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An Assessment Of Soil Quality And Agricultural Production Status In The Bandalli Watershed Soil Region; A Case Study In Hanur Taluk, Chamarajanagar District, Karnataka, India.

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Abstract
Environmental sustainability will only be accomplished by maintenance and improvement of soil quality. Soil quality is considered as the capacity of soil to function. Soil quality, which can be contained using indicators that interact synergistically, is affected by land use types and agricultural management practices. This study assessed the status of soil quality under three adjacent land uses (cultivated, grazing, and fallow) in the Bandalli watershed (400 ha). Considering the inherent and dynamic factors, are introduced. Soil samples were collected from the surface soil (0-20 cm depth) of the identified land uses with three replications and the soil quality parameters were analyzed. A minimum data set of soil quality indicators were selected from physical, chemical, and biological parameters using the literature review and expert opinion method. Linear scoring functions were used to give the unitless scores for the selected data sets, which were then integrated into a soil quality index (SQI). Although universal recommendations on soil quality and sustainability of soil management must not be done, this study presents general trends in soil quality management strategies. This includes arable land identification, crop diversification, organic matter restoration, tillage intensity, and soil input rationalization.

Keywords: Soil Quality, Soil Quality Indicator, Inherent Soil Quality, Land Use.

Introduction
Agricultural use and management systems have been generally derived without recognizing consequences on soil conservation and environmental quality, and therefore a significant decline in agricultural soil quality has occurred worldwide (e.g., Imeson et al., 2006). Soil erosion and diffuse soil contamination are the major degradation processes on agricultural lands as a consequence of the expansion and augmentation of agriculture. The concept of soil quality can be used to evaluate the health and sustainability of soil and to direct soil research, planning, and

conservation policy (Doran & Jones, 1996; Karlen et al., 1997). Soil quality might be considered as the ability of a soil to fulfill its functions in the ecosystem, which are determined by the integrated actions of different soil properties. Concerning agriculture, soil quality would be the soil's fitness to support crop growth after becoming degraded or otherwise harming the environment. The importance of soil quality lies in adequate sustainable land use and management systems, to balance productivity and environmental protection. Unlike water and air quality, simple standards for individual soil-quality indicators do not expose to be sufficient because several interactions and trade-offs must be considered. For assessing soil quality a multiple integration of static and dynamic chemical, physical, and biological factors use to be defined in form to identify different management and environmental scenarios. Soil-quality assessment, based on inherent soil factors and focusing on dynamic aspects of the soil system, is an effective method for evaluating the environmental sustainability of land use and management exercise (Nortclif, 2002).

However, the process of evaluating soil is not new, and agroecological land evaluation has a lot to action. According to the FAO (1976), "the fitness of a given land unit for a specified type of land use" is how land suitability is described in the context of land evaluation in a more practical sense, appropriateness refers to how well the biophysical potentials and constraints of the land unit match the needs of the land-use type. As a result, future investigations need to be grounded in a thorough knowledge of earlier research (De la Rosa, 2005). Agroecological land evaluation predicts land behavior for each particular use, and soil-quality evaluation forecast the natural ability of each soil to function. However, land evaluation is not the same as soil-quality assessment, because biological parameters of the soil are not considered in land evaluation. Soil surveys are the building blocks of the dataset needed for expedition land evaluation. Soil surveys and soil taxonomy systems are used to define with precision specific soil types.

According to the Soil Quality Institute (USDA, 2006), achieving high aggregate stability, biological activity, or any other soil feature is not the end goal of evaluating soil quality. The purpose is to protect and improve long-term agricultural productivity, water quality, and habitats of all organisms including people. By assessing soil quality; a land manager will be able to determine if a set of management practices is sustainable. For example, agricultural management systems located on the most applicable lands, according to their agroecological potentialities and limitations, are the best way to achieve sustainability.

