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Mapping of fertility status of soils in chikkadevarahalli micro-watershed of Channagiri taluk, Davanagere district, Karnataka by GIS techniques

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Abstract
An mapping of soil fertility status was carried out on the soils of Chikkadevarahalli micro-watershed (488.75 ha) during the year 2019 to 2021. Total 48 surface soil samples at 320 × 320 m grid intervals samples at 0 to 15 cm depths were collected and analyzed for it's totally fertility status and were mapped using Arc GIS software. The mapping the status of soils of Chikkadevarahalli micro-watershed indicated that the soil were low (69.96%) to medium (24.29%) in available nitrogen, low (5.70%) to high (28.74%) in available phosphorus, medium (62.72%) to high (30.93%) in available potassium, low (1.18%) to high (40.39%) in available sulphur, whereas exchangeable calcium and magnesium were found to be sufficient. DTPA extractable zinc was sufficient in 304 ha (62.25%) to deficient in 153 ha (31.40%) area. Whereas DTPA extractable iron, manganese, copper were sufficient. Available boron was low (62.25%) to medium (62.25%) in the study area.

Keywords: Arc GIS software, mapping and micro-watershed and soil fertility

Introduction
For economic and production sustainability of the area, there is a need to improve the resource base as well as soil fertility through agroforestry, alley cropping and natural recycling by converting farm waste into wealth either by incorporating the soil of scientific composting method along with sustain fertility. The information regarding the status of nutrients and nutrient mapping of soils is needed to implement the concept of watershed approach successfully. Imbalanced and inadequate use of chemical fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly. In India, low fertility of soils is the major constraint to achieving high productivity goals. Therefore, it is important to investigate the soil fertility status and it may provide valuable information relating crop research. Considering these facts, the study was initiated with the objective to assess the soil fertility status and mapping of Chikkadevarahalli micro-watershed of Channagiri taluk, Davanagere district, Karnataka.

Material and Methods
The study area is a Chikkadevarahalli micro-watershed, covering an area of 488.75 ha. The Davangere district lies in the center of Karnataka between the latitudes 14° 27' 50.7708" N and 75° 55' 17.9796" E. The average rainfall in study area is 808 mm. The detailed soil survey of the Chikkadevarahalli micro-watershed was carried out at 1:7920 scale by using the Quick Bird satellite imagery and cadastral map as base maps. Forty eight surface soil samples were collected by adopting grid techniques (320 x 320 m grid interval) at 0 to 15 cm depth. The collected soil samples were processed and analysed for chemical properties and available nutrients using standard procedures. The pH (1:2.5) and electrical conductivity (EC) of soils were measured by using standard procedures as described by Jackson (1973) [2]. Organic carbon (OC) was determined using the Walkley-Black method (1934) [7]. Available nitrogen (Subbaiah and Asija 1956) [5], Available phosphorus (Jackson 1973) [2], Available potassium (Jackson 1973) [2], Available sulphur (Black 1965) [1], exchangeable calcium and magnesium (Jackson 1973) [2], Micronutrients (Fe, Mn, Cu and Zn) were extracted by DTPA reagent using the procedure outlined by Lindsay and Norvell (1978) [3] and Available boron (John *et al.*, 1975).

Results and Discussion

In the study area, its soil fertility status with respect to pH, EC, organic carbon, available nitrogen, available phosphorus, available potassium, available sulphur, exchangeable calcium and magnesium, DTPA iron, manganese, copper, zinc and available boron were assessed.

Chikkadevarahalli micro-watershed soils were found to be strongly acidic to moderately alkaline. Soil reaction was ranged from 4.95 to 8.36 (Table 1) with a mean value of 6.71 and a standard deviation (SD) of 1.20. About 164 ha (33.59%) of the study area was neutral which was followed by slightly alkaline in 109 ha (22.30%) area and 49 ha area (10.15%) was slightly acidic and moderately alkaline in 42 ha (8.60%) area, moderately acidic in 30 ha (6.09%) and 25 ha (5.12%) was strongly acidic in area (Fig. 1). The variation in soil pH was related to the parent material and topography.

