Research Article

Soil Nutrient Status of Soils of Kanamadi South Sub Watershed of Vijayapura District

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Abstract

An investigation was carried out to determine the fertility status of soils of Kanamadi south sub watershed. A detailed soil survey of Kanamadi south sub watershed was carried out using IRS P6 LISS-IV image and a total of three hundred and ninety seven surface samples which were well distributed in Kanamadi south subwatershed from the depth of 0 - 20 cm were collected for assessment of soil fertility. The fertility status of the study area revealed that the soils were alkaline in nature and non saline, low in available nitrogen and organic carbon, low to medium in available phosphorus, medium to high in available potassium, low to medium in available sulphur. The soils of Kanamadi south sub watershed were moderate in fertility status and suitable for growing crops with suitable addition of manures and fertilizers to obtain maximum yield and restore the soil health.

Keywords: Kanamadi, IRS P6 LISS-IV, surface samples, soil fertility

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Introduction

Soil is one of the most important natural resources on which the sustenance of life depends. From the dawn of agriculture, cultivators recognized good soils being attracted to the fertile soils of river valleys. Most great civilizations have depended on good soils. Continuous replenishment of fertility by natural flooding made possible the stable, organized communities to shift from nomadic to modern society. Mis-management of fertile soils is the only contributing factor to the downfall of society.

Soil is a major source of nutrients needed by plants for growth. The three main nutrients are nitrogen (N), phosphorus (P) and potassium (K). Together they make up the trio known as NPK. Other important nutrients are calcium, magnesium and sulphur. Plants also need small quantities of iron, manganese, zinc, copper, boron and molybdenum, known as trace elements because only traces are needed by the plant. The role these nutrients play in plant growth is complex.

A healthy soil will provide sufficient nutrients for both plants and soil organisms. It is not just dependent on having nutrients existing in the soil as chemical compounds, it also depends on access to those nutrients. Nutrients can be locked-away from plants and soil organisms because of various soil conditions. The conditions that can influence availability and accessibility of soil nutrients include: soil moisture content, soil porosity, soil conductivity, pH, temperature and competitive demand between organisms.

Bijapur, officially known as Vijayapura belongs to the Northern dry zone of Karnataka state. The district is bounded by Solapur district on the North, Bagalkot on the South, Belgaum district on the West, and Gulbarga on the East. Vijayapura has a semi-arid climate. It is located at 16.83°N 75.7°E. It has an average elevation of 606 meters (1988 ft). The climate of the Vijayapura district is generally dry and healthy. In summer, especially in April and May, it is too hot and the temperature is between 40 degrees Celsius to 42 degrees Celsius. The average annual rainfall for the whole district is 552.8 mm, with 37.2 rainy days.

Kanamadi south sub-watershed is located 39.2 km away from Vijayapura (Bijapur), headquarter town of Vijayapura District. This area lies in Northern dry zone of Karnataka and has hot arid ecosystem with hot and dry summers and mild winters (K4D2) and belongs to the sub region 6.1 (K4Dd3) North Karnataka Plateau.

Materials and Methods

Ancillary data

The topographic map of the study area in a scale of 1;50,000 was digitalized geo-referenced to a map coordinate system so as to generate spatial information and subsequent use in a GIS environment. The geo-referenced map was gridded on a 8’x8’ basis. The point of interception of each latitude and longitude represented a soil sample point.

Soil sampling and preparation for analysis

A total of three hundred and ninety-seven surface samples which were well distributed in Kanamadi south subwatershed from the depth of 0 - 20 cm were collected for assessment of soil fertility. The exact sample location (latitude and longitude) was recorded with the help of a hand held GPS device. The soil samples were collected in polythene bags and transported with proper handling to the laboratory for analysis.

The large lumps were broken and spread on stout sheet of brown papers and then air- dried in shade. The air-dried samples were ground with a wooden pestle and mortar and passed through 2 mm sieve to separate the coarse fragments (materials >2 mm). The fine earth samples were stored in suitable sample bottles for various analyses. For easy identification, labels showing a short description of grid number and sample location were placed inside of each bottle.

Soil analysis for soil fertility

- **Soil Reaction (pH):** The soil pH was determined in (1:2.5) soil: water suspension by potentiometric method using glass electrode as described by [1]
- **Electrical Conductivity:** Electrical conductivity was determined in (1: 2.5) soil: water suspension using Conductivity bridge and expressed as dSm^{-1} [1].
- **Organic carbon:** The organic carbon content of a finely ground soil sample was determined by Walkley and Black's Wet Oxidation method by [1] and expressed in g kg^{-1}
- **Available Nitrogen:** Available nitrogen was determined by modified alkaline permanganate method as described by [2].
- **Available Phosphorous:** Available phosphorous was determined by Olsen's method as described by [1].
- **Available Potassium:** Available potassium was extracted with neutral normal ammonium acetate (pH 7.0) and the content of potassium in the solution was estimated by Flame photometer [1].
- **Available Sulphur:** Available Sulphur was extracted from the soil using 0.15 percent calcium chloride solution and Sulphur in solution was determined by turbidometry as outlined by [3] using Spectrophotometer (Spectronic 20-D) at 420 nm.

