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Landform Soils Relationship in Coastal Odisha – Major Problems and Management

R. Srinivasan[1]*, D. C. Nayak[1], S. K. Singh[2] and S. K. Reza[1]
[1]ICAR-National Bureau of Soil Survey and Land Use Planning, RC, Kolkata-700091, India
[2]ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur -440010, India
***Email of corresponding author:** srinivasan.surya@gmail.com

Coastal areas occur in river deltas and in narrow strips of land ranging from a few kilometers to about 50 km close to the sea coast along the low lying lands, estuaries and inland depressions of Odisha. Coastal land, one of the important production systems occupying an area of about 10.78 million ha has a significant contribution to the food grain production of our country. Major landforms are presented in Odisha coastal is foot hills, upland, alluvial plain and coastal plain. The areas are facing the major problems viz. erosion, salinity, improper drainage and poor nutrients status etc. Therefore to increase the productivity and cropping intensity of coastal areas, location specific and appropriate management practices are needed depending on the existing problem.

Introduction

Coastal regions, home to a large and growing proportion of the world's population, are undergoing environmental threat. The reasons for environmental decline are complex, but population factors play a significant role. The coastal agro-ecosystem occupies vast area of land in India. About 20% of the population of India lives in coastal areas. In coastal agro-ecosystem, with the increasing human and animal population, the competition between various land uses has become intensive. Odisha coast line has extended from east to southern, about 445 km. Besides, there is narrow strip of land of few km in width along the sea coast which is saline (Chaudhary *et al.* 2008). The coastal soils are formed mainly in the deltaic alluvium of the Subarnrekha, Brahmani, Baitarani, Mahanadi, Rushikulya and other minor rivers. These lands may be of low or high relief, sand bars running parallel to the coast and lacaustrine sediment of Chilka Lake. The soils of high relief are found on the slopes of hill range constituting sedimentary and igneous rocks and are often characterized by lateritic capping of uneven thickness. Soils of lacustrine sediment of Chilika Lake are affected by salt due to flooding of brackish water during monsoon and build up of sub-soil salinity due to high ground water table in low lying areas in dry season. Major landforms in Odisha coastal is foot hills, upland, alluvial plain and coastal plain. Thus soil development is varied in same climatic condition with different slope, parent materials, topography and biological activity. Soil is one of the most important natural resources and proper understanding of its development and properties are necessary for judicious, beneficial and optimal use on suitable land for crops (Jagdish *et al.* 2009). Yield of the crops depend on various factors. The reasons for yield variations are assigned to the variation in landforms (hilly terrain and plains), land use, management practices and the soil itself (Tamgadge *et al.* 2002). To

achieve sustainable yields of different crops, its needs the knowledge on different land form, soil characteristics and assessing the major problems is an essential requirement.

Major Landforms and Soils Formation

Coastal Odisha is located in eastern part of the state, which comes under agro- ecological sub region (AESR) of 18.4. The mean annual rainfall is 1449 mm and more than 60-70% is received during south-west monsoon (June-September). The mean maximum summer temperature is 39°C and is mean minimum winter temperature is 11.5°C. The soil temperature class is "*hyperthermic*" and moisture regime is "*ustic*" which is hot humid plain with LGP of 180-210 days. Major Soils (Foothills and upland) consist of moderately deep to deep, well-drained and gravelly to extremely gravelly clay soils on weathered gneiss. The gravel content increases with depth. These soils are on the foothills to uplands mostly with a slope gradient of 1 to 5% (Table.1).

Table .1: Major landforms, soil characteristics and constraints

Landforms	Land use	Slope %	Drainage	Erosion	Texture	pH	EC (dS m^{-1})	OC (%)	Major problem
Foothills	cashew	3-5	well	severe	sl-gcl-gsc-gscl-r	5.9-6.4	0.03-0.07	0.94-0.26	Erosion
Upland	vegetables	1-3	well	Moderate	ls-sl-scl-c-c	6.3-5.5	0.12-0.10	0.17-0.18	Erosion
Alluvial plain	Paddy-pulses	0-1	Somewhat poorly	Very slight	c-c-cl-c-c	6.5-8.1	0.64-1.80	1.13-0.18	Salinity
Coastal plain	cashew	3-5	Somewhat excessive	moderate	s-s-s	7.7-7.9	0.45-0.46	0.22-0.01	Wind erosion

The erosion is severe to moderate, which is indicated by the large amount of gravel present (more than 35%) at the surface of the soils (Fig.1). Dark reddish to red soil colour may be due to presence of sesquioxides as the colour is the function of chemical and mineralogical composition as well as textural make up of soil and conditioned by topographic position and moisture regime (Walia and Rao, 1997). Soil is generally acidic and has low cation exchange capacity (CEC), low to moderate base saturation. Surface crusting, poor inherent fertility, P fixation, aluminium toxicity, soil erosion etc, are the major constraints in these soils (Sehgal *et al.* 1998). Alluvial plain consists of very deep, somewhat poorly drained, (up to 100 cm), saline nature, clayey soils found on weathered gneiss. These soils occur on almost plain lowlands with a slope gradient of less than 1.0 %. The depth of the solum is more than 150 cm. The organic matter status ranges between 0.18 and 1.13 per cent. In the lower horizons below 75 cm, common to many iron nodules are noticed. Flooding occurs usually in rainy season. Salt content (EC) is varied from 0.64 to 1.80 dSm^{-1}. Excess salinity is due to the presence of saline ground water table at shallow

