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APPRAISAL OF YEARLY AND SEASONAL WATER QUALITY VARIATION AT CHAMBAL RIVER USING CANADIAN COUNSEL OF MINISTER OF ENVIRONMENT MODEL (CCME)

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ABSTRACT

Rapid industrial and urban development's often witness deterioration of water quality of the river. It is very important to assess the baseline characteristics of river water quality so that, sustainable development can be pursued. Water quality index calculates all the parameters and gives an easy decision making output to analyze the quality of water. The Canadian council of minister of environment (CCME) of water quality index (WQI) is a well accepted and universally applicable model for evaluating the water quality index. The CCME compares observation to the benchmark were the benchmark can be water quality index or sit-specific background concentration, most applications of CCME WQI have used the national water quality standards so this acts as the advantage of index which can be applied to different countries with a few modifications Change. An attempt has been made to assess the water quality of Chambal River India, through six parameters of water. This study reveals that The River water of Chambal comes under the categories of Fair to Poor quality. This indicates Water quality sometimes violates criteria, possibly by a wide margin, for use as a source of drinking water.

I. INTRODUCTION

Water is essential for all socioeconomic development and for maintaining healthy ecosystems. As population increases and development calls for increased allocations of groundwater and surface water for the domestic, agriculture and industrial sectors; the pressure on water resources intensifies, leading to tensions, conflicts among users, and excessive pressure on the environment. The increasing stress on freshwater resources brought about by ever rising demand and profile ate use as well as by growing pollution worldwide is of serious concern. Rivers are the vital source of water, which plays an important role in development of nation and sustenance of life. However, they are being polluted due to rapid industrialization, urbanization and other developmental activities/processes. TheWater quality index is widely used tool in different parts of the world to solve the problems of data management and to evaluate success and failures in management strategies for improving water quality. The index is a numeric expression used to transform large quantizes of water characterization data into a single number, which represents the water quality level (Abbasi 2002). A number of indices have been developed to summarize water quality data for communication to the general public in an effective way. In

general water quality indices incorporate data from multiple water quality parameters into mathematical equation that rates the health of water body with a single number. That number is placed on a relative scale to justify the water quality in categories ranging from very bad to excellent. This number can be easily interpreted and understood by political decision markers, non-technical water manager and the general public. The water quality index (WQI) has been considered as one criterion for drinking water classification based on the use of standard parameters for water characterization. The Chambal River remains one of North India's pretty clean rivers, habitat to a rich diversity of flora and fauna. National Chambal (Gharial) Wildlife Sanctuary is famous for the rare Ganges river dolphin. As it is a well established fact that mighty Chambal river is engulfed with vast tract of ravines. The Chambal River originates from a place Mhow near Indore in Madhya Pradesh (M.P). The total length covered by Chambal River is 960 km encompassing a total catchment area 143,219 Km2 and its average discharge is 456m3/s. The river flows in the North-North East through M.P passing through some parts of Rajasthan forming a boundary between M.P and Rajasthan and then turning towards south east direction to merge with Yamuna in Etawah (U.P). The mean annual rainfall over the Chambal Basin was computed as 797 mm, of which about 93% falls during the four Monsoon months (June-September). Today, the main concern with environmental pollution is with its impact on the health of the present generation and the future ones. Untreated domestic waste way into the rivers through sewage, outfalls drains etc.[3] Water quality index (WQI) is one of the most effective tools to monitor the surface as well as ground water pollution and can be used efficiently in the implementation of water quality upgrading programmed [1]. The water quality is assessed in terms of its physical, chemical and biological parameters [2].

II. MATERIAL AND METHODS

The Data was obtained from the status of water quality in India compiled by CPCB The samples were collected and analyses throughout the years from January to December from Yamuna river by central pollution control board (CPCB), The Complete Stations at Yamuna River were selected in order to study the water quality changes using CCME for the range of 1999-2005, and for six (6) important parameters. Data source: CPCB (2000 copies, 2006). The WQI software has been prepared in Visual Basic by CCME, which can be implemented in MS Excel for computational purpose. Instructions for the implementation are well described in the Calculator Version 1.0 (Canadian Council of Ministers of the Environment (CCME) 2001). The output is available in the form of a table and graph showing the yearly water quality index and seasonal variation of water quality index displaying the values of WQI, Monsoon seasonal variation and Non-monsoon seasonal variation. Yamuna river contained nineteen (19) stations as far the report of CPCB 2006, the data from 1999-2005 were imputed into the excel sheet for the six selected parameters, the status water quality of each year as far nineteen station will be obtained from that the variations, deteriorations and most severely affected stations and years will be known, The data of water quality obtained will be compared with the current available studies of water quality in some station at Yamuna river. For the purpose of this study the Class B(Outdoor bathing organized) category was use as show in Table C except for the current changes of feacal coliform which is 500/100ML and Ammonium 1.37 as shown in the excel sheet.