Soil fertility maps

A dbf file consisting of data for X and Y coordinates in respect of sampling site location was created. A shape file (Vector data) showing the outline of Kanamadi south subwatershed area was created in Arc GIS 10.1. The dbf file was opened in the project window and in X-field,X- cocordinates was selected and in Y-field,Y coordinates was selected. The Z field was used for different nutrients. The Kanamadi south subwatershed file was also opened and from the 'surface menu' of Arc View spatial analyst interpolate grid option" was selected.

On the output "grid specification dialogue", output grid extends chosen was same as Kanamadi south subwatershed and the interpolation method employed was kriging. Then map was reclassified based on ratings of respective nutrients.

Results and Discussion

Surface soil samples were collected from farmer's fields for fertility status assessment (major and micronutrients) on a predetermined grid 320 m apart. Three hundred ninety seven soil samples were collected from Kanamadi South sub-watershed area and analyzed in the laboratory. By linking the soil fertility data to the grid points, soil fertility maps were generated in the GIS environment using kriging option for interpolation. The results of studied soil properties are presented in Table 2.

Soil pH

pH is an indicator of acidity or alkalinity or neutrality of soil. A neutral soil (6.5-7.5) is considered to provide optimum condition for nutrients availability. Soil pH in the sub-watershed area ranged from 7.13 to 9.57 with a mean of 8.46, S.D. of 0.32. The soils of the sub-watershed were moderately alkaline (pH 7.8 to 8.4) in 1629 ha (39.06 %), strongly alkaline (pH 8.4 to 9) in 2477 ha (59.41 %) and very strongly alkaline (pH > 9) in 15 ha (0.37 %) area. (**Figure 1**).

Table 1 Fertility status of soils of Kanamadi south sub-watershed

Soil property	Range	Mean	SD	C.V (%)
pH	7.43- 9.57	8.46	0.32	3.74
Electrical conductivity (dS m^{-1})	0.08 - 0.70	0.20	0.11	58.16
Organic carbon (g kg^{-1})	1.75- 8.36	3.44	2.24	65.27
Available N (kg ha^{-1})	174.0 - 394.40	289.06	48.75	16.87
Available P_2O_5 (kg ha^{-1})	12.4 – 48.6	27.51	9.74	35.39
Available K_2O (kg ha^{-1})	165.6 – 626.7	441.02	100.50	22.79
Available S (kg ha^{-1})	7.8 – 22.01	13.72	6.92	50.45

Table 2 Area (ha) under different chemical and fertility parameters in the Kanamadi South sub watershed

Parameters	Rating		
	Moderately alkaline	**Strongly alkaline**	**Very strongly alkaline**
Soil pH	1629 ha (39.06)	2477 ha (59.41)	15 ha (0.37)
	Non saline	**Slightly saline**	**Medium saline**
Soil salinity	4122 ha (98.83)	-	-
	Low	**Medium**	**High**
Organic carbon	3645 ha (87.4)	477 ha (11.43)	-
Available nitrogen	1566 ha (37.54)	2556 ha (61.29)	-
Available phosphorus	1249 ha (29.95)	2873 ha (68.89)	-
Available potassium	-	148 ha (3.56)	3973 ha (95.27)
Available sulphur	15 ha (0.35)	4055 ha (97.23)	52 ha (1.25)

