Scientia Agriculturae
www.pscipub.com/SA
E-ISSN: 2310-953X / P-ISSN: 2311-0228
DOI: 10.15192/PSCP.SA.2015.12.2.7888

Sci. Agri.
12 (2), 2015: 78-88

Land Use Change and Its Impact on Ecosystem Services, Livelihood in Tanguar Haor Wetland of Bangladesh

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Paper Information

Received: 17 July, 2015

Accepted: 29 September, 2015

Published: 20 November, 2015

Citation

Uddin MR, Miah MGU, Afrad MSI, Mehraj H, Mandal MSH. 2015. Land Use Change and Its Impact on Ecosystem Services, Livelihood in Tanguar Haor Wetland of Bangladesh. Scientia Agriculturae, 12 (2), 78-88. Retrieved from www.pscipub.com (DOI: 10.15192/PSCP.SA.2015.12.2.7888)

A B S T R A C T

Demographic characteristics Tanguar haor showed that most of the respondents were old aged and had primary level of education; most of the family size was medium with small farm size and most of the respondents were fisherman with poor level of income. The most notable changes of land use pattern was increased in settlement and decreased in seasonal freshwater marshes. Highest adopted rice variety was BRRI dhan28 and lowest adopted rice variety was Basful. Regarding forest/wood tree species, *Pongamia pinnata* and *Barringtonia acutangula* were found to increase, while fruit species were decreased. Area and species of swamp forests were increased, while fish and bird species were drastically reduced. Siltation and rising up of river bed were increased, while some haors already became dead. Haor water was reported to pollute now-a-days and quality of drinking water was also decreased. Major problems were damage of road, houses and crops due to major natural disaster flash flood. Multipurpose shelters establishment, infrastructure development and new accommodation for community people during disaster were some important suggestions provided by respondents for better management of wetland ecosystem and improvement of livelihood exist therein.

Key words: *socioeconomic, demographic, respondents, resource, change and wetland ecosystem*

Introduction

Bangladesh is a land of wetlands and more than two thirds of the country may be classified as wetlands (Ramsar Convention Bureau, 2000). Wetlands ecosystems are rich in biodiversity and great importance to Bangladesh because of their critical economic and ecological role in sustaining life and livelihoods of communities living in close proximity to the area (Kabir and Amin, 2006). Tanguar haor wetland is commonly identified as freshwater wetlands, providing social, economic and environmental benefits which are source of their livelihoods providing income and employment (Khan, 1993). It is the home of sweet water fishes and indigenous birds. It has great importance in fish production, maintaining biodiversity, meeting local and regional demand also serve as the good source of fish. People are dependent upon the functioning of ecosystems to survive and improve their standards of living. Amongst the many aspects of global change, land use change has been highlighted as a key human-induced affect on ecosystems (Turner *et al*., 1997; Lambin *et al.*, 2001). An increasingly urbanized society and such land use change directly influence the provision ecosystem services climate regulation, nutrient cycling and cultural identity (Daily, 1997; MA, 2003; Reid *et al*., 2005). Land use change is a direct driver of change to ecosystem services but there is no authentic information about the land use changes and its effect on ecosystem services. Study has been proposed to provide a conceptual framework to understand the effect of land use change and anthropogenic activities on the ecosystem services and how changes in ecosystems services affect livelihood condition in Tanguar haor region of Bangladesh.

Specific objectives of the study

To document the socioeconomic and demographic profile of respondents in the study area,

To identify the changes of resource availability, problems and formulate suggestions for better management of wetland ecosystem in study area

Materials and Methods

Study site and period of the study

The study was carried out at Tahirpur Upazila under Sunamganj District, Sylhet, Bangladesh from June to December, 2012.

Selection of study site

Study sites were selected having a short visit to the area after discussion with the Department of Agricultural Extension (DAE), Fisheries Department, Forest Department and Beneficiaries. A near place where people are directly involved with crop cultivation and fishing for their livelihood. Co-operation of Sub Assistant Agriculture Officer (SAAOs) of these selected areas for conducting study.

Tanguar haor

One third of Tanguar haor lies in Tahirpur Upazila and remainder in Dharmapasha Upazila, both within Sunamganj. About 50% Tanguar haor area (5,682 ha) is water bodies, followed by 31% crop land (IUCN 2011) also about 50 beels and perennial flooded parts of the haor are rich in fish (IUCN, 2010).

