Electronic Supplementary Material of the paper

The costs of living with floods in the Jamuna floodplain in Bangladesh

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1. Method of collecting primary data and analyses

A cross-sectional method was used to gather these primary data. Cross-sectional research involves using different groups of people, both male and female (farmer, fisherman, day-labour, service holder etc.) who differ in the variables of interest but share other characteristics, such as socio-economic status and ethnicity. We aimed to collect approximately the same number of surveys in each of the three SHS. Due to the rural character of the area, most respondents were farmers. An age bias was introduced to collect historical information on flooding, riverbank erosion, livelihood etc. The household surveys were implemented with a combination of purposive sampling and quota sampling. In purposive sampling individuals are selected because they meet specific criteria (e.g., farmer, fisherman, day labour etc.); the quota sampling method selects a specific number of respondents with particular qualities (like farmer's age should be 40 or above). The Raosoft sample size calculator was used to determine the required sample size for the surveys by union (the lowest administrative unit of Bangladesh government). In this calculator the researcher enters values including acceptable margin of error, response distribution, confidence level and size of the population that is to be surveyed. We accepted a 5% margin of error with 95% confidence level to determine the sample size, which is 1% households (863 household surveys) of the study area. In addition, we performed 12 focus group discussions in the study area, four meetings in different unions in each SHS. About 20 participants were present in each of the meetings. Participants were selected based on occupation and location of the households, guaranteeing a uniform spread over the union area. The topics of the discussions were: how is flooding affecting livelihoods; what household coping strategies are used in relation to flooding, for example changing occupation or raising homesteads; migration patterns; community interventions against flooding; river bank erosion and household coping strategies; community interventions against riverbank erosion; governmental initiatives against flooding and riverbank erosion etc.

2. Secondary data

Because of paucity of secondary socio-economic data, we have used only for the years 2003 and 2010 in district level. We have collected detailed demographic data (up to village/Mauza level) from 1961 to the latest published census of 2011. The river water level data (1960-2015) was collected to correlate with the primary flooding data collected during household surveys. We only could collect Radarsat images for the years 1998 – 2004 and they were used to compere the flooded area with flood information of the households. All images were geo-rectified into "Bangladesh Transverse Mercator" (BTM) projection before analysing.

3. Questionnaires for household surveys

Date: Sl. No:
GPS location/ mark in map:

Section A: General household information

1. Name of respondent:
2. Age:
3. Father's / husband's name:
4. Address:
5. Contact number (if any):
6. Distance of house from river (approximately):
7. Main occupation (household main income source):
   7a. Farmer: [] Large (land > 7.50 acres) [] Medium (land 2.5-7.49 acres) [] Small (land 0.5-2.49 acres) [] Marginal (land 0.05-0.5 acres) [] Share cropper
   7b. Fisher: [] Fishing in the rivers [] Fish culture in ponds [] Both
   7c. Businessman: (type)-
   7d. Service holder: (Institute/organization)-
   7e. Daily wage labor: [] Agricultural-labor [] Other (specify)
   7f. Housewife
   7g. Other (specify):
8. Distance of agricultural land from river (approximately):
9. Basic information about household
   9a. Household Size: 9b. No. of earning member:
   9c. Number of household members absent much of time here:
   9d. Assets of the household: Land ownership

Type of Land	Area (dec)	Value (BDT/dec)
Agriculture		
Ponds		
Homestead		
Others		

   9e. Other assets:

Assets	Number	Approximate value (BDT)
Housing materials/ construction type/size		
Livestock		
Others		

   9f. Average annual income of the household (BDT):
   Agriculture: Fisheries: Other sources list:
   9g. Average monthly expenditure of the household (BDT):
   9h. Housing Condition (building material):
10. How long are you living here? ..... years.
11. Information about origin? [] Born here [] Immigrated from another place
12. Reason of immigration (Only applicable for immigrated people from another place):
    12a. From where did you come here?
    12b. What is the reason/s of your immigration?
    12c. Before immigration, did you know if this location was exposed to flooding or not? [] Yes [] No
    12d. Before immigration, did you know if this location was exposed to riverbank erosion or not? [] Yes [] No

Section B: Flood experiences of the household

13. Information about flood:

13a. Have you seen floods in your area before? [] Yes [] No

13b. If yes, please specify:

Years	Months	Flood depth (feet) in your homestead	Flood depth (feet) in your agriculture land	Flood duration (days)

13c. From where does the flood come to your home or agricultural land?

[] Heavy rainfall [] From Jamuna river [] Other rivers/channels (please specify):

13d. Agriculture cropping pattern vulnerable to flood:

Name of crop/s: Stage: Seedling / Vegetative/ Flowering/ Ripening

13e. Did you change your agricultural copping pattern due to flooding? [] Yes [] No

If yes, then how many times and how?

