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Fertility assessment of soils of Duglapura-1 micro watershed under Chikkamagaluru district, Karnataka

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Abstract
An assessment on fertility status was carried out on the soils of Duglapura-1 micro watershed during year 2020-21. Sixty one surface soil samples (0-15 cm) were collected at 320 m X 320 m grid intervals for its fertility status and mapped using ArcGIS software. The soils were low in available nitrogen content (74.86%). Available phosphorus was medium (72.39%). The micro-watershed was medium (72.10%) to high (2.76%) in available potassium and medium (11.88%) to high (62.98%) in available sulphur status. Secondary micro-nutrients *viz.*, calcium and magnesium were sufficient in the entire micro-watershed area. Micronutrients *viz.*, Fe, Cu and Mn were sufficient, whereas Zn was deficient (16.22%) in the Duglapura-1 micro watershed area.

Keywords: Duglapura-1, micro-watershed, fertility, micronutrients and mapping

Introduction
Soil is a vital natural resource and its proper use decides the life supporting system of a country and the socio-economic development of its people. Soils provide food, fodder and fuel for meeting the basic needs of human beings and animals. With the growth of population, demand for food production is on the increase. However, the capacity of the soil to produce is limited. The production is limited mainly by intrinsic characteristics, agro-ecological settings and its management. It is very important for developing an effective land use system for augmenting agricultural production on sustainable basis.

Rain fed agriculture productivity is crucial for food security; Karnataka state has the second largest rain fed area in India after the state of Rajasthan. Crop yields in rain fed areas range from 1 to 1.5 t ha^{-1} which is 2 to 5 times less than those on research farms. Only 35 to 45 percent of rain water is presently used to grow dry land crops in the state. Hence, there is a huge scope for improving rainwater harvesting and efficient use of it for rain fed crops. Scientific technologies including soil and water conservation, crop suitability and irritability could unlock the vast potential of rain fed agriculture.

There was an increasing resistance towards the large river valley development projects and it was often being made out that watershed management on the lines of what is called "Wisdom of the Centuries" is the answer to all our irrigation water management and food security problem. In the recent past, concept of watershed based holistic development has emerged as one of the potential approaches in rain fed areas, which can lead to higher productivity and sustainability in agricultural production. Recent advances in science have led to the development of techniques capable of rapidly and effectively mapping out areas under threat of degradation. These techniques include Remote Sensing and Geographical Information Systems (RS & GIS).

Hence, a detailed study for characterization and evaluation of soils is needed to realize the concept of watershed approach. From the data collected at the land parcel level, the site specific problems and potentials can be identified, conservation measures required can be planned on a scientific basis, suitability of the area for various uses can be worked out and finally viable and sustainable land use options suitable for each and every land parcel can be suggested to the farmer and other stakeholders of the area.

Material and Methods
The study area belongs to the "Southern Transition Zone" of Karnataka, which is having a semi-arid climate with a mean annual average rainfall of 600 mm.

The study area of Duglapura-1 micro watershed belongs to Chikkamagaluru district with a total area of 732.41 ha. The elevation of the area ranges from 769 to 807 m above MSL in the gently sloping uplands. The direction of drainage lines was towards the west to east facing with very gently sloping (1-3%) to sloping lands.

Geologically Chikkamagaluru district is under Dharwar schist and peninsular gneisses. The detailed soil survey of the land resources of the Duglapura mini-watershed of the Duglapura sub-watershed was carried out at 1:7,920 scale using the LISS-IV image and cadastral map as base maps. The survey was carried out by the standard soil survey procedures as described in the soil survey manual (Anon., 1971) [1]. Surface soil samples were collected by adopting grid techniques (320 x 320 m interval in the mini-watershed area) at 0-20 cm depth. Using GPS grid points were identified and a total of 61 were collected from Duglapura-1 micro-watershed.

The collected soil samples were analyzed for fertility status (available nitrogen, phosphorus, potassium, sulphur and secondary micro-nutrients, DTPA-extractable micro-nutrients content). These data obtained from laboratory analysis were mapped using ArcGIS software.

