

Assessment of Soil Quality by Using Remote Sensing and GIS Techniques; A Case study, Chamrajanagar District, Karnataka, India

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Received: December 04, 2017; **Published:** December 30, 2017

Abstract

Assessments of Soil quality help in managing soil, using its functions optimally and preventing soil degradation by nourished future use. In this regard, an integrated approach involving soil physio-chemical analysis, geostatistical, Arc GIS model builder is used to generate soil quality map of Chamrajanagar District. From different landform features eighteen profile samples were collected and tested for EC, pH, BD, OM and the major, secondary and micronutrients. The result indicated that soils of Chamrajanagar District are varying from very low soil quality to very high soil quality this may be due to the large deviation in land and soil properties. The study also demonstrate the importance of GIS in building land resource data base of soil which is very much necessary for better monitoring of soil properties for optimal sustainable resources. There is a need to develop of spatial models to support regional environmental planning and management. Satellite remote sensing data and Geographic Information Systems (GIS) offer excellent tools for the assessment and the evaluation of environmental impacts. The study aims to identify the environmental impacts of rainfall activities on soil erosion. The study area is subject to heavy rainfall and increasing changes in land-use/land-cover that resulting from natural and human activities such as landslide, flash floods, and construction projects of houses and roads resulting from major environmental impacts. The resultant map shows that Soil erosion, salinity and sodicity hazards are serious problems in the study area and lead to reducing the soil quality and increasing the degradation of soil resources. Initial results show spots which high prone to environmental hazards and provide very useful information for decision making and policy planning with such problems. The results include a complete database and models that can be easily adjusted to different planning goals or regions.

Keywords: Arc GIS Model Builder; Chamrajanagar; Geostatistical; Soil Quality

Introduction

It was stated by Atanu and Rattan [1] that there is no standard method established to estimate soil quality indicator for major soils across the World in spite of a numerous attempts have been made to state a stander methodology of soil quality assessment. Soil quality is defined as the soil's capacity to function within natural or managed ecosystem boundaries and to sustain plant productivity while reducing soil degradation [2-5]. To estimate soil quality a wide range of soil indicators or parameters have been identified. This made soil quality has a complex functional concept which cannot be measured directly in the field or laboratory [6] but can only be inferred from soil characteristics [7]. However, soil quality is often related to the management goal and practices as well to soil characteristics. Thus, a mathematical or statistical framework was put forward in early 1990s to estimate soil quality index (SQI) [2,4,5]. The SQI was assessed so that the management goals are not only focused on productivity per se, which may result in soil degradation [8], but also on environmental issues. Thus, an appropriate SQI may have three component goals: environmental quality, agroeconomic sustainability, and socio-economic viability [9,10].

Generally, SQI is playing as useful assessment tool helping in soil resource management and move soil conservation for better changes in productivity [11]. Using the introduction of appropriate interventions of soil quality could provide the necessary information for planners and decision makers to make informed decisions against land degradation from further use. Despite such importance of Soil quality in combating soil degradation, only few studies have been reported in relation to various land use and soil management systems. This indicated that research on soil quality indicator has been mostly neglected for unknown reasons, with the most probable reason which could be technical and financial limitations. Many approaches have been applied and developed the concept of Soil quality indicators (SQI)) by [12-18]. In this study, such concepts are adopted and evaluated to narrow the knowledge/information gap of SQI across different land use and soil management systems in the study area. The objective of this study was to assess and identify an effective SQ indicator dataset among available soil measurements, appropriate scoring functions for each indicator, and an efficient SQ indexing method to evaluate soil quality.

Materials and Methods

Study area

The district (Figure 1) is located in the southern tip of Karnataka state and lies between the North latitude 11° 40'58" and 12° 06'32" and East longitude 76° 24'14" and 77° 46'55". It falls in the southern dry zone of the state. Topography is undulating and mountainous with north south trending hill ranges of Eastern Ghats.

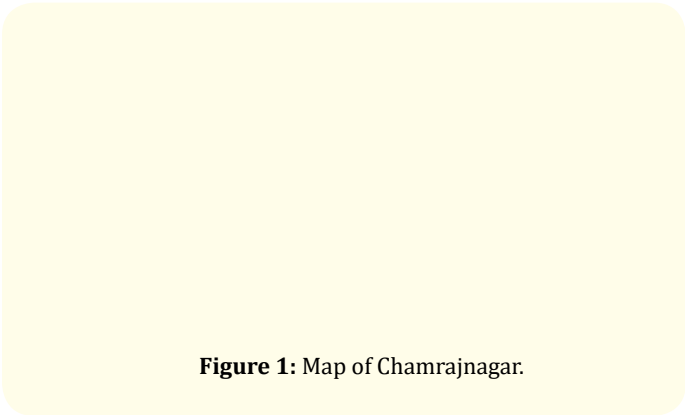


Figure 1: Map of Chamrajanagar.

Remotely sensed data

Indian Remote Sensing satellite (IRS P-6) LISS III and LISS IV sensors have been used to generate soil quality map. Length and degree of slope were derived from SRTM and Topographic maps; Ancillary data (Toposhets used (1: 50,000) and (1: 2,50,000)).