Sampling Technique

Three villages in Tanguar haor area under Tahirpur Upazila were purposively selected. The researchers collected a list of crop cultivation and fishing dependent people from the Upazila Agriculture Office and updated list was prepared with the help of local leaders like chairman, members, SAAO and local NGO workers. About 492 household heads were considered as the population and 50 household heads were randomly selected as sample. A reserve list of 5 household heads was also prepared to use only when a respondents in the original list were not available for interview (Table 1).

Table 1. Distribution of the population, sample and respondents included in the reserve list from 3 villages of 2 unions

Name of union	Village	Population	Sample	Reserve list
Dakshin Sreepur	Hukumpur	209	21	2
Utter Sreepur	Golabari	131	12	1
	Silon Tahirpur	152	17	2
Total		492	50	5

Method of Data Collection

Direct interview method was used to collect data from the respondents. Before interviewing, brief introduction of the aims and objectives of the study were explained to respondents with the help of the local leaders and clarify to them that it had no adverse effect on them and then they provided their full co-operation. Researchers established rapport with respondents so that they did not feel any hesitation. Whenever any respondent felt any difficulty in understanding question, the researcher took utmost care to explain and clarify them properly. Then schedule was checked and verified to be sure that the answers were correct. Secondary data and other related information were collected from different sources like DAE, Fisheries department, Forest department, various literature and study report etc.

Measurement of Variables

Age

Respondents were classified as young (below 35 years), middle (35-50 years) and old (above 50 years) aged as suggested by Haider (2010).

Education

Education levels were divided into four categories such as illiterate (no schooling), primary level (1-5 years schooling), secondary level (6-10 years schooling) and above secondary (>10 years schooling).

Farm size

Farm sizes of respondents were measured by following formula.

Total farm size (ha) = a+b+1/2(c+d) +e ()

Where, a= Land under homestead area; b= Own land under own cultivation; c= Land given to other on contact (borga); d= Land taken from others on contact (borga); e= Land taken from others on lease

The respondents were classified into five categories based on their total farm size based on the national standard viz. landless (<0.02 ha of land), marginal (0.02-0.19 ha of land), small (0.2-1.0 ha of land), medium (1.01-3.03 ha of land) and large (>3.03 ha of land).

Family size

A score of 1 was assigned to each member of the family. Respondents were classified into three categories, like small family (below 5 members), medium family (5-8 members) and large family (above 8 members).

Occupation

Every respondent were asked about their daily activities in which they were involved for maintaining their livelihood.

Estimation of income

Incomes of each respondent from haor activities (fishing, farming, farm labor, livestock rearing, driving boat etc.), non-haor activities (service, business etc.) and other cash income (social benefits scheme, relief and interest) were recorded in taka for estimating total monthly income. According to Begum (2010) the respondents' incomes were classified into four categories such as extreme poor, poor, medium and rich.

Land use change over time

Respondents opinions were classified into two i.e. 10-12 years back and current year to measure land use change over time.

Change of rice varieties

For measurement of the changes of rice varieties over time, rice varieties were categories into high yielding rice (HYV) and local rice (LR).

Change of cultivation practices:

Cultivation practices over time were measured by comparing the respondent's opinions on cultivation practices.

Change of relative prevalence of homestead tree species

For measurement of relative prevalence of homestead tree species i.e. forest /wood species and fruit species respondent's opinions were calculated by following formula.

Relative prevalence = Population of species/homestead x % of homesteads with species

Change of swamp forest

For determining the changes of swamp forest area and species richness over time in the study area Shannon-Wiener Index formula was used.

$$H' = -\sum_{I=1}^{s} (pi)(\ln pi)$$

Where, H'= Shannon-Wiener Index; s = Species; pi = proportion of individuals of species ***i*** in community (= **ni**/**N**; where **n** is the number of individuals of a given species & **N** is the total number of individuals in a sample)

Change of fish species

Types of fish species change were measured by categories it into very common, common, fairly common, few, very few, occasional and very rare.

Change of fish availability

Regarding the availability of fish species over time was categorized into three viz. abundant, less abundant and endangered.

Changing scenario of bird species

Respondents opinion was gathered for number of bird species surrounding 5 beels out of 120 beels. Secondary information on this aspect was collected from relevant sources.

