Application of spectral indices including Landsat tasseled cap transformation to estimate wetlands under natural and regulated hydrological regime changes and direct human impact in the Volga-Akhtuba floodplain.

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Abstract
In the unified ecosystem comprising the Volga river basin - Volga-Akhtuba floodplain (VAF) – Volga delta – Caspian Sea, the Lower Volga is a unique natural territorial complex with intrazonal ecosystems located within arid lands. The spatial and temporal ecosystem dynamics of the VAF are mostly characterised by seasonal and long-term variations in the hydrological regime. Since the mid-20th century the Lower Volga hydrological regime is regulated by the Volzhsko-Kamskiy hydroelectric power station (HEP) cascade. The downstream Volzhskaya Hydro-Electric Power Plant is situated at the top of the VAF. Local field observations of land cover reveal the activation of desertification processes, gradual loss of original wetland ecosystems and their replacement by arid ecosystems in recent years. To evaluate the scale of these changes, accurate monitoring of the VAF region is necessary in order to localize and quantify the desertification processes, estimate the state of wetland plant cover, its seasonal and annual dynamics, so that the hydrological regulation strategies can be adapted to conserve wetland ecosystems and prevent their loss. In this case remote sensing data is extremely useful for monitoring the VAF. Simple band math indices – NDVI and NDWI or MNDWI calculated from Landsat data – are useful because of the ease of calculation, low demands for computational resources and appropriate results for common analyses of land cover feature dynamics. To improve this data we also applied a fundamentally distinct approach to analyze key scenes – tasseled cap transformation techniques (TCT). Although it is time consuming, TCTs are powerful methods for plant cover detection and also provide valuable information about soils and water bodies. We found these methods to be the most appropriate for detecting changes in the VAF wetland plant communities in terms of soil wetness and water body dynamics. These data assays are combined with an analysis of lower spatial but higher temporal resolution data (SeaWifs and MERIS FAPAR products). Our results indicate that vegetation activity may vary greatly depending on the type of ecosystem, its location in the VAF, Volga and Akhtuba water runoff, precipitation, human activities, etc. Our findings from remote sensing data on land cover in the VAF produce reliable conclusions for significant fluctuations of vegetation activity in the floodplain territory and allow the development of proposals for operational strategies on the hydrotechnical facilities which characterise the Lower Volga wetland hydrological regime. The study is vital for the conservation of the VAF’s unique ecosystems and biodiversity.