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Can Location of Sample Area and Expert Knowledge Affect the Results of Geopedological Approach in Soil Mapping?

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ABSTRACT

Soil maps are used for different purposes like agriculture, natural resources, mining and engineering. Thus, their quality is a prerequisite for rational land use and soil management. New versions of soil surveys are used to increase the reliability of soil maps. Geopedology is a systematic approach of geomorphic analysis for soil mapping that construct field operation upon work mainly in a sample area and generalization of the results obtained from sample area to similar landforms in the region. The objective of this study is to determine the effect of location of sample area and expert knowledge on credibility of generalization the results of geopedological approach for similar landforms in south-east of Borujen area, Central Iran. After preparation of primitive interpretation map of the study area on air photos (1:20 000), considering different locations of Pi111 unit that encompasses the maximum space of the study area, the sample area was planed in three different locations. Then, a second-order soil survey was conducted and final soil map was prepared. Also, the idea of two different experts was considered to determine the amount of credibility of generalization the results of geopedological approach for the mentioned unit. Results showed that changing the location of sample area has taxonomic levels (order, subgroup and/or family) and map unit type (complex and consociation) differences in Pi111 unit. In spite of similarity the profiles selected by two experts, soil taxonomy of these profiles were different in comparison with representative pedons (at family level). Therefore, the use of landform phases is recommended to increase the accuracy of geopedological results.

Keywords: Geopedology; Soil mapping; Sample area; Generalization; Borujen area

INTRODUCTION

Soil maps are used for different purposes like agriculture, natural resources, mining and engineering. Thus, their quality is a prerequisite for rational land use and soil management. Zhu et al. (2001) highlighted complete limitations of conventional soil surveying. As a result of these limitations, the current way of conducting soil survey needs to expenditure a lot of time and charge. Therefore, over the past decades, soil survey institutions have tried to minimize field mapping and to substitute conventional mapping methods by modern procedures to facilitate direct interpretation of the soil. In terms of the above-mentioned concepts, models of this kind attempt to comprehend the systematic part of soil variation with information on the geology, geomorphology and pedology.

Geopedological approach for soil survey was developed by Zinck (1989) and is essentially a systematic application of geomorphic analysis for soil mapping (Rossiter, 2000). The main objective in geopedology is to organize and classify the soils in their geomorphological expression in the earth's surface by using a hierarchical legend system (Zinck, 1989). Hengl and Rossiter (2003) concluded that geopedology can be applied by soil survey teams to edit and update current maps and to enhance or replace API for new surveys. Aiman et al. (2004) declared geopedological map and an appropriate interpolation technique can be used to map soil salinity in both discrete and continuous models. Farshad, et al. (2005) also stated that geopedology plays an important role in making decision on how to use salt-affected soils in the Northeast of Thailand. Udomsri (2006) illustrated the geopedological approach is quite valuable to obtain soil data from inaccessible areas particularly sloping lands. Moemeni (1994) illustrated this approach is better than traditional soil mapping method for land suitability classification due to separation of more homogeneous units. Other studies based on geopedological approach have done at different areas of Iran (for example: Moemeni and Farshad; 1998; Toomanian et al., 2006). The fundamental question in this issue is: to what extent the geopedological approach is authentic in generalization of its results? Therefore, the main goal of this research is to determine the effect of location of sample area and expert knowledge on credibility of generalization the results of geopedological approach for similar landforms in south-east of Borujen area, Central Iran.

MATERIALS and METHODS

Study Area

The area under investigation has a size of approximately 1100 ha. It is located between 31° 54' and 31° 56' N, and 51° 12' and 51° 15' E in south-east of Borujen region, Chaharmahal-Va-Bakhtiari province, Central Iran. The study area consists of two dominant landscape units namely hilland and piedmont. Piedmont is the major landscape which divides into two different lithologies by the main road in this area (Fig. 1 and Table 1). The mean annual precipitation and temperature in the Borujen region are 255 mm and 10.7 °C, respectively. The mean altitude in the area is 2277 m above the sea level. The soil moisture and temperature regimes of the area are xeric and mesic, respectively. Irrigated wheat cultivation and pasture are the major land uses in this area.

