Migration and remittances as risk coping strategy after natural disasters: rural Bangladeshi households' response to flood shock

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Research objectives

- *Investigate the effect of inundation generated by flood in Bangladesh* on economic and migratory outcomes of panel households

- Context: Bangladesh, August 2014
- Natural event- treatment:

  flood, 13 Aug-19 Sept. 2014, North-East Bangladesh (Ganges and Brahmaputra basin)
- Data
  - High-resolution satellite data on flood (+ on rain gauge)
  - Panel dataset from IFPRI for 2012, 2015 $\rightarrow$ national coverage for rural areas
- Outcome of interest (2012, 2015)
  - Income and assets (income from main cultivations; savings; outstanding loans)
  - Food and non-food expenditures
  - Migration incidence
  - Share of remittance-recipient households
  - Amount of remittances received

Related literature

- New Economics of Labour Migration (NELM): *migration and remittances as a form of "intra-familial bargaining"* (Stark and Lucas, 1985, 1988)
- Recent literature on possible consequences of natural shocks at origin countries $\rightarrow$ migration and remittance transfers as means to mitigate losses for family left behind
  - De la Briere et al. (2002)
  - Clarke and Wallsten (2003)
  - Yang and Choi (2007)
  - Combes and Ebeke (2011)
  - Balli and Rana (2015)
  - Groger and Zylbeberg (2015)

GIS Analysis

- Treatment variable: exposure of villages to inundation $\rightarrow$ share of inundated areas in a radius of 5 km around each village

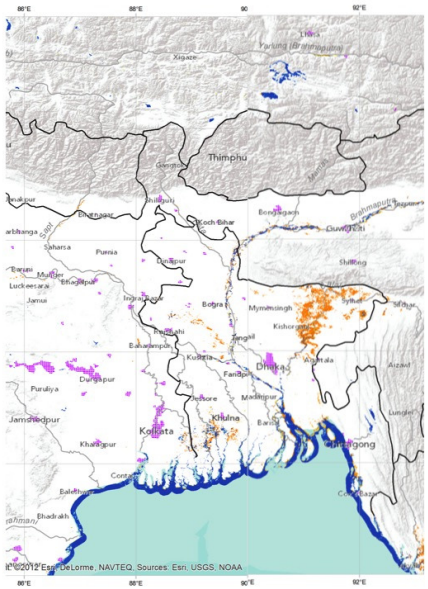
- Unit of observation: village, 4th admin. level (317 rural "unions")
- Use of *georeferenced data* instead of self-reported information from household surveys on the level of damage (Groger and Zylbeberg, 2015)

- Source: *NASA Flood Mapping*
  flood as water observations falling outside normal water levels, 250 m resolution (LANCE processing system applied to MODIS products)

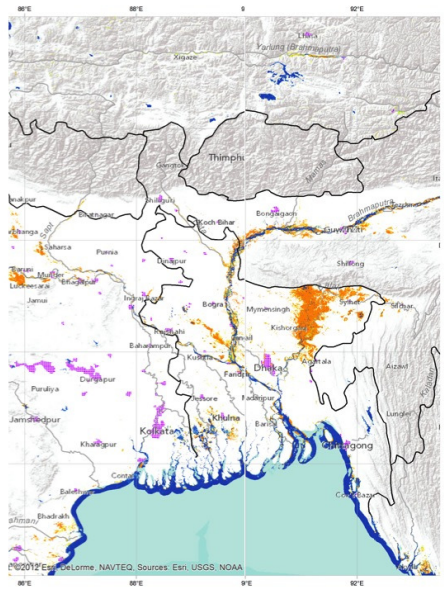
- Data employed: 15 days window for 31 Aug.-15 Sept. 2014
- Control data: July 2014, water coverage in normal periods
  $\rightarrow$ percentage of pixels inundated in the same radius around each village