*Figures in the parenthesis indicate the percentage of total sub watershed area

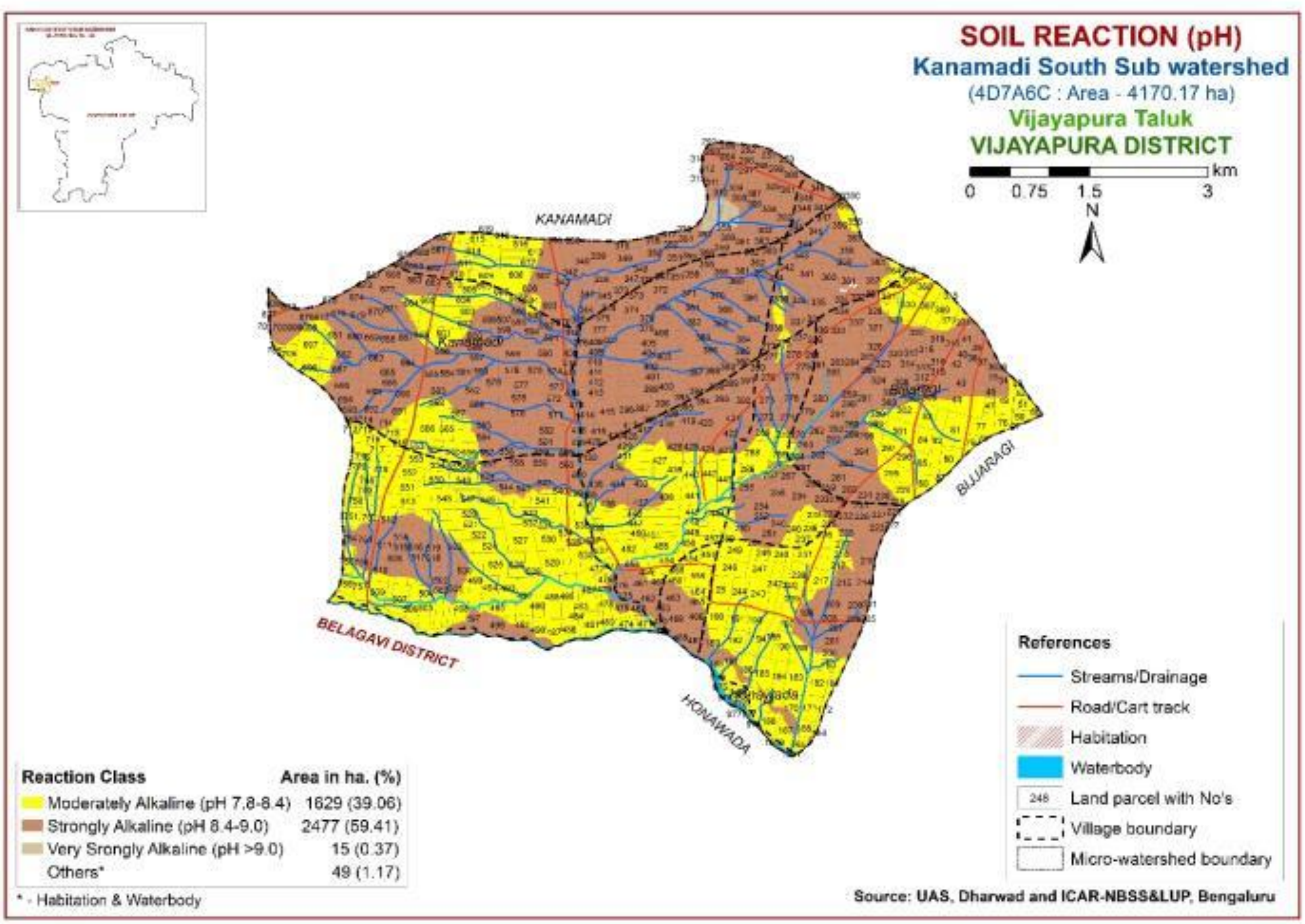

Figure 1 Soil reaction ($pH_{2.5}$) status of Kanamadi south sub watershed

The pH varied from slightly acidic to moderately alkaline in the soils of Sivagiri micro-watershed in Chittoor district of Andhra Pradesh. The variation in soil pH was related to parent material, rainfall and topography [4]. Relatively higher pH value in soil pedons was due to accumulation of the high amounts of exchangeable bases in the solum as they were poorly drained [5].

Electrical conductivity (EC) of soil-water extract (1:2.5)

Higher the EC, higher is the presence of soluble salts. The electrical conductivity of soil ranged from 0.07 to 0.80 dS m^{-1} with a mean of 0.20 dS m^{-1}, S.D. of 0.11 dS m^{-1}. The soils of the entire sub-watershed area is non-saline. The soils of the entire sub-watershed area was non-saline. This might be due to the undulating nature of the terrain coupled with fairly good drainage conditions, which favored the removal of released bases by the percolating and drainage water (**Figure 2**).

According to [6] the electrical conductivity of the soils of Garakahalli watershed ranged from 0.02 to 0.20 dS m^{-1} indicating non-saline nature of the soil. Similarly, the Inceptisols and Entisols of Shahibi basin in Haryana and Delhi were non-saline with electrolyte concentration ranging from 0.18 to 0.95 dS m^{-1} [7].

Organic carbon (OC)

Organic carbon is one of the important soil quality indicators. The organic carbon content of soils of the Kanamadi South sub-watershed ranged from 0.19 to 0.89 per cent with a mean of 0.34 per cent and S.D. of 0.22 per cent. The organic carbon content of the sub-watershed was low in 3645 ha (87.4 %) area and medium in 477 ha (11.43 %) (**Figure 3**). It is due to soils of semi- arid type of climate with high temperature prevailing in the area results in low to medium organic carbon status. [8].

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 [9]. According to [10] higher clay content in black soil was responsible for higher organic carbon.

