Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 3741-3744
Received: 10-03-2019
Accepted: 12-04-2019

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Mapping of soil chemical properties and DTPA extractable micronutrients status of Lakya sub watershed of Dasarahalli-I micro-watershed in Chikmagalur taluk by using GIS technique

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Abstract
A study was undertaken to map the DTPA extractable micronutrients status of Dasarahalli-I micro-watershed in Chikmagalur taluk using GIS technique. Sixty surface soil samples (0-15cm) of Dasarahalli-I micro-watershed were collected and assessed for the soil chemical properties and DTPA extractable micronutrients status. The soils under the study were strongly acidic to slightly alkaline in soil reaction with non- saline in nature and soil organic carbon status was low to medium. The DTPA extractable micronutrients like iron, manganese and copper contents were found to be sufficient in the entire micro watershed area where as zinc content was found to be sufficient in 66 ha (6.61 %) and deficient in 3 ha (0.38 %) and boron content was found to be deficient in the entire micro watershed area. The study highlights the importance of mapping the soil parameters which gives the spatial extent rather than the means which have limited applicability for soil management.

Keywords: Micro-watershed, DTPA extractable nutrients, geographical information system, mapping

Introduction
The concept of watershed-based holistic development has emerged as one of the potential approaches in rainfed areas, which can lead to higher sustainable agricultural production. For regional planning and management, the micro-watersheds are the most functional units. The soil is the basis of agriculture as the productivity of the farm enterprise is strongly linked to the fertility status of the soil. The soil acts as a reservoir for the essential nutrients that crop need for growth. When these nutrients are in sufficient quantities and balance, agricultural productivity is greatly enhanced. On the other hand, if the nutrients are in short supply and imbalanced, crop growth is hampered. Consequently, with time, a soil that is considered fertile will also lose its fertility if no nutrients are added periodically. It is important to assess the fertility status of the soil before cropping and all necessary ameliorations effected in time to ensure a good harvest. Geographic information system (GIS) is a powerful tool which helps to integrate many types of spatial information such as agro-climatic zone, land use, soil management, etc. to derive useful information (Adornado and Yoshida 2008) [7].

Material & Methods
The study area was a Dasarahalli-I micro watershed located in Chickmagalur taluk, Chickmagalur district of Karnataka. The study area lies at latitude 12° 54′ 42″ to 13° 53′ 43″ N and longitude 75° 04′ 46″ to 76° 21′ 50″E. About 6.99 per cent of the study area is cultivable and rest of the area is under protected forest and forest grooves. The average rainfall in the study area was 600 mm. The survey of India toposheet (57 A/6) was used to prepare base maps covering Dasarahalli-I micro-watershed. The cadastral map having parcel boundaries with survey numbers were produced from KSRSAC, Bangalore were used for the study. The survey of India toposheet (57 A/6) with 1:50,000 scale was used along with the satellite imagery for updating the base map. Grid wise surface soil sample from 0 to 15 cm was collected at an interval of 320 m x 320 m in the micro-watershed with 1:7,920 scale. A total of 60 samples were collected from the fixed grid points. The processed samples were analyzed for chemical properties and DTPA extractable micro nutrients using standard procedure (Table 1).

Soil nutrient status mapping
Using the field survey and laboratory analysis results, the soil heterogeneity units were determined using remote sensing and GIS by using the guidelines of Soil Survey Staff (1999).

A *dbf* 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 Dasarahalli-I micro-watershed was created. The *dbf* file was opened in project window and in the X- field, X-coordinates were selected and in Y- field, Y-coordinates were selected. The Z-field was used for different nutrients. The Dasarahalli-I 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 Dasarahalli-I micro- watershed shape and the interpolation method employed was a spline. The generated maps were reclassified based on ratings of respective nutrients.

Results & Discussion

Soil reaction

The mapping of soil pH status (Fig. 1) by GIS technique indicated that 21 ha (2.21 %) of the study area was slightly acidic (5.5-6.0), 16 ha (1.06 %) was moderately acidic (6.5-7.3) and major portion of the study area was neutral in soil reaction (6.50-7.30). The variation in soil pH was related to the parent material, rainfall and topography (Thangaswamy *et al.*, 2005). The soils were acidic due to the acidic parent material (granite gneiss). The relatively low pH in red soils was mainly due to iron hydroxide species which contributed to higher H^+ concentration (Dasog and Patil, 2011).