To assess soil quality, evaluate long-term potential and constraints (inherent soil aspects), and monitor short-term changes (dynamic soil aspects) in response to sustainable soil use and management, it is necessary to examine integrated and multidisciplinary techniques. The characteristics of soil are both inherent and dynamic (USDA, 2006). A soil's ability to function naturally is its inherent characteristic. Compared to soils where bedrock is close to the surface, deep soil has greater space for roots. When comparing a soil's capabilities to those of another and assessing a soil's worth or suitability for a particular use, soil's inherent qualities are sometimes utilized as a benchmark. Dynamic soil quality refers to how soil varies based on management practices. Management choices affect the amount of soil organic matter, soil structure, and water- and nutrient-holding capacity. According to the soil factors considered, soil quality can be physical, chemical, or biological. Most of the physicochemical factors are related to inherent soil quality and biological and some physical factors are dynamic soil quality. Although soil quality often focuses on biological aspects, this must not diminish the importance of physical and chemical factors (Ball & De la Rosa, 2006). It focuses on the possibilities for applying and integrating accumulated knowledge on land-evaluation modeling, to predict soil-quality indexes. Advanced information technologies, which enable the integration of large and complex databases, models, tools, and techniques, are proposed to improve the decision-making process in soil-quality assessment applications. Finally, general trends in soil-quality management strategies are discussed.

Materials And Methods

Study Area:

Bandalli watershed village is roughly in the southwestern part of the Hanur taluk of Chamarajanagar district, Karnataka. The total geographical study zone of the Bandalli watershed village is 400sq.km it comes under the Survey of India toposheet nos. 57H/4 and 57H/8 on a scale of 1:50,000 all the villages are well connected by better roads. The study area lies partly in semi-forest (reserved) and partly in the maidan tract and is situated in the southwestern part of Karnataka state between 12°09′56.3″ North latitude and 77°21′06.5″ East longitude. With an altitude that ranges from 625 to 850 meters above sea level. The area falls into the Archean-Proterozoic Gneiss of Southern Karnataka, which is classified as semi-arid with Gneisses occupying the total area. The study area receives a mean annual rainfall of 700 mm. The mean minimum and maximum annual air temperatures of the area are 18 and 34 ºC, respectively, with a mean annual air temperature of 26 ºC. The study area belongs to one of the five taluks of Chamarajanagar district it's one of the 30th districts in Karnataka state; it's predominately dependent on agriculture. It shows low, narrow, alluvial plain structures. (Fig.1)

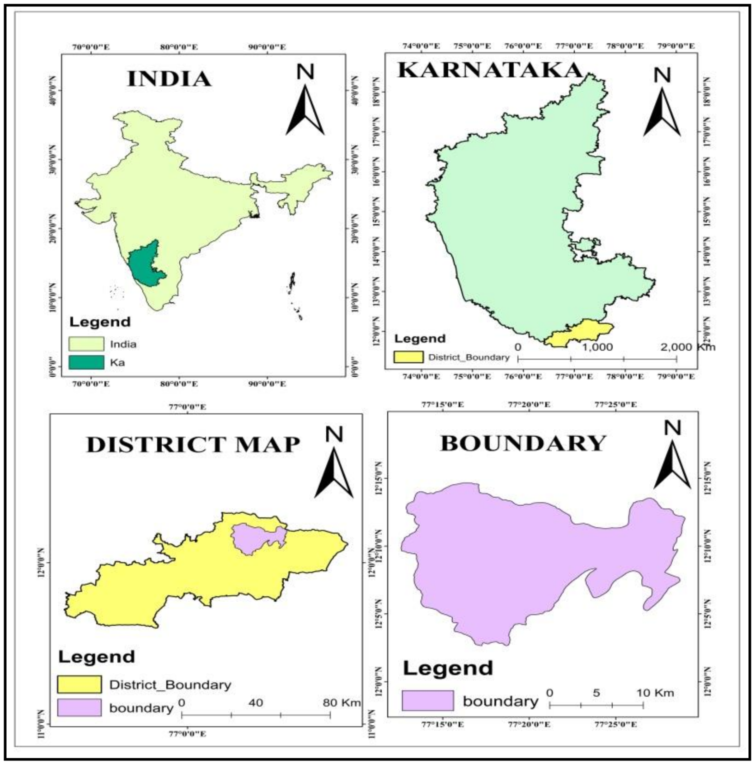

Fig. 1: Location Map Of The Study Area.

