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# Assessment of Physical Properties of Soil from Different Blocks of Coastal Areas, Ganjam District of Odisha, India

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

An investigation was conducted to analyse the physical properties of soils of different blocks of coastal areas of Ganjam district of Odisha. For this purpose, the soil samples were collected at three depths: 0-15 cm, 15-30 cm, and 30-45 cm, from nine different villages of three different blocks of coastal areas, a total of 27 samples collected and analysed for their physical parameter by using standard Laboratory Technique. The result showed that the Soil Texture of Chatrapur, Rangeilunda, and Chikiti block varied from Sandy loam to Sandy clay loam. The Bulk Density reported 1.31-1.36 Mg $m^{-3}$, Particle Density reported 2.41 to 2.59 Mg $m^{-3}$, Specific gravity varied

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from 2.61 to 2.69, Percent of Pore Space varied 44.56 to 48.13 Percent, Water Retaining Capacity ranged 42.98 to 45.92 Percent. Results suggest that farmers should adopt appropriate soil management techniques, such as crop rotation and conservation tillage, which will contribute to maintain the soil physical characteristics to ensure the sustainability of agricultural practices and the long-term health of the soil.

*Keywords: Physical; parameters; coastal areas; Ganjam; Odisha.*

## 1. INTRODUCTION

“The soil is a complex organization being made up of some six constituents’ namely inorganic matter, organic matter, soil organisms, soil moisture, soil solution and soil air. The physical properties of the soil depend upon the amount, shape, structure, size, pore spaces, organic matter, and mineral composition of soil. These physical properties are soil texture, bulk density particle density, percent pore space, water holding capacity, soil structure, soil colour” [1]. “Knowledge of vertical distribution of plant nutrients in soils is useful, as roots of most of the crops go beyond the surface layers and draw part of their nutrient requirement from the sub surface layers. Soil profile characteristics as conditioned by different processes and factors of soil formation have great influence on soil fertility and crop productivity” [2]. “Bulk density is the weight of dry soil per unit volume, while particle density is the weight of dry soil solids per unit volume. High bulk density indicates low porosity, compaction, and poor soil health. It reduces vegetation, increases erosion risk, and causes waterlogging on flat surfaces. Particle density is inversely proportional to bulk density. Porosity refers to the volume of soil voids filled with water and air. It is influenced by particle size, shape, and packing. Particle density is not affected by pore space, size, or arrangement of soil particles” [3]. “Water retaining capacity provides useful information for irrigation scheduling, crop selection, ground water contamination considerations, estimating runoff and determining when plants will become stressed. Soil moisture available for plant growth makes up approximately 0.01 percentage of world's store water. The physical properties are also interlinked. Soil texture and structure greatly influence water infiltration, permeability, and water retaining capacity” [4]. The more you know about your soil, the better you can care for it. The state of Odisha in India has a unique geography that is divided into five distinct morphological units. These units include the Mountainous and Highlands Region, Coastal Plains, Western Rolling Uplands, Central Plateaus, and Flood Plains. Laterite and lateritic soil are the most found types of soil in the state. The Ganjam district of Odisha, which covers an area of 8,070 square kilometers, is divided into two divisions, the Coastal plain area in the East and hill and table lands in the West located on the border of Andhra Pradesh. The importance of soil in India cannot be overstated, as it provides essential resources for shelter, food and economically important materials or ores. Agriculture supports a large population in India, making it crucial to ensure the soil remains healthy and productive for the long-term. To achieve this, a study was conducted to gather extensive information regarding the soil characteristics of nine selected villages in the Ganjam district of Odisha. The aim was to develop effective soil management strategies that can enhance long-term agricultural productivity while preserving soil health. Soil samples were collected from the study area and analysed in the laboratory using standard methods to determine their physical properties. The unique geography of the state provides a diverse range of soil types, which must be managed effectively to ensure their long-term productivity. The study conducted in the Ganjam district is an essential step towards developing effective soil management strategies for the region and can serve as a model for other regions in India facing similar challenges.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Ganjam is a district situated in the southern part of the Indian state of Odisha, along the coast of the Bay of Bengal. The district covers a total area of 8,070 square kilometers, which is approximately 6.69% of the total geographical area of the state. The district headquarters is in the city of Chatrapur, which lies between 85° 3' 5.55'' E Longitude and 19° 23' 14.59'' N Latitude. The topography of Ganjam district is diverse and characterized by a range of landforms, from the high mountains of the Eastern Ghats to the sandy beaches of the coast. The district experiences a hot and humid climate for most of the year, with temperatures ranging from 20°C to 40°C. The average annual rainfall in the district is around 1431 mm. The winter season in the district is relatively mild, with temperatures ranging from 15°C to 30°C.

