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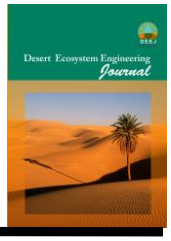

Investigation of Soil Salinity Changes in Torbat Heydariyeh of Khorasan Razavi Province using MODIS Data

Mostafa Dastourani1[1]*, Mohsen Jafari Shalamzari2[2], Hadi Soleimani Moghadam3[3]

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Extended Abstract

Introduction: as a major cause of desertification, soil salinity may be brought about by a variety of factors including but not limited to improper irrigation, poor-quality irrigation water, saline groundwaters, saline geological formations, and improper land management. Considering the fact that direct measurement of soil salinity is costly and time-consuming, this study sought to investigate the chances of using satellite-extracted remote sensing data as a proxy to estimate soil salinity.

Materials and Methods: : This study investigated soil salinity changes in Torbat Heydariyeh city, Khorasan Razavi province using MODIS satellite data collected for the 2005, 2010, 2015, and 2020 periods. Moreover, a combination of MODIS visual images (bands 4 and 6) was used to construct the salinity index. On the other hand, the correlations between salinity, altitude, slope, and EVI (Enhanced Vegetation Index) were measured to evaluate alternative indices and examine the influence of salinity on other environmental variables. Furthermore, to prepare the ground truth map for 2020, some 80 points were selected using random field sampling that was performed on the top 0-5 cm of the soil surface in late June 2020. Soil salinity was also measured via saturated extracts. Finally, the values obtained for salinity were compared with their corresponding values in the 2020 salinity map using the kappa index to ensure the accuracy of the calculations.

Results and Discussion: While the region's salinity level was found not to be very high, the trend of change indicated an increase in the region's salinity, especially in the southern, northern, and central parts of the region. It should be noted that topographically, most of the region is flat, possessing some low elevations in the middle and northern parts. On the other hand, soil salinity is believed to be correlated with a region's topography.

Considering the fact that salts tend to accumulate more in the lowlands, and that highlands become saline only if their parent formation is saline, this study used an accurate digital altitude map with 12.5 meters' resolution extracted from the ALOS satellite to investigate the influence of salinity on the distribution of soil salinity in Torbat-e Heydarieh. To this end, the correlations between salinity, altitude, and slope were measured for different periods. The results suggested that the correlations were insignificant in all the studied periods. However, the highest correlation was found between salinity and altitude, which seems reasonable if the distribution of evaporitic and Marine formations in the plain areas is taken into account.

Moreover, no significant changes were observed in the region's vegetation between 2005 and 2020. Dividing the results of EVI analysis into three coverage classes, the researchers of this study can classify 60% of the region as being coverage-less or possessing very poor coverage (2235 square kilometers), 20% as having medium coverage (745 square kilometers), and 20% as having high coverage (745 square kilometers), respectively. Furthermore, most of the region's vegetation was sparse in the northern plains on the alluvial sediments. Accordingly, some 60% (2235 square kilometers) of the region's total areas fell under the no-salinity class (0-0.17), 35% (1304 square kilometers) under the slight light salinity class (0.17-1.2), and only 5% (186 square kilometers of the region's area) under the extreme class (more than 0.2).

The salinity measured in the field was compared with the corresponding values obtained from the produced map to confirm the validity of the salinity index. Accordingly, the kappa coefficient was found to be 0.65%, which

1. Assistant professor, Faculty of Geography and Environmental Sciences, Hakim Sabzevari University. Sabzevar, Iran, Corresponding Author; m.dastorani@hsu.ac.ir ()

2. Head of the IT section of Payam Nour University, Shahrekord, Iran

3. Assistant Professor of Geography & Urban Planning, Hakim Sabzevari University, Sabzevar, Iran

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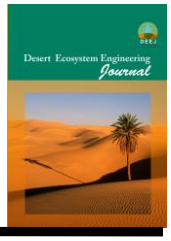

confirms the validity of the measurements performed. However, the results of correlation analysis between different parameters and salinity showed that there was no correlation between slope, altitude, and EVI, which could be attributed to the region's sparse vegetation. Interestingly, the height and slope correlated more with salinity than with vegetation. It seems that the severe lack of vegetation and the accumulation of evaporative formations in a few points of the region have led to the lack of correlation between salinity and height, slope, and vegetation.

Conclusion: The results of soil salinity analysis in Torbat Heydarieh indicated that using the remote sensing data was a plausible alternative to direct measurement of soil salinity. However, soil salinity did not correlate with other environmental factors including vegetation, altitude, and slope gradient, suggesting that these factors cannot serve as proxies of soil salinity in such arid areas. Moreover, it could be argued that the salinity index may be used to monitor the region's salinity as an accurate measurement. The results of this study can help land managers deal more efficiently with salinity, and ultimately with desertification.

Keywords: Salinity, Desertification, Land degradation, GIS, Vegetation.

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