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Infrared thermal remote sensing for soil salinity assessment on landscape scale

Konstantin Ivushkin (1), Harm Bartholomeus (1), Arnold K. Bregt (1), Alim Pulatov (2), Elisabeth N. Bui (3), and John Wilford (4)

(1) Laboratory of Geo-Information Science and Remote Sensing, Wageningen University & Research, Droevendaalsesteeg 3, 6708 PB Wageningen, the Netherlands, (2) EcoGIS Center, Tashkent Institute of Irrigation and Melioration, Qari Niyoziy 39, 100000 Tashkent, Uzbekistan, (3) CSIRO Land and Water, PO Box 1666, Canberra, ACT 2601, Australia, (4) Geoscience Australia, GPO Box 378, Canberra, ACT 2601, Australia

Soil salinity is considered as one of the most severe land degradation aspects. An increased soil salt level inhibits growth and development of crops. Therefore, up to date soil salinity information is vital for appropriate management practices and reclamation strategies. This information is required at increasing spatial and temporal resolution for appropriate management adaptations. Conventional soil sampling and associated laboratory analyses are slow, expensive, and often cannot deliver the temporal and spatial resolution required.

The change of canopy temperature is one of the stress indicators in plants. Its behaviour in response to salt stress on individual plant level is well studied in laboratory and greenhouse experiments, but its potential for landscape scale studies using remote sensing techniques is not investigated yet. In our study, possibilities of satellite thermography for landscape scale soil salinity assessment of cropped areas were studied. The performance of satellite thermography is compared with other approaches that have been used before, like Normalised Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI). The study areas were Syrdarya province of Uzbekistan and four study areas in four Australian states namely, Western Australia, South Australia, Queensland and New South Wales. The diversity of the study areas allowed us to analyse behaviour of canopy temperature of different crops (wheat, cotton, barley) and different agriculture practices (rain fed and irrigated). MODIS and Landsat TM multiannual satellite images were used to measure canopy temperature. As ground truth for Uzbekistan study area we used a provincial soil salinity map. For the Australian study areas we used the EC map for the whole country. ANOVA was used to analyse relations between the soil salinity maps and canopy temperature, NDVI, EVI. Time series graphs were created to analyse the dynamics of the indicators during the growing season.

The results showed significant relations between the soil salinity maps and canopy temperature. The amplitude of canopy temperature difference between salinity classes varies for different crops, but the trend of temperature increase under increased salinity is present in all cases. The calculated F-values were higher for canopy temperature than for all other compared indicators. The vegetation indices also showed significant differences, but F-values were lower compared to canopy temperature. Also the visual comparison of the soil salinity map and the canopy temperature map show similar spatial patterns. The NDVI and EVI maps look more random and noisy and patterns are less pronounced than for the canopy temperature map. The strongest relation between the soil salinity map and canopy temperature was usually observed at the end of a dry season and in the period of maximum crop development.

Satellite thermography appeared to be a valuable approach to detect soil salinity under agricultural crops at landscape scale.