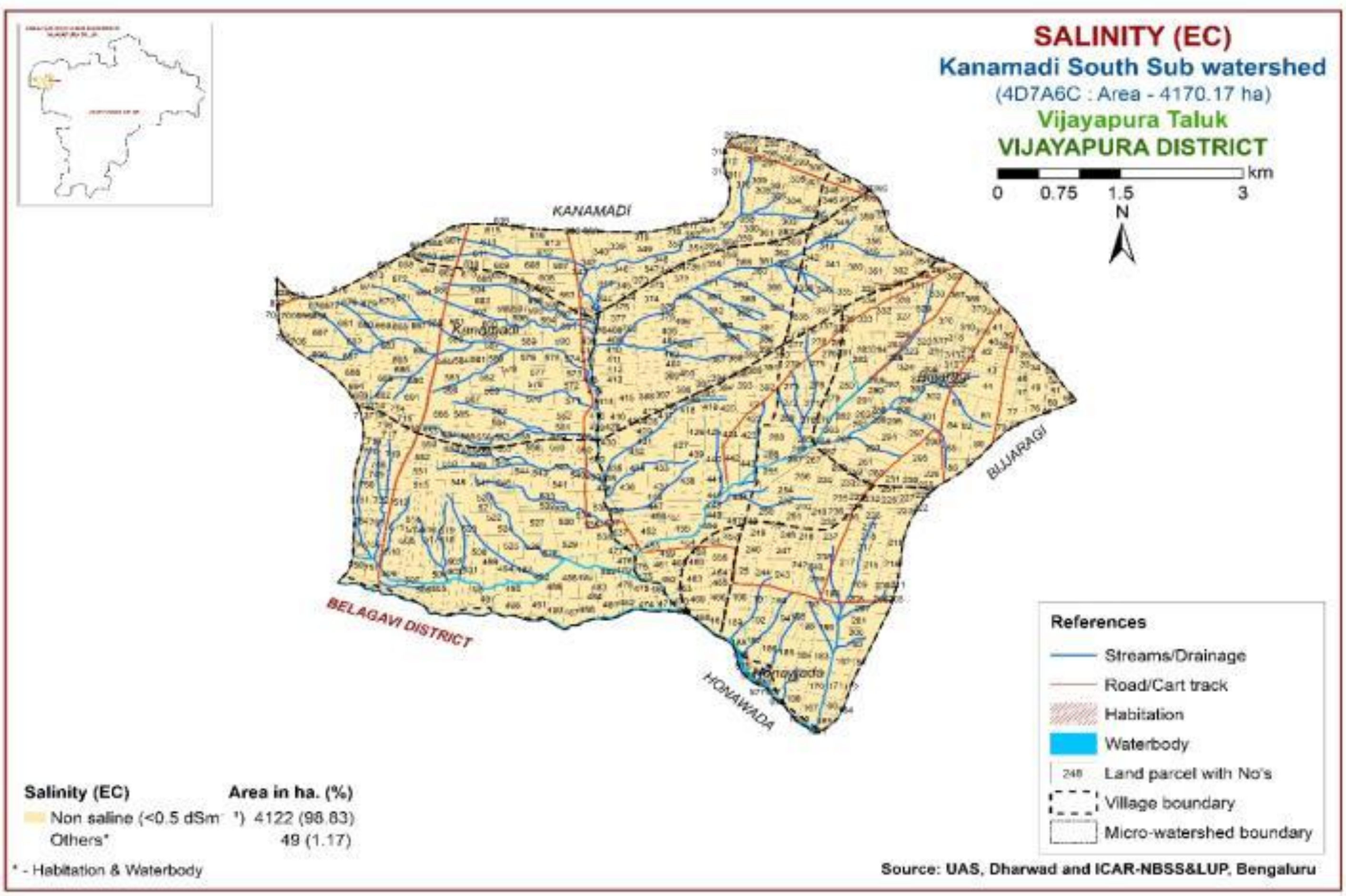

Figure 2 Electrical conductivity (1:2.5) of Kanamadi south subwatershed

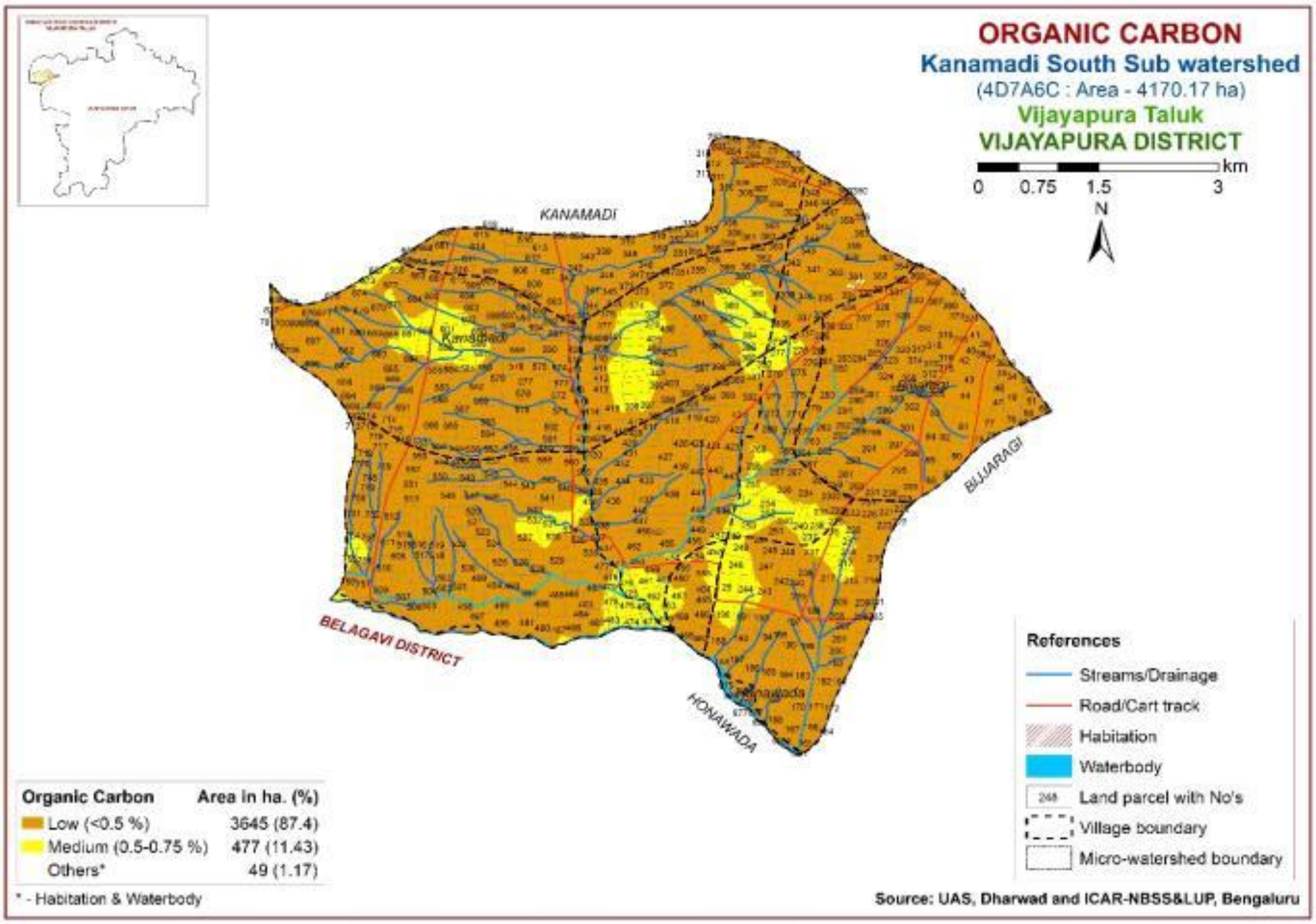

Figure 3 Soil organic carbon status of Kanamadi south sub watershed

Available nitrogen (N)

It is one of the major nutrients, as it significantly contributes to vegetative growth of the plant. The available nitrogen content in the soils varied from 145 to 406 kg ha^{-1} with a mean of 289 kg ha^{-1} and S.D. of 48.75 kg ha^{-1}. Mapping of available nitrogen status revealed that soils of the sub-watershed were found to be low in 1566 ha (37.54 %) and medium in 2556 ha (61.29 %) (**Figure 4**). This might be due to variation in soil properties like clay content accompanied with arid environmental conditions and also due to growing of exhaustive crops like maize, cotton and sunflower. Another possible reason could be due to low organic matter content in these soils. Low rainfall and low vegetation were reported to cause faster degradation and removal of organic matter leading to nitrogen deficiency [11]. The variation in N content under each soil type could be attributed to soil management; application of FYM and fertilizer to previous crop etc. Similarly [12] reported that the nitrogen content in the soils was influenced by temperature, rainfall and altitude. The semi-arid climate, low organic carbon status might have resulted in low N content.

Available phosphorus (P_2O_5)

In order of essential nutrients; phosphorous is next to nitrogen and plays a major role in photosynthesis of plants. Therefore, it is considered as one of the vital nutrients. Available phosphorus content in soil ranged from 11.1 to 56.72 kg ha^{-1} with a mean of 27.5 kg ha^{-1} and S.D of 9.74 kg ha^{-1}

From the fertility maps it is observed that 1249 ha (29.95 %) area of the sub-watershed was low and 2873 ha (68.89 %) is medium in available phosphorus status (**Figure 5**).

This might be due to variation in soil properties like clay content, CEC and P fixation capacity. In addition to this, it was observed that the farmers were using only DAP as the source of nutrients in adequate quantity. At some locations, P_2O_5 was exceptionally high, may be due to heavy use of complex fertilizers. Similar results were reported by [8] and [13]. Similarly, [5] reported that soils of north Karnataka were medium in available phosphorus status.

