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Original Research Article

Available Zinc and Iron Status Mapping by GIS Technique in Asoti-4 Micro-Watershed of Gadag District (Karnataka)

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Keywords

ArcGIS software, GIS, Iron, Micro-nutrients mapping, Micro-watershed, Soil fertility status, Zinc

A B S T R A C T

A study was conducted to map available micro-nutrients zinc and iron status of soils of Asoti-4 micro-watershed in Ron *taluk* of Gadag district by GIS technique. The 44 composite soil samples were collected at 250 X 250m grid interval. The samples were analyzed for their micro-nutrients status and mapped using an ArcGIS software. The pH, EC and organic carbon were moderately alkaline to strong alkaline, non-saline and low to medium, respectively. Available micro-nutrients cations *viz*, Fe and Zn were sufficient. The soils Asoti-4 micro-watershed is fertile with available Zinc and Iron.

Introduction

Total geographical area of India is 328.7m ha which accounts 2.4 per cent of the world and stands at 7th position. With total arable land of 162m ha, India ranks 2nd next only to china. Contribution of agriculture to GDP in 1950-51 was 54.5 per cent and it progressively declined to 16 per cent in 2015 so there exists a wide scope to enhance agriculture sector contribution to nations productivity. Targeted rate of agriculture growth in India is 4 per cent but current growth rate is 1.4 per cent. Lower rate of agricultural growth is due to poor natural resource management and low soil fertility in addition to many other constraints. A publication by Das *et al.,* (2009) revealed that 120.82 m ha (36.5 per cent TGA) is degraded land and another 105.48 m ha is under various stages of desertification. Punjab, Andhra Pradesh, Tamil Nadu and Haryana are leading states in intensive fertilizer usage. But, Uttar Pradesh had the highest total fertilizer consumption. Decline in productivity is mainly due to land degradation and soil fertility and environmental constraints. So, improvement in soil and water productivity is need of the hour. This could be archived through modern scientific data capturing tools like remote sensing and GIS. Intensively cultivated soils are being mined for plant nutrients especially micronutrients.

Therefore, assessment of nutrient constraints of soils that are being intensively cultivated with high yielding crops need to be carried out. Some soils were deficient in micronutrients or may be sufficient due to mineralogy. Soil testing is usually followed by collecting composite soil samples in the fields without geographic reference. The results of such soil testing are not useful for site specific recommendations and subsequent monitoring and mapping. Soil available nutrients constraint assessment and subsequent mapping of an area using Global Position System (GPS) will help in formulating site specific balanced fertilizer recommendations and to understand the status of soil fertility spatially and temporally. Some studies on soil fertility status at representative micro-watershed have been carried out in Gadag district and is essential in planning soil fertility management at cadastral level. Keeping this in mind, detailed soil survey of the area was carried to assess micro-nutrients status of soils in Asoti-4 micro-watershed in Ron *taluk* of Gadag district (Karnataka) for sustainable land use planning Survey of India (SOI) topomaps and cadastral maps as basemaps.

Materials and Methods

Asoti-4 (4D7C4S2g) micro-watershed belongs to Asoti sub-watershed and situated at 45 km away from Gadag city (headquarters of the district), and located in Ron *taluk* in Karnataka. The microwatershed covers 267.04 ha area and located between 15^0 48’ 9.014” N to 15^0 49’ 26.003” N latitude, 75^0 35’ 23.398” E to 75^0 36’ 28.813” E longitude and mean elevation ranged from 441.5 to 541.5 m above MSL. The location map is depicted in Fig 1. The micro-watershed has flat terrain. The climate is semiarid with mean annual temperature of 25 ºC. Average soil temperature ranged from 28 ºC to 32 ºC (more than 22ºC). So, Isohyperthermic temperature regime and Ustic moisture regime prevailed. The area receivs a mean annual rainfall of 671 mm. Basalt, schist, granite, gneiss rocks lead to development of deep black soils. The expanding smectitic of clay minerals were predominant. The soils belonged to Vertisols and Inceptisols of US taxonomical orders. The False Colour Composite (FCC) of IRS P6 LISS IV satellite image (Fig 2), cadastral map and SOI toposheet (Fig 3) is used for physical traversing of micro-watershed to collect the grid samples. The soil samples (0-20 cm depth) were collected at 250 X 250m grid interval. The exact grid location was recorded using a GPS meter. Soil samples were shade dried, processed and prepared for chemical analysis. Available micronutrient cations were interpreted as deficient or sufficient. Available boron was interpreted as low, medium or high. The cadastral base map was geo-referenced, vectorized and created shape files using Arc GIS 10.3 software. Through geostatistical wizard and geoprocessing tools grid points and analytical data was mapped by krigging tools. Area is classified based on analytical results and suitable legends were given with standard colour code as per NBSS & LUP.