## 2.2 Soil Sampling

A total of twenty-seven soil samples were collected from nine different villages in three different blocks of coastal areas, Ganjam district namely Chatrapur, Rangeilunda, and Chikiti. Samples were collected from three different depths *i.e.,* 0-15cm, 15-30cm and 30-45cm. Soils were collected with the help of Spade and Khurpi from Crop fields making V-shaped method. Those samples were dried in shade place and large clods were broken down by using wooden mallet and separated the larger particle of soils by using 2 mm sieve. After that, Soils were collected in a polythene bag and were labelled properly for Laboratory analysis.

## 2.3 Analysis of Physical Parameters

The collected samples were analysed for physical parameters. “Soils were analysed for its textural class by Bouyoucos Hydrometer method (Bouyoucos, 1927), Bulk density and Particle density was determined by graduated Measuring Cylinder method [5], The relative density bottle or pycnometer method, as given by black, 1965 to determine the Specific gravity of soil. The graduated 100 ml measuring cylinder method was used to determine Pore space and Water Retaining Capacity [5].

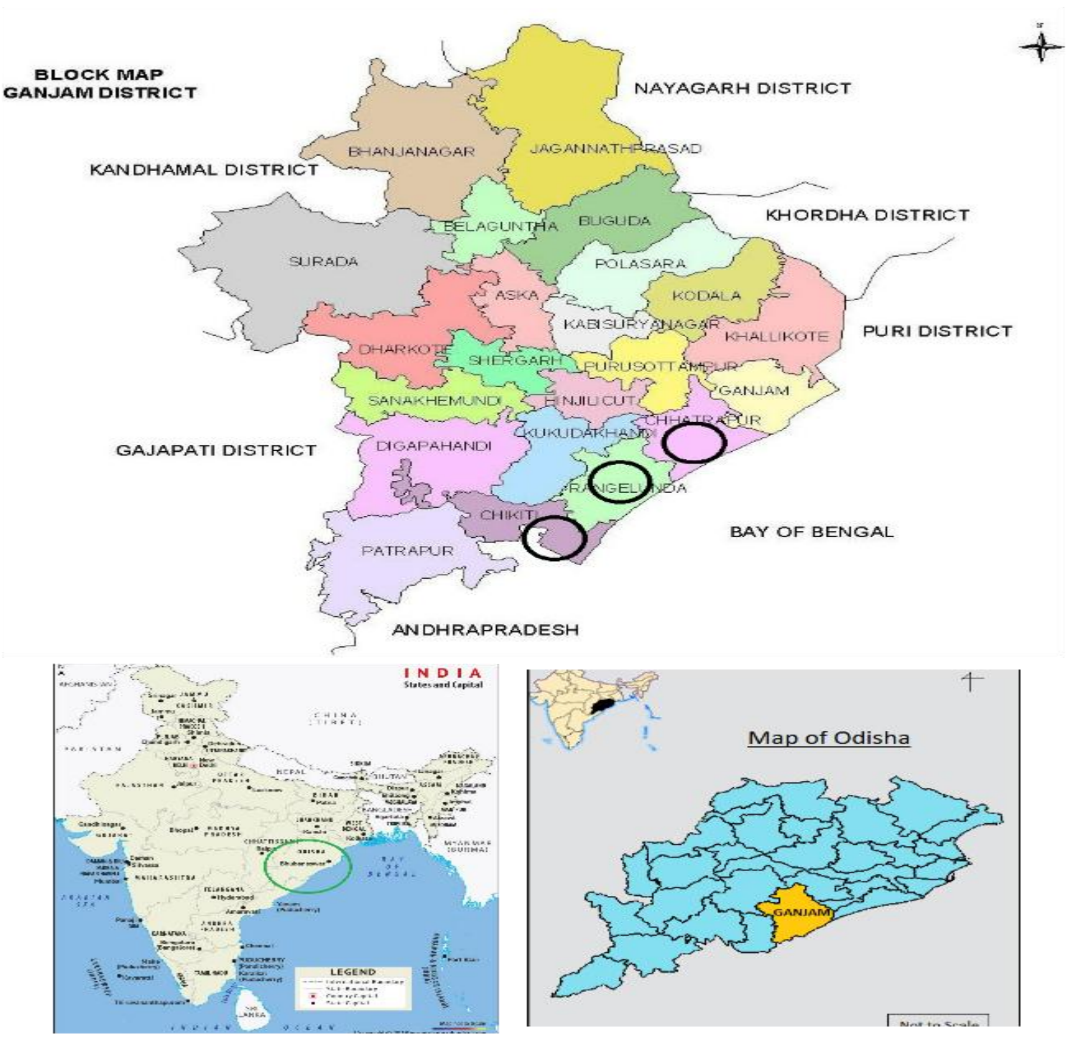


**Fig. 1. Location Map of Study Area**

## 3. RESULTS AND DISCUSSION

### 3.1 Soil Texture

The Soil Texture under investigation varies from from Sandy loam to Sandy clay loam, sand content varied from 68- 78%, silt 5-11% and clay 13-26% (Table 1). Similar results reported by Behera et al. [6]. ($B_1V_1$) Chamakhandi village has found sandy loam due to more sand percentage, while ($B_1V_2$) Podapadar, ($B_1V_3$) Bipulingi village reported sandy clay loam. Whereas in villages of Rangeilunda block it is sandy loam due to the sand dominated fractions, in villages of Chikiti block texture is sandy loam except ($B_3V_9$) Pitatali village which is sandy clay loam. The high content of clay in these soil makes it fit for cultivation [7].

