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Afghanistan Geography: Mountain regions and region specific soil types

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Abstract
Understanding soil variability is necessary for proper land management and improving agriculture practices in a country. This review summarizes the various soil types of Afghanistan by comparing the findings of earlier studies. Soil mapping is crucial for identifying the spatial variability of soil properties. Digital soil mapping techniques are cost and time effective when compared to traditional soil mapping and display continuous soil variability across the landscape.

Keywords: Soil type, Afghanistan soils, soil geography

Introduction
The soil-forming factors in any area include five main features that control the resulting soil type: (1) parent material; (2) climate; (3) topography; (4) biological factors; and (5) time. Parent material is the weathered rock or sediment from which the soil was formed and consequently can have a highly varied composition, depending upon what the original material was made up of. Soils vary in character, depending upon the temperature and moisture of a soil, because weathering types and amounts are so controlled by climate. The slope and aspect of a soil control the moisture and temperature of a soil, with the result that topography controls soil genesis as well. This produces localized soil variation that is called a soil catena. Biological factors strongly influence soils through different kinds of plant roots or organisms that burrow in soil and mix its components. Finally, the amount of time over which the above soil-forming factors act is a continuous control over their effects.
Afghanistan is a nation with wide ranging geography, climate, population, economy, agriculture, and soils. Soil has a critical role in several vital functions such as crop production, hydrologic cycling, and carbon sequestration, to name a few. Understanding soil variability is necessary for proper land management and improving agriculture practices (Rahmani, 2014). Soil in Afghanistan can be considered "pedologically young" because of the arid and semiarid climate conditions. Because of the high content of calcareous material, the pH of Afghan soils is usually greater than 7 and considered as alkaline in terms of reaction (FAO/UNDP, 1972). More than 50% of the soils have a pH between 8 and 8.5, about 35% of the soils have a pH between 8.5 and 9 and only 10% of the soils have a pH of 9 and above (FAO/UNDP, 1972). The soils, in general, have low fertility and low organic matter content (usually less than 2%). Generally, Afghanistan has the following soil orders Aridisols, Entisols, Inceptisols, Alfisols and Mollisols (Shroder, 2014) [11]. One of the first studies conducted on Afghan soils was done by the Institute of Applied Botany of Leningrad. In 1924 and 1926 – 1927 the institute sent scientists to Afghanistan for soil evaluation. They made general observations of the soils and took soil samples for physical and chemical analysis. A general soil map was developed with the following four soil groups:

1. Soils in low river valleys classified as heavy loam.
2. Soils of the foothills in northern Afghanistan identified as loess-like loam.
3. Soils on slopes were classified as medium loams and
4. The irrigated cultivated soils of the oases (urban centers) (Hildreth, 1957) [6].

Due to low precipitation and high evapotranspiration, there is commonly a great accumulation of soluble salts which is generally reported in the soils of arid and semi-arid regions. In the rare periods of high rainfall intensity, the bare surface results in high soil erosion rates in these regions (Balba, 1995) [2].
In 1985, Geokart classified Afghan soils based on the Russian soil classification system. Sierozems (alkali desert soils), Saline, Brown Forest Soil and Takyrs (dry lake basins) classes were noted. Salem and Hole (1969), investigated eight soil profiles in different zones and concluded that five were Aridisols, two were alluvial Entisols, and one was a Mollisol.
Afghanistan is dominated by rugged, mountainous terrain. The massive Hindu Kush Mountains form a barrier between the Northern provinces and the rest of the country. This mountain range divides Afghanistan into three distinct geographic regions:

the Central Highlands, the Northern Plains, and the Southwestern Plateau ("Land and resources" 2001) [1].