Electrical conductivity

The electrical conductivity values were low (0.23 to 0.85 dS m^{-1}) indicating that the soils of the selected micro watershed were non-saline (Fig. 2). The normal electrical conductivity may be ascribed to leaching of salts to lower horizons (Singh *et al*., 2012).

Soil organic carbon

The study area of 3.23 per cent (32 ha) showed low organic carbon status, whereas medium organic carbon content was observed in 37 ha comprising 3.76 per cent (Fig. 3). The medium organic carbon status in the soil attributed to good vegetative growth and consequent addition of organic matter to soil (Patil and Ananthanarayana, 1990). Low organic carbon in the soil was due to low input of FYM and crop residues as well as the rapid rate of decomposition due to high temperature (Binita *et al.*, 2009).

DTPA extractable iron

The DTPA extractable iron content in the micro-watershed was found to be sufficient (Fig. 4). Generally available iron content was higher in red soil. This might be due to the granite gneiss parent material which is known to posses higher iron content (Rajkumar *et al.*, 1994) [6].

DTPA extractable manganese

The DTPA extractable manganese content of the study area was found to be sufficient (Fig.5). The higher available manganese content in soil was attributed to its higher content in granite gneiss parent material with semi-arid climate (Rajkumar *et al.*, 1994) [6].

DTPA extractable copper

The DTPA extractable copper was found to be sufficient in the entire study area (Fig. 6). Rajkumar *et al.* (1994) [6] reported that the overall higher copper content in the study area might be due to the parent material. Soils derived from granite gneiss showed higher copper content.

DTPA extractable zinc

DTPA extractable zinc content was found to be sufficient in 66 ha (6.61 %) and deficient in 3 ha (0.38 %) (Fig. 7) of the study area. Which was attributed to the alkaline soil condition and richness of $CaCO_3$ which might have precipitated zinc as hydroxides and carbonates, it reduced solubility and mobility of zinc and thereby decreased availability of zinc under alkaline soil conditions (Vijayshekar *et al*., 2000) [5].

Available boron

Available boron content was found to be deficient in the entire micro watershed area (Fig. 8). Generally which may be due to low organic carbon status in the micro watershed area.

