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Land Resource Inventory and Soil Mapping for Fertility Status of Humnabad Sub-Watershed

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A B S T R A C T

Growing population pressure and human activities increases the demand on the limited land resources, both for agricultural and other land uses. To meet this unprecedented demand of land for various pursuits, it is imperative to develop land use plans which can counteract the detrimental effects on environment and at the same time improve productivity of land. The present paper on land resource inventory and soil mapping for fertility status of Humnabad sub-watershed of Humnabad taluk, Bidar district, Karnataka primarily deals with land resource inventory, soil mapping, their problems and potentials. Cadastral map, Google earth images, toposheets and satellite imagery were used as base maps. Detailed survey was carried out through the study area (1:7920). Surface soil samples were collected at regular grid interval of 360 cm. The collected samples were analyzed in lab for determining their fertility status. Thematic maps were generated using aforementioned satellite data coupled with ground truth. Based on all these fertility status of the sub-watershed was determined. The available nitrogen status of the watershed ranged from low to medium. The available phosphorus and potassium ranged from low to medium. The available sulphur status ranged from low to high but most of the area was low to medium. All the micronutrients were sufficient in lateritic soil series while, in basaltic soil series iron and zinc were low.

Introduction

Indiscriminate use of finite soil resources coupled with lack of management has led to degradation causing concern to planners, researchers and farmers. This calls for a scientific approach for development and management of these resources at various levels. Soil resource inventory provides an insight into potentialities and limitations for its effective management.

It also provides adequate information in terms of land form, natural vegetation as well as characteristics of soils which can be utilized for land resources management and development (Manchanda *et al.*, 2002). Rational utilization of land resources can be

achieved by optimizing its use, which demands evaluation of land for alternative land use.

Materials and Methods

The study area, Humnabad sub-watershed, Humnabad taluk, Bidar district, Karnataka. It covers an area of 4880.65 ha and lies between longitude $17^0$47'4.218" to$17^0$43'23.067" N and latitude $77^0$3'48.24" to $77^0$10'24.99" E. Humnabad sub-watershed covers eight micro-watersheds viz., Humnabad, Basawapur, Basavtirth-1, Basavtirth-2, Sadlapur-1, Sadlapur-2, Humnabad west-1 and Humnabad west-2. The average elevation of the district is 520 m above MSL. Using base maps, Google earth images, satellite imagery and toposheets traversing was done for physiographic delineations in the study area. The site characteristics includes latitude, physiographic-unit, geology, parent material, rainfall, temperature, topography, elevation, erosion and rockiness in the study area were mapped. Land use/land cover mapping was carried out by visual interpretation techniques as per the land use land cover classification system developed by department of space (Anonymous, 1994).

The satellite imageries, LISS- IV were visually interpreted for land use or land cover, were used as reference materials. The soil mapping of Humnabad sub-watershed was done with hydro-geo-morphology, slope, drainage based on tone, texture, size, association etc. The ancillary data namely Survey of India (SOI) topographical sheets on 1:50,000 scale and cadastral map support of remote sensing satellite images adopting visual interpretation procedure on 1:7920 scale. Soil profile studies, soil correlation and classification were carried out by using standard procedures. Surface samples were collected at a regular grid interval of 320m. Eighteen soil pedons representing the study area were selected based on the topography from various physiographic units identified in the area by field survey. The soils of the study area were categorized into red and black soils based on the geology. Both lateritic and basaltic soil series were found in the study area. The colour of the lateritic soils was dark reddish brown and in case of basaltic soil it varied from dark brown to very dark grayish brown. The soils were described in the field for their morphological properties and later characterized in the laboratory for their physical and chemical properties in the sub-watershed. Based on this soil fertility and thematic maps like slope, drainage, land use/land cover, soil, texture, etc. on the scale of 1:7920 scale were generated.