The Central Highlands

The Central Highlands comprise about 70% of Afghanistan. This region consists primarily of the Hindu Kush, which occupies the center of the country. It is a rugged, snowbound highland that is one of the most impenetrable regions in the world (English 1984) [4]. The Hindu Kush range extends for about 1,000 kilometers in a southwesterly direction from the Vakhan Corridor in the northeast almost to the border with Iran in the west. From the Hindu Kush, other lower ranges radiate in all directions. The Hindu Kush forms the western extremity of the Himalaya and consists primarily of granites and schists that were probably uplifted during the Tertiary period (66-2 million years ago.) Within the system there are also areas marked by the overthrust of Cretaceous limestones on Cenezoic shales and clays. The average elevation of this mountainous region is 2,700 meters and the highest peak, Nowshak, reaches 7,485 meters in the northeast. Small glaciers and year-round snowfields are common (Lonely Planet 2001) [8]. In the first 160-kilometer section west of the Pamirs, the Hindu Kush extends southward. In this section the system has a comparatively wide, plateau-like summit, dotted with small glacial lakes, and passes ranging in height from 3,800 to 5,300 meters above sea level. The system then turns southwest and gains in elevation, and the plateau summit breaks into peaks, the highest of which is Tirich Mir, 7,690 meters, in Pakistan. Many other peaks in this section rise more than 6,100 meters. Other major mountain ranges within Afghanistan include the Pamirs in the upper northeast of the Vakhan Corridor, the Badakhshan Ranges in the northeast, the Parapamisus Range in the north, and the Safed Koh range, which forms part of the frontier between Afghanistan and Pakistan.

