Supporting Information

Drivers of sustained sanitation access: social network and demographic predictors of latrine reconstruction after flooding disasters

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S1. Approach for Income and Flood Damage Costs Estimation

To calculate average annual income, quantification of income sources was selected as the method. Each household was asked to quantify six main income sources (**Table S1**), which were identified as being major sources during the pilot survey. An asset-based index of wealth was not selected because households lost assets to flooding disasters and it can be inaccurate for rural contexts (i.e., research in Ethiopia has demonstrated that not all standard assets are relevant locally).[1] Expenditure data was not selected because the pilot survey determined that recent flooding likely impacted household spending. To calculate the cost of flooding damage, each household was asked to quantify the costs of damages incurred to five main resources damaged by flooding (**Table S*2***), which were identified as being major sources during the pilot survey.

Table S1: Items quantified to estimate average annual income data.

Crops produced (includes crops consumed, sold, and/or gifted on personal or rented land)[a]
Rented agricultural land
Livestock (includes livestock sold, dairy produced, and/or rented)
Selling services (includes physical labor, transportation, and/or crop trading)
Selling products (includes food, beverages, construction, cooking, and/or local kiosk items)
Remittances

[a] Reported values were compared to estimated land area and the World Food Program's Monthly Market Watch Reports.[2]

Table S2: Items quantified to estimate the cost of flooding damages.

Shelter (cost of repairs to achieve previous standard)
Crops (based on the crops grown on the area of land affected)
Livestock
Personal belongings
Excess expenses due to lack of services (purchased drinking water, light sources)

S2. Homophily and Contextual Effects

Table S3. The GEE statistical results for five homophily tests. Binary predictors were created to test for the effect of similarities between an individual and social contact (1 = similar, 0 = not similar). The coefficient and standard error are reported (standard error is in parentheses). Stars (*) are used to show significant associations ($^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$). Coefficients were standardized to help with interpretation of continuously coded predictors (age, household size, young dependents; income and flood damage cost were log transformed). To be considered the "same age", the respondent and social contact needed to be within a similar age group with a range of 10 years (e.g., 30 – 40).

	Model Variables	Same gender	Same language	Same education	Same religion	Same age
Demographic variables	Gender of head	0.252 (0.356)	0.227 (0.354)	0.173 (0.361)	0.236 (0.356)	0.227 (0.356)
	Age of head	-0.111 (0.162)	-0.108 (0.162)	-0.097 (0.163)	-0.110 (0.162)	-0.116 (0.163)
	Education of head	0.481 (0.307)	0.467 (0.306)	0.469 (0.309)	0.463 (0.307)	0.483 (0.307)
	Household size	-0.013 (0.180)	-0.014 (0.181)	-0.009 (0.180)	-0.008 (0.179)	-0.015 (0.181)
	Young dependents	0.180 (0.149)	0.181 (0.149)	0.177 (0.148)	0.185 (0.148)	0.180 (0.148)
	Relocated	-0.202 (0.367)	-0.206 (0.368)	-0.214 (0.370)	-0.198 (0.371)	-0.201 (0.367)
	Income	0.321 (0.231)	0.327 (0.232)	0.296 (0.233)	0.332 (0.230)	0.318 (0.232)
	Flood damage costs	0.129 (0.135)	0.130 (0.134)	0.113 (0.136)	0.134 (0.135)	0.128 (0.134)
Kebele (ref = #1)	Kebele #2	0.109 (0.343)	0.106 (0.343)	0.089 (0.346)	0.139 (0.346)	0.115 (0.343)
	Kebele #3	-2.490*** (0.634)	-2.487*** (0.633)	-2.485*** (0.635)	-2.458*** (0.632)	-2.490*** (0.635)
	Kebele #4	-2.847*** (0.854)	-2.842*** (0.851)	-2.800*** (0.859)	-2.832*** (0.851)	-2.842*** (0.851)
	Kebele #5	0.671 (0.708)	0.668 (0.673)	0.637 (0.725)	0.704 (0.712)	0.677 (0.710)
Social network variables	Social contact owns latrine	1.164*** (0.245)	1.394** (0.576)	1.138*** (0.221)	1.114*** (0.211)	1.185*** (0.201)
	Social contact is flood affected	-0.434*** (0.166)	-0.434*** (0.164)	-0.421** (0.167)	-0.464*** (0.165)	-0.440*** (0.165)
	Social contact is same gender	-0.070 (0.199)				
	Social contact owns latrine* same gender	-0.030 (0.260)				
	Social contact speaks same language		0.100 (0.891)			
	Social contact owns latrine* same language		-0.261 (0.595)			
	Social contact has similar education			-0.349** (0.175)		
	Social contact owns latrine* same education			0.037 (0.235)		
	Social contact is same religion				0.327* (0.185)	
	Social contact owns latrine *same religion				0.008 (0.211)	
	Social contact is similar age					-0.007 (0.186)
	Social contact owns latrine* same age					-0.088 (0.236)
	Households (clusters)	380	380	380	380	380
	Observations (dyads)	3,976	3,958	3,743	3,957	3,976