Results and Discussion

The soil reaction of pedons varied from neutral to slightly alkaline and varied from (SWA) 6.55 to 8.58. Among the lateritic soil series the lowest value (6.55) observed in Karanja Khurd series (KKUiB2G2P2) and ranged from 6.32 to 6.85, whereas the highest value (7.27) observed in Bhadrapur series (BDPiC3G1) and ranged from 7.16 to 7.38. Among the basaltic series the lowest value (6.56) observed in Dhupat Mahagaon series (DMNmB2G1) and ranged from 6.49 to 6.68. Whereas, the highest value (8.40) observed in Kouta -B series (KBBmB2) and ranged from 7.86 to 8.99. Soil pH and EC of major soil pedons increased with depth due to accumulation of leached bases in the subsurface horizons (Table 1). In different soil series organic carbon content ranged from (SWA) 0.41 to 0.78 per cent In general, the surface soil horizons recorded higher organic carbon content than underlying layers and decreased with depth in all soil pedons. The free calcium carbonate content increased with depth. The exchangeable bases were in the order of Ca^{2+}> Mg^{2+}>Na^{+}> K^{+} on the exchangeable complex.

Table.1 Chemical properties of soil series of Humnabad sub-watershed

Mapping unit	Horizon	Depth (cm)	pH	EC (dS m^{-1})	OC (%)	Free $CaCO_3$ (%)
Bhadrapur series						
BDPiC3G1	Ap	0 - 6	7.38	0.04	0.77	0.78
	Bw	6 - 20	7.16	0.18	0.54	0.95
SWA			**7.27**	**0.11**	**0.65**	**0.86**
Rampur series						
RMPiC3G2P1	Ap	0 - 6	6.84	0.22	0.78	1.85
	Bw	6 - 20	6.98	0.06	0.49	1.90
SWA			**6.91**	**0.14**	**0.63**	**1.87**
Kadambal series						
KDMiB2G2P1	Ap	0 - 8	7.25	0.08	0.76	1.02
	Bt1	8 - 28	7.10	0.12	0.51	1.42
	Bt2	28 - 40	7.32	0.07	0.33	1.68
SWA			**7.22**	**0.09**	**0.53**	**1.37**
Madargi series						
MDGiB2G1	Ap	0 - 10	6.49	0.05	0.63	0.23
	Bt1	10 - 30	6.63	0.06	0.59	0.33
	Bt2	30 - 50	6.80	0.03	0.25	0.48
SWA			**6.64**	**0.04**	**0.49**	**0.34**
Musthari series						
MSTiB2G1P1S1	Ap	0 - 9	6.69	0.07	0.66	0.17
	Bw1	9 - 30	6.70	0.08	0.48	0.25
	Bw2	30 - 60	7.05	0.15	0.44	0.75
SWA			**6.81**	**0.07**	**0.52**	**0.39**
Karanja Khurd series						
KKUiB2G2P2	Ap	0 - 10	6.32	0.05	0.59	1.50
	Bw1	10 - 30	6.49	0.09	0.48	1.75
	Bw2	30 - 70	6.85	0.06	0.44	1.95
SWA			**6.55**	**0.06**	**0.50**	**1.73**
Muthangi series						
MTNiB2G1	Ap	0 - 9	7.17	0.04	0.77	0.75
	Bw	9 - 25	7.26	0.06	0.59	1.25
	Bt1	25 - 60	7.06	0.08	0.55	1.55
	Bt3	60 - 98	7.04	0.14	0.40	1.78
SWA			**7.13**	**0.06**	**0.57**	**1.33**
Devgiri series						
DGRiB2G1P1	Ap	0 - 8	6.78	0.08	0.87	0.25
	Bw1	8 - 30	6.96	0.1	0.85	0.75
	Bw2	30 - 60	6.89	0.12	0.82	0.96
	Bw3	60 - 85	7.52	0.19	0.78	1.05
	Bw4	85 - 120	7.54	0.18	0.51	1.15
SWA			**7.13**	**0.13**	**0.76**	**0.83**
Mustarwadi series						
MWDiB2	Ap	0 - 8	7.62	0.16	0.81	1.15
	Bw	88 - 39	7.93	0.12	0.70	1.25
	Bt1	39 - 76	6.81	0.08	0.59	1.33
	Bt2	76 - 98	6.75	0.12	0.48	1.48
	Bt3	98 - 140	6.52	0.16	0.40	1.89
	Bt4	140+	6.40	0.21	0.29	1.97
SWA			**7.00**	**0.14**	**0.54**	**1.51**
Basaltic soil series						
Lingi series						
LINiD3G2P2S4	Ap	0 - 10	7.40	0.12	0.78	10.21