Results and Discussion

The data pertaining to micro-nutrients status of Asoti-4 micro-watershed are presented in Table 1 to 3 and Figures 4 to 5. Surface soil pH values ranged from 8.17 to 8.84. The mean and standard deviation were 8.57 and 0.196, respectively. Predominantly, the soils were moderate to strongly alkaline in reaction Fig 4a. Out of total area (267.04 ha) 233 ha (87.35 per cent) was strongly alkaline and 31 ha (11.59 per cent) moderately alkaline in reaction. The pH increased due to moderate to high free $CaCO_3$ and high CEC and base saturation.

Low rainfall (less than 600 mm annual rainfall) and semi-arid climatic condition do not favour base leaching, therefore, it is logical that these soils are alkaline in reaction. Similar results were obtained by Nadaf *et al.,* (2015) in sugarcane growing Vertisols of northern transition zone of Karnataka. Additionally, Meena *et al.,* (2006) made same observations while studying soils of north Karnataka. The EC values of the surface grid samples ranged from 0.14 to 0.88 dS m^{-1}. The mean and standard deviation values were 0.32 and 0.16 dS m^{-1}, respectively. Most part of the area was non-saline as depicted in the Fig 4b. Out of total area (267.04ha), 252 ha (94.4 per cent) showed non-saline and 12 ha (4.54 per cent) showed slightly saline. The EC values were low due to leaching of soluble salts by irrigation.

Table.1 Descriptive statistical parameters of soil chemical properties

Statistical parameters	pH (1:2.5)	EC (1:2,5, dS/m)	OC (g/kg)
Mean	8.57	0.32	6.28
Range	8.17-8.84	0.14-0.88	2.0-8.4
SD	0.196	0.16	1.69

Note: Statistics of 44 surface soil samples

Table.2 Soil micronutrient Zn and Fe status

Statistical parameters	Available micronutrients ($mgkg^{-1}$)	
	Zn	**Fe**
Mean	0.90	6.19
Range	0.6-1.1	2.5-10.4
SD.	0.12	1.91

Note: Statistics of 44 surface soil samples

Table.3 Area under different status of micro-nutrients availability

Property	**Status**	**Area (ha)**	**Per cent of total area**
pH	Moderate alkaline	31	12
	Strongly alkaline	233	87
EC	Non saline	252	94
	Slightly saline	12	05
OC	Low	15	06
	Medium	247	93
	High	02	00
Zn	Sufficient	264	100
Fe	Sufficient	241	90
	Deficient	23	09

Fig.1 Location of Asoti-4 micro-watershed in Ron *taluk* of Gadag district, Karnataka state