Table S4. The GEE statistical results for contextual effects. The coefficient and standard error are reported (standard error is in parentheses). Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). Coefficients were standardized to help with interpretation of continuously coded variables (age, household size, young dependents; income and flood damage cost were log transformed).

		Same kebele interaction	Neighbor interaction
Demographic variables	Gender of head	0.226 (0.355)	0.240 (0.355)
	Age of head	-0.108 (0.162)	-0.110 (0.161)
	Education of head	0.481 (0.307)	0.475 (0.306)
	Household size	-0.014 (0.180)	-0.018 (0.179)
	Young dependents	0.179 (0.149)	0.178 (0.148)
	Relocated	-0.199 (0.366)	-0.194 (0.367)
	Income	0.315 (0.231)	0.325 (0.230)
	Flood damage costs	0.125 (0.135)	0.132 (0.134)
Kebele (ref. = #1)	Kebele #2	0.122 (0.345)	0.108 (0.345)
	Kebele #3	-2.483*** (0.634)	-2.485*** (0.633)
	Kebele #4	-2.838*** (0.852)	-2.832*** (0.849)
	Kebele #5	0.669 (0.704)	0.651 (0.709)
Social network variables	Social contact owns latrine	1.114*** (0.330)	0.955*** (0.250)
	Social contact is flood affected	-0.401** (0.186)	-0.476*** (0.181)
	Social contact is in same kebele	-0.153 (0.246)	
	Social contact owns latrine*same kebele	0.030 (0.325)	
	Social contact is a neighbor		-0.009 (0.186)
	Social contact owns latrine*is neighbor		0.230 (0.283)
n	Households (clusters)	380	380
	Observations (dyads)	3,976	3,976

S3. Correlation Matrices of Bivariate Correlations for all Variables

Table S5. Bivariate correlations between all demographic variables using the Pearson correlation coefficient. Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). The unit of analysis is the household (n = 380).

		1	2	3	4	5	6	7	8
1	Gender of head	1							
2	Age of head	-0.216***	1						
3	Education of head	0.314***	-0.402***	1					
4	Income	0.208***	0.083	0.132**	1				
5	Household size	0.295***	0.101**	-0.065	0.396***	1			
6	Young dependents	0.092*	-0.246***	-0.005	0.027	0.373***	1		
7	Flood damage costs	-0.176***	-0.024	-0.039	-0.273***	-0.154***	0.024	1	
8	Relocated	-0.052	-0.006	0.068	0.011	-0.068	0.036	0.292***	1

Table S6. Bivariate correlations between the social network variables using the Pearson correlation coefficient. Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). The unit of analysis is the dyad (n = 3,976).

		1	2
1	Social contact owns	1	
2	Social contact is flood affected	-0.011	1

S4. Alternate Specifications of Model A

Table S7. The GEE statistical results for two alternate specifications of Model A to assess the results' robustness to the respondent's household role of married head (male) or spouse (female). The coefficient and standard error are reported (standard error is in parentheses). Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). Coefficients were standardized to help with interpretation of continuously coded variables (age, household size, young dependents; income and flood damage cost were log transformed).

