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PHYSICO-CHEMICAL, HEAVY METAL ANALYSIS OF THUVAKUDI POND WATER, TIRUCHIRAPPALLY, INDIA AND EFFECTIVE REMOVAL OF Fe (III) ION BY NEWLY CONSTRUCTED CGS-POP COMPOSITE

[1,3]Jakeer N, [2]Karthick P, [2]Selvaraj S, [3a,b]Jerome Rozario N, [4*]Sureshkumar M S

[1]Department of Chemistry, Indian School Muscat, Muscat, Oman
[2]Department of Geology, National College, Tiruchirappalli, India
[3a]Department of Chemistry, [3b]Centre for Research and Development, PRIST University, Vallam, India
[4*]Department of Chemistry, School of Natural Sciences, University of Zambia, Lusaka, Zambia
**Author for Correspondence*

ABSTRACT

Water bodies such as lakes and ponds are the potential sources for human and other living species. The presence of a pond in and around an urban or semi-urban areas help to maintain the ground water level. Pond also serves as source of economic development apart from irrigation and a reservoir for urban flood prevention. In the series of water analysis undertaken, the present location selected is Thuvakudi pond.

The physico-chemical parameters of the Thuvakudi pond water, nearby locations in and around the pond area located in Tiruchirappalli district, India carried out. As the sample location is close to the industrial zone, heavy metal analysis emphasized and heavy metal removal carried out using Crumb Rubber-Graphite-Saw Dust in Plaster of Paris (CGS-POP). In this paper, the physic-chemical properties of the Thuvakudi pond and the nearby area around 6 km along with heavy metal treatment is presented.

KEY WORDS: Pond Water, Physico-Chemical Parameters, Irrigation, Bore well, CGS-POP composite, Ion-exchange., etc

I. INTRODUCTION

Lakes and ponds (also known as lentic systems) are a diverse set of inland freshwater habitats that exist across the globe and provide essential resources and habitats for both terrestrial and aquatic organisms. Although widely distributed and vital for many species, including humans, these habitats account for just over 3% of the Earth's surface (Downing *et al.* 2006) [1]. A pond is a body of standing water either natural or artificial that is usually smaller than a lake [2]. Pond – the word originated from the word "pound" meaning a confining enclosure, in which water is enclosed in an area [3]. Other criteria used to define a pond are: presence of wave action, occurrence of rooted macrophytes, penetration of light, etc [4]. When it comes to specify the area of a pond, yet a satisfactory context of its reliability and ease of measurement is required [3]. Biggs *et al.*[11] describe ponds as water bodies with an area between 1 square metre and 2 hectares (20,000 square metres), which may be seasonal or permanent, including both natural and man-made water bodies [4]. Dubey [3] in a published literature entitled "*the biodiversity of the ponds*"

explains many existing criteria to describe ponds — for example, International Ramsar Wetlands Convention sets 8 hectares as the upper limit of the water body to classify as a pond; some regions of the United States classify pond as a surface water body having surface area less than 10 acres (≈ 40,000 square metres); and many European Biologists adopt upper limit of pond as 5 hectares. Thus, no universal agreement on the definition of the term pond exists [4]. In simplest terms, ponds can be defined as a body of standing surface water either natural or man-made (artificial) which is quite smaller than a lake with an isolated depression like vernal pools and prairie potholes [4, 5]. Ponds can also be described as shallow water with marsh, aquatic plants and animals [5].

Ponds are increasingly recognized for their high contribution to regional biodiversity and the provisioning of vital ecosystem services. Ponds silently speak the sustainable solutions of various water management and environmental issues such as nutrient retention, rainfall interception and carbon sequestration. Irrespective of the size of the ponds, they are substantial in ecological values and landscape roles [6]. Meticulous planning along with micro level community involvement, ponds can live lively as a seat of biodiversity, instrument for pollution alleviation, balancing floods and of course, holds intact of the adverse climatic changes [7, 8]. The biodiversity of freshwater habitats is increasingly threatened by human activities. Habitat loss, eutrophication, acidification, chemical contamination, global warming, and exotic species are just some of the factors that have directly or indirectly impacted lentic systems [9].

However, increased human impact, such as nutrient loading, overstocking with fish and reduced water level fluctuation, have resulted in a worldwide deterioration of pond habitats along with the local and regional loss of species. Restoration and conservation measures are therefore increasingly applied in efforts to restore pond habitats. Threat posed by the heavy metals has been increasing globally rendering many water bodies unfit for human consumption. This could be due to the increase in concentrations of these metals above natural background. Risk assessment revealed that high chronic daily intake and metal index were beyond acceptable limit indicating high risk and exposure to toxic metals [10-12]. Ponds feature and exist with better quality are the sources for progressive economy [13]. The preservation, restoration and maintenance of water bodies like ponds, lakes, etc., becomes vital and mandatory to balance eco-system present in the urban areas as less than 1 % of water alone is available for drinking [14, 15]. A detailed discussion about pond water pollution is available [8].

The Government of India, National Water Policy [16, 17] advocates the importance of preserving and restoring ponds, along with complete guidelines for safeguarding the ponds. After the release of the revised National Water Policy [17], the conservation, development and management of ponds have increased [8]. The United Nations Sustainable Development Goal (SDG) 17 SDGs stresses the importance of safeguarding water resources. As the projected demand for water is above 30 % by 2030, necessary measures need to be implemented. Around 30 trillion USD could be saved if these water bodies are preserved [18], failure may lead to the absence of resilience to biosphere and human suffering [19].

1.1 Geological Features of Thuvakudi Village[20]

Thuvakudi, located in Tiruchirappalli district of Tamil Nadu, is primarily characterized by hard rock formations, including gneissic rocks and charnockite. The area also features sedimentary formations like alluvial deposits near the Cauvery River.

The detailed Geological Features are:

Hard Rocks: More than 90% of the Tiruchirappalli district, where Thuvakudi is situated, is underlain by hard rocks of Archaean age. These rocks are primarily gneissic, a type of metamorphic rock, and charnockite, another type of igneous rock.

Sedimentary Formations: Recent alluvial deposits, such as sand, silt, and clay, are found along the banks of the Cauvery River. These are transported sediments deposited by the river.

Other Rock Types: Quartzite, which is resistant to weathering, is also present in patches within the gneissic and charnockite formations.

Hydrogeology: The thickness of aquifers (water-bearing rock layers) in hard rock areas is variable, ranging from 20 to 30 meters below ground level, according to the National Water Mission.

Tectonic Features: The region also exhibits lineaments, which are linear features on the landscape that may indicate underlying fault lines or fractures, particularly in the Kallakurichi and Sankarapuram areas (though they are away from ~120 km from Tiruchirappalli district.

In a series of water analysis carried out [14, 15], the present study involves in obtaining a comprehensive data on the parameters of water available in Thuvakudi pond and to know the influence of the pond through the ground water analysis available in and around Thuvakudi pond from various physico-chemical properties. As Thuvakudi pond surrounded by industries, heavy metals were analysed and in this work the removal of Ferrum (Fe) attempted by preparing and using a novel CGS-POP composite.

II. MATERIALS AND METHODS

2.1 Sampling Location [21]

Thuvakudi is semi-urban area located in between the cities of Tiruchirappalli and Thanjavur of the Tamil Nadu State of Government of India. The average elevation is 88 metres (289 feet) with the coordinates 10.756389°N, 78.801111°E. The topology of Thuvakudi is almost flat with a few isolated hillocks rising above the surface. Thuvakudi pond, located near the town

of Thuvakudi is a water body characterized by its location within a pediplain area and its proximity to the Cauvery River and its tributaries. The sampling location and sample collection point is illustrated in Fig. 1 and 2.

