

“Resurs-P” satellite hyperspectral data: preliminary evaluation of information capacities

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Russian satellite «Resurs-P» has been operating since 2014. A hyperspectral “Resurs-P” images are being acquired by Research Center for Earth Operative Monitoring of Russian Federation Space Agency. At present the complex of researches is performed to assess the information capacities of this satellite.

HS sensor	Spect. range nm	Spect. bands n	FWHM nm	Spat. resol. m	Swath width km
Resurs-P	405 - 1000	130	2,4 .. 7,4	30	35

Table 1. Hyperspectral sensor characteristics. FWHM – full width at half maximum

Following information is needed for a data acquisition to evaluate the information capacity of satellite hyperspectral data and choose an optimal parameters:

- field spectral measurements,
- meteorological observations,
- synchronous airborne data,
- modelling of an interval and monochromatic contrasts of scene elements under various conditions of a survey and atmosphere.

Field spectral reflectance have been collected by the FieldSpec®4 spectroradiometer (ASD) in a spectral range of 350 – 2500 nm. Elements of the landscape having a homogenous surface and unchanged physical characteristics during the day were selected for collecting spectra. The field spectral reflectance was used for an atmospheric correction of remote sensing data and evaluation of the transmission reliability for test surface spectral properties from Resurs-P data. These were used the objects with the known reference spectra that were selected

and measured during the satellite data acquisition. Adjustment coefficients for a data radiometric calibration were determined by these measurements.

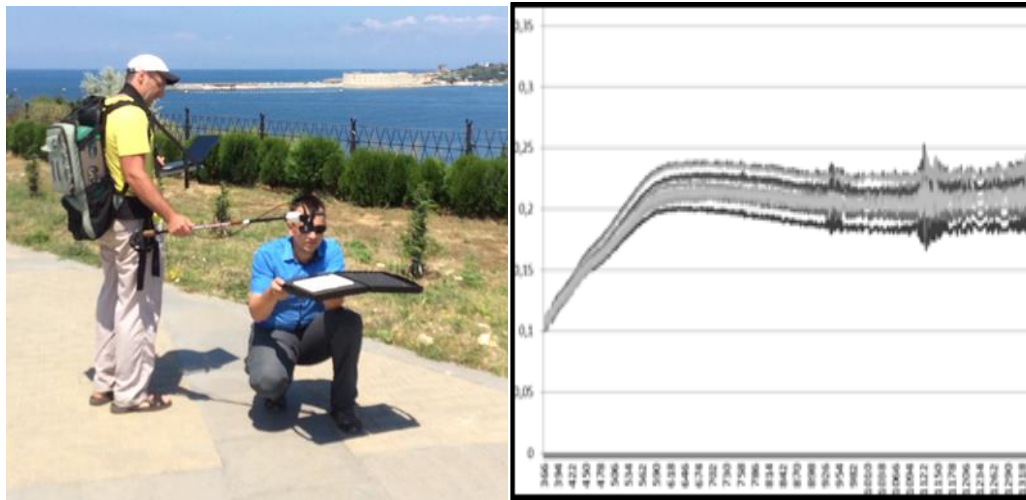


Figure 1. Field spectral reflectance

The total ozone column, water vapor column and aerosol optical thickness were measured by the satellite data. An evaluation of the spectral calibration reliability was carried out by the changes analysis into the known absorption bands of atmospheric gases and aerosols at certain wavelengths based on the spectral resolution of hyperspectral equipment.

Two steps preceded the atmospheric correction of Resurs-P image: 1) deriving the radiometric correction coefficients; 2) approximation of the spectral signature.

The radiometric and geometric corrections of the Resurs-P images were performed by the vendor. The radiometric correction coefficients (K) (Figure 2) were applied to the Resurs-P image before the atmospheric correction (Figure 3).