	Model	Male network	Female network
	Variables		
Demographic variables	Age of head	-0.170 (0.198)	-0.088 (0.198)
	Education of head	0.444 (0.341)	0.516 (0.333)
	Household size	-0.100 (0.210)	-0.106 (0.210)
	Young dependents	0.230 (0.188)	0.261 (0.180)
	Relocated	-0.179 (0.412)	-0.260 (0.420)
	Income	0.416 (0.268)	0.373 (0.263)
	Flood damage costs	0.125 (0.164)	0.112 (0.159)
Kebele (ref. = #1)	Kebele #2	-0.018 (0.412)	0.047 (0.399)
	Kebele #3	-3.484*** (1.049)	-3.552*** (1.050)
	Kebele #4	-3.024*** (0.920)	-2.925*** (0.888)
	Kebele #5	1.133 (1.013)	1.063 (1.078)
Social network variables	Social contact owns latrine	1.082*** (0.194)	0.977*** (0.192)
	Social contact is flood affected	-0.471** (0.226)	-0.495** (0.206)
n	Households (clusters)	291	291
	Observations (dyads)	1,726	1,699

S5. Alternate Specifications of Model C

Table S8. The GEE statistical results for three alternate specifications of Model C to assess the results' robustness to dropping gender, evaluating differences between age groups (i.e., under 26, 26-69, over70), and coding education as continuous. The coefficient and standard error are reported (standard error is in parentheses). Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). Coefficients were standardized to help with interpretation of continuously coded variables (age, household size, young dependents; income and flood damage cost were log transformed).

	Model	Gender dropped	Age binned	Education continuous
	Variables			
Demographic variables	Gender of head		0.988 (0.806)	1.042 (0.783)
	Age of head (continuous)	0.439** (0.225)		0.474** (0.227)
	Age of head, 26-69 (ref ≤25)		0.995 (1.008)	
	Age of head, 70+ (ref ≤25)		2.552** (1.201)	
	Education of head (binary)	0.959** (0.401)	0.722* (0.386)	
	Education of head (continuous)			0.146** (0.058)
	Household size	0.449** (0.212)	0.522** (0.210)	0.513** (0.217)
	Young dependents	-0.081 (0.215)	-0.236 (0.219)	-0.079 (0.225)
	Relocated	0.282 (0.467)	0.434 (0.472)	0.323 (0.464)
	Income	0.469 (0.295)	0.451 (0.289)	0.359 (0.291)
	Flood damage costs	0.050 (0.200)	0.064 (0.198)	0.041 (0.197)
Kebele (ref = #5)	Kebele #1	-1.494* (0.901)	-1.585* (0.865)	-1.485* (0.873)
	Kebele #2	-2.159*** (0.821)	-2.094*** (0.796)	-2.015** (0.801)
	Kebele #4	-1.353 (1.301)	-0.250 (1.278)	-0.547 (1.339)
Social network variables	Social contact owns latrine	0.192 (0.185)	0.265 (0.177)	0.233 (0.187)
	Social contact is flood affected	-0.327 (0.247)	-0.293 (0.243)	-0.304 (0.244)
n	Households (clusters)	216	216	216
	Observations (dyads)	2,245	2,245	2,245

S6. Community Fixed Effects and Bivariate Results

Table S9. The GEE statistical results for the three multivariate models (Models A-C from Tables 3 and 4) with community fixed effects included. The coefficient and standard error are reported (standard error is in parentheses). Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). Coefficients were standardized to help with interpretation of continuously coded variables (age, household size, young dependents; income and flood damage cost were log transformed).

