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# COMPARATIVE EVALUATION OF WATER QUALITY PARAMETERS OF VAIGAI RIVER, MADURAI DISTRICT, TAMILNADU OVER A DECADE (2015 & 2025)

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## ABSTRACT

The present study evaluates the physico-chemical parameters of the Vaigai River at five sampling sites during August 2015 and August 2025 to understand spatial and temporal variations in water quality. Parameters including pH, electrical conductivity, total dissolved solids (TDS), alkalinity, hardness, calcium, magnesium, iron, chloride, nitrate, phosphate, fluoride, Dissolved oxygen (DO), Biological oxygen demand (BOD) and Chemical oxygen demand (COD) were analysed. Results revealed that pH remained largely neutral to mildly alkaline across most sites, although a decline was noted at the downstream station (S5) in 2025, reflecting localized pollution inputs. Conductivity decreased in 2025 compared to 2015, while TDS showed a sharp rise, particularly at Kochadai (S5), indicating increasing contamination from domestic, agricultural and industrial discharges. Hardness and associated ions (Ca, Mg, Fe) were elevated at downstream sites, confirming high anthropogenic influences. Nutrients such as nitrate and phosphate exceeded acceptable limits in several locations, highlighting risks of eutrophication and nitrate-related health concerns. Fluoride concentrations also increased in 2025, surpassing permissible levels at multiple sites. Organic pollution indicators showed marked temporal changes: in 2015, DO levels were critically low (0.9–1.5 mg/L) and BOD extremely high (24–32 mg/L), reflecting severe organic loading; by 2025, DO improved substantially (4.3–9.6 mg/L), while BOD decreased (4.5–22.5 mg/L) but remained above safe levels in downstream stretches. The comparative analysis demonstrates partial improvement in water quality over the decade, yet persistent organic and nutrient pollution continues to affect downstream reaches. Overall, the findings indicate that while the Vaigai River exhibits some recovery, sustained anthropogenic pressures necessitate enhanced wastewater treatment, stricter pollution control and continuous monitoring to restore ecological balance and ensure water safety.

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## INTRODUCTION

The majority of ancient civilizations were developed on the bank of major rivers across the world. India is a country having land forms and rivers. There are 14 major rivers in India. The rivers of India play an important role in the lives of the Indian people. The river systems provide irrigation, potable water, electricity and the livelihoods for a large number of people all over the country [1]. Water is the most important in shaping the land and regulating the climate. It is one of the most important compounds that profoundly influence life Water is essential for life and access to clean drinking water is fundamental for human health. However, the availability of safe water is increasingly threatened due to scarcity and pollution of natural water resources. The quality of river water is influenced by natural factors such as rainfall, temperature and rock weathering, as well as by anthropogenic activities including industrialization, urbanization, sewage discharge and agricultural runoff which alter the hydrochemistry of rivers. These activities contribute to changes in parameters

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such as turbidity, pH, dissolved oxygen, biological oxygen demand (BOD), chemical oxygen demand (COD), electrical conductivity, total dissolved solids (TDS), alkalinity, hardness and the presence of ions like calcium, magnesium, nitrate, chloride and sulphate as The quality of water usually described according to its physical, chemical, characteristics. Rapid urban growth and unplanned waste disposal practices further intensify pollution, leading to ecological degradation and potential risks to human welfare. The present study is an attempt to make an assessment of the change in the quality of water of the Vaigai River in Madurai, Tamil Nadu, physico-chemical parameters such as pH, temperature, EC, TDS, alkalinity, DO, BOD, COD, total hardness, calcium, magnesium, nitrate, nitrite and iron have been assessed to understand the extent of pollution where many people living on its banks still uses it as a source of water for washing and bathing.

