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MAPPING AND RECLAMATION OF WASTELANDS IN CHAMARAJANAGARA TALUK, SOUTHERN TIP OF KARNATAKA, INDIA USING GEOINFORMATICS TECHNIQUE

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KEYWORDS: Mapping; Reclamation; Wastelands; Chamarajanagara; Geoinformatics.

ABSTRACT
Land and water are the most valuable natural resources which has importance in human's daily life. Mapping and demarcation of wastelands was carried out in Chamarajanagara taluk, Karnataka, using geoinformatic techniques for proper maintenance in future use. The present aim is to map and reclaim the wasteland categories available in the study area for several implementation programs. Efforts have been made to evaluate these categories through Visual Image Interpretation Techniques (VIIT) on IRS-1C PAN+LISS-III in False Color Composite (FCC) and updated using Google Earth Image. Various litho units such as gneisses, charnockite, two-pyroxene granulite, amphibolite, migmatites and hornbled schists of Archean age were mapped. Geomorphological landforms were represented by denudational hills, residual hills, pediment, pediplain moderate, pediplain shallow weathered and valley; while each type of soils were also mapped. The final output highlights the demarcation and reclamation strategies of the study area for its sustainability using geoinformatics techniques.

INTRODUCTION
The satellites imageries were most utilized in mapping of several land features using GIS technique (Basavarajappa and Dinakar., 2005). The Remote sensing technology with the field work provides an edge to characterize the geomorphic aspects (Dinakar., 2005). The present study was undertaken to investigate different wasteland categories in Chamarajanagar taluk using Remote Sensing and conventional data (Basavarajappa et al., 2016a). The district does not have any major river flowing, however it is drained by Suvarnavathi and Chikkahole, which were the tributaries of Cauvery River (CGWB., 2008). Forest covers were identified on the imagery based on red colour due to high chlorophyll content and measuring an area of 270 Km2 (Pushpavathi., 2009). Rock exposures/ stony waste observed based on their texture. Evergreen forests were noticed in the eastern parts of the hill ranges (Satish., 2003; Dinakar., 2005; Meenakshi.,). The taluk enjoys the semiarid climate from the India meteorological observatory data (CGWB., 2008). The study area is divided into 2 physiographic regions firstly, the Eastern portion forms hilly terrain with lofty mountains rising up to 1621mts above MSL and secondly, the Western portion forms a plain country with an average elevation of 686mts which includes Kollegal Shear Zone (KSZ) adjacent to Dharwar Craton and Sargur Supracrustals which separates the Southern Granulite Terrain and Dharwar Super Group of Southern Peninsular India (Basavarajappa, 1992; Srikantappa et al., 1992; Basavarajappa and Srikantappa., 1997; 1998; Srikantappa and Basavarajappa., 1997;Basavarajappa et al., 2009). Hoeschele (2003) designed the term wasteland as "rehabilitate wastelands", as is a policy goal in India today in the country's effort to increase food security.

STUDY AREA
It lies in between 11040' to 12010' N latitude and 77011' E longitude to 76043' with a total extent of 1,222 Km2 (Fig.1). The average annual rainfall is 799.3 mm recorded from 9 available rain gauge stations in the study area (CGWB., 2008). Mean temperature ranges from 16.40C to 340C. The main crops like Sugarcane, Maize, Ragi, Paddy, Jowar, vegetables, coconuts, neam, tamarind, mango jack were noticed (Pushpavathi., 2009). Trees like Teak, Honne, Rosewood, Eucalyptus were observed in other parts of the study area. Coffee and cardamom were common in the hilly regions. Silkworm rearing and sericulture industry is quite common in the villages of the study area (Satish., 2003; Basavarajappa et al., 2008; Agriculture census, 2009).

