Int.J.Curr.Microbiol.App.Sci (2019) *8*(5): 2339-2349

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 05 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.805.276

Appraisal and Mapping of soil fertility status for Korasagu-4 micro watershed, by using Geo-spatial techniques

K.T. Gurumurthy, D. Ravikumar, A.V. Priyanka*, Anantakumar Patil, M.D. Rudresh, K.M. Vasanthkumar, S. Raghavendra and A. N. Raghu

SUJALA III Project, Department of Soil Science and Agricultural Chemistry, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, 577204, India

**Corresponding author*

Keywords

Grids, GPS, GIS techniques, Soil fertility and Correlation study

Article Info

Accepted:
18 April 2019
Available Online:
10 May 2019

A B S T R A C T

A study was undertaken to assess the soil fertility status of Korasagu-4 micro-watershed in Channagiri taluk, Davanagere district of Karnataka. Total ninety six grid wise surface soil samples were collected at 0-15 cm depth to assess the soil parameters and prepare thematic maps by using GIS techniques. The results indicated that soils of micro watershed were slightly acidic to strongly alkaline in soil reaction with non-saline in nature. Soil organic carbon content was found to be medium in major area. The available N, P_2O_5, K_2O were found to be low (73.37%), medium (94.65%) and high (58.72%) respectively in the micro-watershed. The 55.89 per cent and 70.17 per cent area of the micro watershed soils were found to be medium in sulphur and boron content. Whereas zinc was found to be deficient in 84.85 per cent of the area. The correlation study showed that organic carbon has significant and positive correlation with the availability of N (r=0.304**), P (r=0.265**), K (r=0.311**),S (r=0.515**), Zn (r=0.239*), Fe (r=0.261*) and significant and negative correlation with Mn (r=-0.453**), Cu (r=-0.431**) and B (=-0.250*) indicating, the compelling role of organic carbon in the maintenance of balanced soil health.

Introduction

Soil is one of the most important resources of the nature. The kind of soil and its associated characteristics provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximising the crop yields and to maintain the adequate fertility in soils for longer period. The physical and chemical properties of soils provide the information about the capacity of soil to supply mineral nutrients. Spatial variation across a field becomes great challenge for assessing the soil fertility of an area. Describing the spatial variability of soil fertility across a field has been difficult until new technologies such as Global Positioning Systems (GPS) and Geographic Information Systems (GIS) were introduced. GIS is a powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data (Burrough and McDonnell, 1998). As human population continues to increase, human disturbance on the earth's ecosystem to produce food and fibre will place greater demand on soils to supply essential nutrients. Imbalanced and inadequate use of chemical fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly (Medhe *et al.*, 2012). In India, low fertility of soils is the major constraint to achieving high productivity goals (SLUSI, 2010). Therefore, it is important to investigate the soil fertility status and it may provide valuable information relating crop research. Considering these facts, the present study was initiated with the objective to assess the soil fertility status of Korasagu-4 micro-watershed, Channagiri taluk of Davangere district.

Materials and Methods

The study was carried out at Korasagu-4 micro-watershed is located in Channagiri taluk of Davangere district of Karnataka and lies between 14° 0' 54.01" N latitude and 76° 4' 10.51" E longitude and 13° 58' 33.80" N and 76° 4' 28.90" E as well altitude 669 MSL with a spatial extent of 980.94 ha (Fig.1). Total area of Korasagu-4 micro watershed was found to be 980.94 ha out of which 928.94 ha (94.29%) area was considered for study and 52 ha (5.71%) area was considered under habitation and water body. The average rainfall in the study area was 756 mm. The survey of India toposheet was used to prepare base maps covering Korasagu-4 micro watershed. The cadastral map having parcel boundaries with survey numbers collected from KSRSAC, Bengaluru were used for the study. The survey of India toposheet with 1:50,000 scale was used along with the satellite imaginary for updating the base maps. Grid sampling (0-15 cm depth) was done in the study area by imposing grids of 320 x 320 m intervals in the micro watershed with 1:7920 scale (Fig. 2). Total 96 surface soil samples were collected from the fixed grid points using hand held GPS for studying soil fertility status in the micro watershed.

