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Changes in Biodiversity and its Impact on Agro-ecosystem in Some Selected Areas of Mymensingh District, Bangladesh

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***Abstract**: This particular study was conducted based on the agro-ecosystem that lies into the human activity of an agricultural society. Being an agro based country eco-friendly environment is crucial for the reproduction of various species like plants, animals, fisheries etc. and to immune them from extinction. Three Upazilas namely Gouripur, Ishwarganj and Haluaghat from Mymensingh district were selected with a view to analyzing the changes of biodiversity of different species and identifying the causes of extinction and the threatened species in the study areas. It was found that, among four indexes (Shannon, richness, evenness and dominance) plant species richness index was increasing which was highest in Ishwarganj (2.68) and dominance index was decreasing which was lowest in Ishwarganj (0.40) in 2014. Some species of medicinal plants were found extinct. In case of animal species the richness and evenness indexes were highest in Ishwarganj 0.61 and 0.93 respectively but dominance index was lowest (0.30) in 2014. On the other hand, various local fish species especially cat fishes found rare except rainy season. Most of the farmers who were using hybrid fingerlings found more efficient in fish farming than others who adopted local varieties.*

***Keywords**: Agro-ecosystem, biodiversity, eco-friendly, extinction.*

I. Introduction

Agricultural diversification is the change in enterprise choices and input use decisions based on market forces and profit maximization principles (Pingali and Rosegrant, 1995). This diversification implies a shift of resources from primary staple crop, namely rice to other cereal crops, from cereals to non-cereal crops, and from crops to non-crop (livestock, fisheries and forestry) agriculture. Biodiversity is the most vital fact for environmental balance. Sustainable agriculture development can be ensured by the proper maintenance of biodiversity and balance of its elements. Bangladesh has subtropical evergreen and deciduous forest tree species that has potential growing capacity to be included in economic forestry activities like massive plantation (Das 1982) or in carbon forestry projects (Rahman and Akter 2013). Total forestlands are about 2.53 million ha of which 0.67 million ha have been classified as evergreen and semi-evergreen forest, 0.12 million ha as tropical moist deciduous forest, and 0.67 million ha as mangrove forest (Hossain 2005; FAO 2007). Forest productivity of the country in terms of wood biomass is satisfactory as the country falls under tropical and subtropical zone (FRA 2010). The IUCN, Bangladesh Red Data Book (2000) has described 266 species of inland fishes, 442 marine fishes, 22 amphibians, 109 inland reptiles, 17 marine reptiles, 388 resident birds, 240 migratory birds, 110 inland mammals, as well as 3 species of marine mammals in Bangladesh. According to the Red List of IUCN, there are 54 species of inland fishes, 8 amphibians, 58 reptiles, 41 resident birds, and 40 mammals, which are threatened throughout the country. Among the marine and migratory species of animals 4 fishes, 5 reptiles, 6 birds, and 3 mammals are threatened (IUCN, 2000).

Several biodiversity research initiatives were taken by the government. The National Conservation Strategy (NCS) emerged in September 1986. Its primary goal was the sustainable use of natural resources. The National Conservation Strategy Implementation Project 1 (1994-1999) was a five-year project implemented by the Ministry of Environment and Forest (MoEF), with financial and technical support from NORAD and IUCN (Ali and Ahmed, 2001). Noticeable changes were found among various tree, animal and fish species in the study areas. Some changes were positive but some were detrimental for the whole ecosystem. According to the diversity index tree diversity was highest in Ishwarganj (1.62) compared to other two areas which revealed that this region was moderately densely populated by tree species. Along with that the farmers were mainly interested in planting the trees having higher growth rate like Shegun (*Tectona grandis*), Sil Koroi (*Albizia*

procera). Hence the richness index was also found for these tree species. Due to the evenness impact in Gouripur the relative abundance of the tree species was found lowest (0.24) and highest in Ishwarganj (0.53) in 2014 (Table 1). The animal diversity scenario was pessimistic in the study areas along with its richness and evenness features but the dominance index was optimistic, highest value was found in Haluaghat (0.36) in 2014 (Table 2). Fish richness index was considerable but the farmers were interested in HYV fingerlings than local species (Table 3). Some of the local and relatively extinct species were found in the study areas (Table 4). The preservation of the biodiversity in the study areas was tough due to excess population pressure, high rate of migration, unconsciousness etc. (Table 5).