	Bw	10-21	7.56	0.26	0.65	10.75
SWA			**7.48**	**0.19**	**0.71**	**10.48**
Mustapurseries						
MPRiB2	Ap	0 - 8	7.69	0.08	0.66	1.87
	Bw1	8 - 20	7.99	0.11	0.37	2.91
	Bw2	20 - 40	8.01	0.29	0.22	3.08
SWA			**7.89**	**0.16**	**0.41**	**2.38**
Gadikusanur series						
GKRmB2G1P1	Ap	0 - 9	7.2	0.12	0.66	8.80
	Bw	9 - 30	7.03	0.11	0.51	9.60
	Bt	30 - 50	7.22	0.09	0.4	10.23
SWA			**7.15**	**0.10**	**0.52**	**9.54**
Pashapur series						
PPRmB2	Ap	0 - 9	8.03	0.10	0.73	7.25
	Bw1	9 - 30	8.18	0.23	0.65	8.50
	Bw2	30 - 70	8.05	0.24	0.45	8.75
SWA			**8.08**	**0.19**	**0.61**	**8.16**
DhupatMahagaon series						
DMNmB2G1	Ap	0 - 8	6.56	0.08	0.79	9.15
	Bw	8 - 20	6.49	0.05	0.57	9.48
	Bss1	20 - 50	6.51	0.16	0.46	9.71
	Bss2	50 - 80	6.68	0.14	0.31	10.54
SWA			**6.56**	**0.10**	**0.53**	**9.72**
Udawah series						
UDHiB2	Ap	0 - 8	6.47	0.07	0.74	10.15
	Bw	8 - 28	6.69	0.11	0.66	10.90
	Bss1	28 - 50	6.93	0.22	0.55	11.35
	Bss2	50 - 85	7.04	0.26	0.29	11.75
	Bss3	85 - 110	7.65	0.29	0.18	12.75
SWA			**6.96**	**0.19**	**0.48**	**11.38**
Kouta- B series						
KBBmB2	Ap	0 - 10	7.86	0.12	0.87	9.75
	Bw	10 - 30	7.98	0.14	0.83	9.95
	Bss1	30 - 70	8.80	0.21	0.74	10.75
	Bss2	70 - 110	8.89	0.26	0.71	10.85
	Bss3	110 - 140	8.90	0.28	0.69	10.91
SWA			**8.40**	**0.18**	**0.78**	**10.32**
Kaudgaon series						
KGNmB2	Ap	0 - 6	8.08	0.15	0.78	9.70
	Bw1	6 - 28	8.23	0.17	0.74	10.14
	Bss1	28 - 70	8.22	0.13	0.67	10.78
	Bss2	70 - 100	8.28	0.19	0.59	11.25
	Bss3	100 - 125	8.15	0.21	0.45	10.98
	Bss4	125 - 150	8.1	0.2	0.24	10.01
SWA			**8.17**	**0.17**	**0.57**	**10.47**
Raipalli series						
RPLmB2	Ap	0 - 8	7.95	0.06	0.78	7.65
	Bw	8 - 42	8.46	0.23	0.69	8.00
	Bss1	42 - 60	8.48	0.25	0.56	8.25
	Bss2	60 - 80	8.49	0.24	0.48	9.87
	Bss3	80 - 100	8.50	0.26	0.44	10.12
	Bss4	100 - 150+	8.43	0.14	0.37	10.45
SWA			**8.38**	**0.19**	**0.55**	**9.05**

Note: pH- Pouviour of Hydrogen (power of hydrogen), EC- Electrical conductivity, OC- Organic carbon, $CaCO_3$- Calcium carbonate

Table.2 Exchangeable cations and cation exchange capacity of the series of Humnabadsub-watershed