GIS Analysis

- *Nasa MODIS images, flood mapping*



(a) July 2014

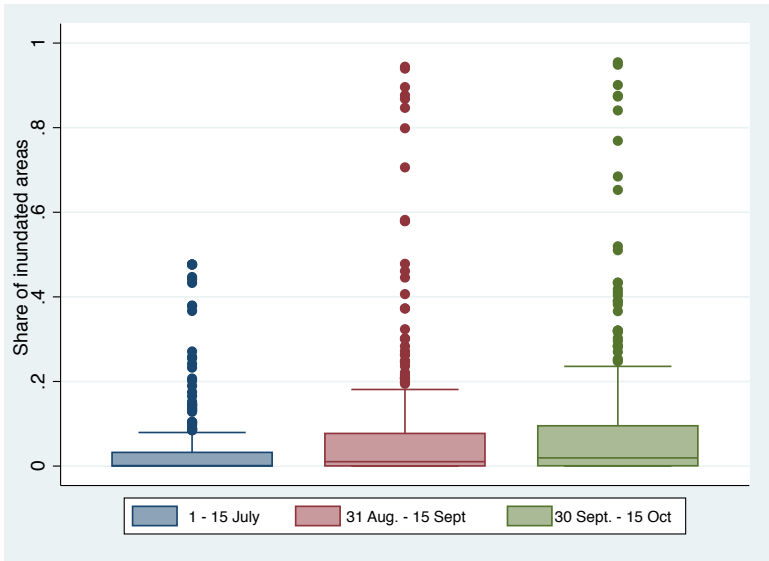


(b) September 2014

Note: Non-flooding period (July 2014) compared to the period of interest (31 Aug.-15 Sept. 2014)

