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ESTABLISHMENT OF A SCIENTIFIC-INFORMATION COMPLEX FOR AEROSPACE TEST SITES ON THE TERRITORY OF THE REPUBLIC OF BULGARIA

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Abstract: *The report presents a concept model for establishment of a scientific-information complex with thematically distributed satellite and subsatellite data base for the aerospace test sites on the territory of the republic of Bulgaria. The subject matter of the scientific-information complex will be: establishment, development, training, collection of thematically oriented data and transfer of techniques, instrumentation and technologies for remote sensing and monitoring of the environment, unfavourable and hazardous natural and anthropogenic processes and phenomena. The scientific-information complex will be used as a system, providing easy access to the data, their quick visualization, processing and analysis. It will support the scientific-research activity of the scientists from the BAS institutes working in the field of earth sciences and the Centre for Aerospace Monitoring at the Ministry of Emergency Situations. The complex will be also used to improve the training provided to Master and Post-Graduate Students in the field of Remote Sensing of the Earth.*

Introduction

In the beginning of the 70-ies, under the *Intercosmos* Programme, a network of aerospace test sites was established for conductance of international quasi-synchronous sub-satellite experiments. Seven test sites were fixed for Bulgaria: *Pleven, Shoumen, Rila, Plovdiv, East Rhodopes, Pchelina* and *Novi Iskur*. The conductance of the experiments on the Bulgarian side was assigned to the SRI-BAS. As a result of more than 80 conducted experiments, a great stock of aerial photos and satellite images was accumulated. To make them adequate for use by modern geoinformation technology means, they should be entered in a thematically distributed data base. This database will be supplemented with the agrometeorological information available on the NIMH-BAS network as well as with new satellite photos.

The development of civilization is accompanied by the increasingly topical problem of forecasting the scale of expected changes of the environment and the changes of man-inhabited environment related with them. Satellite information has become a major source in studying and observation of the Earth's surface. It is preferred in the composition of topical spatial data bases, servicing a given geographic-information system (GIS). In this context, satellite images are a major information source for a number of branch and complex studies.

One of the priority lines of the 7th EU Framework Programme is the establishment of GMES (*Global Monitoring for the Environment and Security*). The adequate participation of Bulgarian scientists in it requires updating the information about the test sites on the territory of the Republic of Bulgaria, bringing it in compliance with the modern substantially new development stage of remote sensing of the earth technologies. For the purpose, a scientific-information complex should be established, with thematically distributed satellite and subsatellite data base for the aerospace test sites on the territory of the Republic of Bulgaria.

The study is implemented within the framework of the contracts: **Establishment of a Scientific-Information Complex for Aerospace Polygons on the Territory of Republic of Bulgaria.** Contract N-НИК-003/07 between the SRI-BAS and the Scientific Research Fund at the Ministry of Education and Science, 2007 – 2008.

The subject matter of the scientific-information complex will be: establishment, development, training, collection of thematically oriented data and transfer of techniques, instrumentation and technologies for remote sensing and monitoring of the environment, unfavourable and hazardous natural and anthropogenic processes and phenomena.

Establishment of scientific-information complex

Such scientific-information complexes are not produced; they are unique in their essence, since they characterize particular physical and geographical conditions, which are specific for the various regions of the world.

Aerospace test sites (ASTSs) are specially selected territories, which are well-studied and equipped for the conductance of synchronous and quasi-synchronous observations and measurements, followed by data analysis and transfer to the scientific-information complex. The need of such centres became apparent and their establishment started in the middle of the 60s of the 20th century, when receiving of remotely sensed data started on a regular basis.

Subsatellite experiments are carried out on the territory of these test sites, which develop along three basic lines:

- Calibration of the characteristics of on-board (air-borne and satellite) equipment and elaboration of a formation model for the spectral characteristics of the individual types of land cover and their condition.

- Verification of the results from the interpretation of the obtained space information. The ASTSs play the role of “deciphering references” in studying the environment.

- Providing an information source for the solution of self-contained scientific and application problems, related with environment monitoring.

