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Research, part of a Special Feature on Education and Differential Vulnerability to Natural Disasters

Impacts of the 2010 Droughts and Floods on Community Welfare in Rural Thailand: Differential Effects of Village Educational Attainment

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ABSTRACT. Climatic events can have disastrous consequences on rural livelihoods, which rely mainly on agriculture and natural resources. The way households and communities respond to climatic shocks depends on their available resources. We formulated that education is a human capital asset that can increase coping abilities in difficult times because education improves access to both social and economic resources. Based on the Thai government surveys of the living conditions and life quality of 68,343 rural villages for the years 2009 and 2011, we investigated the impacts of floods and droughts in 2010 on community welfare, i.e., consumption and income in 2011 at the village level. Using difference-in-difference methods, we analyzed how differential demographic composition and education could reduce or increase economic vulnerability to natural disasters. We found that floods and droughts do not produce a negative effect either on food and nonfood consumption, investment in agriculture and education, or on income. However, this applies mainly to communities with higher educational attainment partly because these communities can better secure government financial aid for flood and drought affected areas. Education thus may have an important role in reducing economic vulnerability.

Key Words: *consumption and income smoothing; drought; economic vulnerability; education; flood; Thailand; welfare*

INTRODUCTION

The frequency and severity of extreme weather events and natural disasters has increased in the past decades worldwide (Diffenbaugh et al. 2005, Solomon et al. 2007). Although some anticipated impacts of climate change are positive in certain areas, developing countries are most likely to suffer from its negative impacts (IPCC 2001). The climate change models in Southeast Asia projected that the region would experience prominent increases in the intensity and/or frequency of extreme events such as tropical cyclones, droughts, floods, as well as a rising sea level (ADB 2009). Apart from fatalities and casualties, these extreme climate events disrupt livelihoods and income generating economic activities. With crops and livestock being destroyed, incomes and consumption decline and savings deplete. This can have long-term implications for well-being, future human capital accumulation, and economic development.

The impacts of natural disasters, both in terms of human and financial losses, are distributed disproportionately across social groups as are coping abilities. Social factors, such as race and ethnicity, health, education, infrastructure, and poverty are crucial determinants of vulnerability (Fothergill et al. 1999, Adger et al. 2004, Vincent 2004, Brooks et al. 2005) because they are related to resource distribution (Blaikie et al. 1994). Social differentiation, in the availability of and access to resources, makes certain groups more exposed to risk and less capable of adapting (Adger et al. 2004, Smit and Wandel 2006).

Consequently, households and communities respond to multiple stressors, including climate stress, depending on available resources. For instance, although households above the poverty line respond to disaster shocks through consumption smoothing, e.g., sell assets, poorer households are more likely to smooth their assets, e.g., decrease consumption, a strategy that can result in human capital depletion (Hoddinott 2006). Coping strategies also vary considerably with household socio-demographic characteristics. Whereas households with female heads, for example, experience consumption reduction because of idiosyncratic income shocks (Kim and Prskawetz 2010), households with higher education have lower vulnerability to income shocks (Skoufias 2007, Silbert 2011). Human assets, such as education and skills, can thus be an important element in promoting adaptive capacity.

The plausible, positive effect of education on risk reduction is noteworthy and can have important policy implications. Education is a human capital asset that can increase adaptive capacity, i.e., "the preconditions necessary to enable adaptation, including social and physical elements, and the ability to mobilize these elements" (Nelson et al. 2007:397). Education is one important way individuals acquired knowledge, skills, and competences that could directly or indirectly influence coping capacities in times of crisis. More educated individuals may have improved access to information and a better ability to interpret and evaluate that information (Patrick and Kehrberg 1973, Jerit et al. 2006), including climate risks and self-protection. Education endows individuals with real skills that are useful for work and for life, such as decision making abilities (Pudasaini 1983) and problem solving skills that can be useful in hard times.

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Likewise, education also indirectly affects adaptive capacity through income. The relationships between education and labor market outcomes, such as earnings and employment, are well established (Oreopoulos 2006, Riddell and Song 2011). Education provides individuals with greater access to full-time, high status, and well-paid work. The improved economic conditions can reduce vulnerability to climate change through enhancing livelihood options and access to external support. Thus, education can provide individuals with additional resources, i.e., skills, information, and relevant knowledge, which may compensate for the assets lost and damages caused by climatic shocks.

We assessed the impacts of natural disasters on community welfare and investigated the role of education as a buffer to livelihood and climate shocks, using Thailand as a case study. Given Thailand's strong reliance on agriculture and natural resources, and its annual experience of natural disasters, particularly floods, droughts, and tropical storms, we analyzed, ex-post, economic vulnerability to climate events, i.e., droughts and floods in 2010 using village-level survey data from Thailand. We hypothesized that although external climate stresses exacerbate economic vulnerability, the areas with an educated population would experience less economic impacts. Education is a human capital, which is fundamental to development, and unlike physical capital, it is transferable and remunerable in different locations. Thus, when experiencing external stresses, areas with high human capital might be able to adapt and recover faster to a new situation.

Most extant studies on climatic stresses and vulnerability rely on household surveys, which generally comprise a sample of households in a selected area or country. Although such data are useful in understanding individual or household-level vulnerability, they might not be nationally representative. As well, longitudinal data are required in this type of analysis, which aims to examine the change in welfare after experiencing extreme weather events. Because individual-level panel data are not widely available in developing countries, exploiting the government survey of all villages located in rural areas in Thailand in the years before and after the disasters hit allowed us to observe how floods and droughts affected community welfare all over the country. In addition, whereas the studies focusing on the impacts of natural disasters in African and Latin American countries are relatively abundant, there is relatively little evidence for countries in Southeast Asia, despite the increasing multiple climate threats in the region. We thus further provide new empirical evidence for Thailand.

SOME BACKGROUND INFORMATION ON THAILAND

Located in the center of the Southeast Asian peninsula, Thailand covers an area of 513,115 km² and comprises 76 provinces. The country has 65.5 million inhabitants, the majority (56%) living in nonmunicipal, i.e., rural, areas (NSO 2010). Based on economic, social, and ecological characteristics, Thailand is usually classified into four geographical regions: central, including Bangkok Metropolitan Region, north, northeast, and south. The central plain is a wide, flat, fertile land, covered predominantly by the Chao Phraya River valley, which runs into the Gulf of Thailand. This is the most populous and productive region, often referred to as the Rice Bowl of Asia. The northern part is mainly mountainous and was traditionally covered by dense forest. The northeast comprises the semiarid Khorat Plateau, a few low hills, and shallow lakes. Its poor soil and long, dry season make the region the least agriculturally productive and the poorest in the country. The south is a narrow peninsula joining the landmass with the Malay Peninsula. It has the highest rainfall in the country.