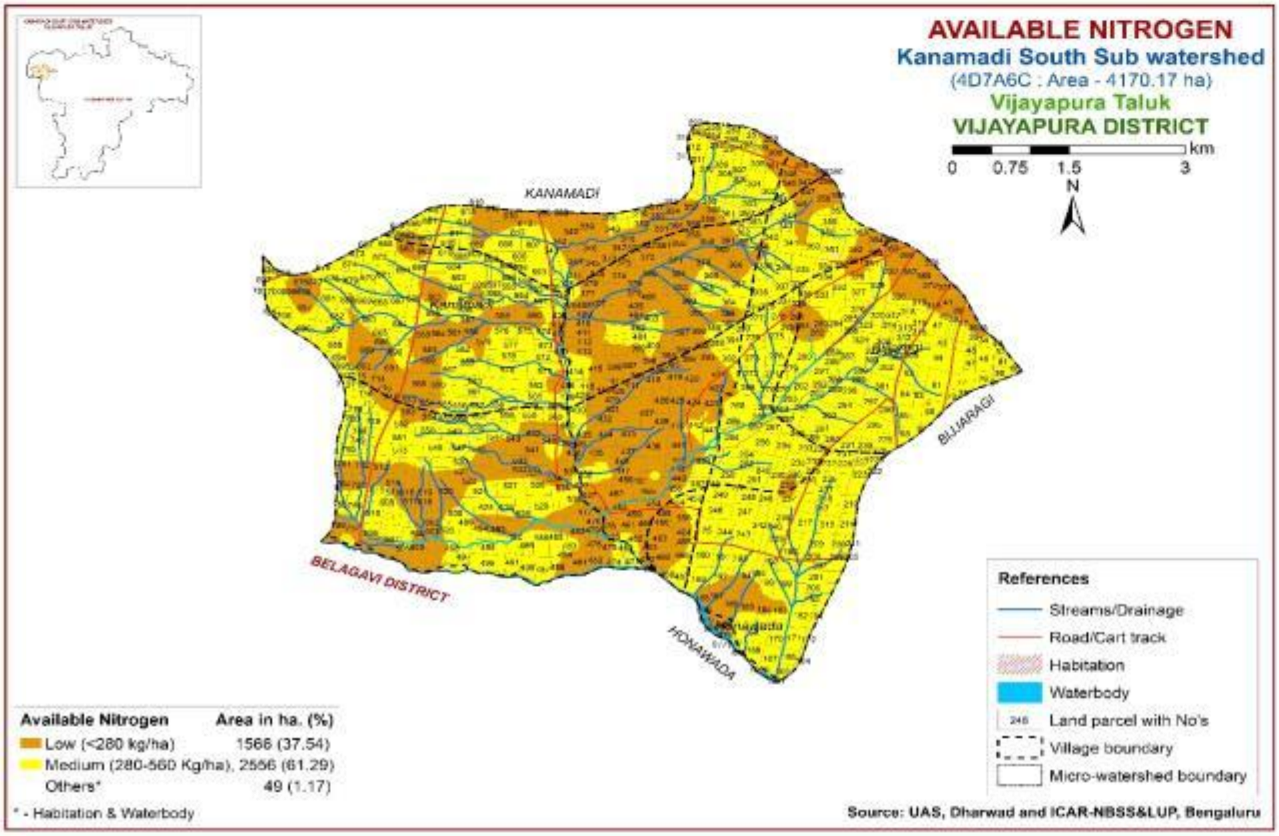

Figure 4 Available nitrogen status of Kanamadi south sub watershed

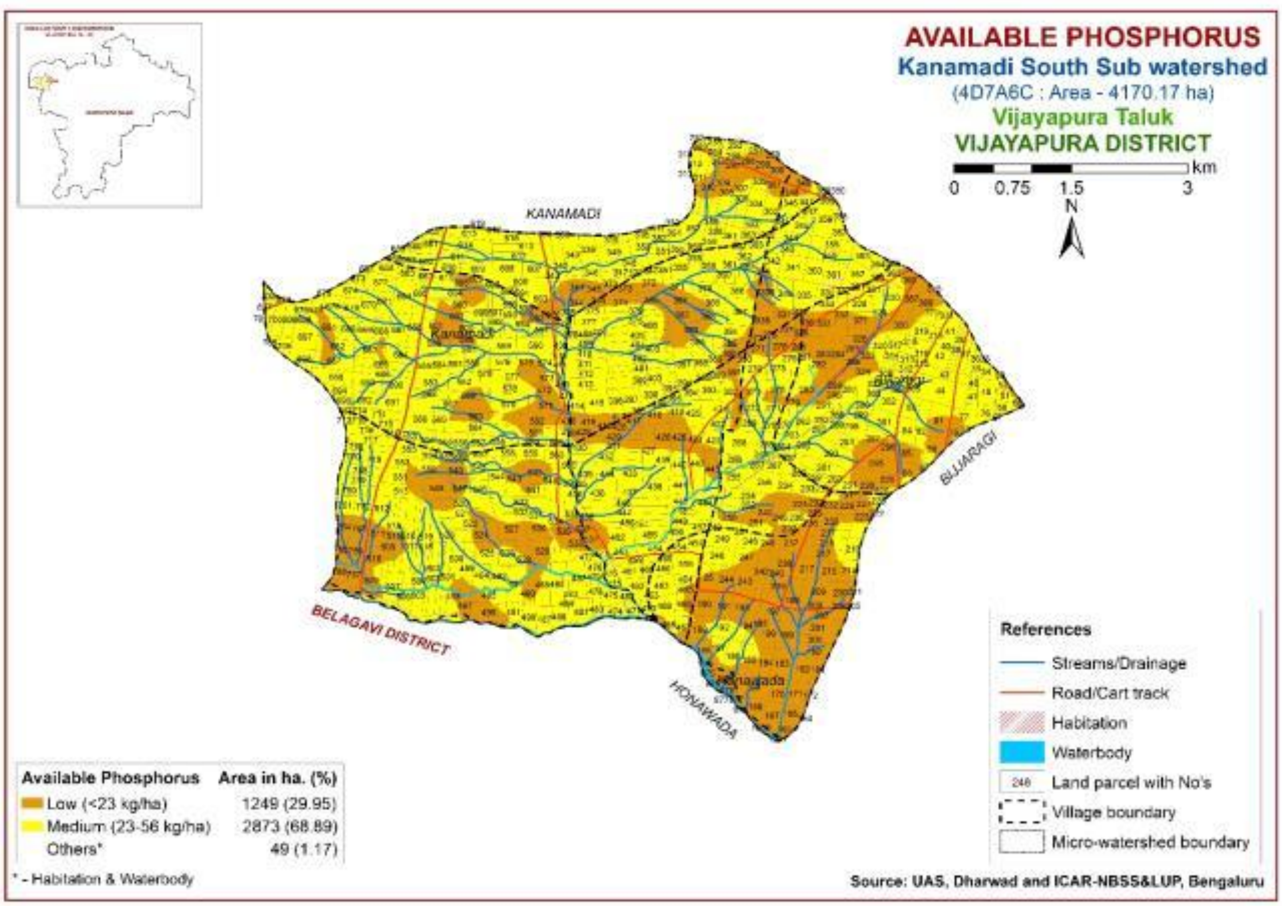

Figure 5 Available phosphorous content in Kanamadi south subwatershed

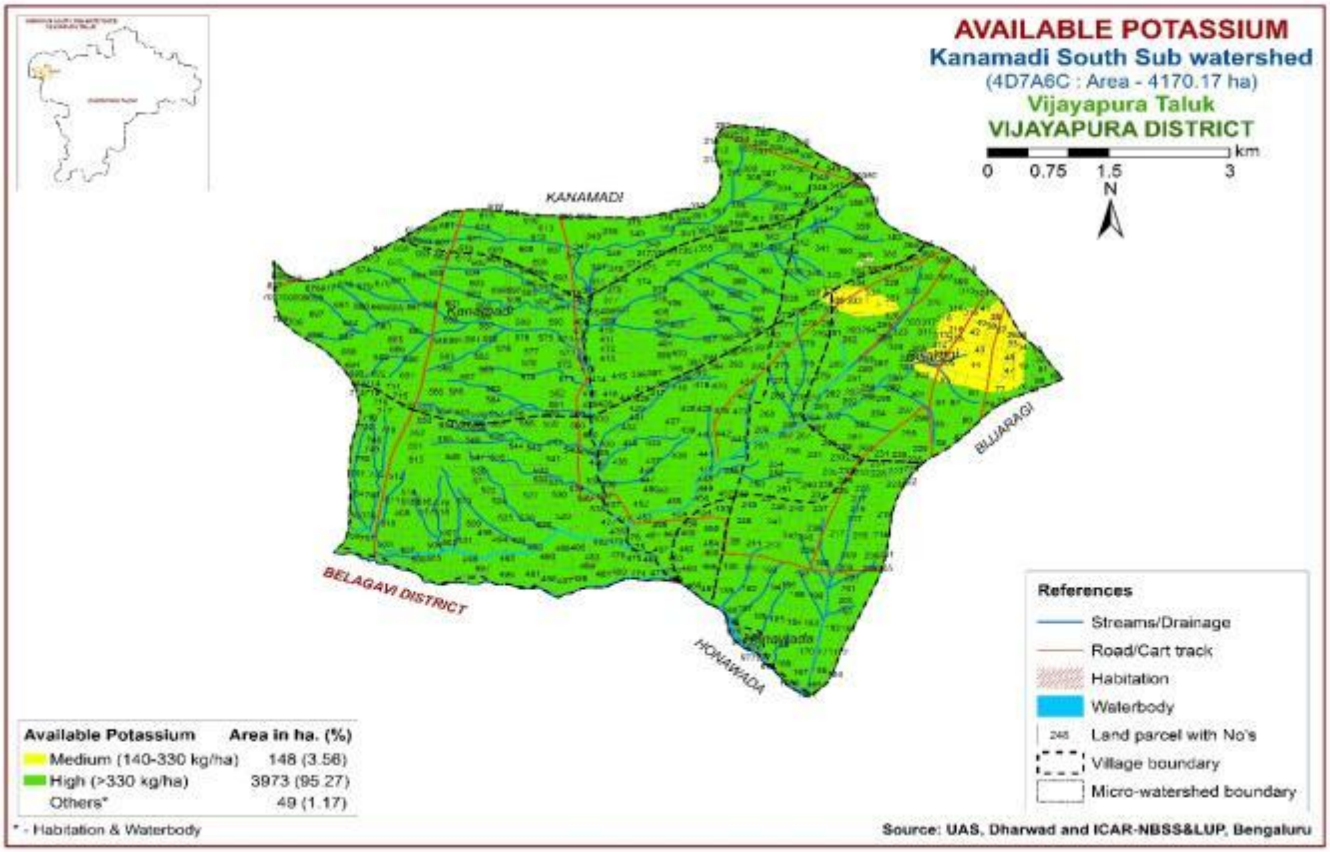

Figure 6 Available potassium status of Kanamadi south sub watershed

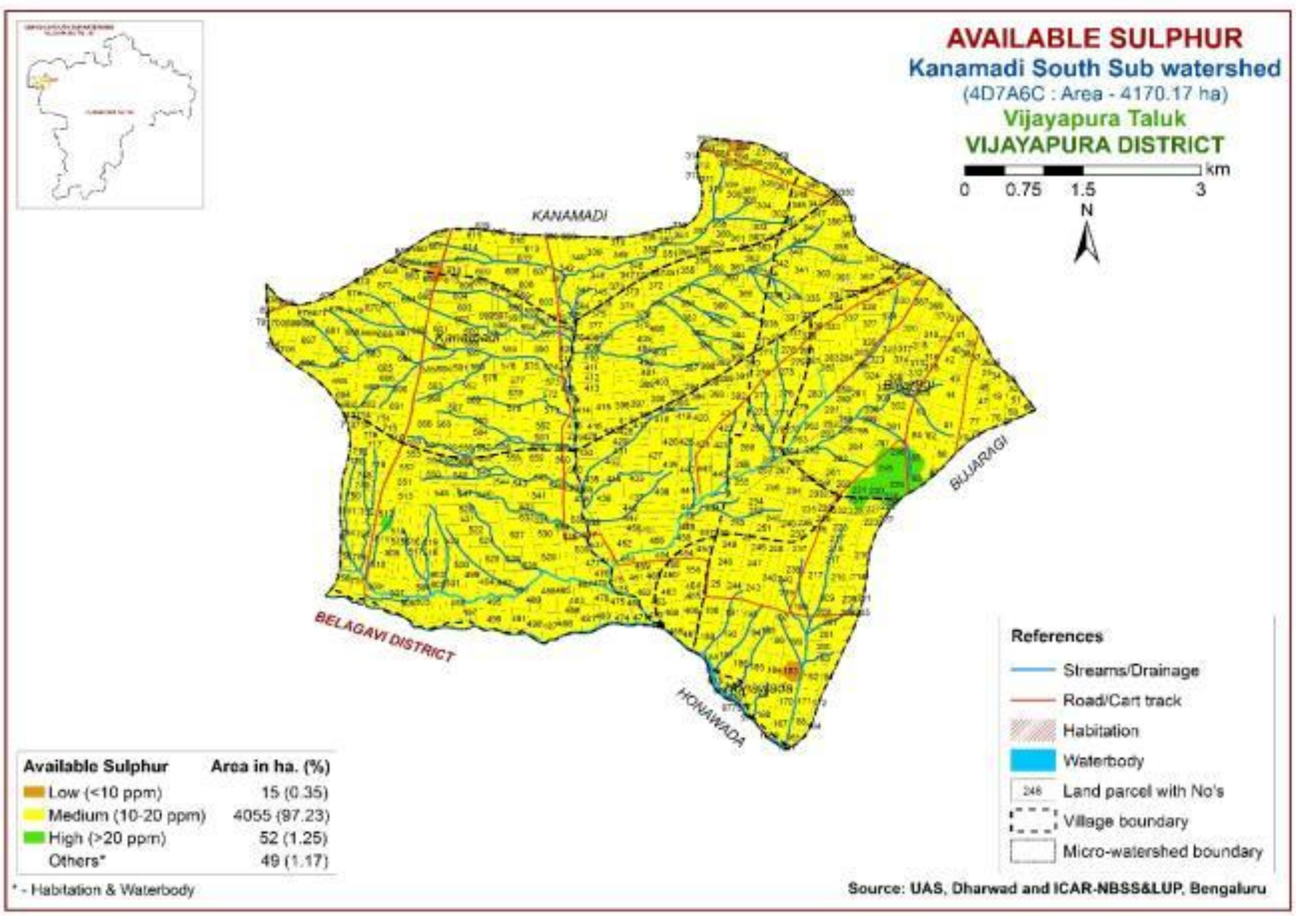

Figure 7 Available sulphur status of Kanamadi south sub watershed

Available potassium (K_2O)

Potassium not only improves plant quality but also contributes to the development of disease resistance in plants. The available potassium content in soils varied from 135 to 726 kg ha^{-1} with a mean of 441 kg ha^{-1} and S.D. of 100.50 kg ha^{-1}. From the fertility maps it is observed that 148 ha (3.56 %) area of the sub-watershed is medium and 3973 ha (95.27 %) is high in available potassium (**Figure 6**). The available potassium content of soils ranged from medium to high but majority of samples were high in available potassium. The higher content might be due to the predominance of potash rich micaceous and feldspar minerals in parent rocks [14], [5] and [15].

Available sulphur (S)

Sulphur is important nutrient for oilseed and pungent crops. Available sulphur status of Kanamadi South sub-watershed varied from 6.2 to 23.08 ppm with mean of 13.4 ppm and S.D. of 6.92 ppm. Mapping of available sulphur content revealed that 0.35 per cent area is low, 97.23 per cent area is medium and 1.25 per cent sub-watershed area is high (**Figure 7**). Low and medium status of available sulphur might be due to lack of sulphur addition and continuous removal by intensive cropping systems [4], [16] and [15].

Conclusions

The fertility status of the Kanamadi south subwatershed revealed that generally, the soils were low in available nitrogen and organic carbon, low to medium in available phosphorus, medium to high in available potassium, low to medium in available sulphur. There is great potential in this area to improve the soil fertility and soil health by judicious use of organic and inorganic fertilizers and manures to improve soil and obtain sustainable production

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