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Research Article

Spatial Variation of Soil Fertility Parameters in Flood affected High Hills of Wayanad District in Kerala

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ABSTRACT

A study was conducted to assess the fertility status of post flood soils of Mananthavady block in Wayanad district of Kerala. Geo referenced surface soil samples from a depth of 0 to 20 cm were collected from the flood affected area and were analyzed for pH, EC, organic carbon and available macro nutrients. GIS based thematic maps of soil pH, organic carbon, N, P, and K were prepared using Arc GIS 10.3. Experimental findings revealed that soil pH ranges from extremely acidic to slightly acidic in the area and the entire area was non saline. There were decline in organic carbon content, and available K in post flood soils whereas available P showed an increasing trend after the flood. The deficiency of available nitrogen was prevalent entire study area. The results of this study demands the relooking of nutrient management practices and need of adopting soil conservation measures.

Keywords: Post flood soils; Available macro nutrients; GIS maps

INTRODUCTION

During June to August 2018, the state of Kerala has also experienced its worst flooding since 1924. The state has received abnormally high rainfall of about 2346.6 mm during first week of June to third week of August, 2018 against the normal rainfall of 1649.5 mm, which was 42% more. This unprecedented rainfall has resulted disastrous flooding in all the districts of Kerala except the northern district, Kasargod. Flood has affected the all the three distinct physiographic zones of the state namely highlands, midlands and low lands (coastal plains). The devastating flood and associated landslides have adversely affected all the aspects of human lives including socioeconomic conditions, transportation, infrastructure, agriculture and livelihood. The soil degradation due to flooding is a serious concern. Soil degradation in India is estimated to be occurring on 147 million hectares of land among which 14 million ha of soil suffer degradation due to flooding annually (Bhattacharyya et al. 2015). The flood will deteriorate soil quality by impairing its physical, chemical and biological properties. The surface and subsurface soils from hilly terrains got eroded due to beating and slaking action of high intensity rainfall and deposited in the low lying flood plains and valleys. Flood in Karnataka during 2009 caused an estimated loss of 287 million tons of top soil and soil nutrient loss from 10.75 million hectares of farmlands (Ramamurthy et al. 2009). Flooded soil experienced post flood syndrome due to water stagnation, soil erosion, nutrient depletion, deposition of sand, silt and clay etc. which needs urgent attention to restore and sustain soil productivity. Hence the present study was conducted to assess and map the fertility status of the flood affected soils of Mananthavady block in Wayanad district of Kerala.

MATERIALS AND METHODS

The Mananthavady block in Wayand district lies between 11.977684 and 11.686728 N latitude, 75.774719 and 76.122055 E longitude. The Mananthavady block comprises of five grama panchayaths (Vellamunda, Thirunelly, Thondernadu, Edavaka and Thavinhal) and one municipality (Mananthavady) and spreads over an area of 66681 ha. The block extend over three agro-ecological zones namely AEU 15 (Northern high hills), AEU 20 (Wayanad central plateau) and AEU 21 (Wayand eastern plateau). Among these Thavinhal, Thondernadu and part of Vellamunda comes under AEU 15, remaining part of Vallamunda, Mananthavady and Edavaka comes under AEU 20 and Thirunelly comes under AEU 21. The northern high hills (AEU 15) has well drained organic matter rich strong acid clay

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soils in hilly terrain and the valleys have imperfectly drained acid clay soils. Deep fairly organic matter rich acid clay soils are present in Wayanad Central Plateau (AEU 20). Slightly acidic to neutral base rich soils are present in the Wayanad eastern plateau (AEU 21) and it indicates the part of highland plateau with less rainfall.