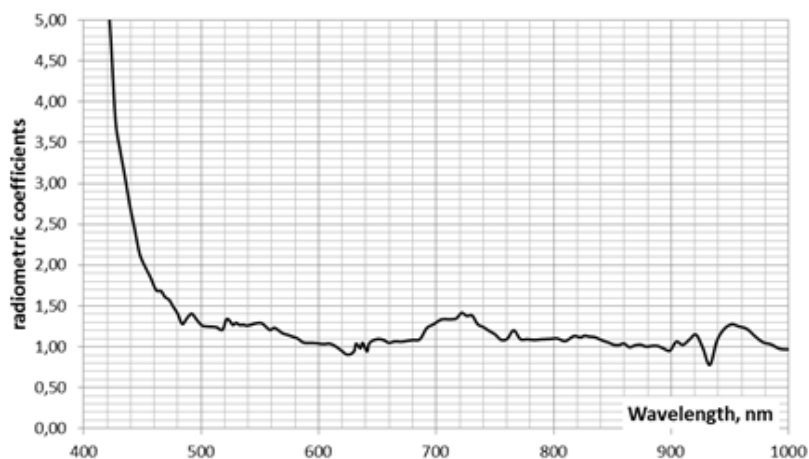


Figure 2. Radiometric correction coefficients (K) for the Resurs-P image

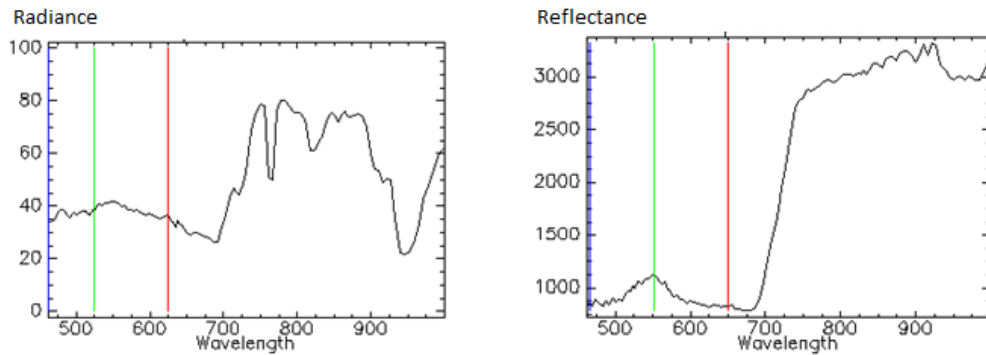


Figure 3. Spectre of a grassland before (left) and after (right) the atmospheric correction

An improvement of the radiometric correction of the Resurs-P data is needed to reduce the level of errors and uncertainties.

To solve practical tasks on the basis of hyperspectral data the original software is used. And for each task a unique set of features is generated and the most efficient method of detection or classification is selected. Object-oriented analysis of Resurs-P data was split into a segmentation and classification. Furthermore, to determine the spectrum ranges for the most effective solving of the task, methods of data statistical estimation are used, such as gradient method, spatially scalable filtering method, and others.

As an example of thematic task, we have estimated the depth of the water body, the Gulf of Finland, by the “Resurs-P” satellite hyperspectral image. The depth from 10 to 20 m was determined (Figure 4) based on approaches for identification of the bottoms’s type and assessment of its reflection characteristics, analysis of hydrooptical indicators of water masses, and classification of mineral and organic substances influencing the absorption and scattering of radiation in the water.