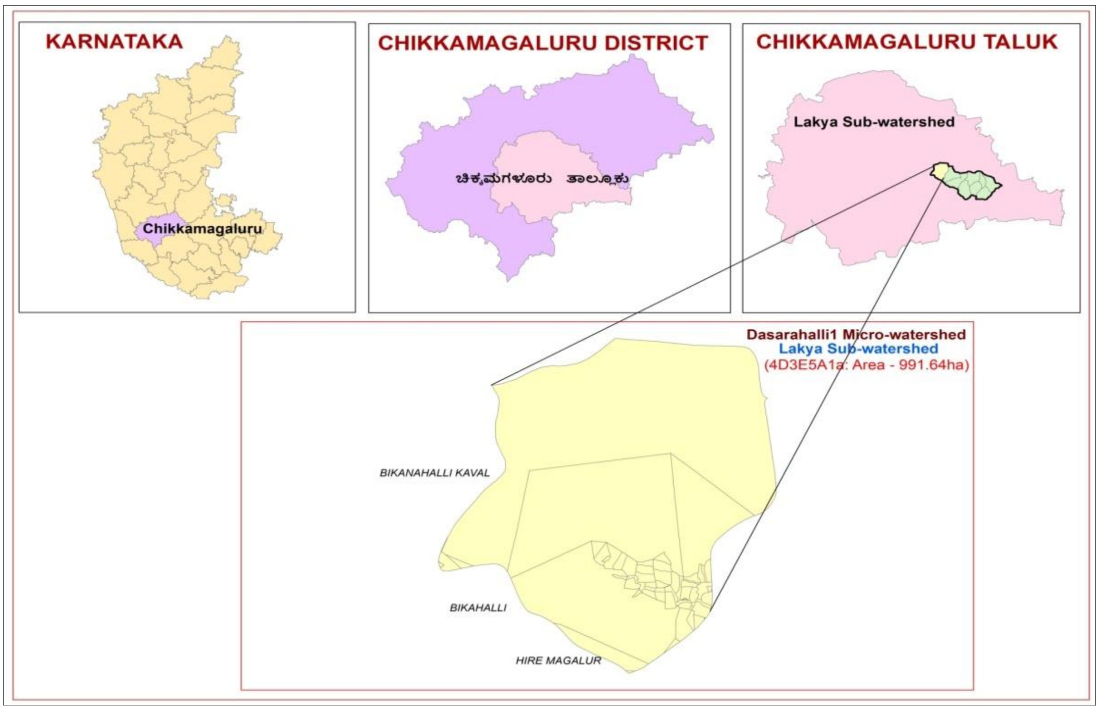

Plate 1: Location of Dasarahalli-I micro-watershed

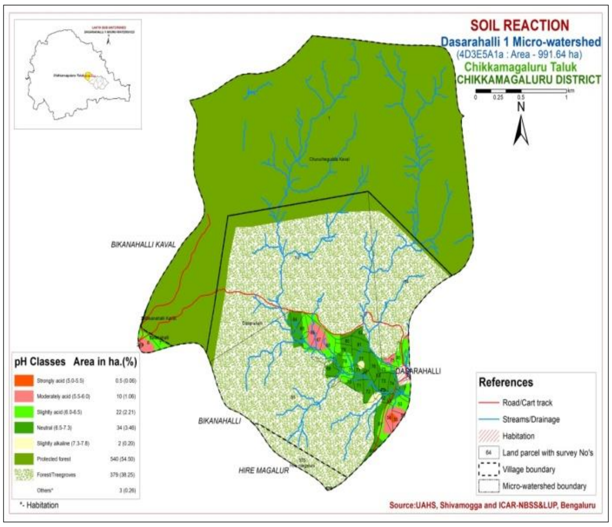

Fig 1: Soil pH status of Dasarahalli-I micro-watershed

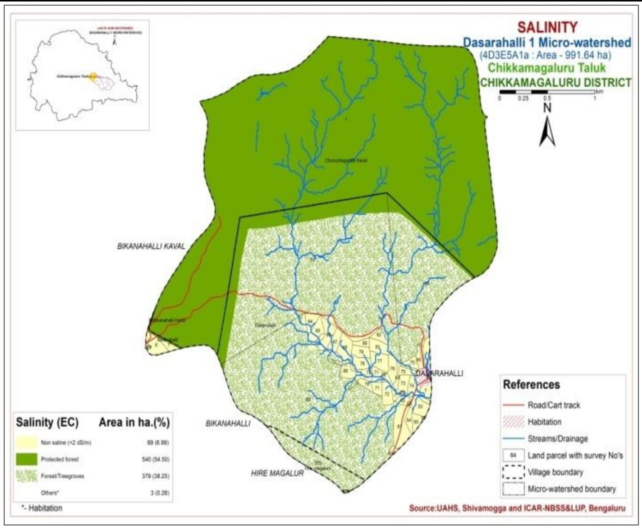

Fig 2: EC status of Dasarahalli-I micro-watershed

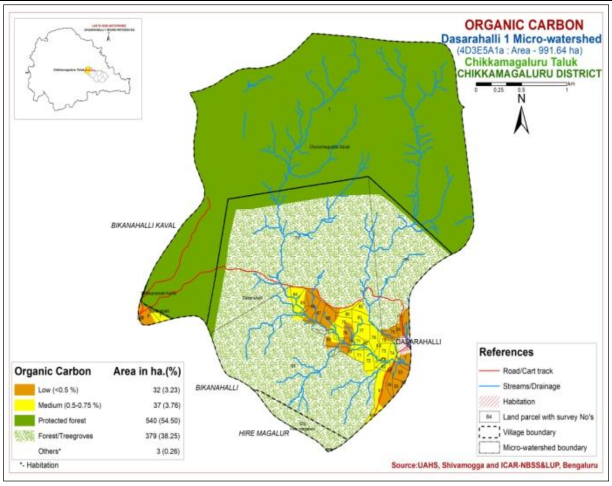

Fig. 3: Soil organic carbon status of Dasarahalli-I micro- watershed

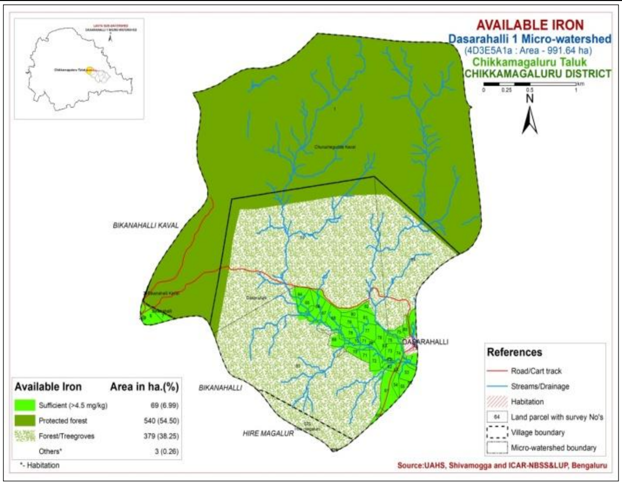

Fig 4: DTPA extractable iron status of Dasarahalli-I micro-watershed

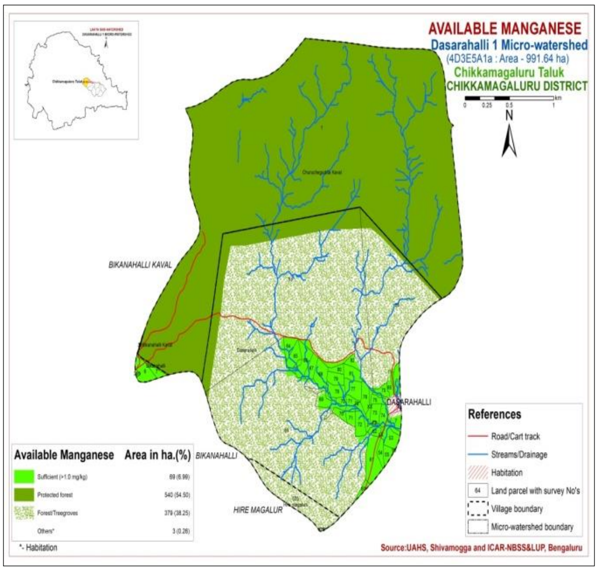

Fig 5: DTPA extactable manganese status of Dasarahalli-I micro-watershed

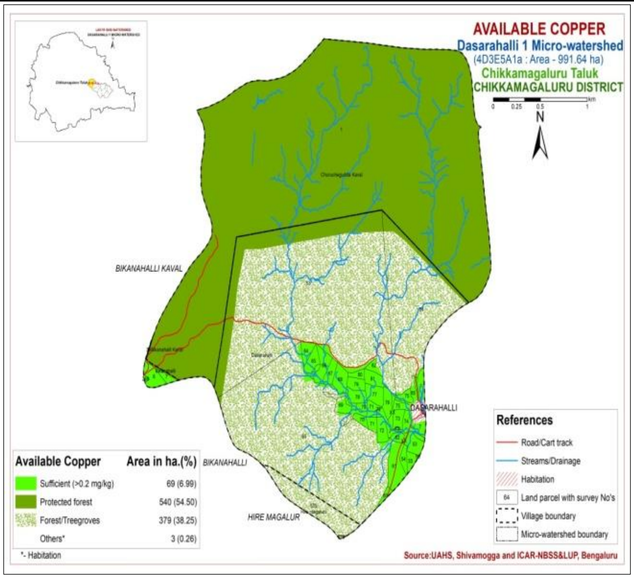

Fig 6: DTPA extractable copper status of Dasarahalli-I micro-watershed

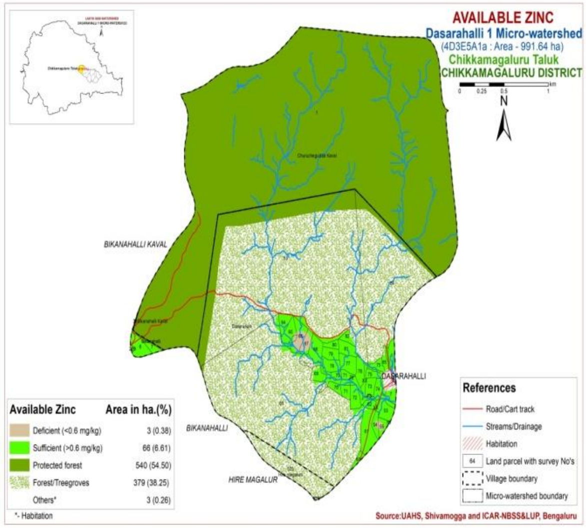

Fig 7: DTPA extactable zinc status of Dasarahalli-I micro-watershed