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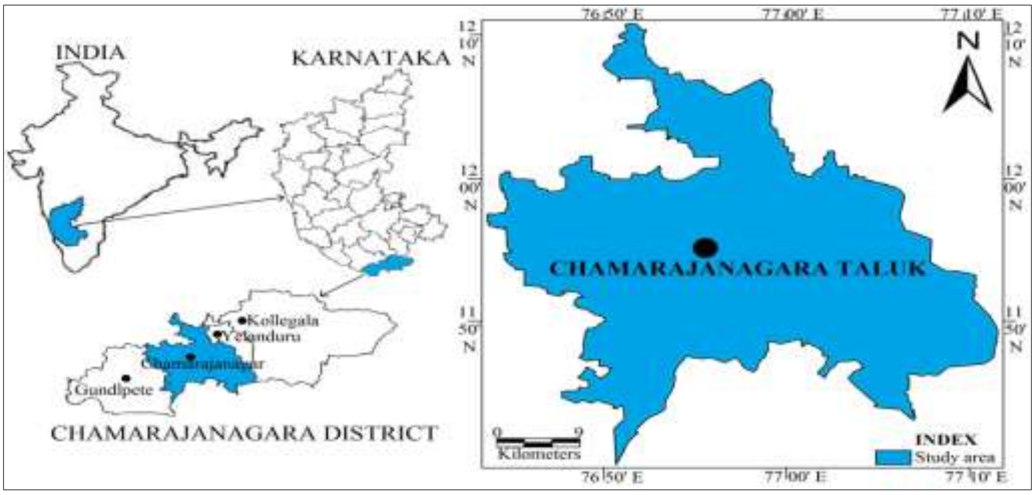

Fig.1. Location map of the study area

METHODOLOGY

Geological and Geomorphological maps were prepared by Visual Image Interpretation Technique (VIIT) on PAN merged IRS-1C LISS-III FCCs (Geocoded) of 5.8m resolution based on the image interpretation elements like tone, texture, pattern, association, etc., and verified during the field visits. The thematic details thus finalized were transferred to the base maps prepared from Survey of India toposheets (Basavarajappa et al., 2016b).

a. Base map: Survey of India (SoI) toposheet no's 57D/16, 58A/9, 13, 14, 58E/2 of 1:50,000 scale (year: 1978-2002) had used as a base map in geo-referencing the Satellite images using certain GCP points (Fig.2).
Source: Survey of India, Bengaluru.
b. Satellite Image: IRS-1C, LISS-III of 23.5 m resolution with band 3,2,1 and acquired in Nov 2008/09 & PAN of 5.8m resolution acquired in Nov 2005-06 (Fig.3); Google Earth Image of >1m resolution which acquired in 6th March 2011 (Fig.4).
Source: ISRO-NRSC, Hyderabad.
c. Software's: Arc GIS v10 and Erdas Imagine v2013.
d. GPS: Garmin-12 had been used to record the exact locations of certain landforms within the study area.