Soil analysis

Soil samples upon arrival in the laboratory were air dried under shade and then crushed in a wooden mortar with a pestle and sieved through a 2 mm sieve to separate the coarse fragments (> 2 mm). The fine earth was stored in separate containers and used for analysis.

The International pipette method was used for particle size analysis as described by Piper [19]. The soil reaction was determined in 1: 2.5 soil : water suspension by potentiometric method using glass electrode [20]. Electrical conductivity of the saturated soil water extract was measured using Elico conductivity bridge (Model CM 82 T) [20]. The cation exchange capacity of soils was determined according to Baruah and Barthakur [21]. The organic carbon was estimated by Walkley and Black wet-oxidation method [22]. Available nitrogen content of the soil was determined by following alkaline potassium permanganate method [23]. Available phosphorus, Available potassium and Available Micronutrient (Copper, Iron, Manganese, and Zinc) were determined as outlined by Jackson [20].

Generating of thematic maps

For this purpose Arc GIS Geostatistical Analyst was used which provided a suite of statistical models and tools for spatial data exploration and surface generation. Using ArcGIS Geostatistical Analyst was created a statistically valid prediction surface from eighteen profiles data measurements.

Data analyses were carried out using ENVI software. Geographic information system (GIS) analyses were done using ArcGIS9.3.1 (ESRI, 2009). Flow direction, flow accumulation, stream order, focal flow and basins are generated according to the following model, as shown in figure 2.

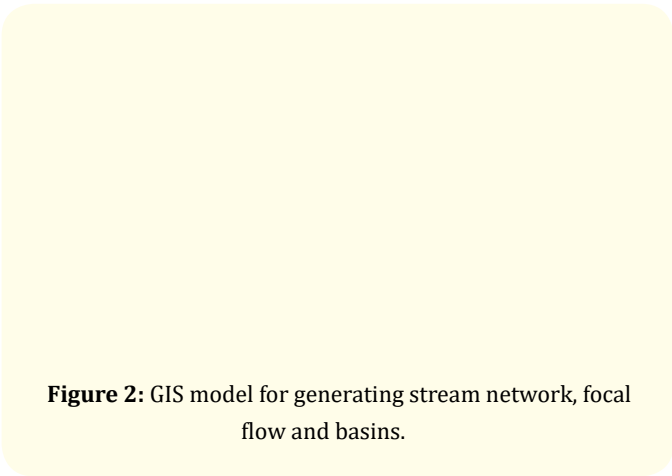


Figure 2: GIS model for generating stream network, focal flow and basins.

Soil quality

The Soil Quality method involved a set of 18 soil profiles and a number of soil quality indicators as parameters. Simple additive SQI was estimated following the method outlined by Amacher, *et al* [24]. In this method, soil parameters were given threshold values based primarily on the literature review and expert opinion of the authors. The threshold levels, interpretations, and associated unitless soil index score values. The individual index values were then summed up to obtain a total SQI:

Simple additive SQI $\sum SQI = \sum \text{Individual soil parameter index values}$

The scaled SQI (SQI-1) of individual soil was computed by Eq.

$$SQI-1 = (\sum SQI - SQI_{min}) / (SQI_{max} - SQI_{min})$$

Whereas, SQI_{Min} = Minimum value of SQI, and SQI_{Max} = Maximum value of SQI from the total dataset.

Results and Discussions

Physiographic units of the study area

Physiography can be defined as the study and description of physical earth surface features, including the processes responsible for their formation and evolution. Therefore, there is a difference between geomorphology and physiography. Physiography (Figure 3) is based on geomorphology (Figure 4) and can provide a good basis for explaining geomorphology through the aerospace images interpretation, using physiographic analysis, that identifies a certain physiographic process, which in turn, provides an important element clue for delineating soil patterns after predicting some certain soil properties (Goosen, 1967).

Figure 3: Geomorphology units of the study area.

Figure 4: Physiographic units of the study area.

Soil map of the study area

The soil map has 24 mapping units consisting of soil family associations with dominant phases based on landform analysis, field survey, laboratory investigation, field reviews and after (Prasad., *et al.* 1998). Soil Unit Description and Soil Taxonomy are described in the following table 1 and figure 5.

Figure 5: Physiographic units of the study area.

Soil physio-chemical properties

The soils of the study area were moderately deep to very deep. The depth of upland pedons was comparatively less than that of lowland pedons. The depth of pedon was due to the manifestation of topography. Similar observations were also made by Singh and Mishra [25]. The variation of depth in relation to physiography, mainly because of non-availability of adequate amount of water for prolonged period on upland soils associated with removal of finer particles and their deposition at lower pediplain have resulted in shallow soils in uplands and deeper soils in lowland physiographic units. The results obtained in the present study are in agreement with the findings of Ramprakash and Seshagiri Rao [26]. The soils of upland pedons showed varying degree of profile development from

A-C to A-B-C and are eroded. The depth to C horizon in upland and midland pedons is less compared to lowland pedons. Similar observations were made by Mahapatra., *et al* [27]. The varying degree of profile development between uplands and midlands is attributed to the removal and deposition of soil particles from different physiographic elements. These results are in conformity with the findings of Sawhney., *et al* [28].