Thailand's economic activities rely heavily on land and water resources, which are vital to both the development of agriculture and nonagriculture sectors. Apart from the problem of land quality deterioration and problematic soils, many areas have been classified as drought- or flood-prone areas. Highly intensive land use, rainfall fluctuations, and physical characteristics in different regions partly contribute to these climate risks (ONREP 2011). The increasing demand for water because of population growth and economic development overstretches the water supply. The increasing frequency and severity of droughts and floods further amplify the water resource tensions.

Although floods are common during the monsoon season, and droughts are common in the summer, climate variability in the past decade has resulted in fluctuating rainfall, which increases the risk of severe droughts and floods. In 2005 and 2008, over 11 million people were affected by water shortages, which largely damaged the rural agricultural region. Meanwhile, in 1994-1995, in 2010, and recently in 2011, an intense rainfall resulted in the worst floods in half a century. The 2011 flood affected 13.6 million people, 65 provinces, and over 20,000 km² of farmland. The estimated economic damages and losses equaled US$45.7 billion (World Bank 2011). The impacts of these natural disasters pose significant risks and burden the development and environment of the country and can seriously harm the local economy.

Likewise, many parts of Thailand are under threat from climate change. Observational records and climate projections predicted that rainfall would increase by about 10-20% across all regions of Thailand in the next 50 years. Mean annual temperatures across the country are predicted to increase with the longer summer, as are more days with temperatures of higher than 33ºC (Chinvanno et al. 2009). Changes in rainfall patterns and the frequency and intensity of rainfall will result in a higher frequency of severe floods and droughts. This can cause substantial damage, not only to property and human life,

but also to the ecosystem, agriculture, and other economic activities, such as food processing and tourism industries that rely heavily on agriculture and natural resources.

The 2010 droughts and floods

The year 2010 provided evidence of increasing extreme weather events in Thailand. In 2010, Thailand experienced the worst droughts and the second worst floods in the past two decades. Because the tropical rainy season ended earlier than usual in November 2009, together with global warming and the El Niño phenomenon, Thailand experienced unusually hot weather and a lack of rainfall at the beginning of 2010. As the country entered the hot season in March, experts had issued national drought warnings, and these droughts stretched until almost the end of August. The Disaster Prevention and Mitigation Department declared 64 provinces to be disaster areas because of severe water shortages. The drought had an adverse impact on more than 4 million people, mainly through damaged agricultural production. The drought damaged 2746 km² of farmland with the estimated loss of 1.5 billion baht (US$46 million; Rerngnirunsathit 2012). Later in the year, Thailand experienced a series of flash floods and seven incidents of flooding. From 15 July to 30 December 2010, all regions in Thailand were hit by floods caused by the La Niña phenomenon, which brought about higher than average rainfall and a longer period of precipitation. The southern part was further hit by a tropical depression, which brought about heavy rainfall and flash floods lasting from 1 November 2010 to 25 February 2011. A combination of inadequate drainage and a well above average rainfall intensity left the country totally unprepared for the disaster. The death toll from the floods stands at 266 people with 1665 people injured. In total, 74 provinces were affected by the floods, 17,455 km² of farmland was damaged with the total estimated loss of 16 billion baht (US$536.6 million; Rerngnirunsathit 2012). A long, severe drought prolonged beyond the first half of the year, followed by destructive floods later in the year, made 2010 a unique year to study the impacts of climate variability.

DATA

Data from different sources were used to analyze the impacts of natural disasters on village welfare. Information on demographic and socioeconomic characteristics at the village level was obtained from two data sources: Basic Minimum Need Survey (BMN) and the National Rural Development Committee Survey (NRD 2C). The Community Development Department (CDD), Ministry of Interior, administered both surveys, which covered all villages located in rural areas in 76 provinces in Thailand. Rural areas are defined as the areas outside the municipality, which is a local administration unit with greater than 5000 citizens. The surveys covered approximately 70,000 villages, accounting for about half of the Thai population.

The BMN is an annual survey of every household in villages and communities all over Thailand. The survey objective is to improve household members' quality of life by enabling local people and communities to meet their own basic, minimum needs in five categories: health, dwelling, education, economy, and values. The head or members of a household are interviewed face-to-face by interviewers selected from members of their village using a structured questionnaire. The information on expenditures and income is adjusted for the number of people in the household. The data are then processed and aggregated at the village level.

The NRD 2C is a biannual survey of living conditions in a village, which focuses on six themes: infrastructure, employment/agricultural productivity and income, health and sanitation, knowledge and education, community strength, and natural resources and environment. The structured questionnaire is filled out by members of the village committee, the village head, and local government officials. The latter provide information acquired through their work, e.g., education of people in the village, death registration, number of disabled people, and village health statistics, including the number of individuals who suffered from various communicable and noncommunicable diseases, such as hepatitis B, tuberculosis, diabetes, and cancer.

The two surveys provide extensive information on demographic, physical, economic, and social conditions covering every village in the country. Because the BMN and the NRD 2C are collected annually and biannually, this allowed us to construct a panel data and assess economic vulnerability after the natural disaster events, controlling for village characteristics in the year before the disasters occurred. Note that the data cover only rural areas, thus the results might not be generalizable to urban areas because the nature of livelihoods differs in the two locations.

The analysis sample was for the years 2009 and 2011 comprising 68,343 villages. We excluded 2486 observations in which socioeconomic information was not available for both years. We matched this sample with district-level disaster data, i.e., the floods and droughts reports for the year 2010, provided by the Department of Disaster Prevention and Mitigation, Ministry of Interior. The floods and droughts reports contain information on the population, the number of households and villages affected by flood/drought, estimated economic loss, and the amount of public aid.

METHODS

The analysis is an ex-post assessment of the extent to which climate shocks cause economic vulnerability to welfare loss at the village level. Although some areas are flood and drought prone, such large-scale disasters, like the ones that occurred in the year 2010, were not anticipated. Thus, the 2010 floods and droughts can be considered to be climatic shocks to

community welfare. We defined vulnerability as a function of shocks, susceptibility and resilience, and namely the interplay between the realization of stochastic events, i.e., shocks, and individual, household, community, and country's ability to anticipate and respond to such events. A community is considered vulnerable to floods and droughts if the risk will result in a loss of well-being or welfare with which the individual or household in a community is unable to cope (Heltberg and Bonch-Osmolovskiy 2011).

Community welfare is measured by income and consumption, which are common, direct, and observable measures of welfare level after experiencing external climatic shocks (Skoufias and Vinha 2013). Both droughts and floods can damage crop production via a decrease in cultivated area and crop yield, which leads to income loss. In addition, floods can destroy households, assets, and infrastructure, which can inhibit income-generating activities. If households cannot perfectly smooth consumption, i.e., maintain the same level of consumption when income is affected by transitory shocks, they then have to finance a fraction of their current consumption and investment based on the income they have.

