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)
  - $\blacktriangleright\,$  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 → 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 → 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 → percentage of pixels inundated in the same radius around each village

## **GIS** Analysis

Nasa MODIS images, flood mapping





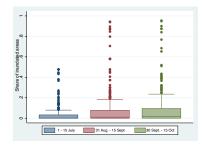
(b) September 2014

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

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## **GIS** Analysis

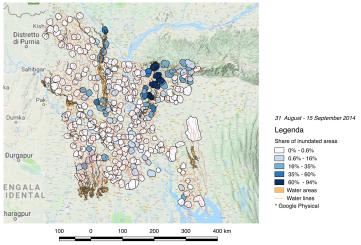
Inundated areas for a radius of 5km around each village



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

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#### Geographical distribution of treatment



Coordinate reference system for Bangladesh: WGSB4, UTM 45N

Note: The map illustrates, besides main water surfaces-rivers and lakes- of Bangladeh, the share of inundated areas for each 5 kilometers buffet built around the 34 villages in the sample. Author's acclutations are based on products from MASA LANCE processing system applied to MODIS images from Terra and Aqua satellites with a 250m resolution, where flooding is determined as water observations failing outside normal water levels. Composite products are referred to the period between 31 August 15 September 2014.

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### 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				
Nork without pay		0.14				
Monthly income per individual (Taka)		2655.70	4148.14	0	1500	144000
Monthly income per individual (\$ PPP)		117.42		-		
Manthly annuality on the final (Tala)		4436.79	3015.14	0	3722	40059
Monthly expenditures per hh, food (Taka) Monthly expenditures per hh, food (\$ PPP)		4436.79	3015.14	U	3122	40059
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					
v. mgrant moviobals (panel bataset)	1003					
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				
Jpper-primary school Secondary		0.35				
		0.19				
Degree holders Dthers		0.03				
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<sub>hvpt</sub>: outcome variables- monetary variables reported in USD (PPP) at constant prices
- T<sub>v</sub> : continuous treatment variable- share of inundated pixels (village level)
- t<sub>=2015</sub>: dummy for the 2nd year
- P<sub>v</sub>: propensity to be inundated in normal times (village level)
- X<sub>ht</sub>: socio-demographic characteristics of hh (hh composition, age, gender of head )
- W<sub>pt</sub>: region-wave fixed effect (division admin. level)
- Potential endogeneity: different topographic charact. of villages may affect treatment and outcomes → control for region-wave fixed effects and allow villages with different inundated areas in normal periods (P<sub>v</sub>) to have different trends
  - *ϵ<sub>hvrt</sub>*: 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)
Expenditure	es	
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