Representative geo referenced surface soil samples (0-20 cm) were collected from hundred sites from flood affected area of Mannathavady block. The soil samples were shade dried, powdered with wooden pestle and mortar, sieved through a 2mm sieve and stored prior to analysis. Then collected soil samples were analyzed for pH (soil - water ratio of 1:2.5) using pH meter (Jackson 1973), organic carbon by wet oxidation method (Walkley and Black 1934), available nitrogen by alakline permanganate method (Subbaiah and Asija 1956), available Phosphorus by colorimetric method (Bray and Kurtz 1945), available potassium by neutral normal ammonium acetate extraction followed by flame photometry method (Jackson 1973). GIS based thematic maps were prepared using ArcGIS 10.3 software following Inverse Distance Weighting method (IDW).

RESULTS AND DISCUSSION

Soil properties

Soil pH

The soil pH varied between 3.71 and 6.03 with a mean value of 4.86 (Table 1). Majority of the soils were very strongly acidic (47%) followed by extremely acidic (20%) and strongly acidic (25%) (Fig 1). There was a decrease in per cent of samples under extremely acidic and moderately acidic by 11% (KSPB 2013). A decrease in percent of soils with extreme acid pH in post flood soils compared to pre-flood indicates the accumulation of deposits having higher concentration of basic cations like Mg and Ca. Spatial variation map of soil pH reveals that extremely acid soils are mainly found in Thavinhal panchayth (Fig 2).

Electrical conductivity

EC varied between 0.04 dS m-1 and 0.76 dS m-1. The mean value of EC for the post flood area of Mananthavady block in Wayanad district was 0.13 dS m-1(Table 1). EC was in the non saline range for all the samples. Flooding increased the dilution of soil, thereby decreasing electrical conductance indicating the absence of soluble ions at the soil surface (Ponnamperuma 1984).

Table 1: Soil pH, EC and organic carbon content in post flood soils of Mananthavady block in Wayanad dstrict.

Panchayat/ Muncipality	Soil pH		EC ()		Organic Carbon (%)	
	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD
Manantavady	4.06-5.50	4.92 ± 0.44	0.04-0.26	0.09 ±0.05	0.42-2.64	1.26 ± 0.74
Edavaka	3.71-5.64	4.85 ± 0.49	0.06-0.76	0.16 ± 0.21	0.30-2.82	1.55 ± 0.95
Thirunelly	4.11-5.92	5.14 ± 0.57	0.05-0.24	0.09 ± 0.06	0.39-1.05	0.73 ± 0.28
Thavinhal	3.73-5.61	4.71 ± 0.47	0.06-0.44	0.17 ± 0.12	0.30-2.31	1.13 ± 0.46
Thondernadu	3.95-5.12	4.96 ± 0.33	0.05-0.28	0.13 ± 0.08	0.90-2.67	1.73 ± 0.45
Vellamunda	4.60-6.03	5.01 ± 0.34	0.05-0.18	0.09 ± 0.04	0.57-3.12	1.34 ± 0.69
Mananthavady block	3.71-6.03	4.86 ± 0.45	0.04-0.76	0.13 ± 0.11	0.30-3.12	1.33 ± 0.70

block

Figure 1: Frequency distribution of soil pH in post flood soils of Mananthavady block in Wayanad dstrict.

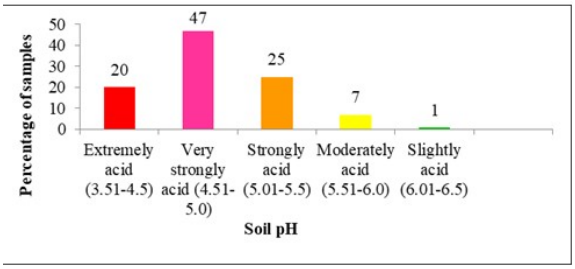
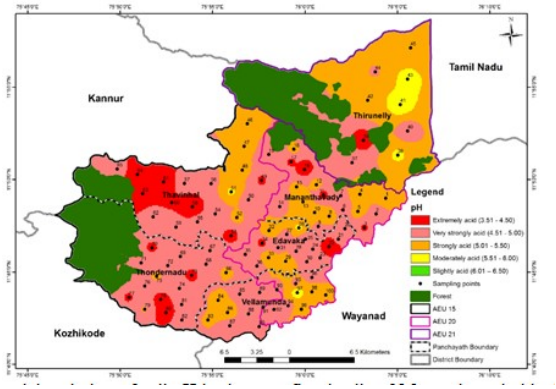


Figure 2: Spatial variation of soil pH in the post-flood soils of Mananthavady block in Wayanad district.