13f. Did you change your agriculture land use pattern due to flooding? [] Yes [] No

Years	Permanently/ Temporarily	Land from- to	Changed area (dec)	Reason for changing

13g. List of household's assets damaged in these flood events (same year as Q13b) and their value:

Household assets	Value (BDT)					
Years						
Agriculture crops						
Farming tools (e.g. pump)						
Fisheries						
Livestock						
House and HH materials						
Others:						

14. How did you recover from these damages? What were the strategies?

15. In your opinion, what is main cause of these floods?

[] Excessive monsoon rain for several days [] Increased discharge of the nearby rivers and channels

[] Rapid sedimentation of riverbeds [] Sea level rise [] Others (please specify; if, necessary explain)

16. What are the effects of these floods you have experienced?

[a] Totally displaced from home [b] Partially (temporarily) displaced from home

[c] Not displaced but the home was submerged under flood water [d] Lost all field crops

[e] Lost all fisheries [f] Loss of daily income

[g] Suffered from diarrhea/stomach flu/ pneumonia/cold/fever/skin disease/snake bite/death

[h] Others (please specify; if, necessary explain)

Years	Codes	**Others** (please specify)

17. Coping strategies of flooding: For homestead:

[a] Raising homestead [b] Raised platform for human

[c] Raised platform for food, fuel, water [d] Moving to flood shelters/ safer places

[e] Raised platform for poultry and livestock [f] Changing eating behavior

[g] Use purifying tablets for drinking water [h] Portable stove for cooking

[i] Transferable construction materials of house

[j] Plantation/ iron sheet/ bamboo around house to prevent erosion

[k] Others (please specify):

Years	Codes	**Others** (please specify)

For agriculture, aquaculture and other economic activities and income generation:

[a] Flood resistant crops (crops:)

[b] Planting a short duration crop after floods

[c] Keep fallow during flood season [d] Grow vegetable in raised land/ platform

[e] Protect fish pond with net [f] Alternative source of income during flood

[g] Selling women jewelry [h] Borrowing from others

[i] Mortgaging and selling land and other productive assets.

[j] Others (please specify):

Years	Codes	**Others** (please specify)

18. Did you change your occupation due to flood? [] Yes [] No

Years	Permanently/ Temporarily	Previous occupation	Changed occupation

19. Has your income level decreased due to flood? [] Yes [] No

If yes then, [] Permanently [] Temporarily

Mention monthly amount and year?

20. Has your cost of living increased due to flood? [] Yes [] No

If yes then, [] Permanently [] Temporarily

Mention monthly amount and year?

21. Is there scarcity of job opportunity due to flood? [] Yes [] No

If yes, mention how does this arise?

22. Is there any new job opportunity due to flood? [] Yes [] No

If yes, mention how does this arise?

23. What is your perception about controlling flood with structure like embankment or others?

[] Good for society, it saves lives and damages

[] Not good for society. (Why? Explain:)

[] Others (please specify)

24. The presence of an irrigation project (with its bunds etc) would affect the pattern of flooding?

[] Yes [] No

Please clarify:

25. Are you thinking of migration to another place for better opportunity? [] Yes [] No

If yes, mention why and where?

[] Temporary migration for few months (explain:)

[] Permanent migration with family (explain:)

26. Do you know anyone (neighbor, family friends) who had migrated from this area? [] Yes [] No

If yes, mention why, which year and where?

[] Temporary migration for few months (explain:)

[] Permanent migration with family (explain:)

Please specify if there are multiple possibilities:

27. Did you receive any early warning message about the flooding? [] Yes [] No

Years	how many days before of the event	from whom	how/medium

28. What measures were taken by the government against flooding?

29. Did you do any special flood response activity for the society? If yes, list them below.

Section C: River bank erosion experiences of the household

30. Information about river bank erosion: (if char erosion then mention)

30a. Have you ever experienced with river bank erosion? [] Yes [] No

30b. Did you migrate due to river bank erosion? If yes, when and how many times in your life?

Years	Old place	New place	Distance (km)	Reasons

30c. Have you lost your lands due to river bank erosion? [] Yes [] No

Years (with occurring month)	Type of lands	Area (ha)	Value (BDT)

If no, then do you think that you will lose your lands in future? [] Yes [] No

30d. Have you lost your homestead and move home due to river bank erosion? [] Yes [] No

Years (with occurring month)	Area (ha)	Value (BDT)	Homestead assets lost	Value (BDT)

If no, then do you think that you will be forced to move home in future? [] Yes [] No

30e. Did you change your agricultural cropping pattern due to river bank erosion? [] Yes [] No

If yes, then how?

31. How did you recover from these damages listed in Q309c, Q30d?
32. In your opinion, what is main cause of river bank erosion?
33. Did you receive any assistance during riverbank erosion? [] Yes [] No

If yes, from whom and how?

34. In your opinion and experience, has the Jamuna embankment helped to protect people from river bank erosion?
35. Coping with riverbank erosion:

For homestead:

For agriculture, fishing and other economic activities and income generation:

36. Did you change your occupation due to riverbank erosion? [] Yes [] No

If yes then, [] Permanently [] Temporarily

Mention the previous occupation(s) and year of change(s)?

37. Has your income level changes due to riverbank erosion? [] Yes [] No

If yes then, [] Fell [] Same [] Rose and [] Permanently [] Temporarily

Mention monthly amount and year?

38. Has your cost of living changed due to riverbank erosion? [] Yes [] No

If yes then, [] Fell [] Same [] Rose and [] Permanently [] Temporarily

Mention monthly amount and year?

