description of solid domestic waste/disposal function.
- The Description of storing place of pesticides function.
- The Description of oil pollution areas function.

The Records of sampling sub-module shall serve to input data about areas of collection of water

samples, soil samples, vegetable sampling and form unique composite sample numbering.

The Records of Radiometric Survey (RS) sub-module shall serve to register Radiometric Survey data by the EDS and RM of RC projects. The functional list of the Records of the RS sub-module:

- The Loading of gamma-radiation survey data function shall serve to load gamma-radiation survey data in the system from file in Excel format, which, in its turn, shall be formed when offloading data from GPS system.
- The Description of anomalous radiation areas function shall serve to register specification of quantity and qualitative characteristics in anomalous areas, data about areas of collection of soil samples for radionuclide testing.

The aggregated Data on Findings of Investigation sub-module shall serve to form and browse the aggregated data system by survey notes within RC, rural district, region, area. The reports can be exported into Excel format.

The sub-module "Records of Radiation Monitoring (RM)" shall serve to register the system of measurement data of radon in water, radon and gamma radioactivity in living accommodation/housing premises.

The functional list of Records of RM the sub-module:

- Registration of measurement results of radon in water.
- Registration of immediate measurement

results of radon and gamma radioactivity in living accommodation/housing premises.

- Registration of integral measurement results of radon in living accommodation/housing premises.

The Normative and legal reference data module consists of 3 sub-modules:

- «Reference manuals of contaminants»,
- «System analysis manuals»,
- «Reference manuals of measurement data values»,
- Normative and legal, methodical documentation”.

The system implies automatic identification of pollution at the moment of making analysis of contaminant measurement data and pollution index. All archives of measurement data values are accessible for browsing. The functional list of the Reference manuals of measurement data values sub-module:

- Estimation of measurement data values of specific impurities in air.
- Estimation of measurement data values of water contaminants.
- Estimation of measurement data values of organoleptic and physicochemical parameter of drinking water.
- Estimation of measurement data values of soil contaminants.
- Estimation of measurement data values of vegetable contaminants.
- Estimation of measurement data values of radon in water and in living accommodation/housing premises.
- Estimation of measurement data values of active interference of radionuclide's.

The sub-module “Normative and legal, methodical documentation (NLMD)” shall serve to register and store the systematic data of documents that are subject to registration of measurement data of contaminants.

The Results of sampling module consists of the following sub-modules:

- The Registration of laboratories sub-module.
- The Results of sampling sub-module shall serve both to display a list of sampling, registered in the Survey Notes module by separate investigated district and to activate interface of sample analysis results registration.
- The Records of measurement data values of air pollution sub-module.

- The Records of displaying measurement data values of water sub-module shall serve to display evaluated and calculated data of the reduced chemical analysis of water, water analysis results for the subject of presence of chemical contaminants, as well as pesticides, value of specific cumulative alpha and beta-activity of the of water sampling, activity value of radionuclides in water. The function shall ensure matching of measurement data values and setting up a filter (specific selected conditions) for analysis of values.

- The Records of browsing RM of water analysis results sub-module.

- The Records of browsing soil analysis results sub-module shall serve to identify results of analyzed soil sampling for the subject of presence of chemical contaminants, results of processing soil samples, collected from different depths of soil cutting on anomalous radioactive sites, from areas of oil pollution. The function shall ensure matching of measurement data values and setting up a filter (specific selected conditions) for analysis of values.

- The Records of browsing vegetable analysis results sub-module.

- The Records of browsing air analysis results sub-module.

The Modules output data of the first series of the IS EDS and RM RC shall be used also for analysis of the desk-mounted GIS applications (ArcGIS Desktop). On their basis both the maps of actual materials (Figure 2, 3), based on a chain of events and analytical, cartographic materials have been developed.

**3. Plans for development of system.** Currently, the works have been started, connected with the system development by elaboration of the information and analytical and geographic information subsystems.

The information and analytical subsystem shall consist of the following components: analytical data storage, expertise and modules of decision-making support.

The data warehouse is a subject-oriented information data base, based on operations of data extraction, data transformation and data loading (ETL – extraction, transformation, loading) from the industrial OLTP system (OLTP that means Online Transaction Processing). Construction of analytical data warehouse of the IS EDS and RM RC allows performance of requests connected with resolution of tasks of expertise and managerial decision-

making process without loading industrial system and dereliction of its stability.

The Module “Expert knowledgebase” shall serve to form knowledgebase by the EDS and RM RC projects in the way of rules of problem identification and risks evaluation, as well as rules of automatic support for decision-making process.

A list of sub-modules:

- Tree of problems.
- Rulebase of problem identification.
- Identification of objectives and a list of measures.
- Rule base by option of measures.
- Construction of the decision-making tree models for selection of better steps for solution of problems.

