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Geometrical Assessment of Soil calcareousness: A case study from Telangana State, India

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ABSTRACT

The accretion and hauling of carbonates are used to identify, and interpret the soil formation processes in the soil profile. Predominantly, these soils types comprise over one-third of the world's land surface area. Generally, Calcareous soils are identified by the presence of calcium carbonate ($CaCO_3$) in the parent material. When the soil samples are treated with dilute Hydrochloric acid, an accumulation of lime through the fizzing occurs, and releases carbon dioxide. The released carbon dioxide gas concentration indicates the level of carbonates present in the soil. In this study, the thematic data integration of calcareous soil values, and soil types is done using Remote sensing and GIS tools to get the action plan maps by Arc GIS 10.3 software. From this, it is identified that almost 50% of Gopannapalle village is suffering from 35-60% calcareous, followed by 30% of the study area with 15-35% slightly calcareous and 70% of Anekunta village is suffering from 35-60% calcareous, followed by 20% of the study area with 15-35% somewhat calcareous. Based on the calcareous maps, it is recommended that the soil infertility and soil pH can reduce by improving proper fertilizer management and organic manure applications to increase its nutrient value.

***Key words**: Soil calcareous, Remote sensing, Calcium carbonate, Irrigation.*

Introduction

Soils weathered under semi-arid, and arid climatic conditions are characterized by an accretion of calcium carbonate in the soil profile. This carbonate accumulation perhaps concentrated in narrow, or more dispersed zones, based on the frequency and quantity of rainfall, vegetation, soil texture, and topography (Taalab *et al*., 2014). These may be very hard and impervious to water. These layers of caliche are mostly generated due to salts leaching in the soil by rainfall at a particular depth where the water content is shallow, and the carbonates precipitate. These caliche layers also formed by upward salts moving along with water table originated by irrigation, and pouring near the soil's capillary fringe. The salts from the poignant water mostly move inside the soil profile through diffusion process. This water flow rate is approximately proportional to the square of channel radius as the soil pores, and channels size varies from milli microns to millimeters (Shawky *et al*., 2004). In calcareous soils where $CaCO_3$ is dominated with high pH, the crop species suffer with nutrient deficiency such as less availability of copper, calcium, phosphorous and zinc etc. (Rasha, 2005). This nutrients deficiency problem

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causes several indirect and direct impacts on the plant growth, crop yield, and also on soil chemistry. Specific physical, and morphological characteristics of calcareous soils should consider while irrigation is practiced. Because irrigation technique other than the investigation of conventional ones to determine calcareous soils are susceptible to salinization (Loeppen and Hallmark, 1985). In these methods, mainly field treatments have to be investigated to overcome the surface crusting effects and encourage the machinery needed for tillage operations which conserve soil resources with minimal disturbances, and finally empowers the economy.

This research presents a way to unify data in the analysis of soil calcareous spatial distribution on Raster maps (aerial photographs), which have been prepared using the GIS (Geographic Information System) technique. Remote sensing is obtaining information about an area by remote sensors. These remote sensing tools used to portray the distribution of Calcareousness in the soils of the study area. Remote sensors capture area under study and the GIS technique gives raster maps based on data obtained from the study. Satellite images are obtained using aerial photography, covering wide geographic areas like natural resources and environmental changes (Praveen *et al.*, 2004). The positioning data is then attached to this gathered information and analyzed using a GIS techniques. The final mapping of calcareous soils provides soil characteristics and helps to identify the rapport between soil morphological characteristics, and other physical properties. Also it helps to understand their effect on crop growth as well as soil and water management practices in the irrigation fields which performs under precise environmental circumstances and used for various land use evaluation purposes.