In the beginning of the 70s of the 20th, on the territory of the member-states of the *Intercosmos* Programme, a network of aerospace test sites was established, where multiple international quasi-synchronous subsatellite experiments were carried out (Koursk, Gobi-Hangay, Caribe, Telegeo, Tyan-Shan and more). In 1973, at an engineering consultation between the representatives of the geodetic agencies of Russia and Bulgaria under the *Intercosmos* Programme, 5 test sites were fixed (*Fig.1*): *Pleven, Shoumen, Rila, Plovdiv,* and *East Rhodopes* [1, 2]. On the Bulgarian side, their organization was assigned to the Central Laboratory for Space Research, now named Space Research Institute, at the Bulgarian Academy of Sciences (BAS). Later, they were supplemented by two more – *Pchelina Dam* and *Novi Iskur*.

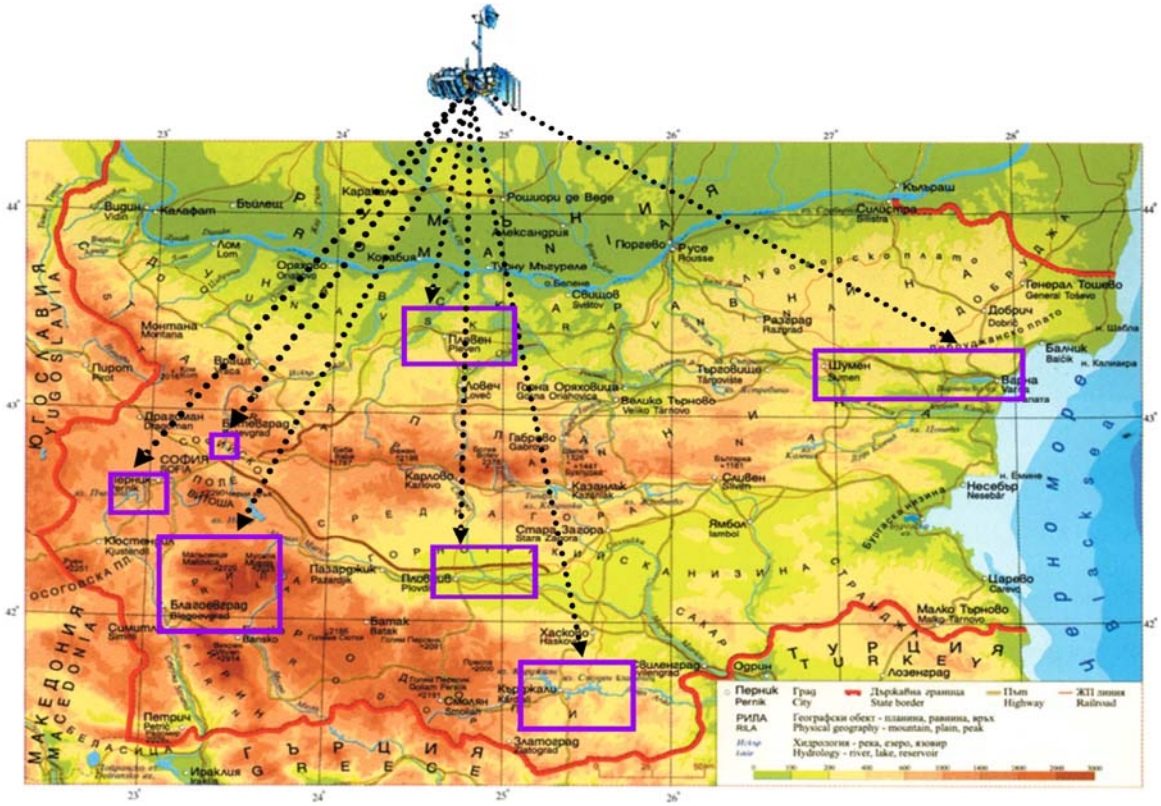


Fig. 1. Map of the aerospace polygons on the territory of Bulgaria

The test sites in North Bulgaria are intended for remote sensing, mainly in the field of agriculture, prospecting of ores and minerals, such as oil-gas depositions and monitoring the anthropogenic changes of the environment. The test sites in South Bulgaria are targeted at the development of ore prospecting methods, study of seismo-tectonic phenomena, exploration of a number of neotectonic morphostructures and faults.

