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

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INTRODUCTION

That the frequency and severity of extreme weather events and natural disasters has increased in the past decades is evident worldwide (Diffenbaugh et al. 2005, IPCC 2007). Although some anticipated impacts of climate change are positive in certain areas, developing countries are mostly 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 rising high 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 wellbeing, 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 so as coping abilities. Social factors such as race and ethnicity, health, education, infrastructure and poverty are considered to be a crucial determinant of vulnerability (Fothergill et al. 1999, Adger et al. 2004, Vincent 2004, Brooks et al. 2005) since they are related to resource distribution, from social to financial assets (Blaikie et al. 1994). Social differentiation in the availability and access to resources makes certain groups more exposed to risk and less capable to adapt (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, while households above poverty line respond to disaster shocks through consumptions smoothing (e.g. selling assets), poorer households are more likely to smooth their assets (e.g. decreasing consumption), a strategy which can result in human capital depletion (Hoddinott 2006). Coping strategies also vary considerably with household socio-demographic characteristics. While households with female heads, for example, experience consumption reduction due to idiosyncratic income shocks (Kim and Prskawetz 2010), households with higher education are found to have lower vulnerability to income shocks (Skoufias 2007, Silbert 2011). Human assets such as education and skills thus can be an important element in promoting adaptive capacity.

The plausible positive effect of education on risk reduction is noteworthy and can have important policy implication. Education is a human capital asset that can increase adaptive capacity, that is “the preconditions necessary to enable adaptation, including social and physical elements, and the ability to mobilize these elements” (Nelson et al. 2007). Education is one important way individuals acquired knowledge, skills and competence that could directly or indirectly influence their coping capacities in time of crisis. More educated individuals may have improved access to and higher ability to interpret and evaluate information (Patrick and Kehrberg 1973, Jerit et al. 2006) including information related to climate risks or self-protection. Education endows individuals with real skills that are useful for work and for life such as decision-making ability (Pudasaini 1983) and problem-solving skills which can be useful in hard times. 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 condition can reduce vulnerability to climate change through enhancing livelihood options and access to external support. Thus, education can provide individuals with additional resources (skills, information and relevant knowledge) which may compensate for the assets lost and damages due to climatic shocks.

This paper aims to assess the impacts of natural disasters on community welfare and investigate the role of education as a buffer to livelihood and climate shocks using Thailand as a case study. Given strong reliance on agriculture and natural resources of its economies and annual experience of natural disasters particularly floods, droughts and tropical storms, this paper analyses *ex-post* economic vulnerability to climate events i.e. droughts and floods in 2010 using village-level survey data from Thailand. We hypothesize that while external climate shocks exacerbate economic vulnerability, the areas with educated population would experience less economic impacts. Education is human capital fundamental to development and unlike physical capital, human capital is transferable and remunerable in different locations. Thus, when experiencing external shocks, areas with high human capital might be able to adapt faster to a new situation and recover faster.

Most extant studies on shocks and vulnerability rely on household surveys which generally comprise a sample of households in a selected area or country. While such data are useful in understanding individual- or household-level vulnerability, they might not be nationally representative. Exploiting the government survey of all villages located in rural areas in Thailand, we are able to explore regional disparities and assess economic vulnerability to external shocks at national level. Besides, whereas studies focusing on 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. This paper thus further provides new empirical evidence for Thailand.

BACKGROUND OF THAILAND

Located in the center of the South-East Asian peninsula, Thailand covers an area of 513,115 km^2 and comprises 76 provinces. The country has 65.5 million inhabitants, the majority of whom (56 per cent) live in non-municipal (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, north east 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 as the “Rice Bowl of Asia”. The northern part is mainly mountainous and was traditionally covered by dense forest. The northeast comprises of the semi-arid Khaorat plateau and 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 non-agriculture 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 this climate risk (ONREP 2011). The increasing demand for water due to population growth and economic development overstretches water supply. The increasing frequency and severity of droughts and floods further amplifies the water resource tensions.

Although floods are common during the monsoon season and droughts in summer, climate variability in the past decade results in fluctuating rainfalls which increase 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 has resulted in the worst floods in half a century. The 2011 flood affected 13.6 million people, 65 provinces and over 20,000 km^2 of farmland. The estimated economic damages and losses equals to US$45.7 billion (World Bank 2011). The impacts of these natural disasters pose significant risks and burden to the development and the environment of the country and can seriously harm the local economy.