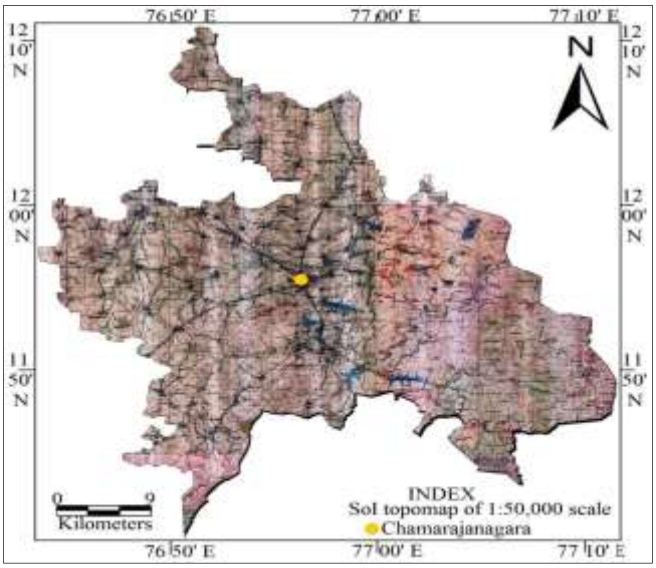

Fig.2. SoI topomap of the study area

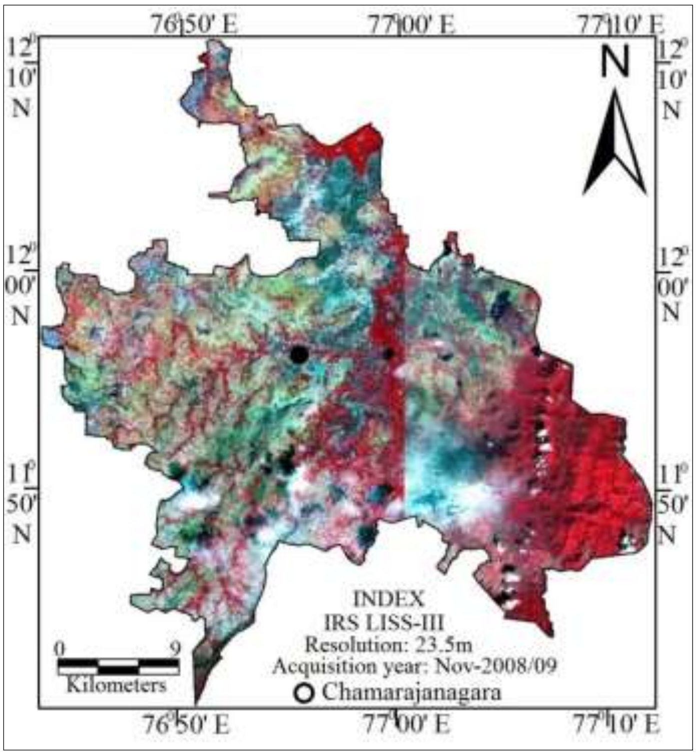

Fig.3. Satellite image of the study area

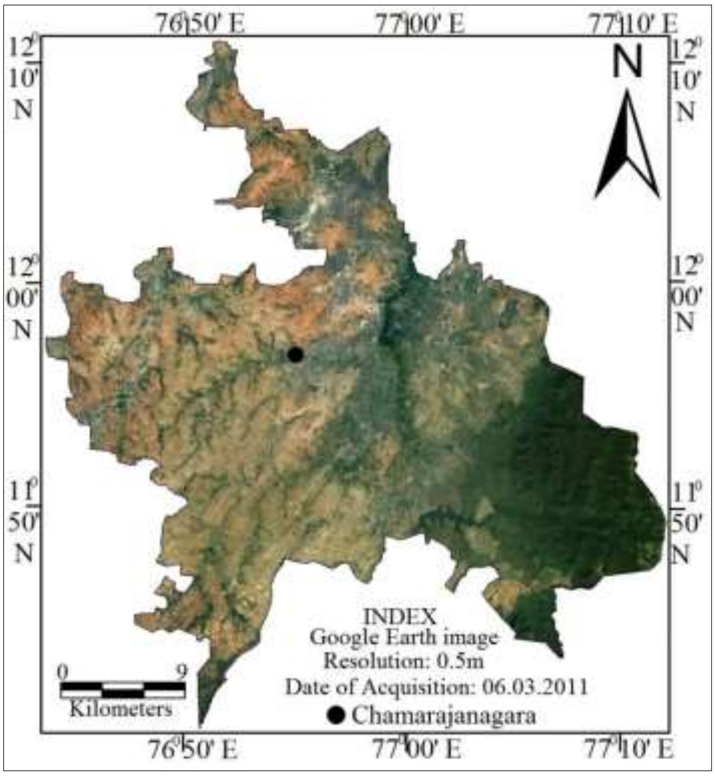

Fig.4. Google Earth map of the study area

LITHOLOGY

The lithological map was derived by Visual Image Interpretation Technique (VIIT) on the satellite imagery and updated through field verification (Fig.5). The study area belongs to Archaean and upper proterozoic group and intensely metamorphosed. Major shear zones like the moyar and Bhavani, joints, faults, folds and deformations were noticed in the study area. The Peninsular Gneissic complex is a heterogeneous association of polyphase grey gneiss ranging in composition from tonalite-trandhjemite-granodiorite (Radhakrishna and Vasudev., 1977). The study area composed of "Syn-accretion" charnockites, formed by the metamorphism of Juvenile calc-alkaline granitoid (Peucat et al., 1989, 1993). These rocks retain the foliation trends after metamorphism dominantly trending NNW-SSE-NS structural trends. Gneiss is the paramount rock type and shows foliation is N-S to N150E with a steep dip of 650 to 800 towards east (Basavarajappa, 1992) and appears as light yellowish green color on standard FCC. Charnockites were prominent rock type and vary in composition from enderbites, charno-enderbites to granulites (Basavarajappa, 1992; Srikantappa et al., 1992; Basavarajappa and Srikantappa, 1999). They were medium to coarse grained, light grey to greasy colored rocks. Foliation is generally trending N-S to N200E with dip of 650W to vertical and appears dark gray patches on standard FCC. Pyroxene Granulites occurs as linear concordant band ranging in width upto 200m and consist of plagioclase, clinopyroxene, orthopyroxene and occurs as small bands on standard FCC. Amphibolites were coarse grained, with gabbroic texture; consisting of tabular plagioclase with interstitial clinopyroxene and greenish brown hornblende to typically dark in color and heavy. On standard FCC, it appears dark green color. Migmatites were composed of a neosome, new material crystallized from incipient melting and a paleosome old material that resisted melting and noticed in the villages Alur, Amchavadi, Ammanapur, Basthipura, Aralipura, Nagavalli and particularly in KSZ. Hornblende-amphibolite schist occurs as small and narrow lenticular patches in gneisses here and there showing altered hornblende grains as its mineralogy (Basavarajappa and Srikantappa., 2014; Basavarajappa et al., 2015) and appears as greenish tone on standard FCC.