On the Plovdiv test site, a number of methodical issues were clarified, related with recognition and mapping of various soil types and soil salination, mapping of land cover dynamics using aerial photos and satellite images. The *Pchelina Dam* test site was introduced in 1987 in relation with the implementation of the *Home Water Catchments* Project under the *Intercosmos* Programme. The *Novi Iskur* test site is a new one, established in 2005 with the financial support of the *Scientific Research* Fund at the Ministry of Education and Science (Contract No.1507). On its territory, studies aiming to improve the methods of landscape-ecological planning using remote sensing are carried out. About 80 experiments [3] were conducted, in which, apart from the specialists of the Remote Sensing of the Earth Department (CLSR, SRI) there participated as well specialists from the *N. Poushkarov* Institute of Soil Studies and Yield Forecasting (ISSYF), the National Institute of Meteorology and Hydrology (NIMH), the Institute of Botany with Botanical Garden (IBBG), the Institute of Geography (IG) and the Institute of Ecology (IE) at the BAS, the Ministry of Environment and Water (MEW), the Chief Administration in Geodesy, Cartography and Cadastre (CAGCC), Military Topographic Service (MTS) and more. During these experiments, a large stock of images, spectrometric, radiometric and ground-based data was collected. The greater part of the performed studies and measurements were of identical nature, which makes it possible to compare and juxtapose the collected information. A great part of them are negatives, photos and magnetic tapes. To make them adequate for use by modern geoinformation technology means, they should be subject to additional processing (digitizing or transfer to CD/DVD medium) and entered in a thematically distributed data base.

The thematically distributed database will be supplemented with parallel information for terrestrial objects to provide for more precise interpretation of remote sensing data measurements.

The solition of a great number of tasks requires before all processing of a large amount of experimental meteorological and agrometeorological observation material. Some of the greater district centres have taken into account the observations of two or three climatic or agroclimatic stations. Thus, the test site territory is covered by 24 stations of the paytoll and volintary и доброволна climatic and agroclimatic network of the NIHM-BAS. The stations' location is chosen in such a way as to comply as much as possible to the test sites subject to satellite or subsatellite experiments.

The distance between the observation points ensures correctness and representativeness of the measured elements' field, related with the meteorological and phenological elements and their derived features.

The technological diagram for the information's organization in catalogues and archives during the composition of the thematically distributed satellite and subsatellite data base is shown in *Fig. 2*.

The major purpose of the database is to create an electronic catalogue of the aerial and satellite image archive available at the SRI-BAS, with the accompanying agrometeorological information, available on the network of the NIMH-BAS for the respective data for which images of the test sites were taken. It will systematize and facilitate the search and use of this archive.

A major requirement for the data base is to store in the long run a great amount of satellite and aerial images, agroclimatic data massifs, as well as the results from their joint processing. It will be open for functional extension and supplementing with new data.

According to the set up task, the most appropriate model for the data base is the relational model. This model features a table structure, the rows (objects) are records of some object information, and the columns are the object characteristics (attributes). The data indexing will substantially reduce data search and data request times.

Digital images in various file formats will be input in the data base. In order to be input in the data base, the aerial and satellite photos and negatives will have to undergo additional processing – digitizing and transfer to CD/DVD/external storage device. For the purpose, the analogue space images have been digitized by scanning.

Construction of a data base

In the first stage, the database type and structure were chosen, and in the next stage, the clients' programs were coded. On analyzing the various types of data bases, the "PostgreSQL" was chosen.

Several types of fields are used (*Fig. 3, 4*.).