### *Study Area*

Madurai is a historic city located in the southern part of Tamil Nadu, India. The city has developed on both banks of the Vaigai River, which serves as its lifeline. Geographically, Madurai is situated at 9°48′ N latitude and 78°06′ E longitude [2]. For the present study, five sampling stations were selected along different stretches of the Vaigai River within Madurai District. Water samples were collected from Sholavandan (S1), Thiruvedagam (S2), Thenur (S3), Thuvariman (S4) and Kochadai (S5).

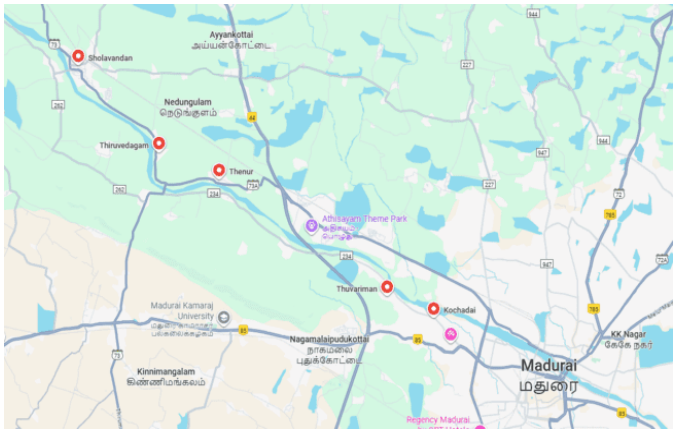


**Figure 1.** Sampling stations of Vaigai River, Madurai District.

## MATERIALS AND METHOD

### *Collection of Sample*

The Vaigai River water samples was collected on August 2015 and August 2025 from Madurai District for the estimation of physical-chemical parameters and bacterial populations. Sampling was done by Grab sampling method in polyethylene bottles of two liter capacity to avoided leaching of metals and interaction with the surface wall of the container. Samples was collected by immersing the rinsed bottles in river waters [5]. All the samples were labelled with source date and time of collection. Temperature and pH of the samples were measured at the site using digital pH meter and digital thermometer respectively. After sample collection, the bottles were kept in ice box and transferred immediately to the laboratory for further analysis. The samples were analysed (Physical and chemical Parameters) by (BIS, 1983 and APHA, 1998) [3-4].

### *Analysis of Water*

The laboratory analysis of Vaigai River water samples was carried out following the standard procedures prescribed by the American Public Health Association (APHA) and the World Health Organization (WHO). A total of fifteen physico-chemical parameters were examined, which included pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness, calcium hardness, magnesium, nitrate, nitrite, chloride and iron.

## RESULT AND DISCUSSION

The water quality of the Vaigai River was evaluated by analysing key physico-chemical parameters across five sampling sites during August 2015 and August 2025. The comparative assessment highlighted clear temporal and spatial variations, indicating that the river continues to experience significant pollution pressures, particularly in stretches influenced by domestic, industrial, and agricultural discharges from the catchment.

The pH of the river water during both study years ranged between 6.0 and 8.5, remaining within a neutral to mildly alkaline range. Across most sites (S1–S4), the pH showed only minor variation between 2015 and 2025, suggesting that the buffering capacity of the river is relatively stable. However, at Kochadai (S5), a noticeable decline in pH was recorded in 2025 compared to 2015, pointing to localized water quality deterioration, possibly due to intensified wastewater inflows. Conductivity values exhibited a contrasting trend across the two years. In 2015, conductivity levels were significantly higher, particularly at Kochadai (S5), reflecting a higher accumulation of dissolved salts and ions. By 2025, conductivity had decreased and stabilized across most sites, which may be attributed to dilution during the sampling season or reduced inflow of saline effluents. Conversely, total dissolved solids (TDS) values followed an opposite pattern. While TDS was comparatively low to moderate in 2015, the 2025 analysis showed a marked increase, especially at Kochadai (S5), where concentrations peaked sharply. This rise highlights growing contamination pressure from untreated sewage, agricultural runoff and industrial discharges, which contribute to higher ionic and mineral content in the downstream reaches.