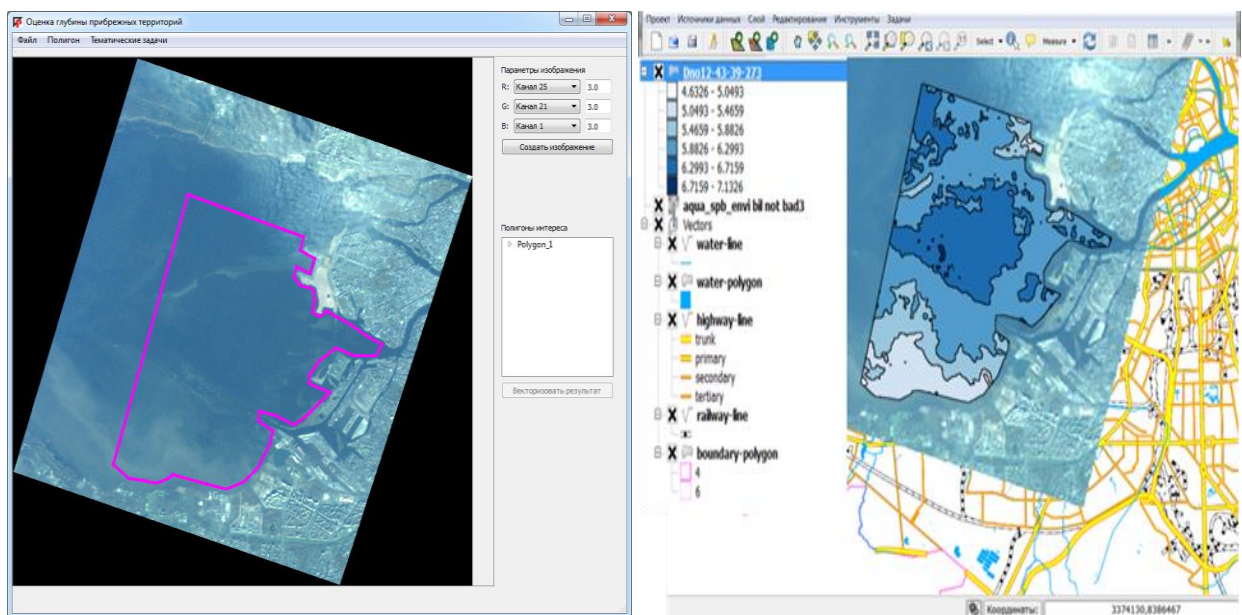


Figure 4. “Resurs-P” satellite hyperspectral image (08.06.15) (left) and the depth from 10 to 20 m (right).

Most informative spectral bands of hyperspectral data were used to identify the light scattering and absorption (425, 545 and 605 nm). Semi-analytic models that reflected the relationship between the qualitative characteristics of water bodies, water actinometrical characteristics and performance of hydro-spectral absorption and scattering coefficients, were applied to verify estimated depths. Results of verification performed by in-situ data have shown that the accuracy of "Resurs-P" hyperspectral measurements on depths is at least 90%.



Figure 5. Field vineyard (left) and soil (middle) spectral reflectance (right).

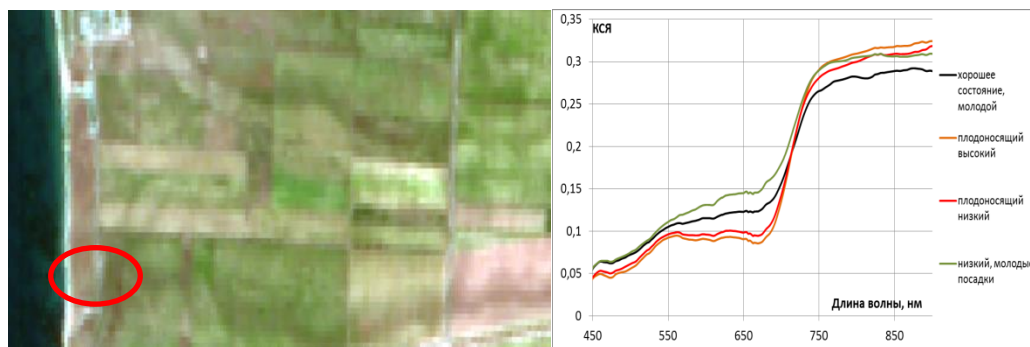


Figure 6. "Resurs-P" satellite hyperspectral image (left) and the spectral reflectance (right).