Reducing expenditures on food and nonfood consumption is one way to deal with a reduction in household income. Households may also change investment priorities because of limited economic resources. For example, to supplement their income, households may send their children to work instead of school, thus reducing the investment in human capital (Jacoby and Skoufias 1997). On the other hand, upon seeing that natural disasters can reduce the expected return to physical capital, rational individuals may shift their investment toward human capital (Skidmore and Toya 2002). Because there is evidence that households adjust their consumption in response to an adverse shock differentially, e.g., reducing nonfood consumption but smoothing food consumption (Skoufias et al. 2011), it is important to analyze the impacts of catastrophic climate shocks on the different dimensions of welfare. We used five variables as indicators of welfare, namely, food expenditure, nonfood expenditure, productive expenditure on agriculture, expenditure on education, and income.

We used a difference-in-difference approach with continuous treatment to assess the effects of floods and droughts on community welfare following a commonly used equation to estimate the degree of consumption smoothing (Townsend 1994, 1995). The intensity of the treatment variable is Sc_j, that is, exposure to floods or droughts in the year 2010.

The model estimating community welfare can be defined as:

$$\Delta \ln w_i = \gamma Sc_j + \partial E_{i2009} + \beta S_{i2009} + \Delta\sigma Z_i + \Delta\delta X_i + \Delta\varepsilon_a \quad (1)$$

where $\ln w_i$ is first difference in the logarithm of expenditures on food, nonfood, agriculture and education, and income of village *i* between the years 2009 and 2011;

Sc_j is a vector of stochastic measures of floods and droughts in district *j* in 2010;

E_{i2009} is a vector of education composition in village *i* in 2009, i.e., proportion of people with elementary and lower secondary education; proportion of people with at least upper secondary education; proportion of people with other education. People with no education are excluded from the model;

S_{i2009} represents a series of demographic and socioeconomic characteristics of village *i* in 2009, i.e., income; proportion of people aged 0-14; proportion of people aged 60+; proportion of female-headed households; proportion of households engaging in agriculture; proportion of households with insufficient access to water; and proportion of households without access to electricity;

Z_i is first difference of a vector of population dynamics of village *i* between years 2009 and 2011, i.e., proportion of disabled people; proportion of sick people; and proportion of deaths. The term Z_i captures the change in the burden of morbidity and mortality, which can be considered as another shock to rural livelihoods and can possibly be related to floods and droughts;

X_i is first difference of a vector of self-reported environmental and economic constraints in land use for agriculture of village *i* between years 2009 and 2011, i.e., poor soil quality; labor shortage; crops plantation not breaking even with investments; lack of knowledge to grow other crops; shortage of water; and inundations; and

$\Delta\varepsilon_a$ is a time-varying idiosyncratic error term.

Note that S_{i2009} and E_{i2009} are measured in 2009 because we want to control for initial conditions. Essentially, we aimed to explore how these characteristics, in the initial year before the floods and droughts hit, contribute to community welfare in 2011. On the other hand, X_i and Z_i are measured as the difference between the years 2009 and 2011 because we wanted to capture the changes in environmental and economic constraints in land use, as well as mortality and morbidity after the experience of floods and droughts. The Stata software version 11.0 was used for the analyses.

Measurement of floods and droughts

The exposure to floods and droughts were measured at the district level. Although the village might not have been hit directly by floods/droughts, there could have been indirect effects that were common to all villages within a district, such as food shortages, rising food prices, and ruptures in infrastructure or transportation. Using the number of villages affected by floods and droughts in the district, the scale of floods/droughts was divided into five levels:

- No villages were hit by floods/droughts;

- 1 - 24% of villages in the district were hit by floods/ droughts;
- 25 - 49% of villages in the district were hit by floods/ droughts;
- 50 - 74% of villages in the district were hit by floods/ droughts;
- 75 - 100% of villages in the district were hit by floods/ droughts.

Summary statistics

Table 1 presents summary statistics of the dependent and independent variables in 2009 and 2011 including the distribution of villages affected by floods and droughts in 2010. Overall, we observed an increase in income and all types of expenditures except for nonfood expenditure in 2011. As for demographic and socioeconomic characteristics of the villages, the mean proportion of people aged 0-14 declined from 19.5% in 2009 to 18.3 % in 2011, whereas the mean proportion of people aged 60 years and over increased from 12.9% to 14.1% in 2011. The proportion of sick people, deaths, people with disabilities, and female-headed households did not substantially change between the two years. The proportion of households engaging in agriculture declined in 2011 as did the proportion of households with inadequate access to water. On average, there was a decline in 2011 of people who mentioned poor soil quality, crop yields not breaking even with investment, and a lack of knowledge of other potential crops as the serious problems inhibiting the full use of land.

The distribution of the proportion of villages affected by floods and droughts in a district is also displayed in Table 1. Both droughts and floods were widespread in rural Thailand in 2010. More than half of the villages were located in the district in which droughts and floods affected all villages. Only 6.3% and 19.5% of villages were located in the district in which flood and droughts, respectively, hit none of the villages. The variation in flood and drought exposure could have different effects on village-level welfare.

In Table 2, we present the distribution of the proportion of individuals with upper secondary education and higher by region and by the level of exposure to floods and droughts. We divided the distribution of the proportion of village members with upper secondary education and higher into a quartile. For the whole country, the average proportion of individuals with upper secondary education and higher is 6.6% in the first quartile compared with 27.8% in the fourth quartile. On average, the north and northeast have the lowest proportion of highly educated individuals. We also verified whether there was an association between education and living in flood and drought prone areas. Table 2 shows that in 2009, the distribution of people with upper secondary education and higher was virtually the same across all levels of flood exposure. In the case of drought exposure, the areas in which 75-100% of the villages were affected by drought had a slightly lower proportion of highly educated individuals. This distribution however, did not change in 2011, apart from the fact that the proportion of highly educated individuals became larger over time. Thus, there is no clear evidence that highly educated individuals moved out of drought affected areas after being affected by the 2010 droughts.

EMPIRICAL RESULTS

Welfare effects of droughts and floods

We matched the flood and drought data with the village-level survey data and ran a series of difference-in-difference OLS regressions to assess the short-term impacts of flood and drought exposures on welfare expenditures and income, as well as to explore the determinants of such economic vulnerability. The regression results of the estimates of expenditures on food, nonfood, agricultural inputs, education, and income are illustrated in Table 3. Because the outcome variables ($\ln w_i$) are on the log-scale, one unit change in a dependent variable x corresponds to $100*\beta 1x$ percent change in $\ln w_i$.