2.1 Canadian Council of Ministers of Environment (CCME)

The CCME Water Quality Index (1.0) is based on a formula developed by the British Columbia Ministry of Environment, Lands and Parks and modified by Alberta Environment. CCME WQI provides a consistent method, which was formulated by Canadian jurisdictions to convey the water quality information for both management and the public. Moreover, a committee established under the Canadian Council of Ministers of the Environment (CCME) has developed WQI, which can be applied by many water agencies in various countries with slight modification. This method has been developed to evaluate surface water for protection of aquatic life in accordance to specific guidelines. The parameters related with various measurements may vary from one station to the other and sampling protocol requires at least four parameters, sampled at least four times. The calculation of index scores in CCME WQI method can be obtained by using the following relation:

$$WQI = 100 - \frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}$$

The index is based on a combination of three factors:

1. The number of variables whose objectives are not met, (**Scope**)
2. The frequency with which the objectives are not met, (**Frequency**) and
3. The amount by which the objectives are not met, (**Amplitude**).

These are combined to produce a single value (between 0 and 100) that describes water quality; three factors that make up the index must be calculated. The calculation of *F1* and *F2* is relatively straightforward; *F3* requires some additional steps.

- **F_1 Scope:** F_1 Indicate the % of parameters whose guideline is not meet.
- $F_1 = \frac{Number\ of\ failed\ variables}{Total\ Number\ of\ variables}$ x 100

F_2 Frequency: F_2 indicates the % of individual tests which do not meet the guidelines (i.e. failed test)

- $F_2 = \frac{Number\ of\ failed\ tests}{Total\ number\ of\ test}$x100

F_3 Amplitude:

F3 indicates the amount by which failed test values do not meet their guidelines, and is calculated in three (3) steps: as in fig A

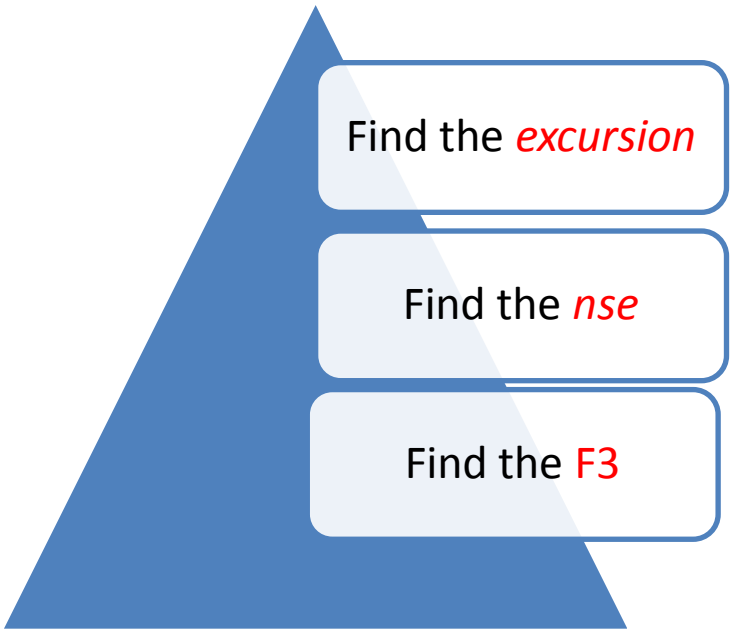

Fig: A

- The amount of times an individual concentration exceed a guidelines is term as an *excursion.*

When the test value must not exceed the objectives:

$$excusion_i = \frac{Failed\ test\ value_{\ i}}{Objectives_{\ j}} - 1$$

When the test value must not fall below the objectives:

$$excusion_i = \frac{Objectivesj}{Failed\ test\ value_{\ i}} - 1$$

$$\boldsymbol{nse = \frac{\sum \textbf{excursionsion}}{\#\ of\ tests}}$$

F3 is then calculated to yield a value between 0 and 100

$$\boldsymbol{F_3 = \{\frac{\textbf{nse}}{0.01nse + 0.01}\}}$$

Once the factors have been obtained, the index itself can be calculated by summing the three factors as if they were vectors. The sum of the squares of each factor is therefore equal to the square of the index. This approach treats the index as a three-dimensional space defined by each factor along one axis. With this model, the index changes in direct proportion to changes in all three factors.