The collected soil samples were analyzed by adopting standard procedure. Particle size distribution was determined by international pipette method (Piper, 1966). Soil pH and electrical conductivity was determined at 1:2.5 soil water suspensions by potentiometric and conductometry method (Jackson, 1973). Organic carbon was measured by Chromic acid wet digestion method (Walkley and Black 1934). Available N in the soil was determined by alkaline potassium permanganate method as described by Subbiah and Asija (1956). Available phosphorus was extracted by using Olsen's extractant (0.5 M $NaHCO_3$) for neutral and alkaline soils and Bray's extractant for acid soils was determined by spectrophotometer (Jackson, 1973). The available K was estimated by extracting the soil with 1 N NH_4OAC (pH 7.0) by using flame photometer. The exchangeable calcium and magnesium were determined by versanate titration method (Jackson, 1973). Available sulphur was extracted from soil using 0.15 per cent $CaCl_2$ solution and determined by turbidometrically (Black, 1965). The micronutrients like Fe, Zn, Mn, Cu and B in the soil were extracted with DTPA extractant by using Atomic Absorption Spectrophotometer (Lindsey and Norvell, 1978). Hot water extractable boron in soil was determined as per the procedure outlined by John *et al.*, (1975) by using Azomethane-H reagent.

Nutrient status of soil maps

A excel format file consisting of data for X and Y co-ordinates in respect of sampling site location was created. A shape file (vector data) showing the outline of Korasagu-4 micro-watershed was created. The excel format file was selected in project window and in the Y co-ordinates were selected. The Z field was used for different nutrients. The korasagu-4 micro-watershed shape file was also opened and from the surface menu of Arc

GIS spatial analyst "Interpolate grid option" was selected, on the output " Grid specification dialogue" output grid extend chosen was same as Korasagu-4 micro-watershed shape and the interpolation method employed. The generated map was reclassified based on ratings of respective nutrients.

Results and Discussion

In the study area its soil fertility status with respect to texture, pH, EC, organic carbon, primary nutrients, secondary nutrients and micronutrients such as Zn, Fe, Cu, Mn and B was assessed. The results obtained are presented and discussed below.

Texture of surface soils

Surface soil texture of Korasagu-4 micro-watershed was mainly covered with sandy clay loam to clay texture (Fig. 3). Sandy loam texture was observed in 95 ha (9.68%) and clay texture in 521 ha (53.16%) of the micro-watershed. The variation in surface soil texture may be due to variations in parent materials, topography, weathering and translocation of clay. It affects absorption of nutrients, microbial activities, infiltration and retention of water, soil aeration, tillage and irrigation practices (Gupta, 2004).

Soil reaction (pH) and Electric conductivity (EC)

The soil reaction status (Fig. 4) of the study area indicated that 51 ha (5.23%) was slightly acidic (5.0-5.5), 119 ha (12.8%) neutral, 63 ha (8.39%) was slightly alkaline and 311 ha (31.71%) was strongly alkaline (8.4 - 9.0) in nature. The variations in soil pH were due to the parent material, rainfall and topography (Tangaswamy *et al.,* 2005). The high pH of the soil was due the presence of high degree of base saturation (Meena *et al.,* 2006). Relatively high pH value in soil was due the accumulation of exchangeable bases in the solum. The soils were acidic due to the acidic parent material (Granite and gneiss). Therefore, periodically agricultural lime incorporation is imperative for improvement of soil pH. The Electric conductivity ranged from 0.05 to 2.15 ds m^{-1} indicating soils of non saline in nature and could be attributed to leaching of soluble salts and runoff transportation due to high precipitation (Singh and Mishra, 2012).

Soil organic carbon, available nitrogen, phosphorus and potassium

High level of soil organic carbon status was observed in major area (192 ha). About 533 ha (56.39%) was medium and 177 ha (18.06%) was low in soil organic carbon status (Fig. 5). The medium to high organic carbon status in soil attributed to good vegetative growth and consequent addition of organic matter to soil (Patil and Ananth Narayana, 1990). Low organic carbon in the soil was due to low input of FYM and crop residues (Binita *et al.,* 2009). The available nitrogen status (Fig. 5) of micro watershed was low in 719 ha (73.37%) and was medium in 209 ha (21.28%). The variation of nitrogen content was related soil management, application of FYM and fertilizer to previous crop (Ashok, 2000). Low nitrogen was due to low organic matter content in this soil.

The available phosphorus status was medium in entire micro watershed area (Fig. 6) and it was ranged from 20.38 to 66.87 kg ha^{-1} with a mean value of 39.07 kg ha^{-1} (Table 1). This may be attributed to the semi arid environment with low rainfall and the continuous use of high analysis phosphatic fertilizers especially SSP (Nalina *et al.,* 2016). The available potassium (K_2O) content was low to high in status (Fig. 6). It was ranged from 108.33 to 723.88 kg ha^{-1} with a mean value of 377.62 kg ha^{-1} (Table 1). The low to high status of potassium in surface soil is due to intense weathering and the release of potassium from organic residues. Similar results were reported by Basavaraj *et al.,* (2005).

