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Effect of predictive factors on sustainable development and management of fresh water wetland fisheries*

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ABSTRACT

Wetlands of India are basically low-lying areas and are one of the most important and potential inland natural fish habitats of the country and provide livelihood to millions of poor fishers living around them. In India, they account for a total area of 3.54 lakh ha covering states of Uttar Pradesh, Bihar, West Bengal, Asom and other North-East states. The present annual fish yield from these wetlands is 350 kg/ha on the average against estimated production potential of 1500kg/ha/year.

Among the Indian states, Asom is endowed with myriads of wetlands ranging from 35 to 3458.12 ha in water spread area. The average existing fish production from wetlands of Asom 173 kg/ha/year against its production potential of 1,000–1,500 kg/ ha/year and several factors, viz. habitat alteration, over exploitation, lack of scientific management, encroachment, etc., are responsible for poor productivity of the wetlands. Hence, a study was conducted in 4 selected floodplain wetlands of the state namely Talu Malu (22.0 ha), Amuguri Basapathar (50.0 ha), Kutuha Bar (16.0 ha) and Bhitorkuri (20.0 ha) floodplain wetlands to see the critical factors associated with sustainable development and management of wetlands. The study revealed that four predictive variables namely management capabilities of wetland development committee (X_{15}), availability of aquaculture inputs (X_{17}), age (X_1), community-based fisheries organization (X_{14}) have significant positive contribution towards sustainable development and management of wetland fisheries (Y) and each of them contributed at 1% ($P<0.01$) level of significance ('t' values as 6.57**, 3.09**, 4.22** and 2.79** with 'SD' value of ± 4.550,1.580,12.595 and 0.992 respectively.

Key words: Community-based fisheries management, Floodplain wetlands, Participatory rural appraisal

Wetlands of India are basically low-lying 'wet lands' whose depth generally does not exceed 6 m. They are generally situated in the basins of major rivers, notably, the Ganga, the Brahmaputra, the Barak, the Mahanadi, the Godavari, and so on (Kar 2007). They are one of the most important and potential inland natural fish habitats of the country and provide livelihood to millions of poor fishers living around them. In India, they account for a total area of 3.54 lakh ha covering the states of Uttar Pradesh, Bihar, West Bengal, Asom and other North East states, and so on. Floodplain wetlands are locally called by different names, such as *wetlands*, *Charhas*, *Baor,Haors* and *Anua*s (in Eastern India); *Mauns, Chaur*s and *Dhars* (in Bihar); *Pats* (in Manipur); *Boar, Jheel* (in West Bengal); *Tals* (in Uttar Pradesh and Madhya Pradesh); *Sar* and *Dal (*in Jammu & Kashmir), etc. (Srivastava and Bhattacharjya 2003, Kar 2007). The present annual fish yield from these wetlands is *c* 350 kg/ha on the average against estimated production potential of 1,500kg/ha/year (Suresh and Chitranshi 2011).

Among the Indian states, Asom is endowed with myriads of wetlands covering more than 1 lakh ha and ranging from 35 to 3458.12 ha in water spread area. The province of Asom is located (25°29'7.27 to 27°23'37.43''N and $90^0$1'50.21" to 96°21'28.44"E) covering an area of 78,434 sq.km. Asom has 27 districts which are enriched with both biotic and abiotic resources representing numerous wetlands and intricate networking of rivers forming the Brahmaputra-Barak-Meghna drainage system. The prolific fish diversity sustains a rich diversity of fisher folk in this region represented by professional, occasional and part-time fishermen (Kar 2007).

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Floodplain wetlands of Asom constitute more than 70% of the total lentic water of the state. Asom wetlands are of three kinds (Kar 2007) and are locally named as (a) 'Beel': Perennial wetlands, (b) 'Haor': Seasonal floodplain wetlands, (c) 'Anua': River-formed oxbow wetlands. There are also other local names, like 'Jala', 'Haloni', etc.

