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Using Innovative Statistical Analyses to Assess Soil Degradation due to Land Use Change

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Soil erosion and overall loss of soil fertility is a serious issue for loess soils of the Golestan province, northern Iran. The assessment of soil degradation at large watershed scales is urgently required. This research investigated the role of land use change and its effect on soil degradation in cultivated, pasture and urban lands, when compared to native forest in terms of declines in soil fertility. Some novel statistical methods including partial least squares (PLS), principal component regression (PCR), and ordinary least squares regression (OLS) were used to predict soil cation-exchange capacity (CEC) using soil characteristics. PCA identified five primary components of soil quality. The PLS model was used to predict soil CEC from the soil characteristics including bulk density (BD), electrical conductivity (EC), pH, calcium carbonate equivalent (CCE), soil particle density (DS), mean weight diameter (MWD), soil porosity (F), organic carbon (OC), Labile carbon (LC), mineral carbon, saturation percentage (SP), soil particle size (clay, silt and sand), exchangeable cations (Ca2+, Mg2+, K+, Na+), and soil microbial respiration (SMR) collected in the Ziarat watershed. In order to evaluate the best fit, two other methods, PCR and OLS, were also examined. An exponential semivariogram using PLS predictions revealed stronger spatial dependence among CEC [r2 = 0.80, and RMSE= 1.99] than the other methods, PCR [r2 = 0.84, and RMSE= 2.45] and OLS [r2 = 0.84, and RMSE= 2.45]. Therefore, the PLS method provided the best model for the data. In stepwise regression analysis, MWD and LC were selected as influential variables in all soils, whereas the other influential parameters were different in various land uses. This study quantified reductions in numerous soil quality parameters resulting from extensive land-use changes and urbanization in the Ziarat watershed in Northern Iran.