Methodology

Calcareous soils generally have free calcium carbonate and contain pH values in the range of 7.0 to 8.3. The high pH associated with these soils is not the calcium level present; it is the carbonate in the ground or the bicarbonate related to the waters found in those soils that control the pH. Calcareous soil mainly contains calcium carbonate in free form, and magnesium carbonate may remain present in small quantities. So that, soil carbonate levels generally quantified by the acid dissolution through volumetric analysis, and further released carbon dioxide (CO_2). In the present study, a simple acidic test is done by placing the drop by drop dilute hydrochloric acid on soil sample which was collected from the field and observed the released CO_2 bubbles. These bubbles indicate the presence of carbonate minerals (FAO, 2020).

$$CaCO_3 + 2H^+ \,!\, Ca^{2+} + CO_2 + H_2O$$

The present study area consists of Anekunta and Gopannapalle villages which are located in Zaheerabad Mandal of Sangareddy District, Telangana State, India. This study area lies between North Latitudes *17037'00.492"* N and *17032'30.676"* N and East Longitudes *77027'01.774"* E and *77033'10.393"* E. In the field, twenty-four samples were collected and estimated calcareousness by treating moist soil samples with dilute Hydrochloric acid based on effervescence observed. The soil calcareousness classes were characterized as "0 - nill effervescence" which indicates non - calcareousness soils, "1 - slight effervescence" which indicates slightly calcareous soils, and "2 - strong effervescence" which indicates "strongly calcareous". For this study, high resolution IRS P6 LISS IV satellite data is used for the field wise spatial map preparation. The revenue map of the study area is geometrically corrected using the Image interpretation techniques and collected GPS control points from the field. This data is linked to the spatial data for the generation of the calcareous information system (Cui *et al.*, 2020). The processes of image rectification, subset, supervised classification, and unsupervised classification for image processing is completed by using ERDAS Imagine software (Ewa *et al.*, 2016). A scheme for thematic data integration of calcareous soil values and soil types is done to get the action plan maps by Arc GIS 10.3 software and verified by the ground truth data.

Results and Discussion

The depth of the groundwater, nature of the weathered products, the texture and the chemical compositions of the water, and thermodynamic conditions play an essential role in the semi-arid and arid conditions concerning the accumulation of calcium carbonate in soils. In studying the relationships between soil, water, and plants, more investigations have to be carried out on the active fractions of $CaCO_3$ and its influence on soil physical and chemical characteristics (Monier *et al.*, 2019). Several soil

samples were evaluated for soil calcareousness and soil classification by using Remote sensing and GIS tools in the study area. In this study, field study is combined with a detailed characterization of the soils. The soil-site characteristics are studied and evaluated in the present study area during the field study, and mappings are interpreted to get the soil map. The soil map is developed based on the Series of Soil (FAO, 2016). The series of Parvatapur(Pvp), Kaveli(Kvl), Bilalpur(Bpl), Madhlal Tanda(Mlt), H.N.Tanda (Hnt), Algol (Agl), J.B.Tanda (Jbt), Didgi (Ddg), Potpalli (Ppl), Ranjol (Rjl) and Yellammaeheruvu (Yme) are identified in the study area (Fig. 1 and 2). In this, Agl-Bpl, Rj-Ppl, Mlt-Bpt-Ymc and Kvl-ppl category combinated soils are highly present in the study area.

