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Physicochemical assessment of bottom soils in Chandil and Hatia Dams: Implications for aquaculture and agriculture

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Abstract
This study investigates the physicochemical properties of bottom soils in Chandil Dam (CD) and Hatia Dam (HD), two significant reservoirs in Jharkhand, India, to assess their suitability for aquaculture and agriculture. Soil parameters, including pH, electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorus (P), and potassium (K), were analyzed across seven sampling sites at each reservoir. Chandil Dam soils exhibit near-neutral pH (mean 6.2857), higher organic carbon (mean 0.94314 Kg/hec), and nitrogen (mean 526.429 Kg/hec), indicating superior fertility and better conditions for aquaculture and agriculture. Conversely, Hatia Dam soils are more acidic (mean pH 4.74286) with lower nutrient content, requiring significant amendments to support productivity. While both reservoirs show potential for resource utilization, targeted management of HD soils and careful monitoring of both dams are necessary to ensure sustainability. These findings underscore the importance of soil quality assessments in optimizing land and water resource management.

Keywords: Chandil Dam (CD) and Hatia Dam (HD) electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorus (P), and potassium (K)

Introduction
Water reservoirs play a critical role in sustaining human livelihoods by providing resources for agriculture, aquaculture, and drinking water. In Jharkhand, India, Chandil Dam and Hatia Dam have emerged as pivotal multipurpose reservoirs, supporting the region's agricultural and aquaculturally productivity. However, the soil quality of the reservoirs' beds significantly influences their capacity to sustain these activities. The physicochemical characteristics of bottom soil, including pH, electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorus (P), and potassium (K), are vital indicators of their suitability for these purposes.
Chandil Dam, constructed on the Subarnarekha River, and Hatia Dam, built on the Manuali River, serve distinct ecological and socio-economic functions. Despite their importance, both reservoirs face challenges, including soil acidification, nutrient variability, and anthropogenic pressures. Understanding the interplay between soil properties and their implications for aquaculture and agriculture is critical for optimizing the reservoirs' usage while ensuring their long-term sustainability. This study aims to provide a comparative analysis of soil quality in Chandil and Hatia Dams by examining key physicochemical parameters. The findings will not only highlight the reservoirs' current state but also offer recommendations for effective soil and water resource_management. By addressing the challenges posed by soil acidity and nutrient deficiencies, this research seeks to enhance the reservoirs' contribution to regional development while safeguarding their ecological integrity.

Research Methodology
Soil processing
The soil samples collected from each plot were dried under the shade with well aeration, soil clods were crushed into fine powder with the help of wooden pestle and marter. It was passed through 2 mm stainless steel sieve. Sieving was done to remove large stones, roots, gravels, and other materials. The fine soil was separated and stored in well labeled plastic bags.

Soil pH

The pH of soil was measured in 1:2.5 (soil: water) suspension with the help of glass electrode digital pH meter as described by Jackson (1973) [1].

Electrical Conductivity

The EC of soils were measured in 1:2.5 (soil: water) suspension by using digital Electrical Conductivity meter as described by Jackson (1973) [1].

Organic Carbon

Organic carbon content of soil samples was determined by using rapid titration method as described by Walkley and Black (1997) [3].

Available Nitrogen

Available nitrogen in soil were determined by Alkaline Potassium permanganate, boric acid and mix indicator. Titration of the distillate collected is done using sulphuric acid as described in the method given by Subbiah and Asija (1956) [4].

Available Phosphorus

Available soil Phosphorus content were extracted by Bray P1 extractant (0.03 N NH_4F in 0.025 N HCI solutions) and estimated calorimetrically by ascorbic acid method. The readings of standard P solution as well as of samples are taken at 660nm wavelength using Double Beam Spectrophotometer as described by Bray and Kurtz (1997) [5].

Available Potassium

Available potassium content in soil samples were extracted with adding 1 Normal Ammonium acetate solution and the suspension obtained is placed on mechanical shaker for 5 minutes and filtered using filter paper. Potassium was then estimated in the filtrate with the help of using Flame Photometer after standardization of the instrument with the help of potassium standard solution as described by Hanway and Heidal (1952) [6].