Impact of and use change on ecosystem services

Ecosystem services were categorized into food, fuel wood, fish, fiber, bird, drinking water, irrigation water, siltation/sedimentation and rising up of land, natural hazards and regulation and availability of house making input. Impact of land use change on ecosystem services were determined by respondent's opinions (present and 10-12 years back).

Hydrological status in the haor area

Some criteria such as sources of irrigation water, quality of haor water, quality of drinking water, depth of water level, duration of inundation period, flooding and condition of haor were selected. Every respondent opinions were categorized into two i.e. 10-12 years back and at present for determining the changes and its impact in each cases.

Problems and proposed suggestions

The problems mentioned by the respondents were ranked as per weightage of the problems. Suggestions of the respondents were recorded to solve their problems and ranked these accordingly.

Statistical Analysis

The SPSS program was used to perform data analysis.

Results And Discussion

Socioeconomic and Demographic Profile of the Respondents

Age and farm size

Age of respondents ranged from 19 to 75 years (average 47.6 years and SD 1.5). Most of respondents (42%) were in the old aged group (Table 2). Average farm size was 0.4 ha and most of the respondents (50%) were small farmer while only 4% of the respondents were large farmer (Table 2).

Table 2. Distribution of the respondents according to their age and farm size

Age group	Respondents		Mean	SD	Farm size	Respondents		Mean	SD
	Number	%				Number	%		
Young (<35)	12	24			Landless (<0.02 ha)	4	8		
Middle (35-50)	17	34	47.6	1.6	Marginal (0.02 - 0.19 ha)	15	30		
Old (>50)	21	42			Small (0.20 - 0.99 ha)	25	50	0.4	0.5
Total	50	100			Medium (1.00 - 3.00 ha)	4	8		
					Large (>3.00 ha)	2	4		
					Total	50	100		

Level of education, family size and occupation

About 42% of the respondents had primary level education whereas 36% were in illiterate group (Table 3). The reported literacy rate was found higher than the national adult literacy level of 65% (BBS, 2002). More than half (54%) of the respondents had medium sized family as compared to 22% had small and 24% had large family size (Table 3). This may be due to the fact that they are conservative and still hold conventional attitude towards family planning. Majority of the respondents (74%) depended on fishing while few respondents' handicrafts (2%) depended (Table 3). Similarly, 70% of the household depend on fishing for their livelihood in Tanguar haor area (IUCN, 2011).

Table 3. Distribution of the respondents according to their educational level, family size and occupation

Educational level		Family size		Occupation			
Types	Respondents (%)	Types	Respondents (%)	Types	Respondents (%)	Types	Respondents (%)
Illiterate (No schooling)	36	Small (<5)	22	Fishing	38.9	Grocer	4.2
Primary	42	Medium (5-8)	54	Farming	33.7	Livestock rearing	3.2
Secondary	18	Large (>8)	24	Business	8.4	Service	3.2
Above Secondary	4			Boatman	5.3	Day labor	2.1
						Handicrafts	1.1

Monthly income

In current year majority of the respondents were in poor group (40%) whereas 12% rich and 10% extreme poor. According to income level, medium and rich people were increased 46.2% and 50.0% respectively, while poor and extreme poor people decreased 16.7% and 44. 4% respectively, compared to 10-12 years ago (Table 4).

Table 4. Changing scenario of monthly income of the respondents

Income group	Income level (BDT tk)	Respondents (%)		Change (%)
		10-12 years back	Present (2012)	
Extreme poor	<1999	18	10	-44.4
Poor	2000 - 4999	48	40	-16.7
Medium	5000 - 7999	26	38	+46.2
Rich	>8000	8	12	+50.0

Land use changes of Tanguar Haor over Time

Change of land use patterns over time

Maximum permanent fresh water lakes and rivers were 48.0% and 36.0% of the total area in 10-12 years ago and currently respectively, while minimum in fallow land 6.0% and 4.0%, respectively (Table 5). The most notable increase of

land use pattern was in settlement (66.7%) while most decrease in seasonal/intermittent freshwater marshes (45.5%) from 10-12 years ago to present (Table 5).