Hardness and associated cations also displayed notable variations. Calcium, magnesium and iron concentrations were highest at Kochadai (S5) in both study years, while other sites remained within safer ranges. The elevated hardness in certain locations suggests contributions from both geogenic sources such as carbonate-rich sediments and anthropogenic influences like agricultural return flows and urban runoff. The significant hardness values indicate a deterioration of water quality, as prolonged exposure to very hard water can cause operational and aesthetic problems, and the results demonstrate a trend of increasing variability between sites over the decade.

Nutrient enrichment was another critical issue. Nitrate concentrations were elevated at several sites, with downstream and urban stretches being the most affected. Such enrichment is commonly linked to sewage disposal, fertilizer leaching and urban runoff and excessive levels make the water unsuitable for safe consumption. Fluoride concentrations, which were relatively stable in 2015, showed a marked rise across all sites in 2025,

frequently surpassing acceptable limits. Elevated fluoride, if persistent, can pose risks of dental and skeletal fluorosis. Similarly, phosphate levels were consistently high across the study period, reaching objectionable limits at all stations. Elevated phosphate promotes eutrophication, leading to enhanced algal growth and further deterioration of oxygen balance in the river.

Indicators of organic pollution, Dissolved oxygen (DO), Biological oxygen demand (BOD), and Chemical oxygen demand (COD), provided the clearest evidence of improvement and persistence of stress across the decade. In 2015, DO values were critically low at all sites, ranging between 0.9 and 1.5 mg/L[8], which reflects severe organic loading and unsuitable conditions for aquatic organisms. By 2025, DO improved substantially, with values between 4.3 and 9.6 mg/L. Upstream stations such as Sholavandan (S1) and Thiruvendagam (S2) showed healthier oxygen levels, while Thuvariman (S4) and Thenur (S3) improved moderately but still exhibited signs of stress. Kochadai (S5), although rising from 1.5 mg/L to 4.3 mg/L, continued to remain oxygen-deficient, confirming persistent pollution stress in this urban stretch.

The BOD results paralleled this trend. In 2015, BOD values were extremely high, ranging from 24 to 32 mg/L, reflecting heavy organic pollution from untreated sewage and industrial effluents. By 2025, BOD levels had reduced but still exceeded safe thresholds, ranging from 4.5 to 22.5 mg/L. Improvements were most visible in Sholavandan (S1) and Thiruvendagam (S2), where BOD approached lower levels, while Thenur (S3) and Thuvariman (S4) remained moderately impacted. Kochadai (S5) continued to record the highest BOD values, underscoring ongoing discharges and inadequate waste management practices. COD values, where measured, supported these findings by indicating the persistent presence of both biodegradable and non-biodegradable organic matter.

Overall, the results show that while there has been partial improvement in some physico-chemical parameters between 2015 and 2025, the Vaigai River continues to face significant water quality challenges, particularly in downstream stretches impacted by urbanization. Parameters such as TDS, hardness, nitrates, phosphates and BOD reveal sustained anthropogenic pressure, and although DO has improved, localized areas still fail to support healthy aquatic conditions. The comparative decade-long evaluation underscores the urgent need for improved wastewater treatment, pollution control and continuous monitoring to protect the ecological and human uses of the Vaigai River.