Result and Discussion

The entire Duglapura-1 micro-watershed was low (74.86%) in available nitrogen status and it varied between 87.81 to 272.42 kg ha^{-1} with an average of 195.22 kg ha^{-1} and standard deviation of 69.24 (Table 1) (Fig. 1). Except Habitation, water body and forest overall area under low to medium in available nitrogen. The lower soil organic matter content in this area because of faster decomposition and consequent removal of organic matter coupled with lesser nitrogen fertilization might be the reason for nitrogen deficiency (Pramod and Patil, 2015) [9]. Similar findings were reported by Ashok, 2001. The available nitrogen (N) was low to medium in the soils of tatrakallu village of Andhra Pradesh (Sashikala *et al.*, 2019) [14] and Basavapura Watershed of Tarikere taluk, Karnataka (Jahnavi, 2020) [5].

The Duglapura-1 micro-watershed area was medium (72.39%) in available phosphorus content and it was ranging from 11.45 to 53.34 kg ha^{-1} with a mean value of 32.08 kg ha^{-1} and standard deviation of 14.05 (Table 1) (Fig. 2). This is mainly due to clay content along with CEC and phosphorus fixing capacity of the soils might be the reason behind the medium range of available phosphorus content (Rajshekhar, 2018) [11]. In general Black soils have higher phosphorus content than red soils.

The available potassium content of soils of Duglapura-1 micro-watershed varied between 143.97 to 456.83 kg ha^{-1} with an average of 241.27 kg ha^{-1} and standard deviation 99.33. About 529 ha (72.10%) of the area of soils were found to be medium and 20 ha (2.76%) was low in available potassium in the soils of the Duglapura-1 micro-watershed (Fig. 3). The predominance to potassium rich micaceous and feldspar minerals led to higher Available Potassium content in black soil compares to red soils (Ravikumar, 2006) [12]. Higher potassium content was noticed in soils this could be due to application of K fertilizers, release of labile K from organic residues, more intense weathering and translocation of potassium from lower depths in upward direction along with capillary raise of ground water. The results of current investigation were in line with the findings of Rajeshwar and Mani (2013) [10].

The available sulphur status of the Duglapura-1 micro-watershed soil was medium in 88 ha (11.88%) and high in 461 ha (62.98%) and it was ranging from 9.65 to 42.13 mg kg^{-1} with the mean value of 25.36 mg kg^{-1} and standard deviation of 8.97 (Table 1) (Fig. 4). The high amount of organic carbon coupled with fine textured soils in the study area contributed to higher sulphur content. A similar observation was made by Seth *et al.* (2017) [15] in the soils of Kumachahalli micro-watershed. Black soils of part of Duglapura mini- watershed available sulphur content in the investigation area ranged from low to medium. This was mainly because of high pH, lack of sulphur addition, continuous removal of sulphur by crops and also might be due to gypsum ferrous nature of sulphur in black soil which is unavailable (Badrinath *et al.*, 1986) [2].

The Duglapura-1 micro-watershed area soil was found to contain sufficient amount of exchangeable calcium and magnesium content. It was ranging from 1.5 to 22 and 0.5 to 13.75 cmol (p^+) kg^{-1} with a mean value of 10.45 and 5.91 cmol (p^+) kg^{-1}, respectively and standard deviation of 5.18 and 3.07 respectively (Fig. 5 and 6). The sufficiency of exchangeable calcium and magnesium in the study area might be due to type and amount of clay present. These results were in confirmation with the findings of Harshitha (2018) [4] and Rajshekhar (2018) [11].

Table 1 revealed that the available zinc status of the Duglapura-1 micro-watershed soil was ranging between 0.27 to 1.00 mg kg^{-1} with average and standard deviation of 0.65 mg kg^{-1} and 0.21, respectively. The available zinc content was sufficient in 429 ha (58.64%) area and deficient in 120 ha (16.22%) area of the Duglapura-1 micro-watershed (Fig. 7). The deficiency of the Zn was found in red soils, which may be due to low organic carbon values. The alkaline condition of soil might be the reason behind the deficiency of zinc in the study area. (Thangasamy *et al.*, 2005) [16]. The available zinc was deficient in the soils samples might be due to the soils were having lower organic carbon values (Jahnavi, 2020) [5].