1. Fields describing the image source – to be used in clients' search programs:
   - Satellite or aerial images;
   - Type of satellite, sensor and aero-photo camera

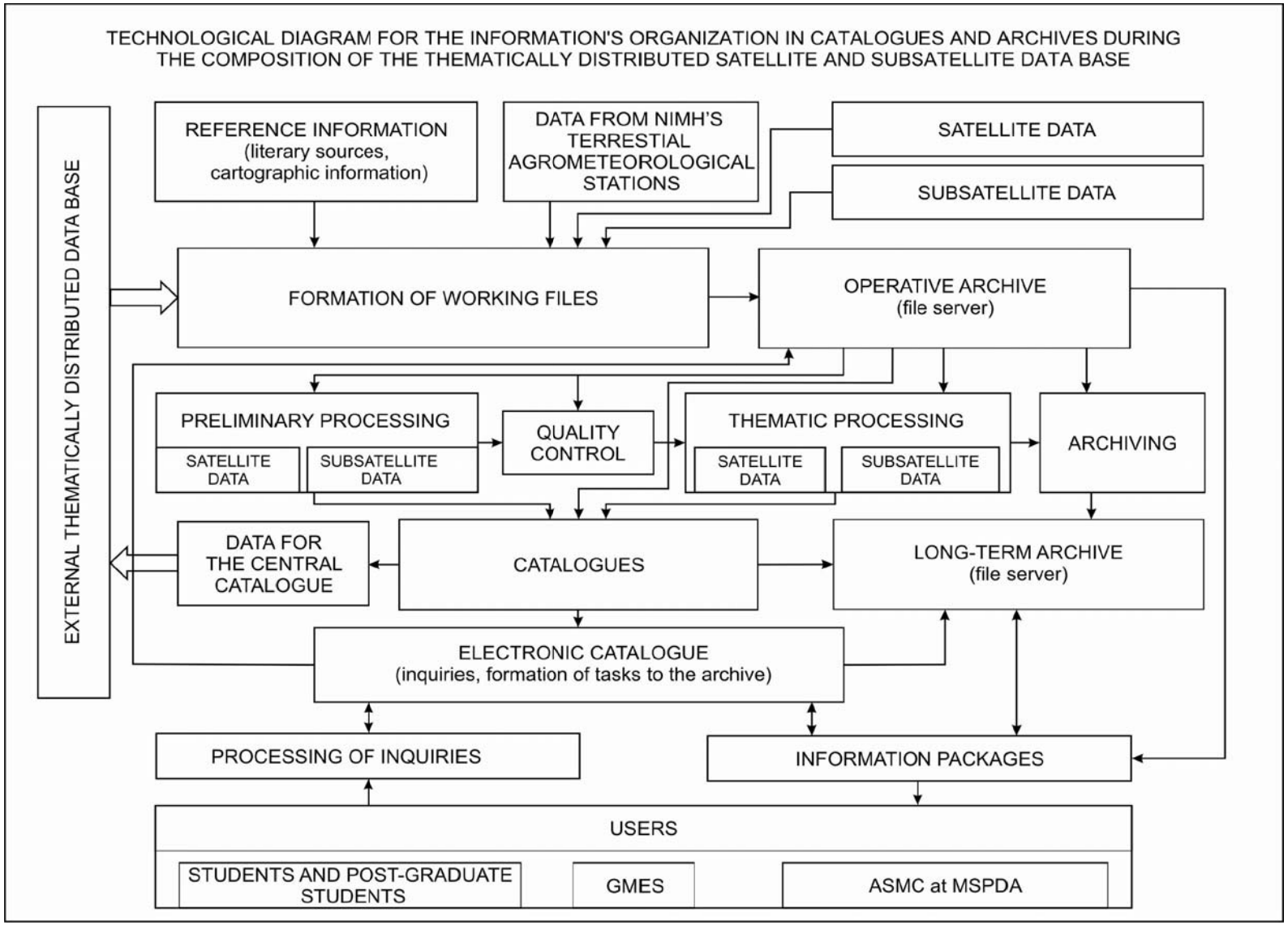


Fig.2 Technological Diagram for the Information's Organization in Catalogues and Archives during the Composition of the Thematically Distributed Satellite and Subsatellite Data Base