Soil Surveying

To prepare the photo-interpretation map (geoform map), aerial photographs (1:20 000) were interpreted under stereoscope by considering geopedological approach (Zinck, 1989). Then, interpreted air photos with the milars were imported into ILWIS software 3.4 (ITC, 2007). After ortho-photo geo-referencing (Rossiter and Hengl, 2001), landforms were mapped and glued via onscreen digitization.

The summarized data for each landform of the geoform map and legend are shown in Fig. 1 and Table 1, respectively.

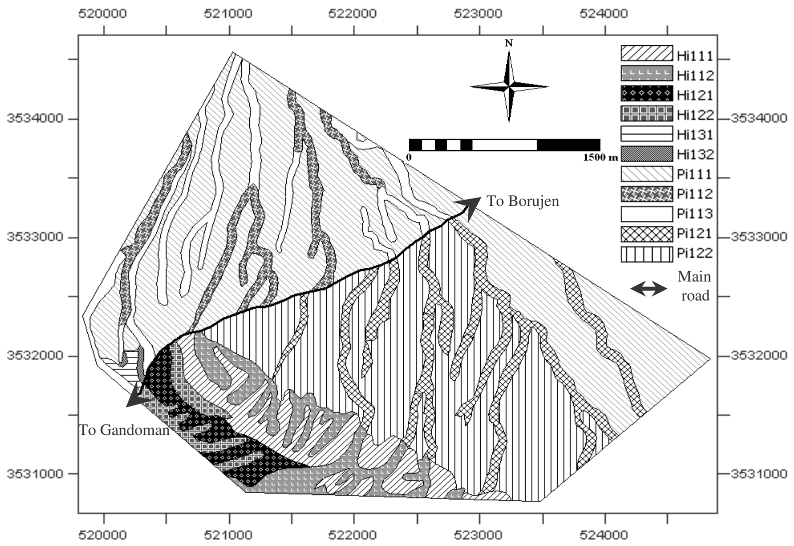

Fig. 1. The geoform map of the study area prepared by geopedological approach.

Table 1. Legend of the geoform map in the study area.

Landscape	Relief	Lithology	Landform	Symbol	Area
Hilland	Low hill	Marl/limestone slaty in part	Shoulder-backslope	Hi111	66.83
			Footslope	Hi112	62.92
		Conglomerate bedded with marl and silt	Shoulder-backslope	Hi121	29.44
			Footslope	Hi122	22.99
		Young terraces and alluvial fans	Shoulder-backslope	Hi131	4.29
			Footslope	Hi132	1.92
Piedmont	Undulated glacis	Young terraces and alluvial fans	Thread-riser complex	**Pi111**	**388.96**
			Swale with grass cover	Pi112	52.21
			Riser	Pi113	73.56
		Old terraces and alluvial fans	Riser	Pi121	103.25
			Thread-riser complex	Pi122	296.20

Considering different locations of Pi111 unit that encompasses the highest surface of the study area (Table 1), the sample area was planned in three different locations. In order to determine the amount of credibility of generalization the results of geopedological approach for the mentioned unit two different expert's knowledge (A and B) were also considered for validation. Then, a stratified grid sampling method with 250 m interval was performed in each sample area to select the profile locations. Three random profiles were dug by each expert for validation (Figs. 2, 3 and 4) and geographic position of all soil profiles was determined by a GPS. Types of map units were determined using criteria of Soil Survey Manual (Soil Survey Division Staff, 1993). Soil samples from different horizons of representative pedons in the sample area were taken for soil physical and chemical analyses and final soil classification according to American Soil Taxonomy (Soil Survey Staff, 2006).