The average existing fish production from wetlands of Asom (173 kg/ha/year) against its production potential of 1,000–1,500 kg/ha/year (Shrivastava and Bhattacharjya 2003, NIAM 2010) is due to several factors, viz. habitat alteration, over exploitation, lack of scientific management, encroachment, etc. Hence, it is the need of hour to adopt participatory bottom up approaches for its sustainable development and management of these resources.

Baruah *et al*. (2000), Barman *et al.* (2006), Barman (2011), World Bank source (2011) indicated that for sustainable development and management of Asom unique floodplain wetlands, community-based fisheries management may be the viable alternative. Accordingly, the study was conducted in 4 floodplain wetlands in Asom to see— (a) the relationship of different predictor variables (X_1 to X_{21}) with dependent variable i.e. sustainable development and management of wetland fisheries (Y), and (b) the most contributing predictor variables that can affect the dependent variable i.e. sustainable development and management of wetland fisheries (Y).

MATERIALS AND METHODS

The study was conducted in Talu Malu wetland (22.0 ha) in Dhubri district; Amuguri Basapathar wetland (49.80 ha) in Golaghat district; Kutuha Bar wetland (16.0 ha) in Dibrugarh district and Bhitorkuri wetland (20.0 ha) (*chotto wetlands*) within Sone Beel wetland (3458.12–409.37 ha) of Karimganj district of Asom. The first 3 wetlands were developed under World Bank financed Asom Agricultural Competitiveness Projects (AACP) through Community-based Fisheries Management (CBFM) approach forming Wetland Development Committee (WDC) under the project. A WDC is a group of 20–500 individuals living in the adjacent villages of a floodplain wetland, coming together for effective utilization of the natural fisheries resources, getting better price for the produce and more market power for enhancement of livelihood in a sustainable manner by the landless, poorer segments like small and marginal wetland users. The fourth wetland, i.e. Bithorkuri wetland was taken as control wetland to get some comparable views with respect to sustainable development and management of wetland fisheries.

Kutuha Bar wetland is situated at 15 km west of Dibrugarh town ($27^0 24' 24.93''$N and $94^0 52' 53.72''$E, elevation 350 ft MSL) while Amuguri Basa Pathr wetland is located at 25 km south from Golaghat town ($26^0 18' 02.76''$N and $93^0 52'$ 16.60"E, elevation 365 ft MSL). Talumalu wetland is situated around 25 km north of Dhubri town ($26^0 19'$ 53.17''N and 90^0 08′35.45"E,elevation129 ft. MSL) and Bhitorkuri under Sone Wetlands is located at 30 km south from Karimganj town ($92^0 24' 50$–$92^0 28' 50''$E and $24^0 36' 40''$- $24^0 44' 30''$N).

A total of 200 households represented by both male and female were randomly selected by using the technique of simple random sampling without replacement technique. Data were collected during 2007–08 to 2009–10 with the help of personal interview through structured interview schedule. Data were also collected from the offices of the concerned district Nodal NGOs, District Fisheries Development Officers, Directorate of Fisheries, Asom and Asom Rural Infrastructural and Agricultural Service Society (ARIASS), Asom. The variables were operationalized either as per the procedures followed by earlier researchers or by developing schedules for the said variables. 'Sustainable development and management of wetland fisheries' (Y) was taken as dependent variable.

Wetland cannot be sustainably developed and managed without community giving a sense of ownership and their participation in the development process for empowerment. It is important so that community can take an active role in development planning and execution as well as in the joint management of wetland resources and can take positive steps towards the interest of the community including gender issues in a participatory manner (Friend 2007, Ramsar Convention Secretariat 2010, Suresh and Chitranshi 2011). Barman *et al.*(2006) further indicated that sustainable development and management of wetland fisheries is not a concept only but also a process of enhancing and ensuring fish production in a systematic way without destroying the existing fish production potentials, so that, the level of production could be continued and enjoyed by the wetlands users at the same rate years after year.

