

# Spatio- Temporal Variation of Phosphate in the Waters of Kortalaiyar River, Tamilnadu, India

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**ABSTRACT:** Kortalaiyar River is one of the three rivers that flow in the Chennai metropolitan. Due to industrialization, the river Kortalaiyar is under the threat of contamination. The industries in Tiruvallur and Manali industrial belts open up their effluents into the river which is a source of freshwater for the residents of Tiruvallur district. In the present study samples of water were collected from 30 locations starting from Poondi Lake to Ennore creek to analyze the major cation like phosphate in the river. The analysis was carried out for Pre Monsoon (PRM) and Post Monsoon (POM) seasons for two consecutive years (PRM-1, POM-1, PRM-2 & POM-2). The maximum concentration of Phosphate is found in POM-1 at Sampling location-3 with a measure of 0.096 ppm and a minimum of 0.021 ppm at Sampling location-27 in PRM-2. The temporal distribution of phosphate varies in the order of POM-2>POM-1>PRM-1>PRM-2. The level of phosphate contamination is figured out to be notably high in certain areas which are above the standards considered. Hence, it is mandatory to monitor the pollution level of river Kortalaiyar to maintain the availability of freshwater to the residents of Chennai city.

**KEYWORDS:** Kortalaiyar River, Ennore Creek, Phosphate, Poondi lake, Surface water.

## I. INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. Rivers make up the major pathway of natural and anthropogenic materials from land to the sea. Compared to other geological agents such as wind, glaciers, ground water etc., the total amount of materials in the dissolved or suspended form carried by rivers is remarkably high. Chemistry of rivers focuses on the processes involved in the distribution and transport of chemical substances, as well as the identification of element sources. The study of river water is very important due to the essence to understand the sedimentology, hydrological, seasonal, and various anthropogenic factors which influence the quality of water. Several attempts have been made to analyze the quality and quantity of river transported materials to the ocean realm. Ever since 20<sup>th</sup> century, efforts are taken to study the sediments transported by the rivers. The chemical properties of rivers are reflections of complex, natural and interdependent relationships involving the chemistry of precipitation, the weathering of minerals, and the evolution or history of its water.

Phosphates are chemical compounds containing phosphorus. Phosphorus is a non-metallic element which is necessary for life and is found in rock as inorganic phosphates. As water runs over and through rocks it carries off small amounts of minerals such as calcium, magnesium, and phosphates. Inorganic phosphates are a plant nutrient and are taken in by plants with water and incorporated into organic phosphate compounds. Animals obtain their essential phosphorus from phosphates in water and plant material. Natural waters have a phosphorus concentration of approximately 0.02 parts per million (ppm) which is a limiting factor for plant growth. On the other hand, large concentrations of this nutrient can accelerate plant growth.

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Phosphates enter waterways through manmade sources also. We contribute approximately 3.5 pounds per capita of phosphate yearly to our environment. The addition of large quantities of phosphates to waterways accelerates algae and plant growth in natural waters; enhancing eutrophication and depleting the water body of oxygen. This can lead to fish kills and the degradation of habitat with loss of species. Large mats of algae can form and in severe cases can completely cover small lakes. As a result, water can become putrid from decaying organic matter. When the concentration of phosphates rises above 100 mg/l the coagulation processes in drinking water treatment plants may be adversely affected. Manmade sources of phosphate include human sewage, agricultural run-off from crops, sewage from animal feedlots, pulp and paper industry, vegetable and fruit processing, chemical and fertilizer manufacturing, and detergents.

## II. STUDY AREA

Kortalaiyar River is one of the three rivers that flow in the Chennai metropolitan area. The river has a length of 136 Km and it originates near Kaveripakkam in Vellore district and finally drains into the Bay of Bengal. The main Kortalaiyar River flows into Poondi reservoir.



Figure 1- Study area

The water flows through Thiruvallur district from the Poondi reservoir, enters into the Chennai metropolitan area, and joins the sea at Ennore creek. Whenever the flood gates of Poondi reservoir are opened, a considerable volume of water drains into the sea through Kortalaiyar River near the Ennore Creek. The area for present study is 30 sampling points starting from Poondi reservoir to Ennore creek. Figure 1 shows the map of the study area.

## III. MATERIAL AND METHODS

In order to obtain the research objective, samples were collected from thirty locations from the river Kortalaiyar for each season, Pre-Monsoon (PRM) and Post-Monsoon (POM) of two consecutive years from July 2012 to July 2014. Season-1 is PRM-1, season-2 is POM-1, season-3 is PRM-2 and season-4 is POM-2. The collected samples were stored in acid-cleaned, wide-mouth high-density polyethylene (HDPE) bottles (1000 ml), which were rinsed with the river water before use. The river water samples were filtered through 0.45  $\mu\text{m}$  Millipore membrane filters to separate suspended sediments. Phosphate was determined using colorimetry [1].