The electrical conductivity of the Chikkadevarahalli micro-watershed was non-saline in nature (Table 1). It was varied from 0.07 to 0.52 dS m^{-1} (Table 1), with a mean of 0.23 dS m^{-1} and a standard deviation of 0.12. On area basis, total of 457 ha (93.65%) were non- saline in nature (Fig. 1). This may be due to undulating nature of the terrain coupled with fairly good drainage conditions, which favored the removal of released bases by the percolating drainage water.

The organic carbon content of the Chikkadevarahalli micro-watershed was ranged from 2.10 to 9.90 g kg^{-1} and with a mean value of 6.33 g kg^{-1} (Table 1) and a standard deviation of 1.90. About 13.14 per cent area (64 ha) of soil was low in organic carbon and 59.96 per cent area was medium (293 ha) and 100 ha area was high (20.55%) in organic carbon status (Fig. 1). The low organic matter content in the soils was attributed to the prevalence of tropical condition, where the degradation of organic matter occurs at a faster rate coupled with low vegetation cover, thereby leaving less organic carbon in the soils. Medium organic matter content is attributed due to rapid rate of decomposition of organic matter due to high temperature and lack of addition of FYM and crop residues. Higher organic matter content mainly due to accumulation of organic materials through crop residue and external applications in the surface soils.

The results indicated that the status of available nitrogen in Chikkadevarahalli micro-watershed was low to medium. It was varied from 100.35 to 370.05 kg ha^{-1} with a mean value of 241.60 kg ha^{-1} and a standard deviation of 70.87 (Table 1). About 339 ha (69.96%) area of the micro-watershed soil was low in available nitrogen status and 118 ha (24.29%) area of the soils were medium in available nitrogen status (Fig. 1).

The available phosphorus content of Chikkadevarahalli micro-watershed soils were varied between 16.26 to 71.68 kg ha^{-1}. The majority of the area was low to high in available phosphorus status with a mean value of 46.47 kg ha^{-1} and a standard deviation of 17.32 (Table 1). About 28 ha (5.70%) area of the micro-watershed soil was low in available phosphorus status and 289 ha (59.21%) area of the soils were medium in available phosphorus and 140 ha (28.74%) area of the soils were high in available phosphorus status (Fig. 2).

The available potassium content of Chikkadevarahalli micro-watershed soils was varied from 140.31 to 510.18 kg ha^{-1} with a mean value of 296.95 kg ha^{-1} and a standard deviation of 103.40. In general, potassium is medium to high (Table 1). About 306 ha (62.72%) area of the micro-watershed soil was medium in available potassium status and 151 ha (30.93%) area of the soils were high in available potassium. The low to high status of potassium in surface soil is due to intense weathering and the release of potassium from organic residues.

Table 1: Soil fertility status of Chikkadevarahalli micro-watershed of Channagiri taluk of Davanagere district

Soil properties	Range	Mean	SD
pH (1:2.5)	4.95-8.36	6.71	1.20
EC (dS m^{-1})	0.07-0.52	0.23	0.12
OC (g kg^{-1})	2.10-9.90	6.33	1.90
Available N (kg ha^{-1})	100.35-370.05	241.60	70.87
Available P_2O_5 (kg ha^{-1})	16.26-71.68	46.47	17.32
Available K_2O (kg ha^{-1})	140.31-510.18	296.95	103.40
Exchangeable Ca (cmol (p^+) kg^{-1})	3.25-17.00	10.17	3.72
Exchangeable Mg (cmol (p^+) kg^{-1})	2.00-12.75	5.20	2.43
Available S (mg kg^{-1})	8.05-31.48	18.73	5.92
Available Fe (mg kg^{-1})	8.58-33.88	20.33	7.17
Available Mn (mg kg^{-1})	6.58-29.30	16.27	5.23
Available Cu (mg kg^{-1})	0.94-3.74	2.06	0.66
Available Zn (mg kg^{-1})	0.27-1.06	0.63	0.19
Available B (mg kg^{-1})	0.14-0.96	0.61	0.21