Fig. 1a

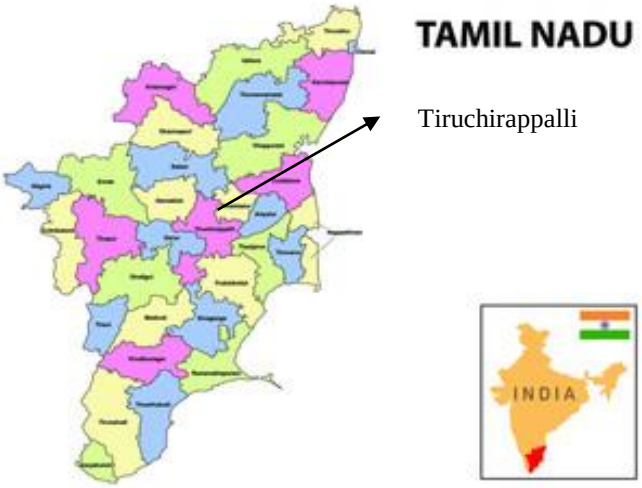


Fig. 1b

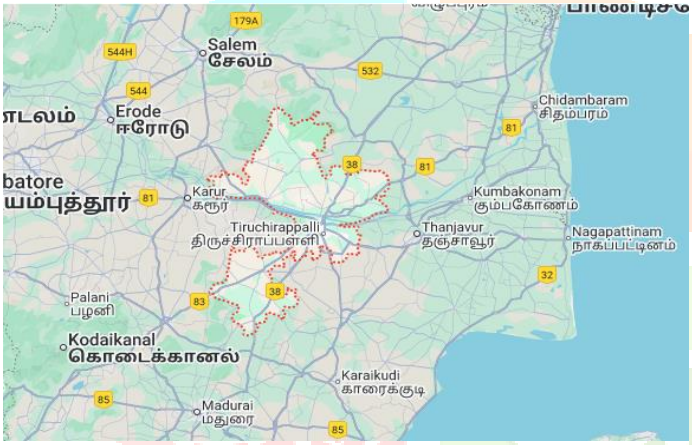


Fig. 1c

Fig. 1d

Fig. 1e

Fig. 1f

Fig. 1 Maps of the Location
1a) Map of India Showing Tamil Nadu State [22]
1b) Map of Tamil Nadu Showing Tiruchirappalli District [23]
1c) Map of Tiruchirappalli showing Thuvakudi [24]
1d) Map of Thuvakudi [24]
1e) Thuvakudi Pond – Terrain View [25]
1f) Thuvakudi Pond – Layer View [25]

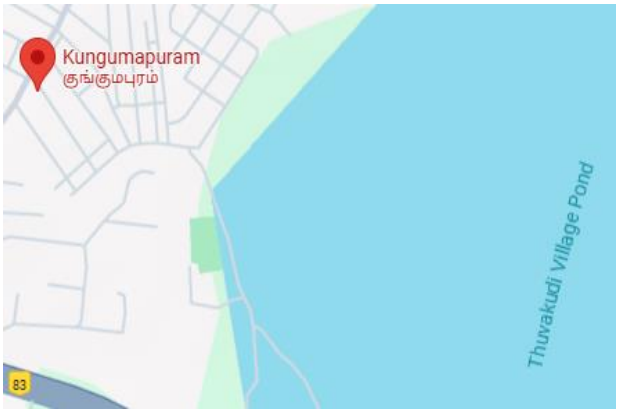


Fig. 2a

Fig. 2b

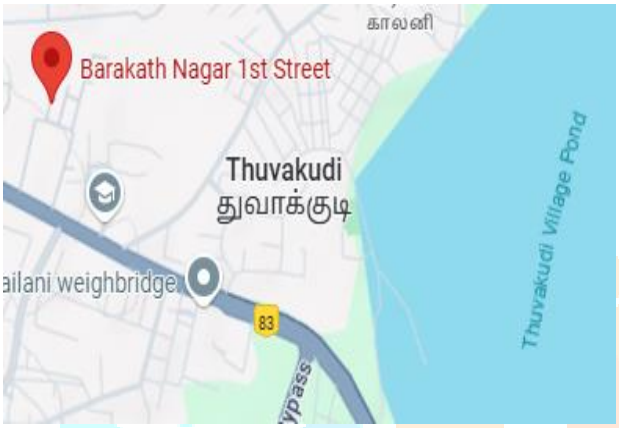


Fig. 2c

Fig. 2d

Fig. 2 Sampling Spots in Sampling Location [25]
2a) Kungumapuram 2b) RECT Nagar
2c) Barakath Nagar 2d) Eechnagadu

The pond is situated within a region that slopes towards the centre where the Cauvery and Coleroon rivers flow. It's surrounded by a mix of flat terrain and some scattered hills, with the Rock Fort hill being a prominent landmark nearby.

Location and Topography: Thuvakudi pond is part of a pediplain area, meaning it's situated on a gently sloping plain. The pond's location in relation to the Cauvery River and its tributaries suggests it may be part of the larger drainage system of the region which is shown as a model in Fig. 3.

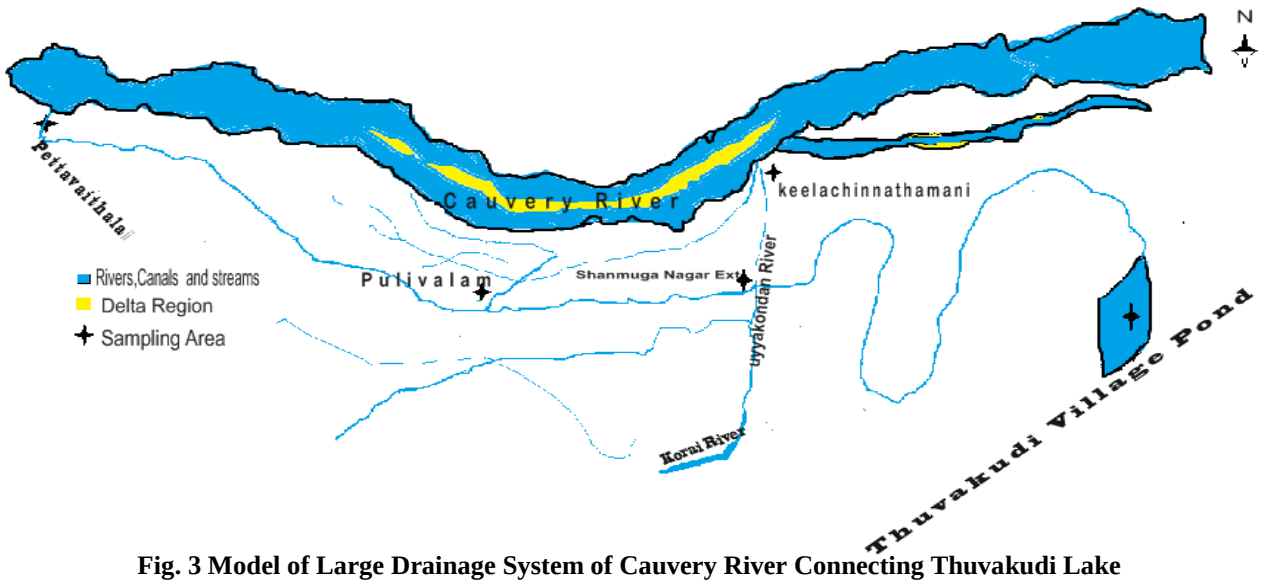


Fig. 3 Model of Large Drainage System of Cauvery River Connecting Thuvakudi Lake

Surrounding Environment: The area around Thuvakudi is generally flat, with some isolated hills. The proximity to Tiruchirappalli and Thanjavur cities makes it an area with both urban and rural influences.