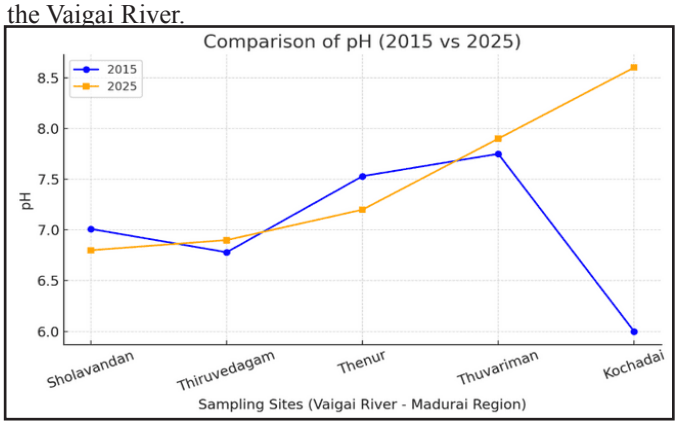


**Fig. 1.** Shows the pH values of different sampling sites of the Vaigai River (2015&2025)

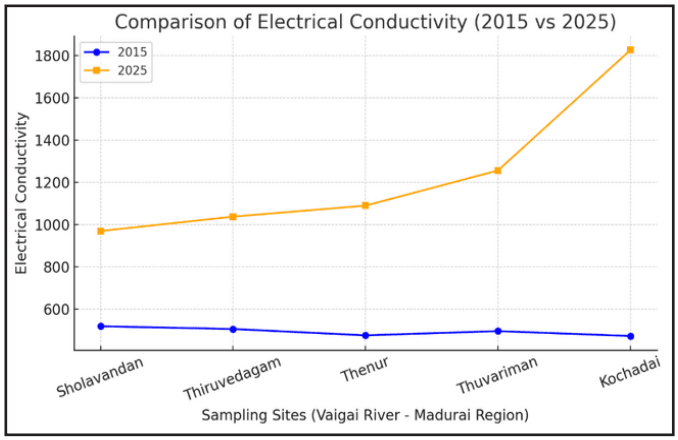


**Fig. 2.** Shows the Electrical Conductivity values of different sampling sites of the Vaigai River (2015&2025)

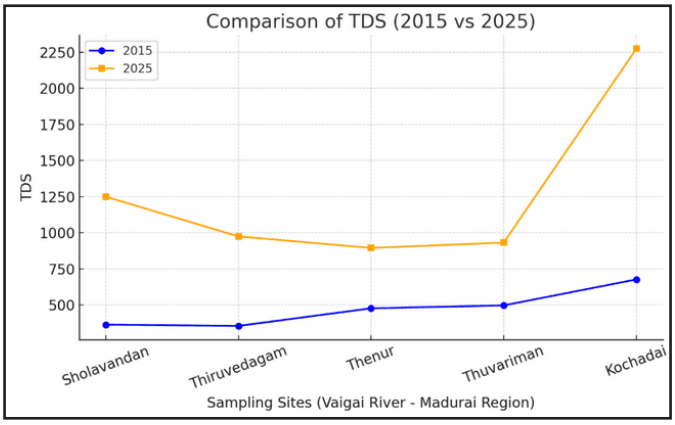


**Fig. 3**. Shows the TDS values of different sampling sites of the Vaigai River (2015&2025)

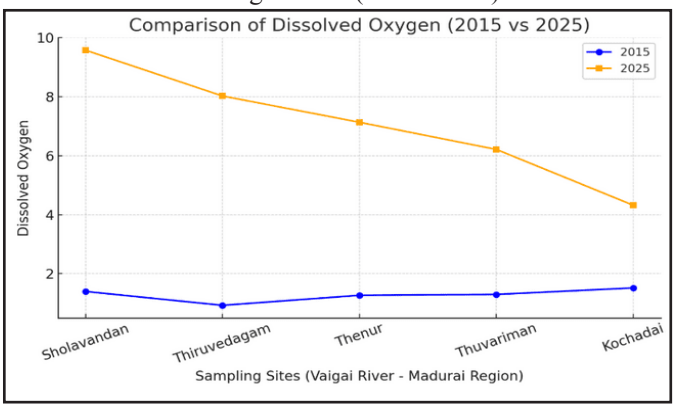