## IV. RESULTS AND DISCUSSION

Phosphates occur in natural or wastewaters as orthophosphates, condensed phosphates and naturally occurring phosphates. Their presence in water is due to detergents, used boiler waters, fertilizers and biological processes. They occur in solution in particles or as detritus. They are essential for the growth of organisms and a nutrient that limits the primary productivity of the water body. Inorganic phosphorus plays a dynamic role in aquatic ecosystems. It is one of the most important nutrients when present in low concentration, but in excess along with nitrates and potassium, causes

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algal blooms. Phosphorous is predominantly present in waters and wastewater as phosphates; these compounds occur either in solution, body of the organisms, particulates or detritus [2].

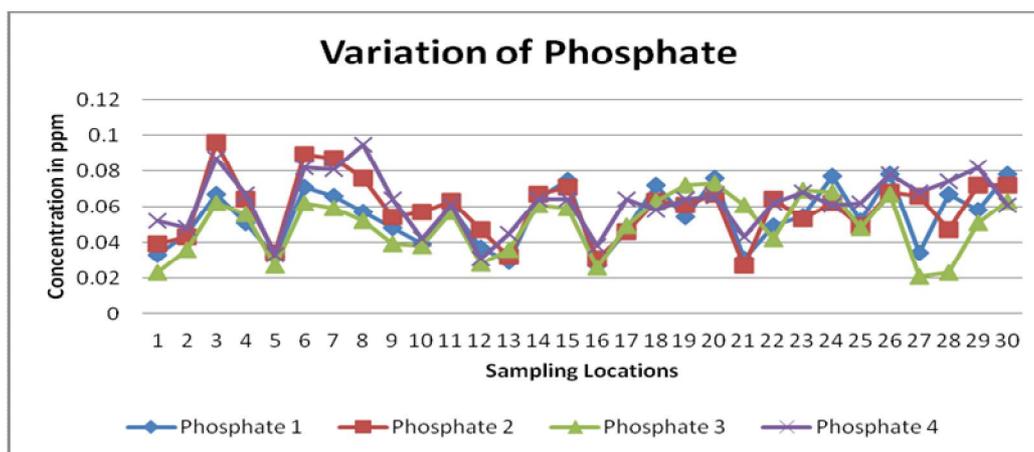


Figure 2- Spatio-temporal variation of Phosphate in water

Phosphorous is an essential requirement for living organisms. However, at high concentrations it is considered as a pollutant, principally for its role in causing eutrophication. Though  $\text{NO}_3^-$  pollution is also responsible for eutrophication,  $\text{PO}_4^{3-}$  is the major cause in freshwaters [2,3]. Eutrophication not only harms aquatic organisms, such as fishes, but also results in increasing the costs of water clean-up process.

Concentration of total phosphorous at 0.1 mg/l (ppm) is unacceptably high; and concentration of 0.02 mg/l (ppm) is often a problem. In the present study phosphate varies from 0.027 ppm to 0.078 ppm in PRM-1, 0.021 ppm to 0.073 ppm in PRM-2, 0.027 ppm to 0.096 ppm in POM-1 and 0.031 ppm to 0.095 ppm in POM-2. The Spatio-temporal variation of Phosphate is shown in Figure 2. The concentration of Phosphate in river Kortalaiyar varies from problematic condition to unacceptably high concentration. The highest concentration of Phosphate is found in the initial stretch of river indicating agricultural run off as the major source. Organic phosphates from household food residues and body wastes end up in sewage [4]. Natural animal manures, including animal excretions, also release phosphates in water resources. Common household detergents have emerged as a modern source of phosphorous in aquatic bodies [5]. The detergents enter wastewater systems and are then released into rivers, ponds, lakes and estuaries [6]. Condensed phosphates, which include pyro, meta and polyphosphate compounds, are chief ingredients of many laundry detergents, such as Sodium tripolyphosphate, and commercial cleaning products; and are also employed extensively to control scaling in boilers [7]. Thus, phosphorous in freshwater resources can come from both discharge of industrial wastewaters and raw or treated sewage [8]. Large scale use of phosphorous containing mineral fertilizers, such a superphosphate (a mixture of calcium dihydrogen phosphate and gypsum), in agriculture also enriches water with phosphates from surface runoff [4,9].

Ferric and calcium phosphates in rocks form the greatest reservoir of phosphates. Naturally, rainfall induced erosion and the runoff of streams cause removal of phosphorous, as weathering, from its reservoir pool [10]. The phosphorous in the soil gets dissolved in water, and in turn flows into the aquatic ecosystems. Another source of phosphorous in surface water is its release from bed sediments. Some specific bacterial actions release phosphate from organic phosphorous compounds, chiefly formed by biological mechanisms, present in the detritus such as plant residues [4, 11]. Organic phosphorous may also be formed in natural aquatic systems and during biological wastewater treatment processes.

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## V. CONCLUSION

The deteriorating status of the river water is well depicted from the high concentration levels of phosphate in the river. The importance of human vigilance on the contamination of the river is a must. Steps ought to be taken to monitor the levels of various cations specially phosphate in the river which in turn controls the presence of other cations and anions in the water. The only way to overcome the disastrous effects of phosphates is to find an alternate. However, an acceptable substitute for phosphates has not yet been found. One of the alternatives is the substitution of synthetic nonionic detergents for ionic detergents in use. Nonionic detergents are not precipitated by Calcium or Magnesium ions. This would reduce the risk of contaminating our water resources.

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