Table 5. Major land use pattern in the study area over time

Land use pattern	Land use pattern over time (%)		Change (%)
	10-12 years back	Present (2012)	
Settlement	6.0	10.0	+66.7
Cropland (seasonally flooded in wet season and rice/crops in dry season)	20.0	32.0	+60.0
Swamp forest	9.0	12.0	+33.3
Permanent fresh water lakes/rivers	48.0	36.0	-25.0
Fallow land	6.0	4.0	-33.3
Seasonal/intermittent freshwater marshes	11.0	6.0	-45.5

Change of rice varieties over time

Adoption of BRRI dhan28 (97.7%) and BRRI dhan29 (91.8%) were almost double while adoption of Hira Dhan (24.4%) was decreased for high yielding varieties (Table 6). Cultivation of local varieties was decreased except two varieties (Shail and Gochi varieties). Highest reduction was found in Basful (68.3%) and least in Baygun Bachi (28.4%) for local rice varieties (Table 6).

Table 6. Change of high yielding and local rice varieties in the study area over time (10-12 years back and currently).

Respondents opinion to increase (+) and decrease (-)					
HYV	%	Local varieties	%	Local varieties	%
BRRI Dhan28	97.7	Shail	5.3	Rata	-50
BRRI Dhan29	91.8	Gochi	4.3	Agam	-51.8
BRRI Dhan45	92.4	Baygum bachi	-28.4	Lakai	-54.4
BR19	15.2	Tepi	-31.8	Basful	-68.3
Hira Dhan	-24.4	Agni	-34.6		

Change of cultivation practices over time

Rice cropping and weeding pattern was remaining unchanged over time. At present, 70% of the respondents opined that duration of planting time of rice was shifted to mid December–mid January in that time Boro season rice was supposed to complete the life cycle before flash flood. 80% respondents opined that duration of harvesting time of rice was shifted to mid April- mid May to avoid the risk of flash flood (during April-May). Use of power tiller for ploughing was increased (650%) at present, whereas in 10-12 years ago, animal power was the main source of ploughing. At present, use of machine for harvesting rice (800%) and threshing (775%) was increased compared to 10-12 years ago for saving harvesting and threshing time (Table 7).

Table 7. Change of cultivation practices in the study area over time

Cultivation practices of rice	Pattern/ Time/ Equipment	Respondent's opinion (%)		Change (%)
		10-12 years back	Present (2012)	
Rice cropping pattern	Fallow-Fallow-Boro	100	100	0.0
	Mid Dec.-mid Jan.	50	70	+40.0
Planting time of rice	January	42	30	-25.0
	January- February	8	0	-100.0
Harvesting time of rice	Mid April- mid May	72	80	+11.1
	April	28	20	-28.6
Ploughing	Not ploughing	6	0	-100.0
	By animal power	86	40	-53.5
	By power tiller	8	60	+650.0
Weeding	Manually by hand	100	100	0.0
	By machine	0	0	0.0
Harvesting	Manually by sickle	98	82	-16.3
	By machine	2	18	+800.0
Threshing	Manually	50	14	-72.0
	By animal power	42	16	-61.9
	By thresher	8	70	+775.0

Resource availability in the study area

Relative prevalence of homestead tree species over time

Among the forest/wood species in the homestead area, Relative Prevalence (RP) of few species was increased such as Koroch (80.7%), Hijal (42.9%) and Acacia (20.0%) while it was decreased for most of the species. Among those species the highest reduction was noted in Neem (95.2%) and lowest reduction in Khair (12.5%). Among fruit species, highest decreased species was Bilimbi (95.7%) and lowest in Custard apple (16.67%) (Table 8).