Likewise, many parts of Thailand is under threat from climate change. Observational records and climate projections predicted that rainfall would increase by about 10-20% across all the regions in Thailand. Mean annual temperature across the country is predicted to increase with the longer period of summer and more days of temperature higher than 33˚C (Chinvanno et al. 2009). Changes in rainfall patterns and the frequency and intensity of rainfall results in 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 which rely heavily on agricultural and natural resources input.

The 2010 droughts and floods

The year 2010 provides evidence of increasing extreme weather events in Thailand. In 2010, Thailand experienced the worst droughts and second worst floods (second to the 2011 floods) in the past two decades. As the tropical rainy season ended earlier than usual in November 2009, together with global warming and El Niño phenomenon, Thailand experienced unusually hot weather and lack of rainfall at the beginning of 2010. As the country entered the hot season in March, experts had issued national drought warnings while the droughts stretched until almost the end of August. The Disaster Prevention and Mitigation Department declared 64 provinces as disaster areas due to severe water shortages. Nearly 16 million people had been adversely impacted by drought which mainly damaged agricultural production. The drought caused damage to 1,716,453 rai (2,746 km^2) of farmland with the estimated loss of 1.5 billion baht (US$47 million).

Later in the year, Thailand experienced a series of flash floods and inundation for seven times. From 15 July-30 December 2010, all regions in Thailand were hit by floods due to La Niña phenomenon which brought about higher than average rainfall and 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 – 25 February 2011. The death toll from the floods stands at 266 people with 1,665 people injured. In total 74 provinces were affected by the floods, 10,909,561 rai (17,455 km^2) of farmland was damaged with the total estimated loss of 16 billion baht (US$505 million). A long severe drought prolonging beyond the first half of the year, followed by destructive floods later in the year made 2010 a year to represent the impacts of climate variability.

DATA

Data from difference sources are used to analyse the impacts of natural disasters on village welfare. Information on demographic and socio-economic characteristics at the village level is obtained from two data sources: Basic Minimum Need Survey (BMN) and the National Rural Development Committee Survey (NRD 2C). Administered by the Community Development Department (CDD), Ministry of Interior, both surveys cover all villages located in rural areas in 76 provinces in Thailand. This covers approximately 70,000 villages accounting for about a half of the Thai population.

The BMN is annual survey of every household from villages and communities all over Thailand. The survey objective is to improve the quality of life of household members through enabling local people and communities to meet their own basic minimum needs in five dimensions: health, dwelling, education, economy and values. The survey is a face-to-face interview of a head or members of a household by interviewers selected from the members of that village using a structured questionnaire. The data are then processed and aggregated at the subdistrict, district, provincial and national levels.

The NRD 2C is a bi-annual survey of living conditions in a village focusing 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 related to their work e.g. village health statistics, death registration and education of people in a village.

The two surveys provide extensive information on demographic, physical, economic and social conditions covering every villages in the country accounting for approximately 48 per cent of Thai population. Since the BMN and the NRD 2C are collected annually and bi-annually, this allows us to construct a panel data and assess economic vulnerability after the natural disaster events accounting for village characteristics in the year before the disasters occurred.

The analysis sample is for the years 2009 and 2011 comprising 68,695 villages with non-missing information for the two years period. We match this sample with district-level disaster data i.e. the floods and droughts report for the year 2010, complied by the Department of Disaster Prevention and Mitigation, Ministry of Interior. The flood and drought reports contain information on the number of population, households and villages affected by flood/drought, estimated economic loss and the amount of public aid.

Table 1 presents basic summary statistics of the sample in 2009 and 2011. The average population per village is 435 individuals and 118 households. The mean proportion of people aged 0-14 declines from 19.4% in 2009 to 18.3 % in 2011 while the mean proportion of people aged 60 years and over increase from 12.9% to 14.1% in 2011. The proportion of sick people, deaths, people with disability and female headed households did not substantially change between the two years. The proportion of agricultural land and households engaging in agriculture declined in 2011 so as the proportion of households without access to electricity and inadequate access to water. On the average, villages mentioning that poor soil quality, crops plantation not breaking even with investments and lack of knowledge to grow other crops are serious problems inhibiting the full use of land declined in 2011.

[TABLE 1: ABOUT HERE]

METHODS

The analysis is an ex-post assessment of the extent to which climate shocks cause economic vulnerability to welfare at a village level. In this study, vulnerability is defined as a function of shocks, susceptibility and resilience and namely the interplay between the realization of stochastic events (i.e. shocks) and individual's, household's, community's, 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 wellbeing or welfare where the individual or household in a community is unable to cope (Heltberg and Bonch-Osmolovskiy 2011).

