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PENINSULAR DIATOM INDEX FOR WATER QUALITY MONITORING

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ABSTRACT

Formulation of a diatom index called Peninsular Diatom Index (PDI) based on nine environmental variables was developed to assess the water quality for Kabini River of Southern Karnataka. The selection of the variables was based on the Principal Component Analysis. Nineteen species of diatoms were identified from 144 samples using standard procedures. Sensitivity(s) and tolerance (v) values were calculated for each of the parameters and each of the species identified.PDI was calculated using the computational metric suggested by *Blanco et al.* (2012) About 4 species, *Caloneis parvum, Nitzschia obtusa, Melosira islandica, Pinnularia gracillum* and *Synedra ulna* indicated that the water quality was good. Only 5 species indicated that the water quality was acceptable, while 8 species indicated that the water quality was poor. *Pinnularia divergens and Stauroneis angular* indicated water quality as bad. The overall quality of the river was poor to acceptable (7.4). The PDI serves as an important tool for detecting water quality at regional level using local water chemistry parameter.

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INTRODUCTION

Diatoms are the most dominant and diverse groups of algae in fresh waters. They form an important component of aquatic ecosystems. Various measures have been adopted to assess water quality of rivers. Among all these, the sensitivity and tolerance of diatoms species to specific but limited environmental conditions can be detected by certain computing metrics. Several methods based on general composition of water quality parameters have been used to detect organic pollution due to human disturbance (Taylor *et al*., 2007). Formulation of new diatoms indices for trophic Indian rivers would aid in the design of appropriate cost effective monitoring methods for river water (Humane *et al.*, 2010; Karthick *et al.* 2010. Alkananda *et al.*, 2011 and Blanco *et al.*, 2012) Peninsular Diatom Index (PDI) is a useful index since it utilizes regional environmental variables in calculating the index. Blanco *et al.* (2012) and Delgado *et al.*, (2010) have developed a diatom based local metric to assess water quality in Spanish water courses. The aim of this study was to develop an index at the regional scale in order to improve water quality assessments in rivers. An index called the Deuro Diatom Index(DDI) was developed for North West Spain on the basis of a few water quality parameters. A similar index has been derived for Kibini river of Southern Karnataka based on the variables such as pH, Electric conductivity, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Nitrates, Phosphates, Chlorides and Total alkalinity. The selection of these parameters were based on the Principal Component Analysis (PCA) among 24 water quality parameters studied for the river. and the top factor loadings were derived.

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MATERIALS AND MEHODS

A Reservoir across River Kabini near Bidarhally and Beechana Halli in Heggadadevanakote Taluk, Mysore District, with canals on both the banks. It is the river of Southern India from the confluence of the Panamaran River and Mananthavady River, and flows eastward to join the Kaveri River at Tirumakudal Narisipur in Karnataka, which empties into the Bay of Bengal. Its' coordinates are 12 13"00N,076° 54"39' E/12.21667° N 76.91083° E. Close to the town of HD Kote it forms a huge Kabini Reservoir. Its backwaters are very rich in wild life especially in summer when the water level recedes to form rich grassy meadows. The Kabini dam is 2,284 feet (696 m) in height with a gross storage of 19.52tmcft but has reduced considerably due to silt accumulation. Sampling: A total of 144 samples were collected during 2011 to 2012in and near the reservoir. Water chemistry variables were selected based on their influence on diatom assemblages in the study area. Auto correlated variables were rejected

(Blanco *et al.*, 2008). The variables were estimated according to the methods described in APHA (1998). Diatom samples were collected according to the method of (Kelly *et al*., 2009). The samples were cleaned and semi-permanent slides were prepared and stored for further use. At least 300 valves were counted and identified at the lowest taxonomic level in each sample using the monograph of Taylor *et al* 2007. Weighted average method (WA) ter Braak and van Dam (1998) was used to derive the auto ecological data of diatoms (Optimum and Tolerance) with respect to measured limn logical variables. According to Birks *et al.* (1990), Denys (2004) Diatom species occur in the highest abundance near their ecological optima. The optimum for each environmental variable was calculated according to the formula developed by Blanco *et a*l., (2012). The sensitivity value(s) and the trophic indicator value (v) for each taxon and each of the environmental variable at each site was calculated as per the computations given by Mingo (1981). The Diatom Index Score for each environmental variable was obtained by applying the equation of Zelinka and Marvan (1961). The final value of the Peninsular Diatom Index (PDI) was calculated by the General Quality Index Equation of Mingo (1981) $PDI=\sum A_{ki}xSxV/\sum A_{ki}$ x v, where Aki is the relative abundance of species, s is sensitivity value and v is the tolerance value of the species.