Water Source: The pond's water source is likely influenced by the Cauvery River and its tributaries, as well as local rainfall. It receives water through the northeast monsoon between October and January. The water channel of river Cauvery enriches this wetland.

Environmental Factors: The region experiences a hot and dry climate for most of the year, with dust storms being common. The pond's water quality and ecosystem would be influenced by these environmental factors.

2.2 Sample collection and analysis

Water samples were collected from **five (5) locations** such as **Thuvakudi pond**, **Kungumapuram**, **RECT Nagar**, **Barakath Nagar** and **Eechankadu** (Fig. 2). Except the pond water, rest of the samples are from bore holes. The sample collection period was July 2016 (Pre Monsoon) and December (Post Monsoon) 2016. Two litres of water samples were collected in a clean, dry and dust free polyethylene bottles from various sampling points as per the standards. In total, ten samples were collected for the two seasons, five samples in Pre Monsoon and another five samples in Post Monsoon. The samples were collected from all the five stations from 11.00 to 12.00 hours in both the seasons. The temperatures of the samples were measured in the field itself at the time of sample collection. Physico-chemical and heavy metal analysis were carried in a water testing laboratory located in Tiruchirappalli, India. All the reagents employed were AR grade and double distilled water used for preparing solutions. Heavy metals were analysed by Atomic Absorption Spectroscopy (AAS) using ICE AAS-3300 model of Thermo Fischer make.

Fig. 4 Sampling Locations as Mapped Using ArcGIS

2.3 Preparation of Crumb rubber-Graphite-Saw Dust mounted on Plaster of Paris (CGS-POP) Composite

Crumb rubber was obtained as available from worn out tires. Then it was crushed mechanically as fine mass. First the mass is treated with dilute Hydrochloric acid followed by the treatment with sodium carbonate. By this treatment the dust and unwanted materials present in crumb rubber removed and it is ready for usage. Then the purified crumb rubber is dried around 40 to 50 ˚C for 1 hour and transferred to a dessicator. Commercially available fine grade graphite is activated using a hot air oven at 50 ˚C for 2 hours. The saw dust as obtained from the wooden industries is utilized in the available form. First it is soaked in distilled water and then the water is drained out. This procedure is repeated for 3 times, so that the dust, dirt, sand, slit, etc., is removed. Then the saw dust is transferred to a hot air oven which is maintained at a temperature of 30 ˚C (above room temperature) for 1 hour. After drying it is sieved. To remove the small metal pieces, a cylindrical magnet is rolled all over the saw dust. In this process, small and thin metal particles were removed. Plaster of Paris as available commercially heated for 100 ˚C in an air oven for 5 hours to remove moisture. Then it is finely ground into powders and stored in vacuum dessicator. A stock solution of the absorbate containing 1000 mg/L (1000 ppm) of Fe (III) was prepared by dissolving the calculated quantity of Ammonium Iron (III) Sulphate in de-ionized water.

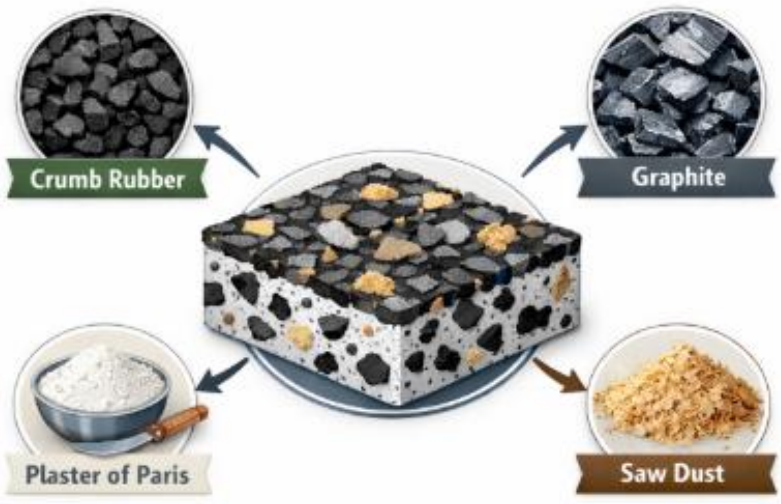


Fig. 5 Schematic Illustration of CGS-POP Composite

The CGS-POP composite prepared by employing a 1:1:1:5 ratios which indicate, 10 g of Crumb rubber, 10 g of Graphite, 10 g of Saw dust and 50 g of dried Plaster of Paris. The above quantities are taken in a 500 ml beaker. In the beaker containing CGS-POP composite, a 50 ml of the stock solution containing Fe (III) ions is poured. Then it is made up to 200 ml using deionised water. After this the beaker is placed in a hot plate maintained at 50 ˚C. During heating the contents were stirred manually and regularly. Like this two beakers were prepared. In one of the beakers 10 ml of hydrochloric acid is poured in the beaker to bring down the pH to 5. Then the beaker is allowed to stand for 3 hours. Then the sample from the beaker is filtered using Whatman filter paper of pour size 40. In another beaker instead of hydrochloric acid, 10 ml of 25 % aqueous ammonia solution added and allowed to stand for 3 hours. Then both the sample analysed

by atomic absorption spectroscopy (AAS) to estimate recovery efficiency of the CGS-POP composite layer. The initial and final concentration of Fe (III) ions were obtained from AAS. Then the sample water is tested with three different contact time intervals such as 3, 6 and 9 hour periods in both the pH (5 and 9) conditions at a temperature of 50 ˚C.

2.4 Weather History [29]

Weather is presented based on the data of the Tiruchirappalli International Airport, Tiruchirappalli, India. The weather report is presented as supporting factor as available [29]. This cannot be considered as an assurance or suitability for further inferences as weather data is prone to errors, outages and other defects. These weather reports are generated based on the reliance on the MERRA-2 model based reconstructions for a number of important data series as reported in the website [29]. These reconstructions: (1) are based on computer models that may have model-based errors, (2) are coarsely sampled on a 50 km grid and are therefore unable to reconstruct the local variations of many microclimates, and (3) have particular difficulty with the weather in some coastal areas especially small islands. Above all, the weather conditions at any given location and time are unpredictable and variable. The scores defined may not suit for specific requirements or references.