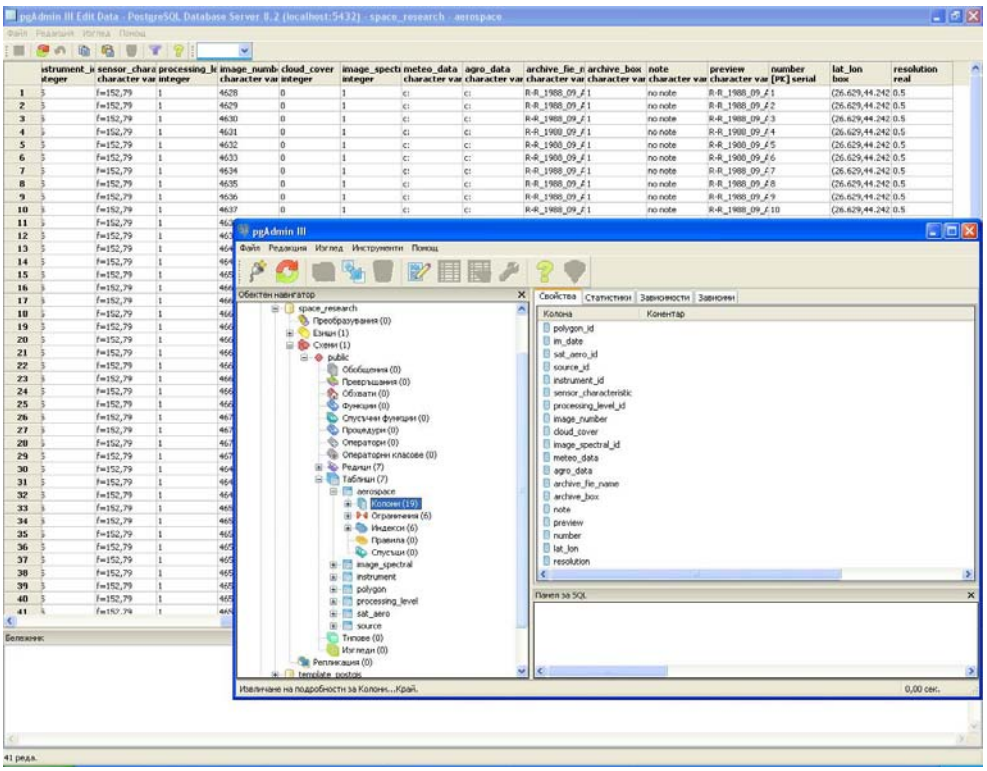


Fig.3. Types of fields used in constructing the data base

- LANDSAT,
- SPOT,
- TERRA,
- AQUA,
- IKONOS,
- MKF-6,
- Wild RC10;

➢ Spectral information.