New environmental issues have come in front of us due to imbalanced ecosystem. Hence the study of biodiversity has become a demand of time. As all the species are important for the biodiversity but now-a-days the local species are at an extinct situation in both village and household levels. This study was intended to assess the changes of species and their extinction at village level or household level.

II. Review of Literature

A number of studies have been undertaken on agro-ecosystem and biodiversity in Bangladesh and other climate vulnerable countries. For precedent, Rahman (2004) studied on the biodiversity of Bangladesh and the extinct species and found that, Bangladesh is also entering through a critical period. Already, 12 wildlife species have become extinct from the country. Pongsiri et al (2009) conducted a study on the disturbance and changes of ecosystem and its impact on human health and concluded that, any disturbance of an ecosystem can induce genetic changes in disease pathogens (e.g. change in pathogen virulence), changes in the population dynamics of vector or host species (abundance, diversity, composition and distribution), changes in community (predation and competition) and changes in structural diversity (complexity, fragmentation and distribution of habitats and area species relationship). Islam (2003) conducted a case study on the plant species of Bangladesh and showed that an estimated 5,700 species of angiosperms alone, including 68 woody legumes, 130 fiber yielding plants, 500 medicinal plants, 29 orchids, 3 species of gymnosperms and 1,700 pteridophytes has been recorded from the country.

A study conducted by (CBD, 2006; 2007) on livelihood and biodiversity loss showed that, the poorest people of those poor countries, who depend most immediately upon local ecosystems for their livelihoods are somehow responsible for the degradation of biodiversity and will mostly affected by the consequence of this biodiversity loss. Reza (2004) conducted a case study on the extinct plant species of Bangladesh and he found that 106 vascular plant species face risks of various degrees of extinction in Bangladesh. Cardinale et al. (2012) conducted a study on the evidence for the effects of biodiversity on ecosystem and mentioned that it was often mixed. The study revealed that there were positive trends or impact for woods, fisheries, pollination and fresh water purification but negative trend was found for pest controls in the review of relationships between different diversity levels (species, genetic and trait).

III. Methodology

The study was conducted in Mymensingh district which is rich in biodiversity. Considering the objectives of the study three Upazilas namely Gouripur, Ishwarganj and Haluaghat were selected. Three villages from Gouripur namely Dapunia, Yousufabad and Satuti, another four villages from Ishwarganj namely Matikhola, Morichar Char, Charal bil and Char Pubail and three villages Norail, Sumonia Para, Hadiser mor were selected from Haluaghat. A simple random sampling technique was used to collect the data from the respondents of the study areas. From each of the study areas 20 samples were taken to conduct the research. Primary data were collected by using structured interview schedule. The secondary data used in this study were from text books, journals, research reports and online materials. The statistical terms like the percentage, standard deviation, calculation of averages and calculation of various indices like Shannon diversity index, Evenness index, Species richness index and Index of dominance were performed to fulfill the objectives.

3.1 Species Diversity Index

One of the most commonly used species diversity measures is the Shannon diversity index. This index combines the concepts of species richness and evenness. The value of the Shannon diversity index is usually between 1 and 4 and is rarely higher than 4. When the number of species in the sample is high the Shannon diversity index may exceed 4. Shannon and Weaver (1963) used the following equation to measure the species diversity:

The species diversity index was measured by using the following equation:

$$H\text{-} = -\Sigma\, p \ln p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where, H-= Shannon diversity index; p = importance probability for each species = n/N; n = number of individuals within each species; N = total number of individuals

3.2 Species Richness Index

Biological diversity was measured by using species richness index .It can be expressed by the following equation:

$$D = (S-1)/\ln N \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, D = species richness index; S = number of species; N = total number of individuals.

3.3 Species Evenness Index

Evenness of diversity was calculated by using evenness index. The measure ranges from 0 to 1 and can be expressed by the following equation:

$$E = (H-)/\ln S \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, E = evenness index; H- = Shannon index

3.4 Species Dominance Index

Index of dominance is measured by the abundance of the most common species in an ecosystem. It is the inverse of the evenness index and ranges from 0 to 1.

The species dominance index was measured by using the following equation:

$$c = \Sigma (n_1/N)\, 2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where, c= index of dominance; n_1= number of each species; N= total number of individuals.