2.4.1 Temperature

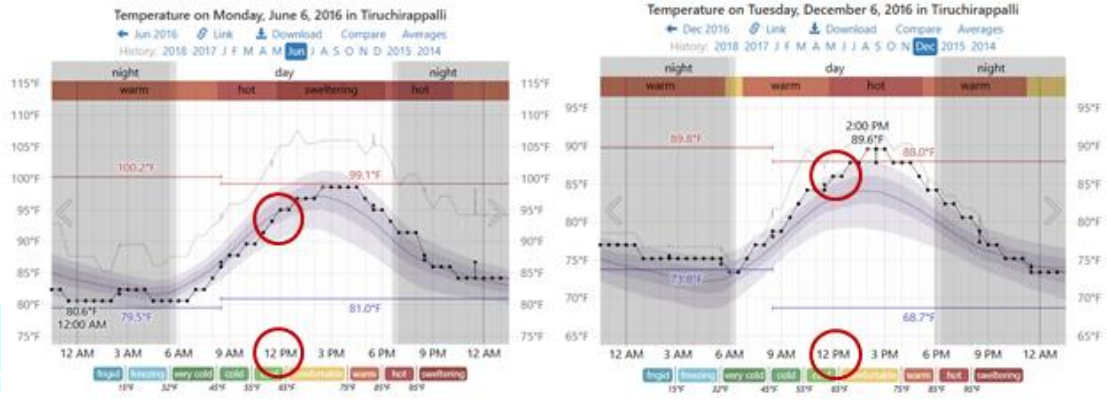


Fig. 5a) Fig. 5b)

Fig. 5 Temperature Profile of the Sampling Day and Time [29]
5a) June 06, 2016 and 5b) December 06, 2016

The temperature observed during the pre-monsoon day (June 06, 2016) sampling time was 97 °F, and the peak temperature was 99.1 °F. On December 06, 2016, the post-monsoon sampling day, the peak temperature was around 88 °F and the recorded temperature during sampling time was 87 °F. All the samples were collected from 12:00 hours of the sampling day. The sample collection started from Thuvakudi lake and then to other locations.

2.4.2 Rainfall

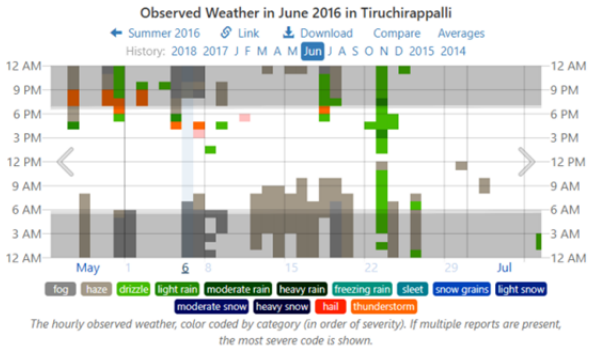


Fig. 6a Rainfall detail on June 06, 2016 [29]

Day	Observations	Precipitation	Codes
Wed, Jun 1	Light Drizzle, Mist		-DZ, BR
Thu, Jun 2	Thunderstorm with Light Rain, Light Drizzle		-TSRA, -DZ
Sat, Jun 4	Light Drizzle		-DZ
Sun, Jun 5	Thunderstorm, Thunderstorm with Rain, Light Rain, Haze, Mist		TS, TSRA, -RA, HZ, BR
Mon, Jun 6	Haze, Mist		HZ, BR
Tue, Jun 7	Thunderstorm, Thunderstorm with Light Rain, Haze, Mist, Showers in the Vicinity		TS, -TSRA, HZ, BR, VCSH
Wed, Jun 8	Light Drizzle, Mist		-DZ, BR
Thu, Jun 9	Drizzle, Haze, Mist		DZ, HZ, BR
Sat, Jun 11	Showers in the Vicinity		VCSH
Sun, Jun 12	Haze		HZ
Mon, Jun 13	Haze		HZ
Tue, Jun 14	Haze		HZ
Wed, Jun 15	Haze		HZ
Thu, Jun 16	Haze		HZ
Fri, Jun 17	Haze		HZ
Sat, Jun 18	Thunderstorm, Drizzle, Light Drizzle, Haze, Mist		TS, DZ, -DZ, HZ, BR
Sun, Jun 19	Drizzle, Haze, Mist		DZ, HZ, BR
Mon, Jun 20	Haze		HZ
Wed, Jun 22	Light Drizzle		-DZ
Thu, Jun 23	Light Rain, Drizzle, Light Drizzle, Haze		-RA, DZ, -DZ, HZ
Fri, Jun 24	Light Drizzle, Haze, Mist		-DZ, HZ, BR
Sun, Jun 26	Drizzle, Light Drizzle, Haze		DZ, -DZ, HZ

Table 1a Rainfall detail on June 06, 2016 [29]

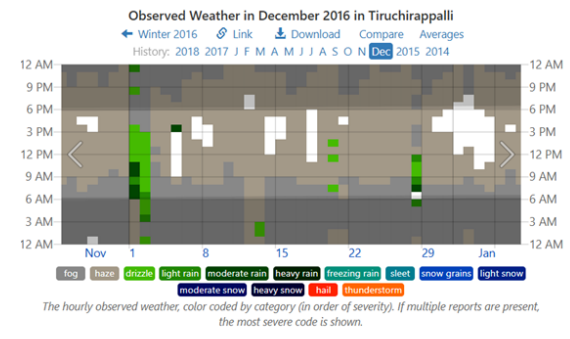


Fig. 6b Rainfall Detail on Dec 06, 2016 [29]

Day	Observations	Precipitation	Codes
Thu, Dec 1	Rain, Light Rain, Drizzle, Light Drizzle, Haze, Mist		RA, -RA, DZ, -DZ, HZ, BR
Fri, Dec 2	Light Rain, Drizzle, Light Drizzle, Fog, Mist		-RA, DZ, -DZ, FG, BR
Sat, Dec 3	Haze, Mist		HZ, BR
Sun, Dec 4	Haze, Mist		HZ, BR
Mon, Dec 5	Rain, Haze, Mist		RA, HZ, BR
Tue, Dec 6	Haze, Mist		HZ, BR
Wed, Dec 7	Haze, Mist		HZ, BR
Thu, Dec 8	Haze, Mist		HZ, BR
Fri, Dec 9	Haze, Mist		HZ, BR
Sat, Dec 10	Haze, Mist		HZ, BR
Sun, Dec 11	Haze, Mist		HZ, BR
Mon, Dec 12	Haze		HZ
Tue, Dec 13	Light Drizzle, Haze, Mist		-DZ, HZ, BR
Wed, Dec 14	Haze, Mist		HZ, BR
Thu, Dec 15	Haze, Mist		HZ, BR
Fri, Dec 16	Haze, Mist		HZ, BR
Sat, Dec 17	Haze, Mist		HZ, BR
Sun, Dec 18	Haze, Mist		HZ, BR
Mon, Dec 19	Haze, Mist		HZ, BR
Tue, Dec 20	Drizzle, Light Drizzle, Haze, Mist		DZ, -DZ, HZ, BR
Wed, Dec 21	Haze, Mist		HZ, BR
Thu, Dec 22	Haze, Mist		HZ, BR
Fri, Dec 23	Haze, Mist		HZ, BR
Sat, Dec 24	Haze, Mist		HZ, BR
Sun, Dec 25	Haze, Mist		HZ, BR
Mon, Dec 26	Haze, Mist		HZ, BR
Tue, Dec 27	Haze, Mist		HZ, BR
Wed, Dec 28	Rain, Light Rain, Light Drizzle, Haze, Mist		RA, -RA, -DZ, HZ, BR
Thu, Dec 29	Haze, Mist		HZ, BR
Fri, Dec 30	Haze, Mist		HZ, BR
Sat, Dec 31	Haze, Mist		HZ, BR

Table 1b Rainfall detail on June 06, 2016 [29]

From the observed weather data as obtained (Fig. 6a and 6b, Table 1a and 1b), the reported rainfall during the observed sampling period (Jun 06, 2016 and Dec 06, 2016) found to be minimum. Particularly during the sampling day, or before and after 24 hours of sampling, little or no rainfall has been recorded (Fig. 6a and 6b).