Exchangeable calcium, magnesium and available sulphur

The exchangeable calcium and magnesium were sufficient in the entire study area (Fig. 7) was due to the type and amount of clay. These results were in confirmation of the findings of Krishnamurthy (1993) reported the highest values of exchangeable calcium and magnesium in surface and sub surface soil. The available sulphur status was high in 379 ha (38.62%). The high content of organic carbon couple with fine textured soils in the study area contributed to higher sulphur content and 548 ha (55.89%) area was medium in sulphur content (Fig. 8). The higher availability of sulphur is due to the negative charge of the clay which shows anionic repulsion to sulphate anion (Seta *et al.,* 2017)

DTPA extractable micronutrients and available boron

Present investigation results indicated that entire micro watershed area (980.84 ha) was sufficient in DTPA extractable micronutrients like copper (Fig. 9), iron (Fig. 9) and manganese (Fig. 10), while the available zinc (Fig. 10) was sufficient in 96 ha (9.80%), deficient in 832 ha (84.85%) area. The available boron content was ranged from low to medium and it was ranged from 0.15-1.43 mg kg^{-1} with a mean value of 0.64 mg kg^{-1} (Fig. 11, Table 1).

The DTPA extractable iron content in micro watershed was sufficient. This might be due to the granite gneiss parent material which was known to possess higher iron content. It was ranged from 2.26 to 38.62 mg kg^{-1}. The DTPA extractable zinc content showed both sufficient and deficient. The zinc deficient was attributed to the alkaline soil condition which might occur due to high precipitation of hydroxides and carbonates (Thanga swamy *et al*., 2005). The DTPA extractable manganese content in entire study area was sufficient. This may be attributed to its higher content in granite gneiss parent material. The DTPA extactable copper in the study area ranged from 0.57- 4.85 mg kg^{-1}. The sufficiency of copper in study area was related to its parent material. Majority of surface soils of the micro watershed, the boron content was low to medium. Like sulphur states, available boron status also closely followed the organic carbon in these soils.

Correlation co-efficient(r) between soil organic carbon and soil available nutrients

The soil organic carbon showed positive and significant correlation with available nitrogen (r=0.304**).The significant and positive correlation between organic carbon and available nitrogen could be because of release of mineralizable nitrogen from soil organic matter in proportionate amounts and adsorption of NH_4 –N by humus complexes in soil. The results are in conformity with those of Kumar *et al.,* (2014). The significant and positive correlation between organic carbon and available phosphorus (r=0.265**) might be due to acidulating effect of organic carbon, formation of easily accessible organophosphate complexes, release of phosphorus from organic complexes and reduction in phosphorus fixation by humus due to formation of coatings on iron and aluminium oxides. The results are in harmony with the findings of Singh *et al.,* (2014). A significant positive correlation (r = 0.311**) was observed between organic carbon and available K content (Table 2). This might be due to creation of favourable soil environment with presence of organic matter. Similar relationship was also reported by Chauhan (2001). Significant positive correlation was also found between available potassium and clay content. It might be due to the presence of most of the mica (biotite and muscovite) in finer fractions. A positive correlation (r = 0.515**) was observed between organic carbon and available sulphur content. This relationship was existed because most of the sulphur is associated with organic matter (Nor, 1981). Available Zn was positive and significantly correlated (r = 0.1**) with organic carbon (Table 2). Similar result was obtained by Minakshi *et al.*, (2005) in soils of Patiala district of Punjab.

Table.1 Chemical properties and nutrient status of Korasagu-4 micro-watershed

Parameters	Range	Mean
Soil pH (1:2.5)	5.02 - 8.95	7.60
EC (ds m^{-1})	0.05 - 2.15	0.31
Soil organic carbon(g kg^{-1})	1.5 – 10.8	6.02
Available nitrogen (Kg ha^{-1})	8.78 - 420.22	235.70
Available phosphorus (Kg ha^{-1})	20.38 - 66.87	39.07
Available Potassium (Kg ha^{-1})	108.33 - 723.88	377.62
Exchangeable calcium (Cmol p+ kg^{-1})	4.50 - 29.5	15.64
Exchangeable Magnesium (Cmol p+ kg^{-1})	2.0 - 22.25	10.03
Available Sulphur (mg kg^{-1})	7.68 - 44.18	21.17
Fe (mg kg^{-1})	2.26 - 38.62	12.76
Zn (mg kg^{-1})	0.24 - 0.88	0.47
Cu (mg kg^{-1})	0.57 - 4.85	1.78
Mn (mg kg^{-1})	0.98 - 28.84	7.85
B (mg kg^{-1})	0.15 - 1.43	0.64

Table.2 Correlation study for soil organic carbon with available macro and micronutrients