Once the CCME WQI value has been determined, water quality is ranked by relating it to one of the following categories as shown in the table 4.0 below.

Excellent: (CCME WQI Value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.

Good: (CCME WQI Value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.

Fair: (CCME WQI Value 65-79) – water qualities usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

Marginal: (CCME WQI Value 45-64) – water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.

Poor: (CCME WQI Value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

The assignment of CCME WQI values to these categories is termed "categorization" and represents a critical but somewhat subjective process. The categorization is based on the best available information, expert judgment, and the general public's expectations of water quality.

Rank	Score	Interpretation
Excellent	95.0-100.0	Water quality meets all criteria for the use as a source of drinking water.
Good	85.0-94.0	Water quality rarely or narrowly violates criteria For use as a source of drinking water.
Fair	65.0-84.0	Water quality sometimes violates criteria, possibly by a wide margin, for use as a source of drinking water.
Marginal	45.0-64.0	Water quality often violates criteria for use as a source of drinking water by a considerable margin.
Poor	0.0-44.0	Water quality does not meet any criteria for use as a Source of drinking water.

Source: CCME Report Table 4.0

III. RESULTS ANALYSIS AND DISCUSSION

Udi (Chambal River): The Table: 1.0 and Figure 1.0 below show the profile of Yearly water quality index (WQI) of Udi from 1999-2005

YEAR	WQI
1999	**12.6**
2000	**44.8**
2001	**18**
2002	**31.5**
2003	**0**
2004	**0**
2005	**2.4**

Table: 1.0

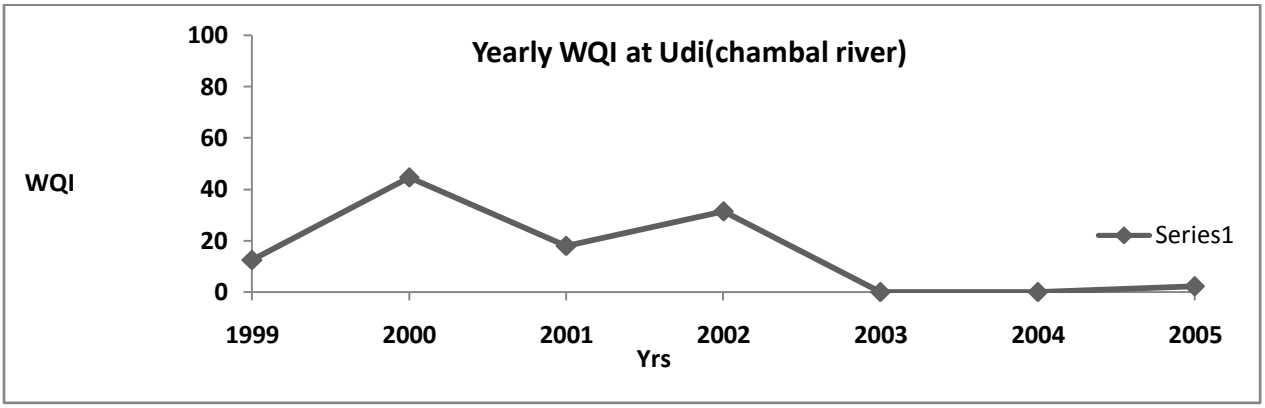

Fig: 1

3.1 Seasonal Variations of Udi Chambal River

A- Monsoon Period (Jul-Sept): The table 1.1 and Figure 1.1 shows the profile of WQI from July to September

