THE IMPACT OF SPATIAL CHANGES OF WETLANDS ON BIO-DIVERSITY: A GEO-SPATIAL STUDY ON TANGUAR HAOR-RAMSAR SITE, BANGLADESH

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ABSTRACT

Bangladesh is the largest delta in the world. Geographical location and seasonal diversity have made this country unique. Tanguar Haor as a Ramsar site is famous throughout the world with a reservoir of aquatic biodiversity. Due to availability of water flow throughout the year it has reached biodiversity compared to other haors in Bangladesh. In every winter, this haor becomes sonorous with the presence of thousands of migratory and resident birds. A lot of aquatic plants are floating and some are submerged. These aquatic plants decompose with seasonal shift and make the soil fertile. Numerous organisms with food and shelter are provided by these aquatic plants. Various species of amphibians and reptiles can also be seen in this vast haor. It has merged with the life and tradition of local people. Also human habitation has increased around the haor since the middle of the last century. About 12,870 ha water body has lost from 23,230 ha during last 60 years. Per year, 1.17% of water body has been lost in Tanguar Haor from 1955 to 2015. As a result, population of birds and wildlife is decreasing alarmingly due to the disturbance in the natural balance of the wetland ecosystem.

Key Word: Haor (wetlands), Ramsar site, biodiversity, wetland ecosystem.

INTRODUCTION

The term "haor" is the collective term of marshes, swamps, bogs and similar areas in aspect of Bangladesh as a floodplain dominated country. It is used for conventional term of wetlands in north-eastern part of Bangladesh, particularly Sunamganj, Habiganj, Moulvibazar, Sylhet, Netrokona and Kishoreganj Districts. The "Tanguar Haor" one of the largest of them, is located in Tahirpur and Dharmapasha Thana of Sunamgange. This haor basin contain must be considered as a unique ecosystem of national and international importance. Each of the haor basins is key elements of complex hydrological, biological, and ecological system, supporting a significant assemblage of rate and vulnerable species of plants and animals, including endemic species (Bevanger et al., 2001). According to the development and growth of the population these haor area is decreasing day by day. The physical and socioeconomic environment has been affected due to these changes of haor area (Cegis and Bhehb, 2012).

The changes of haor area have long been a source of interest and a topic for field research for the geographic and aquatic study. To explore the spatial change of the haor area due to physical and social component like urbanization and industrial development has used some tools and techniques. The topographical maps are used to detect the size, shape and distribution of haor. Remote sensing technology is also used for demarcation and monitoring of land features included water shade (Mahmud et al., 2011) and water quality assessment (Seyhan and Dekker, 1986; Wang and Ma, 2001; Koponen et al., 2002; Brando and Dekker, 2003; Ritchie et al., 2003; Pozdnyakov et al., 2005; Alparslan et al., 2007; Chen et al., 2007 and Giardino et al., 2007). The topographic map of 1955 (US army prepared) that has prepared by using District Gazetteer map of 1911-30 (India), has used to change detection of
Tanguar Haor. The Landsat satellite (USGS) images used to detect the scenario of the last half century (1975 and 2015). The variation between topographic maps and Landsat images has helped to reach the spatial changes of 1955 to 2015 during 60 years. It has estimated that a total of 141 fish species, 11 amphibians, 34 reptiles (6 turtles, 7 lizards and 21 snakes), 206 birds and 31 mammals occur in this haor (Nishat, 1993; Karim, 1993). These aquatic components have been changed comparatively with the spatial changes. There is a strong relationship between spatial changes of haor area and its aquatic ecosystem. The field survey, focus group discussion and field level interview have been conducted to measure the intensity of aquatic diversity. The spatial changes of haor area and aquatic diversity have been interrelated, that mean there are correlation between the spatial changes and aquatic diversity (U.S. G.S and U.S. Department of the Interior, 2008).

The broad aim of the study is to explore the correlation of spatial changes to the status of aquatic diversity of the Tanguar Haor. The specific objectives of the study were to:

a) Identify the location and area of Tanguar Haor observing historical maps and satellite images;
b) Explore the spatial changes of haor area over time period. and

c) Investigate the impact of changes on biodiversity of haor area.