39. Did you receive any early warning message about the riverbank erosion? [] Yes [] No

Years	how many days before of the event	from whom	how/medium

40. What measures taken by the government against riverbank erosion?
41. Do you have any additional comments?

4. Agenda for Focus Group Discussion with livelihood groups

The following agendas was discussed with different groups in the study area. It was as open discussion and all the participants got the equal opportunity to share his/her experiences regarding flood and riverbank erosion.

1. Introduction: discus about the research
2. How flood is affecting the livelihood group and what are the copping strategies?
3. What are the main reasons of flooding in your area?
4. Is the livelihood group has the tendency or bound to change their occupation due to flooding?
5. Is the livelihood group has the tendency or bound to migrate due to flooding?
6. Did your neighbors migrate due to flooding?
7. Do you think any human activity has influence on flooding or increase of flooding?
8. Do you receive any flood forecast form anywhere?
9. What strategies government taken against flooding?
10. How riverbank erosion is affecting the livelihood group and what are the copping strategies?
11. Is the livelihood group has the tendency or bound to change their occupation due to riverbank erosion?
12. Is the livelihood group has any tendency to migrate to another places due to riverbank erosion?
13. Do you receive any forecast regarding river bank erosion?
14. Do you think any human activity has influence on riverbank erosion?
15. What are the initiatives from the government or local administration to mitigate the impacts?

5. ANOVA test and Chi-square test

5.1. Hypothesis 0a: Is there a significant difference in the distribution of the current annual income between the socio-hydrological spaces?

To test the above hypothesis, we use a single-factor analysis of variance (ANOVA). We find that there exists a significant difference in current annual income between the socio-hydrological spaces (with α=0.05).

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SH1	286	361806.3	1265.057	539348.3
SH2	298	289100	970.1342	345594.9
SH3	279	345125	1237.007	3666301

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	15524131	2	7762066	5.233178	0.005508	3.006192
Within Groups	1.28E+09	860	1483241			
Total	1.29E+09	862				

From the table above we find that the average annual income in SH2 is USD 970, which is substantially lower than SH1 (USD 1265) and SH3 (USD 1237). Further, you see that the P-value is lower than the confidence level of 0.05.

Consequently, students' t-tests shows that SH2 significantly differ from both SH1 as SH3. SH1 and SH3 do not differ in annual income (with α=0.05).

5.2. Hypothesis 0b: Is there a significant difference in the distribution of the current annual expenditure between the socio-hydrological spaces?

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SH1	286	370275	1294.668	1396803
SH2	298	286500	961.4094	323451
SH3	279	325575	1166.935	839192.8

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16546240	2	8273120	9.78059	6.31E-05	3.006192
Within Groups	7.27E+08	860	845871.3			
Total	7.44E+08	862				

Here we find that the average annual expenditure for SH2 is lowest (USD 962), followed by SH3 (USD 1167) and finally SH1 (USD 1295). Again, the P-value shows that there exists a significant difference in annual expenditure between the socio-hydrological spaces (with α=0.05). Further, students t-test shows that SH2 significantly differ from both SH1 and SH3, while SH1 and SH3 do not.

5.3. Hypothesis 0c: Is there a significant difference in the distribution of the total wealth between the socio-hydrological spaces?

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SH1	286	9863089	34486.32	2.05E+09
SH2	298	1782068	5980.095	98264341
SH3	279	4923220	17645.95	6.4E+08

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.2E+11	2	5.98E+10	64.99275	5.18E-27	3.006192
Within Groups	7.91E+11	860	9.2E+08			
Total	9.11E+11	862				

Again we find a significant difference between the spaces on total wealth. Additionally, compared to income and expenditure, we also see here a significant difference between SH1 and SH3.

5.4. Chi-Square test: Remembering major floods by SHS

Observed	Socio-hydrological spaces		
Occurances	SHS1	SHS2	Total
Flooded	34	55	89
Non-flooded	21	0	21
Total	55	55	110
Expected	Socio-hydrological spaces		
Sources	SHS1	SHS2	Total
Flooded	44.50	44.50	89
Non-flooded	10.50	10.50	21
Total	55	55	110
p =		3.49E-07	

Observed	Socio-hydrological spaces		
Occurances	SHS1	SHS3	Total
Flooded	34	32	66
Non-flooded	21	23	44
Total	55	55	110
Expected	Socio-hydrological spaces		
Sources	SHS1	SHS3	Total
Flooded	33.00	33.00	66
Non-flooded	22.00	22.00	44
Total	55	55	110
p =		0.69709	

Observed	Socio-hydrological spaces		
Occurances	SHS2	SHS3	Total
Flooded	55	32	87
Non-flooded	0	23	23
Total	55	55	110
Expected	Socio-hydrological spaces		
Sources	SHS2	SHS3	Total
Flooded	43.50	43.50	87
Non-flooded	11.50	11.50	23
Total	55	55	110
p =		6.94E-08	

5.5. Chi-Square test: Remembering major floods by socio-economic groups

p	Modpoor	Mod	Modrich	Rich
Poor	0.3130	0.6799	0.6799	0.3130
Modpoor		0.5499	0.5499	1.0000
Mod			1.0000	0.5499
Modrich				0.5499

