ІННОВАЦІЙНІ АСПЕКТИ ПІДВИЩЕННЯ РІВНЯ ЕКОБЕЗПЕКИ

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GEOINFORMATION AND AEROSPACE TECHNOLOGIES FOR INFORMATION FROM SATELLITE PROCESSING: ENVIRONMENTAL MONITORING

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Use of geoinformation and aerospace technologies for ecological environmental monitoring will provide practical knowledge of environmental condition over the whole territory of Ukraine.
Keywords: geoinformation, aerospace technology, ecology, monitoring the environment.

Геоінформаційні та аерокосмічні технології обробки інформації з супутників Землі: екологічний монітринг. В.Е.Васильев, О.А. Машков, В.Ф. Фролов. Використання геоінформаційних та аерокосмічних технологій для екологічного моніторингу навколишнього природного середовища забезпечить знання про реальний стан екології на всій території України. *Ключові слова:* геоінформація, аерокосмічні технології, екологія, моніторинг, природне середовище.

Геоинформационные и аэрокосмические технологии обработки информации со спутников Земли: экологический мониторинг. В.Е. Васильев, О.А. Машков, В.Ф. Фролов. Использование геоинформационных и аэрокосмических технологий для экологического мониторинга окружающей среды обеспечит реальные знания о состоянии экологии на всей территории Украины. *Ключевые слова:* геоинформация, аэрокосмические технолгии, экология, мониторинг, природная среда.

Ukraine is the spacefaring state where the majority of space activities is developing and so considerable attention is given to the creation of space technology and introduction of new technologies for processing space information for the benefit of users.

Today Ukraine has considerable scientific and industrial potential, which includes Earth's remote sensing (ERS). Over twenty years of independence, Ukraine has been created and launched on Earth Observation Satellites “Sich-1”, “Okean-O”, “Sich-1M”, “Micron”, “YehiptSat-1”, “Sich-2” [1].

Advanced space platforms and specific apparatus (SA) for more advanced ERS: “Sich-2M”, “Sich-3-O”, “Sich-3-P” are developed. The main developers and manufacturers of ERS satellite vehicles in Ukraine are Yuzhnoye Design Bureau named after M.K. Yangel and Production Association Southern Machine-Building Plant named after A.M. Makarov (Dnepropetrovsk). These companies have a long tradition, strong human resources and considerable experience in this field. After launching in 1962, the first Dnepropetrovsk satellite “DC-2” (“Kosmos-1”) more than 70 types of space vehicles were created, about 400 space vehicles were carried into orbit. They are successfully applied to solve a wide range of tasks for the study of Earth and near-Earth space.

The first step to creating its own system ERS Ukraine made in 1995, when space vehicle “Sich-1” was carried into near-earth orbit. There was filming equipment, allowing us to conduct optical and radar survey. Data from the spacecraft were used for solving problems in the field of environmental protection and agriculture, monitoring processes in the atmosphere and the ocean surface, conduct ice-sheet research and floods survey. Customers of processed information were departments, organizations and businesses who are interested in the information of such content.

In 1999 the space vehicle “Okean-O”, which had high technical, resource and information characteristics, was carried in orbit. Photos from this apparatus provided an opportunity for solving a wide range of tasks: a comprehensive study of the oceans and seas, sustainable use of biological and mineral resources, diagnostic pollution of the water surface.

In 2004, “Sich-1M” and the first Ukrainian microsatellite “Micron” were launched. Distinctive features of "Sich-1M" were the improvement of characteristics of onboard scanners and radar side view, snap of optical-microwave scanner with a possible functioning of visible, infrared to microwave wavelengths. The purpose of launching space vehicle "Micron" has provided the development of technology for a microsatellite creation and verification of new technical and technological solutions.

New satellite “Sich-2”, launched in 2012, was created on the modern technological and informational level. The satellite was developed on the base of the new micro-platform “MS-2” and assembled in nonpressurized variant with extensive use of polymeric and composite materials. Onboard equipment of “Sich-2” was developed on the basis of microtechnology, subsystems management is carried out by means of onboard computer complex. Satellite will allow to obtain digital images of the Earth's surface in the panchromatic and multispectral bands with fragmentation better than 8.2 m, and in the mid-infrared range up to 41.4 m. Space images can be successfully used for monitoring the use of agricultural resources, land and forest management, assessment of environmental pollution, monitoring of emergencies, exploration of mineral resources, as well as giving substantial assistance in the implementation of environmental monitoring.