### 3.2 Bulk Density, Particle Density and Specific Gravity

The Bulk density of soils from different villages was varied from 1.31-1.36 Mg $m^{-3}$ (Table 2). ($B_3V_8$) Sorala and Chamakhandi ($B_1V_1$) village reported lowest and ($B_3V_9$) Pitatali village reported highest Bulk density. Which indicates that the soil is widely composed of Clay and aggregated Loams. Bulk density was found to increase with increase in depth due to increase in compaction in the subsurface comparatively [8]. The range of Particle density of soils was varied from 2.41 to 2.59 Mg $m^{-3}$ (Table 2). ($B_3V_7$) Girisola village reported lowest and ($B_1V_2$) Podapadar village reported highest Particle density, Particle density of soil varies according to the mineral composition of the soil particle [9]. The range of Specific gravity was varied from 2.61 to 2.69 (Table 2). ($B_2V_5$) Boxipalli village reported lowest and ($B_1V_2$) Podapadar village reported highest specific gravity similar findings also reported by Jena et al. [10] and Mohanta et al. [11].

### 3.3 Pore Space and Water Retaining Capacity

The range of Pore space was varied from 44.56 to 48.13% (Table 2). ($B_3V_9$) Pitatali village reported lowest and ($B_1V_2$) Podapadar village reported highest porosity. Pore space was found to decrease with increase in depth in the villages. Addition of organic matter increases the porosity of the soil. Same result was done by Sahu et al. [12]. The range of Water Retaining Capacity varies from 42.98 to 45.92 % (Table 2). The lowest Water Retaining Capacity was observed in ($B_3V_9$) Pitatali village and highest observed in ($B_1V_2$) Podapadar village. The variation of water retaining capacity of soil is due to soil texture and organic matter content in the soil. The irregular trend of WRC with depth due to illuviation and eluviation of finer fraction in different horizons. Similarly reported by Chaudhari et al. [13].