**Fig. 4.** Shows the Dissolved Oxygen values of different sampling sites of the Vaigai River (2015&2025)

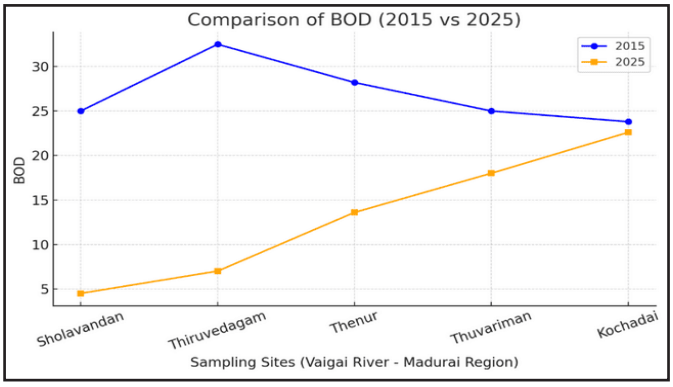


**Fig. 5**. Shows the BOD values of different sampling sites of the Vaigai River (2015&2025)

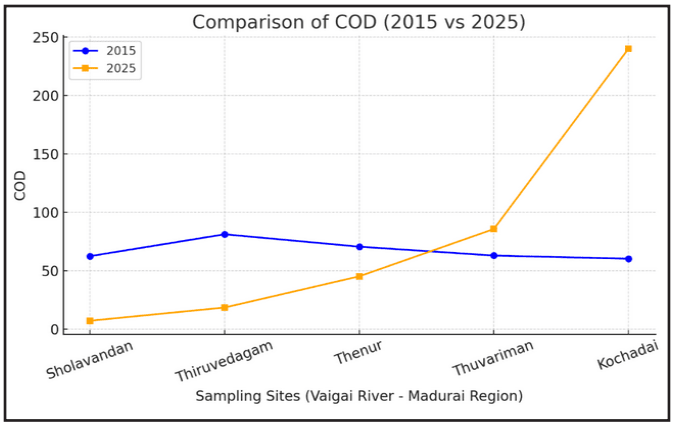


**Fig. 6.** Shows the COD values of different sampling sites of the Vaigai River (2015&2025)

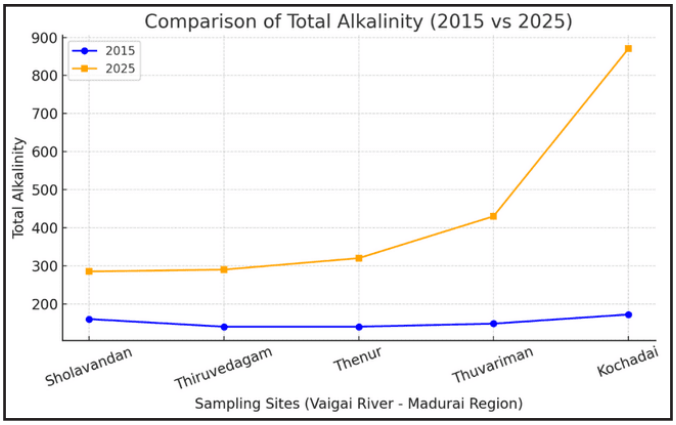


**Fig. 7.** Shows the Total Alkalinity values of different sampling sites of the Vaigai River (2015&2025)

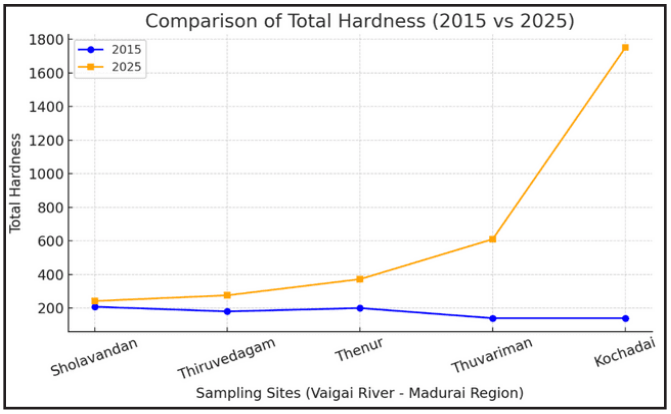