III. RESULTS AND DISCUSSIONS

The sample collected from the locations starting from Thuvakudi Pond, and the residential area around Thuvakudi pond such as Kungumapuram, RECT Nagar, Barakath Nagar and Eechangadu are presented in the forthcoming sections. The nomenclature of the sampling locations is provided in the Table 2. Similarly the pre-monsoon season is indicated as **PR** and the post-monsoon season is indicated as **PO**.

S. No.	Name of the Location	Nomenclature
1	Thuvakudi Pond	L1
2	Kungumapuram	L2
3	RECT Nagar	L3
4	Barakath Nagar	L4
5	Eechangadu	L5

Table 2 Sampling Location Nomenclature

3.2 Cmparison of Physico-Chemical properties: pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD)

Fig. 7a and 7b provides the details of pH, DO and BOD of the sampling locations for Pre Monsoon and Post Monsoon seasons respectively. The variation of pH at different locations for Pre Monsoon found to be 12 % and it is around 13 % for the Post Monsoon. For the complete analysis the difference between the pH values is 14 % with a lowest pH for the Eechangadu and the highest pH observed at Kungumapuram during the Post Monsoon. Though, there are differences observed, when compared with the Thuvakudi Pond, remarkable changes were not observed in the pH value. The overall observation of pH values showed that the water available in the Thuvakudi Pond is alkaline nature towards neutral pH. During the Post Monsoon season, the pH values at all locations are moving towards the upper pH or alkaline pH zone. Though the physical, chemical and ground water quality is the function of physical and chemical parameters which is governed by the geological formations, climatic conditions and anthropogenic activities [26, 27], the higher pH value in the Post Monsoon indicates the influence of rainfall, surface runoff and the dissolution of minerals from rocks and soil of the nearby pond area. A regular trend observed in all the locations confirms that there are no major changes during the assessment period.

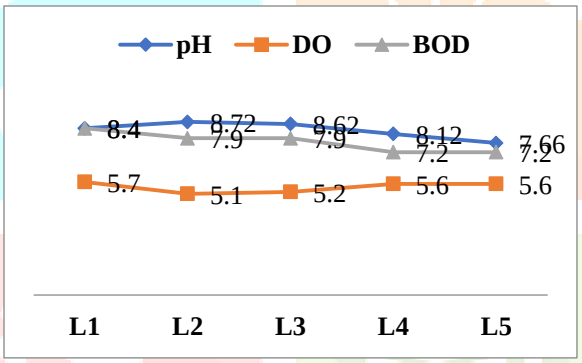


Fig. 7a pH, DO and BOD in PR

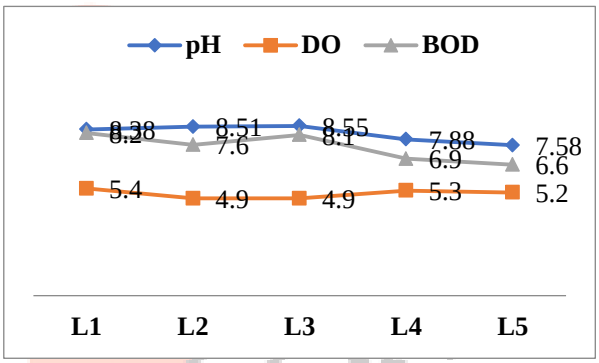


Fig. 7b pH, DO and BOD in PO

Dissolved oxygen found to have a maximum difference of 8 % between different locations and seasons. The optimum level of dissolved oxygen is 5 mg/l for ponds [28]. DO values infer the absence of major environmental changes during the experimental period (May & August 2016). Another reason for a small variation in the DO value of the pond is, the DO of surface water of the pond alone measured. BOD values observed with minor variations, in RECT Nagar the BOD value appear to be similar. These are the factors which convey that the pond environment is not altered during the testing or observation period.

3.3 Comparison of Total Dissolved Salts (TDS), Electrical Conductivity (EC), Total Alkalinity (TA) and Total Hardness (TH)

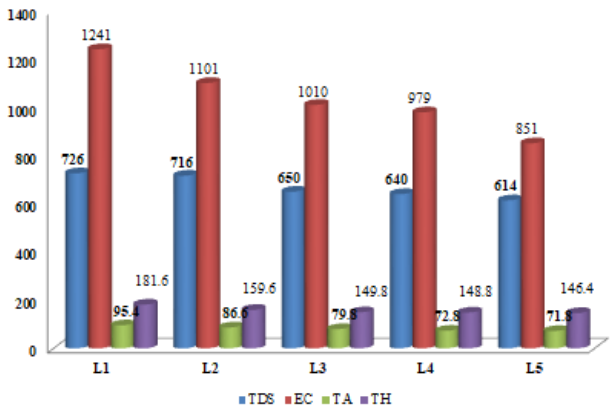


Fig. 8a TDS, EC, TA and TH in PR

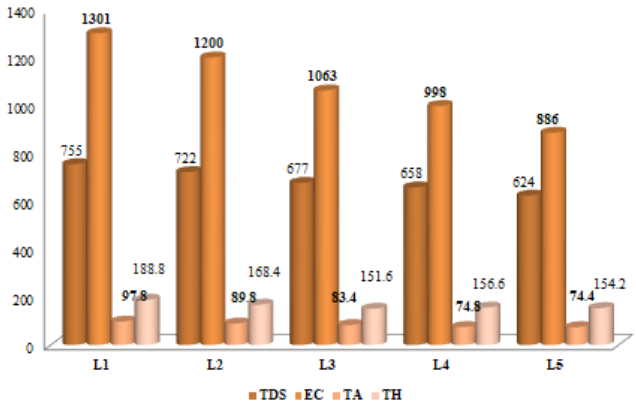


Fig. 8b TDS, EC, TA and TH in PO

The comparative values of total dissolved salts (TDS), electrical conductivity (EC), total alkalinity (TA) and total hardness for both the seasons are presented in Fig. 8a and 8b. It could be clearly observed that, during the post monsoon, comparatively higher values of TDS, EC, TA and TH observed. The direct proportionality of EC and TDS is observed clearly.

Among the five locations, Eechangadu found to have the lowest EC and TDS values. On observing the trend of EC and TDS, hardly 2 – 5 % of variation observed in the two seasons with a slight variation in the higher for Post Monsoon. This could be attributed to the absence of rainfall and continuous evaporation. Also, as there is no fresh runoff of rainwater the concentration salts might have increased. These observations are provided in line with the climatic data shown in Fig. 6a and 6b [29].

Similarly, total hardness and total alkalinity of the various locations were slightly differing. A marginal difference of 27 % and 28 % between total alkalinity values were observed when comparing Pre Monsoon and Post Monsoon values. As observed with the earlier properties Eechangadu location found to possess the minimum total alkalinity value as compared to other locations.

