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How Long Does Soil take to Form: Experiences from India and Ethiopia with a Proposed Reference Soil Group, "Hanisols"

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Abstract

Pedology is neither dead nor buried, but it functions in changing litho-pedo environments as induced by natural factors as well as anthropogenic management inputs. Siltation being alluvial deposits of Kosi river flood in India and colluvial deposits in topographic lows in the highlands of Ethiopia could behave like the soil for growing crops and plantation within a few years of careful management. Both either alluvium or colluvium are the parent material, a reference point of zero time for soil formation. But a congenial litho-pedo environment following a careful integrated management process may result into an early soil development for agricultural and forestry purposes. These soils at the beginning in Ethiopia look almost like the honey in colour and so "Hanisols" is assigned for nomenclature. However, further systematic studies are stimulating to have a desired data base for matching Hanisols in WRB framework. Besides, there is need to refine the concept of modern pedology, wherein soil could also qualify to be a renewable resource.

Keywords: Pedology; Alluvium; Colluviums; Soil development; Renewable resource; Hanisols

Introduction

Pedology is a science of soil, not just to disclose the genetic pathway or its classification alone but to drive a complete integration from its origin in nature within three dimensional limits to various physical, chemical, biological and environmental functions in its whole entity. In fact, pedology is derived from pedon i.e. whole soil body in three dimensions subject to intervention through sustainable management in an open system. Thus, the soil that we use even in situ today is no more a true natural resource as it has been undergone changes. If a soil is disturbed in a pot for growing show-plants or flowers in the house premises or lawn, it cannot be denied for being the soil. We work in field with soils that are disturbed by mechanical manipulation. When the soil at one point is disturbed naturally or manually, detached from clods, transported through water or wind and deposited far off through fluvial process or erosion or even landslide, they are all soils. In certain cases, soils undergo churning under the influence of heavy rain or flood or cyclone and once they settle, they may be used for growing crops according to land use suitability. Urban soil is a recently recognized soil or group that is a by-product of multi-purpose intensive human interferences with urban solid and liquid wastes. The above situations are somehow distinct from the one when soil forms in situ (sedentary) on parent materials, a typical genetic evolution with diagnostic horizons and distinguishing features. Dokuchaev [1] had given a systematic pathway to grasp the genetic process of soil evolution and development. Jenny [2] had nicely forwarded the state functions for five factors in genetic soil evolution. However, it is important to realize the implications of the knowledge paradox for soil science [3]. Alfred [4] has rightly stressed that the future of soil science is brighter than ever.

It is true that the future of soil science is brighter than ever as stressed by Alfred [4]. However, soil science in all fairness deserves a place as an academic discipline in itself so that it can meet the multiple needs of many other disciplines [4]. Merging Soil Science with Natural Resource Management just

as a Programme seems to be questionable and the International Union of Soil Science needs to play its role in the interest of the golden future of soil and its science in Pedology.

Humans are in search of water on moon and elsewhere in the space. The Indian satellite, Chandrayan 1, has discovered the evidence of water on moon and NASA has also authenticated this discovery (http://www.planetary.org/blogs/emily-lakdawalla/2010/2430.html). Next effort in continuation would preferably be intended to look for air or atmosphere on moon. Once the existence of water and air is authenticated, the immediate expected efforts would be to introduce the selected light loving microorganisms or tiny plants such as phototrophic bacteria, blue green algae, lichen etc on moon which on moon's rock surface would promote vegetative mats following the photopedogenesis [5-7] and soil will definitely develop on moon and pedology will function through photopedogenesis in time and space.

However, with a genetic soil evolution, it is believed that the time required for an inch of soil developed genetically is more than thousands of years. As such, soil is a very precious natural resource and said to be a non-renewable natural entity. This paper aims at viewing certain situations that enable the deposited and disturbed materials to become a soil within a few years under favourable climatic conditions, congenial biotic environment and suitable anthropologically induced integrated management processes as experienced in Kosi river basin in Bihar, India and Ethiopian highlands. Pedology as such needs to be harmonized covering emerging interests in soil science.

Background

Bihar Agricultural University, Sabour in India in close coordination with Bihar Government has been contributing commendably after disastrous flood in Kosi river on 18th August, 2008 for regenerating the agricultural activities in severely affected flood plains loaded with varying thickness of silt/sand. In fact, heavy rains and poor maintenance of dam caused a breach in the Kosi embankment, which lies within the Indo-Nepal border (at Kusaha, Sunsari district of Nepal). The river changed its course and affected around 2.3 million people in the northern part of Bihar in around 3700 sq km covering the districts of Supaul, Saharsa, Madhepura, Araria and Purnia. Supaul. The Kosi river flood in 2008 deposited white sand (Figure 1 & 2) in a large area adjoining the Nepal border and extended towards Supaul in India. However, with continued efforts, farmers of adjoining area in India and Nepal started growing cucurbits, tomato, pointed guard, lentil, sunflower and even sugarcane in such sand [6]. The above illustrations (Figure 1-5) testify that agricultural activities in freshly deposited sand/silt could possibly be with use of demand driven technologies and management inputs. Moreover, the research team of soil science, BAU, Sabour led by SC Paul under a research project has established some success story in growing bumper crop of elephant foot yam besides poplar plantation (agroforestry) as demonstrated in Figure 6 in Supaul, India [7]. If 2008 is the reference year when the study area was flooded following a huge deposition of sand (dominant in silt), the management efforts could have made this alluvium "a soil" just only within a couple of years. If alluvium is an unknown parent material probably of polygenic nature, it has to pass through the system under pedogenesis. However, in this case, classical pedogenesis does not seem so relevant and farmers do start cultivation with care following the land use suitability almost immediately after recession of flood. Mishra et al. [8] during 15th WCSS in Mexico forwarded a pedogenic process in such active flood plain soils called Chemihydropedoturbation following a stage of "depositional equilibrium" [9,10].

