3 - KNOWLEDGE BASE OF THE PROJECT"CROP IRRIGATION MANAGEMENT FOR COMBATING DESERTIFICATION IN THE ARAL SEA BASIN"

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Abstract: Collection and processing of information on 281 research projects implemented in Central Asian countries have resulted in creation of the CIRMAN-ARAL project's knowledge base. This database is designed for effective application of the information available and thus achieving more efficient water resources use aimed at ensuring sustainable development of food production in the region without causing damage to nature. The knowledge base also incorporates information data on updated methods to improve the efficiency of water use in agriculture both at field and irrigation system levels, and includes models and respective manuals developed for the project on "Crop irrigation management for combating desertification in the Aral Sea Basin".

Keywords: Knowledge base, Rubricator SRSRI, Irrigation and drainage, Desertification, Environmental impacts.

Introduction

A great deal of information has been already accumulated in Central Asian countries concerning virtually all issues pertinent to water management and water use, particularly in irrigated agriculture. However, application of these materials is a rather arduous exercise since for the most part they are unsystematic, scattered, hard-to-reach and non-adapted to computer processing. At the same time, it should be noted that water professionals and decision makers often lack the opportunity to carry out - just as researchers do – in-depth and detailed studies of findings accumulated by science and practice; they need to obtain such information in an easy-to-use and popular form. The general concept of initiating the knowledge base consists in converting the expertise

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accumulated by professionals in the field of land reclamation and water management into a more formal programming language (or a special language of presenting knowledge), and, as far as possible, with minimal supplements.

One of the efforts along these lines is the activity implemented by the International Program for Technology and Research in Irrigation and Drainage (IPTRID) aimed at developing the WCA-InfoNET informative resource in Internet to provide direct access to a wide range of knowledge in the field of land reclamation and water management. The knowledge base created within the CIRMAN-ARAL project ("Crop Irrigation Management for Combating desertification in the Aral Sea Basin") reflecting long-term experience of Central Asian specialists, coincides in many respects with WCA-InfoNET as to the subject-matter.

Collection, processing and dissemination of information implemented within the CIRMAN-ARAL project with regard to researches carried out in Central Asian region have contributed to information support of the ultimate objective of the project – development of practical recommendations on ways and methods to combat desertification, mitigate impacts of drought and facilitate sustainable development of agriculture through efficient water use in irrigated agriculture.

Goals

The goal of the Operational Pack-1 (OP-1) in the CIRMAN-ARAL project was to create the knowledge base reflecting Central Asian research performed in the past with respect to major themes of the project such as desertification and impacts caused by irrigation. The developed database consists of the following components:

- Subject-matter tree of the knowledge base – constructed on the basis of the rubricator (developed purposefully by the authors) on land and water resources use;
- Set of classified factors and implications - relevant to principle notions incorporated within such topics as "Desertification and monitoring of the process", "Impacts caused by irrigation on various types of water resources", "Methods of irrigation";
- Explanatory (terminological) dictionary – as a supplementary informational structure, providing definitions for notions applied;
- Bibliography - references to books, articles, and abstracts relevant to each definition and phenomenon/occurrence;
- List of projects – implemented in the given domain of knowledge and their description.

Methods

The following methods were applied step-by-step in the development of the knowledge base:

1. *Problem identification* (familiarizing the team of developers with the subject-matter and training, so working out informal wording for the problem). It includes:
   - refinement of goals;
   - planning of procedure for developing a knowledge base prototype, determining necessary resources (time, man-power, PC, etc.);
   - determining sources of knowledge (books, additional experts, and methodology), availability of similar information systems, classifiers, and goals (experience dissemination, automation of chores, etc.).
2. *Knowledge extraction* (obtaining most comprehensive idea about the knowledge domain and the relevant decision making mode). Expert knowledge is transferred to knowledge engineers through applying various methods such as texts analysis, dialogs, expert games, lectures, discussions, interviews, observations, etc. The basic procedure was texts analysis with the object of extraction and classification of knowledge, including:
   - Compiling the "basic" list of literature for getting acquainted with the knowledge domain and reading listed items;
   - Selection of a text for knowledge extraction;
   - A cursory examination of the text and framing an early hypothesis about structure of the text;
   - A perusal of the text in order to single out key words and expressions, i.e. to extract "notional landmarks" (text compression);
   - Identification of relations between key words, development of the text macro-structure in a graph form or "compressed" text (abstract);
   - Field of knowledge generation on the basis of the text structure.
3. *Structuring or conceptualizing of knowledge* (elaboration of informal description of knowledge about data domain in the form of a graph, table, scheme, diagram or text, reflecting principle conception and interrelations between notions in the data domain). Elaboration was carried out as to several most crucial branches of the knowledge tree regarding themes on "Desertification and monitoring of the process", "Impacts caused by irrigation on various types of water resources", "Methods of irrigation".

Terminology concomitant with these themes was specified. The material was represented in the form of an Explanatory (terminological) Dictionary with bibliography references. Conceptual definitions were set into the knowledge

base as generally accepted terms and explanations, which can serve as universal throughout the world.

Construction of the knowledge base tree takes into consideration hierarchical structure of interrelated elements of the knowledge domain and phenomena, as well as current coding and classification systems in the countries where the present studies have been carried out and the countries – recipients of this knowledge.

Classification of information for the knowledge base according to «*GRNTI-SRSRI*»[3]

Hierarchical classifications have been ranking high in the structure of information systems. Regulation and application of hierarchical classifications at the State level was carried out through introduction of *GOST*-7.44-84 "Systematization of Documents; General Requirements" and later of *GOST*-7.59-90 "Indexing of Documents; General Requirements to Systematization and Itemizing". According to this *GOST*, libraries, agencies working with scientific-technical information and other organizations are supposed to apply one or several universal systems of classification, selecting from the following list: - the State Rubricator (SR); - the Universal Decimal Classification (UDC); - the Library-Bibliography Classification (LBC); - the International Classification of Inventions; - the Standards and Technical Classification. Each hierarchical classification takes into account specific features relevant to various contexts of systematization and is applied within a certain domain of activities.

The State Rubricator of Scientific-Research Information (SRSRI) has been chosen to classify materials of the knowledge base on land and water resources of the Aral Sea Basin. The Rubricator represents a complex hierarchical classification system pertinent to various fields of scientific activities that has been applied to systematization of documents and their submission in data bases and informational publications. In essence, it is an information retrieval language of the classification type with hierarchical structure and multi-subject contents. Every level (but the first one) provides for spare positions – thus enabling to input new rubrics in the process of running the Rubricator (its improvement and development) leaving unchanged codes of existent rubrics. The indices system is represented by groups of two-figure numbers divided by dots; Arabic numerals are used.

[3] Choice of the Rubricator-"SRSRI" (The State Rubricator of Scientific-Research Information - *Gosudarstvennyi Rubricator Nauchno-Tehnicheskoy Informatsii – GRNTI*) has been determined by formation of CIS that substituted the former USSR – newly independent states concluded agreements on "Standardization and scientific-technical information" stipulating former *GOST* (State Standards) to remain valid for all CIS countries; as to new standards they are to be developed jointly in the capacity of international standards.

Results

The SIC ICWC coding system (rubricator) is represented in Table 1. In addition, to classify information materials, the following chapters of the SRSRI Rubricator were used: - 68.00 – Agriculture and forestry; - 70.00 – Water management. With respect to the implemented and current projects - along with the above mentioned rubricators – a serial coding system was used employing key words and references (an example, describing a past project is given Table 2).

Table1. SIC ICWC Rubricator for irrigated agriculture.

