Studies on physico-chemical characteristics of soil of Bhogawati river bank in Kolhapur District

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Abstract:
Panchganga is an important tributary of river Krishna in Kolhapur district, Maharashtra. It is formed by five tributaries viz. Bhogawati, Tulshi, Dhamani, Kumbhi and Kasari. Among this Bhogawati river is the vital source of surface water in south-west region of Kolhapur district and is being polluted by increasing discharge of domestic, agricultural and industrial effluents. Eventually, the soil along the bank of river Bhogawati is also being polluted. Hence, the present study was made to investigate the physico-chemical properties of soil at 9 different sites of river Bhogawati. The criteria of seasonal variation were selected to study the varying levels of physico-chemical parameters. The results of the study show the high levels of phosphorous (8.70 ppm) and potassium (53.25 ppm) near Shirgaon and KhadakKoge sites. Also the organic matter (31.05%) and organic carbon (22.82%) are quite high during the post monsoon period.

Keywords: Panchganga, Bhogawati River, Physico-chemical characteristics, seasonal variations.

Introduction:

River catchment or drainage basin is the natural unit of landscape, combining the link between terrestrial and aquatic ecosystems and it encompasses the entire area of land drained by various tributaries to the main river (Vyas, 2012). Rapid developmental activities industrialization, urbanisation and acceleration of agricultural activities over the last two decades are the major contributors to pollute the landscapes by unsafe disposal of industrial wastes into water streams without giving appropriate treatment (Patel, 2012). Such activities can result in stream bank erosion, increased sedimentation, alteration of geomorphology, river habitats, loss of species diversity and other detrimental effects (Rios, 2006). Now a day's modern agriculture practices depends on chemical fertilizers, pesticides and irrigation to produce high quality crops for animal and human consumption. To maximize the crop yield, nitrogen based fertilizers are widely used by farmers. In addition, phosphorus and other essential minerals are also applied in the field. Consequently some are released to the atmosphere, seep into groundwater or are carried to river by runoff where they may create pollution problems. The polluted water stream also pollutes the ground beneath their structures and storage areas.

River buffer zone is an area of trees; usually accompanied by shrubs and other vegetations along river, stream or shoreline that is managed to maintain the integrity of the waterway to reduce pollution and to provide food, habitat and protection sites for fish and wild life (Naiman *et al*., 1993). The change in soil characteristic consequently affects these services. The soil quality is altered mainly because of residential, industrial and agricultural waste material which is added directly or indirectly in to the river. Hence, it is a critical need to study the quality of soil along the river to check its contamination.

Present investigation deals with the determination of physico-chemical characteristic of soil along the banks of Bhogawati river. Bhogawati is an important tributary of river Panchganga. The morphometric study of Bhogawati river indicates that the basin is fifth order basin shows dendritic type drainage pattern (Pisal *et al* ., 2012). The northern half part of the basin is under low relief compared to southern part which shows gentle slopes with low drainage density. Approximate length of the river system is about 83 km. In total, 9 different sites of Bhogawati river were subjected for soil sampling. The soil on bank is mainly used for agricultural practices and ultimately it leads to the agricultural runoff to the river system. Many industrial and developmental activities are also being carried along the bank of river and hence polluting the soil. Pollution of water has a great impact on the soils of adjoining areas. Hence, the study was carried out to analyse the physic-chemical characters of soil.

