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Comparing the Ability of Conventional and Digital Soil Maps to Explain Soil Variability using Diversity Indices

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Introduction: Effective and sustainable soil management requires knowledge about the spatial patterns of soil variation and soil surveys are important and useful sources of data that can be used. Prior knowledge about the spatial distribution of the soils is the first essential step for this aim but this requires the collection of large amounts of soil information. However, the conventional soil surveys are usually not useful for providing quantitative information about the spatial distribution of soil properties that are used in many environmental studies. Recently, by the rapid development of the computers and technology together with the availability of new types of remote sensing data and digital elevation models (DEMs), digital and quantitative approaches have been developed. These new techniques relies on finding the relationships between soil properties or classes and the auxiliary information that explain the soil forming factors or processes and finally predict soil patterns on the landscape. Different types of the machine learning approaches have been applied for digital soil mapping of soil classes, such as the logistic and multinomial logistic regressions, neural networks and classification trees. In reality, soils are physical outcomes of the interactions happening among the geology, climate, hydrology and geomorphic processes. Diversity is a way of measuring soil variation. Ibanez (9) first introduced ecological diversity indices as measures of diversity. Application of the diversity indices in soil science have considerably increased in recent years. Taxonomic diversity has been evaluated in the most previous researches whereas comparing the ability of different soil mapping approaches based on these indices was rarely considered. Therefore, the main objective of this study was to compare the ability of the conventional and digital soil maps to explain the soil variability using diversity indices in the Shahrekord plain of Chaharmahal-Va- Bakhtiari province.

Materials and Methods: The soils in the study area have been formed on Quaternary shale and foliated clayey limestone deposits. Irrigated crops such as wheat, barley and alfalfa are the main land uses in the area. According to the semi-detailed soil survey, 120 pedons with approximate distance of 750 m were excavated and described according to the “field book for describing and sampling soils”. Soil samples were taken from different genetic horizons and soil physicochemical properties were determined. Based on the pedons description and soil analytical data, pedons were classified according to the Soil Taxonomy (ST) up to subgroup level. Using aerial photo interpretation, geology map, google earth image and field observations primary soil map was created. With considering the taxonomic level, the representative pedons were determined and soil map was prepared. Multinomial logistic regression was used to predict soil classes at great group and subgroup levels. The map units that have the highest frequency were selected as indicator to calculate diversity indices in the conventional soil map at each taxonomic level. The selected map units were overlay to digital soil map and further diversity indices were calculated. Diversity indices including the Shannon’s diversity, evenness and richness index. In order to know whether the means of Shannon’s diversity for two approaches are significantly different, means comparison was done.

Results and Discussion: The results confirmed that the Shannon's diversity index was higher in the digital soil map than the conventional soil map for most soil map units. At great group and subgroup levels, a significant difference was observed for the Shannon's diversity index at 0.05 and 0.001 probability levels, respectively. Comparing the conventional and the digital soil maps showed the numbers of soil map units with significant difference regarding the Shannon's diversity index decreased from great group to the subgroup level. Although the conventional soil map did not show a good efficiency to explain the soil variability in this region considering more soil information to select the representative pedons at subgroup level in the conventional soil mapping could increase the ability of this approach.

Conclusion: A significant difference for the Shannon's diversity index between the conventional and the digital soil maps demonstrated that conventional soil mapping has not enough ability to explain the soil

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variability. It is recommended to test the effect of soil mapping approaches on explanation of the soil variability in other areas. Despite the deficiencies of traditional soil survey, it is still difficult to state about their replacement by digital methods.

Keywords: Diversity indices, Multinomial logistic regression, Soil mapping approaches