Measurement for Diversity Indices of Algal Community in different Ponds in Coal Mining City Dhanbad, Jharkhand, India

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Abstract— **Ten ponds in coal mining city Dhanbad were selected for this study to calculate the Species richness, Species evenness and Sannon diversity index for algae in summer season and a total of 36 species were recorded. To elucidate the community structure in each pond, these indexes were calculated. The Species richness, Species evenness and Sannon diversity index indicates the pollution index of different ponds in coal mining city Dhanbad affected by different sources. In ten ponds the indices do not go hand in hand indicating higher diversity with moderately to higher pollution level. Algal biodiversity indices can be used in detecting the community structure and level of pollution in these ten ponds.**

Index Terms— **Species richness, Species evenness and Sannon diversity index, Algae, Coal mining area**

I. INTRODUCTION

Dhanbad is famous for coal mining in India, surrounded by major power plants and coal washeries supported power generation and major industrialization in this eastern zone. Due to underground with opencast coal mining the land use changes in original topography and land degradation had taken place in great ways. Cumulative effects of intensive mining and old quarries had resultant air, noise, surface and ground water with land pollution reduced the vegetation and agriculture in this area. The utilization of coal in power plant generation flyash as a waste product resultant air water and land pollution. This can be accessed through environmental impact assessment and environmental management plan. Overall this has resultant in the major changes in socio-economic. But the quality of life has been affected in this area with all other developments (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 45, 66, 78, 87, 100, 102, 105, 106, 107, 122, 123, 124, 129, 131, 132, 140 and 142).

The effect of mining through modeling and simulation were assessed for effective environmental management to achieve sustainable development (47, 49, 69, 70, 71, 72 and 73).

Flora and fauna drastically affected due to many environmental pressure. This leads to changes in the availability of terrestrial and aquatic flora and fauna with avian species. In this connection a study has been undertaken to investigate the availability of different algal biodiversity which is a very good indicator of different type of environment. Algae have different potentiality for the sustainable development of this disturbed area (108, 110, 111, 113, 114, 115, 116, 118, 119, 120, 127, 133, 134 and 141).

Water environment is most concern in the mining areas. For the reclamation of wastewater with land, bio-approach is effective one to restore many things.

Through this approach solve the food and environmental problems in this area (31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 46, 48, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 65, 67, 74, 75, 79, 80, 81, 82, 83, 84, 85, 90, 91, 92, 93, 94, 96, 104, 109 and 135).

The bio-treatment of polluted water vis-a-vis socioeconomic development had found effective in this area. Bio-purification also include using algae (62, 63, 64, 68, 76, 77, 86, 88, 89, 95, 97, 98, 99, 101, 103, 112, 117, 121, 125, 126, 128, 130, 136, 137, 138 and 139).

The task of finding, developing and maintaining suitable water supplies has not been limited to modern times. It has had to be faced wherever large numbers of people have crowded together in small spaces; and therefore the popular indifference towards safe, clean water has prevailed.

Planning for the maximum development of our water resources for long time benefit of all our people when properly conceived, can bind together individual and the community, farmer and urbanate as few other conservation activities can do (143). Ponds are valuable water systems and intensively used for production of drinking water, for fisheries and bathing with washing of clothes. The ecological nature of many ponds, however have desecrated, mainly as a consequence of eutrophication (144). Algal diversity in ponds plays an important role in their conservation. More the diversity, more useful is a water body (161). In the present investigation ten ponds have been selected; of these remains unprotected and free for public use. The algal biodiversity has been studied and diversity indices have been discussed.

II. MATERIAL AND METHOD

A. Study Site

Ten ponds were selected as study areas and water samples were taken to study physic-chemical analysis of water quality parameters and identify the different algaes located within the following study areas which are as follows (**Fig**.1.).

The selection of different ponds in coal mining city Dhanbad is selected on the basis of its maximum utilization by the nearby community for their daily uses like washing, bathing except drinking purposes (**Fig.2**). As they get drinking water supply either from Jharia water board from Topchanchi lake or Maithon water supply from Maithon dam. These lakes are live throughout the year. The excess drain water in rainy season come in these ponds of that area.

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Fig.1: Map showing the sampling location points of ponds within Coal City Dhanbad, Jharkhand, India

Fig.2: Photographs of ten ponds in coal mining city Dhanbad (a-j)

The ten ponds location details were as follows for which the above photographs are given from 'a' to'j':

(a) BCCL Koylanagar is located at 23° 48′ 2″ N and 86° 27′ 35″ E.
(b) Saraidhela is located at 23° 48′ 51″ N and 86° 27′ 12″ E.
(c) Rajganj is located at 23° 52′ 36″ N and 86° 20′ 25″ E.
(d) Bhuli is located at 23° 49′ 9″ N and 86° 22′ 32″ E.
(e) Susnilewa is located at 23° 50′ 8″ N and 86° 26′ 9″ E.
(f) Bhuiphore is located at 23° 49′ 3″ N and 86° 28′ 43″ E.
(g) Bank More is located at 23° 47′ 16″ N and 86° 24′ 49″ E.
(h) Wasseypore is located at 23° 47′ 25″ N and 86° 25′ 9″ E.
(i) Jharia is located at 23° 44′ 37″ N and 86° 24′ 55″ E.
(j) Dhaiya is located at 23° 49′ 14″ N and 86° 25′ 59″ E.