Material and Methods:

The origin of Bhogawati river is in the Western Ghats at a height of 2350 feet above the MSL. The Bhogawati river basin is bounded between 16°19'45''N to 16°44'30'' N latitude and 73°50'15'' to 74°11'50''E longitude. Catchment area of Bhogawati river is 410.62 sq. km. In order to conduct the study, 9 sites from river Bhogawati were selected. They are villages Piral, Awali, Tarale,

Rashivade, Shirgaon, Khadak Koge, Koge, Haladi and Prayag Chikhali. Among this, Piral, Awali and Tarale are the sites with less human interference as compared to that of remaining sites which are accompanied by industrial area. Sampling was done during monsoon and post monsoon periods i.e. in September and December respectively. Physico-chemical parameters like pH, electrical conductivity, water holding capacity, Calcium and Magnesium, organic matter, organic Carbon, total Nitrogen, available Phosphorus and Potassium were analyzed. All parameters were analyzed by standard methods described in the Hand Book of APHA (2005) and Handbook of methods in Environmental studies by Maiti, 2003.

Results and Discussion:

The present work (Table: 1) illustrates status of soil on the bank of river Bhogawati in Kolhapur District. The quality of soil on bank of river Bhogawati detoriates due to river water pollution and other human activities like agricultural run-off, domestic activities, industrial wastewater etc. Agricultural activities like excess use of fertilizers, pesticides and change in cropping pattern are also responsible for deterioration of river bank soil. This results in imbalance of physico-chemical characteristics of soil.

In the present study, all parameters were analyzed by standard method and the obtained results are discussed below-

Sr.No.	Parameters	Sites								
		Piral	Awali	Tarale	Rashiwade	Shirgaon	Khadak koge	Koge	Haladi	Prayag Chikhali
1	pH	5.9 ± 0.28	5.77 ± 0.21	6.45 ± 0.57	6.91 ± 0.13	5.83 ± 0.46	6.88 ± 0.45	7 ± 0.57	6.19 ± 0.45	5.97 ± 0.61
2	EC (mhos/cm)	0.07 ± 0.08	0.07 ± 0.08	0.07 ± 0.08	0.08 ± 0.08	0.06 ± 0.06	0.07 ± 0.08	0.08 ± 0.08	0.07 ± 0.08	0.03 ± 0.03
3	WHC (%)	52.74 ± 0.36	43.94 ± 0.36	48.18 ± 0.45	44.18 ± 0.43	55.05 ± 7.0	47.72 ± 0.25	47.65 ± 0.49	44.09 ± 0.58	52.84 ± 0.51
4	Ca (mg/L)	2.58 ±0.59	3.8 ±0.57	1.7 ± 0.42	3.75 ± 0.78	3.5 ± 0.71	2.5 ±0.71	2.3 ± 0.14	2.95 ± 0.21	2.65 ± 0.35
5	Mg (mg/l)	1.67 ± 0.89	2.8 ± 0.28	3.05 ± 0.64	1.8 ± 0.28	1.55 ± 0.78	1.72 ± 0	2.5 ± 0.42	2.45 ± 0.64	1.8 ± 0.14
6	OM (%)	35.62 ± 2.26	22.57 ± 3.44	34.28 ± 5.27	41.29 ± 5.35	29.17 ± 2.95	24.46 ± 2.18	24.28 ± 1.44	25.41 ± 2.54	22.3 ± 3.06
7	OC (%)	22.45 ±3.78	13.37 ±2.36	48.56 ± 9.11	19.4 ± 3.39	18.48 ± 3.87	15.78 ± 3.48	16.93 ± 4.82	14.22 ± 0.71	15.21 ± 4.96
8	Total N (%)	1.53 ± 3.06	1.3 ± 0.28	1.17 ± 0.07	1.19 ± 0.01	1.24 ± 0.02	1.21 ± 0.04	1.18 ± 0.03	1.2 ± 0.02	1.18 ± 0.01
9	Ava. P (ppm)	6.8 ±0.99	6.65 ± 0.49	8.15 ± 1.34	10.75 ± 0.64	11.55 ± 0.92	9.65 ± 1.63	10.2 ± 0.57	8.85 ± 0.21	5.57 ± 0.78
10	Ava.K (ppm)	24.15 ± 5.59	23.1 ± 2.69	45.45 ±13.1	36.45 ± 6.01	68.95 ± 12.94	99.1 ± 14.14	67.2 ± 9.33	56.35 ±15.2	58.55 ± 9.83