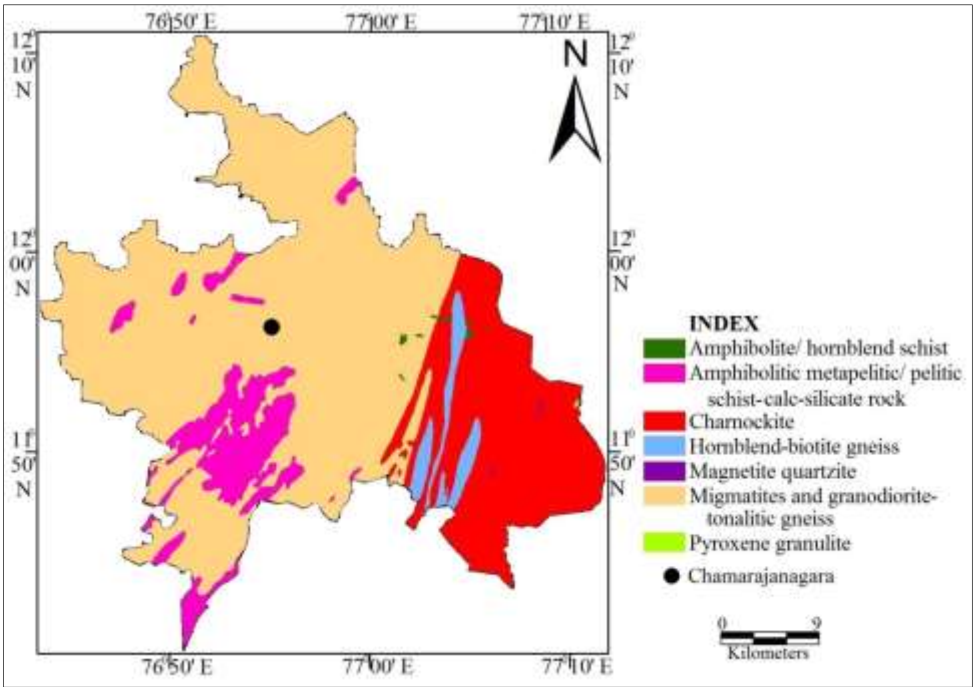

Fig.5. Lithology map of the study area

GEOMORPHOLOGY

The delineation of the geomorphic units were interpreted by Remote Sensing data as well as observations made on field parameters such as topography, relief, slope factor, surface cover, soil and vegetation cover (Fig.6). Denudational hills were underwent denudation action (Aunglwin., 2008) and surface run-off at the upper reaches had caused rill erosion which exposed near the villages of Timmegoudana palya, Melmal, Karivaradaraya betta and Punajanur state reserved forest. The lithological constitutions of these geomorphic units were noticed as gneisses, schists and charnockites covered most of the area with forest and appears as bright red to dark tone on standard FCC. Residual hills occurring as isolated patches were noticed at lower altitutdes as compared to the denudational hill. Inspite of their isolated occurrence, their continuity in the linear or curvilinear fashion gives indication that they were structurally controlled. (Basavarajappa et al., 1998; 2004; 2015) Thus more resistant formation or rocks stand as residue like hills consisting of amphibolite, gneiss, charnockites and hornblend schistose and highly sheared rocks (Basavarajappa, 1992; Basavarajappa et al., 2014; 2015; 2016). These were observed in the villages of Heggotara, Govindvady, Melmal, Hanumanapura, Jothigoudanapura, Hondralu and appears as brownish to reddish tone on standard FCC. Pediment is gently sloping smooth surface of erosional bedrocks situated in between hills & plains; observed in contact between the two lithounits of gneisses and charnockites. They occur near the villages of Badanaguppe, Kastur, Timmegoudana palya, exhibiting dotted outcrops and light brown color on FCC. Pediplain Moderate unit show nearly flat and smooth occupying the topographically low areas near stream courses and associated with fractures/ lineaments. The thickness of weathering is maximum along the axis of the fracture zones. Lithological contents were schistose and gneissic rocks; noticed near the villages of Harave, Buditittu, Somasamudra, Kattepura, Utvalli, and other nearby areas. They appear as bluish grey on standard FCC. Pediplain Shallow Weathered units were generally occupying the relatively elevated divide regions with gently sloping and occasionally associated with fractures or lineament (Basavarajappa et al., 2015). Weathering is more and shows association with wastelands of with or without scrubland, plantations. Lithologically, gneisses were dominate near the areas of Sargur, Nagavalli, Kokkanahalli, Hebsur, Kudlur, Hondralu; appearing as light yellowish tone on standard FCC. Valleys were low-lying depressions and negative landforms of varying size and shape occurring within the hills associated with stream nala course. On FCC image; they appear as reddish color due to the vegetation covered by gneisses and amphibolites in the villages of Heggavadipura, Kavudavadi, Desavalli, Gopalswamy hills.