The uplands, midlands and lowland pedons showed an increase in pH with depth. This might be due to increase in bases with depth and their incomplete downward leaching. In midlands and upland pedons, there was no regular trend in pH, which might be due to downward movement of bases and they get adsorbed at different layers irregularly. The pH of all the pedons varied from 4.95 to 8.11. The lower pH value in surface horizons is mainly due to leaching of bases due to high rainfall [29]. In all pedons C horizon had higher pH which could be attributed to the accumulation of bases. Similar types of results were reported by Thangasamy., *et al* [30]. The A horizon of upland pedons have relatively lower pH values than that of a horizon of lowland pedons. This increase in soil reaction down the slope could be due to leaching of bases from higher topography and getting deposited at lower elevations [31].

All the pedons showed low EC values ranging from 0.10 to 0.99 dS per m indicating the non-saline nature of the soils. The A horizon of uplands relatively less saline which might be due to free drainage conditions which favoured the removal of released bases by percolating water. Pillai and Natarajan [32] also reported similar low EC values indicating the non-saline nature of soils of Garakahalli watershed. In lowlands, slightly higher EC was recorded compared to midlands. This can be attributed due to accumulation of salt in lowlands. These results were similar to those of Sitanggag., *et al.* [31] in soils of Shikohpur watershed in Gurgaon district of Haryana.

The lowlands pedons were higher in organic carbon content than other pedons. The distribution of organic carbon in these profiles is mainly associated with physiography and land use. These findings are in conformity with those findings of Walia and Rao [33]. The organic carbon content of surface soil was greater than sub-surface soil in all the pedons and it decreased with depth. This was attributed to the addition of farmyard manure and plant residues to surface horizons which resulted in higher organic carbon content in surface horizons than that of lower horizons. These observations are in accordance with results of Basavaraju., *et al.* [34] in soils of Chandragiri Mandal of Chittoor district of Andhra Pradesh. In midland organic carbon content was low throughout the profile except slight increase in sub-surface layer. This is attributed to sparse vegetative cover.

The cation exchange capacity was influenced by the amount, type of clay and organic matter present in the soils. The values of cation exchange capacity (CEC) varied from 4.86 to 16.04 cmol (P+) kg-1. The changes brought about in the CEC values in lower layers appear to be largely due to increase in the contents of finer fractions brought down by irrigation water. The irrigation effects have brought fine fractions from the surface soil to the lower horizons resulting in increased CEC values with depth. The cation exchange capacity increased with depth in most of the profiles. The reason for the increased cation exchange capacity in lower depths is due to the increasing clay content of the soils. Similar values of CEC with depth in black and associated soils have also been reported by More., *et al.* [35] and Kaswala and Deshpande [36].