Methodology

Using Satellite sources of the United States Geological Survey (USGS) website and georeferenced to (Universal Transverse Mercator) UTM zone 43, WGS 84 at a 30m resolution. The analysis tool in Arc-GIS was used to produce multiple thematic maps of land use/land cover, Geomorphological, and drainage structures considered for the delineation of soil quality and methods for its assessment. Hydrosoil maps were created using coverage developed by the Geological Survey of India. Spatial or regional analysis includes the use of spatial techniques to expand land evaluation results from point to geographic areas, using soil surveys and other related maps. Furthermore, digital satellite images can be incorporated directly into many GIS maps and area estimates and enables many of the analytical and visualization operations to be carried out in a spatial format, by combining different sets of information in various ways to produce overlays and interpreted maps.

Soil Quality

As suggested in the early 1990s, soil quality is “the capacity of a soil to function”. More specifically, soil quality has been defined by a committee for the Soil Science Society of America (Karlen et al., 1997) as the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. Also, soil quality can be considered as the ability of soil to fulfill its functions in the ecosystem, which are determined by the integrated actions of different soil properties. Concerning agriculture, soil quality would be the soil’s fitness to support crop growth without becoming degraded or otherwise harming the environment.

Clay soil, clay loam soil, gravelly loam sand, red soil, and other types of soil cover most of the area (Fig.2). These soils are ideal for growing various vegetables, crops, and seeds. Soil's role of permeability is an important characteristic that influences the recharging and storage of water through the Porous of the soil layers. The amount of sand and clay in the soil determines the textural class (Fig.3). Because of their ability to hold more water, very fine and medium-grained sizes of soil are better suited for agricultural purposes.

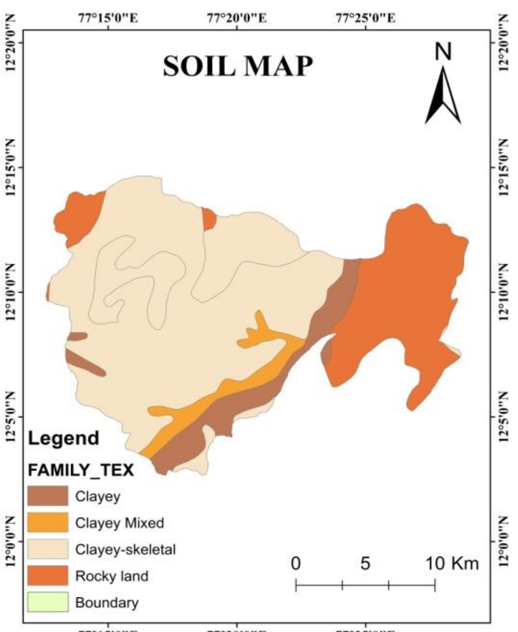

Fig 2. Soil Map Of the study area

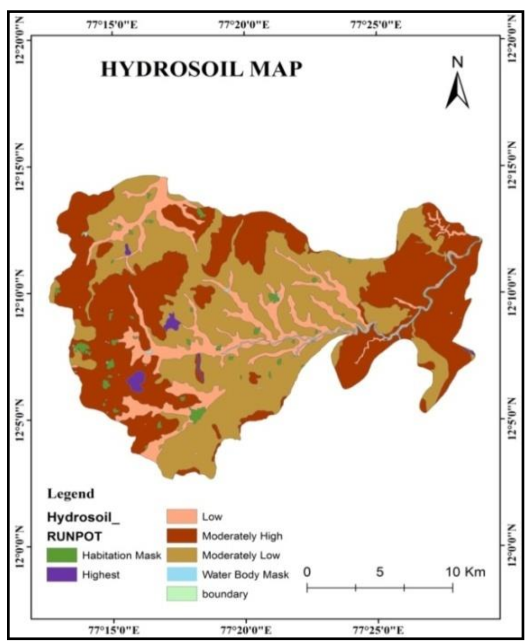

Fig 3. Hydrosoil Map of the study area

Table 1 Specific Soil Functions Considered For Several Soil Quality Issues

Soil-quality issue	Soil function
Crop growth	Plant root penetration, Plant water-use efficiency, Water and