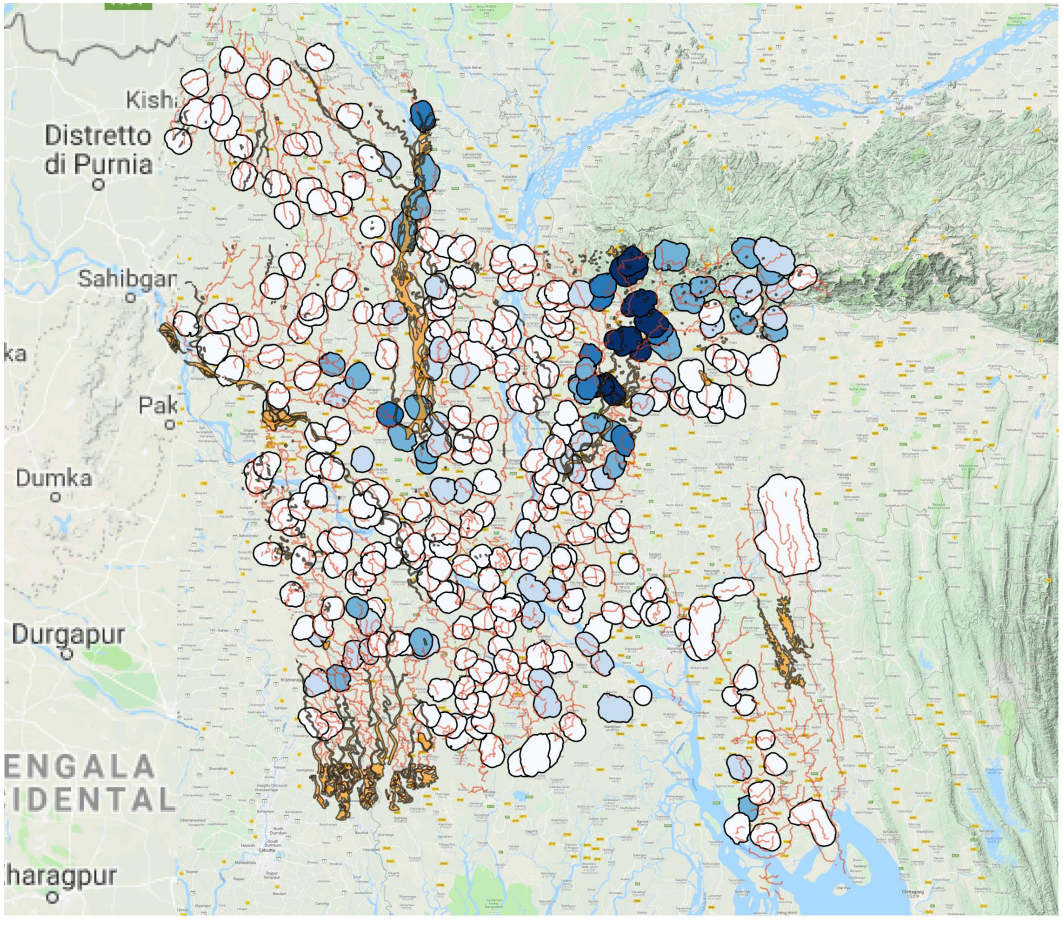
GIS Analysis

- *Inundated areas for a radius of 5km around each village*



Note: Share of inundated areas in a radius of 5 kilometers for each sampled village, before and during the flood.

Geographical distribution of treatment



31 August - 15 September 2014

Legenda

Share of inundated areas

- 0% - 0.6%
- 0.6% - 16%
- 16% - 35%
- 35% - 60%
- 60% - 94%
- Water areas
- Water lines

° Google Physical

Coordinate reference system for Bangladesh: WGS84, UTM 45N

Note: The map illustrates, besides main water surfaces- rivers and lakes- of Bangladeh, the share of inundated areas for each 5 kilometers buffer built around the 314 villages in the sample. Author's calcutlations are based on products from NASA LANCE processing system applied to MODIS images from Terra and Aqua satellites with a 250m resolution, where flooding is determined as water observations falling outside normal water levels. Composite products are referred to the period between 31 August- 15 September 2014.

Household data

- *Bangladesh Integrated Household Survey* by IFPRI

  panel study in two rounds, 1st in 2011-2012 and 2nd in 2015

- National coverage and representative of rural areas
- 6500 households and 27000 individuals
- 4.4% attrition at hh level, and 10% among individuals, uncorrelated with treatment variable

- Main features of sampled hh:
  - agriculture as main sector of occupation, employing the 48% of labour force
  - paddy covering about 77% of the total cropped area
  - 24% of hh with at least one migrant
  - 73% of migrants hh receive remittances

Descriptive statistics

	N.	Mean	Std. Dev.	Min	Mdn	Max
HOUSEHOLD CHARACTERISTICS						
N. hh observations (panel dataset)	6223*					
HH size (excluding overseas members, 2008)		4.83	1.83	1.00	5.00	17.00
Employment status for individuals in labour force						
Daily wage		0.12				
Salary		0.16				
Self employed		0.68				
Work without pay		0.14				
Monthly income per individual (Taka)		2655.70	4148.14	0	1500	144000
Monthly income per individual ($ PPP)		117.42				
Monthly expenditures per hh, food (Taka)		4436.79	3015.14	0	3722	40059
Monthly expenditures per hh, food ($ PPP)		196.17				
Monthly expenditures per hh, non-food (Taka)		1445.35	4796.49	0	870	291358
Monthly expenditures per hh, non-food ($ PPP)		63.90				
Annual expenditures per hh, health (Taka)		6567.44	16178.17	0	2460	626300
Annual expenditures per hh, education (Taka)		4374.05	6131.53	0	2445	176000
MIGRATION OUTCOMES						
N. migrant individuals (panel dataset)	1663					
Proportion of hh with at least one migrant		0.20				
Migration households with more than one migrant		0.19				
Proportion of international migrants		0.31				
Education level emigrants (internal)						
Illiterate/no educ.		0.10				
Primary school		0.35				
Upper-primary school		0.27				
Secondary		0.17				
Degree holders		0.05				
Others		0.06				
Education level emigrants (international)						
Illiterate/no educ.		0.06				
Primary school		0.36				
Upper-primary school		0.35				
Secondary		0.19				
Degree holders		0.03				
Others		0.01				
Proportion of migrant hh receiving remittances		0.73				
Remittance receipts from migrant members per year- migrant hh (Taka)		62535.36 (2765 $PPP)	93544.45	100	30000	1500000
Remittance receipts from external migrants per year- total hh (Taka)		72774.23	150218.8	0	34000	2156000

*Note:** The total number is referred to the subsample of households surveyed in 2012 and re-tracked in 2015, 6223 households and 26286 individuals.