Here community welfare is measured by income and consumption, which are common direct observable measures of welfare level after experiencing external climatic shocks (Skoufias and Vinha 2012). 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. maintaining 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 current income they have.

Reducing expenditures on food and non-food consumption is one way to deal with reduction in household income. Households may also change investment priorities due to limited economic resources. For example, to supplement income, households may send their children to work instead of school thus reducing 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 towards human capital instead (Skidmore and Toya 2002). Since there is evidence that household adjust their consumption in response to an adverse shock differentially e.g. reducing non-food consumption but smoothing food consumption (Skoufias et al. 2011), it is important to analyse the impacts of catastrophic climate shocks on different dimensions of welfare. This study use five items as an indicator of welfare, namely, food expenditure, non-food expenditure, productive expenditure on agriculture, expenditure on education and income.

We use a difference-in-difference approach to assess the effects of floods and droughts on community welfare level following a commonly used equation to estimate the degree of consumption smoothing (Townsend 1994, 1995).

The model estimating community welfare can be defined as:

$$\Delta \ln w_{it} = \gamma Sc_{jt} + \beta Si_{it} + \delta X_{it} + \partial E_{it} + \Delta\varepsilon_{at}$$

where

$\ln w_{it}$ is first difference in the logarithm of expenditures on food, non-food, agriculture and education and income of village *i* between years 2009 and 2011;

Sc_{jt} is a vector of stochastic measures of floods and droughts in district *j* in 2010;

Si_{it} represents a series of demographic and socio-economic characteristics of village *i* (proportion of people aged 0-14; proportion of people aged 60+; proportion of people with disability; proportion of female headed household; proportion of sick people; proportion of deaths; proportion of households engaging in agriculture; proportion of households with insufficient access to water; and proportion of household without electricity access);

X_{it} is a vector of self-reported environmental and economic constraints in land use for agriculture (poor soil quality; labor shortage; crops plantation not breaking even with investments; lack of knowledge to grow other crops; shortage of water; inundations) ; and

E_{it} is a vector of education composition in village i (proportion of people with elementary and lower secondary education; proportion of people with at least upper secondary education).

Note that in the models estimating expenditures, we use weather shocks and changes in self-reported environmental and economic constraints in land use for agriculture as proxies for income following the above mentioned study (Skoufias and Vinha 2012).

The Stata software, version 11.0, was used for the analyses.

Measurement of floods and droughts

The exposure to floods and droughts are measured at the district level. Although the village might not be hit directly by floods/droughts, there could be indirect effects of the natural disasters which are common to all villages within a district such as food shortages, rising food prices, ruptures in infrastructure or transportation. Using the information on the number of villages affected by floods and droughts in the district, the scale of floods/droughts is divided into five levels:

0 = No villages were hit by floods/droughts;
1 = 1 - 24% of villages in the district were hit by floods/droughts;
2 = 25 - 49% of villages in the district were hit by floods/droughts;
3 = 50 - 74% of villages in the district were hit by floods/droughts;
4 = 75 - 100% of villages in the district were hit by floods/droughts

Table 2 shows the distribution of the proportion of villages affected by floods and droughts in the district. Both droughts and floods were widespread in rural Thailand in 2010. More than half of the villages are located in the district where all villages were affected by droughts and floods. Only 7% and 19% of villages are located in the district where none of the villages were hit by floods and droughts respectively. The variation in flood and drought exposure could pose different effects on welfare of villagers.

[TABLE 2: ABOUT HERE]

EMPIRICAL RESULTS

Welfare effects of droughts and floods

Matching the floods and droughts data with the village-level survey data, we run a series of difference-in-difference OLS regressions assessing the short impacts of floods and droughts exposures on welfare – expenditures and income – as well as exploring the determinants of such economic vulnerability. Table 3 presents regression results of the estimates of expenditures on food, non-food, agricultural inputs and education as well as income.

[TABLE 3: ABOUT HERE]

The village socio-demographic characteristics associated with income present the expected sign. The greater the proportion of children (those aged 0 – 14 years), the elderly (those aged 60 years and over), people with disability and female headed households in the village, the lower the village income. The economic shock due to an increase in the number of deaths has a negative impact on income. Access to water and electricity can serve as proxies for the level of development of a village and therefore the lack of access to such facilities is negatively associated with income. The increase in the proportion of households engaging in agriculture results in a reduction in income reduction. Income also decreases with an increase in self-reported environmental constraints such as poor soil quality and water shortage. As for the impacts of droughts and floods, we find that income marginally increases with one unit increase in the scale of floods by 0.01% and decreases with one unit increase in the scale of droughts by -0.01%.