Here 'Sustainable development and management of wetland fisheries' (Y) refers to the activities and achievement related to the areas of (a) conduct of regular community meeting, (b) compliance and adherence to community enforce rules pertaining to maintenance fishing holidays, gear restriction (c) maintenance of community's profit sharing plan including banking transaction, (d) adoption and replication of the package of practices and (e) transparency/ accountability maintained by the Wetland Development Committee pertaining to the project management activities for sustainable wetland fisheries. This variable was analyzed by taking responses from the respondents on schedule. Respondents were awarded with the score of '**1**' and '**0**' based on their response of '**yes**' and '**no**'. The variable was quantified after adding the total scores (in a scale of 1–15) and categorized as (a) high sustainability (12–15 out of 15); (b) medium sustainability (9–11 out of 15) and (c) low sustainability (< 9 out of 15).

From the collected data, descriptive statistics, correlation matrix were prepared and correlation coefficient, regression analysis, path analysis were used to analyze data using

software Statistical Package for Social Sciences (SPSS.Ver.7.50) to enable authentic conclusion.

RESULTS AND DISCUSSION

Detailed descriptive statistics indicating maximum, minimum, mean and standard deviation of variables taken up under the study are given in Table 1. The study revealed that annual income of the wetland users varied from Rs 6,300.00 to Rs 120,000.00 with the mean income of ± Rs 28,880 (SD=20565). Their occupation were varied from fish culture to service i.e. respondents were represented from all section of the people from the surrounding wetland area. Some of them were the members of more than one organization and were the office bearers of another organization which indicate high social participation of the *wetland* users. Their socio political empowerment were varied from low to high with the mean socio-political empowerment of ± 30.520 (SD=6.740).Their women empowerment were found to be high with mean value of ±5.100 (SD=1.010).Management capabilities of wetland development committee were varied from low to high with the mean value of ± 20.360 (SD= 4.550). The pre and post development income indicates that due to project intervention, the income of the *wetlands* users were not enhanced substantially. The scores pertaining to sustainable development and management of wetland fisheries (Y) were varied from low to high with mean score of ± 10.610 (SD=2.120).

Detailed relationship among 21 independent (predictor) variables (X_1-X_{21}) with the dependent (criterion) variables i.e. 'sustainable development and management of wetland Fisheries' (Y) is shown at Table 3. Thus, correlation analysis (Table 3) indicated that out of the 20 (twenty) predictor variables, 5 (five) variables namely wetland users participation in development program (X_{11}), women empowerment (X_{13}), community-based fisheries organization (X_{14}), management capabilities of wetland development committee (X_{15}), availability of critical aquaculture inputs (X_{18}) were significantly and positively correlated at 1% ($P < 0.01$) level of significance with 'sustainable development and management of wetland fisheries' (Y). On the contrary, family size (X_3), land holding (X_5),community-based physical assets (X_9), wetland users decision making ability (X_{12}), involvement of NGOs(X_{16}), pre and post development income (X_{19} and X_{20} respectively) were negatively correlated with sustainable development and management of wetland fisheries (Y) .The remaining 9 (nine) variables namely age (X_1), education (X_2), type of constructed house (X_4), occupation (X_6), annual income (X_7), social participation(X_8), socio political empowerment(X_{10}), community managed markets (X_{18}) and caste (X_{21}) were not correlated ($p > 0.05$) with 'sustainable development and management of wetland fisheries' (Y).

The study further revealed that out of 12 predictor

Table 1. Descriptive statistics of variables under the study

Sl	Sl no code	Predictor variables	Minimum	Maximum	Mean	SD
1	X_1	Age	18.000	84.000	43.080	12.595
2	X_2	Education	0.000	4.000	2.110	1.130
3	X_3	Family size	2.000	14.000	5.750	2.250
4	X_4	Type of constructed house	1.000	3.000	1.460	0.670
5	X_5	Land holding	0.070	5.600	0.886	0.817
6	X_6	Occupation	1.000	5.000	3.530	1.070
7	X_7	Annual income	6300	120000	28880	20565
8	X_8	Social participation	0.000	4.000	1.350	1.070
9	X_9	Community based physical assets	0.000	5.000	2.630	1.120
10	X_{10}	Socio political Empowerment	10.000	43.000	30.520	6.740
11	X_{11}	*Wetlands* users participation in development program	1.000	6.000	5.140	1.460
12	X_{12}	*Wetlands* users decision making ability	0.000	6.000	3.870	2.050
13	X_{13}	Women empowerment	2.000	6.000	5.100	1.010
14	X_{14}	Community-based fisheries organization	1.000	6.000	4.320	0.990
15	X_{15}	Management capabilities of WDC	7.000	37.000	20.360	4.550
16	X_{16}	Involvement of NGOs	3.000	7.000	4.640	0.630
17	X_{17}	Availability of critical aquaculture inputs	6.000	18.000	10.380	1.580
18	X_{18}	Community managed markets	7.000	26.000	19.810	3.370
19	X_{19}	Pre development income	7.000	110.000	23.320	19.760
20	X_{20}	Post development income	7.000	112.000	26.080	20.620
	Y	Sustainable development and management of Wetlands fisheries	6.000	17.000	10.610	2.120

