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THE VOLGA DELTA AGRICULTURAL LANDS ABANDONMENT AND CURRENT STATE MAPPING USING MULTI-TEMPORAL AND MULTI-SENSOR REMOTE SENSING DATA

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Introduction. Approximately 30-40 million hectares of arable land has been abandoned over the past two decades in Russia [Agroecological state and prospects of the use of lands retired from active agriculture in Russia, 2008]. At present, these lands undergo changing in response to regional peculiarities and abandonment duration. The assessment of fallow lands is of importance in identifying the activities on reclamation and melioration of these lands when converting them again into agricultural use. The main object of our study is finding a way of satellite optical and radar images combined application for abandoned agricultural lands mapping.

Test site. The Volga Delta is a region of a special interest. It is located in a semi-arid climate zone, with rather fertile soils, but success of the agriculture here is highly dependent on spring flooding and water availability. Since the 1960s, an irrigated crops and vegetables production based on artificial irrigation has become the major agricultural sector and achieved its peak development by the mid-1980s. Both environmental and socio-economic factors caused the suspension of the agricultural activity and irrigation by now, so a considerable part of the arable lands, protected from flooding and watering by banks, turned out to be exposed to degradation processes i.e. shrub invasion, salinization, pasture digression, halophytic vegetation spreading.

Data used. Russian topographic maps of the late 70's-early 80's and archive of Landsat images obtained from 1984 till present were used for mapping and studying changes in agricultural land use at the delta. Multi-temporal polarimetric Radarsat-2 images obtained in summer 2014 in conjunction with synchronous ground truth observations of the site were used for evaluation of fallow lands current state. The ground truth data is particularly useful in evaluating the radar data processing results accuracy.

Methods. A vector mask of agricultural fields created from topographic maps fixed the maximal areas of arable lands for the early 1980's. Land use/land cover (LULC) patterns for each representative year (1984, 1993, 2002, 2008, 2014) were created using Landsat multi-seasonal composites. The period of fallow lands abandonment was determined basing on multi-year LULC patterns comparison.

SAR data were expected to be helpful for assessing the state of abandoned agricultural lands owing to sensitivity of radio waves to geometric features and moisture content of a terrain. A series of experiments on selecting the optimal radar data type and processing parameters revealed that polarimetric data have significant advantages over single-polarized data for the examined region. The polarimetric data let 93% accuracy in discriminating overgrown and not overgrown fallows while HV-polarized image – 67%. The following processing chain gave the most accurate result: polarimetric decomposition (Yamaguchi) followed by supervised classification (Support Vector Machine with 3 classes extraction) of volume scattering component expressed in decibels.

Results and discussions. The main result is a map of the Volga delta abandoned agricultural lands where for each fallow field period of abandonment and overgrowth level is determined. A comparison of the radar data processing results and map based on optical data shows that there is no a distinct correspondence between fallow lands overgrowth degree and duration of their abandonment period. Apparently, environmental features (such as water availability, soil type and etc.) have a much greater impact on fallow lands state.