SIC code	Rubric	Codification SRSRI
01.00	Irrigated agriculture	68.31.21
01.10	*Water resources*	*70.21.09*
01.10.01.	Surface waters	70.27.07
01.10.02	Groundwater	70.27.07
01.10.03	Return waters	70.27.07
01.10.04	Discharged waters	70.25
01.15	*Quality of water*	*70.27*
01.20	*Irrigated lands*	*70.21.41*
01.20.01	Soils	68.05
01.20.01.10	Regulation of soils' water regimes; moisture balance in soils	70.03.15
01.20.01.13	Filtration and infiltration in soils	70.03.17
01.20.01.15	Dynamics of water regime; water-salt regime of soils	70.03.21
01.20.02	Fertility	68.05.23
01.20.03	Agricultural crops	68.35
01.20.05.10	Water use	70.03.11
01.20.05.15	Crop rotation	68.29.07
01.20.05.20	Yield	68.29.23
01.30	*Irrigation*	*70.21*
01.30.01	Infrastructure	70.21.15
01.30.02	Irrigation systems and management	70.21.15
01.30.03	Methods of irrigation	70.21.31
01.30.09	Impacts of irrigation on various types of waters	70.01.94
01.40	*Salinity*	*68.05.41*
01.40.01	Types of salinity	
01.45	*Methods of combating*	70.21.39
01.45.01	Drainage	70.23
01.45.01.10	*Types of drainage*	*70.23.39*
02.00	*Desertification and monitoring of this process*	
02.01	Causes for desertification	
02.01.10	Natural (climate aridity processes, aeolian transfer, salt accumulation)	
02.01.15	Anthropogenic (deforestation, overgrazing, technological disturbances)	
02.02	Indicators of desertification	
02.03	Criteria	
02.04	Methods of monitoring	
02.04.10	Ground-based measurements (taking soil samples and salimeters)	
02.04.15	Remote sensing (air and space)	

Table 2. Example of description format for accomplished projects.

Descriptor of SIC ICWC	PP00061
Project's Name	Study on efficiency of mineralized drainage water use in localities of their formation
Location	Collective farm named after "22nd party congress", Buvaida district, Fergana province, the Republic of Uzbekistan
Rubric (by SRSRI)	70.03.21; 70.27.07
SIC ICWC Code	01.10.03
Project duration	1976-1986
The head of the project	Murat Yakubov, Water Problems Institute, Uzbekistan's Academy of Sciences, F. Hodjaev street., 25a, 700143, Tashkent
Abstract of the project's contents	Studies were carried out to determine possibility and effectiveness of mineralized drainage water use in localities of their formation with the purpose of reducing volumes of return flow discharge. Experiments were conducted on managing soil water-salt regimes while using mineralized water for irrigation and leaching as well as on managing water quality of drainage flow. Climate – sharply continental. The area – net 94 ha. Irrigation network – concrete flumes. Drainage network – surface, horizontal. Specific length - 45 m/ha. Depth of drains laying – 2.5-3.0 m, collectors – 4.0 m. During experiments slow desalination of soils was achieved under maintaining leaching regime of irrigation in annual and long-term cycles. Mineralization of groundwater decreased from 15 to 5 g/l. Mineralization of drainage waters decreased from c 8-10 to 4-4.5 g/l. Set regimes of irrigation along with improvements of farming technologies and land reclamation allowed achieving increase in cotton yield from 0.7-0.8 t/ha (1977) up to 2.8-3.0 t/ha (1986). Scientifically grounded recommendations were worked out aimed at optimization of ameliorative regimes and improvement of irrigated land productivity under mineralized water use for irrigation.
Key words	Irrigation regime; water/salt balance; drainage flow; mineralized waters
Bibliography	Usmanov, A. U., Bekmuratov, T. U., *Use of waters pumped out from vertical drainage wells for irrigation of long-irrigated land in Ferghana Valley* – Collected works of SANIIRI, issue №160, 1980, pp. 43-49. Yakubov, M. A., *Water-salt regime's dynamics of soils under long-term use of mineralized waters for irrigation in conditions of the central part of Ferghana Valley* - Collected works of SANIIRI, issue №173, 1985, pp. 123-136.