Table 1: Mean and ± SD of soil quality parameters at different sites along Bhogawati river

pH of the sediments is a measure of their acidity or alkalinity and is one of the stable measurements. The pH of the soils at all sites was found to be moderately alkaline in the post monsoon season. The lowest pH (5.5) was observed at Shirgaon while highest (6.8) was at Rashivade in the monsoon while in post-monsoon season it was 5.9 at Awali and 7.4 was at Koge. The lowest pH may be due to the discharge of effluent from nearby industries.

Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics (Solanki and Chavda, 2012). It is well known that electrical conductivity is a good measure of dissolved solids (Singare *et al.,* 2011). Electrical conductivity was quite high in the post monsoon as compared to monsoon. Low conductivity value was found at Prayag Chikhali (0.01mhos/cm) in monsoon and (0.1mhos/cm) in post monsoon season whereas highest (0.136 mhos/cm) was found in Koge site in post monsoon season. Increase in conductivity attribute to high deposition of salts after monsoon season (Paine, 2003).

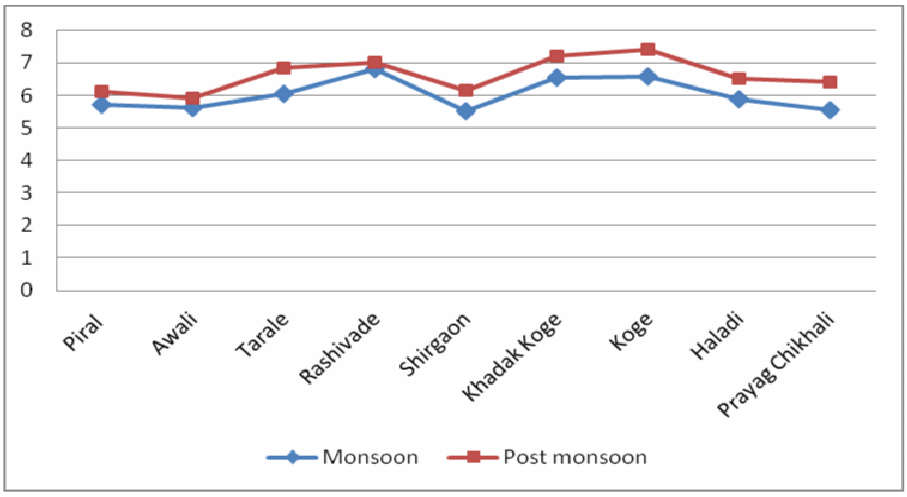

Fig 1: Electrical conductivity (EC) of soil at different sites along Bhogawati River

Calcium and Magnesium are positively charged ions (cations) held to the surface of clay and organic matter in soil by electrostatic charge. These cations exchange with cations in soil solution (Frank). Calcium content was higher in post monsoon season. During the monsoon and post monsoon season, calcium content was found to be lowest at Tarale site i.e. 1.4 mg/l and 2 mg/l respectively while highest was at the Rashivade site i.e. 3.2 mg/l and 4.3 mg/l respectively.