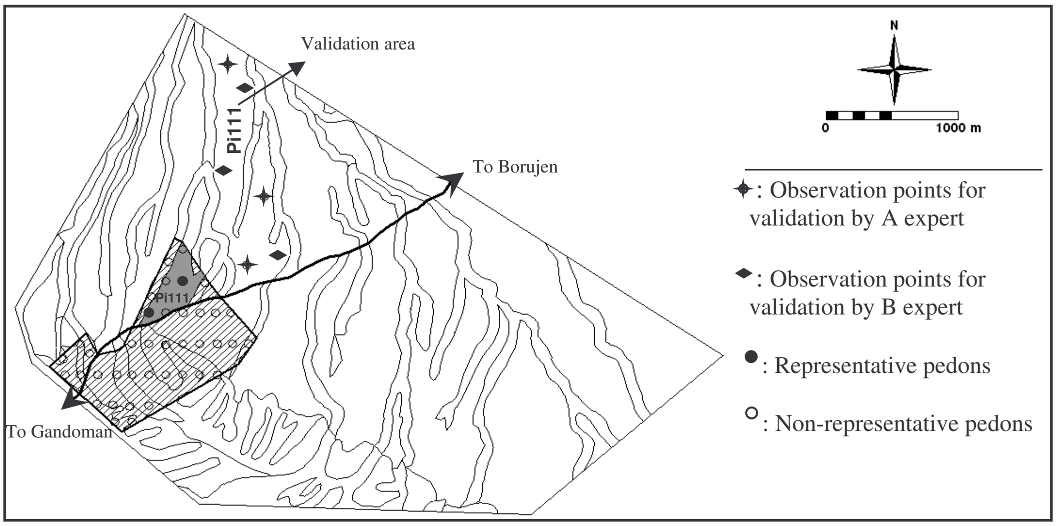

Fig. 2. Location of sample area (Hatched zone), first location of Pi111 unit in the sample area (Dark zone) and validation area with observation points on the geoform map.

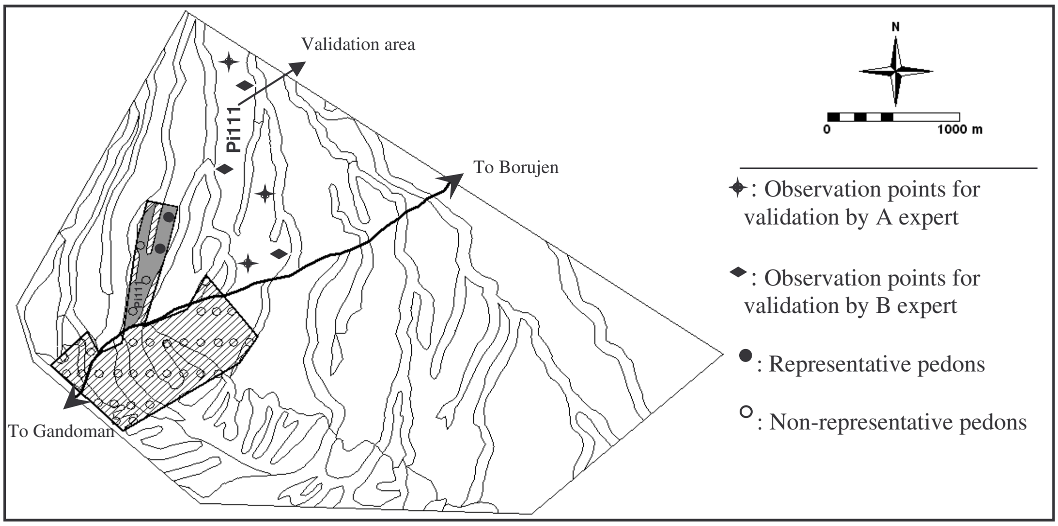

Fig. 3. Location of sample area (Hatched zone), second location of Pi111 unit in the sample area (Dark zone) and validation area with observation points on the geoform map.