The study further revealed that majority of the wetland users i.e. 76 (38%) obtained medium scores followed by 74 (37%) high scores and 50 (25%) low scores with regard to sustainable development and management of wetland fisheries (Table 2).

Table 2. Distribution of respondents according to sustainable development and management of wetland fisheries (Y) (N=200)

Category	Frequency	Percentage
Low sustainability level (< 9 out of 15)	50	25
Medium sustainability level (9–11 out of 15)	76	38
High sustainability level (12–15 out of 15)	74	37
Total	200	100

Table 3. Correlation of different independent (predictor) variables (X_1-X_{21}) with dependent (criterion) variable 'sustainable development and management of wetland fisheries' (Y)

Sl no.	Code	Predictor variables	'r' values of Y
1	X_1.	Age	0.11 NS
2	X_2.	Education	–0.09 NS
3	X_3.	Family size	–0.23**
4	X_4.	Type of constructed house	0.11 NS
5	X_5.	Land holding	–0.22**
6	X_6.	Occupation	0.13 NS
7	X_7.	Annual income	-O.09 NS
8	X_8.	Social participation	0.06 NS
9	X_9.	Community based physical assets	–0.45**
10	X_{10}.	Socio political empowerment	–0.13 NS
11	X_{11}.	*Wetlands* users participation in development program	0.26**
12	X_{12}.	*Wetlands* users decision making ability	–0.32**
13	X_{13}.	Women empowerment	0.18**
14	X_{14}.	Community-based fisheries organization	0.31**
15	X_{15}.	management capabilities of wetland development committee	0.54**
16	X_{16}	Involvement of NGOs	–0.19**
17	X_{17}	Availability of critical aquaculture inputs	0.18**
18	X_{18}	Community managed markets	0.00 NS
19	X_{19}	Pre development income	–0.20**
20	X_{20}	Post development income	–0.20**
21	X_{21}	Caste	–0.06 NS

NS, Nonsignificant; *, significant at 0.05 level of probability (P<0.05); **, significant at 0.01 level of probability (P<0.01).

variables (Table 4) which were found to be significant (either positively or negatively) with 5% (P<0.05) or 1% (P<0.01) level of probability on 'sustainable development and management of wetland fisheries (Y), only four (four) independent (predictor) variables namely management capabilities of wetland development committee (X_{15}), availability of aquaculture inputs (X_{17}), age (X_1), community-based fisheries organization (X_{14}) have significant positive contribution on 'sustainable development and management of wetland fisheries' (Y) and each of them contributed at 1% (P<0.1) level of significant (with their 't' values as 6.57**, 3.09**, 4.22** and 2.79** respectively). On the contrary, community based physical assets (X_9), family size (X_3), wetland users' decision making ability (X_{12}) and involvement of NGOs (X_{16}) reduce the scores of sustainable development and management of wetland fisheries (Y_2) significantly. Change R^2 due to step-wise multiple regression of sustainable development and management of wetland fisheries (Y) on 9 (nine) predictor variables is done where 'F' value to enter is 0.05 and to remove is 0.01. Thus, the adjusted R^2 indicated that the 9 independent variables included in the regression equation, now, can predict 50% of dependent variable i.e. sustainable development and management of wetland fisheries (Y). The required regression equation is given by $Y = \text{Constant} + 6.57\times X_{15} - 3.06 \times X_9 + 3.09 \times X_{17} - 3.01\times X_3 - 2.61\times X_{12} + 4.22\times X_1 + 2.79x\ X_{14} - 2.17x\ X16 - 2.09x\ X_{21}$ where, $R^2 = 0.52$, Adjusted $R^2 = 0.50$, Standard Error (estimated) = 1.50, Constant = 6.77

Best fitted regression co-efficients and 't' values of regression of sustainable development and management of wetland fisheries (Y) on 9 (nine) significantly contributed variables following stepwise method (Table 4).