The tasks that can be solved by satellite “Sich-2” include: monitoring of agricultural resources, water and land cover, emergency situations, dangerous objects, ionosphere, research and evaluation of the effects of volcanic eruptions.[1]

Monitoring agricultural resources plays a significant role in making effective decisions in agriculture, because it allows to:

- monitor the quality of available planting acreage;
- calculate the total acreage of any crop;
- monitor compliance with the rules of crop rotation;
- perform routine monitoring of crops, to determine the degree of convergence, littering or ripening grain;
- conduct a preliminary yield prediction;
- identify and predict adverse effects in agriculture (wind and water erosion, salinity);
- study the environmental conditions that affect agricultural activities (logging and extreme terrain);
- quickly identify area of agricultural land that suffered losses due to adverse environmental conditions;
- determine the total area affected agricultural areas.

Monitoring of aquatic and land covers can be used to determine the status of marine waters and inland waters, forest inventory, land cover classification.

The most promising areas are:

- monitoring of marine areas and inland waters, coastal change tracking lines, riverbeds;
- determination of actual forest cover, the identification of existing and new operational monitoring of felling, fires and windfalls;
- definition of the categories (deciduous, coniferous) and natural composition of forests;
- study of natural conditions that interfere with active agricultural or forestry activities (logging and extreme terrain);
- update topographic and geodetic framework for the correction of master plans for the development of cities;
- geospatial analysis of investment attractiveness of certain areas;
- study of areas within the development of new infrastructure projects.

Monitoring of aquatic and land cover includes monitoring of ice cover, the study of rivers and reservoirs, navigation in territorial waters, determining of species composition of forests, detection of new logging, land cover classification.

Emergency monitoring with the use of space images “Sich-2” will help to solve such problems as:

- monitoring of natural and man-made disasters (floods, snow banks, fire, emission of pollutants);
- analysis of the affected areas and forecasting of emergency situations;
- determination of transport reach capability to rescue units and humanitarian goods within a particular area;
- planning of rescue and search operations in the areas of emergency;
- assessment of damages, monitoring of restoration work;
- monitor the situation in potentially hazardous areas and on sites.

Operational monitoring of emergencies is made in three stages:

• inspection survey of problem areas to identify sources of risk;
• detailed survey to clarify the scope and directions of disasters and catastrophes;
• monitoring of the affected areas at the stage of elimination of consequences of emergency situations.

Low spatial fragmentation data from space apparatuses such as NOAA, Terra, Agua, Landsat are preferably used at the first stage. According to these data it

is possible to detect emergency situations during their origin and estimate the scale of disaster.

However, given the size of the satellite “Sich-2” shot, which is 48.8 x 48.8 km and ability to shoot bands up to 300 km, “Sich-2” can be successfully used in the first phase of monitoring (operational monitoring).

However, under conditions of very high spatial fragmentation of space apparatuses “Sich-2”, which is 8.2 m, it is useful at the second and third stages to make operational monitoring. Data from “Sich-2” will allow to monitor development of emergencies with long, multi-character (forest and peat fires, pollution and coastal areas, etc.) more detailed.

Monitoring of emergencies includes: monitoring of fire conditions and monitoring of flood situation, possible flooding simulation, monitoring of hazardous facilities, monitoring of dust storms, monitoring and evaluation of the effects of volcanic eruptions.

Using space systems you can monitor the Earth's ionosphere. It is known that near space is heavily used by mankind. Number of countries that are part of the "space club" is growing. This increases the number of satellite-based systems. Therefore the task of diagnosis, study and prediction of parameters of space environment are relevant. The main task of the scientific equipment “Potentsial”, located on board of the “Sich-2” is the working methods of monitoring space weather and retrieval of geophysical effects in the ionosphere. At altitudes below 800 km (satellite "Sich-2" is situated at an altitude of 700 km), where the charged components do not exceed 10% of the total concentration of atmospheric dynamics of neutral gas plays a significant and in many cases a decisive role in the behavior of the ionospheric plasma. Direct measurement of neutral particles directly from the satellites carried out only in the 1970s and early 1980s, but the amount of information transmitted to Earth by satellites of those years is negligible. Modern space experiment with new technologies and long-term monitoring of atmospheric and ionospheric parameters will explore the dynamics of the upper atmosphere to a new level.