Education is strongly and positively associated with income. One per cent increase in the proportion of villagers with elementary and lower secondary education and at least upper secondary education results in an income increase by 37% and 62% respectively.

The coefficient estimates of log floods and droughts show that average village consumption per month is protected against any negative income shocks from floods and droughts. We find no evidence that expenditures on food and non-food declined the greater the villages are exposed to droughts and floods. On the opposite, we find significant positive impact of floods and droughts in all types of expenditures.

In terms of physical capital and human capital investment, we do not find that communities cut down their expenditures neither on agriculture nor education. Agricultural expenditures include costs of production such as seed/animal breeding costs, chemical cost (e.g. fertilizers) and other costs (e.g. machinery, petrol). When facing with environmental constraints related to land use such as poor soil quality or water shortage, expenditures on agriculture increase. Similarly, agriculture spending also increased for villages located in districts with greater exposure to floods and droughts by 0.09% and 0.19% respectively.

We find that spending on education increases with one unit increase in the scale of floods and droughts by 0.03% and 0.07% respectively. In particular, education expenditures increased, the higher the average level of education in the villages. Spending on education nevertheless declined the greater the proportion of households engaging in agriculture in the village while the opposite is true for spending on agriculture. This shows that for communities where main economic activity is agriculture, investment in education is lower.

Differences in welfare effects by community educational attainment

In order to explore heterogeneity across the impacts of natural disasters on consumption and income by level of education, we interact the variables on village educational attainment with exposure to floods and droughts. Table 4 displays the effects of floods and droughts on community welfare given the different distribution in educational attainment across villages.

[TABLE 4: ABOUT HERE]

The interaction terms between average level of education in the villages (i.e. proportion of people with elementary and lower secondary education and proportion of people with upper secondary education and higher) and climate shocks show that the impacts of floods and droughts on community welfare vary with education. For consumption, we find that expenditures on food and non-food decreased with exposure to droughts. However, villages with higher proportion of those with secondary education especially upper secondary education and higher do not experience such a decline. Consumption of communities with lower level of education thus is more vulnerable to droughts than those with a higher level of education on average. Similarly, for educational expenditure, villages with higher level of education on average are far more likely to be able to increase the level of spending on education even with drought exposure.

With respect to income, we find a distinctive educational variation in income changes after climate shocks. Villages with higher level of education clearly experience an increase in income with exposure to floods and droughts while villages with a lower proportion of members with secondary education and higher experienced significant income reduction after floods and droughts.

Government aid and income smoothing

Given that the 2010 floods caused much larger economic loss and infrastructure damages 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. Since the Thai government allocated a budget of approximately US$550 million to help flood victims together with US$13 million for drought-affected households, the financial support received from the government might explain why we observe an increase in income for flood-affected villages. In Table 5, we include information on the amount of government monetary assistance for floods and droughts affected districts for the estimation of village monthly income. Note that the sample size gets smaller due to unavailable information on government aid for many flood and drought affected districts.

[TABLE 5: ABOUT HERE]

Exposure to floods no longer has a significant effect on income in the main model when we control for government financial assistance for the floods and droughts affected districts. In fact, we find that village level income increases by 0.02% for each 1 baht increase in financial aid from the government for flood affected areas. Exposure to drought still has a negative effect on income and government financial aid helps smoothing income only slightly with an income increase of 0.002% for each 1 baht increase in government aid for drought affected areas. The interactions between government aid and education show that villages with greater proportion of those in elementary and lower secondary education and those with at least upper secondary education experienced an extra increase in income the more generous the financial assistance for floods received.

DISCUSSION

The results from the main models (without interaction and without controlling for government assistance) show positive impact of floods and droughts on consumption as measured by expenditures on food and non-food. This finding might appear counterintuitive but is in line with many previous studies reporting that weather shocks have 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 on developing countries that household consumption are smoothed when hit by economic shocks (Islam and Maitra 2012)(Chetty and Looney 2005; Cameron and Worswick, Townsend 1994).