The decision-making support modules shall provide ultimate users through the WEB-interface problem identification options of RC by the projects and identification of better steps for solutions of

problems, set-up and browsing the information dashboard, based on application of analytical data warehouse and expertise.

The GIS subsystem shall be developed on the basis of application of the ESRI server-products. The following options will be accessible in the GIS subsystem:

- Access, browsing and analysis of the cartographic input data, areas of radiation background measurement, areas of water samples, oil samples, vegetable samples, routes of ecological threats.
- Search and selection of the ATOC objects and browsing analytical information concerned (a list of problems and advisable actions).
- Creation of dynamic analytical maps for integral evaluation of ecological condition of rural communities.
- Application of analytical models of geographical data processing for selection of better decision.

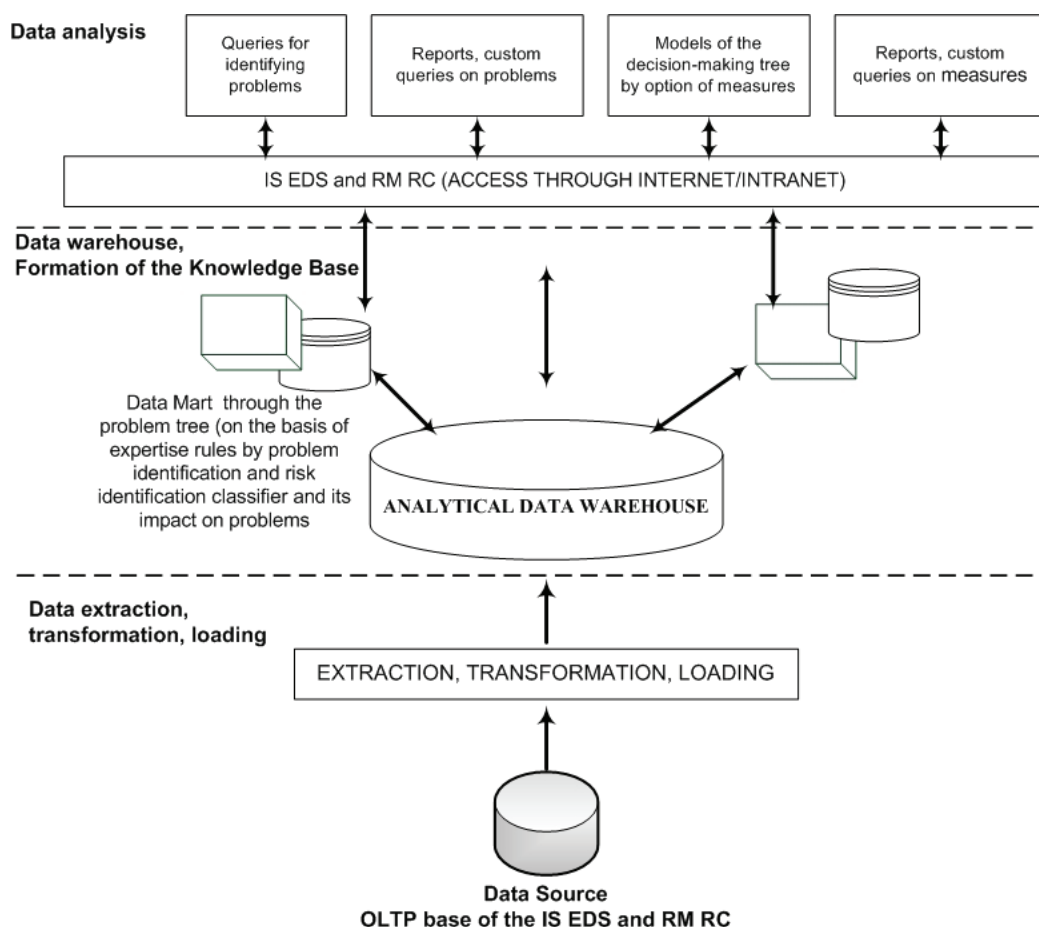


Figure 2 – Architecture of the information and analytical subsystem IS EDS and RM RC

