Status of River Water Quality In India:

- ***INTRODUCTION:***

River water is a crucial natural resources in India, used for various purposes such as drinking, outdoor bathing, propagation of wild life, fisheries, irrigation, industrial cooling, and maintaining aquatic ecosystems. The central Pollution Control Board (CPCB) sets primary water quality criteria for these uses. The Central Government realized in the early 1970s that water was necessary for ecosystems and that river water in particular was a scarce natural resource that was essential to life, livelihood, food security, and sustainable development. Following that, in 1974, the Central government passed The Water (Prevention and Control of Pollution) Act (The Water Act), which had the dual goals of deterring and preventing water pollution as well as penalizing those who pollute and so lower water quality. The Water Cess Act, 1977 and 1988, and the Environment (Protection) Act, or EPA, 1986 are the other Acts that specifically address water pollution in India. According to a survey of the literature, the majority of the research conducted to far have evaluated and determined the physico-chemical characteristics of specific river water in a city or state. In some of research works, it has been established that, water contamination has an economic cost. According to our knowledge, no research has been done to determine whether there are differences in the water quality of the rivers that traverse different Indian states. In this paper, an attempt has been made to Through empirical analysis, this paper attempts to investigate this unresolved issue. Eight parameters have been used to assess each state's performance: pH, nitrite and nitrate (N-N), temperature (T), conductivity (C), dissolved oxygen (DO), biological oxygen demand (BOD), fecal coliforms (FC), total coliforms (TC), and temperature (T). The primary goal is to determine how the chosen states fared during the last twenty-year period (2003-2023). What percentage of them met the chosen parameters with success? What percentage of them didn't perform well? Can some of these states be classified as "good performers" and others as "bad performers"? The statistical tools of rank analysis, scatter plot analysis, convergence-divergence analysis, and cluster analysis have been used to address these issues. We believe that this work falls short on a few crucial points. First, how each state government's policy approach affects the evaluation of water quality. Second, even though the CPCB used the approved standard procedures for sampling and water quality analysis, data bias may still exist because several agencies were involved and there are not enough monitoring stations spread among the states. Thirdly, the nation's entire aquatic resource base has been ignored in favor of just considering river sources.

- ***MATERIALS AND METHODS:***

In order to determine the quality of river water, the CPCB identified highly contaminated sections of 18 main rivers in India. From the monitoring stations installed for the different rivers that have flowed through the states, CPCB gathers water samples. Annual variations occur in the rivers that are included in the monitoring network. In its annual report titled "Status of Annual Water Quality in India (AWQR)," the CPCB details the water quality of these eighteen rivers.

River water is mostly used in India for irrigation, industrial cooling to preserve aquatic ecosystems, outdoor bathing, drinking, as well as for the propagation of wildlife and fisheries. The CPCB has established the primary water quality requirements for these uses. For instance, pH should be between 6.5 and 8.5; DO should be 4 or more; BOD should be 3 or less; TC should be between 50 and 5000, with more than 5% falling between 200 and 20000 and more than 20% falling between 50 and 5000, depending on the uses; C should be 2250 for irrigation, controlled waste disposal, and industrial cooling; and nitrite and nitrate (N-N) should be 1.2 for fisheries and wild life propagation.

- ***METHODOLOGY:***

Firstly, we take a few of India's most industrialized states. Subsequently, we analyze if the behaviour of these states exhibits any homogeneity or heterogeneity in relation to eight water quality metrics of corresponding rivers. Rank and consistency in the states' performance are evaluated by rank analysis and scatter plot analysis. To divide the sixteen major states into "good performing" and "bad performing" groups using the same characteristics, we finally perform cluster analysis.

- ***MAJOR STATES INDIA:***

The Annual Survey of Industries (ASI) data for 25 successive years indicate that there are 16 major states in India that account for more than 90% of the total value of output, invested capital and number of workers. We, therefore, consider these states as major states in India for the purpose of our study. These states are Andhra Pradesh (AP), Assam, Bihar, Gujarat, Haryana, Himachal Pradesh (HP), Karnataka (KRN), Kerala, Madhya Pradesh (MP), Maharashtra (MR), Odisha, Punjab, Rajasthan (RJN), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB).