Observed	**Groups**		
Occurances	**Poor**	**Modpoor**	**Total**
Flooded	39	34	73
Non-flooded	16	21	37
Total	55	55	110
Expected	**Groups**		
Sources	**Poor**	**Modpoor**	**Total**
Flooded	36.50	36.50	73
Non-flooded	18.50	18.50	37
Total	55	55	110
p =		**0.3130**	

Observed	**Groups**		
Occurances	**Poor**	**Mod**	**Total**
Flooded	39	37	76
Non-flooded	16	18	34
Total	55	55	110
Expected	**Groups**		
Sources	**Poor**	**Mod**	**Total**
Flooded	38.00	38.00	76
Non-flooded	17.00	17.00	34
Total	55	55	110
p =		**0.6799**	

Observed	**Groups**		
Occurances	**Poor**	**Modrich**	**Total**
Flooded	39	37	76
Non-flooded	16	18	34
Total	55	55	110
Expected	**Groups**		
Sources	**Poor**	**Modrich**	**Total**
Flooded	38.00	38.00	76
Non-flooded	17.00	17.00	34
Total	55	55	110
p =		**0.6799**	

Observed	**Groups**		
Occurances	**Poor**	**Rich**	**Total**
Flooded	39	34	73
Non-flooded	16	21	37
Total	55	55	110
Expected	**Groups**		
Sources	**Poor**	**Rich**	**Total**
Flooded	36.50	36.50	73
Non-flooded	18.50	18.50	37
Total	55	55	110
p =		**0.3130**	

Observed Occurances	Groups Modpoor	Mod	Total
Flooded	34	37	71
Non-flooded	21	18	39
Total	55	55	110
Expected Sources	**Groups Modpoor**	**Mod**	**Total**
Flooded	35.50	35.50	71
Non-flooded	19.50	19.50	39
Total	55	55	110
p =		**0.5499**	

Observed Occurances	Groups Modpoor	Modrich	Total
Flooded	34	37	71
Non-flooded	21	18	39
Total	55	55	110
Expected Sources	**Groups Modpoor**	**Modrich**	**Total**
Flooded	35.50	35.50	71
Non-flooded	19.50	19.50	39
Total	55	55	110
p =		**0.5499**	

Observed Occurances	Groups Modpoor	Rich	Total
Flooded	34	34	68
Non-flooded	21	21	42
Total	55	55	110
Expected Sources	**Groups Modpoor**	**Rich**	**Total**
Flooded	34.00	34.00	68
Non-flooded	21.00	21.00	42
Total	55	55	110
p =		**1.0000**	

Observed Occurances	Groups Mod	Modrich	Total
Flooded	37	37	74
Non-flooded	18	18	36
Total	55	55	110
Expected Sources	**Groups Mod**	**Modrich**	**Total**
Flooded	37.00	37.00	74
Non-flooded	18.00	18.00	36
Total	55	55	110
p =		**1.0000**	

Observed Occurances	Groups Mod	Rich	Total
Flooded	37	34	71
Non-flooded	18	21	39
Total	55	55	110
Expected Sources	**Groups Mod**	**Rich**	**Total**
Flooded	35.50	35.50	71
Non-flooded	19.50	19.50	39
Total	55	55	110
p =		**0.5499**	

Observed Groups			
Occurance	Modrich	Rich	Total
Flooded	37	34	71
Non-flooc	18	21	39
Total	55	55	110
Expected Groups			
Sources	Modrich	Rich	Total
Flooded	35.50	35.50	71
Non-flooc	19.50	19.50	39
Total	55	55	110
p =		0.5499	

5.6. Anova test for Relocation strategies by the respondents

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SHS1	286	71	0.248252	0.187278
SHS2	298	238	0.798658	0.161345
SHS3	279	116	0.415771	0.243779

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	46.63684	2	23.31842	118.6167	3.2E-46	3.006192
Within Groups	169.0642	860	0.196586			
Total	215.701	862				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Poor	192	146	0.760417	0.183137
Moderate poor	178	123	0.691011	0.214721
Moderate	169	48	0.284024	0.204565
Moderate rich	166	70	0.421687	0.245345
Rich	158	38	0.240506	0.183826

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	39.00671	4	9.751677	47.35261	5.39E-36	2.382307
Within Groups	176.6943	858	0.205937			
Total	215.701	862				

5.7. Anova test for change in occupation by the respondents

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SHS1	286	14	0.048951	0.046718
SHS2	298	21	0.07047	0.065724
SHS3	279	12	0.043011	0.041309

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.121634	2	0.060817	1.180148	0.30773	3.006192
Within Groups	44.31869	860	0.051533			
Total	44.44032	862				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Poor	192	13	0.067708	0.063454
Moderate poor	178	17	0.095506	0.086872
Moderate	169	4	0.023669	0.023246
Moderate rich	166	9	0.054217	0.051588
Rich	158	4	0.025316	0.024833

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.62802	4	0.157005	3.074716	0.015749	2.382307
Within Groups	43.8123	858	0.051063			
Total	44.44032	862				

5.8. Anova test for change in income by the respondents

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SHS1	286	276	0.965035	0.033861
SHS2	298	296	0.993289	0.006689
SHS3	279	271	0.971326	0.027952

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.128964	2	0.064482	2.85738	0.057964	3.006192
Within Groups	19.40754	860	0.022567			
Total	19.5365	862				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Poor	192	187	0.973958	0.025496
Moderate poor	178	174	0.977528	0.022091
Moderate	169	165	0.976331	0.023246
Moderate rich	166	161	0.96988	0.02939
Rich	158	156	0.987342	0.012578