IV. Result and Discussion

4.1 Impact of Changes in Agro-ecosystem in Tree Species

The results in Table 1 showed that, diversified tree plantation habit was practiced by the farmers of Ishwarganj (1.62) Upazila in 2014 which also means a lot of tree species like Jackfruit (*kathal*) (*Artocarpus heterophyllus*), Litchi (*Litchi chinensis*), Mango (*Mangifera indica)*, Mehogani (*Swietenia mahagoni*) etc. were very much available in this study area. This diversification trend paved the way for higher richness (2.68) and evenness (0.53) index but lowest dominance (0.40) indexes in Ishwarganj Upazila. Lower dominance index means there was less biasness in tree plantation and the farmers were used to plant all categories of trees. As it is obvious that if the richness and evenness indexes are higher then the diversity index will also be higher which was found among the farmers of Ishwarganj. In case of Gouripur the diversity index was lowest (0.74) in 2014 that also referred lowest tree richness index (2.47) and lowest tree evenness index (0.24). The result showed that the farmers of this study area preferred to plant only limited number of tree species which were basically cash plants like Mehogani (*Swietenia mahagoni*), Rain tree (*Albizia lebbeck*) etc. hence the dominance index (0.75) was also highest in Gouripur which meant these tree species were dominating other tree species. Due to the dominance some local plants mainly medicinal plants like Ulatkambal (*Abroma augusta*), Kurchi (*Holarrhena antidysenterica*), Horitaki (*Terminalia chebula*) were found extinct. Another study area Haluaghat was mediocre in diversity index (1.15). So, richness index (2.67) and evenness index (0.37) were also mediocre. The dominance index was medium (0.60) compared with other two areas.

4.2 Impact of Changes in Agro-ecosystem in Animal Species

As like trees or plants animal also act as the container of ecological balance in an agro-ecosystem. Table 2 shows the result about the scenario of diversity, richness, and evenness and dominance indexes of animals in the study areas. Besides the domestic animals the wild animals in any ecosystem play same important role in protecting the whole ecological balance. The study focused that, animal diversity was highest in Ishwarganj (1.29). As for other two indexes richness and evenness were usually higher 0.61 and 0.93 respectively in the study area in 2014. Generally animal diversity will be higher in those places which are confined with woodland. Ishwarganj was covered with forest areas mostly than other two areas and provided enough shelter for animal species like Mongoose (*Herpestes edwardsi*), Bon Bidal (*Felis chaus*), Civet (*gandhogokul*) (*Viverra zibetha*), The Golden or the Asiatic Jackal (*Canis aureus*) were found here. Like wild animals domestic animals like Cattle (*Bos indicus*), Goat (*Capra hircus*) and poultry like Hen (*Gallus domesticus*) were available. Less biasness by the farmers and the forest areas was exposed in Ishwarganj. Due to shortage of forest the wild species were less diversified in Gouripur and also some threatened species were categorized. The richness (0.60) and evenness (0.84) indexes were less in Haluaghat than Ishwarganj, hence the diversity index (1.17) was found lowest. Dominance index (0.36) was higher and due to that reason some domestic species like Buffalo (*Bubalus bubalis*), Horse (*Equus caballus*) were found rare and some cases extinct in this Upazila. Cattle (*Bos indicus*), Goat (*Capra hircus*) were found available. Lowest richness index (0.58) and low evenness index (0.89) brought low animal diversity index (1.24) in Gouripur. Some wild species were found endangered like Hare (*Lepus nigricollis*), Bon Morog (*Gallus gallus*), Common Kingfisher (*Alcedo*

atthis), Greater Fruit Bat (*Badur* or *Kola Badur*) (*Pteropus giganteus*) etc. Some wild species in the study areas were found important not only for maintaining ecological balance but also for protecting the crops specially Rice (*Oryza sativa*). Several insects cause huge damage to this crop. But there are some friendly animals like Cobra (*Naja naja,),* Frog (*Bufo melanostictus*) which eat those insects and birds like Falcon (*Falco pregrinus*) and Bazzard (*Buteo buteo*) eat another major enemy of rice Rat (*Rattus rattus*). Due to the absence of these friendly animals huge loss of production is observed.