Mapping unit	Horizon	Depth (cm)	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CEC	ESP (%)
			cmol(p^{+}) kg^{-1}					
Lateritic soil series								
Bhadrapur series								
BDPiC3G1	Ap	0 - 6	8.32	3.49	0.61	0.69	25.89	2.36
	Bw	6 - 20	8.61	3.47	0.52	0.66	26.14	1.99
SWA			**8.47**	**3.48**	**0.56**	**0.67**	**26.01**	**2.17**
Ramapur series								
RMPiC3G2P1	Ap	0 - 6	8.9	3.45	0.43	0.58	27.56	1.56
	Bw	6 - 20	8.56	3.47	0.33	0.60	28.10	1.17
SWA			**8.73**	**3.47**	**0.38**	**0.59**	**27.83**	**1.37**
Kadambal series								
KDMiB2G2P1	Ap	0 - 8	8.51	2.25	0.79	0.45	24.31	3.25
	Bt1	8 - 28	8.38	2.06	0.84	0.61	25.64	3.28
	Bt2	28 - 40	8.64	2.85	0.95	0.67	25.78	3.69
SWA			**8.51**	**2.39**	**0.86**	**0.58**	**25.24**	**3.40**
Madargi series								
MDGiB2G1	Ap	0 - 10	8.31	2.80	1.03	0.63	25.31	4.07
	Bt1	10 - 30	8.20	2.15	1.21	0.58	26.40	4.58
	Bt2	30 - 50	8.40	2.20	0.88	0.63	26.75	3.29
SWA			**8.30**	**2.38**	**1.04**	**0.61**	**26.15**	**3.98**
Musthari series								
MSTiB2G1P1S1	Ap	0 - 9	12.84	4.17	1.25	0.76	27.36	4.57
	Bw1	9 - 30	11.98	4.68	1.17	0.82	27.61	4.24
	Bw2	30 - 60	13.38	4.54	0.73	0.79	28.90	2.53
SWA			**12.73**	**4.46**	**1.05**	**0.79**	**27.95**	**3.78**
Karanja Khurd series								
KKUiB2G2P2	Ap	0 - 10	13.84	5.49	0.25	0.76	28.12	0.89
	Bw1	10 - 30	11.80	5.14	0.95	0.69	29.17	3.26
	Bw2	30 - 70	13.30	5.36	0.56	0.67	29.65	1.89
SWA			**12.98**	**5.33**	**0.58**	**0.71**	**28.98**	**2.01**
Muthangi series								
MTNiB2G1	Ap	0 - 9	9.21	3.89	1.38	0.67	26.32	5.24
	Bw	9 - 25	9.53	3.95	1.37	0.66	28.71	4.77
	Bt1	25 - 60	9.77	4.35	1.07	0.68	29.50	3.63
	Bt3	60 - 98	9.39	4.65	1.02	0.79	30.25	3.37
SWA			**9.48**	**4.21**	**1.21**	**0.70**	**28.69**	**4.00**
Devgiri series								
DGRiB2G1P1	Ap	0 - 8	13.04	5.47	1.40	0.85	24.78	5.65
	Bw1	8 - 30	13.38	8.24	1.18	0.80	25.41	4.64
	Bw2	30 - 60	13.55	7.96	0.87	0.65	26.56	3.28
	Bw3	60 - 85	13.42	8.25	0.86	0.72	27.45	3.13
	Bw4	85 - 120	13.09	8.59	0.79	0.78	27.36	2.89
SWA			**13.29**	**7.70**	**1.02**	**0.76**	**26.05**	**3.92**
Mustarwadi series								
MWDiB2	Ap	0 - 8	8.58	3.40	0.80	0.61	25.67	3.12
	Bw	88 - 39	8.41	3.48	0.78	0.60	25.98	3.00
	Bt1	39 - 76	8.29	3.40	0.75	0.77	26.51	2.83
	Bt2	76 - 98	8.04	3.27	0.76	0.58	27.45	2.77
	Bt3	98 - 140	7.57	3.34	1.03	0.59	27.96	3.68
	Bt4	140+	7.03	3.30	1.12	0.59	28.10	3.99
SWA			**7.99**	**3.36**	**0.87**	**0.62**	**26.40**	**3.23**
Basaltic soil series								