Socio-demographic characteristics associated with the village's income were as predicted. The higher the village income in 2009, the greater was the increase of its income in 2011. Also, the higher the proportion of children aged 0-14 years in 2009, the lower was the increase in village income, whereas the opposite was true for the proportion of female-headed households. The economic shock, because of an increase in the number of deaths and the proportion of disabled people, had a negative impact on income increase. As for the impacts of droughts and floods, incomes rose as the scale of floods increased and decreased as the scale of drought got larger. Education was strongly and positively associated with income. A 1% increase in the proportion of villagers with at least an upper secondary education resulted in a 19% increase in income.

The coefficient estimates for exposure to floods and droughts showed that the average village consumption per month was protected against any negative income shocks from floods and droughts. There was no evidence that expenditures on food and nonfood declined when the villages were exposed to greater droughts and floods. To the contrary, there was a significant positive impact of floods and droughts in all types of expenditures, except for nonfood expenditures. However, when a community was severely affected by both floods and droughts, as shown in the parameter "flood index x drought index" in Table 3, their expenditures of all types declined.

In terms of physical capital and human capital investments, communities did not cut their expenditures either on

Table 1. Summary statistics of dependent and independent variables for the years 2009 and 2011 (N = 68,343).

	2009		2011		
	Mean	Sd	Mean	Sd	Δ Mean
Dependent variables					
Food expenditure	364,591	8777841	409,214	8623081	44,623
Non-food expenditure	1,114,472	22000000	1,103,187	14900000	-11,285
Agriculture input expenditure	93,981	4099454	114,927	4624393	20,946
Education expenditure	93,252	3076278	95,732	3283681	2479
Income	1,715,840	2457227	1,963,383	2370921	247,543
Independent variables					
Proportion with no education (omitted in regression estimates)	0.126	0.093	0.119	0.092	0.008
Proportion with elementary & lower secondary	0.635	0.137	0.638	0.638	0.003
Proportion with upper secondary & higher	0.159	0.090	0.175	0.094	0.015
Proportion with other education	0.079	0.148	0.068	0.122	-0.011
Proportion of female headed household	0.064	0.216	0.062	0.166	-0.002
Proportion aged 0-14 years	0.195	0.055	0.183	0.055	-0.011
Proportion aged 60 years and over	0.129	0.048	0.141	0.052	0.012
Proportion with disability	0.013	0.059	0.015	0.043	0.002
Proportion of sick people	0.051	0.313	0.052	0.257	0.002
Proportion of deaths	0.002	0.024	0.002	0.016	0.000
Proportion of households in agriculture	0.733	1.806	0.715	1.488	-0.019
Proportion of households with insufficient water	0.079	0.326	0.059	0.347	-0.020
Proportion of households with no electricity	0.010	0.065	0.008	0.063	-0.002
Problem with poor soil	0.278	0.448	0.262	0.440	-0.016
Problem with labor shortage	0.140	0.346	0.140	0.347	0.001
Problem with crop planted	0.356	0.479	0.328	0.469	-0.028
Problem with lack of knowledge	0.240	0.427	0.224	0.417	-0.016
Problem with water shortage	0.405	0.491	0.400	0.490	-0.005
Problem with inundation	0.149	0.360	0.148	0.360	0.000
Distribution of villages by level of flood and drought exposure in a district		Proportion	N		
Not affected by floods in 2010		0.06	4298		
1-24% of villages in the district hit by floods in 2010		0.15	9995		
25-49% of villages in the district hit by floods in 2010		0.15	10,096		
50-74% of villages in the district hit by floods in 2010		0.12	8178		
75-100% of villages in the district hit by floods in 2010		0.52	35,776		
Not affected by droughts in 2010		0.20	13,352		
1-24% of villages in the district hit by droughts in 2010		0.06	4049		
25-49% of villages in the district hit by droughts in 2010		0.09	6135		
50-74% of villages in the district hit by droughts in 2010		0.15	10,377		
75-100% of villages in the district hit by droughts in 2010		0.50	34,430		

agriculture or education. Agricultural expenditures include costs of production, such as seed/animal breeding costs, chemical cost, e.g., fertilizers, and other costs, e.g., machinery and petrol. When faced with environmental constraints related to land use, such as water shortages or planted crops not breaking even with investments, expenditures on agriculture increased. Similarly, agriculture spending also increased for villages located in districts with greater exposure to floods and droughts. A 1% increase in the severity of floods and droughts exposure was associated with 0.07% and 0.19% increases in expenditures on agriculture, respectively.

Likewise, spending on education also increased with the level of exposure to floods and droughts. In particular, education expenditure increased the higher the average level of education in the villages. This pattern also holds for other types of expenditures, except for expenditure on agricultural inputs in which communities with higher education spend less. Similarly, the communities with higher income in 2009 have more expenditures of all types.

Differences in welfare effects by community educational attainment

To explore whether there is any heterogeneity across the impacts of natural disasters on consumption and income by level of education, we split our sample into two groups following a median distribution of the proportion of people with upper secondary education and higher. The first group was made up of villages with lower education (N = 34, 172) and the second group of villages with higher education (N = 34, 171). The average proportion of people with at least upper secondary education for the former was 9% compared to 22%

Table 2. Mean proportion of village members with upper secondary education and higher by region and level of exposure to floods and droughts.

Mean proportion upper secondary & higher by region and education quartile [†]	1st quartile	2nd quartile	3rd quartile	4th quartile	Total
Whole country					
Mean	0.07	0.12	0.17	0.28	0.16
N	17,087	17,085	17,086	17,085	68,343
Central					
Mean	0.06	0.12	0.17	0.29	0.19
N	2246	2969	3839	5596	14,650
North					
Mean	0.06	0.12	0.17	0.27	0.15
N	4251	3834	3703	3328	15,116
Northeast					
Mean	0.07	0.12	0.17	0.27	0.14
N	9759	9001	7049	4515	30,324
South					
Mean	0.06	0.12	0.18	0.27	0.20
N	831	1281	2495	3646	8253

Mean proportion upper secondary & higher by year and disasters	2009		2011	
	Floods	Droughts	Floods	Droughts
Not affected by the disaster	0.16	0.18	0.17	0.20
1-24% of villages in the district hit by the disaster	0.16	0.18	0.18	0.20
25-49% of villages in the district hit by the disaster	0.16	0.17	0.18	0.19
50-74% of villages in the district hit by the disaster	0.16	0.17	0.18	0.18
75-100% of villages in the district hit by the disaster	0.16	0.14	0.17	0.16

[†] Education quartile is created by splitting up the proportion of village members with at least secondary education into four groups. The first quartile consists the cluster of villages with the lowest proportion while the fourth quartile consists the cluster of villages with the highest proportion of members with at least secondary education.

for the latter. The effects of floods and droughts on community welfare given the different distribution of people with at least upper secondary education across villages are shown in Table 4 (full results are shown in Appendix 1).