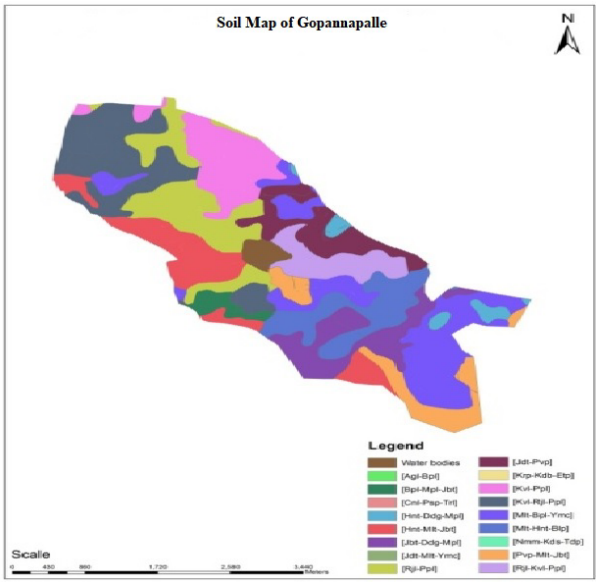

Fig. 1. Gopannapalle Soil Map

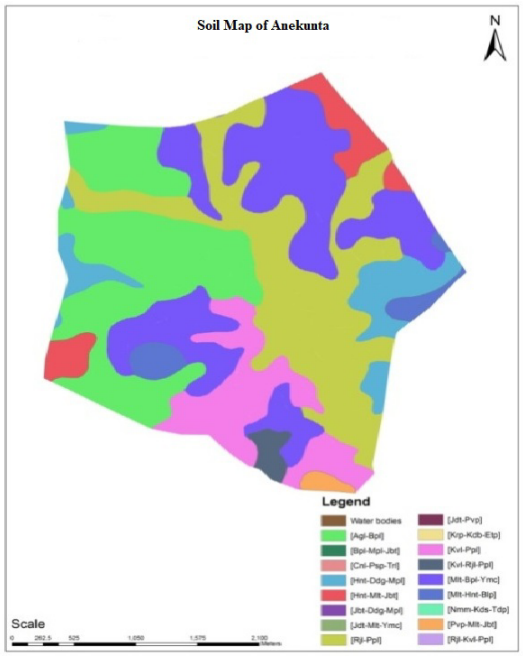

Fig. 2. Anekunta Soil map

The categorization of calcareous soils is represented in the following table-1 as per field survey. Figure 3 shows that almost 50% of Gopannapalle village is suffering from 35-60% calcareous, followed by 30% of the study area with15-35% slightly calcareous. Figure 4 shows that almost 70% of Anekunta village is suffering from 35-60% calcareous, followed by 20% of the study area with15-35% slightly calcareous.

The recommendations adopted by this study are identifying the calcareous soils and reclamation and utilization of these soils in a sustainable manner. A significant feature of calcareous soils is that they mostly develop in stumpy rainfall regions and these must be irrigated to be productive. Normally, the irrigation water is the major cause for so many man-

Table 1. Characterisation of Soil calcareousness

Mapping Unit	Description	Representation in Map (Colour)
0	0- 15% Non-calcareous	Brown
1	15-35 % Slightly calcareous	Green
2	35 -60 % calcareous	Yellow
1000	Water Bodies	Blue

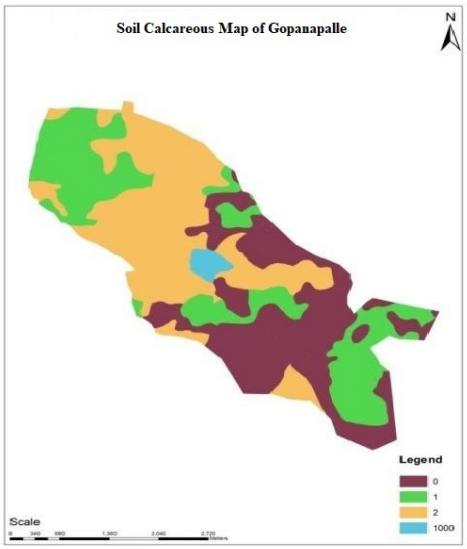

Fig. 3. Gopannapalle Soil Calcareous map

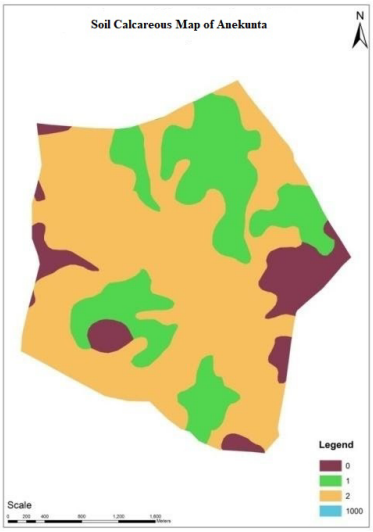

Fig. 4. Anekunta Soil Calcareous map

agement problems in the agricultural sector (Khalefa, 2007). The water used for irrigation contain more inorganic salts as the water seepage over so many earth materials and dissolves most of these substances due to good dissolution capability. These dissolved salts may accumulated in the soil profile to such concentrations and modifies the soil structure, effects the water permeability, and critically injures the plants growth (Rogovska *et al.*, 2009).