Figure 1: Cucurbit plants being covered with blowing silt/sand in a vast area under sand in Supaul, India.

Figure 2: Planning team (BAU, Sabour and ATMA, Supaul) to work on regenerating agricultural activities.

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Figure 3: Composting of Cucurbit in sand, tomato under mulch against blowing wind and deep planted pointed guard.

Figure 4: Nepalese farmer interacting in Kusaha (Nepal) following sunflower and lentil cultivation in sand in Kusaha (Nepal).

Figure 5: Sugarcane with assured irrigation, successful plantation (Ber) in sand and Nepalese public expressing satisfaction.

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Figure 6: Bumper crop of Elephant foot yam and Poplar plant under agro-forestry using flyash in sand.

6A: Introduction of fly ash to forestry plantation for growing interest to the farmer. **6B:** Preparation of field for Elephant foot yam with mixing fly ash. **6C:** Elephant foot yam plant. **6D:** Elephant foot yam plant. **6E:** Harvesting of Elephant foot yam. **6F:** Poplar plant for planting. **6G:** Mixing of fly ash (1:1 ratio). **6H:** Planting of Poplar. **6I:** Six months old Poplar plant.

The Kosi river course is known to have shifted from Purnea towards Saharsa within 200 years, but farmers never wait for pedogenesis rather they immediately start for alternative land uses after flood recession. Currently, the whole Kosi zone is a grain bowl particularly of maize. If one enters the Kosi basin from south (Kursela) in Bihar, the first attraction is maize (honey like harvested crop, cob and grains).

With the above experience and observation in Kosi basin in India, somewhat different pedogenic situation in highland of Ethiopia with mixed mineralogy was observed in which eroded materials, colluvium, from topographic high become the soil within a few years of deposition in topographic lows. Accordingly, the present preliminary investigation was carried out to understand how long time is required to transform a sandy/gravely material (colluvium/alluvium) into a soil that can support the plant growth and development in line with the definition of a soil. There is thus need to establish a new reference soil group (WRB) occurring in Ethiopia and other part of the globe under congenial pedogenic environment and favourable anthropogenic intervention within a short period of time.

Material and Methods

During soil survey programme with PG students in the farm area of the Haramaya University, Ethiopia on 11th March, 2017, a number of sand deposits, differing in time of their deposition, were observed. On inquiry, the first deposit was 8 months old, while second was two years, third was 5 years and fourth was 8-10 years. These colluvial deposits or transported materials were by and large of honey colour with somehow reddish tint, while second one was reddish brown with gray tint (Figure 7), third was dark reddish brown (Figure 8) and fourth was reddish brown with dark gray tint (Figure 9). On further investigation, it was learnt that all the four dumped sand material was brought either from other places or through colluvial process from

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topographic highs. Such simple observation has been the basic clues to discover if soil formation really requires enough period of time in a specific etho-pedo environment. Accordingly, samples from all four sites were collected as sample 1 (only surface, 0-10cm) and samples 2, 3 (0-10 and 10-20cm) and sample 4 (0-10, 10-20 & 20-30cm). These samples were examined for colour, texture, pH and organic carbon contents.

Results and Discussion

The photographs (Figure 7-11) are displayed in sequence of time as indicated with each photo. Figure 7 is comparatively freshly deposited material basically of dominant sand/silt. However, Figure 8 is considerably dull in colour but started forming the loose clods besides favouring the growth of natural vegetation. Figure 9 indicates somehow more stabilized soil mass promoting dense vegetation, whereas Figure 10 indicates larger clods on cutting. Figure 11 is a weak profile of soil giving support to Eucalyptus plantation. If one moves from Figure 7-11, it is obvious that the colluvial materials are gradually turning into a soil profile and support grasses, bushes and Eucalyptus plantation. For preliminary information, the colluvial materials were processed for textural identification with colour, pH, organic carbon and calcium carbonate contents (Table 1).

Figure 7: Transported colluvial materials, 8 m old (Sample 1).

Figure 8: Colluvial materials getting aggregated in large clods, 3yr old (Sample 2).

Figure 9: Colluvial materials getting stabilized with vegetation, 3-5yr old (Sample 3).

Figure 10: Formation of clods with vegetation on surface 3-5yr old (Sample 3).

Figure 11: Profile development with Eucalyptus plantation, 8-10 yr old (Sample 4).

