Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.3, 2015 www.iiste.org

Study on Impact of Development Works or Edge Effect to the Floral Diversity of Dhanmondi Lake, Dhaka, Bangladesh

Md. Shafiqul Islam
Assistant Professor, University of Liberal Arts Bangladesh
Shafiqul.islam@ulab.edu.bd

Abstract

The study was conducted over a period of one month concentrated Dhanmondi Lake, Dhanmondi, Dhaka.The study also focused on impact on development works and edge effect to the floral diversity & micro climate in Dhanmondi Lake. The duration of the sunlight almost 14 hours daylight during the study period and there was little variation in temperature near and 10meter distance from path ways. Only 0.7 (º C) differences were observed at 10cm below the ground inside the lake. Quadrats that were away from the path had a higher D_S value demonstrating lower floral diversity compared to that of the quadrats near the path. Results revealed that the Ds value near to pathway was 0.2608 and 0.7481 for 10 meter distance for all species from the pathway.

1. INTRODUCTION

Biodiversity (Stands for biological diversity) is used to describe the variety of life in a particular area. It is the number and variety of organisms within a particular area. It depicts by three terminology: species diversity (the number of diverse species); ecosystem (or habitat) diversity (the variety of habitats within an ecosystem); and genetic diversity (the genetic variability of a species). Biodiversity is frequently used as a means to assess the health of biological systems. Floral miscellany refers to the biodiversity of plants inside the ecosystem. This overlooks any measurements allied to the animal diversity or the faunal multiplicity.

Dhanmondi Lake is positioned in the Dhanmondi suburban area in Dhaka, Bangladesh. The lake was formerly a dead channel of the Karwan Bazar River, and was linked to the Turag River. The lake is partially associated with the Begunbari Canal. It is almost 3 km in length, 35-100m in width, with a maximum depth of 4.77m and the total area of the water body is 37.37 ha. Dhanmondi area was developed in 1956 with 240.74 ha of land together with the lake. In the development plan, about 16% of the total area of Dhanmondi was designated for the lake. The lake is managed by different authorities for its various aspects. The Ministry and City Corporation is responsible for its ownership; the Fisheries Department looks after fishery development the Dhaka city corporation being the principal civic body, exercises some responsibility in its improvement. The Department of Environment looks after the aspects of proper environment and protection of aquatic resources of the lake.

Flora (Herbs, shrubs and trees) is very common in the Lake and it is important to terrestrial ecosystems- providing nutrients and holding water. Animals depend on them in terms of food and shelter (Gorucu, 1997). Fragmentation can increase the amount of edge in a forest resulting in an increase in the number of different species (Murcia, 1995). Edge effect is the interaction of two adjacent ecosystems separated by boundaries like roads, paths, etc. Occasionally there is a rivalry in these fragments resulting in a decrease in the number of unfit species and invasion by alien species (Murcia, 1995; Jensen, 1997).

The task of this study was to determine impacts of development works and edge effect on floral diversity in Dhanmondi Lake. Several development works including construction work that has been going on. More trees and big shrubs will occupy the interior as they have deeper penetrating roots. The purpose is to collect data for the sites and perform statistical t-test on the diversity index in order to determine if the group near the path and the group away from the path are similar. If so we reject our biological hypothesis and accept the biological null hypothesis to conclude that there is no significant difference between the different sites and so edge effect is not prevalent. The statistical null hypothesis is the diversity of species and their abundance will increase near the path (edge). “Data collected from near the path and 10m away from the path are similar;” whereas the statistical alternative hypothesis is “Data collected from the two groups are different.” The relevance and importance of this study is to determine whether edge effect is a factor responsible for biodiversity in lake and how it affects the ecosystem. Not a lot of experiments were performed on edge effects, but similar experiments have been performed by Carolina Murcia in 1995 as she correlated the conservation of forests to edge effects.