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.02719	4	0.006797	0.298947	0.8787	2.382307
Within Groups	19.50931	858	0.022738			
Total	19.5365	862				

5.9. Anova test for change in expenses by the respondents

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SHS1	286	206	0.72028	0.202184
SHS2	298	236	0.791946	0.165322
SHS3	279	203	0.727599	0.198912

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.911094	2	0.455547	2.418029	0.089703	3.006192
Within Groups	162.0205	860	0.188396			
Total	162.9316	862				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Poor	192	151	0.786458	0.168821
Moderate poor	178	127	0.713483	0.20558
Moderate	169	124	0.733728	0.196534
Moderate rich	166	125	0.753012	0.187112
Rich	158	118	0.746835	0.190277

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.534539	4	0.133635	0.706038	0.587904	2.382307
Within Groups	162.3971	858	0.189274			
Total	162.9316	862				

5.10. Anova test for land loss by the respondents

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SHS1	286	126.5494	0.44248	3.389553
SHS2	143	218.0723	1.524981	5.986728
SHS3	279	241.2072	0.864542	17.67599

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	112.346	2	56.17302	5.884341	0.002921	3.008498
Within Groups	6730.062	705	9.546187			
Total	6842.408	707				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Poor	192	289.5054	1.507841	27.99725
Moderate poor	178	173.2543	0.973339	5.270592
Moderate	169	83.36738	0.493298	1.30381
Moderate rich	166	143.6656	0.865456	3.385565
Rich	158	96.21414	0.60895	4.385045

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	113.3313	4	28.33282	3.138143	0.01414	2.382307
Within Groups	7746.48	858	9.028531			
Total	7859.811	862				

5.11. Anova test for recovery from loss by the respondents

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
SHS1	93	12	0.129032	0.113604
SHS2	265	16	0.060377	0.056947
SHS3	148	17	0.114865	0.102363

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.465151	2	0.232576	2.886189	0.056713	3.013645
Within Groups	40.53287	503	0.080582			
Total	40.99802	505				

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Poor	152	6	0.039474	0.038167
Moderate poor	139	9	0.064748	0.060995
Moderate	71	8	0.112676	0.101408
Moderate rich	93	15	0.16129	0.136746
Rich	51	7	0.137255	0.120784

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.099147	4	0.274787	3.450428	0.008529	2.389731
Within Groups	39.89888	501	0.079638			
Total	40.99802	505				

6. Major flooding events in the study area

The number of households were experienced flooding since 1960s are shown in Figure 1a. According to our household surveys; total 33 major floods were observed in our study area since 1960s. Flood affected area of Bangladesh is shown in Figure 1b. We correlated between flood memories of the households with total flood affected area of Bangladesh and as expected we did not find any good correlation between them (Figure 1c). It is because percentages of study area inundation is different than the percentages of area inundation of the whole country. We also analyzed the flood memory with inundated area of our study area for the years from 1998 to 2004 and it shows a very good correlation between them (Figure 1d). It means the memory of the HH respondents is good enough to remember flood events.