**Fig 8:** shows the Total Hardness values of different sampling sites of the Vaigai River (2015&2025)

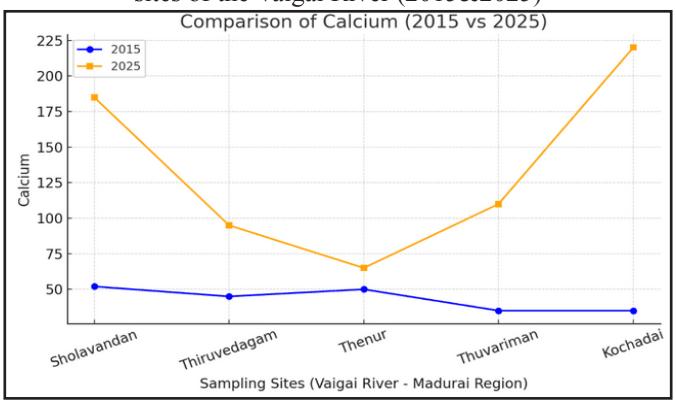


**Fig. 9.** Shows the Calcium values of different sampling sites of the Vaigai River (2015&2025)

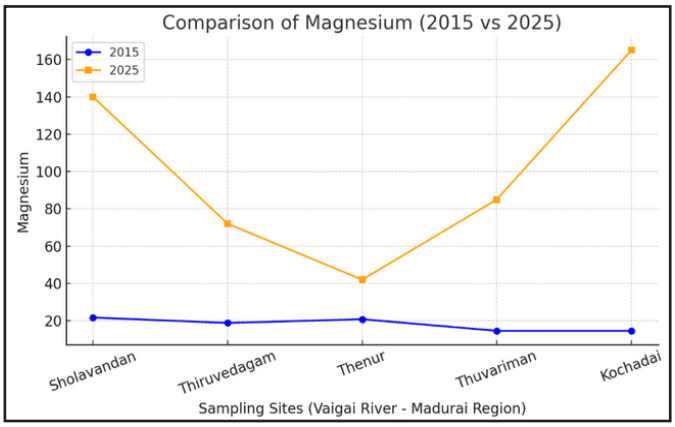


**Fig. 10.** Shows the Magnesium values of different sampling sites of the Vaigai River (2015&2025)

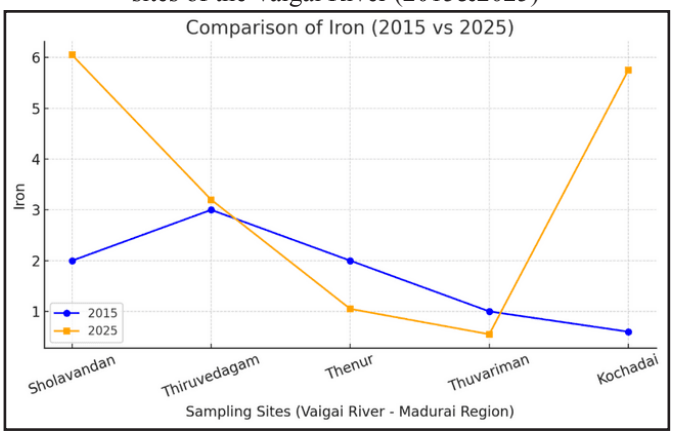


**Fig.11.** Shows the Iron values of different sampling sites of the Vaigai River (2015&2025)

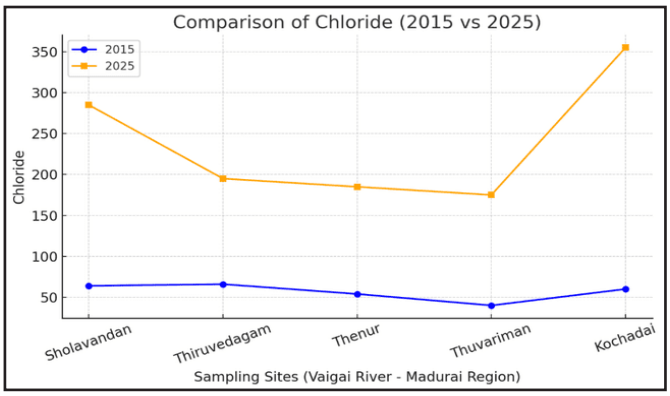