Table 8. Changing scenario on the relative prevalence of homestead tree species

Name of tree species	Scientific name	Relative prevalence of tree species		
		10-12 years back	Present (2012)	Change (%)
Forest/wood species				
Koroch	Pongamia pinnata	5.27	9.52	+80.65
Hijal	Barringtonia acutangula	4.36	6.23	+42.89
Acacia	Acacia auriculiformis	0.5	0.6	+20.00
Khair	Acacia catechu	0.32	0.28	-12.50
Raintree	Samanea saman	1.98	1.44	-27.27
Koroi	Albizia sp	0.95	0.44	-53.68
Shimul	Bombax ceiba	0.78	0.28	-64.10
Mehogony	Swietenia macrophylla	1.29	0.36	-72.09
Neem	Azadirachta indica	0.83	0.04	-95.18
Fruit species				
Custard apple	Annona squamosa	0.36	0.3	-16.67
Black berry	Syzygium cumini	0.87	0.72	-17.24
Guava	Psidium guajava	1.01	0.72	-28.71
Mango	Mangifera indica	3.56	2.28	-35.96
Lemon	Citrus limon	0.58	0.36	-37.93
Jackfruit	Artocarpus heterophyllus	1.46	0.76	-47.95
Betel nut	Areca catechu	1.28	0.48	-62.50
Jujube	Zizyphus jujube	1.11	0.24	-78.38
Coconut	Cocos nucifera	1.02	0.16	-84.31
Olive	Olea europa	1.45	0.16	-88.97
Sofeda	Manilkara achras	0.46	0.04	-91.30
Bilimbi	Averrhoa bilimbi	0.92	0.04	-95.65

Reasons for change of homestead tree species over time

Majority of the respondents opined that tolerate ability in flooding situation (40%) and good income to the household (32%) were the major causes for increased homestead tree species while were reduced homestead area by landslide (24%) was the major reasons for decreased (Table 9).

Table 9. Reasons for change of homestead tree species during last 10-12 years

Tree species changes	Reasons for change	Respondent's opinion (%)
Increase	Tolerate ability in flooding situation	40
	Good income to the household	32
	Consciousness about plantation	18
	Government subsidy	10
Decrease	Reduced homestead area by landslide	24
	Increase family member	20
	Used as house making input	18
	Used as fuel	16
	Natural hazard and anthropogenic activities	14
	Climatic change	8

Change of swamp forest over time

According to area, the highly increased swamp forest with increased species richness was Ulush nagar kanda (71.9%) with 18.8% species richness. On the other hand, according to area, the decreased swamp forest with decreased species richness was Bagmara kanda (27.3%) with 8.0% species richness (Table 10).

Table 10. Change of swamp forest both area and species in the study area over time

Location in swamp forest	Area (ha)			Species richness		
	10-12 years back	Present (2012)	Change (%)	10-12 years back	Present (2012)	Change (%)
Ulush nagar kanda	5.6	9.9	+71.9	2.1	2.5	+18.8
Osakanda	7.6	11.5	+51.1	2.8	5.0	+78.6
Kaillatur	6.6	9.9	+50.0	1.9	2.9	+55.9
Nainder haor	7.8	11.1	+43.5	1.2	2.0	+71.4
Patichula	8.2	10.9	+32.3	3.2	3.9	+20.
Poilla beel	13.4	17.2	+28.3	3.0	3.5	+16.
Razdaigang	11.4	14.4	+26.7	1.8	3.0	+71.4
Bagmara kanda	8.2	6.5	-27.3	3.1	2.9	-8.0
Rajar dai	6.3	4.9	-29.2	2.7	1.9	-28.5
Binna bon	8.2	6.3	-30.0	5.0	4.8	-3.4
Puran gaon	13.2	9.8	-34.5	3.0	2.0	-33.3
Alamdaor	12.4	8.8	-41.0	4.7	1.2	-74.3
Kailary kanda	8.3	5.2	-61.7	2.0	1.3	-37.5
Mean	9.0	9.7	+7.7	2.8	2.8	+1.4

Reasons for change of swamp forest over time

Majority of the respondents opined that involvement of different NGOs such as CVRMP (Central Valley Riparian Mapping Project) for planting of swamp forest species (34%) was the major regions for increased swamp forest both area and species. While, the reasons for decreased swamp forest both area and species were used as fuel (46%) (Table 11).

Table 11. Reasons for change of swamp forest during last 10-12 years

Changes of swamp forest	Reasons for change	Respondent's opinion (%)
Increase	Involvement of different NGOs (CVRMP) for planting of swamp forest species	34
	Availability of water logged tolerable species	32
	Government subsidy in swamp forest development	22
	Consciousness about plantation	12
Decrease	Used as fuel	46
	Deforestation or cutting	30
	Occurrence of flash flood	24

Fish availability in the study area over time

According to respondent's opinion, the highly abundant fish species were Boro Icha (100%), Kaikka (100%), Shorputi (100%), Tengra (100%) in 10-12 years ago but Boro Icha (98%) in 2012. Highly less abundant fish species were Gulsha (53%) before 10-12 years ago but Ayer (94%) in 2012. Highly endangered fish species were Baghai (38%) before 10-12 years ago but Shilon (100%) in 2012 (Table 12).