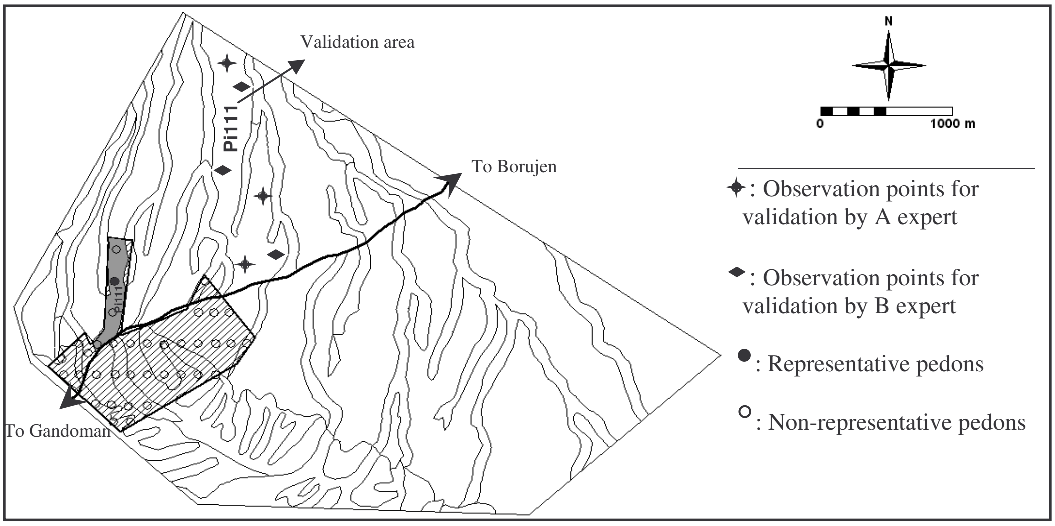

Fig. 4. Location of sample area (Hatched zone), third location of Pi111 unit in the sample area (Dark zone) and validation area with observation points on the geoform map.

RESULTS and DISCUSSION

Classification of representative pedons of Pi111 unit and type of mapping units at three locations are shown in Table 2. Results indicated that changing the location of sample area has taxonomic levels (order, subgroup and/or family) and map unit type (complex and consociation) differences in Pi111 unit. Table 3 shows classification of pedons for validation by two experts. In spite of similarity the profiles selected by two experts, soil taxonomy of these profiles were different in comparison with representative pedons at family level.

Therefore, the results of our study showed that the same soils should not be expected in similar landforms at family level. Now, the fundamental question is "why this much variability is occurred in the soils of the similar landforms". Following points may help to answer:

1. Disability of the mentioned scale (250 m interval) to separate environmental processes due to their scale dependency.
2. Chaotic nature of the soil and landform variability in the study area, as a result of different historical developments (landscape evolution).
3. Lack of efficient and precise landform stratification and the act of extrapolation done by geopedological approach to similar landforms.
4. Area-class models or polygon-based methods for determination of soil variability can not completely represent soil continuous spatial variabilities.

Therefore, although geopedological approach tries to separate more homogeneous soil mapping units (Zinck, 1989), it still is not able to fully define and represent the variability and chaotic nature of the soils. In addition, the convention of describing map units based on representative soil pedons, which differ only in soil type or details of a genetically-based classification system, seems to be not sufficient in describing the real soils distribution. We recommend further investigations in traditional soil surveying methods as well as using new pedometric techniques in order to better analyze and understand the soil variability and to improve sampling and mapping approaches. As the optimum scale for geopedological approach is semi-detailed (1:50 000 to 1:100 000) to reconnaissance (1:100 000 to 1:250 000) surveys (Rossiter, 2000; Udomsri, 2006), the use of landform phases is recommended to increase the accuracy of geopedological results.

Table 2. Classification of representative pedons of Pi111 unit with type of mapping units at three locations.

Type of mapping unit	Soil family	Location of Pi111
complex	Fine-loamy, carbonatic, mesic Typic Calcixerepts Fine, carbonatic, mesic Calcic Haploxeralfs	first
complex	Clayey-skeletal, carbonatic, mesic Typic Calcixerepts Fine, carbonatic, mesic Petrocalcic Calcixerepts	second
consociation	Clayey-skeletal, carbonatic, mesic Petrocalcic Calcixerepts	third

Table 3. Classification of pedons for validation by two experts.

Soil family	Expert
Fine, mixed, active, mesic Calcic Haploxeralfs Clayey-skeletal, carbonatic, mesic Petrocalcic Calcixerepts Fine, carbonatic, mesic Petrocalcic Calcixerepts	A
Fine, mixed, active, mesic Calcic Haploxeralfs Clayey-skeletal, carbonatic, mesic Petrocalcic Calcixerepts Fine, carbonatic, mesic Petrocalcic Calcixerepts	B

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