Boyd’s Diversity Index of Ponds in Coal Mining City Dhanbad, Jharkhand, India

Suman Dhar, Kumar Nikhil

Abstract—Ten ponds in coal mining city Dhanbad were selected for this study to calculate the Boyd’s diversity index for algae in summer season and a total of 36 species were recorded. To elucidate the community structure in each pond, Boyd’s index was calculated. The diversity index of Boyd’s 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 higher pollution level. Algal biodiversity indices can be used in detecting the level of pollution in ponds.

Index Terms—Boyd’s diversity index, Algae, Coal mining and Lackey's drop method

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, 35, 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. 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. MATERIALS AND METHODS

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 algae located within the following study areas which are as follows (Fig.1.)

Mr. Suman Dhar, M.Tech, Student Final Year, Department of Environmental Science & Engineering, IIT-ISM, Dhanbad, Jharkhand India, +918918032703.
Dr. Kumar Nikhil, Principal Scientist, Natural Resource & Environment Management (NREM) Group, CSIR-CIMFR, Dhanbad, Jharkhand, India,+919931194377, +919931135322.)
Boyd’s Diversity Index of Ponds in Coal Mining City Dhanbad, Jharkhand, India

(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) Bhuiyehore 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) Wasseypure 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.

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 comes in these pond of that area.

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 (15x45x), 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

\[ \text{Algae Unit/L} = \frac{n \times V}{C} \times 100 \]

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. Boyd’s diversity index

The diversity index of Boyd indicates the order of pollution of a water body. The main parameter in the index is the number of genera of phytoplankton in a water body and is calculated using the mathematical formula.

\[ H = \frac{S - 1}{\ln N} \]

S is the number of genera of algae;
N is the total number of algae and In is the natural logarithm.

III. RESULT AND DISCUSSION

The resultant values indicate the pollution status of the water body under study. If the values obtained are >4 it indicates less pollution and clean water, values of 3 –2 indicate moderate pollution and values <1 indicate that water is heavily polluted. The distribution of algae in ten ponds is presented in Table 1.
<table>
<thead>
<tr>
<th>Name of Algae</th>
<th>Number of Algae</th>
<th>Total no. of Algae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinastrium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agmenellum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amphora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anabaena</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankistrodesmus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlamydomonas</td>
<td>6000 5000</td>
<td>5000 16,000</td>
</tr>
<tr>
<td>Chlorella</td>
<td>4000 4000</td>
<td>4000 12,000</td>
</tr>
<tr>
<td>Chroococcus</td>
<td>5000 4000</td>
<td>4000 18,000</td>
</tr>
<tr>
<td>Closterium</td>
<td>1000</td>
<td>1000 4,000</td>
</tr>
<tr>
<td>Coelastrum</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>Cosmarium</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Cyclotella</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Cymbella</td>
<td>1000 2000</td>
<td>3000 10,000</td>
</tr>
<tr>
<td>Desmodesmus</td>
<td>2000 2000</td>
<td>1000 5,000</td>
</tr>
<tr>
<td>Diatom</td>
<td>5000 2000</td>
<td>2000 2000 7000</td>
</tr>
<tr>
<td>Dinoflagellates</td>
<td>1000</td>
<td>2000 3,000</td>
</tr>
<tr>
<td>Eucapsis</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Euglena</td>
<td>3000 2000</td>
<td>2000 3000 16,000</td>
</tr>
<tr>
<td>Gleocapsa</td>
<td>2000 5000</td>
<td>4000 2000 4000</td>
</tr>
<tr>
<td>Gomphonema</td>
<td>1000 2000 1000</td>
<td></td>
</tr>
<tr>
<td>Hantzschia</td>
<td>2000</td>
<td>2000 6,000</td>
</tr>
<tr>
<td>Korshikoviella</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Merismopedia</td>
<td>3000 3000</td>
<td>6,000</td>
</tr>
<tr>
<td>Navicula</td>
<td>1000 4000</td>
<td>6000 1000</td>
</tr>
<tr>
<td>Oedogonium</td>
<td></td>
<td>3000 3,000</td>
</tr>
<tr>
<td>Oscillatoria</td>
<td>1000 2000 3000</td>
<td>6000 1000 4000</td>
</tr>
<tr>
<td>Pediasprum</td>
<td>2000 2000</td>
<td>2000 1000 1000</td>
</tr>
<tr>
<td>Phacus</td>
<td>4000</td>
<td>2000 2000</td>
</tr>
<tr>
<td>Phormidium</td>
<td>4000</td>
<td>4,000</td>
</tr>
<tr>
<td>Scenedesmus</td>
<td>2000 11000</td>
<td>9000 8000 4000</td>
</tr>
<tr>
<td>Spirogyra</td>
<td>1000 2000 6000</td>
<td>7000 2000 3000</td>
</tr>
<tr>
<td>Spirulina</td>
<td>1000</td>
<td>9000 10,000</td>
</tr>
<tr>
<td>Stauastrum</td>
<td>4000 1000 1000</td>
<td>1000 2000 1000</td>
</tr>
<tr>
<td>Tetradron</td>
<td>1000 2000 2000</td>
<td>1000 1000 1000</td>
</tr>
<tr>
<td>Ulothrix</td>
<td>4000</td>
<td>4,000</td>
</tr>
<tr>
<td>Volvox</td>
<td>2000 5000</td>
<td>1000 5000 3000</td>
</tr>
<tr>
<td>Total number of Species</td>
<td>12 16 15 12 10 12 16 12 14 12</td>
<td>36</td>
</tr>
<tr>
<td>Total number of Phytoplankton/l</td>
<td>27,000 37,000 47,000 27,000 32,000 36,000 48,000 32,000 38,000 45,000 3,69,000</td>
<td></td>
</tr>
</tbody>
</table>