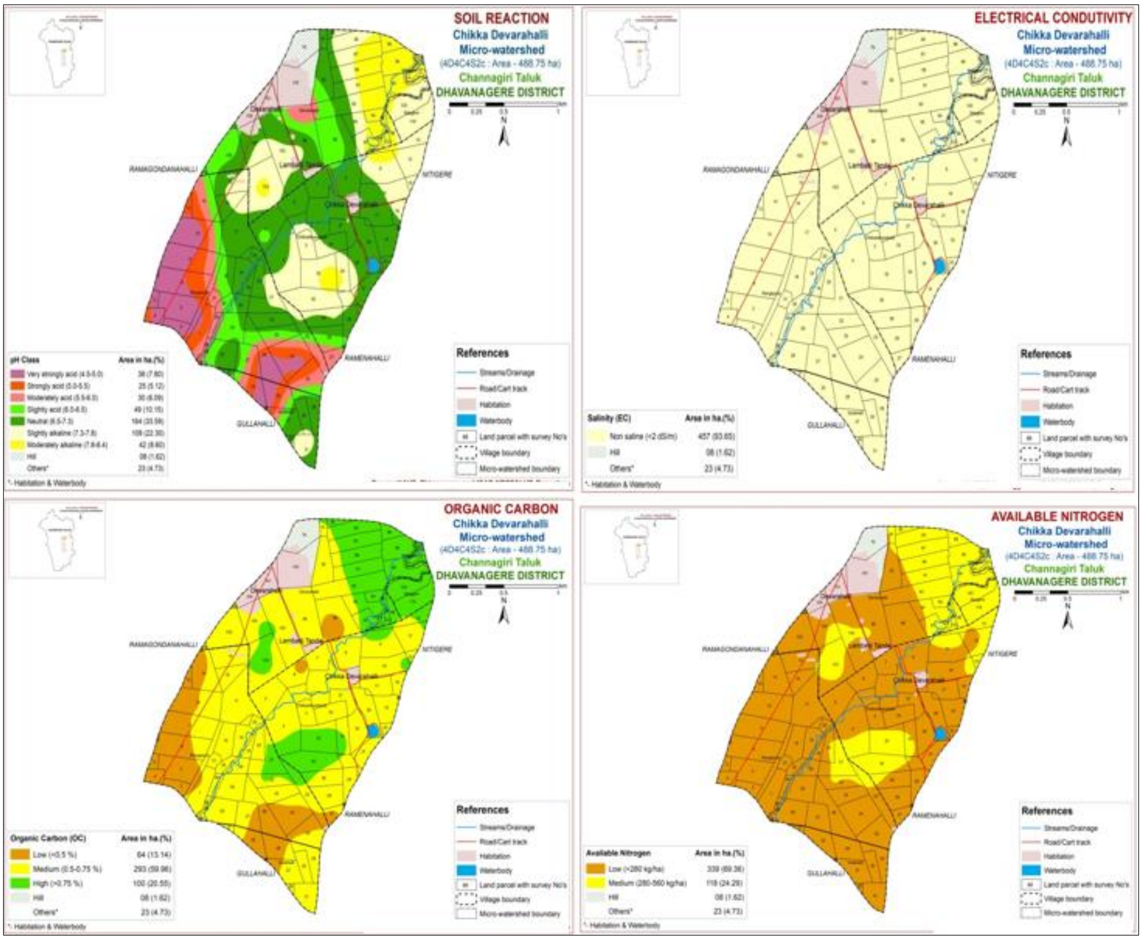

Fig 1: PH, EC, OC and N status of Chikkadevarahalli micro-watershed of Channagiri taluk of Davanagere district