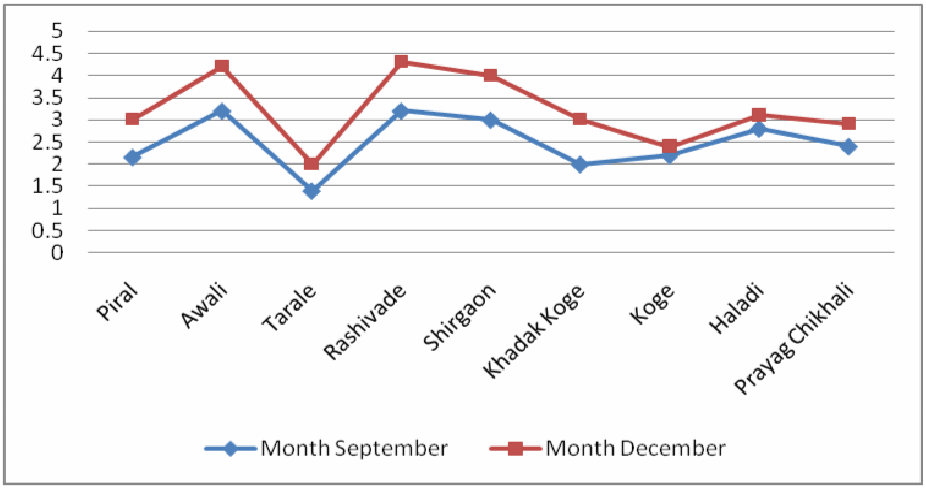

Fig 2: Calcium content of soil at different sites along Bhogawati River

Magnesium (Mg) was increased in post monsoon period. Piral and Shirgaon site shows same amount of magnesium in monsoon i.e.1 mg/l which is the lowest whereas Awali and Tarale site shows highest Mg content i.e 2.6 mg/l. In post monsoon, lowest Mg content were at Rashivade and Prayag Chikhali i.e. 2 mg/l and highest was found at Tarale site i.e. 3.5 mg/l. At Khadak Koge site, Mg content remained unchanged in both the months (1.72 mg/l). According to study conducted by CTAHR, the soil that tends to leach heavily and also weathers highly, usually have low Ca content. Also soil that contains excessive amount of other cations compete with Magnesium and reduces its presence on the cation exchange capacity.

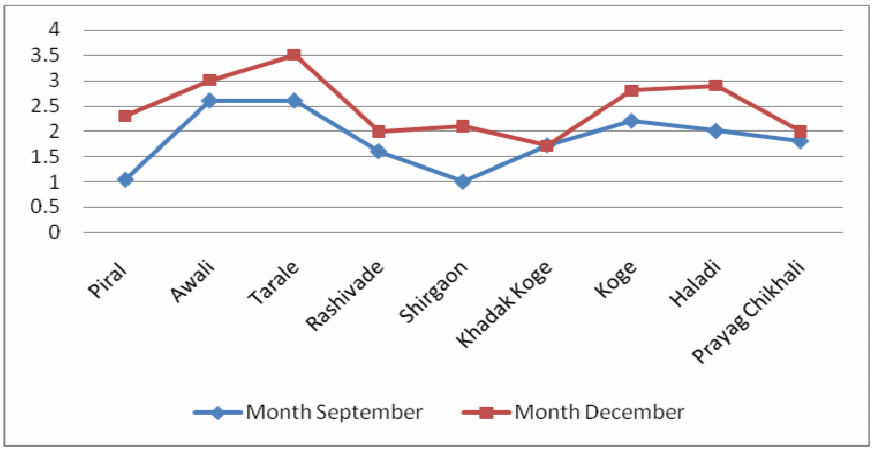

Fig 3: Magnesium (Mg) content of soil at different sites along Bhogawati River

Soil organic carbon (SOC) plays an important role as a source of plant nutrients and in maintaining the soil integrity (Solanki and Chavda, 2012). Organic carbon was found to be higher in post monsoon season. In monsoon, lowest Organic Carbon (OC) was found at Awali and Prayag Chikhali site i.e. 11.7 % while at Haladi lowest OC of 14.72 % was recorded in the month of December. But Tarale site shows highest range of organic carbon i.e. 42.12 % and 55 % in monsoon and post monsoon respectively (Fig. 2). Soils with high clay content tend to have higher soil organic carbon than soils with low clay content under similar land use and climatic conditions. Generally wetland soils have more organic carbon content than terrestrial soil. It has been reported that under hot humid and per humid climates are deficient in organic carbon due to intensive agricultural practices (Bhattacharya *et al.*, 2000).