B. Estimation of Algae

Water samples were collected from all ten ponds for algal population's analysis in black colored plastic carboys of one liter. Filamentous algae and other floating debris were avoided. For each sample collected, 25 ml of 4% formaldehyde was added (145) with few drops of Lugol's iodine. Sedimentation was done in glass columns. The sediment was finally reduced to 20 ml and was preserved in a glass vial. From each vial one drop was mounted on a slide and a cover slip was carefully put over it. Five high power fields (15x 45x), one in each corner of the cover slip and are at the center were made and the algal populations were estimated.

These observations were at random and were repeated four times for each sample. This procedure was repeated for each sample and the number of each organism was extra plotted to extract number of organism/L (146). Algae count was done by Lackey's Drop Method (147) as mentioned in APHA (148) and by Saxena, the modified method (149).

Formula used for the calculation of algae as units /l is

$$Algae\ Unit/L = \frac{n \times v}{V} \times 100$$

Where as
N= No. Of algae counted in 0.1ml.concentrate.
C= total volume of concentrate in ml.
V= total volume of water filtered through net

C. Species Richness index

Species richness indexes (SRI) were calculated using the following formula given below (150):

$$\text{SRI} = \frac{[S-1]}{\log N}$$

Where,

S - Number of species of the particular sample
N - Logerithm of total number (H) of the individuals of all the species of the sample

D. Species Evenness

Species evenness was calculated using the following formula (151):

$$j = \frac{H'}{\log 2S}$$

Where
H' = Shannon and Weaver Index (1949)
S = Species number

E. Shannon and Weaver Index (1949)

The Shannon and Weaver (1949) index was estimated by (152):

$$H' = -\sum_{n=1}^{n} \log \text{pi} \,.\, \log 2\text{pi}$$

Where
S = total individual number of species
N = Total individual number of all species
pi = S/N

III. RESULT AND DISCUSSION

The distribution of algae in ten ponds is presented in **Table 1**. The overall 36 algae species were found in all ten ponds of coal mining city Dhanbad. The species distributions, richness, evenness and Shannon diversity indices were calculated and given in **Table.2**.

Name of Algae	Number of Algae										Total no. of Algae
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	
Actinastrum	2000			2000		2000		2000			8,000
Agmenellum	4000	1000		1000	2000		1000	5000	2000		16,000
Amphora	1000	1000		1000				1000			4,000
Anabaena									3000	2000	5,000
Ankistrodesmus				1000							1,000
Chlamydomonas	6000		5000							5000	16,000
Chlorella		4000					4000			4000	12,000
Chrococcum		5000	4000			4000	5000				18,000
Closterium			1000						1000	2000	4,000
Coelastrum		2000									2,000
Cosmarium	1000				2000						3,000
Cyclotella	1000										1,000
Cymbella	1000		2000				3000	1000	2000	1000	10,000
Desmodesmus		2000	2000				1000				5,000
Diatom	5000	2000	2000			2000	2000	7000	3000	3000	26,000
Dinoflagellates	1000							2000			3,000
Eucapsis								2000			2,000
Euglena		3000	2000			2000	3000		3000	3000	16,000
Gleocapsa	2000		5000		4000	4000	2000	4000			21,000
Gomphonema			1000	2000	1000			1000			5,000
Hantzschia	2000			2000					2000		6,000
Korshikoviella				1000							1,000
Merismopedia				3000	3000						6,000
Navicula	1000	4000				6000	1000				12,000
Oedogonium							3000				3,000
Oscillatoria		1000	2000	3000	6000	1000	4000		7000	6000	30,000
Pediastrum		2000	2000			2000	1000		1000		8,000
Phacus				4000			2000		2000		8,000
Phormidium					4000						4,000
Scenedesmus		2000	11000			9000	8000		4000		34,000
Spirogyra		1000	2000	6000	7000	2000	3000		4000	6000	31,000
Spirulina		1000								9000	10,000
Staurastrum		4000			1000			2000	1000	1000	9,000
Tetradron			1000	1000	2000	1000		1000			6,000
Ulothrix								4000			4,000
Volvox		2000	5000			1000	5000		3000	3000	19,000
Total number of Species	12	16	15	12	10	12	16	12	14	12	36
Total number of Phytoplankton/l	27,000	37,000	47,000	27,000	32,000	36,000	48,000	32,000	38,000	45,000	3,69,000