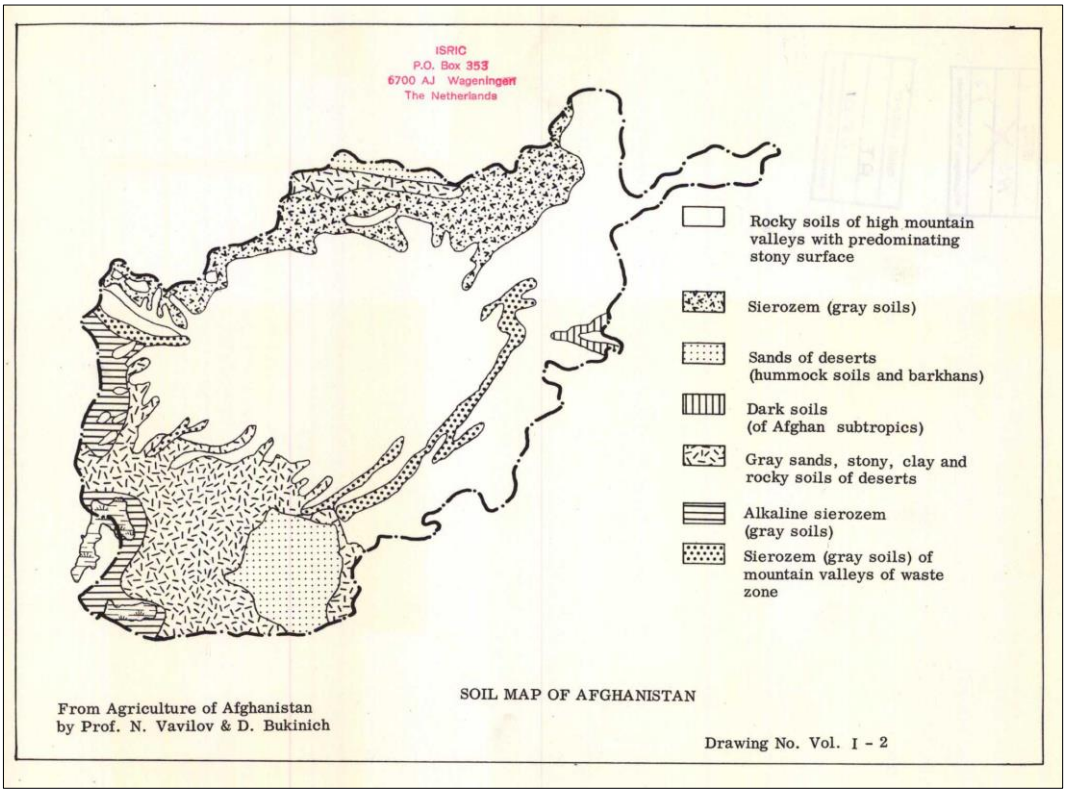
The Southern Plateau

This region of Afghanistan is made up of high plateaus and sandy deserts. It is essentially the lowland area of Afghanistan and includes the Turkistan Plains, the Heart-Ferah Lowlands of the extreme northwest, the Sistan Basin and Helmand River valley of the southwest, and the Rigestan Desert of the south. The soil here is very infertile, except along the rivers in the southwest. The average altitude of this area is about 900 meters above sea level. Sand storms are common in the deserts and plains of this region.

The Northern Plains

The most fertile part of Afghanistan, this region comprises about 15% of the country. It consists of foothills and plains through which the Amu Darya flows. The average elevation is about 600 meters above sea level.

Soil types in Afghanistan



Source: National Soil maps (EUDASM): Vavilov, N.; Bukinich, D., Agriculture of Afghanistan.

Fig 1

Breckle *et al*. (2010) [4] have determined that the rather extreme contradictions in soil quality in Afghanistan are the result of the varied topography, the underlying petrological or lithological basis of the parent material, the climatic differentiation in its hypsometric arrangement, and the vegetation cover, as one could expect. Thus the four following major soil regions can be identified:

The higher altitude regions of central Afghanistan and the Hindu Kush are characterized by weak soil formation without any clear differentiation in the soil profile because they are developed on newer frost-riven debris and constitute Cryorthents developed on rock fragments that can also be considered Entisols.

The hot sandy plains of northern Afghanistan occur as rolling countryside and alluvial lowlands, commonly overlain by wind-blown loess dust,all of which results in mineral-rich soils from the Xeropsamments or sandy Arenosols (FAO classification). Along the south banks of the Amu Darya and its tributaries, extensive sand dunes are also developed.

In the deserts of the southwest, soils have been developed from the group of Torripsamments or sandy Arenosols (FAO classification) in varying ways, typical of arid regions with water deficits resulting in the aridic or torric moisture regimes. The extensive sand dunes of Registan are characteristic, as are saline soils, and much clay as in the Dashti Margo (Desert of Death).

In all of the major river valleys of the country, fertile soils have evolved from the Torrifluvents (Fluvisols of the FAO classification) or alluvial soils that generally have an arid (torric) moisture regime and must be irrigated to maintain their characteristic extensive agriculture.

Only in the wetter eastern areas of Afghanistan where monsoonal rains and warmer temperatures predominate, the soils become more developed (brown mountain forest soils). Otherwise throughout the country the soils tend to be thin, dry, humus-poor, and rather pedogenically undeveloped.

Paddy soil properties in 20 villages in Nangarhar province, East Afghanistan were investigated. The soils, which were mostly classified as sandy loam or loam, were alkaline and contained carbonate ranging from 4.9 to 16.9 g C kg–1. The average total N and organic C, (0.36 N and 6.2 C g kg–1) was low compared to the average values in tropical Asian paddy soils. Calcium was the predominant exchangeable cation followed by Mg, K and Na in that order (Masunga *et al*., 2014). The results concluded that distribution of various types of parent materials such as limestone, dolomite and lava caused the differences in the properties of paddy soils. Watts and Mitchell (2009) [12] reported on the iodine status in soils in Kabul and Nangarhar, but not on any other parameters, while other reports of FAO (1973) [5] and ICARDA (2002) [7] also provided only limited details of soil properties such its pH and electrical conductivity

Conclusion

This review summarizes the various soil types of Afghanistan. Understanding spatial variability of soil properties is needed for sustainable agriculture and land management planning. Soil mapping is crucial for identifying the spatial variability of soil properties. Digital soil mapping techniques are cost and time effective when compared to traditional soil mapping and display continuous soil variability across the landscape.

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