When splitting our sample into two groups, i.e., low and high education, the impacts of droughts on consumption did not vary considerably between the two groups. Expenditures of all types increased the greater the exposure to drought, and this applied to both villages in the low and high education groups. The impact of flood exposure on spending, however, varied with types of expenditures and village-level education. Particularly for educational expenditure, villages in the high education group were far more likely to increase the level of spending on education even with flood exposure. With respect to income, educational variation in income changed after climatic shocks. Although villages in the high education group managed to smooth their income given exposure to floods and droughts, those in the low education group experienced significant income reduction after drought exposure.

In addition, the main effects of the proportion of people with at least secondary education differed between villages in low and high education groups. For villages in the low education group, an increase in the proportion of those with at least secondary education resulted in a large, significant increase in expenditures of all types. This was not necessarily the case for villages in the high education group. This finding suggests that there is a ceiling effect such that the increase in the proportion of people with at least secondary education in the high education group does not make as much difference in the increase in expenditures compared with the low education group.

Government aid and income smoothing

Given that the 2010 floods caused much greater economic loss and infrastructure damage than the droughts, one would expect to observe an income reduction for villages with greater flood exposure. However, our empirical results show that income actually increased for the villages with more severe flood exposure. Because the Thai government allocated a budget of approximately US$550 million to help flood victims, together with US$13 million for drought-affected households, this financial support might explain why we observed an increase in income. In Table 5, we included the amount of government

Table 3. Difference-in-difference estimates of community welfare (standard errors in parentheses): all in sample.

	Food expenditure	Nonfood expenditure	Agriculture input expenditure	Education expenditure	Income
Socioeconomic characteristics in 2009					
Income	0.957***	0.915***	0.919***	0.991***	0.857***
	(0.044)	(0.039)	(0.060)	(0.048)	(0.005)
Proportion with elementary & lower secondary	2.976***	3.373***	6.225***	5.044***	0.062+
	(0.351)	(0.317)	(0.483)	(0.386)	(0.037)
Proportion with upper secondary & higher	2.014***	3.264***	-9.533***	4.856***	0.191***
	(0.475)	(0.429)	(0.655)	(0.523)	(0.050)
Proportion with other education	-0.297	0.552+	-1.810***	1.007**	0.112***
	(0.322)	(0.291)	(0.443)	(0.355)	(0.034)
Proportion of female headed household	0.444**	0.386**	0.184	0.377*	0.109***
	(0.144)	(0.130)	(0.198)	(0.159)	(0.015)
Proportion aged 0-14 years	6.693***	4.636***	10.255***	9.893***	-0.350***
	(0.633)	(0.571)	(0.872)	(0.698)	(0.067)
Proportion aged 60 years and over	4.146***	2.295***	10.810***	4.655***	-0.115+
	(0.639)	(0.577)	(0.881)	(0.704)	(0.067)
Proportion of households in agriculture	0.052**	0.019	0.112***	-0.001	0.004+
	(0.018)	(0.016)	(0.024)	(0.019)	(0.002)
Proportion of households with insufficient water	-0.140+	-0.051	0.220+	-0.012	0.011
	(0.085)	(0.077)	(0.117)	(0.094)	(0.009)
Proportion of households with no electricity	0.170	0.273	-0.331	-0.377	0.026
	(0.419)	(0.379)	(0.578)	(0.462)	(0.044)
Δ (Difference between 2009 and 2011)					
Proportion with disability	-0.894+	-0.329	-1.287+	-0.830	-0.408***
	(0.542)	(0.489)	(0.746)	(0.597)	(0.057)
Proportion of sick people	0.133	0.040	-0.018	-0.124	0.013
	(0.094)	(0.085)	(0.130)	(0.104)	(0.010)
Proportion of deaths	0.561	0.455	0.801	1.781	-0.356**
	(1.288)	(1.163)	(1.775)	(1.420)	(0.136)
Problem with poor soil	0.043	0.012	0.098	0.019	-0.001
	(0.051)	(0.046)	(0.070)	(0.056)	(0.005)
Problem with labor shortage	0.032	0.036	-0.054	0.009	-0.002
	(0.061)	(0.055)	(0.084)	(0.067)	(0.006)
Problem with crop planted	0.083	0.080+	0.263***	0.082	0.002
	(0.052)	(0.047)	(0.071)	(0.057)	(0.005)
Problem with lack of knowledge	-0.010	-0.073	-0.045	0.022	-0.004
	(0.055)	(0.050)	(0.076)	(0.061)	(0.006)
Problem with water shortage	0.129**	0.142***	0.294***	0.193***	0.003
	(0.045)	(0.041)	(0.062)	(0.050)	(0.005)
Problem with inundation	-0.055	-0.019	0.082	-0.048	-0.006
	(0.057)	(0.051)	(0.078)	(0.063)	(0.006)
Experience of floods and droughts in 2010					
Log flood index	0.021**	0.006	0.067***	0.021*	0.002*
	(0.008)	(0.007)	(0.011)	(0.008)	(0.001)
Log drought index	0.061***	0.050***	0.192***	0.083***	-0.001**
	(0.005)	(0.004)	(0.006)	(0.005)	(0.0005)
Flood index x drought index	-0.008***	-0.007***	-0.015***	-0.008***	-0.0001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.0001)
Constant	-17.505***	-16.796***	-18.448***	-20.461***	-12.125***
	(0.712)	(0.643)	(0.981)	(0.785)	(0.075)
Observations	68,338	68,330	68,322	68,338	68,340
R-squared	0.02	0.02	0.05	0.02	0.37

*** p < 0.001, ** p < 0.01, * p < 0.05, + p < 0.1

monetary assistance for floods and droughts in the affected districts for the estimation of village monthly income. Note that the sample size, i.e., number of villages, gets smaller because of unavailable information on government aid for many flood and drought affected districts.

Table 4. Difference-in-difference estimates of community welfare (standard errors in parentheses)[†]: splitting sample into low and high education groups[‡].