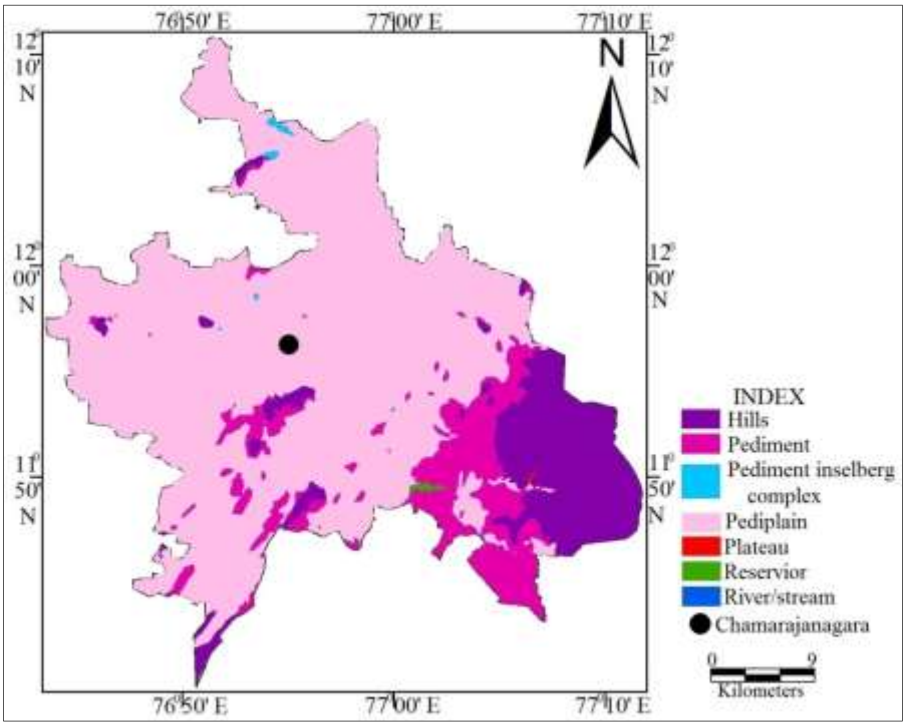

Fig.6. Geomorphology map of the study area

SOIL
There were 4 types of soils noticed distributed in the taluk such as gravelly clayey soil, sand soil, loamy soil, clayey soil, gravelly red soil and rock land which were derived from granitic gneisses and charnockite rocks. (CGWB., 2008; Fig.7). Along the western part of the taluk, the gravelly clayey soils were very deep, well drained

on undulating interfluves with slight moderate erosion were noticed. Along the pockets of the western part deep well drained calcareous cracking clayey soils on undulating interfluves were exist and has undergone moderate erosion. Loamy soils on the ridges exhibit severe erosion (Basavarajappa et al., 2009). The gravelly loamy soil along the slopes and ridges also subjected to erosion. The sandy soils were exposed along the river bed and occupy the mid portions of the taluk, on the banks of the Suvarnavathi, Chikkahole, and Yennehole river bed area (Pushpavathi., 2009). The gravelly red soil were exposed along the steeply sloping hill ranges with moderate erosion were noticed. The rock exposures/Rock land is exposed in the southern and southwestern part of the taluk (Basavarajappa et al., 2015c).