Table 1: Quality classes and ecological status of water according to PDI scores

Quality Classes	PDI values
High	10.00
Good	8.50-9.99
Acceptable	7.50-8.49
Poor	6.00-7.49
Bad	,6.00

RESULTS

Final PDI values for each variable were calculated which vary between 1 and 10. The scores were categorized into five water quality classes based on Mingo (1981) are as shown in Table 1. A total of 19 species of diatoms were recorded in 144 samples analysed during 2010-2012. The most common taxa were *Melosira islandica, Synedra ulna* and *Pleurosigma hippocampus.* The range of physical and chemical variables for River Kabini during the study period is shown in Table 2. The sensitivity values(s) and the tolerance values (v) and the calculated PDI indices are shown in Table 3. Among the diatom species recorded, there were no taxa that indicated high water quality. About 4 species, *Caloneis parvum, Nitzschia obtusa, Melosira islandica, Pinnularia gracillum* and *Synedra ulna* indicated that the water quality was good. Only 5 species indicated that the water quality was acceptable, while 8 species indicate that the water quality was poor. *Pinnularia divergens* and *Stauroneis angular* indicated water quality as bad. The overall quality of the river was poor to acceptable (7.4). Several other diatom indices based on Diatom assemblages using a soft ware "Omnida GB 5.3, have been calculated which reflect the degree of human interference (Basavarajappa *et al.*, 2011).

These indices indicate only the ecological status and are unable to point out the precise environmental influence. The PDI is found to be more appropriate as it is derived for the regional water chemistry variables and the diatom assemblages. *Melosira islandica* and *Synedra ulna* were the prominent indicators. The inflow of organic waste from urban areas into the river, during certain months may be responsible for the variation of Dissolved Oxygen and rise in Electric

Table 2: The range of selected water chemistry variables in Kabini river (2010-2012)

No	Water Quality variable	Average	Minimum	Maximum
1	pH(units)	8.49	7.76	9.17
2	Electric Conductivity(EC- μScm^{-1})	155.96	99.50	224.00
3	Dissolved Oxygen(DO-mg/$L^{-1)}$	9.12	7.29	11.35
4	Biochemical Oxygen Demand(BOD-mg/$l^{-1)}$	4.73	2.03	6.48
5	Chemical Oxygen Demand(COD-mg/l^{-1})	16.33	9.00	22.00
6	Nitrates(N-ppm)	0.09	0.01	0.32
7	Phosphates(P – ppm)	0.13	0.08	0.16
8	Chlorides (Cl-mg/L^{-1})	28.16	18.46	38.34
9	Total Alkalinity(ALK mg/$L^{-1)}$	104.9	10.0	100.0

Table 3: Peninsular Diatom Index for kabini River in Karnataka

No.	Species	Aki	s	v	PDI	Water Quality
1	*Cocconeis placentula* Ehren	1440	6.21	6.38	6.21	Poor
2	*Cyclotellameneghiniana* Kutz	1120	5.96	6.39	5.96	Poor
3	*Caloneis parvum* Cleve	1480	9.27	7.22	9.27	Good
4	*Cymbella leptoceros* Ehr	960	7.58	6.86	7.58	Acceptable
5	*Fragilaria pinnata* Ehr	1760	7.49	7.6	7.49	Acceptable
6	*Flagilaria capucina* Desma	1440	7.43	7.19	7.43	Poor
7	*Gyrosigma attenuatum* Kutz	1280	9.4	7.68	9.40	Good
8	*Nitzschia obtuse* W. M..Smith	960	6.76	6.82	6.76	Poor
9	*Navicula mutica* Kutz	1440	7.44	7.11	7.44	Poor
10	*Navicula rhynchocephala* Kutz	800	6.87	6.52	6.87	Poor
11	*Melosira islandica* O. Muell	3040	8.97	7.0	8.97	Good
12	*Mastagloia smithi* Thwaiks	1800	7.28	7.24	7.28	Poor
13	*Pinnularia gracillum* Hustedt	640	8.24	7.11	8.24	Acceptable
14	*Pinnularia divergens* W. Smith	1440	5.49	4.73	5.49	Bad
15	*Pleurosigma hippocampus* W. Smith	2247	8.14	7.15	8.14	Acceptable
16	*Stauroneis angular* G & G	1440	4.83	5.69	4.83	Bad
17	*Surirella robusta* Ehr	800	7.88	7.43	7.88	Acceptable
18	*Surirella ovate* Kutz	1447	7.42	6.99	7.42	Poor
19	*Synedra ulna* Nitzsch.	2400	8.84	7.46	8.84	Good

Aki is relative abundance of species; s is sensitivity value calculated for each species, v is tolerance value for each species, PDI is Peninsular Diatom Index.($PDI=\sum A_{ki}xSxV/\sum A_{ki}x\ v$)

conductivity. These coupled reactions may have an influence on the quality of water. Taylor *et al.* (2007) have reported high counts of *Melosira islandica* and *Synedra ulna* species at higher levels of Electric conductivity. The alkalinity of the water was also responsible to a certain extent. In the present study it is probable that the auto ecological response to Electric conductivity and alkalinity may have led to a significant correlation of the Peninsular Diatom Index with water chemistry variables.

Conclusion

The study evaluated the nature of sensitivity and tolerance of Diatom taxa to specific environmental factors. The Peninsular Diatom Index (PDI) developed for assessing the water quality helps in evaluating the role of diatoms in predicting the status of the river water. This index proves to be a promising index in monitoring human induced disturbances. It also helps to detect potential pollution source if any. The water quality rating in the present study is 7.4 and indicates that the water is poor to acceptable. The index has used only 9 local environmental variables to evaluate the status of the water and hence it serves as an important tool for the evaluation of waters at the regional level.

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