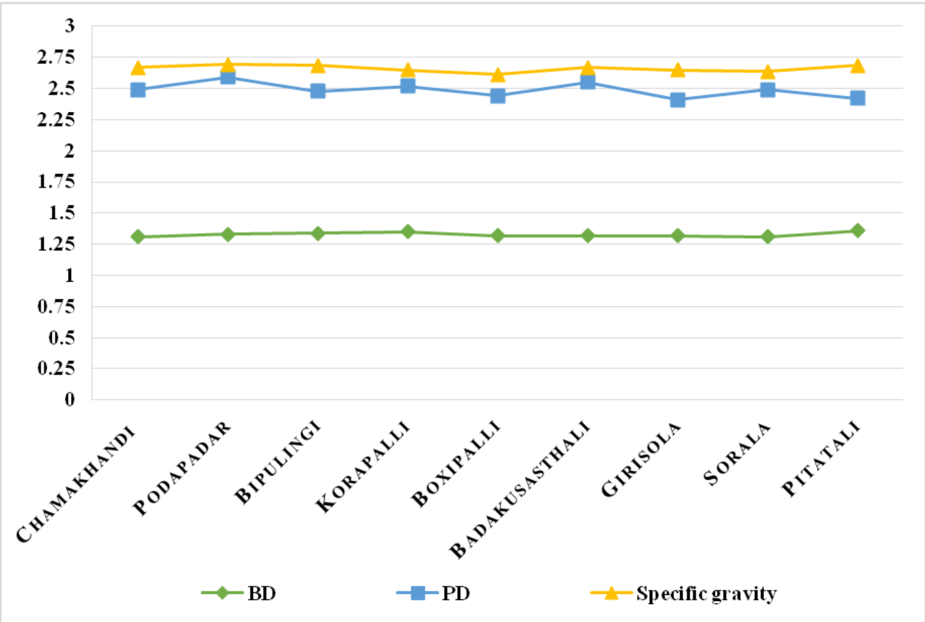


**Fig. 2. Bulk density (Mg $m^{-3}$), Particle density (Mg $m^{-3}$) and Specific Gravity**

**Table 1. Physical Properties**

| Block | Village | Sand | Silt | Clay | Textural Class |
|---|---|---|---|---|---|
| **Chatrapur ($B_1$)** | **$V_1$** | 74.26 | 10.94 | 14.80 | Sandy loam |
| | **$V_2$** | 68.66 | 6.84 | 24.50 | Sandy clay loam |
| | **$V_3$** | 69.10 | 6.23 | 24.67 | Sandy clay loam |
| **Rangeilunda($B_2$)** | **$V_4$** | 72.34 | 8.10 | 19.56 | Sandy loam |
| | **$V_5$** | 75.23 | 9.14 | 15.63 | Sandy loam |
| | **$V_6$** | 76.73 | 8.30 | 14.97 | Sandy loam |
| **Chikiti ($B_3$)** | **$V_7$** | 77.56 | 8.93 | 13.51 | Sandy loam |
| | **$V_8$** | 77.00 | 6.30 | 16.70 | Sandy loam |
| | **$V_9$** | 69.33 | 5.13 | 25.54 | Sandy clay loam |

**Table 2. Physical Properties**

| Block | BD (Mg $m^{-3}$) | | PD (Mg $m^{-3}$) | | Specific Gravity | | Pore space (%) | | WRC (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Range** | **Mean** | **Range** | **Mean** | **Range** | **Mean** | **Range** | **Mean** | **Range** | **Mean** |
| **$B_1V_1$** | 1.27 – 1.35 | 1.31 | 2.48 – 2.51 | 2.49 | 2.77 – 2.59 | 2.67 | 48.80 - 46.21 | 47.27 | 46.36 – 45.01 | 45.53 |
| **$B_1V_2$** | 1.28 – 1.39 | 1.33 | 2.58 – 2.61 | 2.59 | 2.80 – 2.51 | 2.69 | 49.38 – 46.74 | 48.13 | 47.81 – 44.72 | 45.92 |
| **$B_1V_3$** | 1.31 – 1.39 | 1.34 | 2.47 – 2.50 | 2.48 | 2.76 – 2.60 | 2.68 | 46.97 – 44.40 | 46.12 | 44.98 – 42.38 | 44.12 |
| **$B_2V_4$** | 1.32 – 1.40 | 1.35 | 2.51 – 2.54 | 2.52 | 2.71 – 2.58 | 2.65 | 47.42 – 44.89 | 46.45 | 46.29 – 43.11 | 45.20 |
| **$B_2V_5$** | 1.26 – 1.39 | 1.32 | 2.43 – 2.46 | 2.44 | 2.68 – 2.55 | 2.61 | 48.15 – 43.50 | 45.92 | 47.02 – 42.12 | 43.80 |
| **$B_2V_6$** | 1.28 – 1.37 | 1.32 | 2.54 – 2.56 | 2.55 | 2.73 – 2.61 | 2.67 | 49.61 – 46.49 | 47.98 | 47.83 – 45.42 | 45.57 |
| **$B_3V_7$** | 1.26 – 1.39 | 1.32 | 2.40 – 2.43 | 2.41 | 2.69 – 2.60 | 2.65 | 47.50 – 42.80 | 45.25 | 46.24 – 41.91 | 43.53 |
| **$B_3V_8$** | 1.22 – 1.40 | 1.31 | 2.48 – 2.51 | 2.49 | 2.70 – 2.56 | 2.64 | 49.81 – 44.23 | 47.08 | 47.18 – 43.10 | 44.44 |
| **$B_3V_9$** | 1.31 – 1.43 | 1.36 | 2.41 – 2.44 | 2.42 | 2.76 – 2.58 | 2.68 | 45.65 – 43.40 | 44.56 | 43.51 – 42.58 | 42.98 |