Method

- Diff. in diff.

$$Y_{hvrt} = \beta_0 + \beta_1 T_v * t_{=2015} + \beta_2 T_v + \beta_3 P_v * t_{=2015} + \beta_4 P_v + \beta_5 X_{ht} + \beta_6 W_{rt} + \epsilon_{hvrt}$$

- *where*
  - Y_{hvpt}: outcome variables- monetary variables reported in USD (PPP) at constant prices
  - T_v : continuous treatment variable- share of inundated pixels (village level)
  - $t_{=2015}$: dummy for the 2nd year
  - P_v: propensity to be inundated in normal times (village level)
  - X_{ht}: socio-demographic characteristics of hh (hh composition, age, gender of head)
  - W_{pt}: region-wave fixed effect (division admin. level)
- Potential endogeneity: different topographic charact. of villages may affect treatment and outcomes $\rightarrow$ control for region-wave fixed effects and allow villages with different inundated areas in normal periods (P_v) to have different trends
  - ϵ_{hvrt}: error term with standard errors clustered at the *division* level (2nd admin. level)
- FE regression: $Y_{hvrt} = \beta_0 + \beta_1 T_v * t_{=2015} + \beta_2 P_v + \beta_3 X_{ht} + \beta_4 W_{rt} + \alpha_h + \epsilon_{hvrt}$

- Regression results- benchmark specification

Outcomes	OLS	Fixed effect
Income		
Monthly income, wage labour	-54.01***	-50.93***
	(10.95)	(6.513)
Annual income from paddy	-499.9***	-103.5
	(186.3)	(146.4)
Monthly income, farming/livestock	-15.97***	-15.97***
	(3.968)	(2.553)
Expenditures		
Tot. monthly expenditures	-64.92***	-72.18***
	(4.572)	(11.37)
Monthly expenditures, food	-52.28***	-50.53***
	(8.202)	(5.630)
Monthly expenditures, non-food	-12.64	-21.65**
	(15.10)	(9.507)
Health expenditures, yearly	-306.8***	-302.0***
	(78.20)	(60.23)
Education expenditures, yearly	-151.4***	-93.72***
	(30.16)	(19.78)
Observations	6,503	6,503

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Regression results for 3 subsamples: **non-migrant, internal migrant, international migrant households** (FE)

Outcomes	Main explanatory: share of inundated areas, 5km
Whole sample	
Migration incidence	0.0635***
	(0.00275)
Remittance incidence	0.0203***
	(0.00174)
Net remittances received yearly	195.0***
	(22.80)
Observations	6,503
Non-migrant households	
Migration incidence	0.0678***
	(0.00338)
Observations	5,150
Internal migrant households	
International migration incidence	0.0362***
	(0.00573)
Remittances incidence	0.267***
	(0.0320)
Net remittances received yearly	230.0***
	(38.34)
Observations	870
Households with more than one internal migrants	
Net remittances received yearly	204.5***
	(24.2)
Observations	166
International migrant households	
Remittances incidence	0.221***
	(0.0372)
Net remittances received, yearly	397.9***
	(33.09)
Observations	475
Households with more than one international migrants	
Net remittances received yearly	1200.2***
	(109.2)
Observations	93

Standard errors in parentheses
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Net remittances received yearly	195.0***
	(22.80)
Observations	6,503
Non-migrant households (5158 hh, 79%)	
Migration incidence	0.0678***
	(0.00338)
Observations	5,150
Internal migrant households	
International migration incidence	0.0362***
	(0.00573)
Remittances incidence	0.267***
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Observations	5,150
Internal migrant households (870 hh, 13%)	
International migration incidence	0.0362***
	(0.00573)
Remittances incidence	0.267***
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Net remittances received yearly	230.0***
	(38.34)
Observations	870
Households with more than one internal migrants (166 hh, 2.5%%)	
Net remittances received yearly	204.5***
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Remittances incidence	0.267***
	(0.0320)
Net remittances received yearly	230.0***
	(38.34)
Observations	870
Households with more than one internal migrants	
Net remittances received yearly	204.5***
	(24.2)
Observations	166
International migrant households (475 hh, 7.3%)	
Remittances incidence	0.221***
	(0.0372)
Net remittances received, yearly	397.9***
	(33.09)
Observations	475
Households with more than one international migrants (93 hh, 1.4%)	
Net remittances received yearly	1200.2***
	(109.2)
Observations	93