Unit No.	Soil Unit Description	Soil Taxonomy
1	Very deep, well drained, clayey soils on undulating interfluves, with slight erosion; associated with: Shallow, somewhat excessively drained, gravelly clay soils, moderately eroded.	(Fine, mixed, Rhodic Paleustalfs) (Clayey-skeletal, mixed, Lithic Ustropepts)
2	Moderately shallow, well drained, gravelly clay soils with very low AWC on undulating interfluves, with moderate erosion; associated with: Moderately deep, welldrained, gravelly clay soils with very low AWC.	(Clayey-skeletal, mixed, Typic Rhodustalfs) (Clayey-skeletal, mixed Typic Haplustalfs)
3	Shallow, well drained, gravelly clay soils with very low AWC, strongly gravelly in the subsoil on undulating interfluves; associated with: very deep, moderately well drained, calcareous, cracking clay soils, moderately eroded.	(Clayey-skeletal, mixed, Typic Ustropepts) (Very-fine, montmorillonitic, Typic Pellusterts)
4	Very deep, moderately well drained, clayey soils of valleys, with problems of drainage and slight salinity in patches; associated with: Moderately deep, well drained, loamy soils	(Fine, mixed, Typic Ustropepts) (Clayey over loamy, mixed, Typic Ustifluvents)
5	Deep, moderately well drained, clayey soils of valleys, with problems of drainage and slight salinity in patches; associated with: Deep, imperfectly drained, clayey over sandy soils.	(Fine, mixed, Typic Ustropepts) (Fine, mixed, Typic Ustifluvents)
6	Deep, well drained, calcareous, cracking clay soils on undulating interfluves, with moderate erosion; associated with: Moderately deep, well drained, calcareous, clayey soils with slight salinity under irrigation.	(Very-fine, montmorillonitic, Typic Chromusterts) (Fine, montmorillonitic, Vertic ustropepts)
7	Very deep, moderately well drained, calcareous, cracking clay soils on gently sloping interfluves, with slight erosion; associated with: Deep, well drained, calcareous, clayey soils, moderately eroded.	(Very-fine, montmorillonitic, Typic Pellusterts) (Fine, montmorillonitic, Vertic Ustropepts)
8	Very deep, well drained, gravelly loam soils, strongly gravelly in the subsoil on rolling lands, with moderate erosion; associated with: Shallow, somewhat excessively drained, gravelly clay soils with very low AWC.	(Loamy-skeletal, mixed Typic Ustrorthents) (Clayey-skeletal, mixed, Lithic Ustorthents)
9	Rock outcrops.	Rock land
10	Very deep, well drained, gravelly clay soils, strongly gravelly in the subsoil on steeply sloping high hill ranges, with moderate erosion; associated with: Very deep, well drained, clayey soils.	(Clayey-skeletal, kaolinitic, Typic Kandiestalfs) (Fine, kaolinitic, Kandic Paleustalfs)
11	Moderately deep, well drained, gravelly clay soils with low AWC, strongly gravelly in the subsoil on rolling lands; associated with: Moderately deep, well drained, gravelly clay soils with very low AWC.	(Clayey-skeletal, mixed, Typic Paleustalfs) (Clayey-skeletal, mixed, Rhodic Paleustalfs)
12	Deep, well drained, gravelly clay soils with low AWC on rolling lands, with moderate erosion; associated with: Moderately deep, well drained, gravelly clay soils with very low AWC.	(Clayey-skeletal, mixed, Typic Rhodustalfs) (Clayey-skeletal, mixed, Typic Ustropepts)
13	Moderately deep, well drained, clayey soils on escarpment slopes, with severe erosion; associated with: Deep, somewhat excessively drained, gravelly clay soils, moderately eroded.	(Fine, mixed, Typic Haplustalfs) (Clayey-skeletal, mixed, Typic Rhodustalfs)
14	Deep, well drained, gravelly clay soils with low AWC on undulating uplands, with moderate erosion; associated with: Moderately deep, well drained, gravelly clay soils with very low AWC.	(Clayey-skeletal, kaolinitic, Kanhaplic Haplustalfs) (Clayey-skeletal, kaolinitic, Oxic Ustropepts)
15	Moderately deep, well drained, clayey soils with low AWC on undulating uplands and Valleys; associated with: Deep, well drained, clayey soils, moderately eroded.	(Fine, kaolinitic, Kanhaplic Haplustalfs) (Fine, kaolinitic, kandic Paleustalfs)
16	Moderately shallow, well drained, gravelly clay soils on hills and ridges, with moderate erosion; associated with: Shallow, well drained, gravelly clay soils with very low AWC.	(Clayey-skeletal, mixed, Typic Ustropepts) (Clayey-skeletal, mixed, Lithic Ustropepts)
17	Moderately shallow, somewhat excessively drained, clayey soils on hills and ridges, with severe erosion; associated with: Shallow, somewhat excessively drained, clayey soils.	(Fine, mixed, Typic Ustropepts) (Clayey, mixed, Lithic Ustropepts)
18	Shallow, somewhat excessively drained, gravelly clay soils on steep ridges, with severe erosion; associated with: Shallow, somewhat excessively drained, gravelly loam soils.	(Clayey-skeletal, mixed, lithic Ustorthents) (Loamy-skeletal, mixed, Lithic Ustorthents)
19	Very shallow, somewhat excessively drained, loam soils on ridges, with severe erosion; associated with: Shallow, somewhat excessively drained, loamy soils.	(Loamy-skeletal, mixed, Lithic Ustorthents) (Loamy, mixed, Lithic Haplustalfs)
20	Very deep, well drained, gravelly clay soils with low AWC on low hill ranges, with moderate erosion; associated with: Moderately deep, somewhat excessively drained, gravelly clay soils.	(Clayey-skeletal, kaolinitic, Ustic Haplohumults) (Clayey-skeletal, kaolinitic, Ustic Kanhaplohumults)
21	Deep, well drained, clayey soils on undulating up lands, with moderate erosion; associated with: Deep, well drained, gravelly clay soils, with low AWC.	(Clayey, Kaolinitic, Kanhaplic Haplustults) (Clayey-skeletal, mixed, Kanhaplic Rhodustalfs)
22	Rook outcrops; associated with: Shallow, somewhat excessively drained, gravelly loamy soils on ridges, with severe erosion.	(Rock land) (Loamy-skeletal, mixed, Typic Ustropepts)
23	Rook outcrops.	(Rock land)
24	Very shallow, somewhat excessively drained, loam soils on ridges, with severe erosion; associated with: Shallow, somewhat excessively drained, loamy soils.	(Loamy-skeletal, mixed, Lithic Ustorthents) (Loamy, mixed, Lithic Haplustalfs)

Table 1: Soil Unit Description and Soil Taxonomy of Chamarajanagar district.