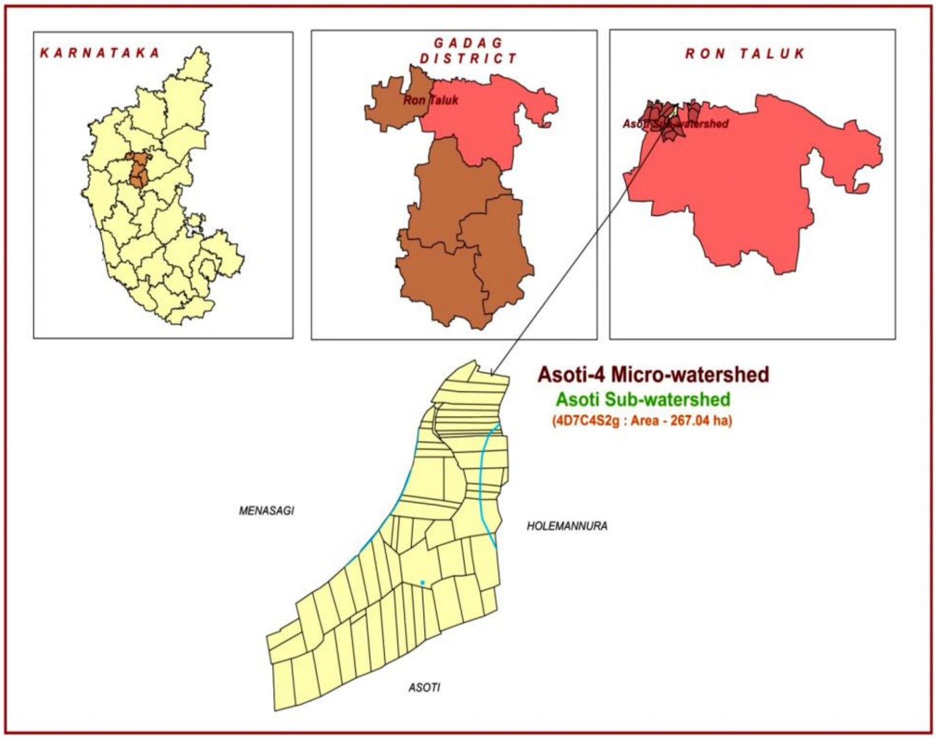


Fig.2 The IRS-P6-LISS IV satellite image

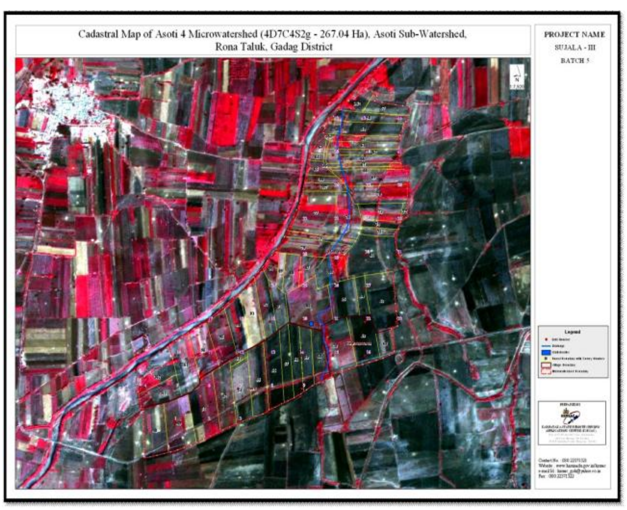


Fig.3 Cadastral base map

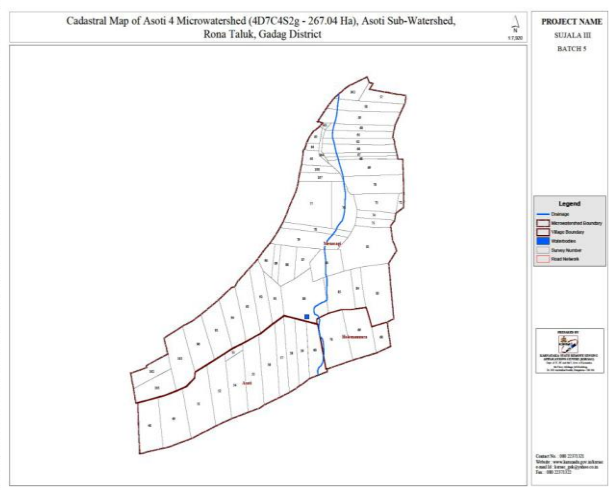
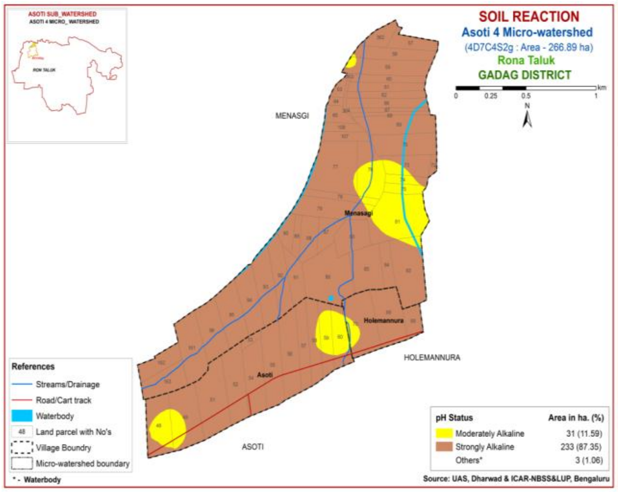