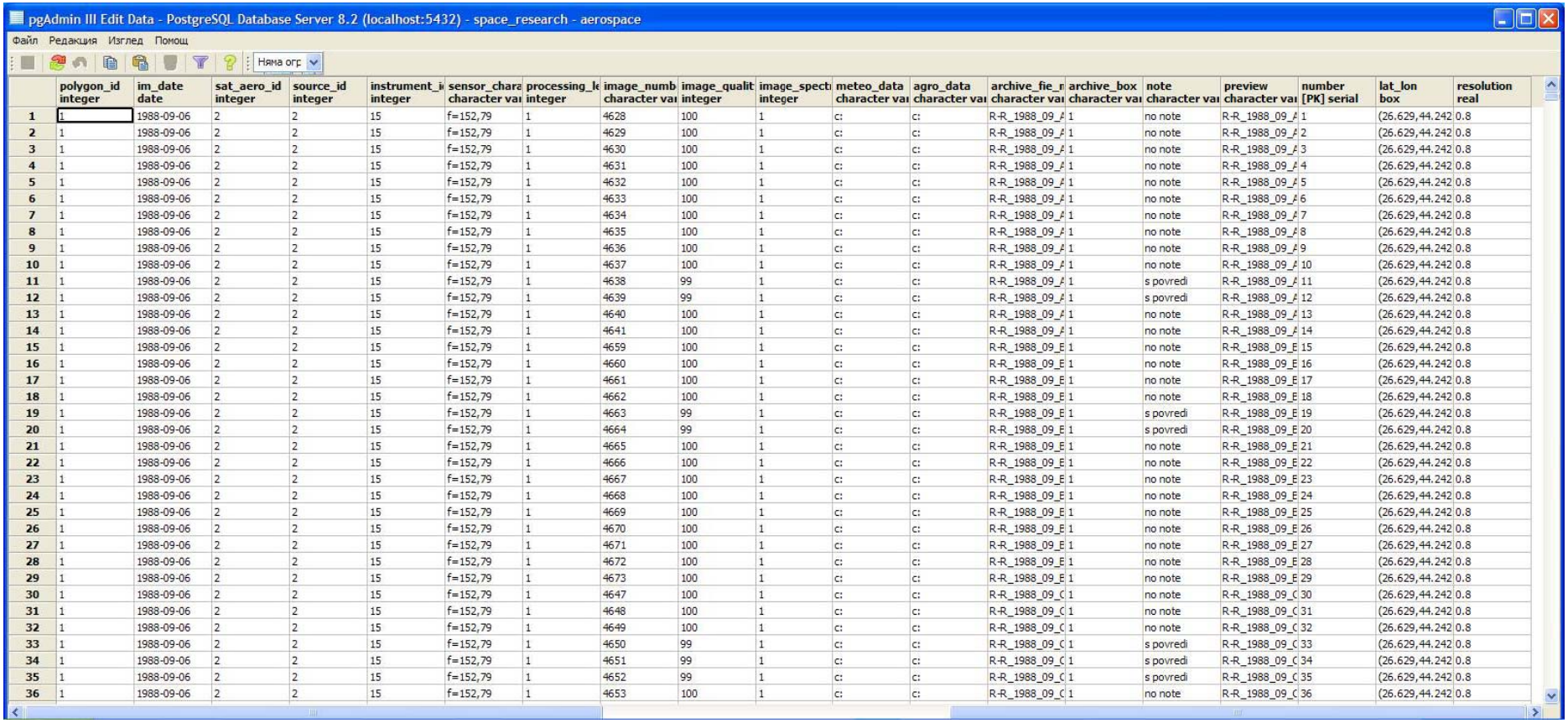
2. Fields describing the image parameters – to be used depending on the set up task:

➢ Test sire;
➢ Coordinates;
➢ Acquisition date;
➢ Source
  - scanner,
  - image,
  - vector data,
  - GPS points,
  - raster maps;

➢ Spatial resolution;
➢ Processing level;
➢ Image number;
➢ Quality in %.

3. Description and location of archive – to find the image and the accompanying meteorological and agroclimatic data: meteo data, agroclimatic data, phonological information, file archive name, reduced image for quick visualization (preview) to serve the clients' programs (Fig. 5).