3.5 Comparison of Cations (Ca^{2+}, Mg^{2+}, Na^{+} & K^{+}) and Anions (HCO_3^-, CO_3^{2-}, Cl^-, SO_4^{2-}, NO_3^-, OPO_3^{3-})

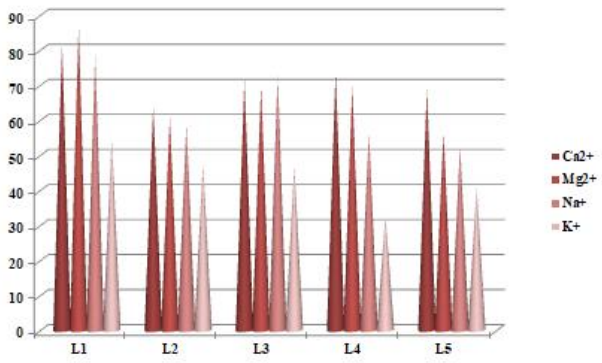


Fig. 9a Cations in PR

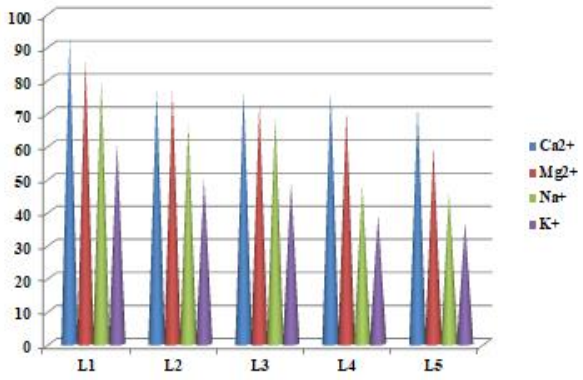
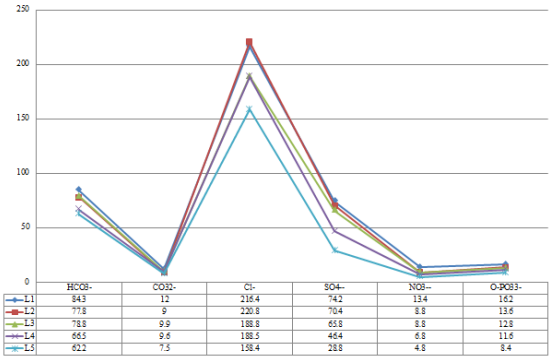
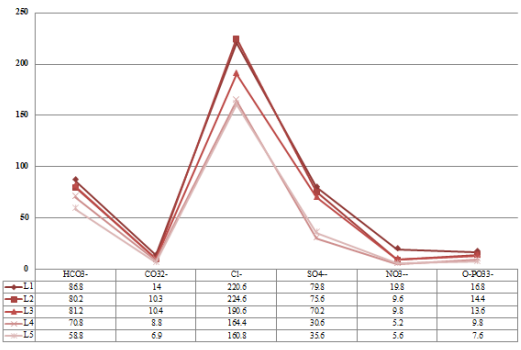


Fig. 9b Cations in PO



	HCO3-	CO32-	Cl-	SO4--	NO3--	O-PO33-
L1	84.3	12	216.4	74.2	13.4	16.2
L2	77.8	9	220.8	70.4	8.8	13.6
L3	78.8	9.9	188.8	65.8	8.8	12.8
L4	66.5	9.6	188.5	46.4	6.8	11.6
L5	62.2	7.5	138.4	28.8	4.8	8.4

Fig. 10a Anions in PR



	HCO3-	CO32-	Cl-	SO4--	NO3--	O-PO33-
L1	86.8	14	220.6	79.8	19.8	16.8
L2	80.2	10.3	224.6	75.6	9.6	14.4
L3	81.2	10.4	190.6	70.2	9.8	13.6
L4	70.8	8.8	164.4	30.6	5.2	9.8
L5	58.8	6.9	160.8	35.6	5.6	7.6

Fig. 10b Anions in PO

The physico-chemical properties as observed by first author carried out during his M. Phil., thesis work has been presented. A slight or similar trend has been reported the author. At the same in the same season that is from the month of March 2016 to August 2016, a different trend has been reported [30]. The correlation matrices for the different physico-chemical parameters of Thuvakudi pond water as obtained by Karl's Pearson coefficient are presented in Table 3. Both positive and negative correlation has been observed. Highest negative correlation of -0.4122 has been observed with the DO. Remaining other parameters is close to the unit value with positive correlation. However, much change was not observed in the properties.

	pH	TDS	EC	DO	BOD	TA	TH	Ca	Mg	Na	K	HCO3	CO3	Cl	SO4	NO2	PO4
pH	1																
TDS	0.76527	1															
EC	0.73716	0.966151	1														
DO	-.41225	-0.00929	0.10591	1													
BOD	0.82285	0.789469	0.846892	-0.0325	1												
TA	0.70285	0.951546	0.964386	0.06682	0.87523	1											
TH	0.41156	0.846272	0.899071	0.42359	0.71521	0.90741	1										
Ca	0.25081	0.525432	0.698008	0.66039	0.59105	0.63907	0.78932	1									
Mg	0.56847	0.736611	0.874277	0.33028	0.77558	0.79421	0.81833	0.8663	1								
Na	0.69873	0.711831	0.815663	-0.1145	0.88046	0.8353	0.67193	0.6262	0.81195	1							
K	0.69138	0.841628	0.867606	0.01217	0.87876	0.9401	0.81422	0.6268	0.71905	0.8717	1						
HCO3	0.88868	0.876898	0.907265	-0.143	0.91171	0.88804	0.69557	0.5637	0.80233	0.8994	0.894	1					
CO3	0.61172	0.787825	0.906389	0.20471	0.81157	0.85372	0.81685	0.837	0.92301	0.9007	0.8309	0.8787	1				
Cl	0.77499	0.931438	0.901878	-0.2516	0.74128	0.88145	0.70782	0.3729	0.64337	0.7398	0.7494	0.8303	0.7416	1			
SO4	0.8681	0.862787	0.870366	-0.2816	0.89419	0.88877	0.64293	0.4283	0.67981	0.8764	0.8398	0.9135	0.7903	0.9243	1		
NO2	0.52797	0.792375	0.88449	0.25893	0.82615	0.90132	0.87786	0.8137	0.81602	0.8635	0.8929	0.8156	0.9441	0.7354	0.7938	1	
PO4	0.79625	0.907	0.949685	-0.1043	0.86139	0.92131	0.76414	0.5988	0.83617	0.916	0.8603	0.9553	0.9235	0.917	0.94	0.8712	1

Table 3: Correlation of physico-chemical parameters of Thuvakudi Pond Water with other sites

3.6 Heavy metal analysis

The heavy metal analysis data for the various locations are presented in Table 4. When compared to the heavy metals analysed, Fe found to be dominant in both the seasons.

S. No	Sampling stations	Season	Trace metal parameters (mg/l or ppm = water)						
			Cd	Cr	Cu	Fe	Ni	Pb	Zn
1.	Thuvakudi Village Pond water	Pre Monsoon	0.16	BDL	0.22	**2.16**	BDL	0.12	0.67
		Post Monsoon	0.18	BDL	0.26	**2.10**	BDL	0.14	0.66
2.	Kungumapuram	Pre Monsoon	0.12	BDL	0.18	**1.94**	BDL	0.10	0.42
		Post Monsoon	0.13	BDL	0.19	**2.02**	BDL	0.11	0.58
3.	RECT Nagar	Pre Monsoon	0.10	BDL	0.12	**3.44**	BDL	0.10	0.59
		Post Monsoon	0.11	BDL	0.14	**3.68**	BDL	0.11	0.61
4.	Barakath Nagar	Pre Monsoon	0.08	BDL	0.08	**2.98**	BDL	0.08	0.44
		Post Monsoon	0.12	BDL	0.10	**3.12**	BDL	0.09	0.46
5.	Eechangadu	Pre Monsoon	0.05	BDL	0.04	**1.99**	BDL	0.05	0.33
		Post Monsoon	0.06	BDL	0.05	**2.20**	BDL	0.06	0.36

Table 4: Heavy Metal Analysis Data

As stated in the Section 2.3, two different beakers were prepared to find out the removal of Fe^{3+} as it was the major heavy metal present in the sample. The correlation matrices of heavy metals are presented in Table 5. As Chromium and Nickel has been is observed below the detectable limit through ICP-AS analysis, those are not included in the correlation matrices. Cadmium shows positive correlation with Copper Lead and Zinc but, shows negative correlation with Iron. Copper shows positive correlation with Lead and Zinc except Iron. On the other it shows negative correlation with Iron. Iron shows positive correlation with Lead and Zinc. Lead shows positive correlation with Zinc.