Organic carbon

The values for organic carbon ranged between 0.30% and 3.12% in the post-flood soils of Mananthavady block in Wayanad district with a mean of 1.33% (Table 1). Most (61%) of soils having medium status of organic carbon content followed by medium status in 31% soils (Fig 3). A decline in percent of samples with high status of organic carbon was observed from 55% in pre-flood to 31% in post flood soils (KSPB 2013). A

decrease in per cent samples with high organic carbon compared to the pre flood data might be due to the washing away of organic matter by the heavy flowing flood water. Similar result was reported by Akpoveta et al. (2014) who observed a decline in organic carbon content on flooding due to leaching of organic carbon such as organic acids and humus. The spatial distribution of organic carbon content in the post flood soils of Mananthavady block depicted in Fig 4.

Figure 3: Frequency distribution of organic carbon in post flood soils of Mananthavady block in Wayanad dstrict.

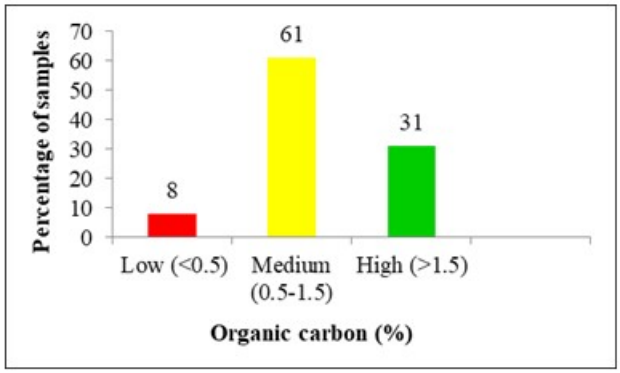
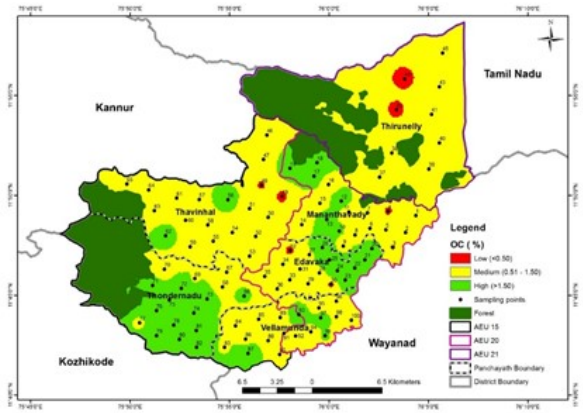


Figure 4: Spatial variation of organic carbon in the post-flood soils of Mananthavady block in Wayanad district.



Available nitrogen

Available N content varied from 112.90 kg ha-1 to 332.42kg ha-1 with a mean value of 204.52 kg ha-1 (Table 2).Very low available N contents were reported from crop lands with low organic carbon content. About 94% of soil samples showed a low range and 6% showed a medium range of available nitrogen (Fig 5). The low availability of nitrogen in soil might be due to leaching of nitrate nitrogen present in soil and also due to nitrogen loss through nitrate reduction and denitrification under anaerobic condition (Unger et al. 2009). The spatial distribution of available nitrogen in the post flood soils of Mananthavady block depicted in Fig 6.

Figure 5: Frequency distribution of available N in post flood soils of Mananthavady block in Wayanad dstrict.