4. Notes and comments on type and quality – to facilitate the archive's review: sensor characteristics.



	polygon_id integer	im_date date	sat_aero_id integer	source_id integer	instrument_i integer	sensor_chara character var	processing_le integer	image_numb character var	image_qualit integer	image_specti integer	meteo_data character var	agro_data character var	archive_fie_r character var	archive_box character var	note character var	preview character var	number [PK] serial	lat_lon box	resolution real
1	1	1988-09-06	2	2	15	f=152,79	1	4628	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	1	(26.629,44.242	0.8
2	1	1988-09-06	2	2	15	f=152,79	1	4629	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	2	(26.629,44.242	0.8
3	1	1988-09-06	2	2	15	f=152,79	1	4630	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	3	(26.629,44.242	0.8
4	1	1988-09-06	2	2	15	f=152,79	1	4631	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	4	(26.629,44.242	0.8
5	1	1988-09-06	2	2	15	f=152,79	1	4632	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	5	(26.629,44.242	0.8
6	1	1988-09-06	2	2	15	f=152,79	1	4633	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	6	(26.629,44.242	0.8
7	1	1988-09-06	2	2	15	f=152,79	1	4634	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	7	(26.629,44.242	0.8
8	1	1988-09-06	2	2	15	f=152,79	1	4635	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	8	(26.629,44.242	0.8
9	1	1988-09-06	2	2	15	f=152,79	1	4636	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	9	(26.629,44.242	0.8
10	1	1988-09-06	2	2	15	f=152,79	1	4637	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	10	(26.629,44.242	0.8
11	1	1988-09-06	2	2	15	f=152,79	1	4638	99	1	c:	c:	R-R_1988_09_A	1	s povredi	R-R_1988_09_A	11	(26.629,44.242	0.8
12	1	1988-09-06	2	2	15	f=152,79	1	4639	99	1	c:	c:	R-R_1988_09_A	1	s povredi	R-R_1988_09_A	12	(26.629,44.242	0.8
13	1	1988-09-06	2	2	15	f=152,79	1	4640	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	13	(26.629,44.242	0.8
14	1	1988-09-06	2	2	15	f=152,79	1	4641	100	1	c:	c:	R-R_1988_09_A	1	no note	R-R_1988_09_A	14	(26.629,44.242	0.8
15	1	1988-09-06	2	2	15	f=152,79	1	4659	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	15	(26.629,44.242	0.8
16	1	1988-09-06	2	2	15	f=152,79	1	4660	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	16	(26.629,44.242	0.8
17	1	1988-09-06	2	2	15	f=152,79	1	4661	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	17	(26.629,44.242	0.8
18	1	1988-09-06	2	2	15	f=152,79	1	4662	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	18	(26.629,44.242	0.8
19	1	1988-09-06	2	2	15	f=152,79	1	4663	99	1	c:	c:	R-R_1988_09_E	1	s povredi	R-R_1988_09_E	19	(26.629,44.242	0.8
20	1	1988-09-06	2	2	15	f=152,79	1	4664	99	1	c:	c:	R-R_1988_09_E	1	s povredi	R-R_1988_09_E	20	(26.629,44.242	0.8
21	1	1988-09-06	2	2	15	f=152,79	1	4665	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	21	(26.629,44.242	0.8
22	1	1988-09-06	2	2	15	f=152,79	1	4666	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	22	(26.629,44.242	0.8
23	1	1988-09-06	2	2	15	f=152,79	1	4667	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	23	(26.629,44.242	0.8
24	1	1988-09-06	2	2	15	f=152,79	1	4668	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	24	(26.629,44.242	0.8
25	1	1988-09-06	2	2	15	f=152,79	1	4669	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	25	(26.629,44.242	0.8
26	1	1988-09-06	2	2	15	f=152,79	1	4670	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	26	(26.629,44.242	0.8
27	1	1988-09-06	2	2	15	f=152,79	1	4671	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	27	(26.629,44.242	0.8
28	1	1988-09-06	2	2	15	f=152,79	1	4672	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	28	(26.629,44.242	0.8
29	1	1988-09-06	2	2	15	f=152,79	1	4673	100	1	c:	c:	R-R_1988_09_E	1	no note	R-R_1988_09_E	29	(26.629,44.242	0.8
30	1	1988-09-06	2	2	15	f=152,79	1	4647	100	1	c:	c:	R-R_1988_09_C	1	no note	R-R_1988_09_C	30	(26.629,44.242	0.8
31	1	1988-09-06	2	2	15	f=152,79	1	4648	100	1	c:	c:	R-R_1988_09_C	1	no note	R-R_1988_09_C	31	(26.629,44.242	0.8
32	1	1988-09-06	2	2	15	f=152,79	1	4649	100	1	c:	c:	R-R_1988_09_C	1	no note	R-R_1988_09_C	32	(26.629,44.242	0.8
33	1	1988-09-06	2	2	15	f=152,79	1	4650	99	1	c:	c:	R-R_1988_09_C	1	s povredi	R-R_1988_09_C	33	(26.629,44.242	0.8
34	1	1988-09-06	2	2	15	f=152,79	1	4651	99	1	c:	c:	R-R_1988_09_C	1	s povredi	R-R_1988_09_C	34	(26.629,44.242	0.8
35	1	1988-09-06	2	2	15	f=152,79	1	4652	99	1	c:	c:	R-R_1988_09_C	1	s povredi	R-R_1988_09_C	35	(26.629,44.242	0.8
36	1	1988-09-06	2	2	15	f=152,79	1	4653	100	1	c:	c:	R-R_1988_09_C	1	no note	R-R_1988_09_C	36	(26.629,44.242	0.8

Fig.4 Attributive Table.