Lingi series								
LINiD3G2P2S4	Ap	0 - 10	18.59	7.26	3.90	0.63	38.90	10.03
	Bw	10-21	18.61	7.30	3.72	0.58	39.54	9.41
SWA			**18.6**	**7.28**	**3.58**	**0.61**	**39.22**	**9.72**
Mustapur series								
MPRiB2	Ap	0 - 8	13.65	5.69	0.81	0.74	24.87	3.26
	Bw1	8 - 20	12.98	5.93	0.75	0.66	25.41	2.95
	Bw2	20 - 40	10.14	5.83	0.65	0.63	25.98	2.50
SWA			**12.26**	**5.82**	**0.73**	**0.67**	**25.42**	**2.90**
Gadikusanur series								
GKRmB2G1P1	Ap	0 - 9	29.43	8.19	3.97	0.75	40.10	9.90
	Bw	9 - 30	29.08	7.38	3.69	0.63	40.25	9.17
	Bt	30 - 50	28.9	7.78	3.16	0.64	40.98	7.71
SWA			**29.14**	**7.78**	**3.61**	**0.67**	**40.44**	**8.93**
Pashapur series								
PPRmB2	Ap	0 - 9	21.81	4.97	3.80	0.61	32.36	11.74
	Bw1	9 - 30	21.76	4.69	3.97	0.62	33.50	11.85
	Bw2	30 - 70	21.04	4.45	3.72	0.61	33.87	10.98
SWA			**21.54**	**4.71**	**3.83**	**0.61**	**33.24**	**11.53**

DhupatMahagaon series								
DMNmB2G1	Ap	0 - 8	27.48	8.11	1.06	0.84	38.94	2.72
	Bw	8 - 20	27.35	7.85	1.03	0.66	39.12	2.63
	Bss1	20 - 50	27.47	7.58	0.35	0.81	40.20	0.87
	Bss2	50 - 80	27.78	7.95	0.41	0.82	41.23	0.99
SWA			**27.52**	**7.87**	**0.71**	**0.78**	**39.87**	**1.81**
Udawah series								
UDHmB2	Ap	0 - 8	22.51	8.63	1.13	0.58	34.16	3.31
	Bw	8 - 28	22.94	8.62	0.79	0.62	35.84	2.20
	Bss1	28 - 50	22.9	8.62	0.75	0.85	36.12	2.08
	Bss2	50 - 85	23.96	8.60	0.63	0.68	38.79	1.62
	Bss3	85 - 110	23.02	8.50	0.61	0.68	38.09	1.60
SWA			**23.07**	**8.59**	**0.78**	**0.68**	**36.60**	**2.16**
Kouta- B series								
KBBmB2	Ap	0 - 10	13.36	8.56	2.50	0.64	34.20	7.31
	Bw	10 - 30	13.49	9.98	2.48	0.63	35.64	6.96
	Bss1	30 - 70	13.63	9.75	3.07	0.64	36.24	8.47
	Bss2	70 - 110	14.25	8.46	3.10	0.65	36.57	8.48
	Bss3	110 - 140	14.31	8.48	3.24	0.68	36.78	8.52
SWA			**13.68**	**9.19**	**2.79**	**0.64**	**35.66**	**7.80**
Kaudgaon series								
KGNmB2	Ap	0 - 6	28.32	8.47	3.53	0.70	39.65	8.90
	Bw1	6 - 28	29.03	9.15	3.46	0.60	39.97	8.66
	Bss1	28 - 70	28.98	9.94	2.60	0.70	40.23	6.46
	Bss2	70 - 100	29.12	8.42	2.51	0.77	41.56	6.04
	Bss3	100 - 125	29.92	8.51	2.14	0.74	41.85	5.11
	Bss4	125 - 150	28.70	8.43	2.02	0.66	40.10	5.04
SWA			**28.85**	**8.82**	**2.71**	**0.70**	**40.56**	**6.70**
Raipalli series								
RPLmB2	Ap	0 - 8	22.82	8.99	3.75	0.86	35.02	12.49
	Bw	8 - 42	23.86	8.96	3.40	0.77	36.47	10.80
	Bss1	42 - 60	23.90	8.98	3.31	0.72	36.98	10.04
	Bss2	60 - 80	23.97	8.98	3.29	0.73	36.46	9.55
	Bss3	80 - 100	23.66	9.04	3.24	0.74	37.05	9.24
	Bss4	100 - 150+	23.14	9.02	2.09	0.74	37.16	5.94
SWA			**23.56**	**8.99**	**3.18**	**0.76**	**36.52**	**9.68**