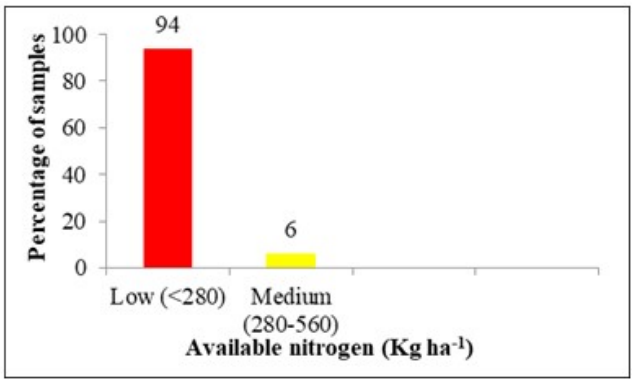


Figure 6: Spatial variation of available nitrogen in the post-flood soils of Mananthavady block in Wayanad district.

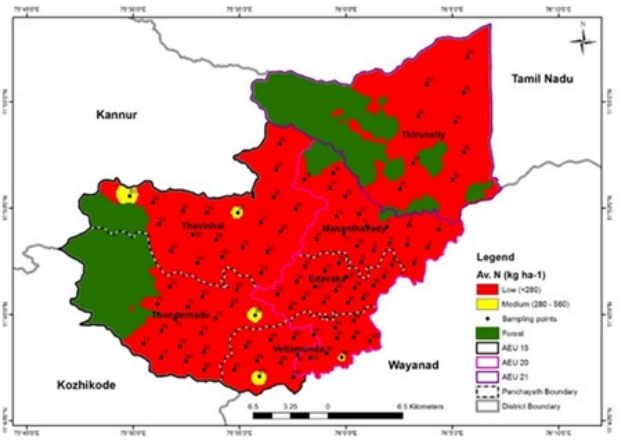


Table 2: Available N, P and K content in post flood soils of Mananthavady block in Wayanad district.

Panchayat/ Municipality	Available nitrogen (kg ha-1)		Available phosphorus (kg ha-1)		Available potassium (kg ha-1)	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ±SD
Mananthavady	125.44-282.24	190.47 ± 43.46	18.01-156.73	45.06 ± 35.68	36.18-408.24	171.99 ± 106.76
Edavaka	112.90-225.79	168.61 ± 33.25	16.37-80.33	34.14 ± 20.42	36.74-727.78	172.78 ± 187.15
Thirunelly	131.71-206.98	154.01 ± 24.52	17.27-51.23	27.58 ± 11.99	53.87-419.10	133.38 ± 115.19
Thavinhal	130.71-301.06	220.41 ± 47.09	17.32-125.31	33.24 ± 25.93	64.51-509.26	208.47 ± 126.99
Thondernadu	200.70-313.60	243.50 ± 27.18	15.85-183.75	38.80 ± 47.38	70.90-697.42	251.82 ± 195.82

Vellamunda	144.26-332.42	224.05 ± 50.31	15.43-41.26	21.76 ± 5.86	±	48.83-737.30	201.84 ± 191.14
Mananthavady block	112.90-332.42	204.52 ± 49.22	15.43-18 3.75	34.01 ± 29.44	±	36.18-737.30	194.89 ± 159.69

Available phosphorus

Available P varied from 15.43 to 183.75 kg ha-1 (Table 2) and was found to be medium status in 56% of the soils, and high in 44% of the soils (Fig 7). About 49% of soils were high, 20% of soils were medium and 31 % of soils were low in available phosphorus in the pre flood scenario (KSPB, 2013). Up on inundation release of large quantity of phosphorous takes place as a result of reduction of iron (Zhang et al. 2003; Loeb et al. 2008). Also most of the farmers in the area are regularly applying phosphatic fertilizers like factomphos, rajphos, and diammonium phosphate in the field. These might be the reason for an increase in per cent of available P in medium range as compared to pre flood. Spatial distribution of available phosphorous presented in Fig.8 revealed that available phosphorous was medium in some areas of Thavinhal, Thonderndu, Vellamunda and Thirunelly whereas high in rest

Figure 7: Frequency distribution of available P in post flood soils of Mananthavady block in Wayanad dstrict.