1.1 Objectives

The main objective of the study was to know the impact of development works (like building paths, roads, etc.) on the floral diversity in the Dhanmondi Lake. The specific objectives were to:

- know the variation of surface and below ground (10 cm below ground) temperature in different quadrats
- find out variation in duration of sunlight in different quadrats

- record the frequency of plants species
- find a relationship between development works (edge effect) and floral diversity
- Factors of development

2. METHODOLOGY

The study was conducted in Dhanmondi lake, Dhanmondi, Dhaka, Bangladesh. Total 8 quadrats were set for data collection. Four rectangular quadrats in the lake at zero meter distance and ten meters from the path were laid down for the study. Temperature (both surface and below 10cm of the ground) was measured in each and every quadrat. The number of plant species was counted from every quadrat in measuring species diversity. Four sites were selected, 100m apart, and marked into one meter by one meter quadrats, taken at 0 and 10 meter distance from the path. The task was to measure, the surface temperature and soil temperature, light, floral diversity, etc. The thermometer was used to measure temperature at the soil surface and 10 cm below the ground. The diversity of the vegetation in each quadrat was recorded along with their frequency using a simple technique. The study hypothesized that the diversity of species and their abundance will increase near the path (edge). The data were recorded and calculate using following formulae:

1. Simpson's Diversity Index

$$D_S = \frac{\sum n_i(n_i - 1)}{N(N-1)}$$

2. Standard Deviation

$$\left[\sigma = \sqrt{\frac{\sum(\overline{X} - X_i)^2}{N-1}}\right]$$

3. t-statistic

$$\left[t = \frac{(\overline{X_1} - \overline{X_2})}{S_{X_1X_2}\left(\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right)}\right]$$

4. Standard deviation for the t-statistic

$$\left[S_{X_1X_2} = \sqrt{\frac{(n_1 - 1)S_{X_1}^2 + (n_2 - 1)S_{X_2}^2}{n_1 + n_2 - 2}}\right]$$

The Simpson's Diversity Index (D_s) was then calculated for every quadrat. The standard deviation value for the Simpson's Diversity Index was calculated to check for reliability of the data. A Student's t-test was performed with the species diversity index to test whether the species diversity close to the path are significant to that away from the path.

3. RESULTS

The results showed variation of temperature both above and below ground temperature in different quadarats. At the same time the study reflected the floral diversity in different quadrats in both o meter distance and 10 meters away from pathways. The result was divided into two parts: Part (1) Variation of microclimate including temperature and light; and Part (2) Floral Diversity measuring diversity using Simpson's Diversity Index.

3.1 Microclimate

Sunlight duration inside the lake was recorded to be almost 14 hours of daylight. The temperature inside the lake remained more or less unchanged. The variation of surface temperature is very minimal between o and 10 meters distance from pathway but 0.7 (º C) differences were observed at 10cm below the ground (Table I). The degree of temperature indicates the rate of microbial activity that is going on into the soil. If microbial activity is high, then the quality of soil should also be good resulting in more plants in the region. The temperature remained fairly similar between the two groups. Site 1 had the maximum surface temperature for both near the path and 10m away from the path. Site 2 had the maximum underground temperature of 32.8 degrees at 10 m away from the path; whereas, near the edge it was site 2 with 32.2 degrees. This could be because of the frequent rainfall the region encountered during the temperature measurement process which kept the soil very wet causing soil temperatures to be more or less constant at the surface and 10cm below the surface. Similar soil temperature indicates that the microbial activity, on the soil surface, is almost similar in the two groups. The average underground temperature recorded near the path was 31.9 degrees which is slightly below that 10 m away from the path which is 32.6 degrees. This is mainly because the number of microorganisms in the soil 10 m away from the path was slightly greater contributing to more heat due to greater respiration. The average surface temperature was almost the same for both near the path and away from the path.