Fig.4 Soil chemical status map of Asoti-4 micro-watershed



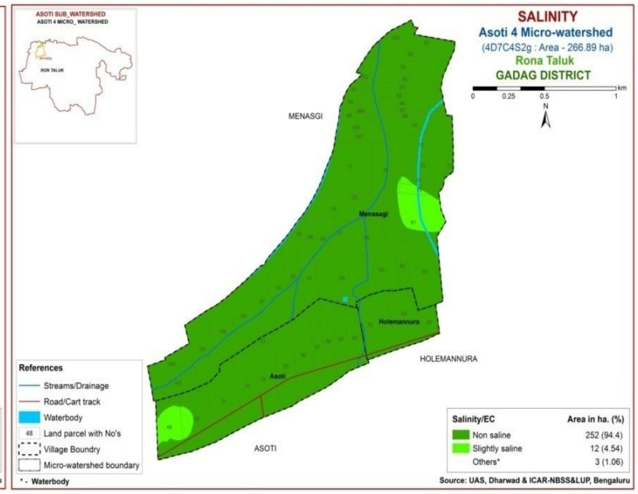


Fig.4a Soil reaction status map

Fig.4b Soil salinity status map

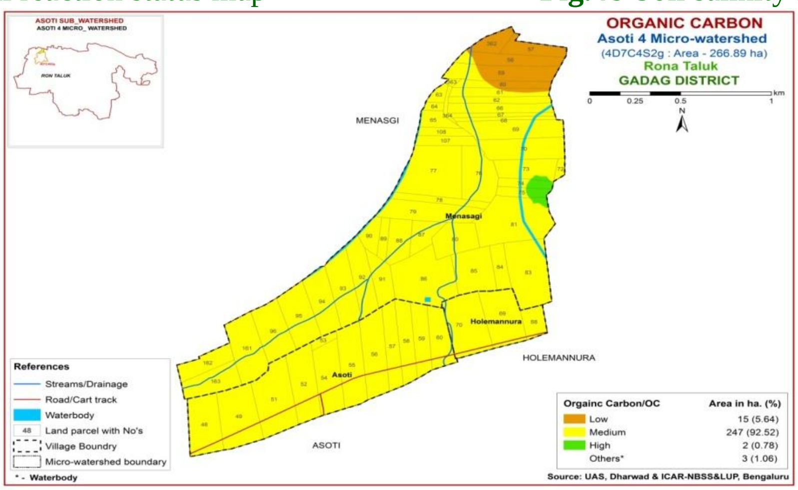
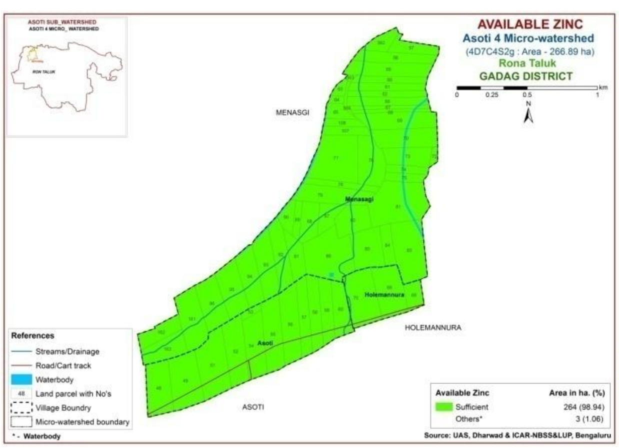