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While sample           Migration incidence         0.0635***           Remittances incidence         0.00174)           Net remittances received yearly         125.01***           Observations         6.503           Non-migrant households         0.00378)           Migration incidence         0.0637***           Observations         5.150           Internal migrant households         0.0330)           Net remittances received yearly         23.00***           Observations         870           Households with more than one internal migrants         Net remittances incidence           Households with more than one internal migrants         106           Net remittances received yearly         24.5****           Observations         106           International migrant households         106           International migrant mouseholds         107212           Net remittances received, yearly         33.09           Households with more than one international migrants         475           Households with more than one intern	Outcomes	Main explanatory: share of inundated areas, 5km			
Migration incidence     0.0635***       Remittances received yearly     0.00275)       Remittances received yearly     195,0***       Observations     0.0738**       Migration incidence     0.00338)       Observations     0.673**       Migration incidence     0.00737)       Remittances received yearly     23.0***       Remittances received yearly     23.0***       Remittances received yearly     23.0***       Observations     670       Hermittances received yearly     23.0***       Observations     160       Hermittances received yearly     24.5***       Observations     167       Hermittances received yearly     23.0***       Observations     167       Households with more than one internal migrants       Remittances received yearly     23.5***       Observations     160       Remittances received yearly     30.7***       Observations     167       Net remittances received yearly     33.09       Observations     475       Households with more than one international migrants       Net remittances received yearly     130.09       Observations     475       Households with more than one international migrants       Net remittances received yearly     120.2*** <td></td> <td></td>					
(0.00275)           Remittances received yearly         (0.0174)           Net remittances received yearly         (22.80)           Observations         6.503           Migration incidence         (0.00338)           Observations         5.150           Internal migrant households         (0.00373)           Remittances incidence         0.3022***           (0.00573)         (0.00573)           Remittances incidence         0.3022***           (0.00573)         (0.00573)           Remittances received yearly         (20.377)           Net remittances received yearly         (20.377)           Observations         1870           Households with more than one internal migrant souseholds         1870           Deservations         166           Remittances received yearly         (20.372)           Net remittances received, yearly         307.97**           Observations         166           Remittances received, yearly         307.97**           Observations         167           International migrant households         475           Households with more than one internal migrant souseholds         100.27**           Observations         475           Households with more th	Minutian insidence				
Remittances incidence     0.023***       (0.00174)     (0.00174)       Net remittances received yearly     155,0***       (022,80)     (023,80)       Observations     0.067***       (0.0038)     0.067***       Observations     105,0***       Observations     105,0***       Internal migrant households     5,150       International migration incidence     0.00573)       Remittances received yearly     230,0***       (03320)     (0367**)       Net remittances received yearly     230,0***       Observations     870       Households with more than one internal migrants     166       Remittances incidence     (0.0320)       Observations     166       Remittances incidence     (0.320)       Observations     166       Remittances incidence     (0.321)       Net remittances received yearly     (24,5***       Observations     166       Remittances incidence     (0.322)       Net remittances received, yearly     (33.09)       Observations     475       Households with more than one international migrants       Net remittances received yearly     (32.09)       Observations     475       Households with more than one international migrants       <	ivigration incidence				
Net remittances received yearly     195,0***       Observations     (22.80)       Observations     0.6533       Migration incidence     0.0673***       Observations     Internal migrant households       International migration incidence     0.0367***       Observations     Internal migrant households       International migration incidence     0.030731       Remittances incidence     0.005731       Remittances received yearly     230.0***       Observations     870       Households with more than one internal migrants       Net remittances received yearly     (24.5)***       Observations     166       Remittances incidence     0.0371       Observations     166       Remittances incidence     0.03721       Net remittances received yearly     (24.5)***       Observations     160       Remittances incidence     0.03721       Net remittances received yearly     (33.09)       Observations     475       Households with more than one international migrants       Net remittances received yearly     (30.9)       Observations     475       Households with more than one international migrants       Net remittances received yearly     120.2 ***	Remittance incidence				
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International migration incidence 0.0362*** (0.00573) Remittances incidence 0.267*** (0.0320) Net remittances received yearly 230,0*** Observations Households with more than one internal migrants Net remittances received yearly (24.2) Observations 166 International migrant households Remittances incidence 0.221** Net remittances received, yearly 37.9** Households with more than one international migrants Net remittances received, yearly (37.5) Households with more than one international migrants Net remittances received yearly (37.5) Households with more than one international migrants Net remittances received yearly 1200,2*** (109.2)					
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Observations         870 '           Households with more than one internal migrants           Net remittances received yearly         204,5***           Observations         (24,2)           Observations         166           International migrant households         0.0372)           Net remittances incidence         0.221***           (0.0372)         (33,09)           Observations         475           Gloseholds with more than one international migrants           Net remittances received yearly         1200,2***           (109,2)         (109,2)	Net remittances received yearly	230.0***			
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	Observations	93			

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

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Outcomes	Main explanatory: share of inundated areas, 5kr
	Whole sample
Migration incidence	0.0635***
6	(0.00275)
Remittance incidence	0.0203***
	(0.00174)
Net remittances received yearly	195.0***
,	(22.80)
Observations	6.503
Non-migrar	nt households (5158 hh, 79%)
Migration incidence	0.0678***
0	(0.00338)
Observations	5,150
Inte	rnal migrant households
International migration incidence	0.0362***
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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 mi	grant 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

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### Robustness checks

Ist 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<sub>vt</sub> 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))

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#### Robustness check using rainfall instrument

Outcomes	Rainfall instrument	Main explanatory: share of inundated areas (IVreg)
	Incom	e
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)
	Expendite	
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 ou	
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 → 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 → 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

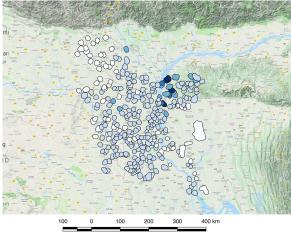
### Further developments

 Alternative variable for treatment: measure of economic loss due to flood according to <u>land use</u>

- 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<sup>2</sup> 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<sup>2</sup> 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 thre kilometers around the village the share of inurundated parks has been untilipted for the potential economic dumage value in the area; the latter is calculated as a weighted average of the maximum damage per square meter of each park component of the radius according to its fand use category, where each unit is multiplied for the resolution of the park (250-252 meters).



#### 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

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## 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
Inco		
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)
Expend	litures	
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		
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)		
Expenditur				
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 outo				
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***		
<b>0</b> 1	(28.55)	(22.71)		
Observations	6,503	6,503		

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

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