MATERIALS AND METHOD

Study site

"Tanguar Haor" is located in Tahirpur and Dharmapasha Thana of Sunamganj district in the north-eastern part of Bangladesh. The Tanguar haor, being declared as an "Ecologically Critical Area" by the Bangladeshi government in 1999, and as Bangladesh's second RAMSAR site since 10 July 2000, is particularly threatened by overexploitation of fishery stocks, deforestation and large-scale waterfowl harvesting (Bevanger et al., 2001). The geographic location of "Tanguar Haor" is 25°09'N to 25°12'N latitude and 91°04'E to 90°07'E longitude (Google-Earth, 2016 and USGS, 1955) (Figure 1).

Methods

To attain the aim and objectives of this research, three-track methodology had been used for four time intervals, while in the first, secondary literature was reviewed to find out the relevant data about Tanguar Haor. The second track is to identity the Tanguar Haor from topographic map and satellite (Landsat) images. Thirdly, to explore the spatial changes and aquatic dynamics (Table 1). Finally, there have analysed the trends of spatial changes of the Tanguar Haor.

Sources of Data

The District Gazetteer map of 1911-30 based on topographic maps (US. army prepared) of 1955 has been used to detect the area of Tanguar Haor of 1955. The Landsat Multi-Spectral Scanner, (USGS: Landsat MSS, 147/043) images has used to detect the area of Tanguar Haor of 1975 and Landsat Operational Land Image (USGS: Landsat OLI, 137/043), had been used to detect the area of the Tanguar Haor of 2015 (Table 1).

Data Processing Approaches

Based on the objectives, some technical approaches have used to explore the changes of the haor area and diversity of aquatic species. This process has gradually been followed step-by-step approaches according to the research purpose. By using the topographic map of 1955, the haor area is identified and creates the vector data of it with GIS technology (Arc GIS 10.2). Landsat satellite imageries also used for identify the change detection of the haor area and for that; there have taken the images of 1975, 1995 and 2015 at a same time of period (January). To analyze images there have used same wavelength band combination by using Erdas Imagine 2014.
Figure 1. Location of Tanguar Haor

Table 1. Data and Materials

<table>
<thead>
<tr>
<th>No</th>
<th>Objectives</th>
<th>Data materials</th>
<th>Methods</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Location and area.</td>
<td>Article, Topographic Maps, Satellite Imagery.,</td>
<td>Remote sensing, GIS, Virtual Satellite (Google Earth).</td>
<td>Size, Distribution and Area</td>
</tr>
<tr>
<td>3</td>
<td>Impact of changes on biodiversity.</td>
<td>Published research documents and field survey.</td>
<td>Literature review, Public Interview.</td>
<td>Threats and Status of Biodiversity.</td>
</tr>
</tbody>
</table>

The mid and near infrared spectral bands of satellite images have strong reflectance by soil and vegetation and absorbance of water, which make possible to separate the land from water and can be used to detect the water body (Kuleli, 2010). Landsat MSS (Multi Spectral Scanner) imagery were used for detecting the haor area of 1975 and 1995. NIR (Near Infrared) band-4 is taken here for water body detection. Landsat OLI (operational land image) imagery have been used for 2015 (NIR, band-5) spatial analysis. The normalized difference water index (NDWI) model have developed this web length characteristic (Gao B, 1996). The equation of NDWI model have given below:

\[
NDWI = \frac{\text{Green band} - \text{NIR band}}{\text{Green band} + \text{NIR band}}
\]

Where:
NDWI = Normalized Difference Water Index
The NDWI effective to water body detect (Gao B, 1996). The same coordinate system; Bangladesh Transverse Mercator (BTM) have been used to spatial analysis. The SPSS tools have been used to statistical analysis of collected field data.

RESULT AND DISCUSSION

Tanguar Haor

The Tanguar Haor is the second largest fresh water resource of the Bangladesh. The deeper part of the Tanguar Haor that retain water in the dry season are called beels. The Tanguar Haor are consist with more than 50 various beels within 10,000 ha. The Sillong plateau (Asam, India) which lies to the north of Tanguar Haor is an elevated block of Pre-cambrian basement rock (Kabir and Amin, 2007). The surrounding topography of this plateau have morphologically influenced to develop the Tanguar Haor (Figure 2). Assam hilly area, as a heavy precipitation zone have been supplied a lot volume of water; as a result, the deeper part of Sunamganj District has been developed water logging, this water logging area is known as the Tanguar Haor.