Table 12. Respondent's opinion on fish (major species) availability during last 10-12 years

Fish species	Scientific Name	Respondent's opinion on fish availability (%)					
		Abundant		Less abundant		Endangered	
		10-12 years back	Present (2012)	10-12 years back	Present (2012)	10-12 years back	Present (2012)
Ayer	Sperata aor	60	2	40	94	0	4
Baghai	Bagarius bagarius	11	0	51	16	38	84
Baim	Mastacembelus armatus	54	26	46	74	0	0
Bata	Labeo bata	34	0	50	28	16	72
Bele	Apocryptes bato	77	52	23	46	0	2
Boro boal	Wallago attu	50	18	47	82	3	0
Boro Icha	Penaeus monodon	100	98	0	2	0	0
Boro Rui	Labeo rohita	69	34	30	66	1	0
Chanda	Chanda nama	54	22	44	76	2	2
Chitol	Chitala chitala	60	12	34	74	6	14
Darkina	Rasbora rasbora	57	0	33	8	10	92
Elong	Megarasbora elanga	32	0	41	50	27	50
Filon	Notopterus notopterus	40	0	50	64	10	36
Ghoina	Labeo boggut	80	58	20	38	0	4
Gojar	Channa marulius	90	76	10	24	0	0
Gulsha	Colisa fasciata	31	28	53	62	16	10
Kaikka	Xenentodon cancila	100	96	0	4	0	0
Kajoli	Ailia coila	32	0	37	18	31	82
Kali Baush	Labeo calbasu	51	24	40	74	9	2
Katla	Catla catla	71	0	20	8	9	92
Koi	Anabas testudineus	78	16	22	82	0	2
Magur	Clarias gariepinus	98	68	2	30	0	2
Meni	Labeo ariza	57	46	38	48	5	6
Moha shol	Tor Tor	60	0	22	14	18	86
Mrigel	Cirrhinus cirrhosus	51	16	38	84	11	0
Pabda	Ompok bimaculatus	48	0	39	56	13	44
Pangash	Pangasius pangasius	33	0	40	4	27	96
Puti	Puntius ticto	70	50	30	50	0	0
Rani	Botia dario	22	0	50	4	28	96
Shilon	Silonia silondia	23	0	46	0	31	100
Shing	Amblyceps mangois	89	50	11	50	0	0
Shol	Channa striata	70	96	21	4	9	0
Shorputi	Puntius sarana	100	94	0	6	0	0
Tengra	Batasio tengana	100	94	0	6	0	0

Change of fish species over time

Very common, common and fairly common fish species were decreased to 42.9, 20.0 and 11.5% respectively while few, very few, occasional and very rare fish species were increased to 46.7, 21.0, 125.0 and 200.0% respectively from 10-12 years ago to still now (Table 13).

Table 13. Change of type of fish species over time in 10-12 years back and currently on the basis of respondents opinion

Species availability	Decreased (%)	Species availability	Increased (%)
Very common	-42.9	Few	46.7
Common	-20.0	Very few	21.0
Fairly common	-11.5	Occasional	125.0
		Very rare	200.0

Reasons for change of fish species over time

Many reasons have been identified behind decreased number of fish species during last 10-12 years while over fishing by local people (36%) was the major (Table 14).

Table 14. Reasons for change of fish species in the study area during last 10-12 years

Changes of fish species	Reasons for change	Respondent's opinion (%)
Decrease	Over fishing by local people	36
	Poor implementation of rules and regulations of fishing	27
	Destruction of several natural reservoirs	23
	Excessive use of pesticides and fertilizers	14

Change of bird species over time

Highest decreased (75%) bird species were Common sandpiper, Great cormorant, Grey headed lapwing and Pied kingfisher while less (9.68%) in Indian pond heron (Table 15).

