International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.1 pp 110-115, 2017

Assessment of Physico- Chemical Characteristics of the Soil in Vaigai Reservoir, Tamilnadu, India

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Abstract : Industrialisation, urbanisation and modern agricultural practices play a vital role in the quality and yield of water resources. Proper management as well as protection and exploitation of the water resources are the challenges imposed by the population growth.The use of fertilizers in the catchment area of vaigai reservoir as well as agricultural waste inflow cause some changes in the nutrients of the soil.The present study deals with the change in physico chemical properties of the soil in the upstream side of vaigai reservoir. The physico chemical properties such as moisture content, specific gravity, plasticity, pH, electrical conductivity etc., were studied. The nutrients such as nitrates, phosphates and potassium present in the soil were also analysed. These results demonstrate that agricultural management impacts will vary the soil nutrients depending on climatic conditions and also the erosion in the upstream side may also leads to changes in the characteristic properties of the soil.
Keywords : Industrialisation, Nutrients, Plasticity, Reservoir, organic matter.

Introduction

The life of reservoir iscrucial since soil erosion remains one of the world's biggest environmental problem threatening both developed and developing countries. There are many reservoirs that can no longer perform their design functions because much of their original active storage volume has been filled by sediment [1]. Soil erosion is a major environmental problem worldwide. Today, nearly all major river systems in the world have dams built across them for the purpose of irrigation, drinking water, and hydroelectric power generation.[2,3,4] . Suspended sediments containing organic and inorganic molecules, are the main source of total suspended matter which control the turbidity of water[4]. Soil erosion causes problems such as loss of soil nutrients, declining crop yields, reduction in soil productivity [5]. At the end of the 20th century, approximately 45,000 large dams (i.e. dams higher than 15 m)with a total reservoir surface of about 500,000 km^2have been exploited in the world, mainly for irrigation, hydroelectricity and as drinking water reservoirs[6,7]. They provide a major contribution to the economic development of industrial as well as of developing and rural countries, and are often considered as sustainable, e.g. "sustainable hydropower" or"green hydropower" [8,9].Due to increased competition of human activities and industrial uses, fresh water resources becoming limited[10].It was observed that soil analysis is an important method for monitoring plant nutritional requirements and nutrients shortage of newly reclaimed soils mostly cases related to their alkalinity, clay content and low organic matter [11].The application of compost to the soil improves the chemical, physical, and biological characteristics of soils. It improves water retention and soil structure by increasing the stability of soil aggregates[12]. Moreover, effects of the organic matter applied to the soil in compost are seen in increased

efficiency of mineral fertilizer utilization by crops and improved performance[13,14]. In addition organic manures plays an important role in improving the physical properties of soils, especially the sandy and calcareous ones, and they are valuable resources rich in P, N and micronutrients essential for plant growth, that are slowly released after degradation by microorganisms.Major changes in the river system occur upstream and downstream. River diversion may occur upstream in order to bring more water into the reservoir and increase its capacity. This measure may partially dehydrate the landscapes. Before construction of reservoir infrastructures, dam projects are generally evaluatedaccording to the latest developments in engineering standards with respect to floods, seismic hazards and other causes of failure, such as overtopping of the dam, foundation defects, and karst or slope instability [15,16,17].Soil salinity becomes a serious problem in both agricultural and natural soils. Saline soils are limiting factors to agriculture in arid and semi- arid regions, crop growth and production.Control of the diseases depends mainly on fungicides and nematicides application. Such chemicals are not always desirable due to potential hazards to human beings and the environment.Desert lands management pay great attention to water as it is one of the most important factors in crop production. Effective irrigation management is essential for maximizing the productivity from each unit of applied water[18].Repeated cropping and no application or limited application of fertilizers leads to reduce the macro and micronutrients from soil leading less crop yield. Analysis of soil helps to know which mineral elements are scare or satisfactory levels [19].The ability of soil to provide various nutrients for biological production are assessed through theanalysis of important soil constituents such as pH, specific conductivity, total alkalinity, calcium, magnesium, chloride,nitrate-nitrogen, phosphate-phosphorus, sulphate, sodium and potassium[20].The present investigation is therefore, undertaken to evaluate the nutritional status and also the presence of chemicals in the upstream side of vaigai reservoir by collecting different soil samples and analyzing the experimental results.

Materials and Methodology

Study Area

For the present study, the Vaigai Reservoir on Vaigairiver,Tamilnadu, India is chosen for analysis of chemicals and nutrients.Vaigai reservoir is located at 70 km from Madurai and lies $10^0\ 00'$ and $10^0\ 10'$ North Latitudes and $77^0 30'$ and $77^0\ 40'$ East longitude.The front view of Vaigai dam is shown in Fig1. The stored water in the reservoir is used for irrigation, power generation and drinking water of Madurai city. The catchment area of Vaigai reservoir is 2253.30 km^2, the entire catchment lies in Madurai andTheni districts of Tamilnadu. The catchment area comprises Cumbamvalley,Varushanadu valley, Varushanadu hills and Western Ghat.Rock formation and sand deposition in the upstream side of river is given in Fig2.