Table 1: Table showing microclimatic variation- light, temperature (at 10 cm below ground and at the surface) near the edges (0 m) and away from the edges (10m) inside the Dhanmondi Lake

Distance from Path (m)	**Site No.**	**Light in Quadrat (hours)**	**Temperature at 10 cm below (ºC)**	**Surface Temperature (ºC)**
0	1	14	32.1	33.1
	2	14	31.5	33
	3	14	32.2	33
	4	14	31.8	33
Mean		**14**	**31.9**	**33**
10	1	14	31.7	33.2
	2	14	32.8	33.1
	3	14	33	33.1
	4	14	32.7	33
Mean		**14**	**32.6**	**33.1**

3.2 Floral diversity

The study hypothesis revealed that the diversity of species and their abundance is more near the path (edge) due to the more availability of sunlight, intensive care, water and space thus contributing to the edge effect. Thus the hypothesis is accepted. Every quadrat was inhabited with different species of grasses, shrubs and trees. The following species were identified in the different quadrats and tabulated them in Table 2.

Table 2: Table showing Species Diversity in vegetation- the different species of plants and their abundance that were found in each site that is near the edge and 10 m away from the edge.

Vegetation	**Distance from the Edge**									
	Quadrat at 0 m					**Quadrat at10 m**				
	1	**2**	**3**	**4**	**Total**	**1**	**2**	**3**	**4**	**Total**
Grass	7	4	-	9	**20**	16	14	13	8	**51**
Krishnochura	1	-	1	-	**2**	1	-	-	1	**2**
Rose	-	2	1	-	**3**	-	-	1	1	**2**
Neem	1	1	-	-	**2**	-	-	-	-	**0**
Lemon	3	-	2	-	**5**	-	-	1	-	**1**
Palm	1	-	-	-	**1**	-	-	-	-	**0**
Mango	2	1	-	1	**4**	-	1	1	1	**3**
Jackfruit	-	-	-	1	**1**	-	-	-	-	**0**
Hasnahena	1	-	1	1	**3**	-	-	-	-	**0**
Total	**16**	**8**	**5**	**12**	**41**	**17**	**15**	**16**	**11**	**59**

The abundance of species near the edge is lower (total 41) than that 10m away from the edge (total 59). This shows more species abundance 10 cm away from the path. The Simpson's Diversity index for table 2 is then calculated and tabulated in table 3.

Table 3: Table showing the Simpson's Diversity Index (D_S) for the quadrats near the edge and away from the edge (10m).

Distance from path (m)	Site No.	D_S	Mean (D_S)	Standard Deviation
0	1	0.2083		
	2	0.2500		
	3	0.1000		
	4	0.5455		
	For total number of species	0.2608	0.2759	0.1905
10	1	0.8824		
	2	0.8667		
	3	0.6500		
	4	0.5091		
	For total number of species	0.7481	0.7271	0.1799

The Simpson's Diversity Index (D_S) value is fluctuating between the 0.10 to 0.55 marks for the sites near the path. Site 3 had the minimum value (0.1000) and site 4 had the maximum value (0.5455). The D_S value for the sites 10m away from the path ranged between 0.50 and 0.89. Site 4 had a value of 0.5091 which was the least and site 1 had the highest value of 0.8824. Site 3 had an approximate value of 0.6500 and site 2 a value of 0.8667. Sites that were away from the path had a higher D_S value compared to that of the sites near the path. The data was plotted in the following chart:

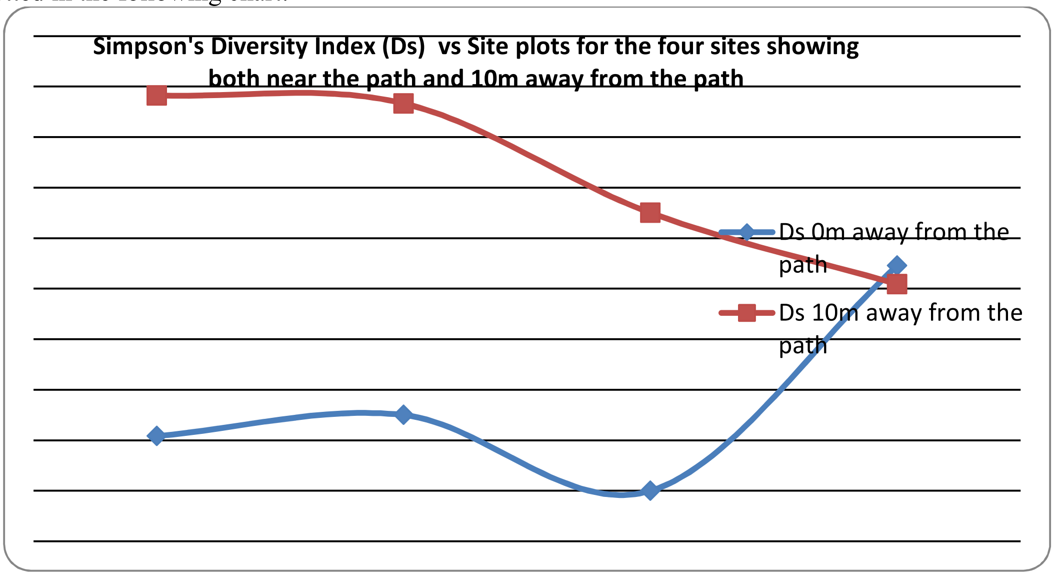

Figure 1. Showing a line graph of the Simpson's Diversity Index for the two groups- 0 m away from the edge and 10 m away from the edge.

Near the path there diversity was more or less constant around the 0.3 range except for site 4 where it goes up to almost 0.6. The Ds value was higher 10 m away from the edge.

A low Ds value indicates high floral diversity whereas a high Ds value indicates low floral diversity. According the calculations, Sites near the pathway had a high diversity compared to sites away from the pathway as indicated by the low average Ds values for sites 0m away from the path. This is probably due to the artificial plantations and the growing of fast growing alien species which have been exposed to more sunlight near the pathway. It should also be noted that the standard deviation for the Ds values near the edge was comparatively closer to the average Ds value. This indicates very low reliability of the data collected for the sites near the path. On the other hand, the standard deviation value for the sites 10m away from the path was comparatively low indicating more reliability.

The relationships between the species diversity (Ds) and the microclimate conditions were not that significant as microclimate conditions were fairly constant.

A Student's t-test was performed with the D_S values. Calculation of t-statistic was performed using the set of data from table 3. The calculated t value was 3.4441 and the critical t value for 6 degrees of freedom for 5% level of significance (α=0.05) was 2.447 ($t_{0.05,6}$ = 2.447) [Appendix 1].

4.0 DISCUSSIONS

According to the results it can be concluded that development work has an impact on the floral biodiversity of

Dhanmondi Lake in the form of edge effect. The study predicts that there is lesser number of species deeper inside the lake and a greater number of species near the edge. Soil fertility increases as we move away from the edge due to thicker humus and more nutrients being gathered at the inside (Gorucu, 1997). The results indicate that the diversity is lesser in the quadrats 10m away from the path than to that are near the edge. This is indicated by the large difference in the Simpson's Diversity Index values for the two groups (Figure 1); where for sites closer to the path has low Ds value indicating high diversity and sites away from the path has higher Ds value indicating low diversity. This agrees with our hypothesis and proves edge effect in the Dhanmondi Lake valley. Although, the soil near the path had smaller humus layer and was very compacted than that 10m away from the edges, which was near the lake with more water available, the region near the path obtained more sunlight and has been invaded by fast growing alien species. Thus we can conclude that although plant species prefer thicker humus layer, other factors like sunlight, slope, etc are involved in the diversity.