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

extra

Robustness checks

- 1st robustness check: instrumenting the flooding treatment with exogenous indicator for exposure of village natural disaster, i.e. rainfall

- Two-stage least squares method

$$T_{vt} = \beta_0 + \beta_1 R_{vt} + \beta_2 P_{vt} + \beta_3 P_{vt}^R + \beta_4 X_h t + \beta_5 W_{rt} + \alpha_h + \epsilon_{hvrt}$$
$$Y_{hvrt} = \beta_0 + \beta_1 \hat{T}_{vt} + \beta_2 P_{vt} + + \beta_3 P_{vt}^R + \beta_4 X_h t + \beta_5 W_{rt} + \alpha_h + \epsilon_{hvrt}$$

- R_{vt} is average mm of rainfall per day in the 5 km radius around each village, cumulated for the 15 days of interest (Source: NASA Integrated Multi-satellite Retrievals for GPM (IMERG))

Robustness check using rainfall instrument

Outcomes	Rainfall instrument	Main explanatory: share of inundated areas (IVreg)
	Income	
Monthly income, farming/livestock	-0.00285***	-36.07***
	(0.000474)	(6.025)
Annual income from paddy	-0.0321***	-318.3***
	(0.00806)	(108.2)
Savings, yearly	0.0595***	752.0***
	(0.0109)	(102.5)
	Expenditures	
Tot. monthly expenditures	-0.0690***	-872.9***
	(0.000592)	(15.45)
Monthly expenditures, food	-0.0154***	-194.6***
	(0.000898)	(3.240)
Monthly expenditures, non-food	-0.00747***	-94.52***
	(0.000438)	(5.710)
	Migration outcomes	
Migration incidence	1.07e-05***	0.136***
	(3.14e-06)	(0.0397)
Remittances incidence	.0000247***	0.313***
	(0.000241)	(0.0309)
Net remittances received yearly	0.369***	467***
	(0.0147)	(201.9)
Flood treatment (1st stage)	.0000791***	
	(1.34e-06)	
Observations		6,503

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- 2nd robustness check: controlling for topographic characteristics of villages

  - 1st specification: wave fixed effect interacted with

    - dummy for being located in plain areas, low/steep hills or mountains,
    - dummy for closeness to rivers or other water surfaces
    - control for *flows direction* (potential catchment areas)

  - 2nd specification: control for average rainfall in the same period of interest (August-September) for the years 1970-2000.

  - 3rd specification: control for a *vulnerability index* built for each village according to the euclidean distance from rivers, lakes and water surfaces and from the nearest coast line

- 3rd robustness check: parallel trend test

  $\rightarrow$ check whether differently treated villages would have follow similar trends in the absence of the flood

- Lack of 3rd wave for pre-shock period $\rightarrow$ *night lights* data as outcome at village level
- Amount of light observed from outer space considered as valuable proxy for economic activity (Henderson et al., 2012)
- Placebo test for 2012, 2013
- Source: NOAA/NCEI $\rightarrow$ average monthly composite measures for the intensity level of night lights
- $Y_{vrt} = \beta_0 + \beta_1 T_v * t_{=2015} + \beta_2 T_v + \beta_3 P_v * t_{=2015} + \beta_4 P_v + \beta_5 W_{rt} + \epsilon_{vrt}$