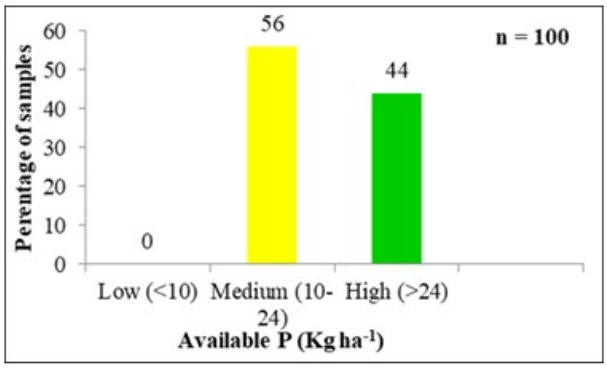
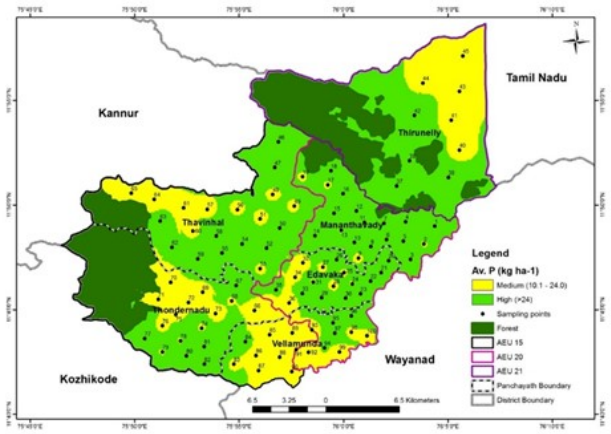


Figure 8: Spatial variation of available P in the post-flood soils of Mananthavady block in Wayanad district.



Available potassium

The available potassium of post flood soils of block ranged from 36.18 kg ha-1 to 737.30 kg ha-1(Table 2). Majority (41%) of the soils were medium in available K, 22% high and 37% low (Fig 9). On the contrary, about 25%, 59% and 16% per cent of soil samples in the Mananthavdy bock had low, medium and high available potassium in the pre flood scenario (KSPB, 2013).Spatial variability of available K is presented in Fig 10. A decline in concentration of potassium content was observed in the flood affected areas of the Mananthavady block. It was similar to the findings of Akpoveta et al. (2014) where reduced level of potassium was observed on flooding of farmlands of Asaba and Onitsha in Nigeria. Potassium might got leached out during flood

Figure 9: Frequency distribution of available K in post flood soils of Mananthavady block in Wayanad dstrict.

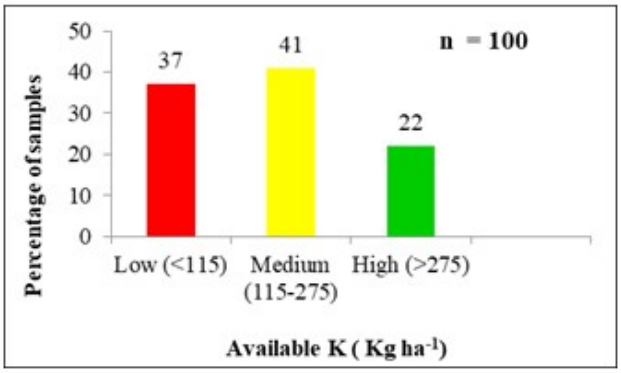
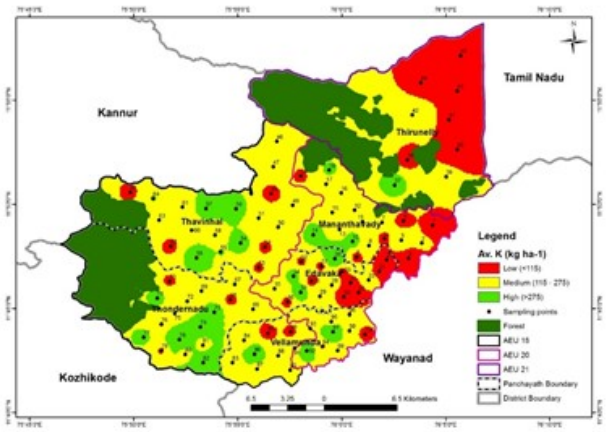


Figure 10: Spatial variation of available P in the post-flood soils of Mananthavady block in Wayanad district.