Note: CEC- Cation exchange capacity, ESP- Exchangeable sodium percentage

Table.3 Fertility status of the soil series of Humnabad sub-watershed

Mapping units	Horizons	Depth (cm)	Available nutrients				DTPA extractable			
			N	**P_2O_5**	**K_2O**	**S**	**Cu**	**Zn**	**Fe**	**Mn**
			kg ha^{-1}			**ppm**	**ppm**			
Lateritic soil series										
Bharapur series										
BDPiC3G1	Ap	0 - 6	263.42	10.71	269.70	12.42	3.34	0.84	7.12	3.76
	Bw	6 - 20	250.88	11.53	256.82	13.45	3.58	1.24	5.40	3.66
SWA			**257.15**	**11.12**	**263.26**	**12.94**	**3.46**	**1.04**	**6.26**	**3.71**
Ramapur series										
RMPiC3G2P1	Ap	0 - 6	263.42	7.41	225.68	18.02	1.23	0.61	6.80	3.66
	Bw	6 - 20	238.33	9.05	233.96	15.78	1.42	0.58	8.00	3.26
SWA			**250.88**	**8.23**	**229.82**	**16.90**	**1.33**	**0.60**	**7.40**	**3.46**
Kadambalseries										
KDMiB2G2P1	Ap	0 - 8	238.33	25.52	177.18	17.9	4.94	0.12	7.18	3.69
	Bt1	8 - 28	213.24	2.47	239.56	19.17	3.28	0.38	6.15	3.25
	Bt2	28-60	188.16	1.64	260.73	19.54	4.80	0.22	4.41	2.94
SWA			**213.24**	**9.88**	**225.82**	**18.87**	**4.34**	**0.24**	**5.91**	**3.29**
Madargi series										
MDGiB2G1	Ap	0 - 10	291.23	21.41	246.96	15.20	3.64	1.47	8.00	3.74
	Bt1	10 - 30	288.69	17.29	225.12	15.23	3.4	1.26	8.06	3.72
	Bt2	30 - 50	271.06	12.35	246.18	11.00	3.02	2.74	7.08	3.83
SWA			**283.66**	**17.02**	**239.42**	**13.81**	**3.35**	**1.82**	**7.71**	**3.76**
Musthari series										
MSTiB2G1P1S1	Ap	0 - 9	263.424	22.79	255.57	14.23	4.36	1.46	9.23	3.96
	Bw1	9 - 30	263.424	20.13	270.99	12.50	3.81	1.32	8.29	3.34
	Bw2	30 - 60	275.968	17.29	298.46	8.96	2.11	0.93	2.57	3.02
SWA			**267.60**	**20.07**	**275.01**	**13.36**	**3.43**	**1.24**	**6.70**	**3.44**
Karanja Khurd series										
KKUiB2G2P2	Ap	0 - 10	263.42	23.05	298.70	17.93	3.39	0.44	6.95	3.28
	Bw1	10 - 30	238.34	22.23	270.48	14.57	3.54	0.68	4.89	3.66
	Bw2	30 - 70	238.34	17.29	261.97	10.08	3.05	0.62	3.98	3.76
SWA			**246.70**	**20.86**	**277.05**	**14.19**	**3.33**	**0.58**	**5.27**	**3.57**
Muthangi series										
MTNiB2G1	Ap	0 - 9	338.688	27.99	261.52	25.78	2.47	1.34	7.24	2.38
	Bw	9 - 25	263.424	13.98	258.72	15.69	1.38	0.48	6.33	2.60
	Bt1	25 - 60	213.248	10.7	266.33	8.98	2.91	0.52	5.16	3.13
	Bt3	60 - 98	188.16	8.23	309.68	7.90	3.39	0.68	5.04	2.34
SWA			**250.88**	**15.22**	**274.06**	**14.58**	**2.53**	**0.75**	**5.94**	**2.61**
Devgiri series										
DGRiB2G1P1	Ap	0 - 8	288.51	15.64	331.29	20.17	4.70	0.92	8.90	1.15
	Bw1	8 - 30	163.07	14.82	312.70	12.51	4.18	0.97	7.42	2.03
	Bw2	30 - 60	213.24	10.7	253.0	19.14	2.87	0.64	3.00	2.22
	Bw3	60 - 85	163.72	9.88	281.56	19.05	2.06	0.42	1.86	2.99
	Bw4	85 - 120	175.61	9.05	303.18	16.9	1.59	0.54	1.79	2.76
SWA			**200.70**	**12.01**	**296.35**	**17.55**	**3.08**	**0.70**	**4.59**	**2.23**
Mustarwadi series										
MWDiB2	Ap	0 - 8	313.6	38.9	236.99	17.93	1.54	0.52	7.48	2.88
	Bw	8 - 39	288.51	23.05	234.52	18.17	1.05	0.49	8.36	2.64
	Bt1	39 - 76	273.51	13.17	302.51	19.78	1.54	0.52	8.18	3.74
	Bt2	76 - 98	250.88	10.7	225.79	19.17	1.72	0.49	8.98	3.28
	Bt3	98 - 140	238.33	9.88	232.51	15.69	1.98	0.72	7.38	3.21
	Bt4	140+	200.70	9.05	231.72	10.08	2.04	0.68	6.34	3.10
SWA			**263.42**	**17.45**	**244.01**	**16.80**	**1.65**	**0.57**	**7.79**	**3.14**
Basaltic soil series										