YEAR	WQI
1999	32.4
2000	56.8
2001	16.7
2002	59.7
2003	59.7
2004	2.9
2005	11.9

Table: 1.1

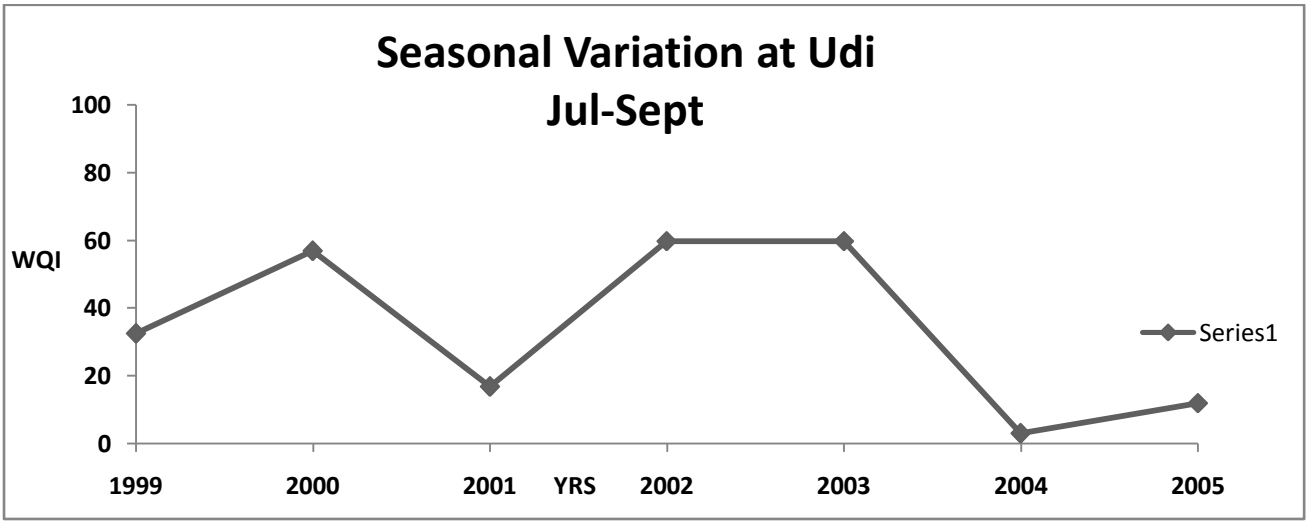

Fig: 1.1

B - Non-Monsoon Period (JAN-JUN): The table 1.2 and Figure 1.2 show the profile of WQI from JAN-JUN

YEAR	WQI
1999	64.76
2000	39
2001	49.3
2002	13.6
2003	0
2004	22.6
2005	26

Table: 1.2

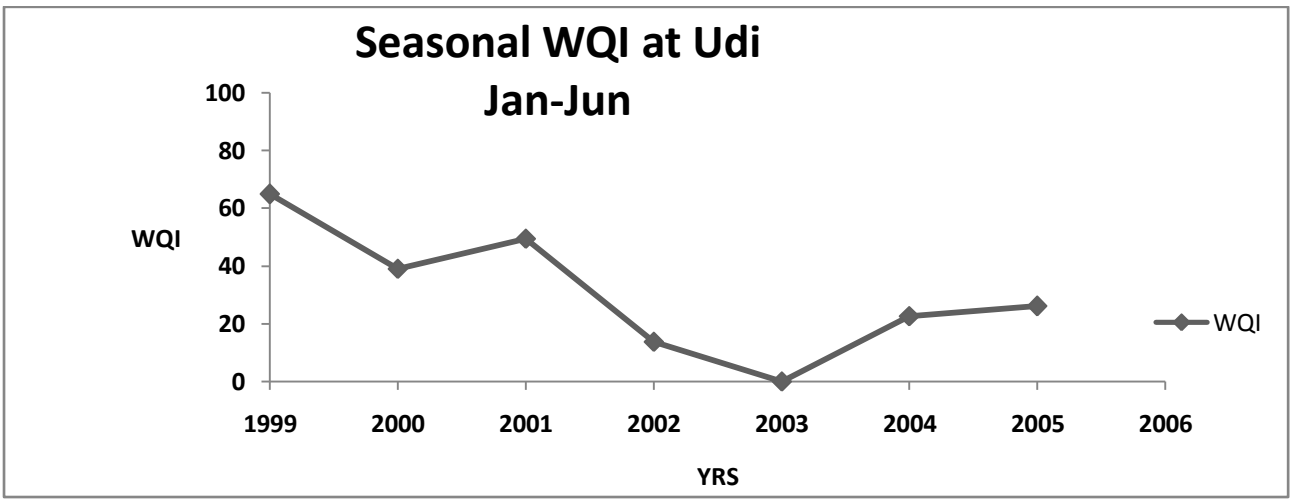

Fig: 1.3

C - Non-Monsoon Period (OCT-DEC): The table 5.3 and Figure 5.3 show the profile of WQI from Oct-Dec