Fig.4c Soil organic carbon status map

Fig.5 Available micronutrient Zn and Fe status



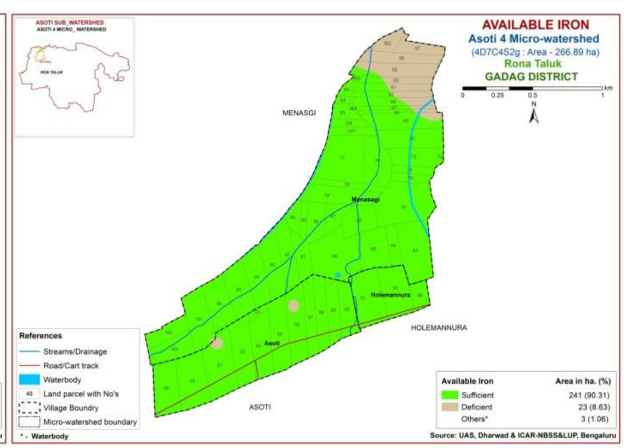


Fig.5a Available zinc

Fig.5b Available Iron

The similar interpretations were made by Devi *et al.,* (2015) through their study in Chittoor district in Andhra Pradesh. The soil organic carbon content ranged from 2 to 8.4 g kg^{-1}. The mean and standard deviation values were 6.28 and 1.69 g kg^{-1}, respectively. Out of 267.04 ha area, 247 ha (92.52 per cent), 15 ha (5.64 per cent) and 2 ha (0.78 per cent) had medium, low and high status, respectively. The micro-watershed area was predominantly medium in organic carbon status (Fig 4c). However, in some areas of the micro-watershed organic carbon was the main land productivity constraint because available nitrogen remained low. The lower soil organic matter content was attributed to lack of addition of recommended dose organic manures. Similar observations were made by Singh and Rathore (2015) and Basanta *et al.,* (2013) in Aravali mountain ranges and Medak district of Andhra Pradesh, respectively.

The Zn and Fe were sufficient in micro-watershed (Fig. 5). Although, the area was predominantly under calcareous black soils, micronutrient status was sufficient due to medium organic matter status and abundant occurrence of micronutrient bearing minerals (hematite, magnetite, hornblende, pyroxene, olivine, etc.,). The similar studies were made by Basanta *et al.,* (2013) in Medak district of Andhra Pradesh. The organic carbon has potential to supply micronutrients. The available zinc content ranged from 0.6 to 1.1 mg kg^{-1}. Mean and standard deviation values were 0.9 and 0.12 mg kg^{-1}, respectively. The soils of the area were sufficient in iron. The available iron content ranged from 2.5 mg kg^{-1} to 10.4 mg kg^{-1}. The mean and standard deviation values were 6.19 mg kg^{-1} and 1.91 mg kg^{-1}, respectively. Medium level of SOC and presence of iron bearing minerals made soils rich in available iron. Soils of Asoti-4 micro-watershed were moderate to strongly alkaline in reaction, non-saline, low to medium in organic carbon. Predominantly soils of Asoti-4 micro-watershed are sufficient in available Zinc and Iron.

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