Parameters	Organic carbon
Organic carbon	-
Available N	0.304**
Available P2O5	0.265**
Available K2O	0.311**
Exchangeble Ca	0.374**
Exchangeble Mg	0.525**
Available S	0.515**
DTPA Zn	0.239*
DTPA Fe	0.261*
DTPA Mn	-0.453**
DTPA Cu	-0.431**
Available B	-0.250*

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level

Fig.1 Location map of Korasagu-4 micro watershed

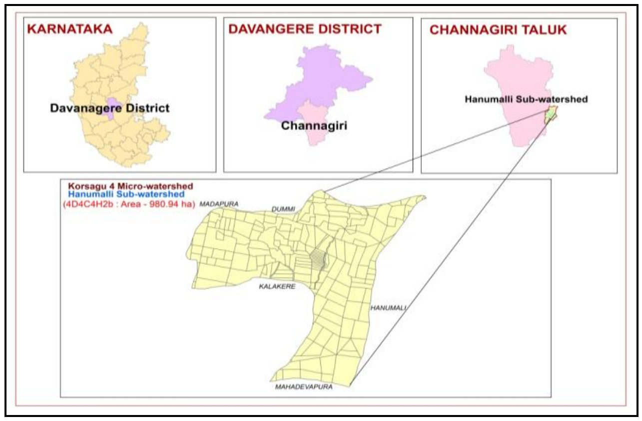


Fig.2 Grid map of Korasagu-4 micro watershed

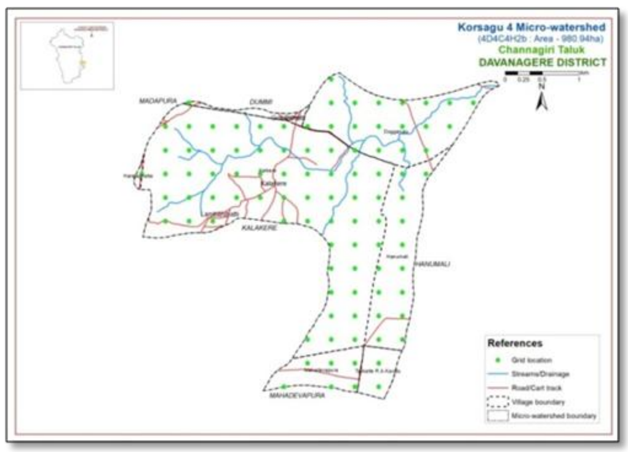


Fig.3 Soil surface texture map of Korasagu-4 micro watershed

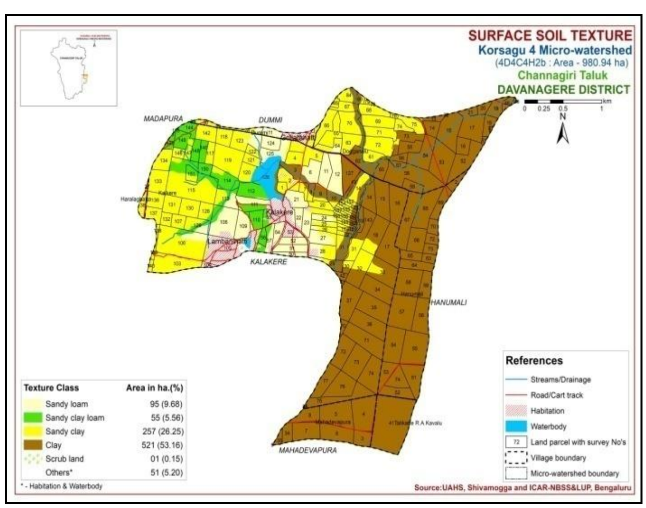


Fig.4 Soil reaction and Electrical conductivity map of Korasagu-4 micro watershed