Lingi Series										
LINiD3G2P2S4	Ap	0 - 10	200.70	11.53	244.83	17.93	2.25	1.04	3.19	3.08
	Bw	10-21	150.53	8.24	228.59	11.21	1.67	0.74	3.16	3.28
SWA			**175.62**	**9.88**	**236.71**	**14.57**	**1.96**	**0.89**	**3.17**	**3.18**
Mustapur series										
MPRiB2	Ap	0 - 8	263.42	14.00	288.62	17.93	3.45	0.98	9.08	2.62
	Bw1	8 - 20	250.88	9.88	256.26	13.45	2.60	0.62	5.16	3.56
	Bw2	20 - 40	200.70	8.24	245.28	12.33	2.72	0.71	6.14	2.04
SWA			**238.34**	**10.71**	**263.39**	**14.57**	**2.92**	**0.77**	**6.79**	**2.74**
Gadikusanur series										
GKRmB2G1P1	Ap	0 - 9	275.97	27.17	292.54	8.96	1.49	0.79	3.64	2.88
	Bw	9 - 30	263.42	13.99	246.85	15.69	1.37	1.12	3.74	2.64
	Bt	30 - 50	238.34	9.05	251.55	17.93	1.10	1.01	2.43	1.78
SWA			**259.24**	**16.74**	**263.65**	**14.19**	**1.32**	**0.97**	**3.27**	**2.43**
Pashapur series										
PPRmB2	Ap	0 - 9	301.056	26.23	239.00	15.69	2.18	0.52	1.36	2.55
	Bw1	9 - 30	275.968	14.82	240.91	17.66	3.78	0.88	1.89	2.18
	Bw2	30 - 70	225.792	12.35	238.89	18.2	0.64	0.51	0.95	2.35
SWA			**267.60**	**17.80**	**239.60**	**17.18**	**2.20**	**0.64**	**1.40**	**2.36**
DhupatMahagaon series										
DMNmB2G1	Ap	0 - 8	288.51	23.05	327.26	20.17	3.64	1.32	4.05	2.05
	Bw	8 - 20	263.42	18.94	257.60	17.90	4.04	1.04	8.52	0.54
	Bss1	20 - 50	225.79	10.70	318.19	18.42	3.99	1.92	8.19	0.44
	Bss2	50 - 80	188.16	7.41	319.65	18.66	3.50	1.04	8.20	0.48
SWA			**241.47**	**15.03**	**305.68**	**18.79**	**3.79**	**1.33**	**7.24**	**0.88**
Udawah series										
UDHiB2	Ap	0 - 8	338.69	21.71	228.03	12.33	3.04	0.92	3.54	1.27
	Bw	8 - 28	275.97	21.58	242.59	7.84	3.67	0.82	4.93	0.50
	Bss1	28 - 50	250.88	20.88	331.63	6.72	3.18	0.48	5.13	2.07
	Bss2	50 - 85	225.79	20.24	267.12	16.81	1.47	0.43	2.62	0.98
	Bss3	85 - 110	188.16	20.01	265.22	11.21	1.83	0.42	2.11	1.34
SWA			**255.90**	**20.88**	**266.92**	**10.98**	**2.64**	**0.61**	**3.67**	**1.23**
Kouta- B series										
KBBmB2	Ap	0 - 10	288.16	21.52	250.65	23.54	3.24	0.81	2.71	1.81
	Bw	10 - 30	263.42	21.17	244.83	17.93	4.42	1.70	1.14	2.36
	Bss1	30 - 70	213.24	20.08	251.82	11.30	5.54	2.14	1.24	1.34
	Bss2	70 - 110	175.61	20.06	254.51	7.84	1.68	0.66	1.29	1.25
	Bss3	110 - 140	175.04	20.01	253.05	7.32	1.23	0.42	1.02	1.13
SWA			**235.10**	**20.71**	**250.45**	**15.15**	**3.72**	**1.33**	**1.60**	**1.69**
Kaudgaon series										
KGNmB2	Ap	0 - 6	315.97	27.88	273.17	16.81	3.39	0.98	3.24	1.92
	Bw1	6 - 28	309.42	27.05	234.53	15.69	4.00	1.07	2.18	1.90
	Bss1	28 - 70	302.25	26.55	272.50	19.05	3.34	0.98	1.29	1.02
	Bss2	70 - 100	297.62	26.23	301.95	18.42	3.91	1.05	1.27	1.20
	Bss3	100 - 125	284.62	25.41	290.53	17.93	3.94	0.76	1.16	1.13
	Bss4	125 - 150	277.07	24.58	259.50	12.30	2.86	0.55	1.02	1.23
SWA			**297.82**	**26.28**	**272.03**	**16.70**	**3.57**	**0.90**	**1.69**	**1.40**
Raipalli series										
RPLmB2	Ap	0 - 8	358.51	28.71	335.66	17.93	1.62	0.64	1.57	4.72
	Bw	8 - 42	330.88	18.18	302.62	13.45	1.37	0.66	1.16	3.78
	Bss1	42 - 60	313.07	28.06	280.00	5.60	2.59	0.58	1.42	3.98
	Bss2	60 - 80	303.07	27.18	284.14	4.48	1.03	0.73	1.12	3.56
	Bss3	80 - 100	295.44	26.53	287.39	12.33	2.30	0.66	1.90	3.40
	Bss4	100 150+	270.35	26.18	288.28	14.57	1.48	0.54	1.18	2.42
SWA			**311.89**	**25.80**	**296.35**	**11.39**	**1.57**	**0.64**	**1.39**	**3.64**