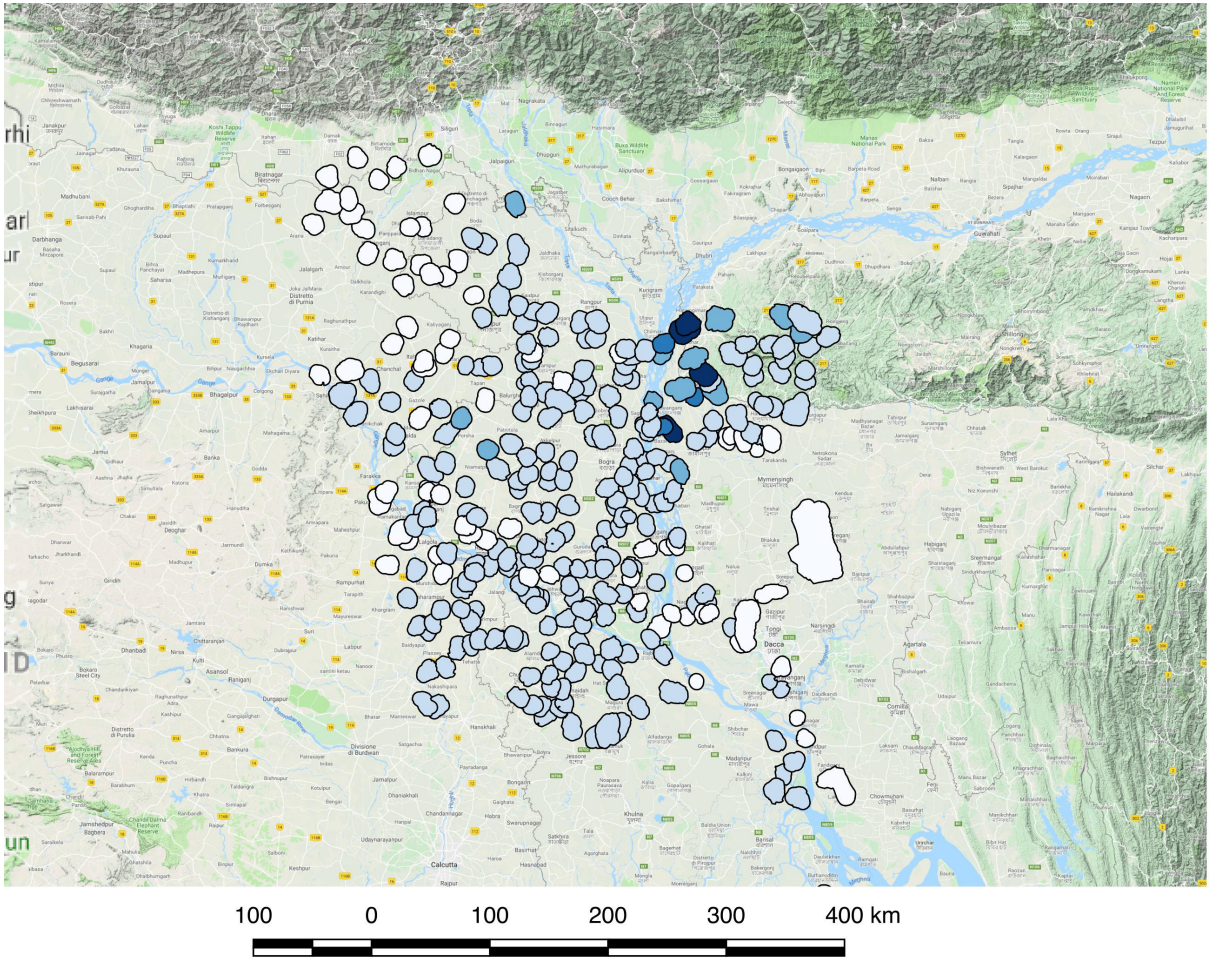
Outcomes	OLS	Fixed effect
Night lights intensity	-0.0130	-0.0130
	(0.0455)	(0.0091)
Observations		318