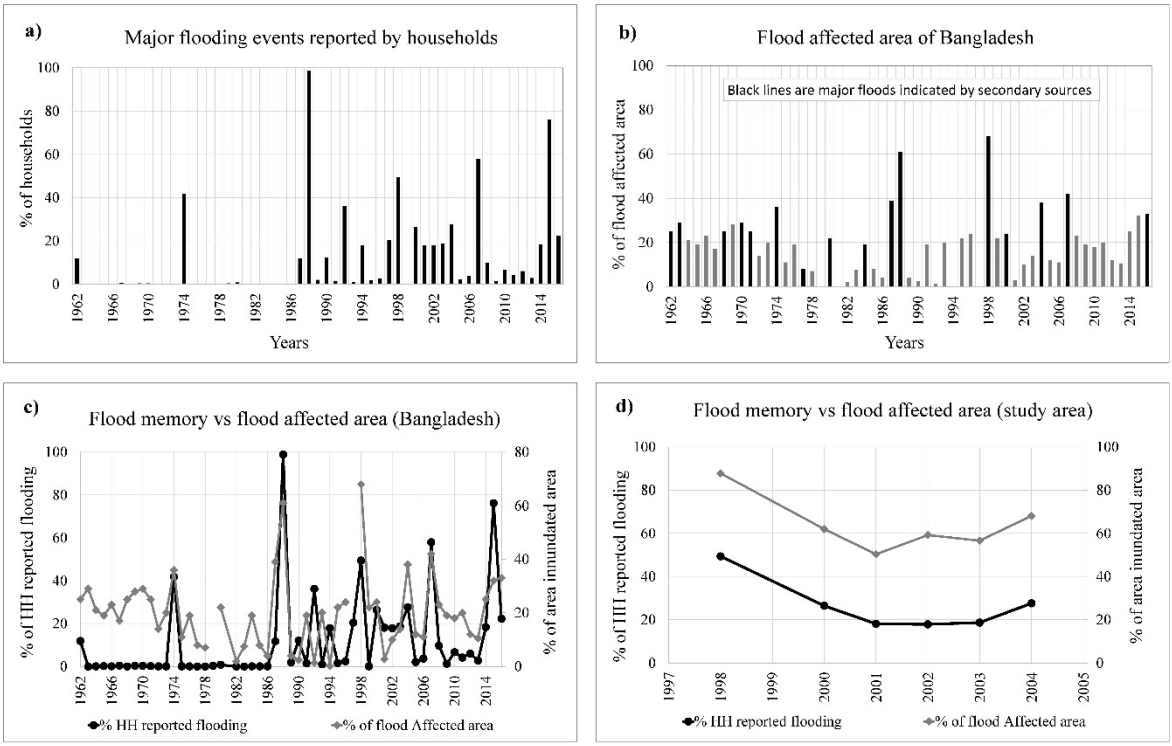

Figure 1. Major flooding events in the study area.

7. Correlation between flood severities with the reported losses

To do this analysis we have used time series household data from 1960 to 2016 on flooding events and their respective losses. We correlated the damage data with yearly maximum water level of the Jamuna River but could not find any good correlation between them (Figure 2a). Then we analyzed the damage data with flood depth at homestead and agricultural land but here we also could not find any good correlation between them. We analyzed the flood damages with the inundated area of the study area and observed similar trends but the correlation was not so good (Figure 2b).

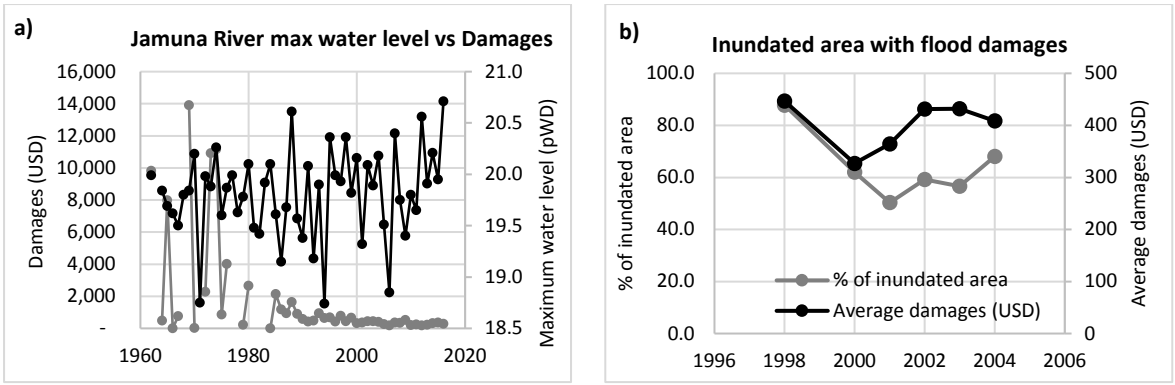

Figure 2. Correlation between flood severities with the reported losses.

8. Changing cropping pattern

To analyses the change in cropping pattern due to flooding event we have used the time series data on cropping pattern from 1960 to 2015. Most of the households do not change their cropping pattern due to flooding. With their indigenous knowledge, they have developed a unique technique to cultivate rice and they are following this technique in every year. Still due to abnormal floods, this technique does not work and they lose everything. About 20% HH cultivated fast growing crops after the abnormal flood event in 1988 and about 15% HH cultivated fast growing crops after the flood event in 2007 and 2015 (Figure 3). Few farmers were found to put fallow their agricultural land during flood season as they do not want to lose their investments in the field.

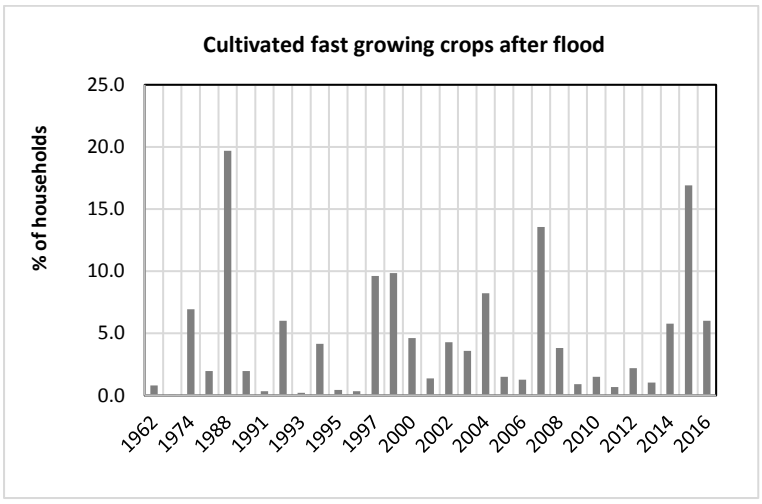

Figure 3. Cultivated fast growing crops after flood in the study area.

9. Construction of raised houses

To do this analysis we have used time series household data from 1960 to 2016 on construction of houses by the HH respondents. Very few HH respondents have raised their homestead to avoid flooding. About 11% HH raised their homestead platform in the study area (Figure 4a). More households from rich and moderately rich households have raised their homestead platforms (Figure 4b).