Cation exchange capacity of the soils was generally low in all the pedons and it varied from 4.86 to 16.04 cmol(+) kg⁻¹ of soil. Low CEC values even with high clay content indicate the dominance of low activity clays particularly, 1:1 type clay minerals i.e. kaolinite [37]. The higher CEC values were observed in surface horizons, due to the influence of organic matter. The availability of micronutrients in soils increased with CEC of soils due to more availability of exchange sites of soil colloids with increase in organic matter which enhanced the soil structure and aeration protects the oxidation and precipitation and increases the solubility. On the other hand there was reduced availability of micronutrients due to increased pH and CaCO₃ content of soils. Similar results were reported by Kumar and Babel [38]. The profiles with sandy clay loam texture and lesser organic matter content showed high BD values this was evidenced by the findings of Srivatsava, *et al* [39]. The CEC values of upland pedons were low whereas the lowland had high CEC. Similar observations were made by Suresh Kumar, *et al.* [40] in laterite soils developed on different geomorphic conditions which might be due to the clay content being significantly and positively correlated ($r = +0.40$) with CEC [41]. The CEC decreased with depth, which could be attributed to decreased organic carbon and clay content below the solum depth. The results are in agreement with the findings of Swaranam, *et al.* [42] whereas; in most of the pedons maximum CEC was observed in the horizon where illuviation of clay from surface to sub surface horizons had taken place. Similar observations were also made by Pillai and Natarajan [32]. The CEC values of upland pedons were low whereas, lowland pedons had high CEC. Similar observations were made by Suresh Kumar, *et al.* [40] in laterite soils developed on different geomorphic conditions which might be due to the clay content being higher and positively correlated with CEC [41]. The CEC decreased with depth, which could be attributed to decreased organic carbon and clay content below the solum depth. The results are in agreement with the findings of Swaranam, *et al* [42]. Whereas, the CEC increased with depth, could be attributed to increased clay content with depth. Maximum CEC was observed in the horizon where illuviation of clay from surface to sub surface horizons had taken place. Similar observations were also made by Pillai and Natarajan [32]. The base saturation was found to vary from 15.4 to 100.0 per cent. The A horizon of upland pedons is less base saturated than A horizon of lowland pedons, indicating high degree of leaching in upper slopes. These findings are in conformity with those reported by Sitanggang, *et al* [31]. Base saturation in Epiaquepts of Banda plain region was varying from 75 to 89 per cent [43].

The data on ESP of these soils of the study area, revealed, both an increasing trend and decreasing trend of ESP with depth. Slightly lower ESP at the surface layer in some may be attributed to high organic carbon content of the soil [44]. The reduction in the ESP is due to the evolution of CO₂ released during the decomposition of organic matter. The release of CO₂ reacts with water to form carbonic acid which in turn solubilises the precipitated calcium carbonate and Releasing calcium which replaces sodium in the exchange complex. This reduces the soil sodicity and pH values in the surface layers and increase in ESP down the soil profile. Similar observations were made by Yerriswamy [45] for salt affected soils of Upper Krishna Project in Karnataka and Balpande, *et al.* [46] for Poorna Valley in Maharashtra. The exchangeable sodium percentage was high in the low land profiles samples. Bhumbla [47] reasoned that alternate wet and dry conditions seem to be the contributing factor for sodic soil formation. Bhargava [48] reported that, alkali soils of South India have high exchangeable sodium percentage values

coupled with very heavy soil texture and a clay content of 35 to 40 per cent. Krishnamoorthy and Govindarajan [49] reported that the alkali soils of Andra Pradesh, in spite of dominance of calcium, has exchangeable sodium percentage values of more than 15 and is due to heavier texture of soils having higher clay (28 to 49 per cent), makes the soil behave as alkali soils.

The pH and EC values of the surface horizons ranged from 5.57 to 8.88 and 0.10 to 0.99 dSm⁻¹. The reasons for lower pH and EC values were discussed at 5.1.3.1 and 5.1.3.2, respectively. The organic carbon content of surface horizons ranged from 0.33 to 1.31 per cent. The reason for low organic carbon content in these soils might be attributed to the prevalence of tropical conditions, where the degradation of organic matter occurs at a faster rate coupled with little or no addition of organic manures and low vegetative cover on the fields, thereby, leaving less chances of accumulation of organic carbon in the soils. Similar observations were also made by Nayak, *et al.* [50] in soils of Central Research Station OUAT, Bhubaneswar. The available nitrogen in the study area ranged from 94.08 to 501.76 kg per ha. Major portion of the nitrogen pool is contributed by organic matter. The low organic matter content in this area due to faster degradation and consequent removal of organic matter coupled with lesser nitrogen fertilization leading to nitrogen deficiency. The results obtained in the present study are in agreement with the findings of Govindarajan and Datta Biswas [51]. The available phosphorous content ranged from 9.87 to 147.37 kg P₂O₅ per ha. The low values are due to low CEC, clay content and soil reaction of < 6.5. The results are in conformity with the findings of Bopathi and Sharma [52]. The available potassium in the study area was medium in status due to the predominance of K rich micaceous and feldspar minerals in parent materials. Similar results were observed by Ravikumar [53]. The available K was low in uplands, because of lesser finer fractions in their A horizons. The available sulphur ranged from 0.93 to 48.15 mg/kg. The low amount of sulphur in surface samples is mainly because of acid reaction and low EC values. Similarly, Sharma and Gangwar [54] noticed negative correlation between total sulphur and pH and also between total sulphur and electrical conductivity.

Remote sensing work

Digital Terrain Model (DTM) is the representation of continuous elevation values over a topographic surface by a regular array of z-values, referenced to a common datum. Digital Terrain Model was generated to represent terrain relief of Chamrajanagar and its vicinities as shown in figure 6. 3D surface view of Chamrajnagar and its vicinities is shown in figure 7.

Figure 6: 3D surface view.