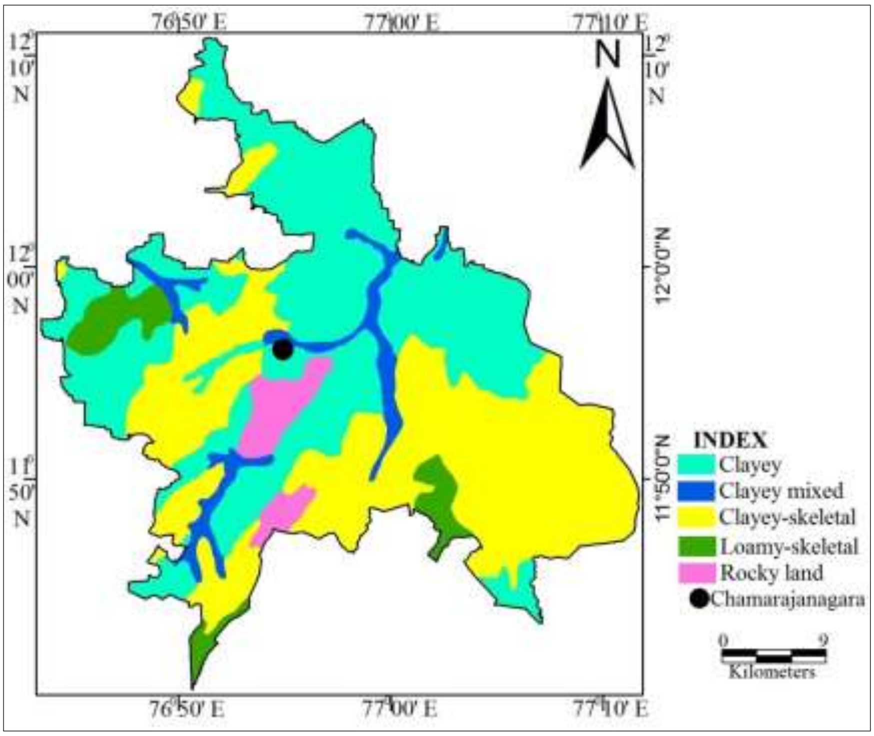

Fig.6. Soil map of the study area

WASTELANDS

Wastelands are ecologically unstable which have developed toxicity in the roots zones affecting directly the growth of most plants and animals (Bhumbla and Khare., 1984). This may be due to the impact of water, wind erosion, floods, water logging, soil salinization and alkalinization. Over development of industries/ mining/ factories ecologically impacts the forest and agricultural practices and become sensitive areas of fertile soils (NWDB., 1985). A technical task force group was constituted by Planning Commission and National Wastelands Development Board (NWDB) to arrive at precise definition of wasteland categories. The following were the wasteland categories noticed in the study area.

i. Barren Rocky/Stony Waste/Sheet Rock: These show thin soil/ sand or rocky exposures of varying lithology often barren and devoid of soil cover and vegetation. On FCC, they appear as greenish blue to yellow or brownish in tone with varying size associated with steep isolated hillocks and irregular in shape. These barren rocky stony wastes were noticed in north-western parts with an area of 8.82 Km2 (0.7215%).

ii. Land with Scrub: This occupies relatively high topographic locations (Ranade, 2007) which were subjected to degradation or erosion. They mainly consist of thorny bushes excluding hilly and mountainous terrain; also noticed along the ridges, valley complex, linear ridges and steep slope areas. This category appears as yellowish tone with irregular shapes on FCC. These features are mainly occupied in eastern and south-western parts (Basavarajappa et al., 2015) with an aerial extent of 63.19 Km2 (5.1691%).

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iii. Land without Scrub: The category is prone to degradation/ deterioration and may not have scrub cover with dry environment and associated with higher topography. They appear as light yellow tone/greenish blue with higher altitudes on FCC. They show varying size associated with gentle relief and moderate slope in plain & foothills surrounded by agriculture land. This category was noticed at central and northern parts with an aerial extent of 0.28 Km2 (0.0235%).

iv. Mining or Industrial Wasteland: Over development of mining/ industries/ factories nearby any water associated agricultural lands will have major impact on soil, water and land resources directly. Mining wastes generated during the extraction, beneficiation and processing of minerals dumping mining waste, pits left without any treatment or restoration and tailing on a plain land were the parameters cause environmental pollution if not properly controlled. This unit occurs in patches of dirty white to grayish tone on FCC with an area of 0.74 Km2 (0.0612%).

v. Salt-Affected Area: Salt affected land is a major problem across many parts of the country (Crobishely and Pearce, 2007) which were adversely affected the growth of most plants due to the action of high exchangeable sodium. These were identified near river plains and in association with irrigated lands of the study area resulted due to severe index of base exchange and ion exchange (Basavarajappa et al., 2015a). This category was identified based on white to light blue tone showing high intensity of erosion with an area of 5.34 Km2 (0.4369%).