	Food expenditure	Nonfood expenditure	Agriculture input expenditure	Education expenditure	Income
Low education group					
Socioeconomic characteristics in 2009					
Proportion with elementary & lower secondary	2.847***	3.313***	5.338***	5.013***	0.074+
	(0.416)	(0.376)	(0.561)	(0.464)	(0.045)
Proportion with upper secondary & higher	8.061***	7.362***	6.405***	15.306***	0.328*
	(1.251)	(1.131)	(1.686)	(1.394)	(0.134)
Proportion with other education	0.097	0.808*	-0.838+	1.893***	0.125**
	(0.374)	(0.339)	(0.505)	(0.417)	(0.040)
Experience of floods and droughts in 2010					
Log flood index	0.021*	0.002	0.049***	0.011	0.002+
	(0.010)	(0.009)	(0.014)	(0.011)	(0.001)
Log drought index	0.030***	0.024***	0.132***	0.048***	-0.002*
	(0.007)	(0.006)	(0.010)	(0.008)	(0.001)
Flood index x drought index	-0.011***	-0.008***	-0.011***	-0.012***	0.0001
	(0.002)	(0.002)	(0.003)	(0.002)	(0.0002)
Constant	-16.331***	-15.237***	-19.973***	-19.328***	-11.689***
	(0.996)	(0.901)	(1.342)	(1.110)	(0.107)
Observations	34,169	34,165	34,158	34,169	34,170
R-squared	0.02	0.02	0.03	0.02	0.32
High education group					
Socioeconomic characteristics in 2009					
Proportion with elementary & lower secondary	2.102**	2.576***	5.591***	3.069***	0.023
	(0.666)	(0.601)	(0.934)	(0.726)	(0.069)
Proportion with upper secondary & higher	-0.383	1.470*	-14.645***	0.376	0.234**
	(0.824)	(0.744)	(1.156)	(0.898)	(0.086)
Experience of floods and droughts in 2010					
Log flood index	0.021+	0.008	0.074***	0.031*	0.001
	(0.012)	(0.011)	(0.016)	(0.013)	(0.001)
Log drought index	0.085***	0.071***	0.232***	0.109***	-0.001
	(0.006)	(0.006)	(0.009)	(0.007)	(0.001)
Flood index x drought index	-0.005**	-0.006***	-0.017***	-0.005**	-0.0002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.0002)
Constant	-17.243***	-17.041***	-15.303***	-18.767***	-12.469***
	(1.089)	(0.982)	(1.527)	(1.187)	(0.113)
Observations	34,169	34,165	34,164	34,169	34,170
R-squared	0.02	0.02	0.06	0.02	0.40

*** p < 0.001, ** p < 0.01, * p < 0.05, + p < 0.1

[†]The full estimation results are presented in Appendix 1.

[‡] The villages are split into two educational groups following a median distribution of the proportion of people with at least upper secondary education. The average proportion of people with at least upper secondary education for the low education group is 9% and 22% for the high education group.

In the first model (Table 5), we did not control for village income in 2009. Exposure to floods no longer had a significant effect on income in the main model when we controlled for government financial assistance for the flood and drought affected districts. In fact, village-level income increased by 0.02% for each 1% increase in financial aid from the government for flood affected areas. Exposure to drought still had a negative effect on income, and government financial aid helped smooth income only slightly with an income increase of 0.002% for each 1% increase in government aid for drought affected areas. However, when controlling for initial income in 2009 in Model 2 (Table 5), the positive association between government financial assistance for flood-affected areas and income increase disappeared. This is because village income in 2009 was likely to be correlated with financial aid received because of floods.

When splitting the sample of villages into low and high education groups in Models 2.1 and 2.2 (Table 5), respectively, villages in the high education group experienced an extra increase in income when the financial assistance for droughts was greater.

Table 5. Difference-in-difference estimates of income (standard errors in parentheses): effects of government financial assistance.

	Model 1: All in sample	Model 2: All in sample	Model 2.1: Low education	Model 2.2: High education
Socioeconomic characteristics in 2009				
Income	-	0.834***	0.806***	0.859***
		(0.009)	(0.013)	(0.013)
Proportion with elementary & lower secondary	0.264**	-0.015	0.020	-0.105
	(0.101)	(0.084)	(0.105)	(0.144)
Proportion with upper secondary & higher	1.238***	0.085	0.195	0.045
	(0.126)	(0.106)	(0.248)	(0.180)
Proportion with other education	0.486***	0.081	0.080	0.247+
	(0.087)	(0.073)	(0.089)	(0.138)
Proportion of female headed household	-0.031	0.200***	0.034	0.238***
	(0.040)	(0.034)	(0.071)	(0.038)
Proportion aged 0-14 years	-0.593***	-0.342**	-0.408*	-0.280
	(0.154)	(0.129)	(0.162)	(0.217)
Proportion aged 60 years and over	-0.766***	0.052	0.204	-0.053
	(0.143)	(0.120)	(0.168)	(0.173)
Proportion of households in agriculture	-0.074***	0.006	-0.021	0.017*
	(0.008)	(0.007)	(0.014)	(0.008)
Proportion of households with insufficient water	-0.099***	-0.036*	-0.012	-0.057*
	(0.021)	(0.017)	(0.025)	(0.024)
Proportion of households with no electricity	-0.156	0.041	0.067	-0.020
	(0.120)	(0.101)	(0.127)	(0.164)
Δ (Difference between 2009 and 2011)				
Proportion with disability	-1.793***	-0.704***	-0.636**	-0.710***
	(0.178)	(0.149)	(0.219)	(0.209)
Proportion of sick people	0.069*	0.030	0.046	0.006
	(0.031)	(0.026)	(0.034)	(0.039)
Proportion of deaths	-1.753**	-0.164	-0.617	0.192
	(0.534)	(0.446)	(0.836)	(0.537)
Problem with poor soil	-0.009	0.012	0.002	0.025+
	(0.011)	(0.009)	(0.013)	(0.014)
Problem with labor shortage	-0.012	-0.008	-0.000	-0.020
	(0.014)	(0.011)	(0.015)	(0.017)
Problem with crop planted	0.017	0.015	0.019	0.012
	(0.012)	(0.010)	(0.013)	(0.014)
Problem with lack of knowledge	-0.016	-0.007	-0.014	0.001
	(0.012)	(0.010)	(0.014)	(0.015)
Problem with water shortage	-0.012	-0.002	0.006	-0.010
	(0.010)	(0.008)	(0.011)	(0.013)
Problem with inundation	0.000	-0.011	-0.023	0.003
	(0.012)	(0.010)	(0.014)	(0.015)
Experience of floods and droughts in 2010				
Log flood index	0.020	0.026+	0.022	0.033
	(0.016)	(0.014)	(0.018)	(0.021)
Log drought index	-0.019***	-0.005	-0.004	-0.005
	(0.004)	(0.003)	(0.004)	(0.004)
Log financial aid for flood	0.019***	0.001	0.002	-0.0005
	(0.004)	(0.003)	(0.005)	(0.005)
Log financial aid for drought	0.002**	0.002**	0.001	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Flood index x drought index	0.004	0.0003	0.0003	0.0003
	(0.003)	(0.002)	(0.003)	(0.003)
Constant	-0.450***	-11.813***	-11.444***	-12.118***
	(0.123)	(0.159)	(0.215)	(0.242)
Observations	20,192	20,192	11,103	9089
R-squared	0.04	0.33	0.30	0.37

*** p < 0.001, ** p < 0.01, * p < 0.05, + p < 0.1

DISCUSSION

The results from the main model, i.e., total sample, shows the positive impact of floods and droughts on consumption as measured by food and nonfood expenditures. This might appear counterintuitive but it is in line with other literature, which reports that weather shocks have a positive impact on household consumption (Dercon and Krishnan 2000, Irac and Minoiu 2007, Davies 2010). This suggests that communities are able to keep their consumption from deteriorating, as found in previous studies in developing countries, i.e., household consumption is smoothed notwithstanding the occurrence of economic shocks (Townsend 1994, Chetty and Looney 2006, Irac and Minoiu 2007).