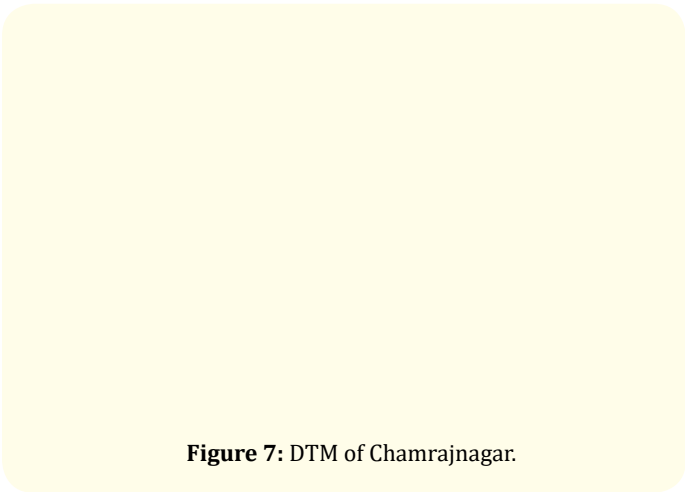


Figure 7: DTM of Chamrajanagar.

Digital Terrain Model (DTM) was generated to represent terrain relief of Chamrajanagar and its vicinities. Stream network task depends mainly upon DTM to extract the required parameters of slope, flow direction, flow accumulation, stream network, focal flow, and Hillshade. A drainage basin was generated to calculate the total area flowing to a given outlet. Chamrajanagar has first-order streams that are dominated by overland flow of water; it has no upstream concentrated flow. Because of this, it is most susceptible to nonpoint source pollution problems and can derive more benefit from wide riparian buffers than other areas of the watershed.

Land Use/Land cover

The Land Use/Cover area frame statistical in the study area occupied by forest with 47.54 per cent of the total area, agricultural land occupied 42.61 per cent, wastelands occupied 4.58 per cent, water bodies occupied 1.92 per cent, built-up land occupied 1.03 per cent, grassland/grazing land occupied 0.28 per cent and others occupied 2.04 per cent of the total area as shown in figure 8.

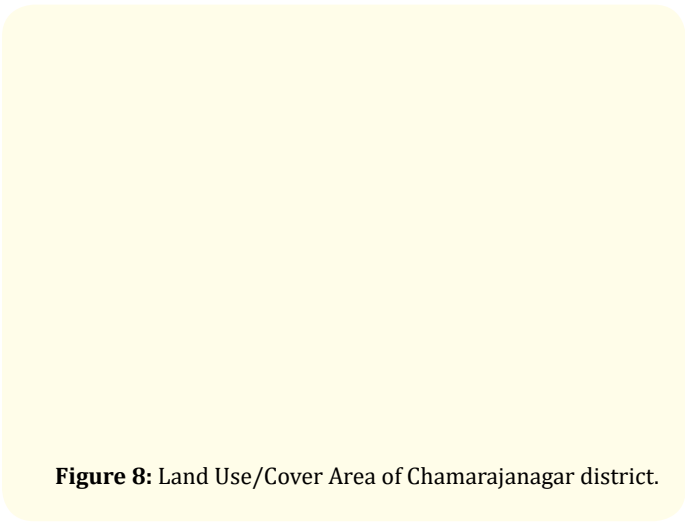


Figure 8: Land Use/Cover Area of Chamrajanagar district.

The integration of remote sensing and Geographical Information System (GIS) was found to be effective in determining and extracting land use/cover and providing valuable information necessary for planning and research. A better understanding of the spatial distribution of the land use/cover, provided by this study, forms a basis for better planning and effective agricultural activities for future development of Chamrajanagar district.

Soil quality

Broad categories of soil quality generated based on weighted overlay of SQI in spatial model based on soil, slope, and land use/land cover, current soil properties status. The distribution of various SQ categories delineated through interpretation of soil data using geostatistical as shown in the figure 9; High occupied 26.24 per cent of the total area, Moderate occupied 415.54 per cent, Low occupied 12.99 per cent, and Very low occupied 8.15 per cent of the total area and the remain areas are for Rock land 11.06 per cent and Water bodies 0.02 per cent of the total area.

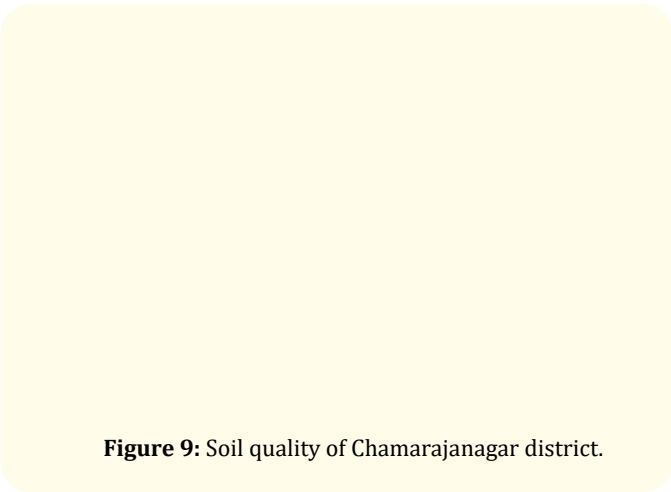


Figure 9: Soil quality of Chamrajanagar district.