4.3 Impact of Changes in Agro-ecosystem in Fish Species

Table 3 represents the outcome of the richness in the study areas. A series of data were taken (from 1994 to 2014) to calculate the richness index. The richness index in Gouripur had an increasing trend from 1994 to 2014 and in 2014 it was the highest (2.59) which meant that the farmers were cultivating the particular hybrid fish varieties like Tilapia(*Oreochromis mossambicus*), Silver carp (*Hypopthalmicthys molitrix*) etc. skipping the local varieties. In case of both Ishwarganj and Haluaghat the index had a decreasing trend in 2004, the lowest index was found in Ishwarganj (0.65). A comparative analysis of Ishwarganj and Haluaghat with Gouripur has shown in Fig. 1 and Fig. 2. Some of the fish species like Rui (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus marigala*), Grass Carp (*Ctenopharyngodon idellus*), Silver carp (*Hypopthalmicthys molitrix*), Thai sarputi (*Puntius gonionotus*), were mostly available in the study areas but some other local varieties like Pabda catfish (*Ompok pabda*), Lal Chanda (*Pseudambassis ranga*), Chitol (*Chitala chitala*), Gozar (*Channa marulius*), Punti (*Puntius puntio*) etc. were found rare, extinct or absent (Table 4).

V. Tables and Figures

Table 1: Different Indexes of Tree Species in the Study Areas in 2014

Indexes	Gouripur	Ishwarganj	Haluaghat
Shannon Index	0.74	1.62	1.15
Richness Index	2.47	2.68	2.67
Evenness Index	0.24	0.53	0.37
Dominance Index	0.75	0.40	0.60

Source: Field Survey, 2014

Table 2: Different Indexes of Animal Species in the Study Areas in 2014

Indexes	Gouripur	Ishwarganj	Haluaghat
Shannon Index	1.24	1.29	1.17
Richness Index	0.58	0.61	0.60
Evenness Index	0.89	0.93	0.84
Dominance Index	0.34	0.30	0.36

Source: Field Survey, 2014

Table 3 Fish Species Richness Index in the Study Areas

Index	Gouripur			Ishwarganj			Haluaghat		
	1994	2004	2014	1994	2004	2014	1994	2004	2014
Species richness index	1.94	1.29	2.59	0.97	0.65	0.97	1.62	1.29	1.62

Source: Field Survey, 2014

Table 4 Scenario of Fish Species in the Study Areas

Local Name	Gouripur			Ishwarganj			Haluaghat		
	1994	2004	2014	1994	2004	2014	1994	2004	2014
Rui	1	1	1	1	1	1	1	1	1
Katla	1	1	2	1	1	1	1	2	1
Mrigal	1	1	1	2	1	1	2	1	1
Kalibaus	-	-	-	-	-	2	2	-	-
Bata	-	-	-	-	-	-	1	-	-
Bighead carp	-	-	3	-	-	-	-	-	-
Grass carp	2	2	2	-	2	-	1	2	1
Common carp	-	-	-	-	-	-	-	-	-
Silver carp	2	2	2	2	-	2	1	2	1
Mirror carp	-	-	-	-	-	-	1	-	-
Chitol	-	-	-	-	-	-	-	-	-
Shoal	-	-	1	-	-	-	-	-	-
Nilotika	-	2	-	-	2	-	1	-	1
Mozambique tilapia	1	-	-	-	-	-	-	3	-
Gozar	3	3	0	0	3	3	0	0	0
Chanda	3	0	0	3	0	0	0	0	0
Lal chanda	-	-	-	-	-	-	-	-	-
Puti	-	-	-	-	-	-	-	-	-
Shor puti	2	1	2	2	1	2	1	2	1
Magur	2	-	-	-	2	-	0	-	-
Pabda	3	3	3	3	3	3	0	0	3
Koi	1	2	-	1	-	2	3	3	-

Source: Field Survey, 2014

1= abundant, 2=common, 3= rare, 0=extinct, - =absent

Table: 5 People's Perception about the Causes of Ecological Disturbance

Reasons	Gouripur(%)				Ishwarganj(%)				Haluaghat(%)			
	SA	A	DA	NR	SA	A	DA	NR	SA	A	DA	NR
Excess population pressure	45	55	-	-	45	55	-	-	15	85	-	-
Demand is higher than supply	-	30	45	25	-	30	25	45	-	35	25	40
High rate of migration	-	50	20	30	-	55	35	10	-	25	30	45
Unconsciousness	45	55	-	-	40	60	-	-	30	70	-	-
Lack of proper care	35	65	-	-	45	55	-	-	50	50	-	-
Deforestation	60	40	-	-	80	20	-	-	60	40	-	-
Use of cultivated land in other purposes	40	60	-	-	30	70	-	-	45	55	-	-