	air-filled pore space, Water infiltration.
Natural fertility	Nutrient availability, Cation-exchange capacity, Acidity, Salinity/alkalinity, Toxicity.
Erosion risk	Runoff potential, Erodibility, Cover protection, Sub-soil compaction.
Compaction risk	Water retention, Water infiltration, and Cohesion.
Contamination risk	Leaching potential, Toxic absorption, Toxic mobility, Chemicals degradation.

Crop Diversification

Crop diversity is helpful for several reasons. Each crop contributes a unique root structure and type of residue to the soil. A diversity of organisms can benefit the control of pest populations, and a diversity of cultural practices can reduce weed and disease pressures. Diversity across the landscape and over time can be increased by using buffer strips, small fields, contour strip cropping, crop rotations, and by varying tillage practices. Changing vegetation across the landscape or over time increases plant diversity, and the types of insects, microorganisms, and wildlife (USDA, 2006). In contrast, the simplification of crop rotation as a relevant element of arable intensification has led to soil decomposition and other unfavorable environmental impacts. These areas of Lu/Lc were predetermined to recognize and map the various Lu/Lc classifications. Major Lu/Lc elements are buildup land, cropland, fallow land, plantation, forest, and scrub forest; a total of 43% of the area falls beneath agriculture remaining Forest and scrub land accounted for 32% and 25% of the total area respectively (Fig.4). Although these sites have good groundwater recharge structure, they are often limited.

Within agricultural lands, complete soils can be used for almost all crops if sufficient inputs are supplied. The application of inputs might be that it dominates the conditions in which crops are grown, such as it can be the case in greenhouse cultivation. However, each soil unit has its potentialities and circumspection (soil suitability), and each crop has its biophysical requirements. To minimize the socio-economic and environmental costs of such inputs, the second major objective in managing soil quality is to predict the inherent suitability of a soil unit to support a specific crop for a long period. This kind of study provides a rational basis to diversify agricultural soil systems considering all the possible crops (De la Rosa & Van Diepen, 2003). These natural standard soils supporting mature vegetation would be used as high-quality reference soils, because of the ideal balance existing between their physical, chemical, and biological properties. The selection of soil indicator attributes should be based on: (i) land use (ii) soil function (iii) reliability of measurement (iv) spatial and temporal variability (v) sensitivity to changes in soil management (vi) comparability in monitoring systems and (vii) skills required for the use and interpretation (Nortcliff, 2002). As shown in Table.3, USDA (2006) select seven physical, three chemical, and two biological indicators.

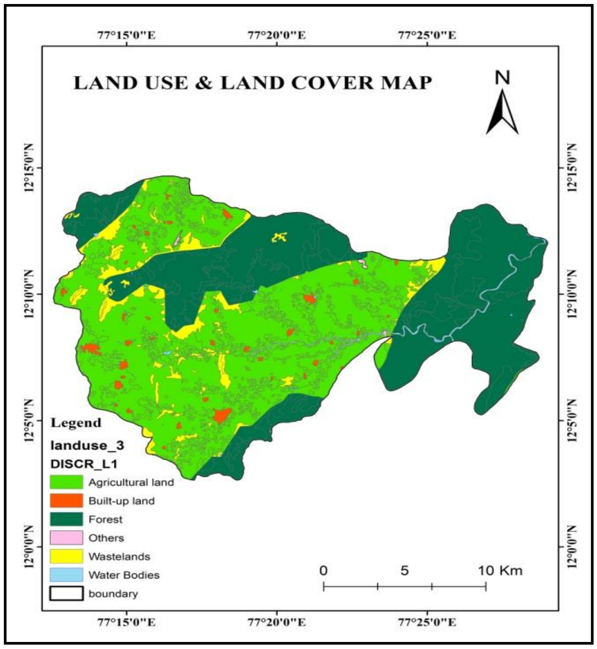

Fig 4. Lu/Lc Map Of The Study Area

Table 2. Comparison Of Present Land Uses And Agroecological Land-Capability Classes In Bandalli Watershed Region.