About 74.86 percent area of the Duglapura-1 micro-watershed area soil is sufficient in available iron content (Table 1) and a variation of 4.47 to 36.16 mg kg^{-1} with an average of 19.99 mg kg^{-1} and standard deviation of 10.76 was observed (Fig. 8). This might be due to the granite gneiss parent material, which was known to possess higher iron content. These results were in conformity with the finding of Ravikumar *et al.* (2009) [13] and Denis and Patil (2014) [3].

The available manganese status of Duglapura-1 micro-watershed recorded an average 15.98 mg kg^{-1} and standard deviation of 7.99 with the variation 3.11 to 31.93 mg kg^{-1}, (Table 1). Majority of the micro-watershed area was sufficient for available manganese (74.86%) (Fig. 9). Sufficient content of manganese due to high organic matter content. The higher DTPA extractable manganese content in the mini-watershed area was attributed to its higher content in granite gneiss parent material. The sufficient content of manganese due to high organic matter content was observed in the Upper Krishna of command area by Yeresheemi (1996) [17]. Similar findings were reported by Kuligod *et al.* (2000) [7] and Krishna *et al.* (2017) [6].

Duglapura-1 micro-watershed area soils were found to be sufficient in available copper (74.86%) (Table 1) and it was ranging from 0.27 to 3.99 mg kg^{-1} and standard deviation of 0.83 (Fig. 10). The sufficiency of copper in the study area was related to its parent material *i.e.*, granite gneiss containing higher copper content. Similar results were observed by Ravikumar (2006) [12] and Harshitha *et al.* (2018) [4]. The

major portion of the investigation area was under sufficient rating for available Cu status. Results of the current investigation were in line with the findings of Kumarnaik *et al.* (2020) [8].

Table 1: Fertility status of surface soils of Duglpaura-1 micro watershed Chikkamagaluru District, Karnataka

Soil property	Range	Mean	SD
Available N (kg ha^{-1})	87.81-272.42	195.22	69.24
Available P_2O_5 (kg ha^{-1})	11.45-53.34	32.08	14.05
Available K_2O (kg ha^{-1})	143.97-456.83	241.27	99.33
Exchangeable Ca (cmol (p^+) kg^{-1})	1.5 -22.0	10.45	5.18
Exchangeable Mg (cmol (p^+) kg^{-1})	0.5-13.75	5.91	3.07
Available S (mg kg^{-1})	9.65-42.13	25.36	8.97
Available Zn (mg kg^{-1})	0.27-1.00	0.65	0.21
Available Fe (mg kg^{-1})	4.47-36.16	19.99	10.76
Available Mn (mg kg^{-1})	3.11-31.93	15.98	7.99
Available Cu (mg kg^{-1})	0.27-3.99	2.55	0.83