The sub-chapter "Irrigated agriculture" of the "Land and Water resources of the Aral Sea Basin" knowledge tree, created on the basis of the Rubricator, is represented by Fig.1. The created set of classified factors and implications relevant to principle definitions (subject, phenomenon/occurrence, etc.) of development within such topics as "Desertification and monitoring of the process", "Impacts caused by irrigation on various types of water", "Methods of irrigation" is shown below (Fig. 2, 3 and 4).

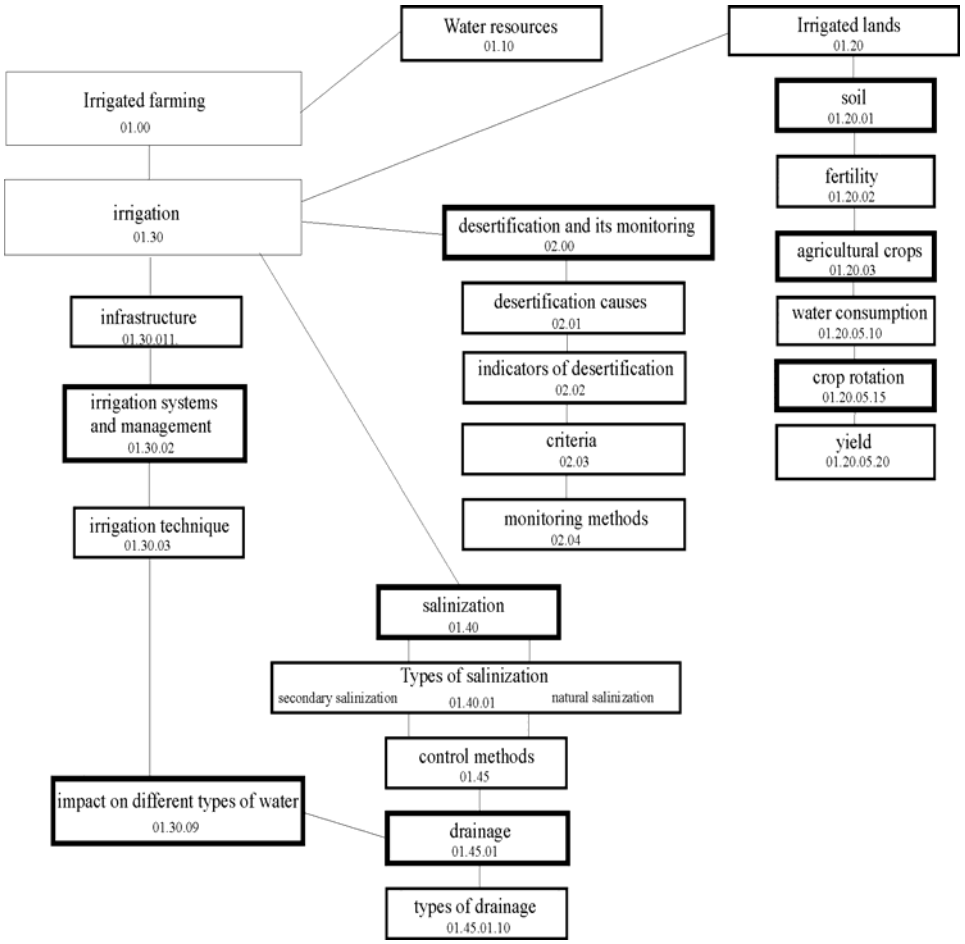

Fig. 1. Base of knowledge "Land and water resources of the Aral Sea Basin" sub-section Irrigated Farming.