	Model Variables	Model A	Model B	Model C
Demographic variables	Gender of head	0.232 (0.355)	0.247 (0.355)	0.975 (0.773)
	Age of head	-0.110 (0.161)	-0.115 (0.161)	0.448* (0.229)
	Education of head	0.479 (0.306)	0.474 (0.307)	0.847** (0.408)
	Household size	-0.013 (0.180)	-0.016 (0.178)	0.443** (0.219)
	Young dependents	0.179 (0.149)	0.176 (0.148)	-0.114 (0.227)
	Relocated	-0.199 (0.367)	-0.177 (0.367)	0.309 (0.468)
	Income	0.318 (0.232)	0.329 (0.231)	0.432 (0.297)
	Flood damage costs	0.128 (0.135)	0.130 (0.135)	0.065 (0.200)
Kebele	Kebele #1	reference	reference	-0.868 (1.316)
	Kebele #2	0.117 (0.344)	0.113 (0.343)	-1.489* (0.898)
	Kebele #3	-2.485*** (0.634)	-2.474*** (0.638)	NA
	Kebele #4	-2.839*** (0.852)	-2.832*** (0.851)	reference
	Kebele #5	0.670 (0.708)	0.657 (0.690)	-2.099*** (0.810)
Social network variables	Social contact owns latrine	1.139*** (0.155)	0.490** (0.250)	0.225 (0.185)
	Social contact is flood affected	-0.442*** (0.164)	-0.426** (0.182)	-0.315 (0.249)
	Social contact speaks daily to respondent (Model B only)		-0.323 (0.208)	
	Social contact owns latrine*speaks daily (Model B only)		0.805*** (0.265)	
n	Households (clusters)	380	380	216
	Observations (dyads)	3,976	3,976	2,245

Table S10: Bivariate models for all variables. The coefficient and standard error are reported (standard error is in parentheses). Stars (*) are used to show significant associations ($^{*}p\leq0.1$; $^{**}p\leq0.05$; $^{***}p\leq0.01$). Coefficients were standardized to help with interpretation of continuously coded variables (age, household size, young dependents; income and flood damage cost were log transformed). To run bivariate models, social network variables were recoded to percent of a household's social contacts that: (i) own a latrine and (ii) were flood affected.

		Outcome 1: Reconstructed latrine	Outcome 2: Improved latrine choice
Demographic variables	Gender of head	0.118* (0.063)	0.228*** (0.083)
	Age of head	-0.034 (0.025)	0.056* (0.034)
	Education of head	0.167*** (0.052)	0.178*** (0.062)
	Household size	0.056** (0.025)	0.100*** (0.033)
	Young dependents	0.048* (0.025)	-0.027 (0.035)
	Relocated	0.045 (0.072)	0.027 (0.086)
	Income	0.060* (0.032)	0.141*** (0.037)
	Flood damage costs	0.039* (0.022)	-0.032 (0.025)
Social network variables	Percent of household's social contacts that own latrine	0.799*** (0.057)	0.164 (0.108)
	Percent of household's social contacts flood affected	-0.345*** (0.131)	-0.331** (0.150)
n	Households (clusters)	380	216