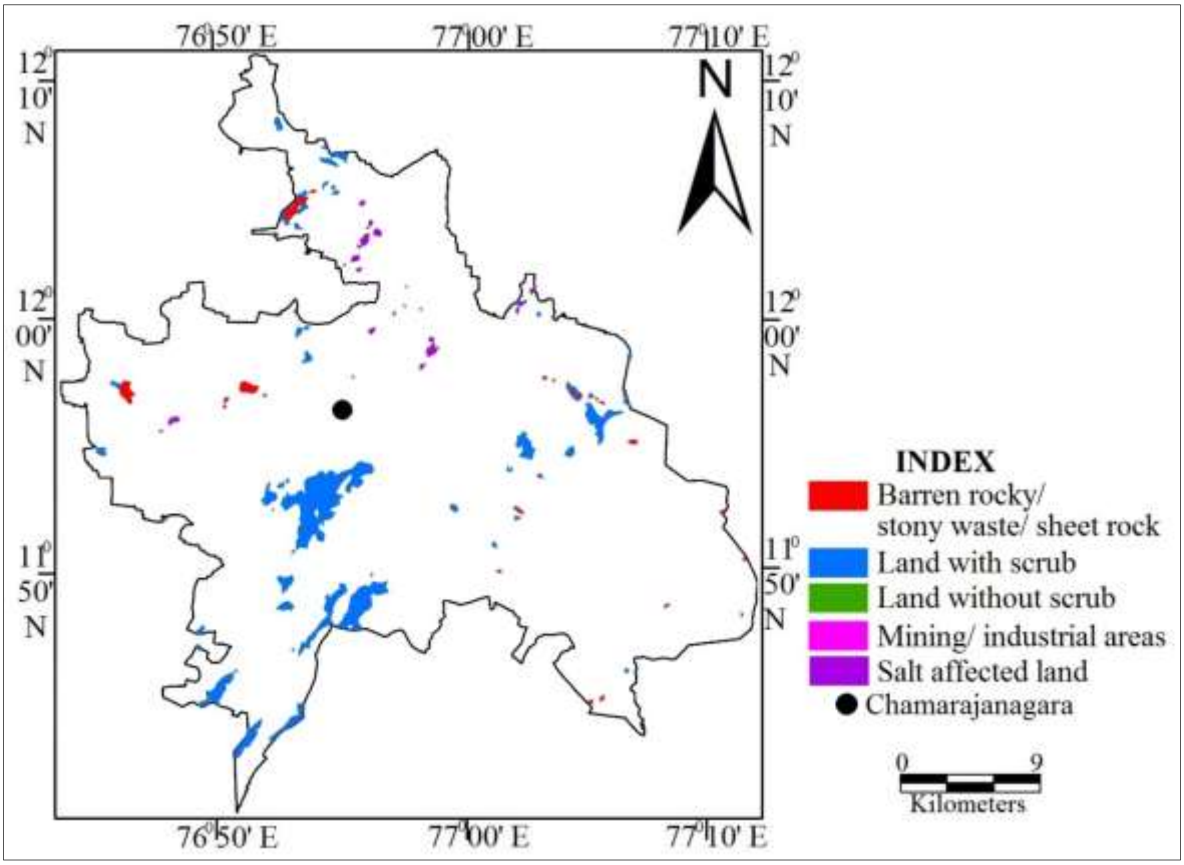

Fig.7. Wasteland categories map of the study area

Fig.8. Salt affected land near Jannur *Fig.9. Quarry waste area near Jothigowdanpura*

Fig.10. Quarry waste area near Kothalvadi *Fig.11. Land with scrub near Yeraganahalli*

Table.1. Wasteland categories & its Reclamation strategies for the study area

Sl. No	Types of wastelands	Area in Km^2	Percentage	Reclamation strategies
1.	Barren rocky/ stony waste	8.8207	0.7215	Pasture development with proper channel
2.	Land with scrub	63.1920	5.1691	Natural re-generation of vegetal cover; Forest plantation; Sericulture; Agriculture; Grass/ pastures
3.	Land without scrub	0.2875	0.0235	
4.	Mining/industrial wasteland	0.7484	0.0612	Open wells for recharging groundwater; Plantations; Urban/ rural waste dump
5.	Salt affected land	5.3414	0.4369	Built-up land; Growing Soil treatment plants (Prosophys Juliflora etc)
	Total wastelands	***78.3900***	***6.4123***	
	TGA	***1,222.4844***		