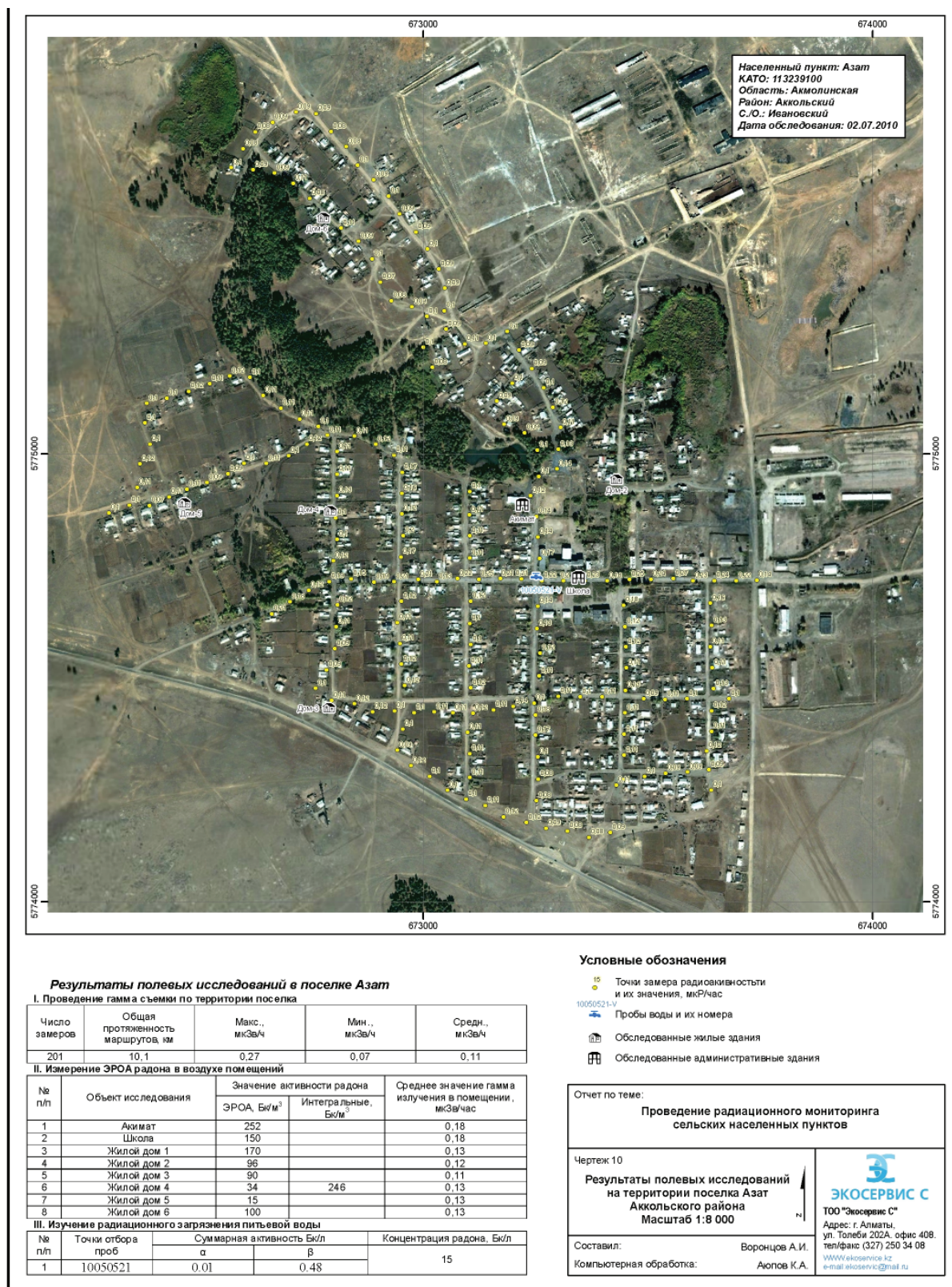


Figure 3 – Sample of a map of actual material by the RM of RC project

Application of the IS EDS and RM RC ensures not only qualitative input and data processing of the projects, but also allows a large group of potential users (public authorities) to use actual

and analytical projects data for information and cartographic decision-making support for improvement of ecological and radiation situation in rural communities.

**Д. Әбиева, В. Бенсман**

**Қазақстан Республикасының ауылдық елді мекендеріне радиациялық мониторинг пен экологиялық-демографиялық зерттеу жүргізудің ақпараттық жүйесін жасау мен дамыту жоспары**

Мақалада Қазақстан Республикасының ауылдық елді мекендеріне радиациялық мониторинг пен экологиялық-демографиялық зерттеу жүргізу жобасының зерттеу нысандары бойынша далалық және зертханалық деректерді өндеуге арналған ақпараттық жүйенің техникалық және функционалдық архитектурасын жасау мақсатында түсінік берілген. Жүйені дамыту жоспарына ақпараттық-аналитикалық және геоақпараттық қосалқы жүйелердің талдамалары енгізілді.

**Д. Абиева, В. Бенсман**

**Создание и планы развития информационной системы эколого-демографического обследования и радиационного мониторинга сельских населенных пунктов Республики Казахстан**

В статье дано описание целей создания, технической и функциональной архитектуры информационной системы, созданной для обработки полевых и лабораторных данных по объектам обследования проектов эколого-демографического обследования и радиационного мониторинга сельских населенных пунктов Республики Казахстан. В план развития системы включена разработка информационно-аналитической и геоинформационной подсистем.