YEAR	WQI
1999	39
2000	48
2001	34
2002	82
2003	61
2004	22.22
2005	35

Table: 5.3

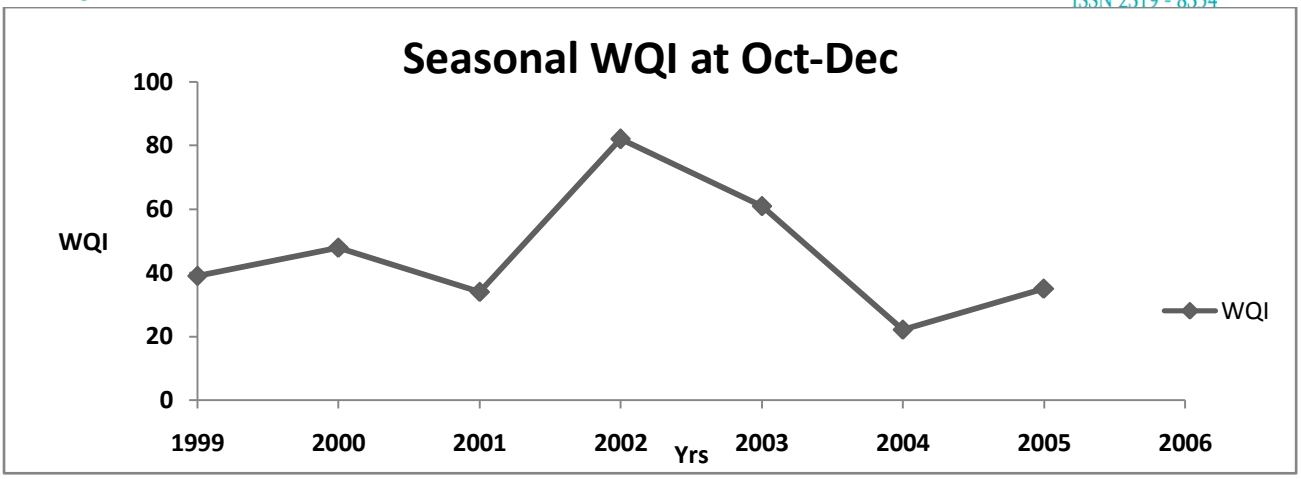

Fig: 1.3

IV. CONCLUSIONS

4.1 Close examinations of the Figure 1.0 shows that:

From the water quality ranking of CCME it was clearly shown that the water quality at Udi station was fall under the category of **Marginal to Poor** with the range of 0-45 as shown in the table above. It was also indicate that at year 2000 the water quality is often violate the criteria for the use as a source of drinking water quality by considerable margin, In years 1999 and 2001-2003 the WQI falls under the **Poor** category with the range of 0-32 it does not meet any of criteria as the source of drinking water. From the table above we can see that the water quality is deteriorating with respect to FC, AMM, and slight drop down of pH, at the year 200-2004 the quality value indicate the severely affected stations.

4.2 Conclusion of Udi Chambal River Seasonal Variation:

A- During these period of monsoon that is July to September the result indicate that the water quality of Udi is deteriorating only in respect of Fecal coli form(FC) and the deterioration occur at 2000-2001 and 2003-2004 with water quality index value of 57-18 and 60-3 respectively, and also the severely affected station is 2004 with the water quality value of 3.0 it was observed that the parameters were almost within the prescribed limit except for the value of FC and WT which are higher than the prescribed limit at 2000 for FC as well as drastic declined in the value of water temperature (WT).

B- A close examination of Non-monsoon period indicate that the water quality of this season falls within the category of **Fair** to **Poor** with the range of water quality index (WQI) of 0 at 2003 to 65 at 1999 indicating that at 2000,2002-2005 the water quality does not meet any criteria as the source of drinking water and at 1999 in which the water quality is 65 indicating the violation of criteria ,possibly by the wide margin for the use as a source of drinking water and at 2001 the WQ fall under the marginal category. It also indicate that DO concentration ,BOD,AMM,WT, pH and FC are all within the prescribe limit except some slight variation of FC at 2003,2004 and 2005 which is major factors that make the water quality not to fall within the prescribe limit. With the year 2003 marked the severely affected stations.

C- The water quality at this season Oct-Dec falls within the category of **Fair** and **Poor** from the table above we can see that the highest value of WQI is 82 at 2002 and lowest at 2004 with the value of 22 being the

severely polluted year it was noticed from the excel data that the deteriorations is with the respect of FC only and all the parameters are within the prescribe limit except for the slight value of FC .

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