	Cd	Cu	Fe	Pb	Zn
Cd	1				
Cu	0.95753	1			
Fe	-0.1333	-0.2597	1		
Pb	0.95306	0.94784	0.05153	1	
Zn	0.8292	0.81135	0.22216	0.9152	1

Table 5: Correlation Matrices of Heavy Metals

3.7 Heavy metal removal

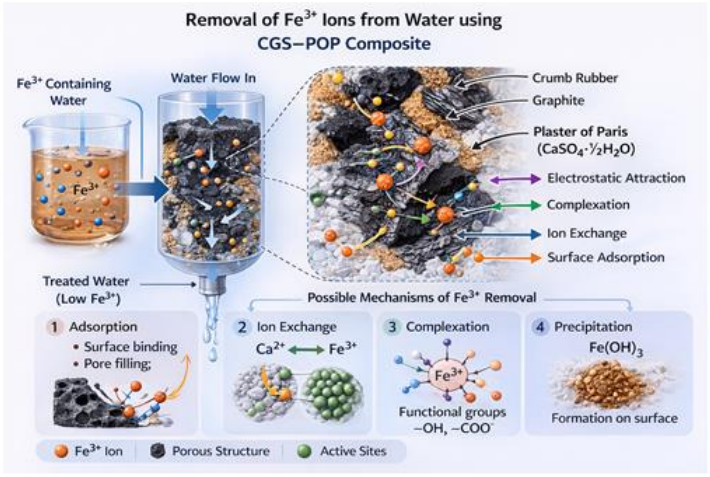


Fig. 11 Possible Mechanism for the Removal of Fe^{3+}

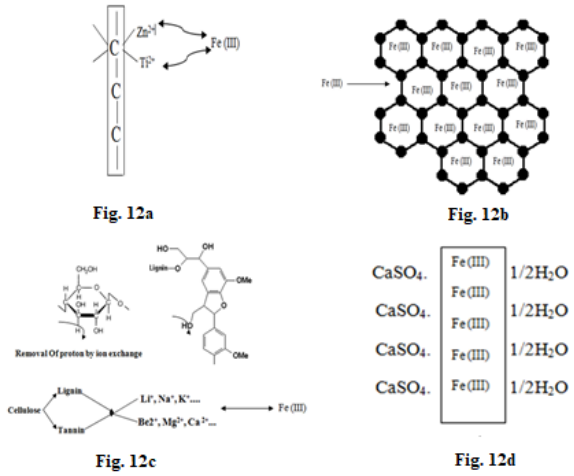


Fig. 12 Possible Ion Exchange of Fe^{3+} in various media
Fig. 12a In Crumb Rubber Medium
Fig. 12b In Graphite Medium
Fig 12c In Saw Dust Medium
Fig. 12d In Plaster of Paris Medium

Based on the studies carried out earlier [31-42], the target heavy metal (Fe) was attempted to separate as detailed in the Section 2.3. Studies have found that the components of a crumb rubber that absorb many inorganic metals are mainly polymeric materials and partially other materials such as Carbon-Black. In addition to that it also contains additives such as (TiO_2 and ZnO_2) additionally it also contains trace amounts of metals such as copper and zinc are found in steel belted tyres.

The size of graphite powder is usually 0.1mm about the size of coarse sand is usually have larger internal surface area and smaller internal pores, which make the particle with a faster adsorption rate and high interaction rate with heavy metals.

Sawdust, having a great potential as an adsorbent, has attracted the most attention of the scientific dealing with different aspects of waste water purification by biosorption. Not much attention has been paid so far to the mechanism of bonding of the metal ions on to sawdust. The researchers dealing with the sawdust adsorption supposed that an ion exchange mechanism between metal ions and some functional groups existing in the ligno cellulosic composition molecular structure was able to replace protons by some particular metal ion species from the aqueous phase. It is mainly composed of cellulose (45-50%) and lignin (23-30%). It is proved that an exchange of earth-alkali and alkali metals ions and hydroxyl, carboxylic and phenolic groups from organic molecules which can bond with heavy metal ions from aqueous phase.

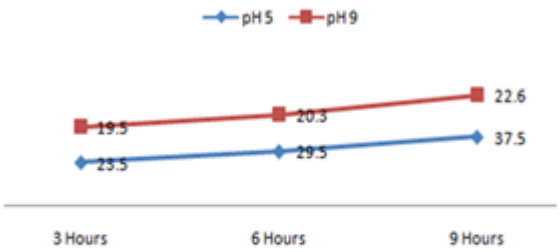


Fig. 13 Adsorption of Fe^{3+} under different pH Conditions at various time period

The plaster is made by calcinating gypsum, a process which involves exposing the gypsum to very high temperature to create calcium sulphate and then grinding it into a fine white powder. The chemical structure of calcinated gypsum is: $CaSO_4$. $½H_2O$, the adsorption property is due the adsorption at the intra molecular space between $CaSO_4$ and water molecule, because the bond strength between them are weak, thus by accommodating higher rate of heavy metal adsorption with respect to pH and Temperature. The adsorption of Fe (III) ion is found be maximum at pH 5 and at 9 hours period. It was observed that the adsorption rate is dependent on contact time and pH condition. Fig. 12a-12c shows the proposed physical mechanism for the Fe^{3+} removal.

As stated in Section 2.3, the initial concentration of the Fe^{3+} was maintained at 50 mg/l. Different pH such as acidic (pH = 5) and alkaline (pH = 9) were selected. The test temperature was maintained at 50 °C. All the samples were passed through the CGP-POP composite, for 3, 6 and 9 hours respectively in both the pH conditions. The results are presented in Fig. 13.

IV. CONCLUSION

The slight variation in physico-chemical parameters between pre-monsoon and post-monsoon seasons observed indicates that the pond is of fresh water type with moderate level of anthropogenic activities and contamination. Seasonal factors such as rainfall, evaporation, temperature changes, and runoff influence water chemistry but usually do not cause drastic shifts unless significant pollution or anthropogenic disturbances occur. At the same time, similar attempts with less specific details report a different data which is provided in the discussion section. As this research work is a maiden attempt to assess the physico-chemical parameters of Thuvakudi Pond, Tiruchirappalli district, India, this could serve as a starting point for further researchers possibly to find out the actual climatic variations in a given season. The heavy metal studies confirm the suggested method could be a viable process to remove Fe^{3+}, where the locality is surrounded by heavy industries.

V. ACKNOWLEDGEMENT

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VIII. REFERENCES

[1] Downing, J. A., Prairie, Y.T., Cole J.J., Duarte, C.M., Tranvik, L.J., Striegl, R.J., Mc Dowell, W.H., Kortelainen, P., Caraco, N.F., Melack, J.M., & Middelburg J.J., (2006). The global abundance and size distribution of lakes, ponds and impoundments. Limnology and Oceanography, 51, 2388-2397.

[2] https://en.wikipedia.org/wiki/Water_garden

[3] Dubey, T. P., (2013). The Biodiversity of the Ponds: Water and Biodiversity, Uttar Pradesh State Biodiversity Board, 30-36.

