EARTH SPACE SENSING FOR THE INTERESTS OF THE DEVELOPMRNT OF THE ECONOMY

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Thirty years ago, on October 4,1957, the first in the world man-made satellite was launched in the USSR. Since then, the cosmonautics has eventually become very important both for science and economy.

The problem of long-distance radio communication, telecasting, navigation, hydrometeorology, astrophysics, determination of geodetic positions, exploration of planets, production of new materials and drugs are now being solved with the help of space techniques. More and more important become studying of the natural resources of the Earth and environmental control depending on space data obtained by means of remote sensing from satellites.

The use of the most efficient methods of natural studies is very vital for the USSR whose vast territory covers more than 22 mln.km² including both developed areas and hard-to-reach areas of Siberia, Far East regions, seas of three oceans. Therefore, the elaboration and utilization of such methods are now a State problem being solved by many large bodies of scientists and specialists.

A special multi-purpose space system for studying natural resources and environment is under creation in compliance with a long-term plan. This system will include both standard and borrowed facilities:

automatic space vehicles, types "Cosmos" and "Meteor";

manned space stations and spacecrafts;

flying laboratories for conducting "under-satellite" observations and detailed studies;

network of reference-and-measuring ranges;

mobile ground and sea-borne facilities for making close and contact measurements;

aerospace data receiving and interdepartamental processing centers;

number of various users of space information which utilize the data obtained through remote sensing for the purposes of science and economy.

As the analysis of needs of the national economy in space date has revealed, the majority of users is interested in obtaining long-term information provided by means of remote sensing. In this case, immediateness in supplying the information to users is not a decisive factor. Judging from the above-said and taking into account a number of other technical, economical, and organizational problems, decision has been taken to first promote multispectral photography with low, medium, and high resolution alongside development of facilities for operative sensing by means of electronic methods,with information so obtained being received via rf channels.

Used for oprative sensing of the Earth are TV, scanning, radar, spectrometric system installed on the earth satellites, types "Meteor" in the "Cosmos" series, and on space stations.

Information obtained is received with antennas of ground or ship-borne receiving stations and is used for hydrological and weather forecasting, for meeting the requirements of agro-industrial complex, assessing risk of forest fire, for piloting convoys in the Arctic and Antarctic seas, etc.

Operative sensing systems find application in studying other planets such as Venus, Mars. These systems have also been used for exploration of the Halley comet.

About 90% of problems encountered in studying natural resources and environment are solved with the use of materials of space photographic surveys.

The largest share applies to multispectral and false-color photography alongside integrated photography with the use of color and black-and-white films. The camera equipment is installed on automatic space vehicles series "Cosmos", manned space stations and spacecrafts.

Owing to ever-growing interest in using materials of such space photography, it is essential to mention particular characteristics

of space data obtained and basic parameters of camera system used. For general (large-coverage) surveying, use is made of a КАТЭ-140 topographic camera, with the film gate being 180x180 mm and focal length 140 mm. Photographing can be accomplished using black-and-white, false color, and color films. Resolution of pictures taken from standard orbits is about 50 m, per frame coverage being 250,000m².

For the first time, the КАТЭ-140 camera was installed on the "Salyut-4" space station and until now it is in extensive use on manned stations owing to its high reliability and output.

Close cooperation of the specialists from the GDR and the USSR has resulted in a multispectral camera system, type МКФ-6, and its various versions. This camera system in manufactured by the VEB "Karl Zeiss" in the GDR. For the first time, this system has been installed on the "Soyuz-22" spacecraft and, then, has been in use on type "Salyut" space stations. The МКФ-6 camera system provides for photographing in six bands of the spectrum including the near IR band. The film gate of the camera is 56x81 mm, with the focal length being 140 mm.

Depending on the shooting channel and altitude of flight, space resolution varies from 20 to 80 m, with the area covered being 28,000 km². The МКФ -6 and КАТЭ -140 cameras comprise a mutually complemented system for solving a great number of problems facing the space nature study and mapping. The equipment mentioned is used for carrying out experimental, pilot, and production surveys in compliance with the "Intercosmos" program by multinational crews on the Soviet made space stations. These two cameras made it possible to perform a great number of investigations in the field of remote sensing methodology.

A great amount of long-term space data relating to production and scientific problems is obtained by means of unmanned space vehicles, type "Cosmos". This information is delivered to the "Priroda" State Center for appropriate processing and use for the purposes of the national economy and international cooperation.

The "Cosmos" type satellites carry, depending on the goals to be attained, different hardware. One of the systems carried by these vehicles is a multispectral photographing system making it possible to obtain video information in 3 to 5 frequency ranges of the spectrum including the near IR range. As the experience shows

the optimum is photographing in three channels viz.500 to 600, 600 to 700, and 700-900 mm. The camera of each channel has a film gate equal to 180x180 mm and focal length, to 200 mm.