S7. Additional Results for Latrine Reconstruction

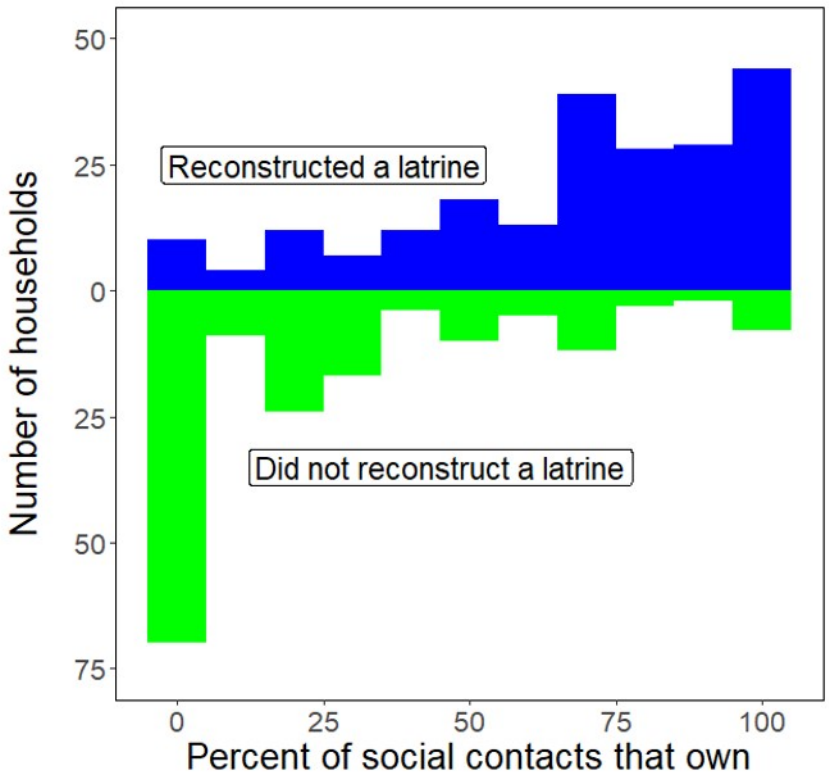

Figure S1. There was no threshold of social contact latrine ownership that guaranteed a household's reconstruction decision. This tornado plot shows the number of households that reconstructed (blue) and did not reconstruct (green) as a function of each household's percent of contacts that own a latrine.

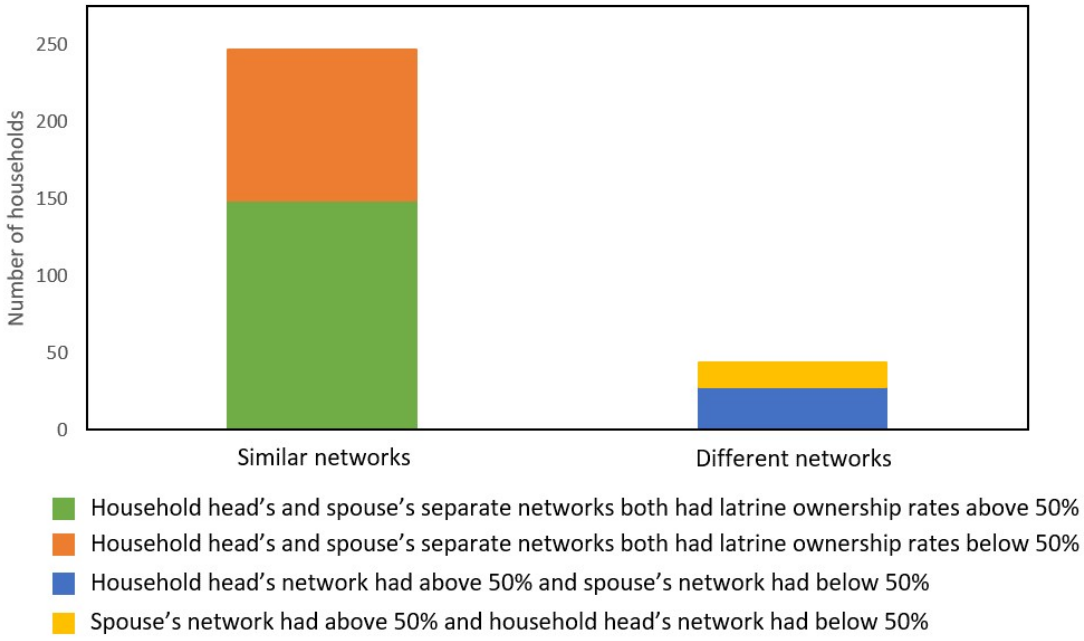

Figure S2. The social networks of male household heads and their female spouses (n = 291) had similar sanitation outcomes.

S8. REFERENCES

(1) Dekker, M. Estimating Wealth Effects Without Expenditure Data: Evidence From Rural Ethiopia. *Ethiop. J. Econ.* **2006**, *15* (1). https://doi.org/10.4314/eje.v15i1.39817.

(2) World Food Program. *Ethiopia, Monthly Market Watch*; 2018.