Table.1: Total algal population in ten different ponds of coal mining city Dhanbad

Sampling Site	Species Richness	Shannon's Diversity Index	Evenness Index
BCCL Koylanagar	3.3375	2.28	0.92
Saraidhela	4.1236	2.67	0.96
Rajganj	3.6362	2.43	0.90
Bhuli	3.3375	2.31	0.93
Susnilewa	2.5969	2.09	0.91
Bhuiphore	3.0696	2.31	0.93
Bank More	3.8960	2.59	0.93
Wasseypore	3.1739	2.28	0.92
Jharia	3.5738	2.09	0.81
Dhaiya	2.8897	2.31	0.93

Table.2: Species richness, evenness and Shannon's diversity index of ponds in coal mining city Dhanbad

Richness Index (RI)

Species richness or richness index of sampling of ponds in coal mining city Dhanbad were given in **Fig**.3. The species richness of 3.33, 4.12, 3.63, 3.33, 2.59, 3.06, 3.89, 3.17, 3.57 and 2.88 were observed in ponds from BCCL koyalanagar, Saraidhela, Rajganj, Bhuli, Susnilewa, Bhiphore, Bankmore, Wasseypore, Jharia and Dhaiya respectively (**Table.2**). The lowest and heighest values resulted were 2.88 and 4.12 at stations Dhaiya and Saraidhela during June, 2017.

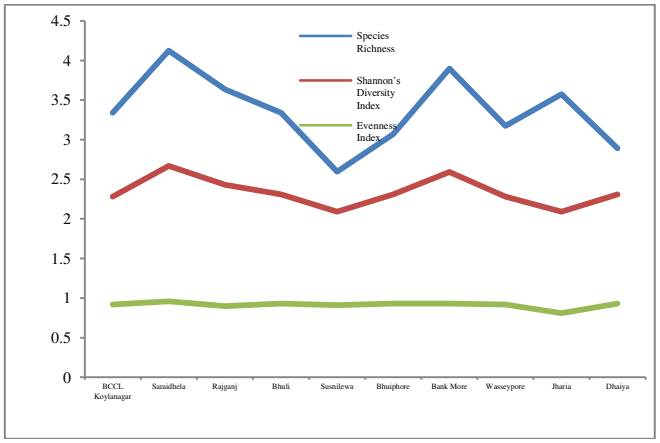

Fig.3: Species richness, evenness and Shannon's diversity index of ponds in coal mining city Dhanbad

Species Evenness

Species Evenness of all the ten sampling ponds in June 2017 are provided in (Fig.3). The species evenness ranged from a minimum of 0.81 for Jharia and maximum of 0.96 for Saraidhela pond. Rest of other ponds have 0.92, 0.90, 0.93, 0.91, 0.93, 0.93, 0.92 and 0.93 species evenness indices for BCCL koyalanagar, Rajganj, Bhuli, Susnilewa, Bhiphore, Bankmore, Wasseypore and Dhaiya respectively (**Table.2**).

Shannon Diversity Index

Shannon and Weiner index (152) represents entropy. It is a diversity index taking into account the number of individuals as well as the number of taxa. It varies from 0 for communities with only single taxa to high values for community with many taxa each with few individuals. This index can also determine the pollution status of a water body. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species. Examining the diversity in the range of polluted and unpolluted ecosystems, the values of the index greater than 3 indicate clean water, values in the range of 1 to 3 are characterized by moderate pollution and values less than 1 are characterized as heavily polluted (155). Moderate pollution can be inferred in this study for the all the ten ponds studied. The Shannon's Diversity Index for all the ten ponds studied were found to be from 2.09 to 2.67 which is less than 3 means all ponds are moderately to heavily polluted.

In environmental monitoring it is assumed that the adverse effects of pollution will be reflected in the reduction of diversity or change in the composition of species abundance. Both these factors involve diversity as an index of a good ecosystem (156). The enriched or polluted ecosystems display a reduction in diversity (157 and 158). Shannon and Wiener index is widely adopted in pollution monitoring (159, 160) discussed the role of phytoplankton species and assemblage as bio-indicators. Simple species richness and dominance measures are invariably informative. There is considerable evidence that conservation strategies may be improved if information on species abundance patterns is taken into account.

IV. Conclusion

The Shannon and Weaver (152) Diversity Index is an important aspect indicating the distribution of phytoplankton and their relation to pollution. Soyer's Frequency Index and Pieolu's Eveness Index, clearly signify the distribution of plankton all through the year and the relation between the frequency of species and their Evenessin distribution in the two lakes (153) Therefore diversity indices serve as important tools in algal biodiversity and pollution assessment of aquatic environments (154).

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