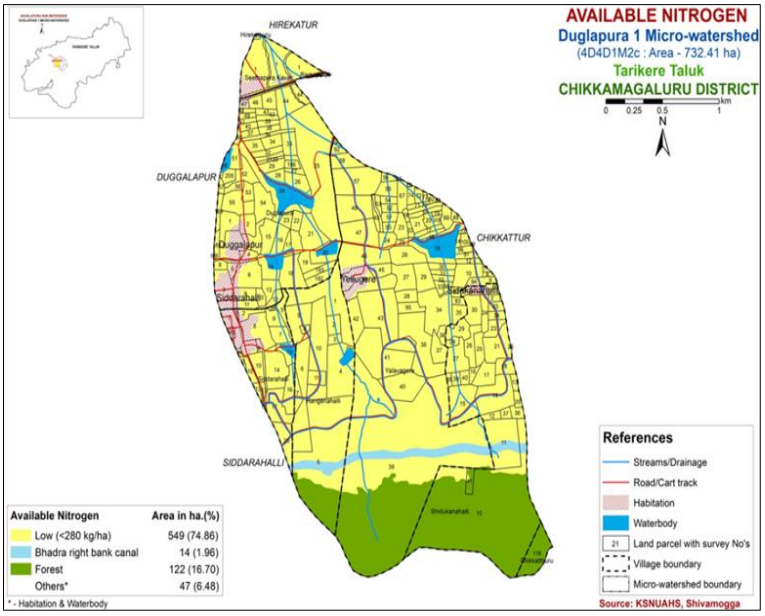

Fig 1: Available Nitrogen status of Duglapura-1 micro watershed

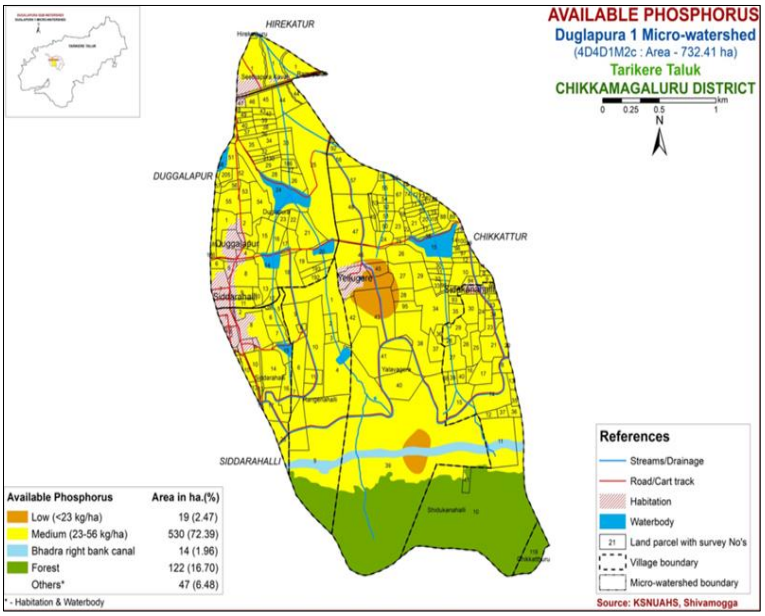

Fig 2: Available Phosphorus status of Duglapura-1 micro watershed

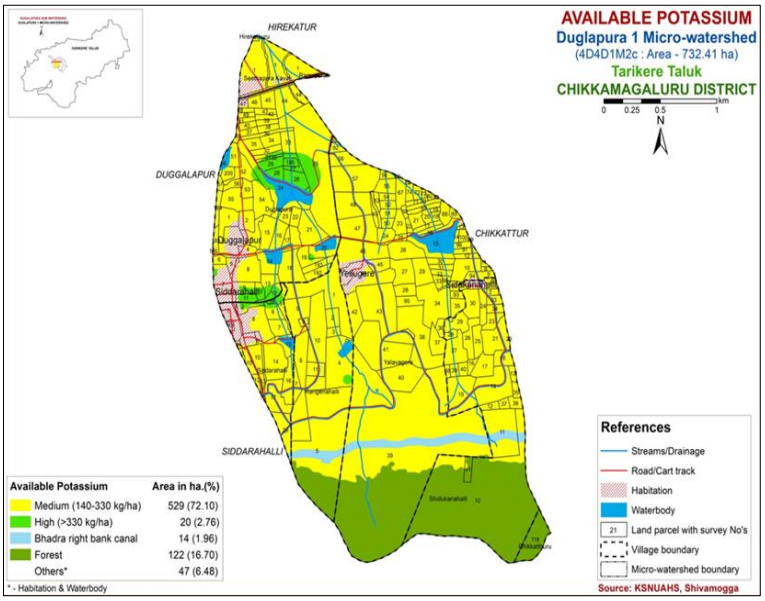

Fig 3: Available Potassium status of Duglapura-1 micro watershed

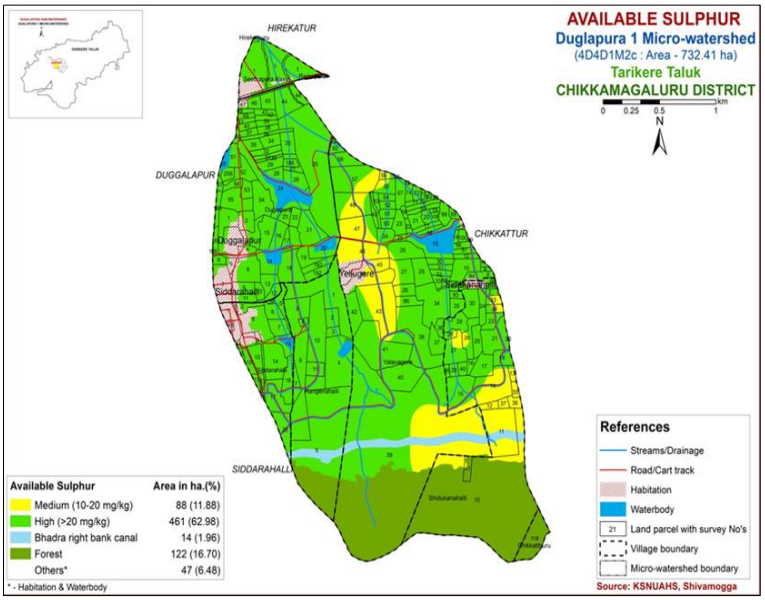

Fig 4: Available Sulphur status of Duglapura-1 micro watershed