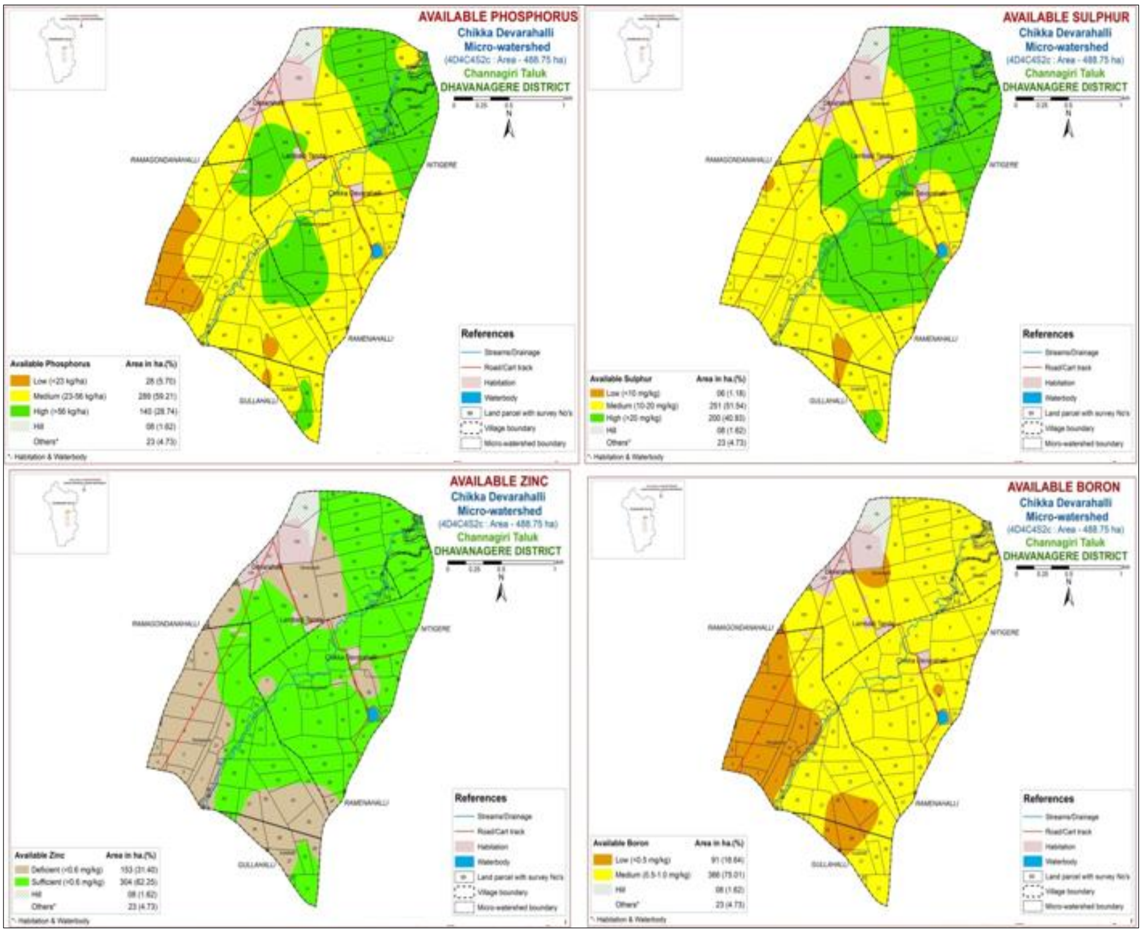

Fig 2: Available P, S, Zn and B status of Chikkadevarahalli micro-watershed of Channagiri taluk of Davanagere district

The exchangeable calcium and magnesium content of Chikkadevarahalli micro-watershed was ranging from 3.25 to 17.00 and 2.00 to 12.75 cmol (p^{+}) kg^{-1}, respectively with an average value of 10.17 and 5.20 cmol (p^{+}) kg^{-1}, respectively and standard deviations of 3.72 and 2.43, respectively (Table 1). The Chikkadevarahalli micro-watershed area soil was found to be sufficient of exchangeable calcium and magnesium status. The studied areas are sufficiency of exchangeable calcium and magnesium might be attributed to the type and amount of clay present.