In some areas, where the irrigation soil and the water are very salty, and also the land is level, the planted seed effects with the maximum quantity of salt leaches from the seedbed. If it is compulsory to use furrows, then the seeds better to be planted in the bottom of the trench to avoid possible leaching from the seedbed. Crusting sensitivity to slaking, moisture, compaction and other soil morphological characteristics strongly influence the irrigation practices, so that suitable seeds should select to cultivated in the salt affected soils (Loeppert, 2008). Applicability of low-quality water for the effected calcareous soils is better to investigate in irrigation system by determining calcareous soils' susceptibility to secondary salinization. Management of calcareous soils are essential through reclamation and improvement methods in the study area to achieve sustainable agricultural management.

Conclusion

The results shown that 50% of Gopannapalle and 70% of Anekunta villages are evaluated with high calcareous soils. Almost 20 - 30% of the study area is suffering from slight calcareous soils. Based on the extent of lime content obtained from calcareous maps, soil infertility, and soil pH can be reduced by potential fertilizer management and organic manure application to increase its nutrients value. This study further recommended that proper improvement, reclamation and management activities for the high calcareous soils through the following methods. Proper knowledge on the management of calcareous soils should reach the farmers and also the gaps between the farmers and researchers has to be reduced through developmental activities. Significant optimum yields on calcareous soils are possible by recommending the adapted crops and agricultural varieties for the soil calcareous conditions. The study and utilize of the indicator plant species grown in the calcareous soils should encourage in the study area. Effective solutions can be realized to the field problems of calcareous soils, and an intensive cooperative and provincial approach be required to implement these in semi-arid and arid regions of the various nations.

References

Cui Zou, Zesong Wang, Xianping Cui and Yaser Ostovari. 2020. GIS-based digital modeling of soil infiltration in calcareous soils. *Soil and Plant Analysis Journal.* 51-12 : 1590-1601.

Ewa Glowienka, Krystyna Michalowska, Agnieszka Pekala, Beata Hejmanowska, 2016. Application of GIS and Remote Sensing Techniques in Multitemporal Analyses of Soil Properties in the Foreland of the Carpathians. *IOP Conference Series: Earth and Environmental Science.* 44 (5): 052044.

FAO, 2016. *Management of Calcareous Soils.* FAO Soils Portal.

FAO, 2020. Standard operating procedure for soil calcium carbonate equivalent. Titrimetric method, Rome.

Khalefa, 2007. Response of maize to application of microbial activator, sulphur and phosphorus to maize grown on a calcareous soil. *J. Biol Chem. Sci.,* 2(2): 165-188.

Loeppen, R. and Hallmark, 1985. Indigenous soil properties Influencing the availability iron in calcareous soils. *Soil Sci. Soc. Am. J.* 49 : 597-603.

Monier Morad Wahba, Fawkia Labib and Alaa Zaghloul, 2019. Management of Calcareous Soils in Arid Region. *Int. J. of Environmental Pollution & Environmental Modelling.* 2(5): 248-258.

Praveen Raj Saxena, V. Sudarshan, B. Chandrashekar, and Manoj Raj Saxena, 2004. Application of Remote

Sensing, GIS and Geo-Electrical Methods for Ground Water Exploration in Zaheerabad, Medak Dist. A.P., India. PS ICWG II /IV ThS. 13(4), pp-67.

Rasha. The relation between active calcium carbonate and some properties of calcareous soils in North Africa. 2005. Cairo, Univ. of Ins. of African Res. and studies Dep. of Natural Resources.

Loeppert. 2008. Reactions of iron and carbonates in calcareous soils. Journal of plant nutrition. p.no 195-214.

Rogovska, Natalia & Blackmer, Alfred. 2009. Remote sensing of soybean canopy as a tool to map high pH, calcareous soils at field scale. Precision Agriculture. 10:175-187.

Shawky, El-Amir, Nasr, Wahdan and Bakry. 2004. Calcareous soil definition from the hydraulic and physical point of view. *Egypt J. Soil Sci.* 44(1): 97-107.

Taalab, Ageeb, Hanan Siam, Safaa, and Mahmoud. 2014. Some Characteristics of Calcareous soils. *A Review-Middle East Journal of Agriculture.* V-1, p.no: 96-105.