With the passage of the satellite "Sich-2" above ground test sites, including by means of active influence on the ionosphere, it will be to experiment with recording effects on Earth and the satellite. These means of influence are: incoherent scattering radar and station of vertical ionospheric sounding of Institute of National Academy of Sciences and Ministry of Education and Science of Ukraine, ionospheric sensing system based on radio telescope UTR-2 and low-frequency observatory Radioastronomic Institute NASU devices partial reflection and partial Doppler sensing of Kharkiv National University of V.N. Karazin, heavy-duty stand acoustic sensing of Lviv Centre of Institute of Space Research Institute NASU-NSAU. Considerable interest causes also joint observations with foreign partners - auroral stands of the European Association of EISCAT (Tromse-sity, Norway), HAARP (Alaska, USA), Sura (Russia).

Ground infrastructure of Space system “Sich-2” is created at the National Control and Test Center of Space (NCTCS).

Ground infrastructure includes:

1. Ground control (GC) of space apparatus, which comprises:

- mission control center (MCC);
- control station of S - band;

- main information center.

2. Earth based information complex (EBIC) includes:

- operational centre;
- receiving data of X-band;
- complexes of information pre- processing and archiving.

Ground control provides management of satellite "Sich-2" from the moment of launching into orbit to stop its operation. Mission Control Center was created using modern computer technology and information technology. Software and hardware tools and data base organization and management for a single database MCC provides ability to control group of one type satellites on the basis of perspective space apparatus launching. Special software of MCC provides if necessary adjustability of programs transmitted on board of space apparatus in the previous communication session until the time of their execution. MCC provides:

- formation of long-term and operational management plans of SA onboard systems;
- formation of a command program information for controlling the SA onboard equipment;
- acceptance of current navigation parameters, prediction of motion parameters, the calculation of the standard ballistic information;
- monitoring and analysis of functioning of SA onboard systems;
- plan drafting for work of SA revenue load;
- interaction between the elements of ground control and earth based information complex.

Ground control stations provide:

- transmission of software command information to SA board;
- reception from SA and transfer to GC telemetry navigational information;
- measurement of current navigation parameters of SA during communication session.

Ground information complex provides reception and provides users with ERS data (space images) according to the applications. It comprises means for receiving, processing, archiving and dissemination of ERS data. The complex provides the following functions:

- obtaining from the operator space system applications for images;
- development and transfer of PCO coordination (long-term) plans of payload SA;
- receiving information from SA remote sensing;
- annotating, preprocessing and normalization of remote sensing data;
- archiving of ERS data obtained;
- formation and by providing ERS data (space images).

Operational plan of revenue load work of SA is formed by the coordination plan in the control center.

The initial products of complex are:

- normalized information derived Earth observation data that should be stored for a long term;
- automated directory ERS data obtained;
- ERS database.

Analysis of national and international space programs suggests that formed the new space vision problems, based on the priority needs of sustainable economic and social development, the need to address global challenges. These space activities will be:

- to determine the future of the economy;
- to influence the society and its destiny;

- to possess ability to provide global life needs of mankind.

Formation of the National Space Program of Ukraine for 2013 - 2017 is based on positions arising from the goals, objectives and key priorities for space activities in Ukraine and in other countries [2]:

- implementation of space programs shall be subject to and focused solely on the interests of the consumer: the highest priority should be the use of space in order to enhance quality of life;

- space activity takes an international character that defines high openness and available at the stage of project development, and on the stage using the results.

One of the properties of the Programme is a close link with the programs of individual states and the international programs and projects that are carried out under the auspices of the UN.

Conclusions. Based on the information we can draw some conclusions. ERS information can be used to monitor agricultural resources, water and land cover, emergency and Earth's ionosphere. This information is much needed to ministries and agencies to make decisions to prevent adverse effects of human activities on the environment and human health, but also allow to assess the extent of the environmental situation in some areas and objects. This information will provide the implementation of environmentally sustainable technologies and monitoring of "green" procurement. The purpose of this activity is economic incentives for the introduction of cleaner production technologies, to integrate the environmental component in all sectors of the economy to natural resource management and sustainable development of production, the introduction of lean manufacturing, cost of energy and material resources, reduce production costs, increase the competitiveness of domestic producers.

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