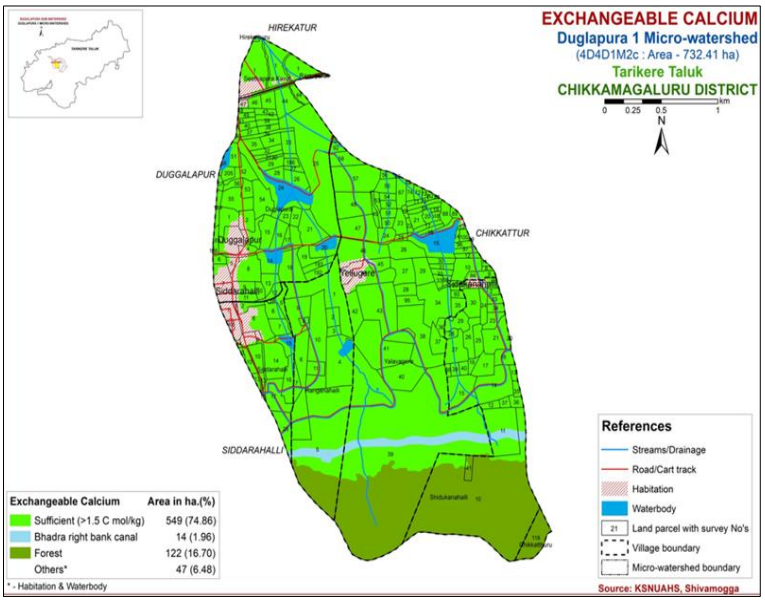

Fig 5: Exchangeable Calcium status of Duglapura-1 micro watershed

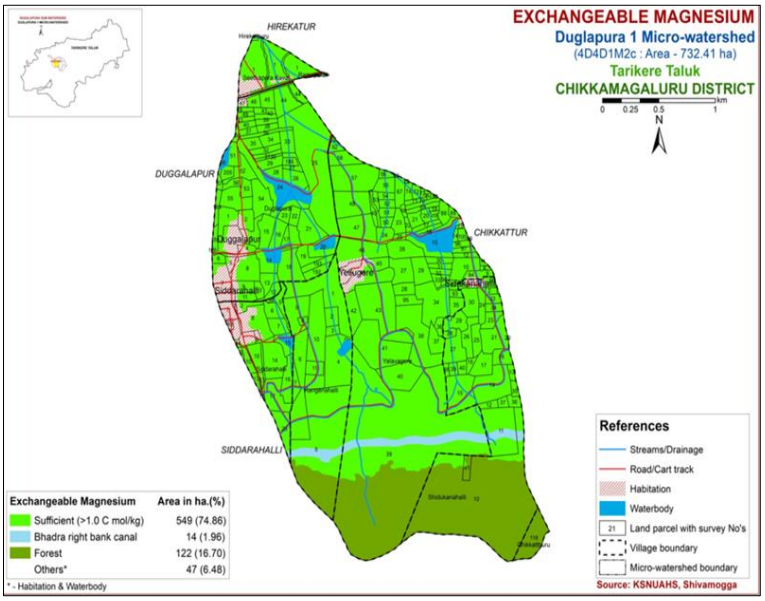

Fig 6: Exchangeable Magnesium status of Duglapura-1 micro watershed

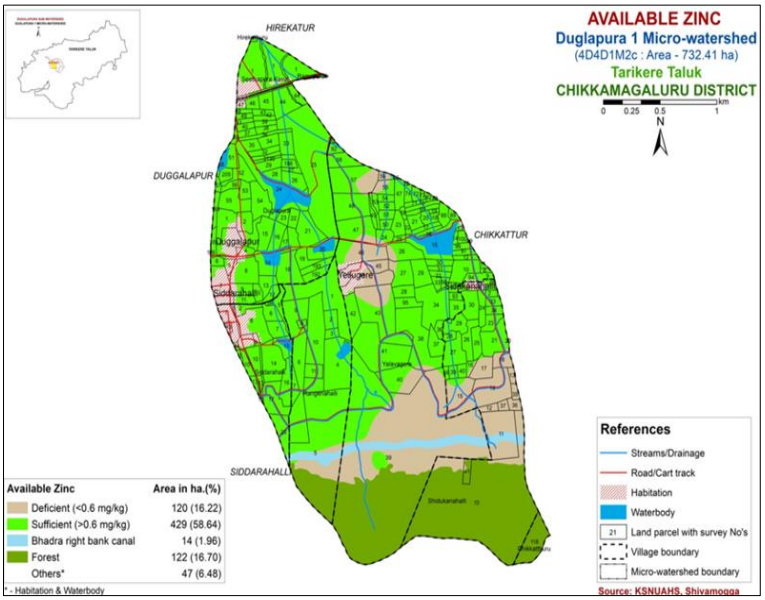

Fig 7: Available Zinc status of Duglapura-1 micro watershed

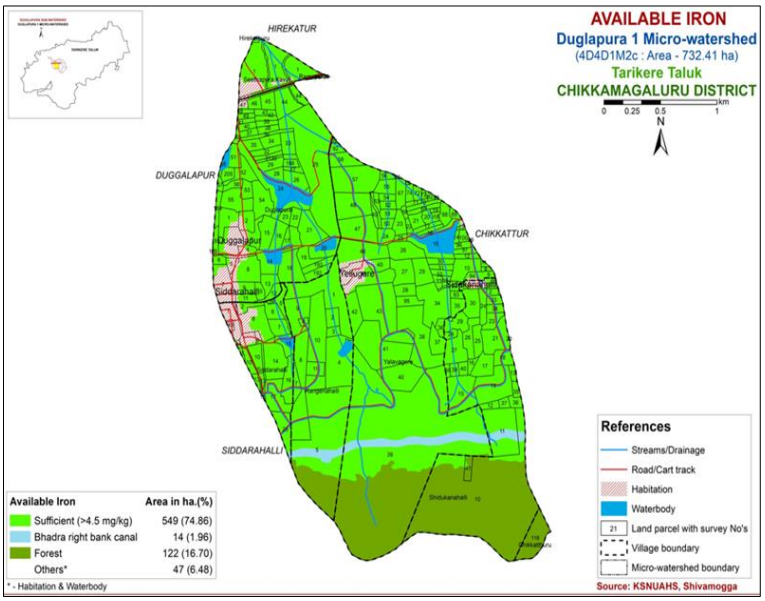

Fig 8: Available Iron status of Duglapura-1 micro watershed