Results

Table1: Soil Parameters of Chandil Dam

Parameter	Unit	CD 01	CD 02	CD 03	CD 04	CD 05	CD 06	CD 07	MEAN
pH		5.7	6.3	5.9	6.6	7.4	6.4	5.7	6.285714
EC	%	0.043	0.034	0.053	0.038	0.039	0.06	0.045	0.04443
OC	Kg/hec	0.851	1.032	0.963	0.963	0.945	0.95	0.899	0.94314
N	Kg/hec	460	565	525	525	535	535	540	526.429
P	Kg/hec	17.74	15.38	22.43	17.31	12.82	33.3	21.22	20.0329
K	Kg/hec	170.7	189.69	249.98	205.6	207	215	233.6	210.226

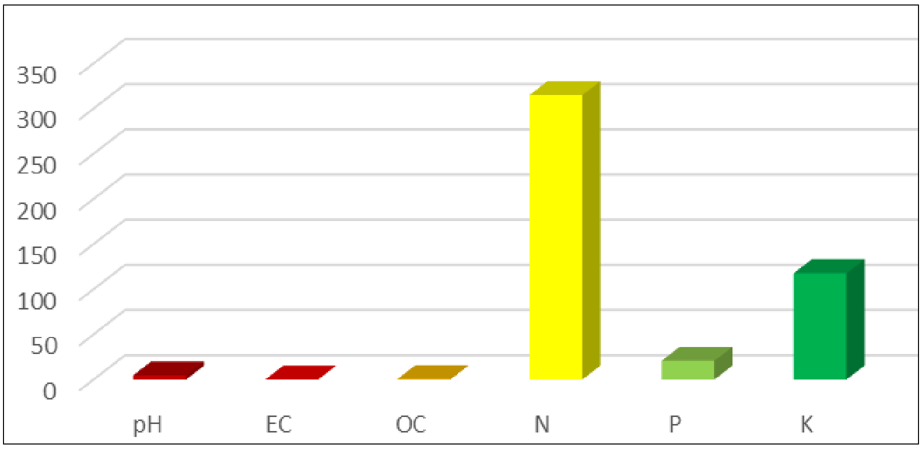

Fig 1: Bottom Soil parameters of Chandil Dam, expressed as mean

Table 2: Soil Parameters of Hatia Dam

Parameter	Unit	HD 01	HD 02	HD 03	HD 04	HD 05	HD 06	HD 07	MEAN
pH		4.4	5.5	5	4.5	4.4	4.5	4.9	4.74286
EC	%	0.037	0.059	0.033	0.041	0.029	0.16	0.045	0.05829
OC	Kg/hec	0.223	0.349	0.448	0.448	0.991	0.88	0.554	0.556
N	Kg/hec	155	215	265	265	535	470	300	315
P	Kg/hec	17.95	17.3	21.15	10.26	15.38	41.7	22.15	20.8357
K	Kg/hec	55.1	195.24	102.44	96.77	102.1	168	105	117.813

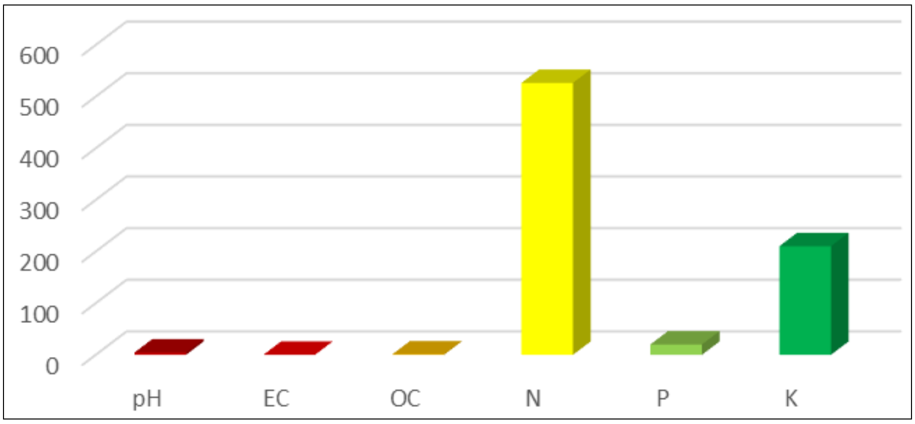

Fig 2: Bottom Soil parameters of Hatia Dam, expressed as mean

pH

Chandil Dam (CD): The pH ranges from 5.7 to 7.4, with a mean of 6.2857, indicating slightly acidic to near-neutral soil conditions. Hatia Dam (HD): The pH ranges from 4.4 to 5.5, with a mean of 4.74286, indicating more acidic soils compared to CD. CD soils, with their near-neutral pH, are better suited for both aquaculture and agriculture. Aquatic organisms and crops generally thrive in near-neutral pH, minimizing stress and maximizing productivity.