Conclusion

The present study was conducted during 2011-2014. In this study soils from eighteen sites representing soil quality status of the study area were morphologically examined and analyzed for physical and chemical properties. From the physical and chemical characteristics of the soils studied, it has been found that the soils of the area are exposed to degradation in the surface and sub surface horizons in all the lowland areas and non-saline and non-sodic in both upland and midland areas. Maximum low land area had higher sub surface sodicity than surface horizon. Maximum upland areas are exposed to water erosion and Maximum low land area are exposed to salinization, alkalinization, and physical degradation. The geostatistical analysis was performed for soil quality indicators and was performed by weighted average in the spatial model tools to generate soil quality map in the district.

Bibliography

1. Atanu Mukherjee and Rattan Lal. "Comparison of Soil Quality Index Using Three Methods". *PLoS One* 9.8 (2014).
2. Doran J., *et al.* "A framework for evaluating physical and chemical indicators of soil quality" (1994).
3. Doran JW and Parkin TB. "Defining and assessing soil quality". *SSSA special publication* 35 (1994).
4. Karlen DL., *et al.* "Soil Quality: A Concept, Definition, and Framework for Evaluation (A Guest Editorial)". *Soil Science Society of America Journal* 61 (1997): 4-10.
5. Karlen DL and Stott DE. "A framework for evaluating physical and chemical indicators of soil quality". In: Doran JW, Coleman DC, Bezdicek DF, Stewart BA, editors. *Defining soil quality for a sustainable environment*. Madison, WI: Soil Science Society of America. (1994): 53-72.
6. Stocking MA. "Tropical Soils and Food Security: The Next 50 Years". *Science* 302 (2003): 1356-1359.
7. Diack M and Stott D. "Development of a soil quality index for the Chalmers Silty Clay Loam from the Midwest USA". *Purdue University: USDA-ARS National Soil Erosion Research Laboratory* (2001): 550-555.
8. Larson WE and Pierce FJ. "Conservation and enhancement of soil quality. Evaluation of Sustainable Land Management in the Developing World". International Board for Soil Research and Management, Bangkok, Thailand (1991).
9. Andrews S., *et al.* "A comparison of soil quality indexing methods for vegetable production systems in Northern California". *Agriculture, Ecosystems and Environment* 90.1 (2002): 25-45.
10. Gebreyesus B T. "Soil Quality Assessment Strategies for Evaluating Soil Degradation in Northern Ethiopia". *Applied and Environmental Soil Science* (2014).
11. Andrews S S., *et al.* "The soil management assessment framework: a quantitative soil quality evaluation method," *Soil Science Society of America Journal* 68.6 (2004): 1945-1962.

12. Doran J W. "Soil health and global sustainability: translating science into practice," *Agriculture, Ecosystems and Environment* 88.2 (2002): 119-127.

13. Carter M R. "Soil quality for sustainable land management: organic matter and aggregation interactions that maintain soil functions" *Agronomy Journal* 94.1 (2002): 38-47.

14. Mastro R E., *et al.* "Alternative soil quality indices for evaluating the effect of intensive cropping, fertilisation and manuring for 31 years in the semi-arid soils of India". *Environmental Monitoring and Assessment* 136.1-3 (2008): 419-435.

15. Amacher M C., *et al.* "Soil vital signs: a new soil quality index (SQI) for assessing forest soil health" Research Paper of USDA, Forest Service, Rocky Mountain Research Station (2007).

16. Harris R F., *et al.* "A conceptual frame-work for assessment and management of soil quality and health". in *Methods for Assessing Soil Quality*, J. W. Doran and A. J. Jones, Eds., Soil Science Society of America, Madison, Wis, USA 49 (1996): 61-82.

17. Andrews S S and C R Carroll. "Designing a soil quality assessment tool for sustainable agroecosystem management". *Ecological Applications* 11.6 (2001) 1573-1585.

18. Gugino B K., *et al.* "Cornell Soil Health Assessment Training Manual" Cornell University, Geneva, NY, USA, 2nd edition (2009).

19. Piper C S. "Soil and Plant Analysis". Hans Publishers. Bombay, India (1966).

20. Jackson M L. "Soil Chemical Analysis". Asia publishing House, New Delhi (1973).

21. Baruah T C and Barthakur H P. "In: Text book of soil analysis". Vikas Publishing House Pvt. Ltd. New Delhi (1999).

22. Jackson M L. "Soil Chemical Analysis". Prentice-Hall Inc., Englewood Cliffs, New Jersey (1958): 498.

23. Subbaiah B Y and Asija G L. "A rapid procedure for the estimation of available nitrogen in soils". *Current Science* 25 (1956): 259-260.

24. Amacher MC and Perry CH. "Soil vital signs: A new Soil Quality Index (SQI) for assessing forest soil health (2007).

25. Singh V N and Mishra B B. "Pedogenic Characterization of some typic soils of Gandak command area of Bihar for evaluation of land suitability". *Journal of the Indian Society of Soil Science* 44 (1996): 136-142.

26. Ramprakash T and Seshagiri Rao M. "Characterization and classification of some soils in a part of Krishna district, Andhra Pradesh". *The Andhra Agricultural Journal* 49 (2002): 228-236.

27. Mahapatra S K., *et al.* "Characterization and classification of soils of different physiographic units in the sub-humid ecosystem of Kashmir region". *Journal of the Indian Society of Soil Science* 48.3 (2000): 575-577.

28. Sawhney J S., *et al.* "Soil physiography relationship in south-eastern sector of submontane tract of punjab". *Agropredology* 10 (2000): 6-15.