When photographing from standard orbits, the scales of images obtained are 1:1,000,000, 1:1,3000,000, the strip covered is 200 to 240 km, and area photographed per frame is up to 55,000 km². Resolution of the pictures taken is 10 to 30 m.

Pictures mentioned feature high photogrammetric properties, bear a reference grid for accounting for errors, make it possible to compose multispectral images, to obtain stereoscopic effect, and to measure altitudes of the relief.

To record the three-dimensional position of pictures of the Earth surface, the system includes a camera for photographing stars and constellations. Pictures of stars and constellations are used for constructing strip and area three-dimensional photogrammetric networks covering large territories.

For making detailed studies of the natural resources and compiling maps, the "Cosmos" type space vehicles may carry long-focus superwide-format cameras, with film gate being 300x300 mm and main focal length equal to 1,000 mm. The scale of images so obtained is from 1:200,000 to 1:260,000, space resolution is about 5 m, area per frame is about 6,000 km², and strip of view is 120 km. Cameras with f_k = 1,000 mm make it possible to obtain pictures on multiemulsion and black-and-white films. In most cases photographing is carried out on two-layer films resulting in false-color images. Such photographing is very fruitful for studying vegetation, shelf, atmosphere pollution, etc. Large-scale space photos can be processed with the use of stereoscopic effect that substantially widen their use as sources of information. Judging from reports in foreign scientific publications, large-scale space photos taken with the use of cameras with f_k=1,000 mm feature quality and detailedness far superior than other space data used for studying the natural resources and environment control.

Space information is of many-target and interdepartamental nature and shall be multiply used. Therefore, its primary processing is centralised in the USSR. After this processing, materials so obtained are distributed among the users concerned. Inter-branch

processing is accomplished by means of production lines comprising optomechanical and optoelectronic devices and systems and versatile computers.

Special devices mentioned include, first of all, the equipment for composing multispectral images. The variety of devices created for the purpose in the USSR is intended for solving practically all problems in processing multispectral information. The peculiarity of these devices is that the devices are capable of processing wide-format pictures, up to 500x600 mm.

Besides, widely used are the МСП-4 camera equipment manufactured by VEB "Karl Zeiss" (GDR), and other devices intended for processing photos made by the МКФ-6 and МСК-4 cameras. It should be noted that fruitful cooperation of the USSR and GDR scientists and specialists resulted in such devices for processing space photos as a "Rectimat-C" rectification apparatus and ФЕАГ-200 optoelectronic system for processing information on digital level.

The "Rectimat-C" apparatus provides for correcting space photos obtained by means both of manned and unmanned space vehicles to the specified cartographic projection. Worked out are the methods for using this apparatus for accounting for errors caused by the curvature of the Earth surface and refraction of light beams in the Earth atmosphere. The technology for composing multispectral color images is also elaborated for the given apparatus.

The ФЕАГ-200 system used together with the USSR made computer СМ-1420 makes it possible to digitally code space photos, to process the arrays of digital data according to programs specified, and to supply users with video images of required properties.

The USSR cooperates with the People's Republic of Bulgaria, Czechoslovakia, and other countries in creating and using the technologies and means for processing space data.

The level of utilization of remote sensing materials in the USSR is characterized by the following.

The number of problems solved amounts to 300, the number of users is over 900, the amount of information supplied for the purposes of the national economy exceeds 1 million of units.

The materials of space photographic surveys serve as a basis for making and revising topographic and thematic maps, for prospecting oil and gas deposits as well as ore deposits, for working out the designs for constructing railways and roads, for studying the forest stock of the USSR, for mapping soils and assesing the amount of fodder on pastures, for studying shallow areas of the shelf, for monitoring the environment, for carrying out investigations in the fundamental problems of geography and natural studies, etc.

The most efficient way in using remote space data is a complex study and manning of the natural resources. This way boils down to a conjugated study of the natural-economical potential of large regions in many aspects of natural studies and nature management.

The investigations performed result in making the sets of thematic maps which are the source of concentrated information required for proper planning, management expoitation and monitoring of use of natural resources.

The materials of sensing of the Earth from space obtained by means of the USSR space vehicles can be given and are being given to foreign users interested on the basis of appropriate conditions and provided that such users strictly adhere to norms established by the UN and included in appropriate intergovernmental agreements.

We, in the USSR, asume that investigations of the natural resources of the Earth with the use of the space-based material are very promising for multi-target and fruitful cooperation, both economic and scientific, of the scientists and specialists all over the world for the benefit of the all mankind.