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

The calculated value of Boyd’s diversity index is shown in Table 2.

<table>
<thead>
<tr>
<th>S.N</th>
<th>Name of Site</th>
<th>No. Of species (S)</th>
<th>Total number of algae (N)</th>
<th>In N</th>
<th>Diversity index $H = \frac{S - 1}{\ln N}$</th>
<th>Order of Pollution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BCCL Koylanagar</td>
<td>12</td>
<td>27,000</td>
<td>10.203</td>
<td>0.767</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>2</td>
<td>Saraidhela</td>
<td>16</td>
<td>37,000</td>
<td>10.518</td>
<td>0.595</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>3</td>
<td>Rajganj</td>
<td>15</td>
<td>47,000</td>
<td>10.757</td>
<td>0.650</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>4</td>
<td>Bhuli</td>
<td>12</td>
<td>27,000</td>
<td>10.203</td>
<td>0.767</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>5</td>
<td>Susnilewa</td>
<td>10</td>
<td>32,000</td>
<td>10.373</td>
<td>0.937</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>6</td>
<td>Bhuihpore</td>
<td>12</td>
<td>36,000</td>
<td>10.491</td>
<td>0.791</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>7</td>
<td>Bank More</td>
<td>16</td>
<td>48,000</td>
<td>10.778</td>
<td>0.611</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>8</td>
<td>Wasseypore</td>
<td>12</td>
<td>32,000</td>
<td>10.373</td>
<td>0.781</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>9</td>
<td>Jharia</td>
<td>14</td>
<td>38,000</td>
<td>10.545</td>
<td>0.682</td>
<td>Heavily polluted</td>
</tr>
<tr>
<td>10</td>
<td>Dhaiya</td>
<td>12</td>
<td>45,000</td>
<td>10.714</td>
<td>0.809</td>
<td>Heavily polluted</td>
</tr>
</tbody>
</table>

4=Clean water, 3-2=moderately polluted, <1 = heavily polluted

Table 2: Boyd’s diversity index for order of pollution
As per the diversity index of Boyd, Susnilewa ponds nearby Dhanbad airstrip (0.937) is moderately polluted as the index reaching 1 and followed by Dahiya, Bhuihora, Wasseypur, Bhuli, BCCL Koyalanagar, Jharia, Raiganj, Bankmore and saraidhela in ascending order for heavily polluted (Table 2).

On an average the ponds according to Boyd index is heavily polluted from major disturbances due to different points sources (151). The diversity index (<1.00) indicates that most of the ponds are heavily polluted (Fig.3). The major reason behind the pollutions is that the sampling is done in the summer season which causes the concentration.

IV. CONCLUSION

The Boyd’s index (1981) indicates that all ten ponds are heavily polluted with distribution of algae which have very close relation to the pollution.

ACKNOWLEDGMENT

The authors are thankful to Director, CSIR-CIMFR, Dhanbad, Jharkhand, India, who had provided all sorts of facilities during in-house training project work and supported to bring up this excellent experimental finding.

REFERENCES


Manoj Kumar, Kumar Nikhil and M.Sundararajan (2007) “ Micro-irrigation system for the improvement of livelihoods in rural India” Seminar on TECHVITA-2007 Role of Engineering in providing better transportation facilities in micro-irrigation/ rainwater harvesting (cheaper tube wells) in the context of rural


[143] Frank Rudolph Olson (July 17, 1910 – November 28, 1953, an American bacteriologist, biological warfare scientist, and Central Intelligence Agency (CIA) employee who worked at Camp Detrick (now Fort Detrick) in Maryland. to establish the top secret U.S. bioweapons program beginning in 1943, a time when interest in applying modern technology to warfare was undergoing a boom. Olson’s duties included experiments with aerosolized anthrax. After 10 years, he was a senior bacteriologist at the program.


[151] Sudeep. B.M* and Shankar P. Hosmani, Algal biodiversity and diversity indices in two lakes of Mysore district, Department of Studies in Botany , University of Mysore. Manasagangotri, Mysore - 570006, Karnataka , India.