Source: Field Survey, 2014

SA= strongly agreed A= agreed NR= no response DA=disagree

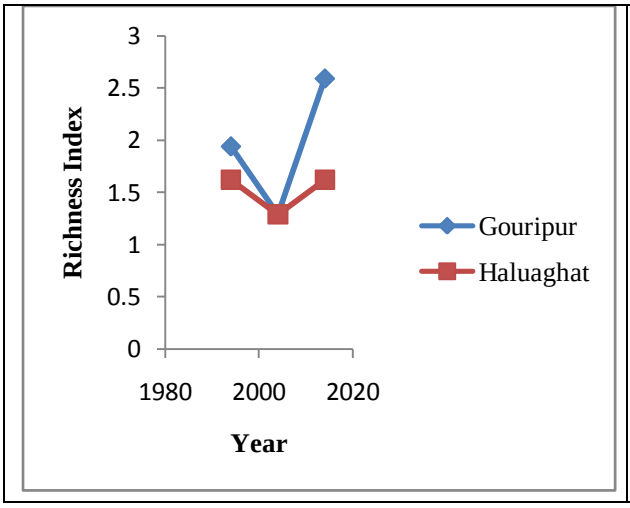

Figure 1: Comparative analysis of fish species richness of Gouripur and Haluaghat

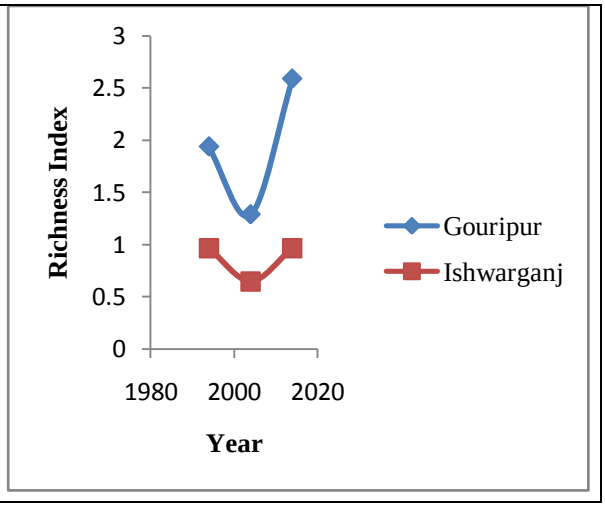

Figure 2: Comparative analysis of fish species richness of Gouripur and Ishwarganj

VI. Conclusion

This comparative study was initiated to explore the changes of biodiversity and its impact on nature due to the extinction of various domestic and wild species in the study areas. Biodiversity is an important concept, which is the dynamic system of the nature where all types of living components and beings interact, cooperate and share living components with each other. If anyhow the chain is broken then the whole system will be collapsed. Among three study areas the tree and animal species diversity were mentionable and highest in Ishwarganj which were 1.62 and 1.29 respectively. This result showed that the farmers of this study area were conscious and unbiased in tree plantation to protect the environment. Along with that their efforts helped to keep a sound and healthy wild nature in forest and also domestic nature in household level. But comparatively the farmers of other two study areas were biased in their choice of tree plantation and rearing domestic animals. As a result the extinct and threatened species were found to a large extent in these areas. Some of these species had significant impact on the production of rice and other cereals. About 85% of the respondents in Haluaghat and 55% in Gouripur responded that the excess population pressure was the major reason for the ecological disturbance in the study areas. In case of fish species the richness was found highest in Gouripur (2.59) in 2014 due to the availability of water sources. The farmers were found to depend on the hybrid fingerlings for fish production. The advantage of this study was that, it helped to find out some information's which were alarming for the agro-ecosystem and biodiversity of Bangladesh. Forest areas are reducing at an alarming rate and the species lived on the forest areas are now threatened or extinct in some cases. Most of our farmers now prefer to use the HYV breeds than the local varieties which are considered as a threat for the future of those varieties. So, this study could be a new privilege to protect the threatened and almost extinct local species for saving the agro-ecosystem and the biodiversity.

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