Comparing different remote sensing based methods for mapping post-Soviet abandoned cropland in Central Asia

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The surging demand of the former Soviet Union to become independent of cotton imports and to satisfy demands for its fast growing growing population has been met by immense increases of domestic production. This succeeded, but predominantly by extending irrigated agriculture in countries currently located in Central Asia, and concurrently at the expense of an unsustainable use of land and water resources in this region. These were exploited in a way that an ecological tipping point was reached as substantiated in a widespread soil degradation and consequent cropland abandonment. Driven by growing environmental concerns, fear for food insecurity of a growing population and the adverse projections of climate change for the region, the productivity enhancement of degraded and abandoned croplands has been put back on the political agenda. Such croplands do not only represent a potentially valuable resource, even when realizing the potentially lower crop yields, but it is recognized also as an effective means in levering on previous investments to extend the irrigation and drainage infrastructure. Latest research findings point also at the potential for implementing alternative sustainable land management options such as e.g. afforestation and renewable energy production. The lack of robust data and information, needed to identify rapidly and over a wide area abandoned croplands, can be bridged by satellite earth observation (EO) data. The availability of repetitive and objective data can be used to assess alterations in surface characteristics and consequently map large territories. Yet, current remote sensing methods have each (dis)advantages which a priori cannot be assessed for the situation in Central Asia. Therefore, the findings of abandoned cropland mapping by six common methods were compared. The comparison followed a step-wise procedure: First an agricultural land mask was produced to separate agricultural from non-agricultural land. Secondly NDVI time series from the MODIS Terra and Aqua platforms for 2003-2014 were compiled. These were consequently used to one unsupervised method based on thresholds, two different supervised methods, two trend based methods and a simple fusion method based on majority voting. The results of the six methods were then fused, based on a weighted fusion algorithm that accounted for the performance of each method. To summarize patterns of abandoned cropland across Central Asia, the percentage of abandoned cropland relative to the sum of abandoned plus active cropland was estimated. Abandonment rates were summarized by biophysical suitability for agriculture, using a crop suitability index from FAO. Overall accuracies of the methods ranged from 0.678 – 0.825. The weighted fusion increased the accuracy even more (0.858) whilst the difference between the weighted fusion and the single best approach was statistically significant ($P < 0.05$). Overall, the dimension of abandoned cropland varied between 10%-35% of the agricultural land, depending on the method used. None of the methods was exclusively superior in all irrigated regions across Central Asia. Agreement showed however that abandoned croplands appeared especially in the lowland regions, typified by water deficits and land abandonment is driven predominantly by land degradation. In some regions, abandonment appeared however also in places with highest recorded suitability for crops. The assessment revealed overall that no individual method can be promoted as the most accurate across all irrigated land in Central Asia. Yet, once fusing the different methods a first reliable and unified abandoned cropland layer in Central Asia could be elaborated, which should be of interest to local practitioners and land use and political decision-makers alike.