Table 15. Changing scenario of different bird species in the study area over time (In surrounding 5 beels out of 120 beels)

Name of birds	Change of bird species over time		
	10-12 years back (Number)	Present (2012) (Number)	Change (%)
Indian pond heron	31	28	-9.68
Green sandpiper	15	12	-20.00
Gadwall	1905	1500	-21.26
Intermediate egret	7	5	-28.57
Eurasian wigeon	305	210	-31.15
Common kingfisher	3	2	-33.33
Purple swamphen	810	530	-34.57
Cotton pygmy-goose	52	34	-34.62
Brown-headed gull	15	9	-40.00
Gergeny	220	125	-43.18
Black drongo	11	6	-45.45
Little cormorant	225	120	-46.67
Common moorehen	100	53	-47.00
Purple heron	2	1	-50.00
Pheasant tail jacana	300	140	-53.33
Northern pintail	20	9	-55.00
Eurasian coot	930	411	-55.81
Brahminy kite	5	2	-60.00
Grey heron	5	2	-60.00
Little grebe	10	4	-60.00
Striated grassbird	5	2	-60.00
Spotted redsank	18	7	-61.11
Little egret	8	3	-62.50
Tufted duck	320	111	-65.31
Great creasted grebe	7	2	-71.43
Red crested pochard	7	2	-71.43
Common sandpiper	4	1	-75.00
Great cormorant	4	1	-75.00
Grey headed lapwing	40	10	-75.00
Pied kingfisher	8	2	-75.00

Reasons for change of bird species over time

Major reason for decreased bird species was illegal poaching (33%) followed by deforestation (25%), frequent natural hazard and anthropogenic activities (23%) and climate change (19%) (Table 16).

Table 16. Reasons for change of bird species in the study area during last 10-12 years

Changes of bird species	Reasons for change	Respondent's opinion (%)
Decrease	Illegal poaching	33
	Deforestation	25
	Frequent or natural hazard and anthropogenic activities	23
	Climate change	19

Impact of land use change on ecosystem services

Due to impact of land use change anthropogenic activities like food (20.0%), fiber (26.0%), fuel wood (40.0%), drinking water (50.0%), natural hazards and regulation (50%), fish (56%), bird (64%) and availability of house making input (85.0%) were decreased and siltation/sedimentation and rising up of land was increased (30.7%) while irrigation water remained same compared to 10-12 years ago (Table 17).

Table 17. Change of ecosystem services in the study area over time

Ecosystem services	Ecosystem services from haor (%)		
	10-12 years back	Present (2012)	Change (%)
Siltation/sedimentation and rising up of land	62	81	+30.7
Irrigation water	100	100	0.0
Food	100	80	-20.0
Fiber	45	33	-26.7
Fuel wood	100	60	-40.0
Drinking water	50	25	-50.0
Natural hazards and regulation	40	20	-50.0
Fish	80	35	-56.3
Bird	70	25	-64.3
Availability of house making input	100	15	-85.0

Change of hydrological status of Tanguar haor over time

Haor water has been polluting and majority of the respondents (78%) reported that illegal transportation of coal, misuse or cocktail use of pesticides, overdose and frequent use of fertilizers and throwing domestic wastes were the reasons for increased pollution (550%) of the study area (Table 18). Majority of the respondents (72%) were satisfied to drinking water about 10-12 years ago but presently the satisfaction level was decreased (135.7%) which was supported by more than half (66%) of the respondent (Table 18). About 10-12 years ago, 20% respondents opined that depth of haor water remained above 6 meters while this statement was currently supported by only 4% respondents. Currently, 18% respondents opined that water level has been going to below 5 meters. The reasons for decreased water level in the study area were scarcity of rainfall due to climate change, obstruction of water flow by creation of embankment in several rivers of India and by establishment of unplanned sluice-gate in different areas of haor (Table 18). About 10-12 years ago, 32% respondents reported that haor area was inundated at duration of 8 months while this statement was currently supported by 14% respondents. At present, 50 and 12% respondents opined that haor area were inundated at the duration of 7 months and 6.5 months respectively, while before 10-12 years ago this statement was supported by 26% and 8% respondents, respectively. The reasons for decreased inundation period were scarcity of water entrance in the haor area from Meghalaya hills range and from different rivers of India (Table 18). Before 10-12 years ago to still now, almost all of the respondents reported that flash flood was the major natural disaster. Flash flood increased 2.1% and it is caused by heavy or excessive rainfall in a short period of time, adjacent to the region in Assam and Meghalaya hills range in India causing immense damage to the standing Boro crops, lives and properties every year (Table 18).