In terms of investment in agriculture and human capital, agricultural spending also increased for villages located in districts with greater exposure to floods and droughts. Communities do not shy away from investment in agricultural production because of expected lower returns to investment or high risks involved. Similar to a previous study on the effects of natural disasters on educational investment in Indonesia (Kim and Prskawetz 2010), spending on education increased with the scale of floods and droughts. Thai rural communities continued to invest both in income-generating activities, i.e., agriculture, as well as human capital, i.e., education, after experiencing climate shocks.

Although communities managed to protect their consumption when affected by flood or drought, when both events occurred together their expenditures were significantly reduced. This is likely because two disaster events in the same year were quite rare. Although the communities were able to cope with the expected seasonal floods or droughts, the shock of a severe drought followed by a flood later in the year did disrupt lives and livelihoods considerably. Thus, the increase in intensity and frequency of climate shocks may pose negative consequences on community welfare, especially when the events are not anticipated.

In addition, flood and drought do not always have the same impact on community welfare. Although income significantly increases with exposure to flood; the opposite is true for exposure to drought. This is probably because of the difference in intensity and duration of the two shocks (McCann et al. 2011). Drought is a slow-onset type of disaster, whereas flood is rapid onset. Because droughts typically unfold on a timescale of months to years, can have a strong impact on agriculture, and affect prices for agricultural commodities, the deleterious impacts of droughts can be long lasting. However, floods are likely to be more localized and rather short-lived. Thus, communities may be able to compensate for flood damage more quickly than those of droughts.

With respect to welfare differentials by level of education, increased average level of education in a village was associated with higher food and nonfood consumption, expenditure on education, and income. The positive effect of education on consumption was also reported in studies investigating consumption smoothing at the household level. Studies in rural Malawi and in Indonesia reported higher per capita consumption among households with heads who had higher education levels (Davies 2010, Skoufias et al. 2011). Education is positively associated with recovery after natural disasters. A study on household-level recovery after floods in Pakistan reported the positive effect of the education of household heads on the overall recovery (Kurosaki et al. 2012). This suggests that higher education may offer a wider portfolio of coping strategies, such as borrowing, receiving help from formal and informal safety networks, or generating alternative income sources.

The protective effect of education can be seen not only in terms of consumption smoothing, but also in terms of avoiding inefficient coping mechanisms, such as the reduction of investment in education. In general, the expenditure on education increases the greater the exposure to droughts for both villages with low and high education. However, for the groups of villages with higher education, spending on education is even greater among communities with more exposure to floods. Highly educated communities might have considered the lower return to physical capital because of frequent weather shocks and decided to shift their investment toward human capital instead (Skidmore and Toya 2002).

Villages with high education benefitted from government financial aid for drought more than villages in the low education group. It is possible that higher education facilitates access to external resources as recorded in a study in Bangladesh, which demonstrated that education was positively associated with access to support from government and nongovernment sources (Paul 1998). Although government aid does explain the increase in income after natural disasters, the benefit seems to be concentrated among the communities with higher educational attainment.

CONCLUSION

We investigated how Thailand's worst droughts and second worst floods in two decades affected community welfare. Our results suggest that rural communities are able to smooth consumption in such a way that droughts and floods do not produce a negative effect on food and nonfood expenditures. Rather than cutting down their investment in physical and human capital to smooth consumption on necessary items such as food, spending on agriculture and education increased with flood and drought exposure.

There was some variation in consumption smoothing across communities with differing educational levels. In particular, communities with high education were able to increase education expenditure following the experience of flood or drought, whereas communities with low education increased their spending on education only marginally after drought.

Also, there was no evidence of income reduction because of flood or drought exposure in the highly educated communities partly because these communities were more able to benefit from government financial assistance.

These findings shed light on the presence of positive externalities of education. In normal times, education enhances skills and knowledge, which in turn can increase earning capacity. Education could also reduce vulnerability to climatic shocks by enabling individuals, households, and communities to overcome hardships after natural disasters because education is a transferable asset. In addition, that government financial assistance plays a key role in reducing climate-induced income shock is relevant for targeting flood and drought relief and transfers.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/5871

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Appendix 1

Table A1.1. Difference-in-difference estimates of community welfare (standard errors in parentheses): low education group

	Food expenditure	Non-food expenditure	Agriculture input expenditure	Education expenditure	Income
Socio-economic characteristics in 2009					
Income	0.854***	0.792***	0.979***	0.859***	0.825***
	(0.064)	(0.058)	(0.087)	(0.072)	(0.007)
Proportion with elementary & lower secondary	2.847***	3.313***	5.338***	5.013***	0.074+
	(0.416)	(0.376)	(0.561)	(0.464)	(0.045)
Proportion with upper secondary & higher	8.061***	7.362***	6.405***	15.306***	0.328*
	(1.251)	(1.131)	(1.686)	(1.394)	(0.134)
Proportion with other education	0.097	0.808*	-0.838+	1.893***	0.125**
	(0.374)	(0.339)	(0.505)	(0.417)	(0.040)
Proportion of female headed household	0.002	0.128	-0.874*	0.509+	0.092***
	(0.259)	(0.234)	(0.349)	(0.289)	(0.028)
Proportion aged 0-14 years	5.108***	3.218***	8.605***	7.897***	-0.489***
	(0.803)	(0.726)	(1.082)	(0.894)	(0.086)
Proportion aged 60 years and over	3.410***	2.314**	8.226***	3.896***	0.043
	(0.907)	(0.820)	(1.222)	(1.011)	(0.097)
Proportion of households in agriculture	0.170***	0.069	0.344***	0.026	0.008
	(0.047)	(0.043)	(0.064)	(0.053)	(0.005)
Proportion of households with insufficient water	-0.115	-0.040	-0.018	0.099	0.018
	(0.107)	(0.097)	(0.145)	(0.120)	(0.011)
Proportion of households with no electricity	0.272	0.251	0.564	-0.525	0.116*
	(0.549)	(0.496)	(0.739)	(0.611)	(0.059)
Δ (Difference between 2009 and 2011)					
Proportion with disability	-1.691*	-0.809	-0.459	-0.749	-0.383***
	(0.801)	(0.724)	(1.079)	(0.893)	(0.086)
Proportion of sick people	0.365+	0.117	-0.903***	0.049	0.016
	(0.192)	(0.174)	(0.259)	(0.214)	(0.021)
Proportion of deaths	-3.045	-1.375	1.490	-0.441	-0.540**
	(1.904)	(1.721)	(2.565)	(2.122)	(0.204)
Problem with poor soil	0.040	-0.013	0.010	0.037	-0.007
	(0.068)	(0.062)	(0.092)	(0.076)	(0.007)
Problem with labor shortage	0.011	0.016	0.145	-0.014	-0.009
	(0.084)	(0.076)	(0.113)	(0.093)	(0.009)
Problem with crop planted	0.140*	0.152*	0.290**	0.106	0.006
	(0.070)	(0.064)	(0.095)	(0.078)	(0.008)
Problem with lack of knowledge	-0.092	-0.132+	-0.214*	-0.011	-0.014+
	(0.075)	(0.068)	(0.101)	(0.083)	(0.008)