Figure 2. Physiography of Tanguar Haor  
(Source: Google Earth)

The core area of the haor system supports a larger number of waterfowls including native and migratory species, seasonally harboring up to 60,000 migratory waterfowl along with many resident birds, more than 140 fish species and last vestiges of swamp forest. But the floral and faunal diversity of Tanguar Haor is under extensive threat because of unsustainable use of resources (Sobhan et al., 2012). In this circumstance, The Government of Bangladesh declared the Tanguar Haor as an “Ecologically Critical Area” to highlight its ecological importance and to monitor its environmental quality in
1999. In 2000, the Tanguar Haor was declared as the second RAMSAR site of Bangladesh for wetland of international importance.

**Spatial Changes of Tanguar Haor**

The haor area has been reduced with the passing of time period due to human disturbance and structural developments, which are working as the main agents of haor area reduction along the natural activities. The functional and socio-economic changes of the society in the haor area also influencing for the changes of the haor area. The historical image analysis clearly indicates the shrinking of the total haor area (Figure 3 and 4).

In 1955, 1975, 1995 and 2015 the area of Tanguar Haor are 23,230 ha, 19,000 ha, 14,000 ha and 10360 ha respectively (Table 2). These areal changes indicate the trend of spatial changes of the haor area (Figure 5). On an average, every year about 214.5 ha haor area has been lost from 1955 to 2015, which is 1.17% of the total haor area.

At present the haor area is reduced to almost half of the total area as it was in 1955. During the last 60 years, spatial changes represents that the haor have lost 12,870 ha of water body.

![Figure 3. Spatial Changes of Haor Area from 1955 to 2015](image-url)
Table 2. Decreasing Rate of Haor Area from 1955 to 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (ha)</th>
<th>Lost Area from 1955 (ha)</th>
<th>Percentage of Lost from 1955</th>
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</thead>
<tbody>
<tr>
<td>1955</td>
<td>23230</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1975</td>
<td>19000</td>
<td>-4230</td>
<td>-18.20 %</td>
</tr>
<tr>
<td>1995</td>
<td>14000</td>
<td>-9230</td>
<td>-39.73 %</td>
</tr>
<tr>
<td>2015</td>
<td>10360</td>
<td>-12870</td>
<td>-55.40 %</td>
</tr>
</tbody>
</table>

Figure 4. Haor Area Decreased from 1955 to 2015

Figure 5. Haor Area is Decreasing Gradually from 1955 to 2015
In the analysis of spatial changes, there is found a very strong negative correlation ($r^2 = -0.99$) between haor area and time, which representing the reduction of the haor area. As a result, the haor area and biodiversity have related positively. Here is this statistical aspects, time means the human disturbance and structural development in the haor area, those are working as an agent of haor area changes and threatening on the biodiversity of the Tanguar Haor.

**Impact of Spatial Changes on Bio-diversity of Tanguar Haor**

The Tanguar Haor are ecologically very rich for aquatic environments. There is a total of 200 wetland plant species, 141 fish species, 11 amphibians, 34 reptiles (6 turtles, 7 lizards and 21 snakes), 206 birds and 31 mammals occur in this haor (Gieson and Rashid, 1997). According to Bangladesh Bird Club (BBC) an average fifty thousand individuals of around 70-80 species are found every year from the Tanguar Haor. About 60 species of migratory birds come to this haor in every winter as this haor is an ideal place for their food and habitat. It has the estimated that, the number of 141 species of fish are in 35 families. This number is more than half of Bangladesh's total 260 freshwater fish species (DoZ, 1997; Nurazzaman, 1997; Khan, 1997).

During the last 60 years the wetlands have been changing in a yearly decreasing rate of 1.17% and 55% of the total haor area (Table 2). This decreasing rate disrupted in the biodiversity of the wetlands. The aquatic fauna has been decreasing with the changing of haor land. In the dry season about 60 species of migratory birds come to this haor area and they are affected by various chemical and poisoning effluents due to agricultural cultivation. The population has been increasing rapidly in the haor area due to socio-economic condition; as a result the economical use of haor land has been increasing.

**CONCLUSIONS**

The second large fresh water wetlands of Bangladesh and a RAMSAR site; Tanguar Haor is haven for resident and migratory birds. It is a model habitat for wildlife, such as: fish cat, amphibians, wild cat, turtles, lizards, snakes and other aquatic flora and fauna. During the passing of year the haor land have changed and decrease as a result the wetland ecosystem would day by day destroy. Some haor management policy and plan have taken by government and non-government originations, but these are not sustainable for haor management. The social recognition, government legislation and strategy, non-government activities and community based action are most important for conservation of haor and its biodiversity.

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