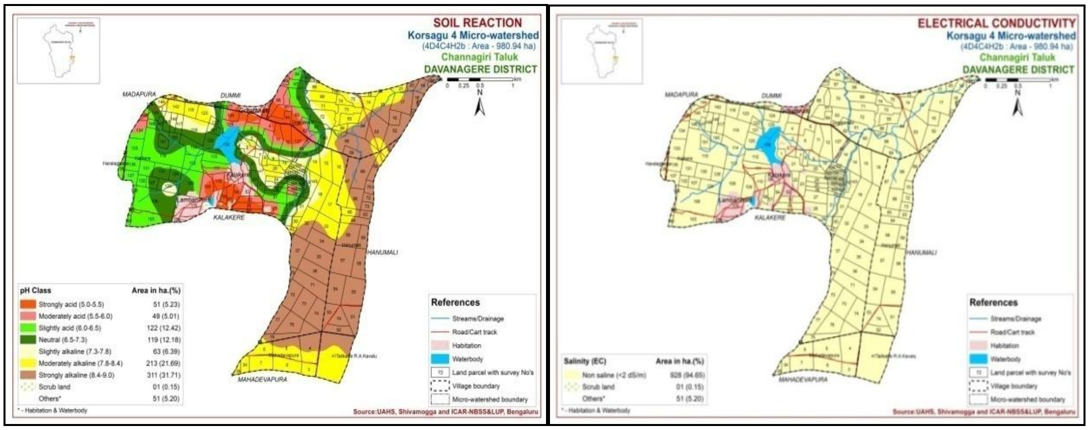


Fig.5 Soil organic carbon and available nitrogen map of Korasagu-4 micro watershed

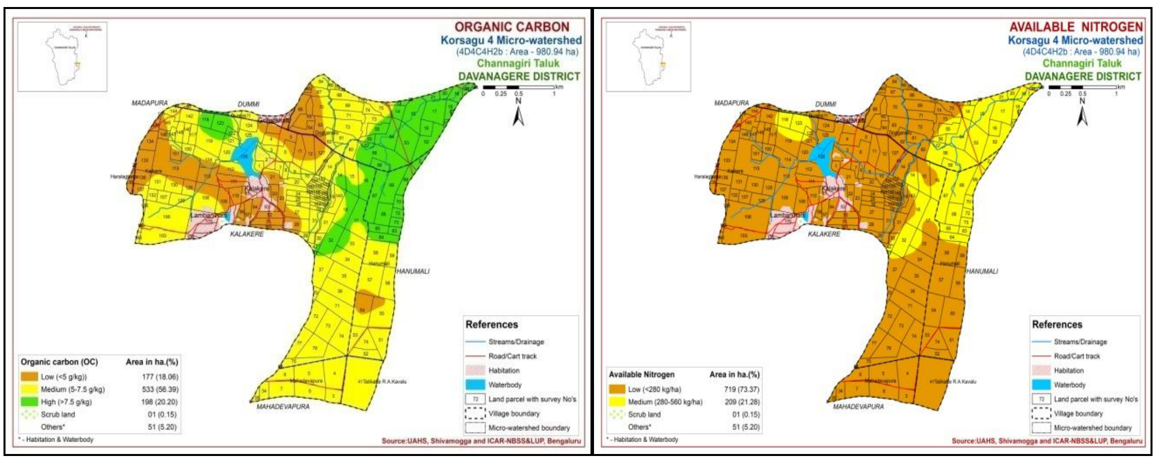


Fig.6 Available phosphorus and available potassium map of Korasagu-4 micro watershed