The exchangeable calcium and magnesium ranged from 7.99 to 29.14 cmol(p^+) kg^{-1} and 2.38 to 9.19 cmol(p^+) kg^{-1}, respectively. The cation exchange capacity of various soil pedons ranged from moderate to high. The black soil pedons exhibited higher CEC due to higher clay content and predominance of 2:1 type clay minerals where as in case of red soils it was moderate as shown in Table 2.

Table 3 shows that the available nitrogen status of the watershed ranged from low to medium and varied from (SWA) 175.60 to 330.33 kg ha^{-1}in Humnabad sub-watershed. The available phosphorus ranged from low to medium and varied from (SWA) 8.23 to 20.86 kg ha^{-1}. The available potassium ranged from low to medium and varied from (SWA) 225.82 to 305.68 kg ha^{-1}. The available sulphur status ranged from low to high but most of the area was low to medium and values varied from (SWA) 18.87 to 10.98 ppm.

The DTPA extractable zinc varied from (SWA) 0.24 to 1.82 ppm, copper varied from (SWA) 1.32 to 4.34 ppm, manganese varied from (SWA) 0.88 to 3.76 ppm and iron varied from (SWA) 1.35 to 7.79 ppm. All the micronutrients were sufficient in lateritic soil series while, in basaltic soil series iron and zinc were low.

The soil reaction of pedons varied from neutral to slightly alkaline. Soil pH and EC of major soil pedons increased with depth due to accumulation of leached bases in the subsurface horizons. In general, the surface soil horizons recorded higher organic carbon content than underlying layers and decreased with depth in all soil pedons. The free calcium carbonate content increased with depth. The exchangeable bases were in the order of Ca^{2+}> Mg^{2+}>Na^+> K^+ on the exchangeable complex. The cation exchange capacity of various soil pedons ranged from moderate to high. The black soil pedons exhibited higher CEC due to higher clay content and predominance of 2:1 type clay minerals where as in case of red soils it was moderate.

The available nitrogen status of the watershed ranged from low to medium. The available phosphorus and potassium ranged from low to medium. The available sulphur status ranged from low to high but most of the area was low to medium. The present study shows that the study area was sufficient in micronutrients in lateritic soil series while, in basaltic soil series iron and zinc were low.

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