The slope and aspect have influence on the microclimate in different fragments of the forest (Murcia, 1995). Sites that were near the edges and had suitable aspect and slope received a greater amount of light resulting in slight increase in temperature. The average light transmission was more or less the same. Just that, since near the pathway it was clear, with slightly more light, we found small shrubs, grasses and trees near the edges that cannot capture light in crowded areas. The sites away from the edges were inhabited by bigger trees, grasses and shrubs that can easily capture sunlight. This corresponds to my prediction of finding smaller shrubs and trees near the edges and bigger trees and shrubs away from the edge. We can depict from our observation that near the path the forest structure remained unchanged as the increased light intensity promoted plant growth. The plants physiologically suited for this environment, exploited this condition and increased in number. This mostly includes invasive alien species and artificial plantations. This is a contradiction to Carolina Murcia's research where she found that due to such growth effects, the species along the edges constantly change and this change differs from forest to forest due to different climatic conditions. Since temperature was more or less similar for all the sites, there was no significant correlation between temperature and species richness. This could be because of the frequent rainfall the region encountered during the temperature measurement process which kept the soil very wet keeping soil temperatures more or less constant at the surface and 10cm below the surface. Plant species tend to favor better soil and nutrient conditions to temperature as they can adapt to different temperature conditions through phenotypic plasticity (Gorucu, 1997). This situation can be described such that since the soil condition is better away from the edge, plants favor the richer soil and thus become more diverse.

As the soil becomes saturated with organic wastes, the soil microbes break the wastes and recycle the matte (Gorucu, 1997). If there are not enough microbes near the paths, the decaying matter makes the soil acidic. Neutral pH is favored by most plants[1] yielding to high species diversity. In our case, the microbe density at the surface of the soil was probably similar to that 10cm below the surface resulting in similar temperatures.

Humid conditions favored the species richness in the sites that were away from the edges. The humidity was higher due to it being hot rainy season and high rates of transpiration in the trees, which also resulted in the high moisture content in the soil. The temperature within the soil remained more or less similar for both the groups as the humus acts as an insulator (Planty et al, 1996). Since humus consists of broken down leaves, twigs, etc. it creates a spongy layer to trap moisture, which retains heat. Also due to its looseness and airspaces, drastic soil temperature drops are prevented. Our statistical results from the Student's t-statistic test gave us a t-value (3.4441) which was greater than that of the critical t-value (2.447). Thus we reject the statistical null hypothesis that the Simpson's Diversity indexes of the sites near the paths were similar to that of the sites 10 m away from the path. This infers that the species richness or diversity is different near the edges as well as away from the edges, which partially agrees with my hypothesis that they will differ such that species near the edges will be more abundant to that away from the edges. In this case, the species diversity was higher away from the path than near the path, which is the contradicting part. The reasons for this may be that there were errors in our measurements and counting of the species due to the enormous numbers of species present in every site. The high value of the standard deviation questions the reliability of the experiment and requires the use of more samples. Due to wet conditions of the soil, it was difficult counting and abundant in grass. There was much cloud cover during the experiment that led to fluctuations in light transmission. Our measurements might interact with more than one variable, and also that the species might respond in different ways to edges depending on the time and space scale. These are similar reasons to Carolina Murcia's reasons on edges not leading to edge effect. She also states that edges interact with each other as a result of which our taking measurements in sites near and far away from edges may not vary considerably to fully support my hypothesis. Another factor might be that the number of sites observed was too low and the quandrats were smaller in dimension. In certain cases, bigger plants and trees took up the entire quadrat space thus not allowing other organisms to be counted. In a lot of cases, people that sit near the paths, pick the smaller plants and trees from the ground preventing them from flourishing as a result of which they do not show up in all the quadrats. Most of the flora near the path looked alien. Due to artificial seeding and plantations, and throwing of seeds here and there caused certain alien species like lemon and hasnahena to show up in the species count. According to Janet (1999) study sites without any disturbance did not support exotic plants. Physically disturbed sites on low fertility soils supported only one exotic species

5. CONCLUSION

Development works can reduce the variation in the forests rendering the forest to lose its ecological balance (Murcia 1995). When edges get exposed, the features along the edge gets modified and inhabited by alien species which makes such a situation possible. The alien species then compete for food, space and reproduction. Due to higher reproduction rates of the alien species, they invade the forest and thus modifying the entire forest. This creates an ecological imbalance and changes the microclimate conditions (Murcia, 1995; Jensen,1997 and Strayer,1999). Future research can be done to investigate this phenomenon and how this affects the microclimate.