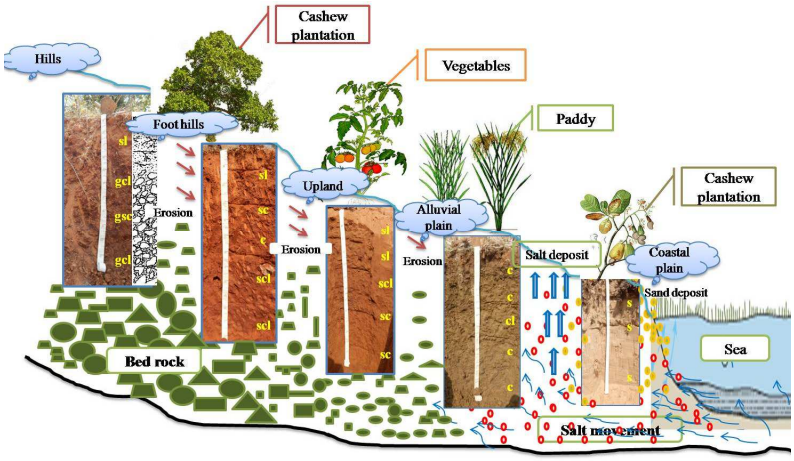

Fig .1: Relationships between landforms, soils and vegetations

depth and frequent brackish water inundation in the low lying areas (Fig.1). The ground water is generally influenced by sea and brackish water estuaries and it reaches the soil surface through capillary rise during dry season, evaporates from the soil leaving salts behind, finally making the soil saline and unproductive for agricultural crops. The soil salinity thus shows high temporal and spatial variation depending on the elevation, soil texture, climate, drainage and other related factors. Coastal plain consists of very deep, somewhat excessive drained, slight saline, sandy nature found in near to sea. These soils occur on almost undulating landform with a slope gradient of 3-5 per cent and subjected to moderate wind erosion. The depth of the solum is more than 150 cm. The organic matter status ranges between 0.01 and 0.22 per cent. The major problems are soil texture which is sandy nature; therefore poor water holding capacity and nutrients status and also during summer, wind erosion also found in this region.

Management of Approaches in Coastal Soils to Improve the Crop Productivity

Erosion

Topsoil is lost through soil erosion. This can reduce soil quality and cause water pollution. The effects of soil erosion as well as preventive measures, includes increased vegetation, terracing, crop rotation and strip cropping.

Tillage: Conservation cropping practices in plain area during summer, that maintain cover on soils include minimum and zero tillage practices.

Contour banks and strip cropping: Runoff concentration is managed by structural measures such as contour banks in upland areas, or strip cropping on floodplains. These systems involve a total change in

- Cultivating steep slopes.
- The less you tear up the top layers of soil, the more resistant that soil is to water runoff.
- Plant filter strip in low lying gullies and runoff areas which reduces speed of water.
- The grasses and small trees on those steep slopes can able to control.
- Use strip cropping to control erosion in windy areas.
- Consider using a cover crop (especially legumes) during off season times.
- Plant more trees in line for windbreaks in coastal sea shores.

The land's position, soil type and slope determine how vulnerable it will be to erosion. It may not be suitable for agriculture, or suitable only for an activity which limits erosion. Soil erosion can be avoided by using land within its capability. The steeper slopes and shallower soils suitable for growing forest trees and pastures, and the lower slopes and deeper soils suitable for cashew crops

Salinity

***Improving drainage*:** In soils with poor drainage, deep tillage can be used to break up the soil surface as well as claypans and hardpans, which are layers of clay or other hard soils that restrict the downward flow of water. Tilling helps the water movement downward through the soil. Water of suitable quality can be used to irrigate adjacent areas and installing sub-surface drainage is also able to control the soil salinity. Irrigation regimen and intervals must be appropriate to the soil conditions and to growth stage of the crop. Frequent and shallow (superficial) applications result in salt accumulation in the root zone, while larger applications, in longer intervals, will flush the salts below the root zone.

***Leaching*:** It can be used to reduce the salts in soils. You must add enough low-salt water to the soil surface to dissolve the salts and move them below the root zone. The water must be relatively free of salts particularly sodium salts.

***Reducing evaporation*:** Applying residue or mulch to the soil can help lower evaporation rates.
Use appropriate fertilizers: The fertilizers type and their quantities should coincide with to the requirements of the crop and with nutrients which are already in the soil. There are fertilizers which contain salts which are not taken up by plants in large amounts, such as chlorides. These salts tend to accumulate in the soil.
***Chemical treatments*:** Before leaching saline soil, must be treated with chemicals remediation, to reduce the exchangeable sodium content. To remove or exchange with the sodium, add calcium in a soluble form such as gypsum.
Growing of suitable crops: In coastal areas rice is the most preferable crop, which is salt tolerant and can be grown under submerged condition. Rice cultivation promotes the leaching of salts from coastal saline soils. Selection of suitable rice variety depending upon the salinity level and depth of water regime is highly appreciable.
Nutrient management: Most of the coastal soils are deficient in nitrogen due to heavy loss through volatilization, leaching and run-off. Phosphorus deficiency is also a common phenomenon in coastal saline soils. Use of nitrogenous fertilizers is very much essential to obtain higher yield of crop in coastal saline soils. Application of rock phosphate as phosphorus source is highly beneficial.

Conclusion

Odisha coastal have different landforms with varied soils characteristics. The major problems during rainy season are soil erosion in uplands and flooding in low lands. During summer severe salinity occurs in near to coastal and also wind erosion is found in sandbar. The management practices should be based on the problems of the area and proper management and planning can reduce or improve the soil health and sustaining livelihood in Odisha coastal system

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