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Further developments

- Alternative variable for treatment: measure of economic loss due to flood according to land use
  - Economic damages caused by flooding and losses for hh differ according to land use in the specific areas considered
  - Employ max damage value per m^2 for 5 categories of land use in Asia:
    residential buildings, commerce, industry, transport, infrastructure, and agriculture (J.R.C., European Commission, 2017)
  - weight flood extent X flood depth X m^2 econ. damage value
    of the correspondent class of land use for each area of observation
    (van der Sande, 2002)

Geographical distribution of land use treatment



Coordinate reference system for Bangladesh: WGS 84, UTM 45N

Note: the map illustrates the geographical distribution of the alternative treatment variable estimated. For each radius of five kilometers around the village the share of inundated pixels has been multiplied for the potential economic damage value in the area; the latter is calculated as a weighted average of the maximum damage per square meter of each pixel component of the radius according to its land use category, where each unit is multiplied for the resolution of the pixel (250x250 meters).

31 August - 15 September 2014

Legenda

* Share of inundated areas weighted for economic damage value
* Google Physical

MAX. DAMAGE VALUE PER LAND USE CATEGORY

Categ.1 Residential building: 13650 Taka/ 176 USD per m2

Categ.2 Commerce: 16971 Taka/ 219 USD per m2

Categ.3 Industry: 14019 Taka/ 181 USD per m2

Categ.4 Infrastructure: 25703 Taka/ 332 USD per m2

Categ.5 Agriculture: 2.4 Taka/ 0.03 USD per m2

extra

Conclusions and contributions

- Outlining differences between internal and international migration as shock coping strategy after natural disaster

  $\rightarrow$ insurance role of international remittances that allow affected households to smooth consumption

- Employing *Bangladesh Integrated Household Survey* by IFPRI combined with satellite data for impact analysis of natural shock

- Robust to
  - Robustness checks with topographic indexes for flood vulnerability instead of rain gauge
  - Parallel trend test employing *night lights* as outcome variable
  - Alternative treatment variable for economic damages, employing depth-damage curves for land use categories

- Regression results for 2 subsamples: **net food buyer and net food seller households** (FE)

Outcomes	Net food buyer	Net food seller
Income		
Monthly income, wage labour	-35.71***	-77.78***
	(8.374)	(10.54)
Monthly income, farming/livestock	-8.655***	-31.26***
	(2.845)	(5.080)
Annual income from paddy	-251.3***	-26.94
	(0.00806)	(294.6)
Expenditures		
Tot. monthly expenditures	-34.42**	-142.8***
	(16.02)	(13.96)
Monthly expenditures, food	-46.36***	-71.67***
	(7.489)	(8.140)
Monthly expenditures, non-food	11.94	-71.15***
	(13.55)	(11.18)
Migration outcomes		
Migration incidence	0.0575***	0.0674***
	(0.00371)	(0.00407)
Remittances incidence	0.00842	0.0153***
	(0.00512)	(0.00557)
Net remittances received yearly	205.4***	185.2***
	(33.48)	(26.88)
Observations		6,503

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Difference in difference estimation controlling for **variation in food prices**

Outcomes	OLS	Fixed effect
Income		
Monthly income, wage labour	-53.75***	-50.92***
	(10.95)	(6.517)
Annual income from paddy	-504.3***	-148.3
	(186.7)	(147.2)
Monthly income, farming/livestock	-13.94***	-15.08***
	(3.974)	(2.561)
Expenditures		
Tot. monthly expenditures	-65.77***	-72.20***
	(18.03)	(11.39)
Monthly expenditures, food	-52.78***	-50.74***
	(8.208)	(5.621)
Monthly expenditures, non-food	-12.99	-21.46**
	(15.15)	(9.541)
Health expenditures, yearly	-301.6***	-303.4***
	(78.41)	(60.42)
Education expenditures, yearly	-149.0***	-93.74***
	(30.24)	(19.85)
Migration outcomes		
Migration incidence	0.0497***	0.0638***
	(0.00892)	((0.00276)
Remittance incidence	0.00745	0.0128***
	(0.00769)	(0.00379)
Net remittances received yearly	180.9***	195.2***
	(28.55)	(22.71)
Observations	6,503	6,503

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

main