CONCLUSION

The study reveal that soil reaction and nutrient status were slightly changed after the flood. In case of soil acidity samples with extremely acid and moderately acid were decreased by 11% whereas samples with very strongly acid were increased by 18%. Entire area was observed to be non saline due washing of soluble salt in the food. Organic carbon content and available potassium were found to be decreased in post flood soil especially in hilly terrains. These might be due to top soil

erosion and as well as leaching of nutrients. Percent sample with medium evel of phosphorus was observed to be increased after the flood. This variation in the soil Ph and nutrients demands the revision of existing soil management practices and also to incorporate more soil conservation measures.

REFERENCES

1. Akpoveta VO, Osakwe SA, Ize-Iyamu OK, Medjor WO, Egharevba, F. Post flooding effect on soil quality in Nigeria: the Asaba, Onitsha experience. Open Journal of Soil Science. 2014;4(2):13-19.
2. Bhattacharyya R, Ghosh BN, Mishra PK, Mandal B, Rao CS, Sarkar D, Das K, Anil KS, Lalitha M, Hati KM, Franzluebbers AJ, et al. Soil degradation in India: Challenges and potential solutions. Sustainability. 2015;3528-3570.
3. Bray RH, Kurtz IT. Determining total, organic and available forms of phosphate in soils. Soil Science. 1945;59(1):39-45.
4. Loeb, R., Lamers, L.P. and Roelofs, J.G. 2008. Prediction of phosphorus mobilisation in inundated floodplain soils. Environmental Pollution. 2008;156:325-331.
5. Ponnamperuma, F. N. (1984) Effects of flooding on soils. In:Kozlowski, T. T. (ed.), Flooding and Plant growth. Academic press, Harcout Brace Jovanovich Publishers. 1984;9-45.
6. Ramamurthy V, Nalatwadmath SK, Srinivas S, Rama Mohan Rao MS, Shivaprasad CR, Adhikari RN, Naidu LGK, Patil SL, Raizada A, Dipak Sarkar, Singh SK, Mishra PK. Soil Erosion in Karnataka. National Bureau of Soil Survey and Land Use Planning, Nagpur. 2009;70.
7. Subbiah BV, Asija GL. 1956. A rapid procedure for the estimation of available nitrogen in soils. Current Science. 1956;25:259-260.
8. Unger IM, Motavalli PP, Muzika RM. Changes in soil chemical properties with flooding: a field laboratory approach. Agricultural Ecosysystem Environment. 2009;131:105-110.
9. Walkley AJ. Black IA. Estimation of soil organic carbon by chromic acid titration method. Soil Science. 1934; 31:29-38.
10. Zhang Y, Lin X, Werner W. The effect of soil flooding on the transformation of Fe oxides and the adsorption/desorption behavior of phosphate. Journal of Plant Nutrition and Soil Science. 2003;166:68-75.
11. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Ltd, New Delhi. 1973;219-221.
12. Kalshetty BM, Giraddi TP, Sheth RC, Kalashetti MB. River krishna flood effects on soil properties of cultivated areas in bagalkot district, Karnataka state. Glob. Journal of Science Frontier Research Chemistry. 2012;12:23-28.
13. KSPB (Kerala State Planning Board). Soil Fertility Assessement and Information Management for Enhancing Crop Productivity in Kerala. Kerala State Planning Board, Thiruvananthapuram. 2013;447-457.