29. Sivasankaran K., *et al.* "Physico-Chemical properties and nutrient management of red and laterite soils under plantation crops in southern India". NBSS AND LUP, Nagpur, Publication 37(1993): 280.

30. Thangasamy A., *et al.* "Characterization, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor district in Andhra Pradesh for sustainable land use planning". *Journal of the Indian Society of Soil Science* 53 (2005): 11-21.

31. Sitanggang M., *et al.* "Characterization and classification of soils in watershed area of Shikohpur, Gurgaon district, Haryana". *Journal of the Indian Society of Soil Science* 54.1 (2006): 106-110.

32. Pillai M Y and Natarajan A. "Characterization and classification of dominant soils of parts of Garakahalli watershed using remote sensing technique Mysore". *Journal of Agricultural Science* 38 (2004): 193-200.

33. Walia C S and Rao Y S. "Genesis, characteristics and taxonomic classification of some red soils in Bundelkhand region of Uttara Pradesh". *Journal of the Indian Society of Soil Science* 44.3 (1996): 576-581.

34. Basava Raju D., *et al.* "Characterization, classification and evaluation of soils in chandragiri mandal of chittoor district, andhra Pradesh". *Agropedology* 15.1 (2005): 55-62.

35. More S D., *et al.* "Characterization of some salt affected soils of Purna Command area of Maharastra". *Journal of the Indian Society of Soil Science* 36.1 (1988): 146-150.

36. Kaswala R R and Deshpande S B. "Physico-chemical and mineralogical characteristics of some coastal and inland soil series of south Gujarat-I. Physico chemical characteristics". *Journal of the Indian Society of Soil Science* 31.2 (1983): 285-286.

37. Walia C S and Chamuah G S. "Influence of topography on canterly soils in old flood plain Assam". *Journal of the Indian Society of Soil Science* 44.3 (1988): 476-581.

38. Kumar M and Babel A L. "Available micronutrient status and their relationship with soil properties of Jhunjhunu tehsil, district Jhunjhunu, Rajasthan, India". *Journal of Agricultural Science* 3.2 (2011): 97-106.

39. Srivatsava A K., *et al.* "Effect of sugarcane ratooning on variability in bulk density". *Journal of the Indian Society of Soil Science* 35 (1987): 349-352.

40. Suresh Kumar L M., *et al.* "Pedogenic characerisation and productivity of some lateritic soils developed on different geomorphic conditions". *Agropedology* 11 (2001): 37-44.

41. Sharma V K and Anil Kumar, "Characterization and classification of the soil of upper Maul Khad catchment in wet temperate zone of Himachal Pradesh". *Agropedology* 13 (2003): 39-49.
42. Swaranam T P, *et al.* "Characterization and classification of some soils from Shahibi basin in parts of Haryana and Delhi". *Agropedology* 14 (2004): 114-122.
43. Walia C S., *et al.* "Clay mineralogy of some soils of Bandaplain in relation to physiography". *Clay Research* 16 (1997): 19-30.
44. Garg V K and Jain R K. "Effect of fuel wood plantation on some properties of sodic waste lands". *Journal of Tropical Forest Science* 9.2 (1996): 194-205.
45. Yerriswamy A N. "Studies on salt affected soils of Upper Krishna Project Command Area". M. Sc. (Agriculture) Thesis, University Agriculture Science, Bangalore (1996).
46. Balpande S S., *et al.* "Factors and processes of soil degradation in Vertisols of Poorna Valley, Maharashtra, India". *Land Degradation and Development* 7 (1996): 313-324.
47. Bhumbra D R. "Salinity and alkalinity problem of arid regions of India". *Proceedings of the Indian National Science Academy* 44.6 (1978): 331-343.
48. Bhargava G P. "Soil and water quality surveys in a decade of research". CSSRI-Publication, Karnal (1979): 22-34.
49. Krishna Moorthy P and Govindarajan P V. "Genesis and classification of Associated Red and Black soils under Rajolibunda diversion irrigation scheme (Andhra Pradesh)". *Journal of the Indian Society of Soil Science* 25.3 (1977): 293-246.
50. Nayak R K., *et al.* "Characterization and classification of the soils of Central Research Station, Bhubaneswar". *Agropedology* 12 (2002): 1-8.
51. Govindarajan S V and Datta Biswas N R. "Characterization of certain soils in the subtropical humid zone in the south eastern part of Indian soils of Muchkand basin". *Journal of the Indian Society of Soil Science* 16 (1968): 117-186.
52. Bopathi H K and Sharma K N. "Phosphorus adsorption and desorption characteristics of some soils as affected by clay and available phosphorus content". *Journal of the Indian Society of Soil Science* 54.1 (2006): 111-114.
53. Ravikumar M A. "Soil resource characterization of 48A Tributary of Malaprabha Right Bank command for sustainable land use planning". M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka, India (2006).
54. Sharma Y K and Gangwar GS. "Distribution of different forms of sulphur and their relationship with some soil properties in Alfisols, Inceptisols and Mollisols of Moradabad district, Uttar Pradesh". *Journal of the Indian Society of Soil Science* 45.3 (1997): 332-335.

Volume 2 Issue 1 January 2018

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