Organic matter was found to be increased during post monsoon period. At Awali and Prayag Chikhali lowest content of organic matter was found i.e. 20.13 % in September while 24.46 % in December at Prayaag Chikhali site which was the lowest. Highest organic matter was at Rashivade site i.e. 37.5 % and 45.07 % in the months of September as well as December. Total organic carbon and total organic matter were high because the fact of this site received heavy organic matter in form of municipal waste, agricultural waste, sewage, human and cattle excreta and similar trends were observed in Tapti sediments (Marathe *et al.*, 2011).

Soil organic matter (SOM) is the key component that determines soil Water Holding Capacity (WHC). More the SOM content more is the WHC of the soil (Vengadaramana A., 2012). WHC of all the sites was more or less similar in both the seasons. But Shirgaon site which is consecutive to Rashiwade, shows highest WHC of 50.1 % and 60 % in the months of September and December respectively.

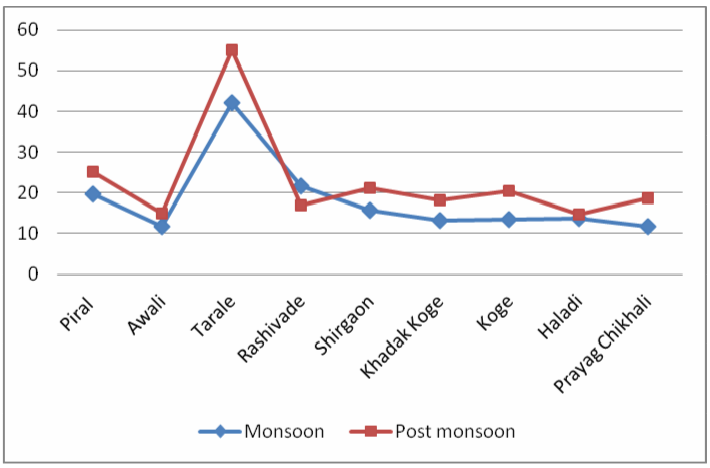

Fig 4: Organic carbon content of soil at different sites along Bhogawati River

Nitrogen, Phosphorous and Potassium are macronutrients essential for plant growth. Values of Total Nitrogen remained almost same in both the seasons except three sites viz. Piral, Awali and Tarale which records more. In monsoon, Tarale site shows lowest Total Nitrogen i.e. 1.12 % whereas 1.1 % at Awali site in the post monsoon. Shirgaon site shows highest total nitrogen content in monsoon and post monsoon i.e. 1.22 % and 1.25 % respectively (Fig: 3). As Shiragon site is a downstream of sugar industry at Rashiwade, there may be direct discharge of high organic matter. The major proportion of Nitrogen in the soil is influenced due to organic matter present in the soil (Baruah,1997).

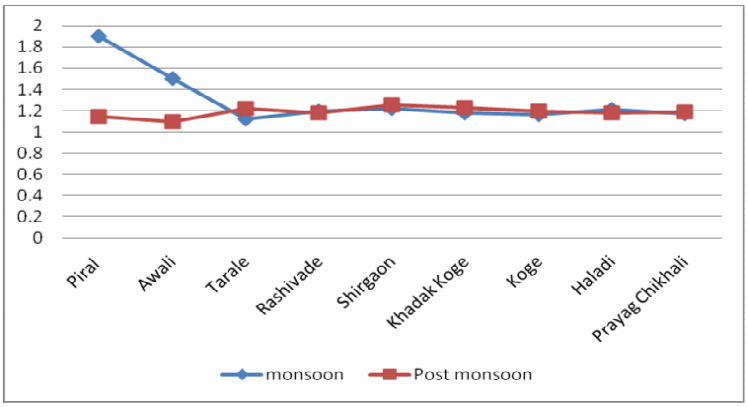

Fig 5: Total Nitroen content of soil at different sites along Bhogawati River

The result shows that available phosphorous was more in monsoon (Fig:4). It was found to be lowest at Prayag Chikhali i.e. 6.3 ppm and 5.2 ppm in monsoon and post monsoon respectively. Highest content of available phosphorous was found to be at Shirgaon in September (12.2 ppm) and in post monsoon at Rashivade site (11.2 ppm). High contents of phosphorous were found in Shirgaon and Rashivade sites which is a result of direct contact of the source of pollutants wherein waste from sugar industry is released to the river (Patel and Parikh, 2012).