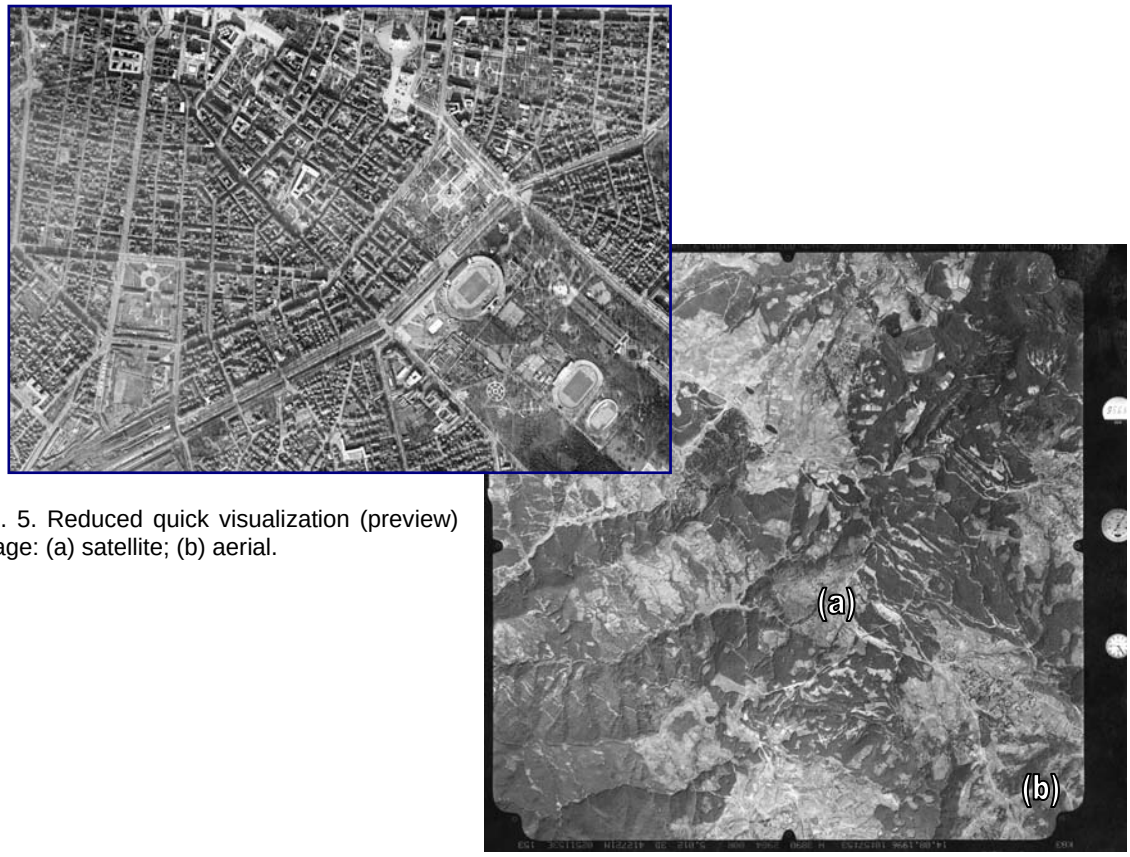


Fig. 5. Reduced quick visualization (preview) image: (a) satellite; (b) aerial.

To speed up the access to some database fields, 6 primary codes are used.

Conclusions

The research-information complex will operate as:

- Information-reference system providing easy access to the data stored in the data base and their quick visualization;
- Information-reference system providing both reference functions, as well as data processing and analyzing options to produce essentially new information on environmental state and change;
- Information-modelling system for evaluation of the impact of natural and anthropogenic factors on man-inhabited environment;
- Information system assisting the scientific-research activity in the institutes of the BAS working in the field of earth sciences and Aerospace Monitoring Centre at the Ministry of Emergency Situations. The Complex will be used as well to improve the training given to Master and Post-Graduate Students.

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