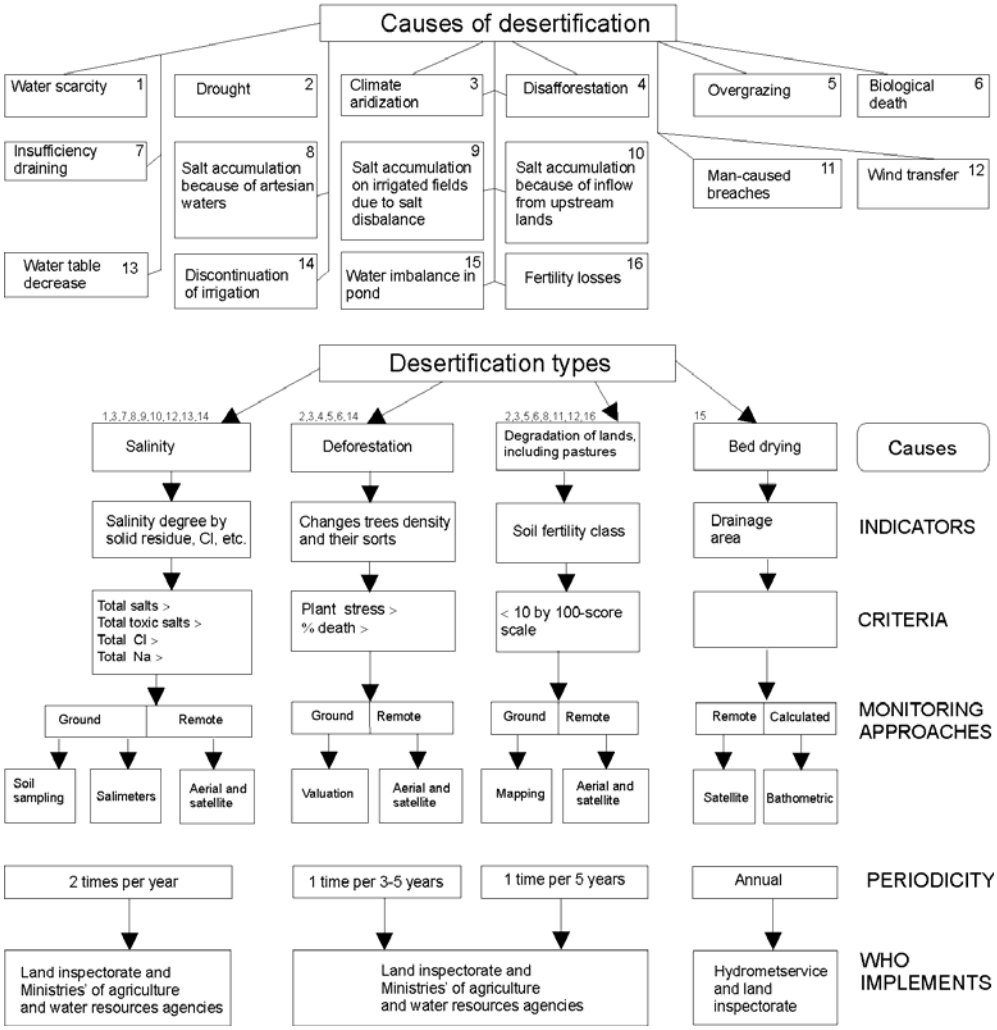

Fig. 2. Desertification and its monitoring.