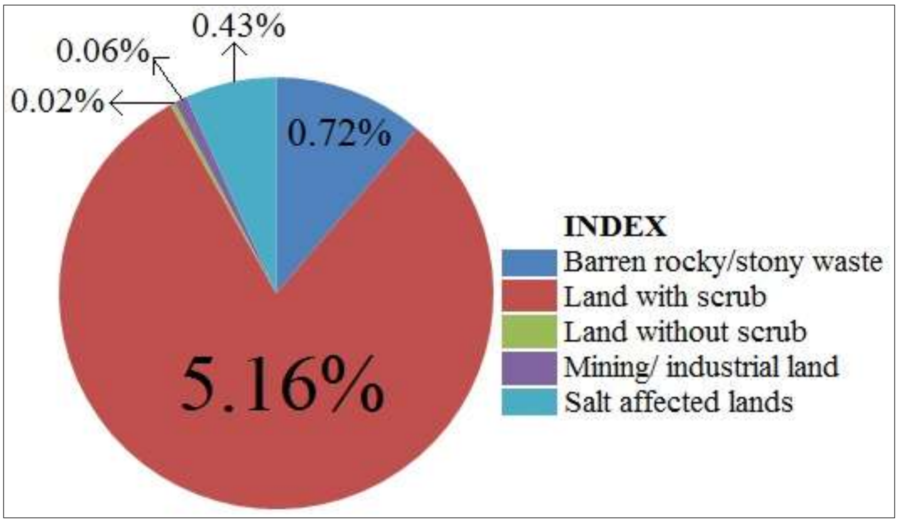

Fig.12. Pie chart depicting the Wasteland categories in Percentage-wise

STRATEGIES FOR THE RECLAMATION MEASURES

Different types of utilization to the maximum extent are possible due to increasing pressure on land and their physical landscape (Pushpavathi, 2009). Barren rocky/stony waste areas have to be channelized to regulate grazing activity and also to use as building materials with proper channel. In Gullied or ravenous land preventing the formation of a gully is much easier than controlling it once it has formed; become longer, larger and much deeper if these were not stabilized over periodic management (Basavarajappa et al., 2016a). Once gullies have begun to form however, they must be treated as soon as possible to minimize further damage and restore stability. In addition to proper land management practices specific slope-treatment measures such as retention and infiltration ditches, terraces, wattles, fascines and staking should be carried out above the gully area and in the eroded area between the branch gullies to reduce the rate and amount of surface runoff (Basavarajappa et al., 2015b).

For land with scrub/without scrub, treatments like contour bunding, stone or earthen walls built across a slope (along the contours) to act as a barrier to runoff as contour bunds. It helps in reducing soil erosion and increasing water retention capacity of soil lined with geo-textiles and filled with rock, stacked or placed to form an erosion resistant structure (Pushpavathi, 2009).

The mining/ industrial wastes should be dumped into a pit after the completion of mining activity for leveling the ground (Pushpavathi, 2009). After a long period, these wastes/ inorganic material can be used as manure. Open trenches will acts as the infiltration during rainy season and helps in storing the groundwater. Proper plantation on specific dump can also helps in wastelands reclamation.

Soil and water conservation were the preventive measures in salt affected lands. Individual efforts of the farmer for treating a micro watershed through soil and water conservation measures will limit the salt effected lands. These lands should be kept under continuous cropping rather than keeping it fallow for long period. Growing Prosophis Juliflora species on saline areas (Maliwal, 1990) for ten years and less can significantly decrease the alkalinity from the soils (Manjunatha et al., 2015).

CONCLUSION

Chamarajanagar taluk consists of 78.39 Km2 of total wastelands have effectively identified and mapped using SoI topomap and IRS-1C PAN+LISS-III image which were on Google Earth image in March 2011 through GIS software's. Most of these wasteland categories were noticed in the villages of Bagali, Jannur, Kudhalli, Amchavadi, Govindvady, Hosahalli, Yeraganahalli, Kothalavadi, Jothigowdanapura, Ummathur, Yanagahalli during Ground Truth Check (GTC). The wasteland categories were identified as barren rocky/stony waste (8.82 Km2; 0.7215 %), land with scrub (63.19 Km2; 5.1691 %), land without scrub (0.28 Km2; 0.02 %), mining/industrial wastelands (0.74 km2; 0.0612 %) and salt affected land (5.3414 Km2; 0.4369 %). Digitized thematic layers such as geology, geomorphology and soil types derived the undulations and helps during reclamation and land developmental programs. Most parts of the study area are of metamorphosed terrain and highly deformed, shear controlling rocks (KSZ) which were evident of joints, lineaments that helps in demarking the exact locations of linear fractures through which the inclusions of dumped materials & effluents from mining/ industrial areas will be avoided.

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