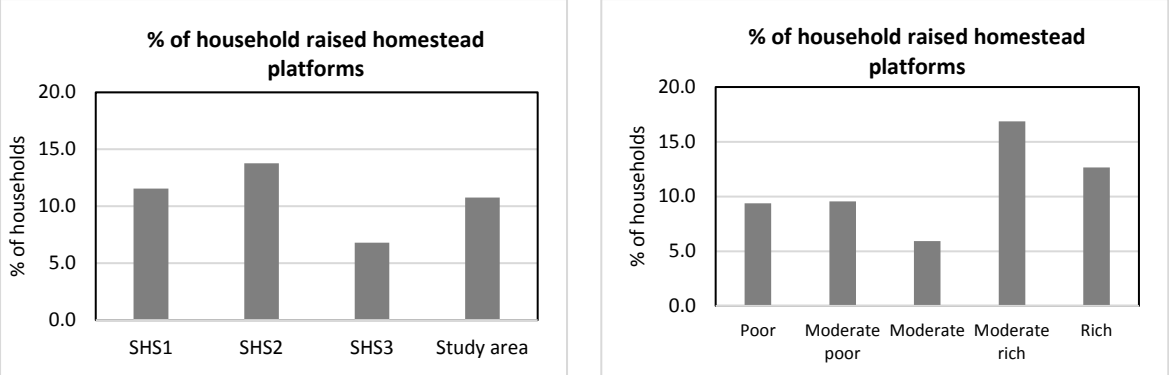

Figure 4. Percentages of households raised homestead platform in the study area.

10. Relocation distances of households

The respondents relocated within 5 km from their previous locations (Figure 5a), and many of the poor and moderate poor household are thinking to relocate again to save from riverbank erosion (Figure 5b).

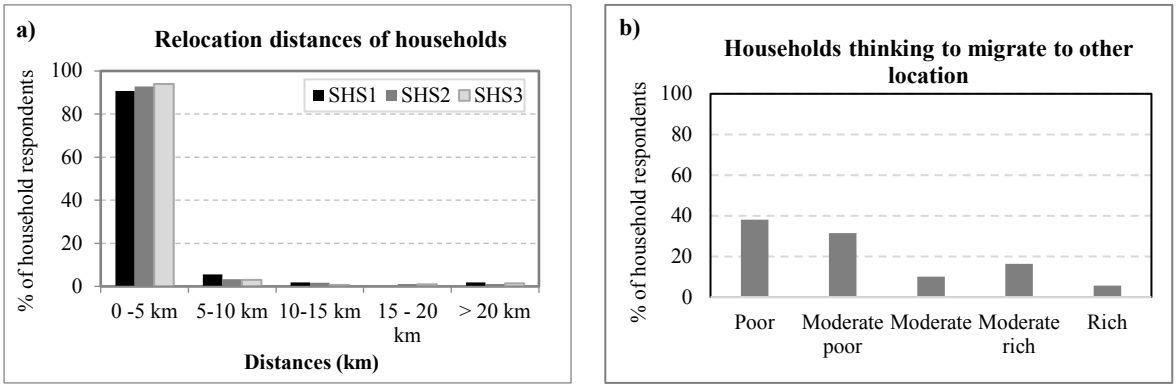

Figure 5. Relocation distances of households in the study area.

11. Total assets loss

Our survey data includes time series on land loss, agricultural crop loss, homestead loss and other assets loss due to flood and riverbank erosion. If we look at the total assets loss, households in SHS3 have lost most assets, at around 2,000 USD per year (Figure 6a). By socio-economic status, poor households have lost most assets at more than 2,000 USD (Figure 6b).

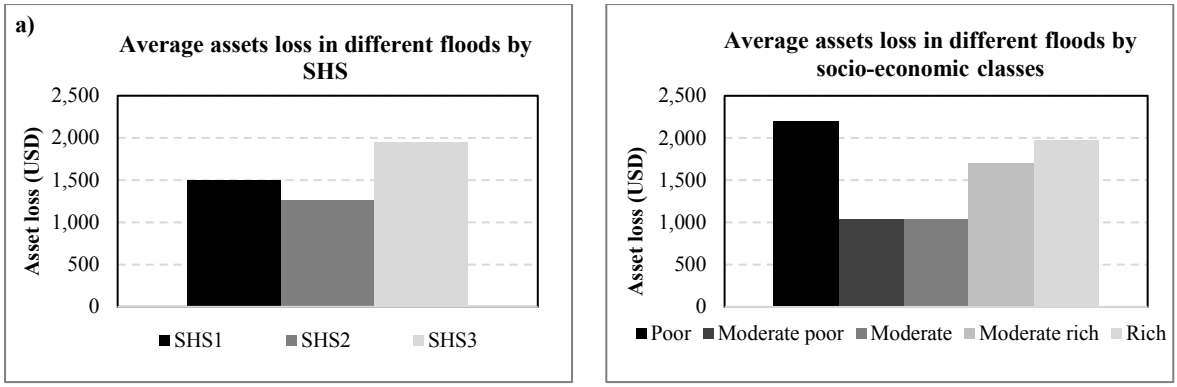

Figure 6. Average assets loss by households in different floods in the study area.

12. People moved due to river bank erosion

Households in the study area are moving their homes due to riverbank erosion. It found that one household had to move 40 times in their entire life (Figure 7).