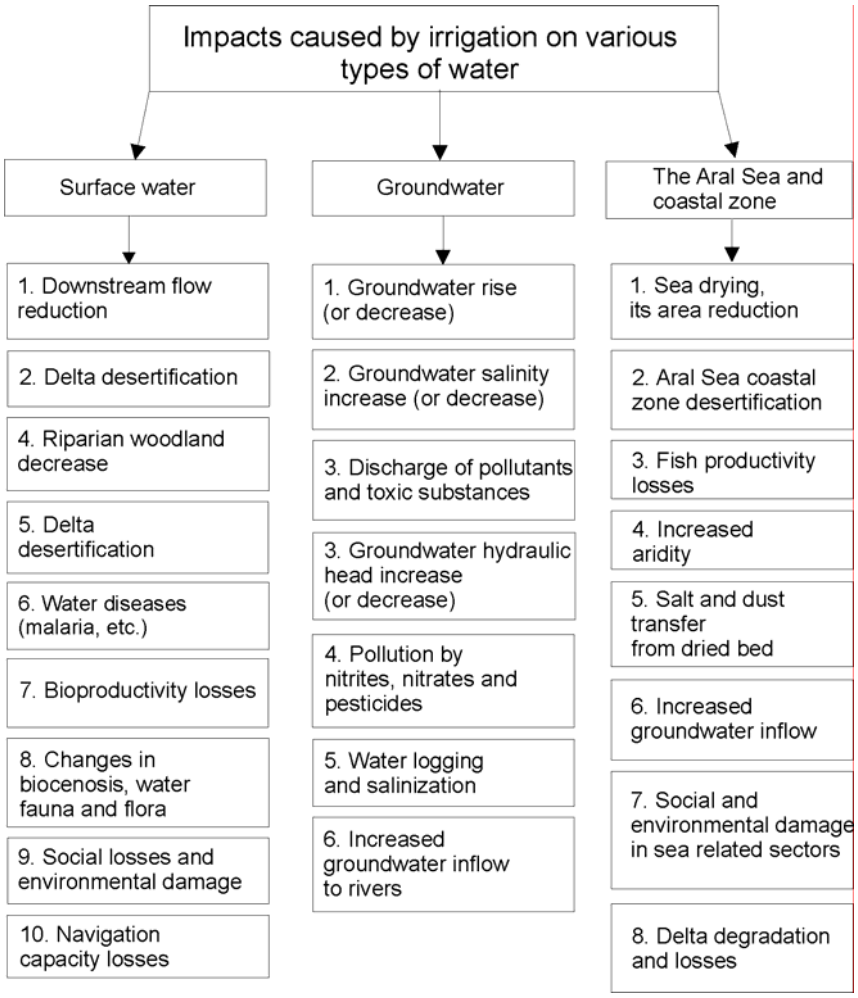

Fig. 3. Impacts caused by irrigation on various types of water.

The developed Explanatory (terminological) Dictionary contains definitions for 110 notions (terms) applied within the main themes of the project. The bibliography incorporates references to 138 publications (books, articles, and abstracts). The material has been collected and processed relevant to 65 current (unaccomplished) projects supported by donors and 216 pilot (completed, Table 3) projects being under implementation in Central Asian countries.