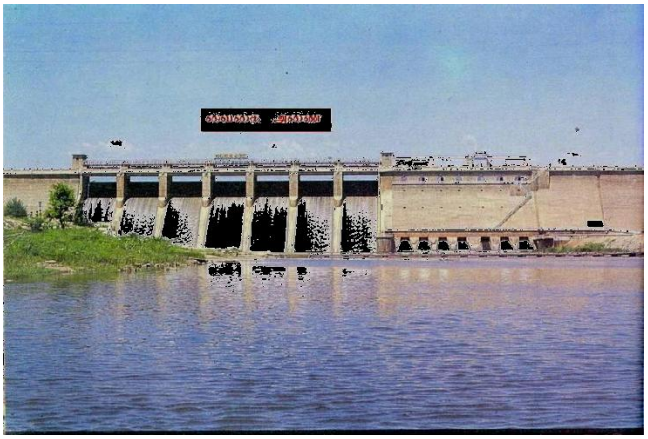

Fig1. Front view of vaigai dam

Fig2. Rock Formation and Sand Deposition on U/S of Vaigai River

Materials and methods

Nearly, 1 kg of the soil sample is taken and sieved to know about the particle size distribution. The percentage of different soil particles such as clay,silt,sand and gravel etc.,were found based on the percentage of particles retained in the particular size sieve and it is given in table 1. Physico chemical properties of the soil and the nutrients present in the soil were also analysed .For analyzing these properties,soil samples were collected from seven locations and kept air dry and then the tests were done. pH was determined using digital pH meter. Conductivity was measured using digital conductivity meter. Nitrates and phosphates were estimated using spectrophotometer. Potassium was analyzed using atomic absorption unit.Specific gravity is found in the laboratory by the use of pycnometerand Liquid limit is found by using Casagrande'sLliquid limit Apparatus. Moisture content is found by keeping the soil samples in the oven for 24 hours. All the above test results were obtained and plotted in table 2.

Results and Discussion

Particle size distribution curve

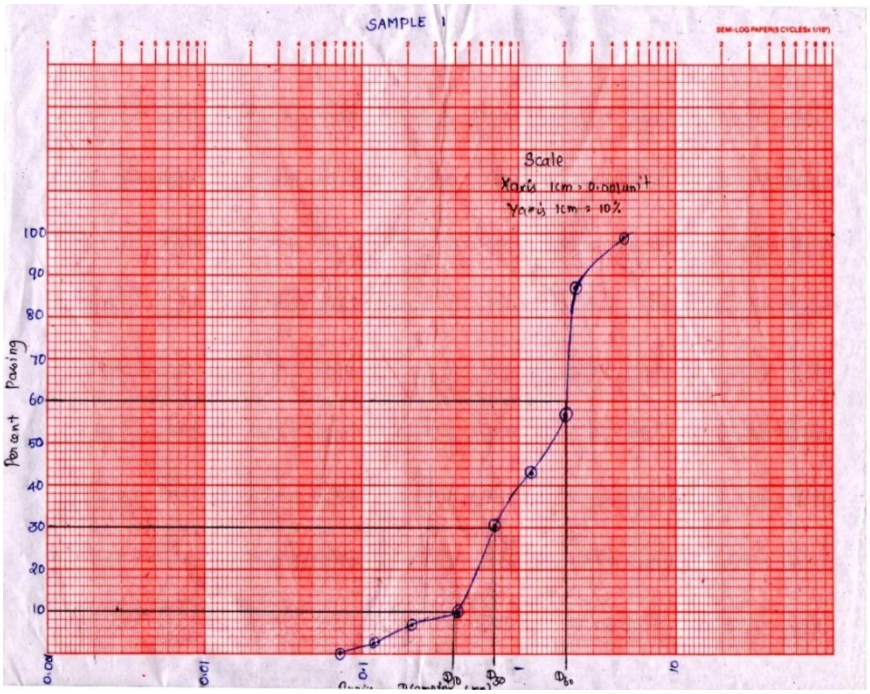

Fig3. Particle size distribution graph

It is a graph with percentage finer (N) plotted along the vertical axis (ordinate) innormal scale and particle diameter (D) along the horizontal axis(abscissa)in logarithmic scale. The plotted graph is given in Fig3.

Particle size distribution graph is analysed to know about the Various percentages of soil particles such as clay, silt, sand and gravel. After observing, it is clear that the soil consists of mainly sand particles.