Table 18. Changing scenario of hydrological status in the haor area over time

Hydrological status	Changes	Respondent's opinion (%)		
		10-12 years back	Present (2012)	Change (%)
Sources of irrigation water	Haor	100	100	0.00
	Irrigation scheme	0	0	0.00
Quality of haor water	Polluted	12	78	+550.0
	Non polluted	88	22	-75.0
Quality of drinking water	Satisfied	72	34	-52.8
	Not satisfied	28	66	+135.7
Depth of water level	Below 5 meters	6	18	+200.0
	5 – 6 meters	74	78	+5.4
	Above 6 meters	20	4	-80.0
Duration of inundation period	April–November (8 months)	32	14	-56.3
	May –Mid December (7.5 months)	34	24	-29.4
	May– November (7 months)	26	50	+92.3
	Mid May–November (6.5 months)	8	12	+50.0
Flooding	Early flooded	4	2	-50.0
	Late flooded	2	2	0.0
	Flash flooded	94	96	+2.1

Condition of Tanguar haor over time

Now-a-days siltation and rising-up of river bed was increased in study area. Now 70% and 30% respondents opined that Tanguar haor became silted and some haors already became dead respectively, while before 10-12 years this statement was supported by 62 and 16% respectively. This was due to the landslides from hill and river bed movement (Table 19).

Table 19. Changing scenario of Tanguar haor area over time

Condition of haor	10-12 years back	Present (2012)
Silted	62	70
Dead	16	30

Major Problems and Proposed Suggestions Prevailed in Locality/Community

Problems

The problems mentioned by the respondents were ranked as per weightage. Damage of road communication due to flash flood (90%) was the major problem while sudden extreme climatic event like drought, storm, excess rainfall, water logging etc. (8%) was the minor (Table 20).

Table 20. Major problems faced by the respondents to maintain their livelihood

Problems	Respondent's opinion	
	Percent	Rank
Damage of road communication due to flash flood	90	1
Damage of house and crops due to flash flood	86	2
Outbreak of different types of diseases such as diarrhoea, cholera, fever etc. during flood and after recession of flood water	76	3
Loss of crop production due to hail storm and cyclones	70	4
Unavailability of drinking water during flood and drought	66	5
Death of human and animals due to flood	60	6
Damage of rice and winter crops due to high pest infestation during Mid January to Mid April	58	7
Embargo in fishing by government agencies	46	8
Lack of sanitary/ latrine facilities due to pollution of haor water	40	9
Lack of technical knowledge for crop production	28	10
Decrease of homestead area	18	11
Lack of capital	16	12
High management cost	12	13
Sudden extreme climatic event like drought, storm, excess rainfall, water logging etc.	8	14

Suggestions

Majority of respondents (88%) suggested to establish multipurpose shelters (e.g., flood/disaster shelter, school, community clinic, market, etc.) and new accommodation for community people, security personnel, tourists etc. that might be useful to cope with damage of crops, house and road communication (Table 21).

Table 21. Proposed suggestions to overcome the problems as suggested by the respondents for their better livelihood

Suggestions	Respondent's opinion	
	Percent	Rank
Multipurpose shelters establishment (like flood/disaster shelter, school, community clinic, market, etc.) and new accommodation for community people, security personnel, tourists etc. during disaster.	88	1
Infrastructure development (such as building roads and sub-mergible pucca/concrete embankments, protection walls, dredging, etc.)	80	2
Availability of early rice variety and training on production techniques such as IPM (Integrated Pest management)	78	3
Dredging of adjacent rivers for easy water flow	64	4
Ecosystem friendly tree plantation (such as Hijal and Karoch, reeds)	56	5
Awareness creation for conservation of fish, birds, swamp forest etc.	50	6
Protection of water from pollution	46	7
Building mounds (killa) for livestock shelter during disasters	34	8
Alternate income generating opportunities such as 'Ecotourism facilities/ service provides (guiding to tourist)	30	9
Easy availability of doctor and medicine for health care	26	10

Conclusion

Land use change has been highlighted as a key human-induced affect on ecosystem services. The most notable changes of land use pattern that greatly influence on the ecosystem of the study area and livelihoods. Therefore, appropriate steps should be taken by the concerned authorities in order to face the challenges of wetland ecosystem of Tanguar haor areas in Bangladesh.

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