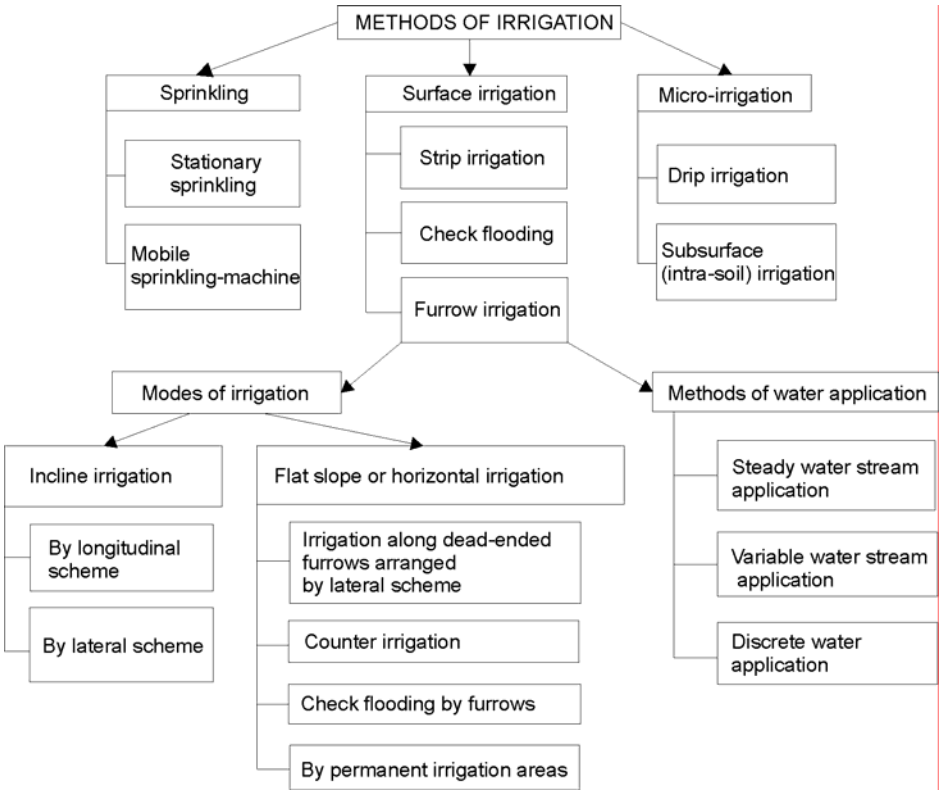

Fig. 4. Methods of irrigation.

Table 3. Summary on number of documents already included in the knowledge base categories according the adopted descriptor.

Rubric	Number of documents (pilot projects)
Irrigated farming	1
Ground water	2
Water quality	8
Irrigated lands	1
Soil water regime regulation. Soil water balance	18
Filtration and infiltration in soils	1
Water regime dynamics. Soil water-salt regime	51
Fertility	2
Water consumption	6
Regime of Irrigation	36
Irrigational systems and management	8
Ways of an irrigation	42
Methods of fight	27
Drainage	2
Types of drainage	14

Dissemination of information

The next phase of work within OP-1 provides for making information accessible to all participants of the project and their partners – to ensure this a special section has been set up at the SIC ICWC web-site (www.sic.icwc-aral.uz/projects/copern), where the information package of materials obtained in the course of the first phase implementation (Fig. 5).

Fig. 5 The main page of the CIRMAN-ARAL project web-site.

In the process of creating the information resource in Internet for the knowledge base the following has been accomplished:

1. Structures and designs of pages were developed based on the prepared materials so that scanning of the web-site pages would be possible under various resolving capacities without any distortions. Optimization of the web-site code was made to provide for scanning pages in major web browsers and their versions.
2. Data translation and pages formatting were carried out, as well as optimization of the web-site's graphic matter (both structural and informational) – thus minimizing time needed for the web-site users to load from the server.
3. Two navigation bars with buttons were worked out – a global bar for the whole section (placed at the top of all pages, contains references to every sub-section by Working Packages indicating location of the current sub-section page in this list), and a local bar for the "Knowledge base" sub-section. The navigation is designed - as its one general object – to present by

visual demonstration the current location of the user and possible options of scrolling through the structure of informational space. The row of green buttons at the top of all pages enables users to easy identify the current location at the site and get simple access to both the first page and all sub-sections (Fig. 6).

Fig. 6. The main navigation bar; a pressed dark blue button indicates the current sub-section by the Working Package-2 (WP-2).

In addition to moving through the whole informational space of the site, users need to be able of scrolling within a local area (sub-section) (Fig. 7).