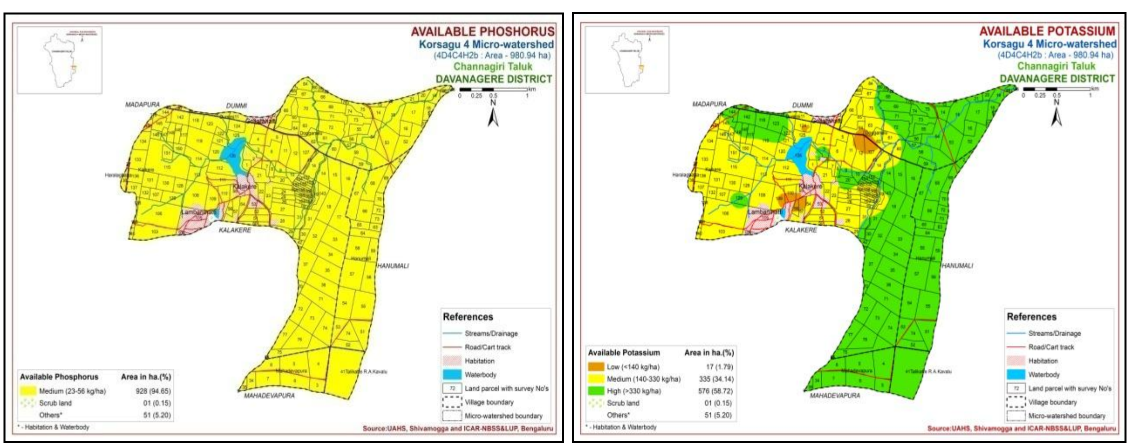


Fig.7 Exchangeable calcium and magnesium map of Korasagu-4 micro watershed

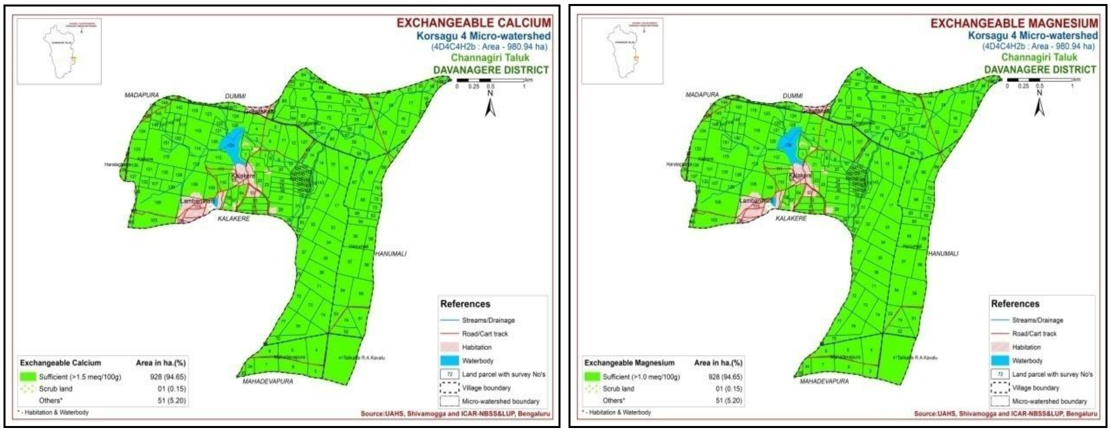


Fig.8 Available sulphur map of Korasagu-4 micro watershed

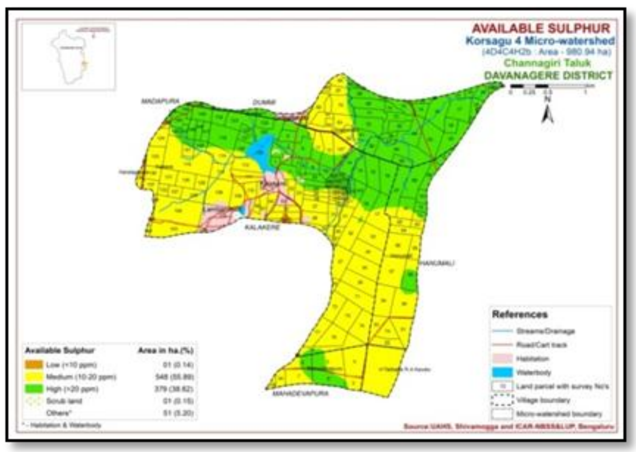


Fig.9 Available copper and iron map of Korasagu-4 micro watershed

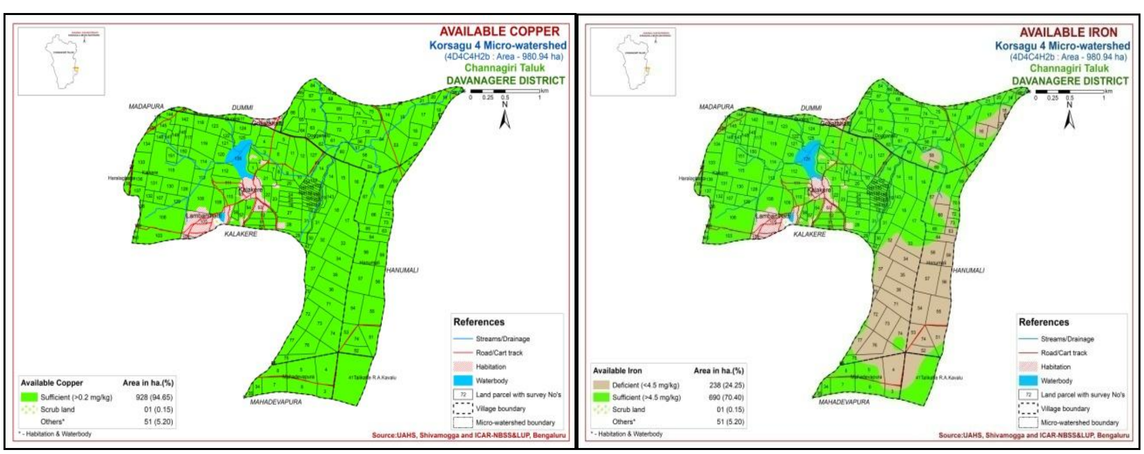


Fig.10 Available manganese and zinc status of Korasagu-4 micro watershed

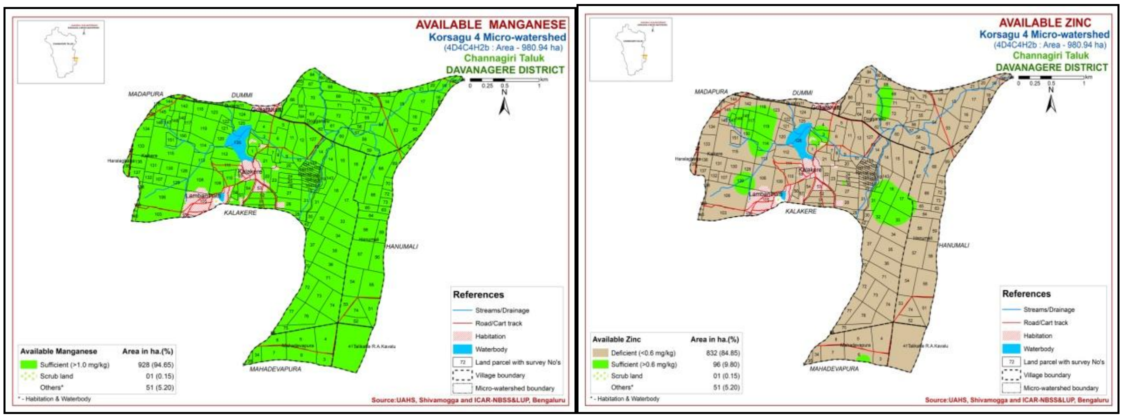
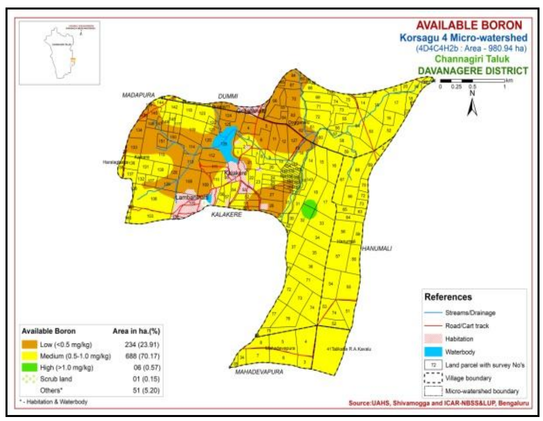


Fig.11 Available Boron status of Korasagu-4 micro watershed



A significant positive correlation (r = 0.261**) was found between organic carbon and available Fe content (Table 2). The availability of metal ion (Fe) increase with increases in organic matter may supply chelating agents (Yadav and Meena, 2009). The increase in availability of sulphur by organic carbon may be attributed to release of sulphur from organic complexes as well as acidulating action of soil organic carbon thus enhancing the weathering of minerals containing sulphur. Similar results were reported by Pareek (2007). The significant and positive correlation between soil organic carbon and available iron content might be due increases in organic matter may supply chelating agents. Yadav and Meena (2009) but soil organic carbon showed negative and significant correlation with available manganese (r=-0.453**), Copper (r=-0.431**) and Boron (r=-0.250*). It shows with increase in organic carbon availability Mn, Cu and Born decreases (Table 2).