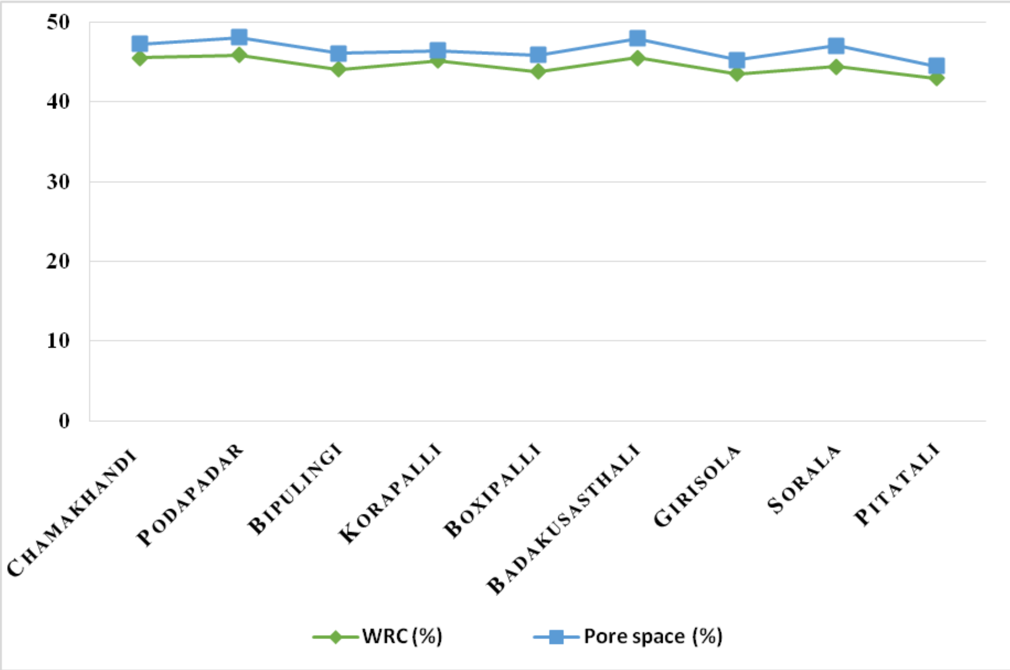


**Fig. 1. Pore Space (%) & Water Retaining Capacity (%)**

## 4. CONCLUSION

Based on the experimental results, it can be concluded that in the villages of coastal blocks of Ganjam district indicates that the soil physical characteristics, including bulk density, particle density, specific gravity, pore space, and water retaining capacity, are well within the acceptable range of parameters. This suggests that the soil in these areas is suitable for agricultural practices, and may not require any significant interventions to improve its physical properties. However, practicing appropriate soil management techniques, such as crop rotation and conservation tillage, which will contribute to maintain the soil physical characteristics to ensure the sustainability of agricultural practices and the long-term health of the soil.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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