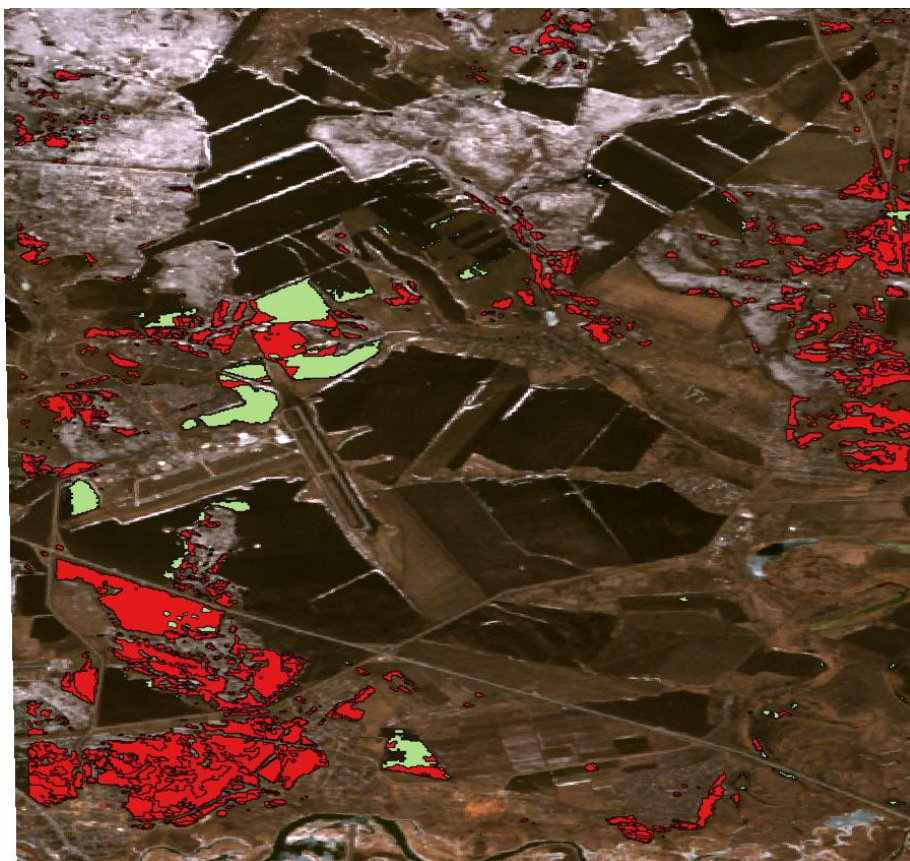
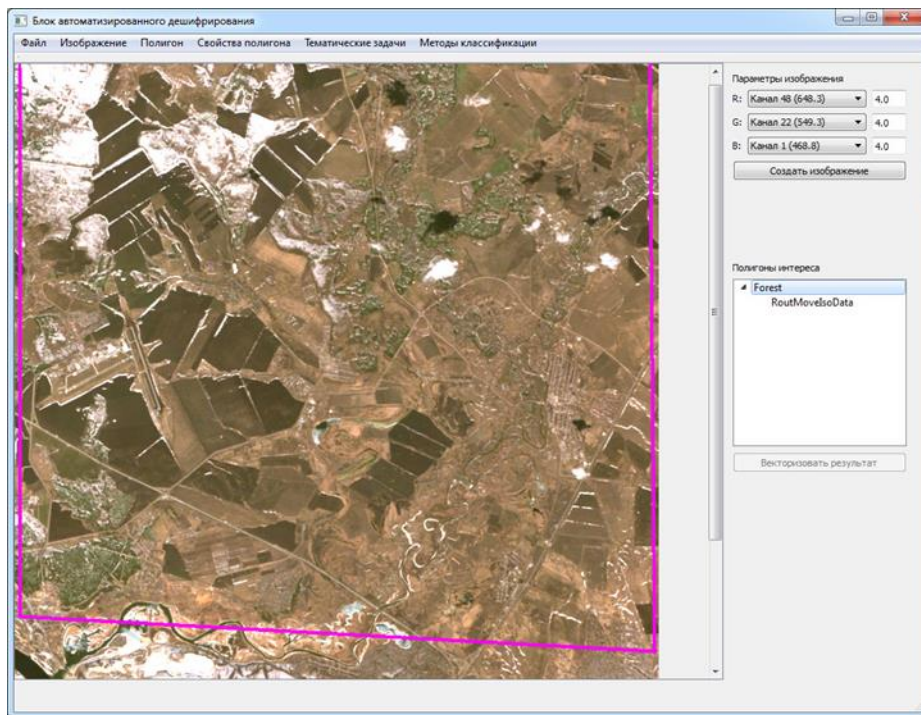


Figure 7. “Resurs-P” satellite hyperspectral image (above) and distribution of forest classes in forestry map (below).

Results of species classification from Resurs-P data were comparable with the forestry map. Classification results showed that Resurs-P provides good ability to remotely map basic forest species and their mixture.

In general, conducted researches confirmed the high information capacities of the "Resurs-P" hyperspectral data and the appropriateness of their wide use in solving tasks of environmental analysis.

The study analysis demonstrated that the satellite hyperspectral sensor Resurs-P can produce useful information, but also indicated that developments in pre-processing steps are still required to improve the mapping accuracy.

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