In short it can be concluded that soils under study area was strongly acidic to slightly alkaline in soil reaction with non saline in nature and soil organic carbon was 5 -18 g kg^{-1}. The DTPA extractable micro nutrients like iron, copper and manganese were found to be sufficient in entire study area. Whereas zinc was found to be sufficient in 96 ha (9.8%) and deficient in 832 ha (84.85%) and boron content was found to be low to medium. The study highlights the importance of mapping the parameters which give the spatial extent rather than the means which have limited applicability for better soil management and precise management of nutrients.

Acknowledgement

Authors are thankful to World Bank for funding this project under KWDP II, SUJALA III WDD Government of Karnataka, Bengaluru.

References

Ashok, K. S., 2000, Studies on soils aggregation in vertisols of north Karnataka. M.Sc. (Agri.) Thesis, Univ. Agril. Sci., Dharwad Karnataka (India)

Basavaraj., Naidu, D., Ramavatharam, M. V. S., Venkaih, N., Rama Rao, K. G. and Reddy, K. S, 2005. Characterization, classification and evaluation of soils in Chandragiri mandal of Chittoor district, Andhra Pradesh. Agroped., 15: 55– 62.

Binita, N.K., G.S. Dasog and P.L. Patil. 2009. Soil fertility mapping in ghataprabha left bank canal command area of north Karnataka by geographic information system technique. Karnataka J. Agric. Sci., 2 (1): 73-76

Black, C.A. (Ed.), 1965, Methods of soil analysis, part I and II. American society of Agronomy, Inc., Publishers, Medison, wisconsin, USA.

Burrough, P.A., and McDonnell, R. A. (1998). Principle of geographic information systems. Oxford: Oxford University Press.