HD soils, being more acidic, may hinder plant and aquatic organism growth unless neutralized using lime or other amendments.

Electrical Conductivity (EC)

CD: EC ranges from 0.034% to 0.06%, with a mean of 0.04443%. HD: EC ranges from 0.029% to 0.16%, with a mean of 0.05829%. Both reservoirs have low EC, signifying minimal salinity levels. However, HD soils display greater variability in EC, which could indicate localized salinity hotspots. These conditions are favorable for aquaculture and agriculture, as excessive salinity can be detrimental to both fish health and crop yields.

Organic Carbon (OC)

CD: OC ranges from 0.851 to 1.032 Kg/hec, with a mean of 0.94314 Kg/hec.

HD: OC ranges from 0.223 to 0.991 Kg/hec, with a mean of 0.556 Kg/hec. CD soils are significantly richer in organic carbon, which is crucial for soil fertility and microbial activity that supports both aquaculture and agriculture.

HD soils, with lower organic carbon content, may require organic matter addition to enhance productivity.

Nitrogen (N)

CD: N ranges from 460 to 565 Kg/hec, with a mean of 526.429 Kg/hec. HD: N ranges from 155 to 535 Kg/hec, with a mean of 315 Kg/hec. Higher nitrogen levels in CD soils support vigorous growth of aquatic plants and crops, contributing positively to aquaculture and agriculture. HD soils exhibit lower nitrogen content, potentially limiting productivity and requiring nitrogen-rich fertilizers.

Phosphorus (P)

CD: P ranges from 12.82 to 33.3 Kg/hec, with a mean of 20.0329 Kg/hec. HD: P ranges from 10.26 to 41.7 Kg/hec, with a mean of 20.8357 Kg/hec. Both reservoirs have adequate phosphorus for agricultural purposes. However, higher phosphorus levels in some HD samples may increase the risk of eutrophication, which could negatively affect water quality and aquaculture sustainability. Careful management of phosphorus levels is required to avoid ecological imbalances.

Potassium (K)

CD: K ranges from 170.7 to 249.98 Kg/hec, with a mean of 210.226 Kg/hec.

HD: K ranges from 96.77 to 195.24 Kg/hec, with a mean of 117.813 Kg/hec.

CD soils have higher potassium levels, supporting plant growth and soil fertility. HD soils have lower potassium, necessitating potassium supplementation for optimal crop productivity.

In Chandil Dam, Near-neutral pH (mean 6.2857) provides a stable environment for aquatic organisms, minimizing stress and promoting growth. High organic carbon and nitrogen levels enhance primary productivity, supporting the food web essential for aquaculture. In Hatia Dam, Lower pH (mean 4.74286) may stress aquatic organisms and require intervention such as liming to stabilize pH. Limited organic carbon and nitrogen reduce the natural productivity of the ecosystem, necessitating external inputs to sustain aquaculture activities. Fertile soils with higher organic carbon, nitrogen, and potassium levels make CD ideal for crop cultivation. Near-neutral pH allows for a wider range of crops to be cultivated without significant soil amendments.

Acidic soils with lower organic carbon and nutrient levels require significant amendments (lime, organic matter, and fertilizers) to support agriculture.

Variable EC and phosphorus levels must be carefully managed to avoid salinity stress and eutrophication. The superior fertility of CD soils highlights its potential for sustainable aquaculture and agriculture. However, careful management is required to maintain water quality and prevent overexploitation of resources. HD soils, while less fertile, can still be utilized effectively with targeted interventions to enhance soil quality. The slightly higher variability in HD parameters demands localized management practices.

Conclusion

The comparative analysis of soil quality between Chandil and Hatia Dams reveals that Chandil Dam exhibits better overall soil fertility, making it more suitable for aquaculture and agriculture. Its near-neutral pH, higher organic carbon, nitrogen, and potassium levels provide a robust foundation for sustainable resource use. On the other hand, Hatia Dam soils, though less fertile, can be utilized with appropriate amendments and management strategies. Both reservoirs require ongoing monitoring and intervention to address challenges like acidity and nutrient imbalances to ensure long-term sustainability.

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