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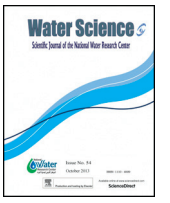

Research Article

Effect of physicochemical and biological parameters on the quality of river water of Narmada, Madhya Pradesh, India

Nidhi Gupta [a], Pankaj Pandey [a,*], Jakir Hussain [b]

[a] *Amity University Rajasthan, Jaipur P.O. Box 303002, India*
[b] *National River Water Quality Laboratory, Central Water Commission, New Delhi 110016, India*

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Abstract

Narmada River is considered to be the holy river of the state Madhya Pradesh. A study was considered for the development of water quality index using eight parameters pH, Temperature, Total Dissolved Solids (TDS), Turbidity, Nitrate-Nitrogen (NO_3-N), Phosphate (PO_4^{3-}), Biological Oxygen Demand (BOD), Dissolved Oxygen (DO) measured at six different sites (S1–S6) along the river Narmada. Three methods (Weighted Arithmetic Water Quality Index, National Sanitation Foundation Water Quality Index and Canadian Council of Ministers of the Environment Water Quality Index) were used for calculation of water quality index. This was observed that the water quality was found to be excellent to good in the season summer and winter and poor to unsuitable for human consumption in the season monsoon along the river Narmada. The fall in the quality of water in monsoon season was due to poor sanitation, turbulent flow, soil erosion and high anthropogenic activities.

Keywords: Narmada River; Physicochemical and biological parameters; Water quality indices; Water quality standard

1. Introduction

For the human and industrial growth, water is considered to be the main requirement. Increase in population and industrialization, the demand of the freshwater increases in the last decades. This demand fulfilled by the rivers which provide the water for human life and agriculture purposes. Due to the waste discharged from the human and industrial activities, the quality of river water has deteriorated which affects human as well as aquatic life. According to WHO, CPCB, BIS, ICMR, the water quality of about 70% river water was contaminated due to pollutants in India and some of the river water was too poor for human consumption (Ramakrishnaiah et al., 2009; Jindal and Sharma, 2010). Assessment of quality of river water using various parameters (physico-chemical and biological) and the different

* Corresponding author.
E-mail address: pkpandey@jpr.amity.edu (P. Pandey).
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ways and techniques to protect the river water have been reported in the literature (Santosh et al., 2008; Yisa and Jimoh, 2010; Shah et al., 2015). One approach for determination of quality of river water is water quality index, found to be an efficient and useful method for assessing the water quality. This method gives an idea about the overall quality of water to the concern policy makers (Asadi et al., 2007). Water quality index incorporate the different physical, chemical and biological parameters for the determination of water quality indices using the various mathematical equations (Yogendra and Puttaiah, 2008). The use of a WQI was initially proposed by Horton (1965) and Brown et al. (1970). Since then, many different methods for the calculation of WQI's have been developed. The procedure for the calculation of WQI was differ proposed by the scientist (Zagatto et al., 1998; Stambuk Giljanovic, 1999). The different water quality index used worldwide are US National Sanitation Foundation Water Quality Index (NSFWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), British Columbia Water Quality Index (BCWQI), Oregon Water Quality Index (OWQI), Weighted Arithmetic Water Quality Index (WAWQI) (Abbasi, 2002; Kannel et al., 2007; Lumb et al., 2006; Sharifi, 1990). Generally two steps are needed for the calculation of water quality indices. First one is the transformation of the selected water quality characteristics into sub index values. Second is the aggregation of these values for the water quality index value. Various studies on the water quality indices were reported in the literature by many researchers (Stambuk Giljanovic, 1999; Miller et al., 1986; Ott, 1978; Hallock, 2002; Pesce and Wunderlin, 2000; Brown et al., 1970; Bordalo et al., 2001; Cude, 2001a,b; Liou et al., 2004; El-Gafy et al., 2005; Sinha and Saxena, 2006; Boyacioglu, 2006; Gomez et al., 2007; Fulazzaky, 2009; Tyagi et al., 2013). Many countries across the world utilizes these water quality index criteria to assess the quality of the water bodies, such as United States (Canter, 1996), United Kingdom (House, 1989), Canada (CCME, 2001), India (Tiwari and Mishra, 1985), Egypt (Amman, 1995), Argentina (Almeida et al., 2012), Brazil (Coletti et al., 2010), Spain (Sanchez et al., 2007), Iran (Nikoo et al., 2011) and Malawi (Wanda et al., 2012). Bhargava (1983a,b,c) introduced the water quality index concept in India and gave an index scale ranging from 0 to 100 for highly polluted to unpolluted water. Studies on the water quality of different rivers of India have been performed and the results have analyzed for the use of the water for human beings (Bhargava et al., 1998; CPCB, 2000; Upadhyay et al., 2010). Little work has been reported on the quality of Narmada River (largest west flowing river of the peninsular India). Studies on the effect of the various physico-chemical and biological parameters on the quality of water of the Narmada River has been performed and discuss the suitability of the water for human consumption based on values of water quality index. The methods used for calculation of WQI are Weighted Arithmetic Water Quality Index (WAWQI), National Sanitation Foundation Water Quality Index (NSFWQI) and Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI) in this study.

2. Study methodology

2.1. Study area

Narmada is the largest west flowing river (total length 1312 km) covering Madhya Pradesh, Gujarat, Maharashtra and Chhattisgarh states of India having an area of 98,796 km^2 which is nearly 3% of the total geographical area of the country with maximum length and width of 923 and 161 km respectively. It lies between 72°38′ to 81°43′ east longitudes and 21°27′ to 23°37′ north latitudes. It rises from Maikala range near Amarkantak in Anuppur district of Madhya Pradesh, at an elevation of about 1057 m and bounded by the Vindhyas on the north, the Maikala range on the east, the Satpuras on the south and the Arabian Sea on the west. Narmada drains into the Arabian Sea through the Gulf of Khambhat. There are eight (08) water quality stations at Barmanghat, Dindori, Handia, Hoshangabad, Madleshwar, Manot, Garudeshwar and Sandia on the main stream of river Narmada while ten (10) water quality stations are located at its tributaries viz., Orsang, Banjar, Sakkar, Burhner, Sher, Ganjal, Uri, Kundi, Hiran and Goi. Narmada River has 41 tributaries (22 and 19 are on the left and right bank). Out of 41 important tributaries, the Burhner, Banjar, HiranTawa, ChotaTawa, Orsang and the Kundi River are the major tributaries. (*Source: Central Water Commission, Ministry of water Resources, Narmada Basin, Version 2.0, March, 2014.*) Four distinct seasons such as cold, hot, south-west monsoon, post-monsoon occur in the Narmada basin in a year. The normal annual rainfall for the Narmada basin is about 1100 mm of which south-west monsoon (June to October) contribute about 94% of the annual rainfall. Temperature is maximum and minimum in the month of May and January, respectively. (*Source: Central Water Commission, India Meteorology Department, Probable Maximum Precipitation (PMP) Atlas for Narmada, Tapi, Sabarmati, and Luni*

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