[4] Biggs, J., Williams, P., Whitfield, M., Nicolet, P., and Weatherby, A. (2005). 15 Years of Pond Assessment in Britain: Results and Lessons Learned from the Work of Pond Conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 15: 693-714.

[5] https://en.wikipedia.org/wiki/Water_garden

[6] Céréghino, R., Boix, D., Cauchie, H-M., Martens, K., and Oertli, B (2014). The Ecological Role of Ponds in a Changing World, *Hydrobiologia*, 723, 1-6.

[7] The Pond Manifesto (2008). European Pond Conservation Network (EPCN).

[8] Kumar, M., Padhy, P.K. (2015). Environmental Perspectives of Pond Ecosystems: Global Issues, Services and Indian Scenarios. Current World Environment, 10 (3), http://dx.doi.org/10.12944/CWE.10.3.16

[9] Brönmark, C., Hansson, L. A., (2002). Environmental issues in lakes and ponds: Current state and perspectives. Environmental Conservation 29, 290-307.

[10] Ling, F., Whitaker, R., Le Chevallier, Mark W., Liu, Wen-Tso (2018). "Drinking water microbiome assembly induced by water stagnation". The ISME Journal. 12 (6) 1520–1531. https://www.nature.com/articles/s41396-018-0101-5

[11] Oertli B, Biggs J, Céréghino R, Grillas P, Joly P, Lachavanne J-B., (2005). Conservation and monitoring of pond biodiversity: introduction. Aquatic Conservation: Marine and Freshwater Ecosystems. 2005;15(6):535–40.

[12] Pechar L., (2007). Impacts of long-term changes in fishery management on the trophic level water quality in Czech fishponds. Fisheries Management and Ecology, 7 (1–2):23–31.

[13] Ray, M. K., Majumdar, S (2005). Evaluating Economic Sustainability of Urban and Peri-urban Water bodies: A Case Study from Kolkata Ponds. Editors: Sengupta, N., and Bandyopadhyay, J. Biodiversity and Quality of Life, Macmillan, New Delhi, 135-146.

[14] Jakeer, N., Sureshkumar, M.S., Nicholas Daniel, A. (2020) Physico-Chemical Parameters and Comparative Studies on Ground Water in Songea, Tanzania. *International Journal of Creative Research Thoughts*, 8 (9) 1293-1297. http://doi.one/10.1729/Journal.42437

[15] Sureshkumar, M.S., Jakeer, N., Nicholas Daniel, A. (2021). Ground Water Quality and its Physico-Chemical Nature at Ten Miles, Chibombo District, Zambia, *International Journal of Creative Research Thoughts*, 9, (1), 911-919. http://doi.one/10.1729/Journal.43143

[16] National Water Policy (NWP), Ministry of Water Resources, Government of India, 2002.

[17] National Water Policy (NWP), Ministry of Water Resources, Government of India, 2012.

[18] IUCN, International Union for Conservation of Nature (2015). World Water Week: A New Course for Water and Development.

[19] Status of Water Quality in India – 2010, (2011). Monitoring of Indian National Aquatic Resources, Series: MINARS/2010-11, Central Pollution Control Board (CPCB), Ministry of Environment and Forests, Government of India.

[20] https://shorturl.at/pw5qp

[21] https://rb.gy/oq61im

[22] https://www.toptourguide.com/toptour-indiamap.htm

[23] https://stock.adobe.com/in/search?k=tamilnadu+map

[24] https://shorturl.at/y6LeN

[25] https://shorturl.at/TH2re

[26] Matthess, G. (1982). The Properties of Groundwater, John Wiley and Sons., New York.

[27] Subramani, T., Elango, L., Damodarasamy, S.R. (2005). Groundwater Quality and its Suitability for Drinking and Agricultural Use in Chitar River Basin, Tamil Nadu, India, *Environmental Geology*, Vol. 47, 1099-1110.

[28] http://www.agritech.tnau.ac.in/fishery/fish_water.html

[29] https://weatherspark.com/h/y/109340/2016/Historical-Weather-during-2016-in-Tiruchirappalli-Tamil-Nadu-India

[30] Rajendran, R., Alice Emerenshiya, C., Dheenadayalan, M.S., (2017). Ground Water Quality Assessment in and around Ariyamangalam, Tiruchirappalli City. *International Journal of Recent Research in Physics and Chemical Sciences*, Vol. 3, Issue 2, 1-5.

[31] Sankar, K.R., Venkatraman, B. R., Arivoli, S. (2010), Equilibrium and Thermodynamics Studies on the Removal of Iron (III) onto Plaster of Paris, *International Journal of Engineering Innovation & Research*, Volume 2, Issue 1, ISSN: 2277 – 5668.

[32] Dimple Lakherwal- Adsorption of Heavy Metals: A Review, *International Journal of Environmental Research and Development*, Volume 4, Number 1 (2014), 41-48.

[33] Babel S. and Kurniawan T.A., (2003). Low-cost adsorbents for heavy metals uptake from contaminated water: a review, *J. of Hazard Mater*, 97, 219–243.

[34] Velizar Stanković, Dragana božić, Milan Gorgievski (2009). Technical Faculty Bor, University of Belgrade, Bor, Serbia scientific paper, Heavy metal ions adsorption from mine waters by sawdust. *Chemical Industry & Chemical Engineering Quarterly*, Vol. 15, No. 4, 237–249.

[35] Sanchez, D., Alamo, L., del Valle, A., Roman, F., Perales, O. (2007). Removal of Lead, Copper and Cadmium Ions from Aqueous Solutions using Waste Tire Crumb Rubber, Proceedings of the 7th Caribbean Island Water Resources Congress 97.

[36] Gao W, Majumder M, Alemany L, Tharangattu N, Miguel A, Bhebendra K, Pradhan, Pulickel M (2011). Engineered Graphite Oxide Materials for application in water purification. *J. American Chemical Society Applied. Material interfaces*, 3 (6), 1821-1826.

[37] Shannon M, Bohn PW, Elimelech M, Georgiadis JG, Marinas BJ, Mayes AM (2008). Science and technology for water purification in the coming decades. *Nature*, 452: 301–310.

[38] Ahmad B. Albadarin, Chirangano Mangwandi, Gavin M. Walker, Stephen J. Allen and Mohammad N. Ahmad (2011). Biosorption Characteristics of Sawdust for the Removal of Cd(II) Ions: Mechanism and Thermodynamic Studies. DOI:10.3303/CET1124217

[39] Taty-Costodes, V.C., Fauduet, H., Porte, C., Delacroix, A., (2003). Removal of Cd(II)and Pb(II) ions, from aqueous solutions, by adsorption onto sawdust of Pinus sylvestris. *Journal of Hazardous Materials*, 105, 121-142.

[40] Babel, S., Kurniawan, T.A., (2003). Low-cost adsorbents for heavy metals uptake from contaminated water: a review. *J. Hazard. Mater*. B97, 219–243.

[41] Barakat, M.A., (2008). Adsorption of heavy metals from aqueous solutions on synthetic zeolite. *Res. J. Environ. Sci. 2* (1), 13–22.

[42] Barakat, M.A., (2008). Removal of Cu(II), Ni(II), and Cr(III) ions from wastewater using complexation–ultrafiltration technique. *J. Environ. Sci. Technol*. 1 (3), 151–156.

*Author for Correspondence: **Prof. (**Dr.**) M.S. Sureshkumar:** drmssureshkumar2011@gmail.com