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Monitoring Oil Exploitation Infrastructure and Dirt Roads with Object-Based Image Analysis and Random Forest in the Eastern Mongolian Steppe

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Rapid changes in land use due to intensifications of oil exploration and exploitation adversely affect the Eastern Mongolian steppe ecosystem. The expansion of supporting infrastructure and dirt road networks for oil production contribute to accelerate the human-induced land degradation process in the grasslands. So far, neither the extents of road networks nor the extent of surrounding grasslands affected by the oil industry are monitored which is generally labor consuming. This causes that no information on the changes in the area which is affected by those disturbance drivers is available. Therefore, the major aim of this study is to provide a cost-effective model to map the supporting infrastructure, sites and dirt roads of oil exploitation through classifying remotely sensed images using object-based classifications with Random Forest. By combining satellite data with different spatial and spectral resolutions (PlanetScope, RapidEye, and Landsat ETM+), the product delivers data since 2005. In the image classification, the variables of segmentation, spectral characteristics, and indices were extracted from all above mentioned imagery and used as predictors. Within this study examined the comparison analysis in order to quantify the uncertainty arising from the combination of data from different sensors in their spectral and spatial configurations. Besides that, this study analyzed the consequence of supporting infrastructure and dirt roads on surrounding ecosystems combining data from field vegetation surveys and drone imagery. Results show that overall accuracies of land use maps ranged 73%–93% mainly depending on satellites' spatial resolution. Since 2005, the area of grassland disturbed by dirt roads and oil exploitation infrastructure increased by 88% with its highest expansion by 47% in the period 2005–2010. Consequently, the comparison of multiscale classification suggests that, although high spatial resolutions are clearly beneficial, all datasets were useful to delineate linear features such as roads. Furthermore, the results of this study provide an effective evaluation for the potential of Random Forest based model for extracting relatively narrow linear features such as roads from multiscale satellite images and map products that are possible to use for detailed land degradation assessments.