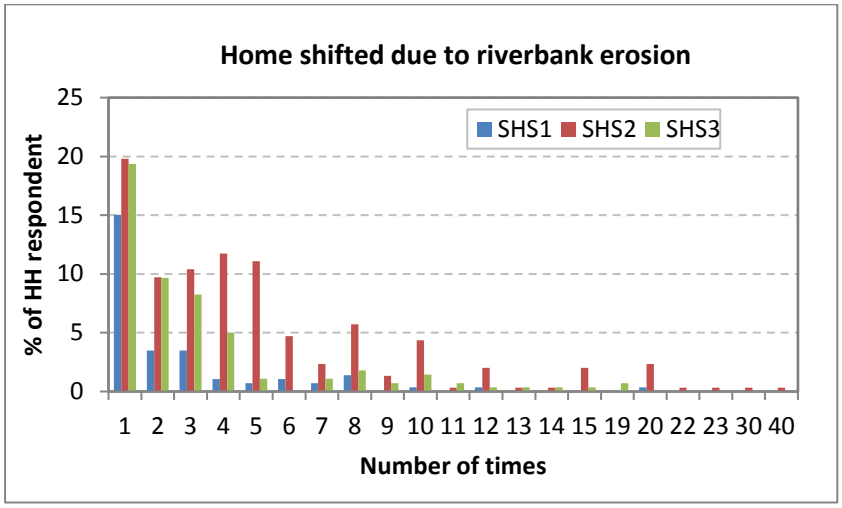

Figure 7. Households shifted their homes due to river bank erosion.

13. Story of Mr. Mohammad Abdul Mazid, an example of living with floods in the study area

Mr. Mazid, who is 81 years of age, living in a char of Jamuna River in Fazlupur union of Fulchari upazila of Gaibandha district. He is an agricultural farmer. He organize his livelihoods around the river. He for instance grow rice, maize, jute and vegetables on a field by the Jamuna River char. The ever-changing course of the river or a flood forces them to relocate their home and farm every two to three years. Over the period 1973 - 2018, the family moved 9 times. Because of population pressure, finding possible places to farm and live has become more difficult. Where in the past he would has access to some 5 hectares of land (a large famer according to the agricultural land size), today he has only 2 hectres of land (a medium famer according to the agricultural land size) due to consecutive riverbank erosion. He mentioned that his lands are not so much fertile and that's why his income from land is also low. His monthly income is only about 60 US dollars. As his income from agricultural land is not enough for the family, he limit his daily needs. His house is made of locally available materials with earthen floor, wood with tin on the top of the house. Mr. Mazid is an example of many people living in the Jamuna floodplain and its char. Many people like him used to be rich earlier but due to flooding and erosion they have

become poor. His timeline of moving from one place to another place due to river bank erosion is presented in the following Figure 8.

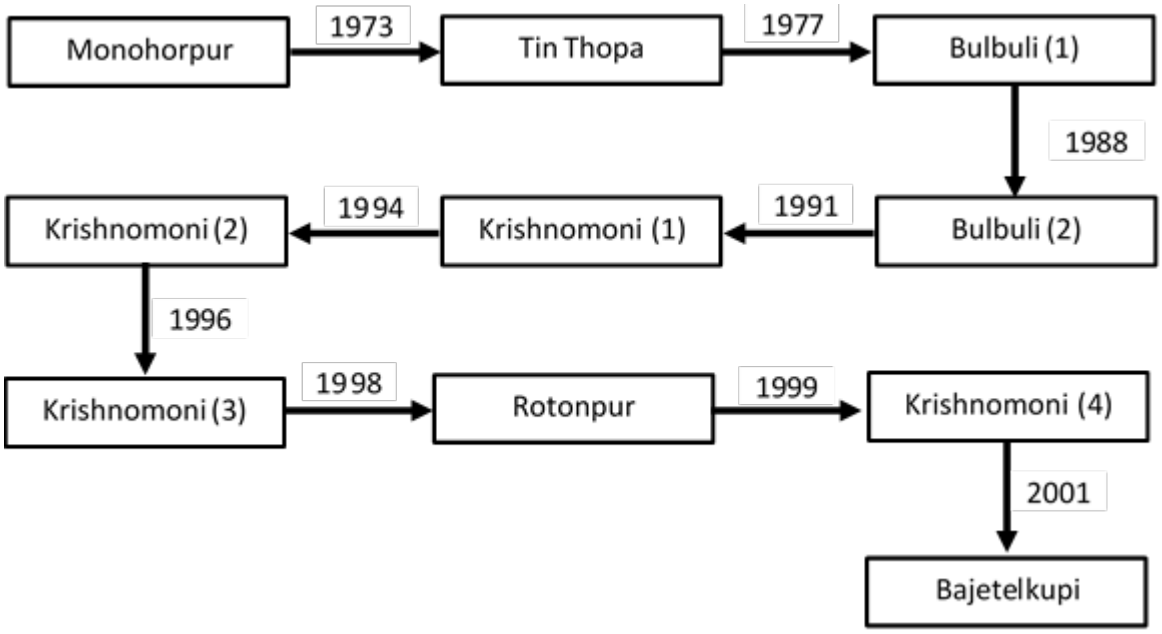

Figure 8. Moving timeline of Mr. Mazid