**Fig. 12**. Shows the Chloride values of different sampling sites of the Vaigai River (2015&2025)

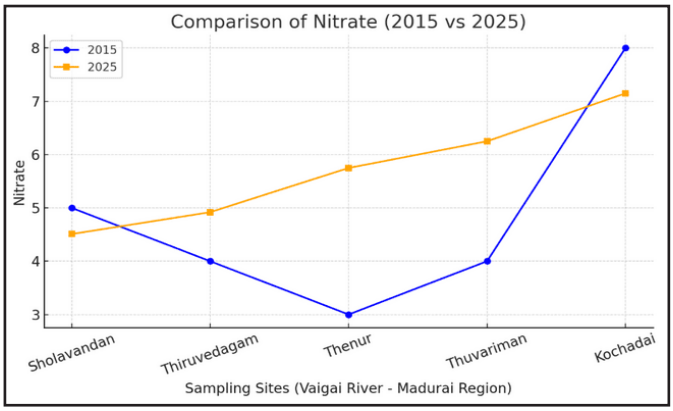


**Fig. 13.** Shows the Nitrate values of different sampling sites of the Vaigai River (2015&2025)

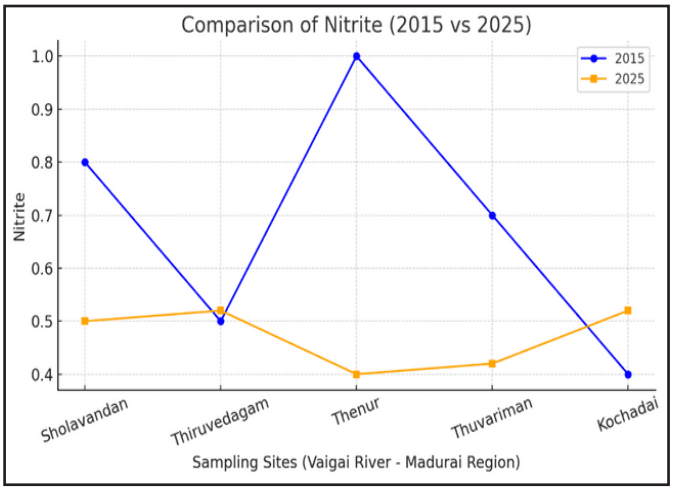


**Fig. 14.** Shows the Nitrite values of different sampling sites of the Vaigai River (2015&2025)

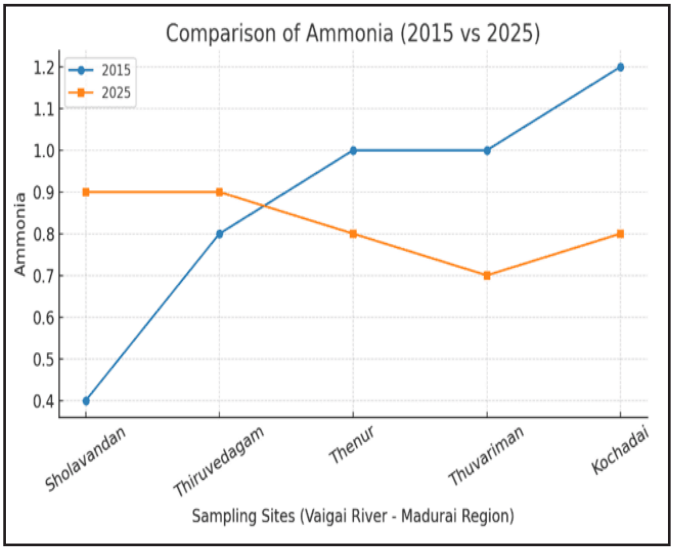