6. RECOMMENDATIONS

Improvements can be made here by taking the entire Dhanmondi Lake into consideration. The number of sites could be increased with quadrats having larger area. This would reduce counting errors by a few factors and improve accuracy. More measurements like soil type, soil pH, humidity measurements, slope, aspect, and light intensity measurements, instead of number of daylight hours, could be considered and correlation study could be performed with the Simpson's Diversity Index. Also the artificial plantation of alien species has lead to a change in the floral biodiversity of the Dhanmondi Lake which should also be taken into consideration. Future studies can involve these aspects.

References

1. Gorucu, O. 1997. Forest resources planning in the scope of sustainable development. Faculty of Forestry, University of Kahramanmaras, Sutcu Imam, Turkey: 146-157.
2. Janet C Lake, Michelle R Leishman (2004) Invasion success of exotic plants in natural ecosystems: the role of disturbance, plant attributes and freedom from herbivores. Biological Conservation. Volume 117, Issue 2, May 2004, Pages 215–226
3. Jensen, L.R. 1997. Soil tillage- effects on turnover of soil organic matter (SOM) and nutrient availability. *Plant Nutrition and Soil Fertility Laboratory.* Integrated Plant Nutrition and Soil Fertility Management in the Tropics: 1-6
4. Murcia, C. 1995. Edge effects in fragmented forests: implications for conservation. Trends in Ecology and Evolution, Volume 10: 58-62(5).
5. Planty-Tabacchi, A.M., Tabacchi, E., Naiman, R.J., Deferrari, C., and H. Decamps. 1996. Invasibility of species-rich communities in riparian zones. Conservation BiolGorucu. 1997. Conservation Biology [CONSERV. BIOL.]. Vol. 10, no. 2, pp. 598-607.
6. Strayer, L.D. 1999. Effects of alien species on freshwater mollusks in North America. Journal of the North America Benthological Society. Vol. 18: 74-98.

Appendix 1

Table 4: Table showing the calculations of the Simpson's Diversity Index for all the Sites.

	$n_i(n_i-1)$									
Vegetation	Site 1	Site 2	Site 3	Site 4	total	Site 1	Site 2	Site 3	Site 4	total
Grass	42	12	0	72	380	240	182	156	56	2550
Krishnochora	0	0	0	0	2	0	0	0	0	2
Rose	0	2	0	0	6	0	0	0	0	2
Neem	0	0	0	0	2	0	0	0	0	0
Lemon	6	0	2	0	20	0	0	0	0	0
Palm	0	0	0	0	0	0	0	0	0	0
Mango	2	0	0	0	12	0	0	0	0	6
Jackfruit	0	0	0	0	0	0	0	0	0	0
Hasnahena	0	0	0	0	6	0	0	0	0	0
Total $\sum n_i(n_i-1)$	50	14	2	72	428	240	182	156	56	2560
N(N-1)	240	56	20	132	1640	272	210	240	110	3422
$D_S = \frac{\sum n_i(n_i-1)}{N(N-1)}$	0.2083	0.2500	0.1000	0.5455	0.26080	0.8824	0.8667	0.6500	0.5091	0.7481

Calculation for Standard deviation

$$\left[\sigma = \sqrt{\frac{\sum(\overline{X} - X_i)^2}{N-1}} = \sqrt{\frac{0.00276 + 0.000117 + 0.0259 + 0.0811}{3}} = 0.1905\right]$$

Calculation for t-test

$$\left[t = \frac{(\overline{X_1} - \overline{X_2})}{S_{X_1X_2}\left(\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\right)} = \frac{0.7271 - 0.2759}{0.18527 \times \sqrt{0.5}} = 3.4441\right]$$

Where, $$\left[S_{X_1X_2} = \sqrt{\frac{(n_1 - 1)S_{X_1}^2 + (n_2 - 1)S_{X_2}^2}{n_1 + n_2 - 2}}\right] = \sqrt{\frac{3 \times (0.03629 + 0.03236)}{6}} = 0.18527$$

The calculated t value was 3.4441 and the critical t value for 6 degrees of freedom for 5% level of significance (α=0.05) was 2.447 ($t_{0.05,6} = 2.447$). So we reject null hypothesis.