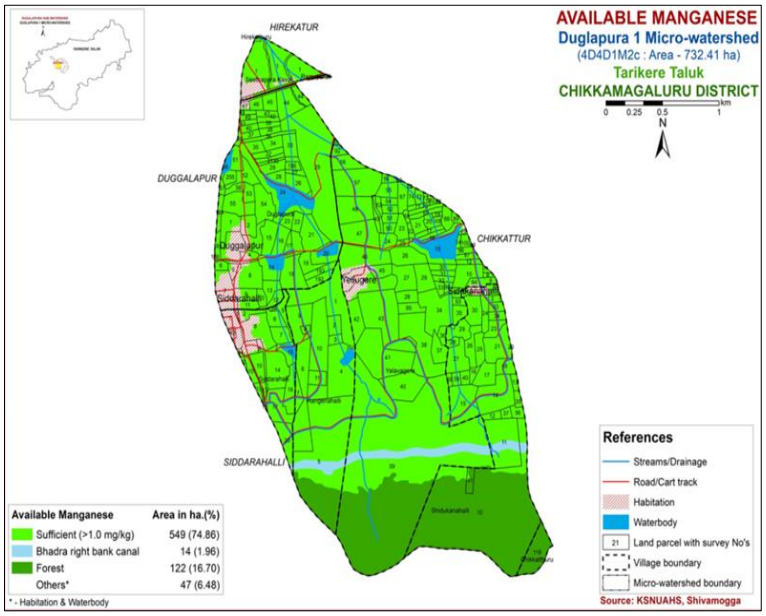

Fig 9: Available Manganese status of Duglapura-1 micro watershed

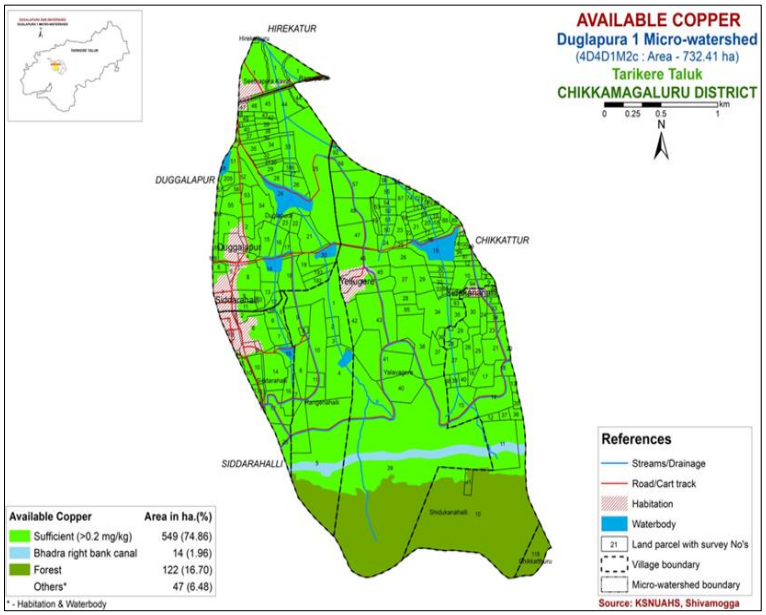

Fig 10: Available Copper status of Duglapura-1 micro watershed

Conclusion

The fertility status of Duglapura-1 micro-watershed revealed that the soils were low in available nitrogen content (74.86%). Available phosphorus was medium (72.39%). The micro-watershed was medium (72.10%) to high (2.76%) in available potassium and medium (11.88%) to high (62.98%) in available sulphur status. Secondary micro-nutrients *viz.*, calcium and magnesium were sufficient in the entire micro-watershed area. Micronutrients *viz.*, Fe, Cu and Mn were sufficient, whereas Zn was deficient (16.22%) in the Duglapura-1 micro watershed area.

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