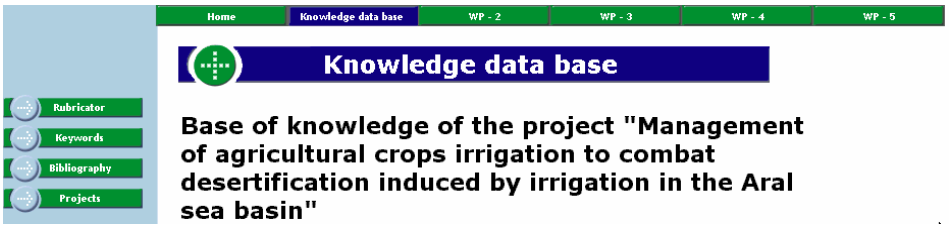

Fig. 7. The local navigation bar of the “Knowledge base” section.

The navigation bar of the “Knowledge base” section contains references to “Rubricator”, “Key words”, “Bibliography”, and “Projects”. Cross-references interrelate information on projects implemented in the past according to the classification system (Rubricator) developed by SIC ICWC; semantic relationship is also reflected in a systematic set of classified factors and implications relevant to principle definitions in the “Key words” section, which in their turn are linked to the “Bibliography” section. Conceptual definitions are set into the knowledge base as generally accepted terms and explanations, which can serve as universal throughout the world.

At the final phase the knowledge base of the CIRMAN-ARAL project was supplemented by the following methodological materials:

1. Methods of determining land productivity.
2. Methods to increase land productivity.
3. Methods of determining water use.
4. Methods to determine water-salt balance.
5. RZWQM (The model of physical/chemical/biological processes for modelling growth of plants and transport of water, nutrients, and pesticides in the root zone on a representative area of the agricultural production system).

6. Methods to determine parameters and evaluate current drainage efficiency; methods of mineralized water use.
7. Electronic versions of publications in Russian developed for users who apply CROPWAT, WINISAREG, and GISAREG software (other material produced in the final part of the project like models SADREG and SEDAM will be added next):
   - Textbook on CROPWAT (developed by the land and water resources office of FAO-UN) designed for calculation of water use by crops on the basis of climatic data, soil characteristics and parameters of agricultural crops;
   - User's guide on WINISAREG program (developed in the Lisbon Technical University, Portugal) for irrigation scheduling simulation. It enables users to carry out calculations for both long-term and short term using weather data observations and soils and crop data, allowing both the follow-up of field observations and the definition of irrigation water saving strategies;
   - Manual on application of the GISAREG model designed for compiling irrigation schedules based on GIS to improve water use practices and ecological monitoring.

Conclusions

Development of the knowledge base for the CIRMAN-ARAL project employing up-to-date information processing technologies enables users to most effectively apply information that has been already accumulated based on materials of accomplished projects and scientific publications. The knowledge base incorporates data vital not only for Central Asian countries, but for other regions too with regard to desertification, including monitoring of these processes and impacts caused by irrigation on surface, underground waters and the Aral Sea.

The knowledge base is intended to provide users (scientists, experts, ecologists, policy makers and society as a whole) with easily accessible information necessary for efficient land and water resources use. It should be reiterated that the ultimate objective of the knowledge base is dissemination of advanced experience, achievements, methodology in the field of water resources (specific case studies of addressing problems, descriptions of pilot projects, etc.), distributed by the knowledge tree branches (sub-rubrics): irrigation, drainage, hydro-schemes, etc..

That further development of the knowledge base on land and water resources use in the Aral Sea basin within other projects employing methodical approaches used as described herein have very high potential usefulness for research and practical application, since activities along these lines are in full

compliance with the policies aimed at creating the civil society based on knowledge.

Bibliography

Gendina, N.I., 1998. *Hierarchical classifications within the framework of the linguistic support of state-of-the-art information-librarian technology: multipurpose use, updating and development issues*. Preprint, M.: GPNTB of Russia, 15 p.

Government Standard, 1985. *7.44-84 Document classifications. General requirements.* Librarianship and bibliographical standards, M. Izdatelstvo standartov Publ., pp. 201-204.

State scientific technical information rubricator / VINITI – M., 2000.

Universal decimal classification, 1979. Vol. 7, 3rd edition, M. Izdatelstvo standartov Publ..