Table 1.Experimental calculation for sieve analysis

Sl.No	Sieve size (mm)	Weight of soil on each sieve (g)	Cumulative weight retained(g)	% Cumulative weight retained	% finer
1	4.75	2	2	02	99.8
2	2.36	156	158	15.8	84.2
3	1.18	262.9	420.9	42.09	57.91
4	0.600	150.5	571.4	57.14	42.86
5	0.425	130.9	702.3	70.23	29.12
6	0.300	198.5	900.8	90.08	9.12
7	0.212	25.5	926.3	92.63	7.37
8	0.150	51.7	978	9.7.8	2.2
9	0.075	22	1000	100	0
Total			1000		

Table2. Results of the soil test

Moisture content(%)	28.94	31.46	27.63	32.76	33.63	22.52	34.4
Organic carbon (%)	2.3	2	2.1	2.7	2.8	2.6	2.4
Nitrogen Kg/hectare	49	51	56	54	59	41	44
Phosperous Kg/hectare	36	31	38	29	27	22	24
Potassium Kg/hectare	132	125	118	140	137	97	120
Electrical conductivity dSm^{-1}	0.21	0.26	0.21	0.24	0.24	0.16	0.23
Specific Gravity	2.72	2.68	2,59	2.1	2.64	2.42	2.62
Liquid limit(%)	30	33	36	38	29	29	31
Plastic limit(%)	17.8	26.28	27.23	20.53	26.28	9.09	15.5
pH	6.1	5.9	6.1	5.8	6	5.5	6.5

As agriculture is one of the most important occupations in India, it is very much essential to knowthe nutrients present in the soil for a suitable crop. The soil study shows that considerable amount of soil and plant nutrients were lost through erosion. This study also indicates that top soil loss due to accelerated erosion results

in changes in soil properties [21]. Changes insoil pH, elasticity, plasticity and moisture contents were highly and positively correlated with cumulative soilloss occurred due to erosion in the upstream side of reservoir. In general, the soils in this region are of deep sandy loam with reddish colour. The physico-chemical properties of the soil indicate that the soil pH is slightly acidic in reaction (5.50 and 6.5).The Electrical conductivity of the soils ranges from 0.16 to 0.26dS m^{-1}, a characteristic of a normal soil. The status of organic carbon in the soils is low.Repeated cropping and no application or limited application of fertilizers leads to reduce the macro and micronutrients from soil leading less crop yield[19]. A regular use of organic manures may enhance the soil organic carbon. The presence of Nitrogen in this soil is 41-59 kg/hectare at various locations observed, which is considered as low as per ICARstandards. The presence of nitrogen in the soil can vary from year to year and this variation depends on many factors such as irrigation management practices, soil type (e.g. sandy soils, impermeable soils, etc.), and depth of the water table and precipitation range. A soil's nitrogen supplying capacity depends on the microbial breakdown of organic matter and the conversion of the nitrogen in organic matter to the ammonium and nitrate forms (called mineral nitrogen). Since this conversion process depends on the highly variable factors of soil temperature and moisture, it is very difficult to predict exactly. In addition organic manures plays an important role in improving the physical properties of soils, especially the sandy and calcareous ones, they are valuable resources rich in P, N and micronutrients essential for plant growth, that are slowly released after degradation by microorganisms. The amount of P (Phosphorus)used and P availability are affected by soil, climate, and crop yield. From the macro nutrient data of analyzed soils, it seems that low level of nitrogen and phosphorous might be major cause of less crop yield [19].The amount of N relative to P in manure is usually less than that required by most crops, including corn. Thus, when manure is applied at a rate estimated to meet N requirements, P may be applied in excess of the crop P requirements. In addition organic manures plays an important role in improving the physical properties of soils, especially the sandy and calcareous ones, they are valuable resources rich in P, N and micronutrients essential for plant growth, that are slowly released after degradation by microorganisms [22].Direct P losses from manure and especially with high erosion rates are related to steep slopes, proximity to water bodies and some tillage practices. Long term application of synthetic chemical fertilizers will damage the physico-chemical and biological properties of soil[23].The nitrate and phosphate concentration in soil affected due toagricultural runoff and anthropogenic activity in and around the reservoir [20]. A regular use of organic manures is also recommended as the soils are deficient in the soil nutrients.

Conclusion

Organic matter affects both the chemical and physical properties of the soil and its overall health. Properties influenced by organic matters are soil structure, moisture holding capacity, diversity and activity of soil organisms, both those that are beneficial and harmful to crop production and nutrient availability.Top soil loss due to erosion in the upstream side of the reservoir is one of the main causes for the reduction of soil nutrients and changes in the physic chemical properties of the soil. Suitable conservation measures can be adopted in the upstream side to reduce the soil loss. Regular use of organic manures can also be used to stabilize the soil nutrients.

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