Chauhan J.S., 2001. Fertility status of soils of Birla Panchayat Samiti of Jodhpur district (Rajasthan). M.Sc. (Ag.) Thesis, MPUAT, Udaipur.

Gupta, P.K. (2004): Soil, plant, water and fertilizer analysis. Shyam Printing Press, Agrobios, India, 38p.

Jackson, ML. 1973. Soil Chemical Analysis. Second edition. Printice Hall of India, New Delhi. 498.

John, M. K., Chuah, H. H., and Neufield, J. H. 1975. Application of improved azomethine-H method to the determination of boron in soils and plants: Analytical Left. 8, 559-568.

Krishnamurthy, K G., 1993, Properties, genesis and classification of red soil o f North Karnataka. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad (India).

Kumar, A, Mishra VN, Srivastav LK, Banwasi R. Evaluation of soil fertility status of available major nutrients (N, P and K) and micronutrients (Fe, Mn, Cu and Zn) in vertisols of Kabeerdham district of Chhattisgrah, India. *Inter. J. Interdisc. Multidisci. Studies.* 2014; 1(2): 72-79.

Lindsay, W. L., and Norvell, W. A. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of American Journal*, *42*, 421 – 428.

Medhe, S. R., V. G. Takankhar and A. N. Salve. Correlation of chemical properties, secondary nutrients and micronutrient anions from the soils of Chakur Tahisil of Latur district, Maharashtra. Trends in life science, 2012,1(2):34-40

Meena, H. B., Sharma, R. S. and Rawat, R. S., 2006, Status of Macro and Micronutrients in some soils of Tonk district of Rajasthan. J. Indian Soc. Soil Sci., 54(4): 508- 512.

Minakshi, N.S., Tur, V.K., Nayyar, P.K. Sharma and Sood, A.K. (2005). Spatial distribution of micronutrient in soils of Patiala district – A GIS Approach. J. Indian Soc. Soil Sci., 53(3): 324-329.

Nalina, C. N., Anil Kumar, K. S., Chandrakala, M., Sheela Rani, S., Sujata, K., Shilpa Shree, K. G., Rajendra Hegde and Sing, S. K. 2016, Soil nutrient status mapping of

Nagenahalli micro-watershed under Eastern Dry Zone of Karnataka by remote sensing, detailed soil survey and GIS techniques. Indian J.Agric.Res., 50(5): 389-397.

Nor, Y.M. 1981. Sulphur mineralization and adsorption in soils. Pl. Soil, 60: 451-459.

Patil, P. L and Ananthanarayana, R., 1990, Determination of lime requirement of some acid soils of Uttara kannada district, Karnataka J. Agric. Sci., 3:161-170

Pareek, N. Soil mineralisable sulphur a sulphur availability index. J. Ind. Soc. Soil Sci. 2007; 3: 289- 293.

Singh, R. P. and Mishra, S. K., 2012, Available macro nutrients (N, P, K and S) in the soils of Chiraigaon block of district Varanasi (U.P) in relation to soil characteristics. Indian J. Sci. Res., 3(1): 11-21

Singh Nongmaithem Raju, Jhariya MK, Loushambam RS. Performance of soybean and soil properties under poplar based agroforestry system in Tarai belt of Uttarakhand, India. Ecology Environment and Conservation. 2014; 20(4):1569-1573.

Subbaiah, BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr. Sci. 1956; 25:259-260.

SLUSi, (2010). Annual Report 2009-2010. Soil and Land Use Survey of India. Kodigehalli Road, Bangalore, India.

Thangasamy, A., Naidu, M. V. S., Ramavatharam, N. and Reddy, R. C., 2005, Characterization, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. J. Indian Soc. Soil Sci., 53: 11–21.

Walkley, A.J., and Black, I.A. (1934). Estimation of soil organic carbon by the chromic acid titration method. *Soil Science, 37*, 29-38.

Yadav, R. L. and Meena, M. C. (2009). Available micronutrients status and relationship with soil properties of Degana soil series of Rajasthan. *Journal of the Indian Society of Soil Science.* 57(1): 90-92.

How to cite this article:

Gurumurthy, K.T., D. Ravikumar, A.V. Priyanka, Anantakumar Patil, M.D. Rudresh, K.M. Vasanthkumar, S. Raghavendra and Raghu, A. N. 2019. Appraisal and Mapping of Soil Fertility Status for Korasagu-4 Micro watershed, Channagiri Taluk, Davanagere District, Karnataka, India. *Int.J.Curr.Microbiol.App.Sci.* 8(05): 2339-2349.
doi: https://doi.org/10.20546/ijcmas.2019.805.276