**Fig. 15.** Shows the Ammonia values of different sampling sites of the Vaigai River (2015&2025)

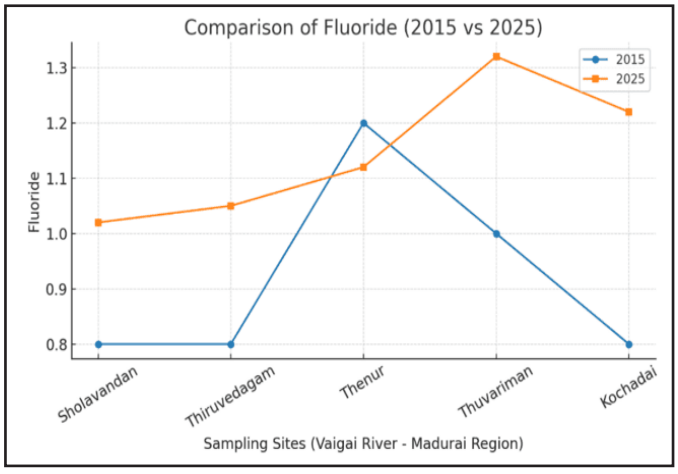


**Fig. 16.** Shows the Fluoride values of different sampling sites of the Vaigai River (2015&2025)

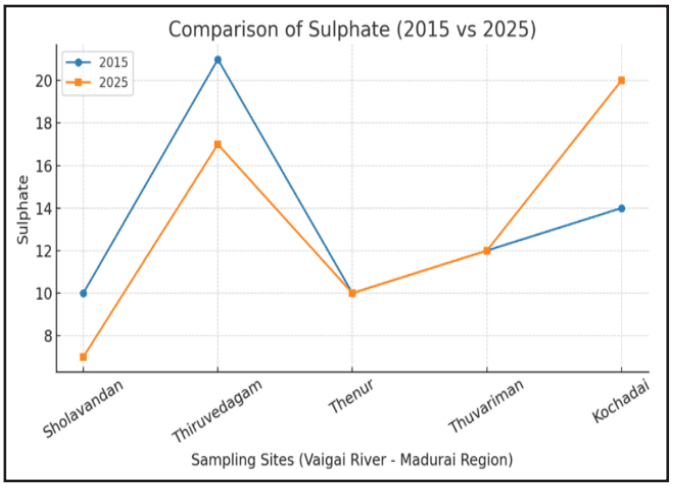


**Fig. 17.** Shows the Sulphate values of different sampling sites of the Vaigai River (2015&2025)

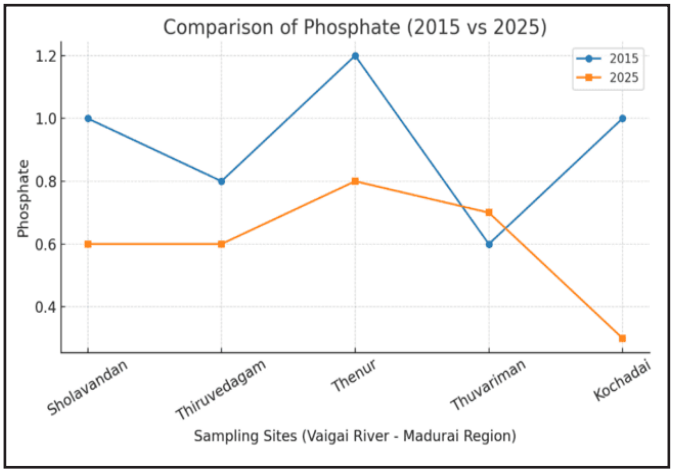


**Fig. 18.** Shows the Phosphate values of different sampling sites of the Vaigai River (2015&2025)

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