The available sulphur content of the Chikkadevarahalli micro-watershed ranged from 8.05 to 31.48 mg kg^{-1} with the mean value of 18.73 mg kg^{-1} and a standard deviation of 5.92 (Table 1). In the Chikkadevarahalli micro-watershed, the available sulphur status of soil was recorded as low to high. About 61 ha (1.18%) area of the micro-watershed soil was low in available sulphur status and 251 ha (51.54%) area of the soils were medium in available sulphur and 200 ha (40.39%) area of the soils were high in available sulphur (Fig. 2). The studied areas are high in organic carbon content, along with fine-textured soils, contributed to higher sulphur content.

The available iron content in the Chikkadevarahalli micro-watershed was 8.58 to 33.88 mg kg^{-1} with the mean value of 20.33 mg kg^{-1} (Table 1). It was sufficient (93.65%) in the entire micro-watershed area of the Chikkadevarahalli. The amount of available iron in the study area was sufficient. This might be due to the granite gneiss parent material having larger iron content.

In the Chikkadevarahalli micro-watershed, the available manganese content was varied from 6.58 to 29.30 mg kg^{-1} with a mean of 16.27 mg kg^{-1} (Table 1). The entire micro-watershed area soil is sufficient (93.65%) in available manganese content. The available manganese was sufficient content due to high organic matter content. The higher DTPA extractable manganese content in the micro-watershed area was attributed to the parent material's higher content of granite gneiss.

The available copper content of Chikkadevarahalli micro-watershed soils were ranging from 0.94 to 3.74 mg kg^{-1} with the mean of value 2.06 mg kg^{-1} (Table 1). The entire micro-watershed was sufficient (93.65%) in copper. Copper found to be higher in this micro-watershed area due to $CaCO_3$ and clay content resulting in copper fixation. The overall higher copper content in the micro watershed area was due to the parent material.

The available zinc status in the Chikkadevarahalli micro-watershed area was deficient in 153 ha (31.40%) and sufficient in 304 ha (62.25%) area (Fig. 2). It was ranging from 0.27 to 1.06 mg kg^{-1} with the mean value of 0.63 mg kg^{-1} (Table 1). The larger extent of zinc deficiency was attributed to the alkaline soil condition and richness of $CaCO_3$. Which might due to high precipitation of zinc as hydroxide and carbonates. Many researchers reported reduced solubility of majority of zinc and there by decreased availability of zinc under alkaline soil conditions. The alkaline soil condition could be the cause of zinc deficiency in the study area (Thangasamy *et al.*, 2005) [6]. The available zinc was sufficient in the surface samples because the soils were not subjected to intensive cultivation (Rajashekar, 2018) [4].

The available boron status in Chikkadevarahalli micro-watershed soils were low in 91 ha (18.64%) and medium in 366 ha area (75.01%) (Fig. 2) and it was varied from 0.14 to 0.96 mg kg^{-1} with the mean of value 0.61 mg kg^{-1} and a standard deviation of 0.21 (Table 1).

Conclusion

The soils of the Chikkadevarahalli micro-watershed were low to high in organic carbon, low to medium in available nitrogen, low to high in available phosphorus and medium to high available potassium, exchangeable calcium and magnesium status were sufficient and low to high in available sulphur content. DTPA extractable iron, manganese and copper were sufficient, whereas zinc were sufficient to deficient. Available boron content was low to medium in the micro-watershed area. There is need of regular application of FYM, intercropping of green manure, proper fertilizer recommendation and soil management practices can be made productive, thereby increasing the crop yield in the studied area.

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