Kutty (1997), Bhaumik (1997), Barman *et al.* (2012a) indicated that fisheries sustainability is just impossible unless and until people participate willingly in the development program since its early stages of planning and implementation of development program, rather than at the end. So, it is important to involve all groups of people including administrators, scientist, extension functionaries, fishers in the process of formulating and implementing management measure for the development process for sustainable wetland fisheries. Formation of community-based organization (CBO) with the involvement of community members for effective development and management of wetland resource through participatory way is crucial for its sustainability (Yadava 2003, Barman *et al.* 2012a). Similar findings were also reported by Dana *et al.*(2005), Barman *et al.* (2009) and stated that for sustainable development and management of wetland fisheries on long term basis, maximum emphasis should be given in building social and physical capital of wetland users along with strong women empowerment through different fisheries development activities such as net making, ornamental fisheries and other activities pertaining to fish seed rearing activities to ensure sustainable wetland fisheries .

Study also revealed that sustainability of resource is depend on availability and supply of critical aquaculture inputs in a timely manner for enhancing productivity of wetland fisheries. Aquaculture inputs like quality fish seeds, lime organic and inorganic fertilizers, prophylactic and other therapeutic drugs, fishing and harvesting equipments and post harvest facilities are to be in placed at the appropriate time

Table 4. Predic for variables

Sl	Sl no Code	Predictors variables	β-coefficient	"t " value
1	X_{15}	Management capabilities of wetland development committee	0.38	6.57**
2	X_9	Community based physical assets	–0.18	–3.06**
3	X_{17}	Availability of aquaculture inputs	0.16	3.09**
4	X_3	Family size	–0.16	–3.01**
5	X_{12}	Wetlands users decision making ability	–0.18	–2.61**
6	X_1	Age	0.23	4.22**
7	X_{14}	Community based fisheries organization	0.16	2.79**
8	X_{16}	Involvement of NGOs	–0.13	–2.17*
9	X_{21}	Caste	–0.11	–2.09*
Constant			6.77	4.84
R	R^2 value	Adjusted R^2	Standard error (estimated)	
0.72	0.52	0.50	1.50	

as these are the important prerequisite for sustainable wetland fisheries (Barman *et al.* 2008, 2012). Age (X_1) of the wetland users also plays a significant role when sustainability of the resource is concerned. Because, formation of community-based fisheries organization like WDC with the members of the wetland development committee have direct bearing in overall management of the wetlands(Barman, 2011). In our study, it was revealed that most of the wetland users i.e. 113 (56.5%) were from the middle age group (31–50 years) and hence they actively participated in the wetland development activities as they were very keen in sustainable development and management of the wetland resources. Thus our overall findings of study were similar with the findings of Kutty (1997), Bhaumik (1997), Dana *et al.* (2005), Barman *et al*. (2006, 2008, 2012a, 2012b.), Friend (2007), Ramsar Convention Secretariat (2010) and Suresh and Chitranshi (2011).

Study concluded that for sustainable development and management of wetland fisheries, four independent variables namely management capabilities of Wetland Development Committee (X_{15}), availability of aquaculture inputs (X_{17}), age (X_1), community-based fisheries organization (X_{14}) were found to be most significantly contributing variable that can predict 52 percent (R=0.66; R^2=0.43; SE=6.56) on dependent variable i.e. sustainable development and management of wetland fisheries (Y). Hence, necessary importance should be given to make the concerned Community based Organization i.e. wetland development committee more prompt and transparent along with uniform supply of aquaculture inputs in time with the active participation of the community members to ensure sustainable wetland fisheries in long term basis.

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