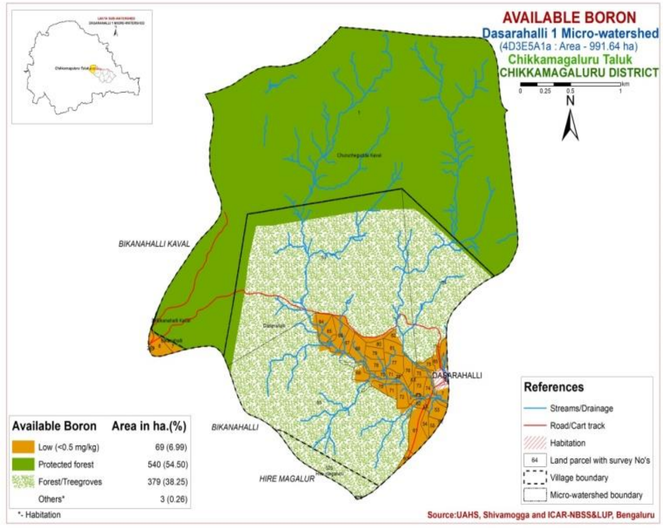

Fig 8: Available boron status of Dasarahalli-I micro-watershed

Table 1: Analytical methods used for estimation of soil properties

Soil parameters	Methods	Reference
Soil reaction	Potentiometry	Jackson (1973) [1]
Electrical conductivity	Conductometry	Jackson (1973) [1]
Organic carbon	Wet oxidation and titrimetry	Walkley and Black (1934) [4]
Available boron	Hot water extraction method	John *et al.* (1975) [2]
DTPA extractable micronutrients	AAS	Lindsay and Norvell (1978) [3]

Table 2: Chemical properties and major nutrient status in Hebbalagere micro-watershed

Parameters	Range	Mean
Soil pH	5.02 - 7.80	6.51
EC (dSm^{-1})	0.23-0.85	0.47
Soil organic carbon ($g\ kg^{-1}$)	3.30 - 7.50	5.27
Iron ($mg\ kg^{-1}$)	4.43-25.24	15.30
Manganese ($mg\ kg^{-1}$)	3.90-22.68	13.24
Copper ($mg\ kg^{-1}$)	1.14-5.76	2.07
Zinc ($mg\ kg^{-1}$)	0.39-1.45	0.81
Boron ($mg\ kg^{-1}$)	0.21-0.66	0.39

Conclusion

The soils under the study area were strongly acidic to slightly alkaline in soil reaction with non-saline in nature and the soil organic carbon was low to medium. The DTPA extractable micronutrients like iron, manganese and copper contents were found to be sufficient in the entire micro watershed area where as zinc content was found to be sufficient in 66 ha (6.61 %) and deficient in 3 ha (0.38 %) and boron content was found to be deficient in the entire micro watershed area. The study highlights the importance of mapping the soil parameters which give the spatial extent rather than the means which have limited applicability for better soil management and precise management of nutrients.

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