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Table 1: Selected soil properties.

Sample	Depth, cm	Munsell Notation	Colour	Sand %	Silt %	Clay %	Texture	OC* %	pH	$CaCO_3$%
1 (8month)	0-10	5YR6/6	Reddish yellow	97	2	1	Sand	0.53	7.14	2.1
2 (3years)	0-10	5YR5/4	Reddish brown	96	1	3	Sand	0.67	7.59	2.2
	10-20	5YR3/2	Dark reddish brown	95	1	4	Sand	0.53	7.69	2.3
3 (3-5years)	0-10	5YR4/3	Reddish brown	83	6	11	Loamy sand	0.85	7.3	2.8
	10-20	5YR4/3	Reddish brown	86	5	9	Sand	0.74	7.56	1.5
4 (8-10 years)	0-10	5YR3/2	Dark reddish brown	91	3	6	Sand	1.55	5.26	1.6
	10-20	5YR5/4	Reddish brown	90	3	7	Sand	0.95	4.8	0.4
	20-30	5YR5/6	Yellowish Red	92	2	6	Sand	0.85	5.8	2.9

All sample 1 to sample 4 are virtually sand in texture, but gradually the texture is tended towards loam with more increasing trend in clay followed by silt per cent. Similarly, the surface layer of all three sample sites do indicate increasing trend in organic carbon content varying from 0.53% in the sample 1 (0-10cm) to 1.55 in sample 4 (0-10cm). The increment in organic carbon content with age of colluvial materials as well as depth in bare sand is importantly of scientific interest. Congenial climatic condition as well as geologic arrangement could be responsible for relatively more intake of organic carbon in sand texture of colluvial parent materials.

Figure 12: Dark gray coloration of soil under Eucalyptus roots, other roots least impacted.

Figure 13: Dark peds show somewhat shining surface.

When observation of soil in close proximity of Eucalyptus roots was made, it was further interesting. The Hanisols nearer to Eucalyptus roots was observed dark to black in colour, whereas the soil being a little bit away from Eucalyptus root was reddish brown colour. Such contrast distinction in colour of the soil (Figure 12) is another specific outcome that needs a thorough investigation. The clods being examined was also showing somehow shining ped surface (Figure 13). Eucalyptus tree thus deserves thorough investigation.

Nomenclature of Soil under investigation

While deciding the nomenclature of these soils, we considered the Kosi soils influenced by disastrous flood and conditioned by churning processes as a result of shifting courses of river. These soils belong to the grain bowl of maize in Kosi area

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of Bihar, wherein harvested crops, cobs and grains are somehow identical to honey. Similarly, in Ethiopian highlands, the reference colluvial deposits seem to be identical to the colours of honey. In view of such logical interpretation, the soils under studies are named as Hanisols at least temporarily unless detailed studies are established in line with framework of the World Reference Base [11,12].

Conclusion

The systematic future efforts and detailed investigation on Hanisols lead to disclosure of certain facts that may help to elaborate the basic criteria with management issues following the refinement in modern pedology, a science that can extend our understanding on the soil resource based on its sustainable management. The soil types qualifying this group will typically be the renewable resource that necessitates a shift towards modern pedology. Future of soil science is better than ever before and so pedology needs to be harmonized.

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References

1. Dokuchaev VV (1883) Russian Chernozems (Russkii Chernozems). Israel Prog Sci Trans, Jerusalem.
2. Jenny H (1941) Factors of soil formation: A System of Quantitative Pedology. Dover Publications, New York, USA.
3. Bouma J (2010) Implications of the knowledge paradox for soil science. Adv Agron 106: 143-171.
4. Alfred E, Hartemink (2006) The Future of Soil Science. International Union of Soil Science, The Netherlands.
5. Mishra BB (1996) Theory of photopedology. Journal of Indian Society of Soil Science 44: 541-543.
6. Mishra BB (2016) Soil and Land Use Report on Silt dominant Sand Dunes in Supaul District of Bihar 2016, Bihar Agricultural University, Sabour, Bhagalpur, India.
7. Mishra BB (2015a) Soil Science and Land Use Planning: Myth, Reality, Evidence and Challenge. EC Agriculture 1(3): 140-148.
8. Mishra BB, Choudhary CD, Singh NK, Mall J, Singh VN (1994) Fluvisol as a proposed Order in soil Taxonomy for active flood plain soils. Trans XVth World Congress Soil Science 6B: 55-56.
9. Mishra BB (2000) Fluvisol as the 13th Order in USDA Soil Taxonomy for floodplain soils with Chemihydropedoturbation Pedogenic process-A proposition. Proceedings of International Conference on Natural Resource & Sustainable Agriculture in 21st Century 2: 86-88.
10. Mishra BB (2015b) Soil Based Integrated Management Inputs for Flood and Flood Plain Soils of Bihar, India. EC Agriculture 1(2): 109-123.
11. WRB (2014) World reference base for soil resources. World Soil Resources Report No. 106. FAO, Rome, Italy.
12. Mishra BB, Gebrekidan H, Beyene S (2006) Photopedogenesis: Concept and application. Journal of Food, Agriculture and Environment 4: 12-14.

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