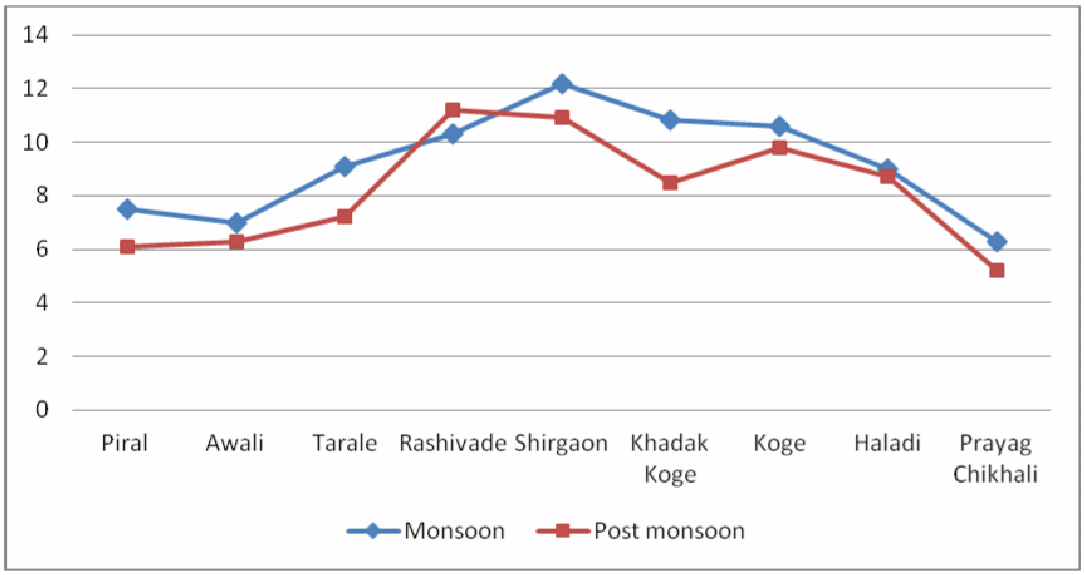

Fig 6: Phosphorous content of soil at different sites along Bhogawati River

Potassium content was found to be increased in the month of December than September. Lowest Potassium was at Piral site i.e. 20.2 ppm and 28.1 ppm in monsoon and post monsoon respectively whereas Khadak Koge shows highest potassium in both seasons of monsoon and post monsoon i.e. 89.1 ppm and 109.1 ppm respectively.

Conclusion:

Intensive assessment of rivers clearly indicates that the river systems are strongly affected by anthropogenic activities. This study provides useful data which helps to understand the soil pollution along Bhogawati river and identify various threats to the riparian area. All the parameters analysed shows significant increase in values during post-monsoon season. The major source of pollutants in the study area are anthropogenic activities, agricultural runoff and industrial effluent. Shirgaon and Khadak-Koge sites shows high range of N, P, K which may be directly attributed to heavy mixing of industrial effluent and domestic sewage. The upstream sites of river Bhogawati are not disturbed by industrial discharge but it pose threat of chemical fertilizers and agricultural run-off .These sites showed high range of Mg, soil OC and soil OM whereas Prayag –chikhali , extreme downstream of river Bhogawati is deficient in soil OC and soil OM. The study concludes that the soil quality of the river is going under severe depreciation.

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