Category	Estimated Extension (400 ha)	Percentage (%)
Present Land Use		
Irrigated agricultural lands	200	50
Rainfed agricultural lands	23.67	5.91
Forestry, grazing, and natural lands	154.39	38.59
Others	21.96	5.49
Land Capability Class		
S1. Excellent agricultural lands	105.24	26.31
S2. Good agricultural lands	111.84	27.96
S3. Marginal agricultural lands	94.74	23.68
Nonagricultural lands	88.18	22.05

Table 3. Soil Attributes That May Be Used As Indicators Of Soil Quality

Grouping Type	Soil Indicators
Physical Attributes	Soil texture, Stoniness, Soil structure, Bulk density, Porosity, Aggregate strength and stability, Soil crusting, Soil compaction, Drainage, Water retention, Infiltration, Hydraulic conductivity, and Topsoil depth.
Chemical Attributes	Color, Reaction (pH), Carbonate content, Salinity, Sodium saturation, Cation exchange capacity, Plant nutrients, and Toxic elements.
Biological Attributes	Organic matter content, Populations of organisms, Fractions of organic matter Microbial biomass, Respiration rate, Mycorrhizal associations, Nematode communities, Enzyme activities, Fatty acid profiles, Bioavailability of contaminants.

Results

The results disclosed that bulk density, aggregate stability, pH, cation exchange capacity (CEC), available P, and soil organic carbon (SOC) had a significant difference in SQI among the different land uses. The soil quality indices were 0.69 for grazing land, 0.62 for cultivated land, and 0.59 for fallow land. The SQI of all the land uses falls in the intermediate soil quality ($0.55 < SQI < 0.70$) class. Thus, the result of this study highlighted the potential of the land use types in improving or sustaining soil quality. Hence, locally appropriate soil fertility, productivity, and integrated soil conservation practices, as well as enhancing soil organic matter also other attributes should be identified and implemented. These will contribute significantly to the maintenance of soil quality for sustainable agricultural production in the study area.

Conclusion

Maintenance and improvement of soil quality is one of the most important prerequisites to accomplishing environmental sustainability. Despite the massive controversy (Sojka & Upchurch, 1999), the modern concept of soil quality is a valid and important framework for interpreting scientific soil information and predicting sustainable soil use and management. Soil-quality indicators are important tools and are finding increasing application. However, dynamic soil indicators should be measured after the estimation of inherent soil indicators. An agroecological approach follows two steps: (i) developing long-term, inherent, specifically physicochemical evaluation, and (ii) short-term, dynamic, specifically biological evaluation (De la Rosa, 2005). The focus on biological approaches must not decline appreciation of the physical and chemical factors, to develop a productive integration of the three sets of factors. The selected case study points out that soil-quality aspect are inherent and dynamic, and can be measured and explained through land-evaluation modeling and simple indicators comparison, respectively.

However, several general principles can apply in most situations across international boundaries. These basic principles of sustainable agricultural practices focus on the positive effects on soil quality: (i) increased organic matter (ii) decreased erosion (iii) better water infiltration (iv) more water-holding capacity (v) less subsoil compaction and (vi) less leaching of agro-chemicals to groundwater. To achieve these objectives, the following sustainable soil use and management strategies will be developed. (i) Arable land identification (ii) Crop diversification (iii) Biomass restoration (iv) Appropriate tillage intensity and (v) Soil input rationalization.

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Conflict Of Interest: There are no conflicts of interest among the authors.

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