- ***ANALYSIS OF GROWTH, DISPERSION, RANK AND CONSISTENCY IN PERFORMANCE:***

Looking at the basic data derived from AWQR, it appears that heterogeneity exists in the water quality of rivers of major states with respect to eight parameters. We have used sigma (σ) and beta (β) convergence and divergence analyses to vindicate such presumption. Concept of σ convergence focuses attention on the dispersion of value of the parameter in question over a cross section of some comparable units (in our case 16 major industrially developed states) over a period of time. Widely used measure of dispersion is Coefficient of Variation (CV). Units are said to satisfy the condition of σ convergence if dispersion decreases over time. Similarly, if dispersion increases over time, σ divergence is said to be prevailing among the comparable units. On the other hand, β convergence is said to exist when there is a negative relationship between the rates of growth enjoyed by a cross section of comparable units and level of their selected parameters at a given initial point of time. In case the slope is positive, it would indicate β divergence. The methodology adopted is as follows. For each of the 16 major states having the value of one parameter, say, DO for the given period, we construct first a log linear line of best fit which results in 16 different growth rates. A regression is then performed with initial value of DO of 16 states as the independent variable and the log linear growth rates as dependent variable.

Ranks of 16 states are derived from average value of each parameter. We then construct a scatter plot with respect to 16 states. Rank score with respect to a chosen parameter is placed on the horizontal axis and rank in terms of the measure of volatility (i.e., CV) is placed on the vertical axis. Idea is to analyse performance of any state simultaneously in terms of a score on individual value of a parameter and the associate dispersion of the concerned parameter. The states placed in A1 quadrant are consistently good performer (high value of mean with low value of CV). States placed in A2 are inconsistently good performer (high value of mean with high CV). States placed in A3 are consistently bad performer (low value of mean with low CV). States placed in A4 are inconsistently bad performer (low value of mean with high CV).

- ***CLUSTER ANALYSIS***

The act of segregating units into two heterogeneous groups, namely, “good performing” and “bad performing” can be performed by the standard statistical method of cluster analyses. Our purpose is to check whether the status of states as identified by the rank and scatter plot analysis remains unaltered when the exercise is performed in terms of the cluster analysis. We perform this analysis with one of the non-hierarchical clustering techniques, namely, K-means method.

- ***RESULTS AND DISCUSSION***

A deeper look into the results of various empirical analyses would indicate that major states in India diverged over the reference period in terms of important parameters, particularly, FC, TC and T and they converged with each other in both the phases with respect to N-N. The flipside is that the results are not statistically robust. This signifies that inter-temporal behaviour of the states over the last 20 years with respect to select parameters has not changed much. The analyses that we so far performed did not provide us a robust support in favour of the argument that there existed heterogeneity or homogeneity amongst the major Indian states with reference to the select water quality parameters.

The results of the cluster analyses indicate that 16 major states can be divided into two clusters - cluster 1 (bad performing) and cluster 2 (good performing). Phase 1 (1990 – 2002) there are eight states in each of the clusters. As the average value of Assam, Bihar, Gujarat, Haryana, Kerala, Odisha, UP, WB are “bad performing” states, while Andhra Pradesh (AP), Himachal Pradesh (HP), Karnataka (KRN), Madhya Pradesh (MP), Maharashtra (MR), Punjab, Rajasthan (RJN) and Tamil Nadu (TN) are “good performing” states. Further analyses indicate that it amongst the eight “bad performing” states, Gujarat, UP and WB are the worst performing while MR, RJN and HP are the best of the “good performing” states. The results that we obtain from the cluster analysis almost match the outcome of our earlier analyses, namely, rank analysis and scatter plot analyses.

- **CONCLUSION**

According to the outcome of the empirical analysis, it is found that, there has been variation in river water quality across India's sixteen largest industrially developed states during the course of the two decades of economic change. Despite being divided into two categories for our study— “good performing” and “bad performing” states—the results of our empirical investigation show that the high concentration of TC and FC in the river waters of the majority of the “good performing” states prevented them from meeting CPCB standards for drinking water and outdoor bathing. In comparison to other states, the FC, TC, and BOD levels of river water in industrially developed states like MR, Gujarat, TN, and UP are low. This suggests that inappropriate handling may have occurred with warm-

blooded animal effluents. Regardless of the outcome, additional investigation is required to fully understand the conduct of India's leading industrialized states and to determine the causes of as to why the states with good record of socio- economic performance are ‘bad performing’ in respect of keeping the rivers passing through them as less polluted.