Problem with water shortage	0.145*	0.131*	0.249**	0.173*	0.013*
	(0.061)	(0.055)	(0.082)	(0.068)	(0.007)
Problem with inundation	-0.162*	-0.078	-0.033	-0.134	-0.003
	(0.078)	(0.071)	(0.105)	(0.087)	(0.008)
Experience of floods and droughts in 2010					
Log flood index	0.021*	0.002	0.049***	0.011	0.002+
	(0.010)	(0.009)	(0.014)	(0.011)	(0.001)
Log drought index	0.030***	0.024***	0.132***	0.048***	-0.002*
	(0.007)	(0.006)	(0.010)	(0.008)	(0.001)
Flood index x drought index	-0.011***	-0.008***	-0.011***	-0.012***	0.0001
	(0.002)	(0.002)	(0.003)	(0.002)	(0.0002)
Constant	-16.331***	-15.237***	-19.973***	-19.328***	-11.689***
	(0.996)	(0.901)	(1.342)	(1.110)	(0.107)
Observations	34,169	34,165	34,158	34,169	34,170
R-squared	0.02	0.02	0.03	0.02	0.32

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table A1.2. Difference-in-difference estimates of community welfare (standard errors in parentheses): high education group

	Food expenditure	Non-food expenditure	Agriculture input expenditure	Education expenditure	Income
Socio-economic characteristics in 2009					
Income	0.984***	0.972***	0.765***	0.997***	0.881***
	(0.060)	(0.054)	(0.084)	(0.065)	(0.006)
Proportion with elementary & lower secondary	2.102**	2.576***	5.591***	3.069***	0.023
	(0.666)	(0.601)	(0.934)	(0.726)	(0.069)
Proportion with upper secondary & higher	-0.383	1.470*	-14.645***	0.376	0.234**
	(0.824)	(0.744)	(1.156)	(0.898)	(0.086)
Proportion with other education	-0.280	0.663	-2.785**	0.209	0.104
	(0.658)	(0.594)	(0.923)	(0.717)	(0.068)
Proportion of female headed household	0.532**	0.486**	0.527*	0.245	0.112***
	(0.189)	(0.171)	(0.265)	(0.206)	(0.020)
Proportion aged 0-14 years	9.351***	6.943***	13.611***	13.127***	-0.184+
	(1.029)	(0.928)	(1.442)	(1.121)	(0.107)
Proportion aged 60 years and over	4.915***	2.474**	12.902***	5.271***	-0.222*
	(0.908)	(0.819)	(1.273)	(0.989)	(0.094)
Proportion of households in agriculture	0.034+	0.013	0.072**	-0.003	0.004+
	(0.019)	(0.018)	(0.027)	(0.021)	(0.002)
Proportion of households with insufficient water	-0.268+	-0.103	0.454*	-0.211	-0.005
	(0.141)	(0.127)	(0.198)	(0.154)	(0.015)
Proportion of households with no electricity	0.090	0.382	-1.318	-0.079	-0.086
	(0.645)	(0.582)	(0.905)	(0.703)	(0.067)
Δ (Difference between 2009 and 2011)					
Proportion with disability	-0.226	0.098	-1.065	-0.779	-0.442***
	(0.748)	(0.675)	(1.049)	(0.815)	(0.078)
Proportion of sick people	0.020	-0.009	0.160	-0.179	0.015
	(0.112)	(0.101)	(0.157)	(0.122)	(0.012)
Proportion of deaths	2.791	1.842	1.502	2.996	-0.222
	(1.811)	(1.634)	(2.539)	(1.973)	(0.188)
Problem with poor soil	0.039	0.032	0.178+	-0.013	0.007
	(0.075)	(0.068)	(0.105)	(0.082)	(0.008)
Problem with labor shortage	0.055	0.057	-0.267*	0.034	0.004
	(0.089)	(0.080)	(0.125)	(0.097)	(0.009)
Problem with crop planted	0.015	-0.001	0.227*	0.047	-0.001
	(0.075)	(0.068)	(0.106)	(0.082)	(0.008)
Problem with lack of knowledge	0.081	-0.007	0.154	0.066	0.006
	(0.081)	(0.073)	(0.113)	(0.088)	(0.008)
Problem with water shortage	0.110+	0.150*	0.334***	0.212**	-0.009

	(0.066)	(0.060)	(0.093)	(0.072)	(0.007)
Problem with inundation	0.049	0.036	0.176	0.027	-0.008
	(0.083)	(0.074)	(0.116)	(0.090)	(0.009)
Experience of floods and droughts in 2010					
Log flood index	0.021+	0.008	0.074***	0.031*	0.001
	(0.012)	(0.011)	(0.016)	(0.013)	(0.001)
Log drought index	0.085***	0.071***	0.232***	0.109***	-0.001
	(0.006)	(0.006)	(0.009)	(0.007)	(0.001)
Flood index x drought index	-0.005**	-0.006***	-0.017***	-0.005**	-0.0002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.0002)
Constant	-17.243***	-17.041***	-15.303***	-18.767***	-12.469***
	(1.089)	(0.982)	(1.527)	(1.187)	(0.113)
Observations	34,169	34,165	34,164	34,169	34,170
R-squared	0.02	0.02	0.06	0.02	0.40

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1