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

With respect to welfare differentials by level of education, we find that increased average level of education in a village is associated with higher food and non-food consumption, expenditure on education and income. The positive effect of education on consumption is also reported in studies investigating consumption smoothing at the household level. A study in rural Malawi and recent study in Indonesia reported higher per capita consumption among households with higher level of education of the head of household (Davies 2010, Skoufias et al. 2011). It is also found that education is positively associated with recovery after the natural disasters. A study on household-level recovery after floods in Pakistan reported the positive effect of the education of household head 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. Hence, our analysis shows that the communities with higher proportion of members with lower secondary education and upper secondary education and higher experienced an increase in investment in education. Expenditure on education is even higher among communities with a greater exposure to droughts and with a greater proportion of members in upper secondary education and above. This shows that highly educated communities might have considered the lower return to physical capital due to frequent weather shocks and decided to shift their investment toward human capital instead (Skidmore and Toya 2002).

While our initial analysis shows that income significantly increases with the exposure to floods and droughts, a further analysis indicates that the positive association between income and natural disasters only apply to villages with higher proportion of members with elementary and secondary education and above. It is possible that higher education facilitate access to external resources as recorded in the previous study in Bangladesh showing that education is positively associated with access to support from government and non-government sources (Paul 1998). Therefore, we find that government aid explains the increase in income after the natural disasters and the benefit seems to be concentrated among the communities with higher educational attainment.

CONCLUSION

In this paper, we investigate how Thailand's worst droughts and second worst floods in two decades affect 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 non-food expenditures. Rather than cutting down their investment on physical and human capital in order to smooth consumption on necessary items such as food, we find that spending on agriculture and education increase with flood and drought exposure. The increase in all types of expenditures can be explained by the findings that income has not declined following droughts and floods events.

We further observe that there is significant variation in consumption smoothing across communities educational attainment levels. While communities with lower level of education are prone to lower food and non-food consumption as well as lower spending on educational investment after climate shocks, communities with higher proportion of members with elementary and at least secondary education enjoy the increase in income and consequently consumption.

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

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Table 1: Summary statistics of village characteristics for the years 2009 and 2011

	2009		2011	
	Mean	Sd	Mean	Sd
Number of population	436.88	255.65	433.54	255.08
Number of households	115.99	75.76	119.76	80.29
Proportion of female headed households	0.06	0.23	0.06	0.17
Proportion with elementary and lower secondary education	0.72	0.15	0.72	0.13
Proportion with upper secondary and higher	0.24	0.15	0.24	0.13
Proportion aged 0-14	0.19	0.05	0.18	0.06
Proportion aged 60 and over	0.13	0.05	0.14	0.05
Proportion disabled	0.01	0.06	0.01	0.04
Proportion of sick people	0.05	0.31	0.05	0.26
Proportion of deaths	0.00	0.02	0.00	0.02
Proportion of households engaging in agriculture	0.74	1.94	0.72	1.51
Proportion of households with insufficient water	0.08	0.38	0.06	0.35
Proportion of households with no electricity	0.01	0.07	0.01	0.06
Problem with poor soil	0.28	0.45	0.26	0.44
Problem with labor shortage	0.14	0.35	0.14	0.35
Problem with crop planted not break-even	0.36	0.48	0.33	0.47
Problem with lack of knowledge	0.24	0.43	0.22	0.42
Problem with water shortage	0.41	0.49	0.40	0.49
Problem with inundation	0.15	0.36	0.15	0.36

Table 2: Distribution of village exposure to floods and droughts

	Not exposed	1-74% of villages exposed	All villages exposed	N
Drought	0.20	0.30	0.50	68,695
Flood	0.07	0.41	0.52	68,695

Table 3: Difference-in-difference estimates of community welfare: main models

	Food expense	Non-food expense	Agriculture input expense	Education expense	Income
P elementary & lower secondary	1.806	2.272	3.738	3.493	0.368
	(5.30)**	(7.19)**	(7.72)**	(9.09)**	(8.08)**
P upper secondary & higher	0.598	1.369	-0.524	2.589	0.617
	(1.76)	(4.35)**	(1.09)	(6.76)**	(13.59)**
P female headed household	0.163	0.038	0.440	-0.157	-0.059
	(1.18)	(0.30)	(2.23)*	(1.01)	(3.21)**
P aged 0 – 14	3.436	2.464	9.818	6.528	-0.583
	(8.53)**	(6.60)**	(17.12)**	(14.37)**	(10.83)**
P aged 60 and over	1.264	1.075	4.937	1.449	-0.890
	(3.02)**	(2.77)**	(8.28)**	(3.07)**	(15.92)**
P disabled	-0.878	-0.461	-1.143	0.040	-0.802
	(1.57)	(0.89)	(1.44)	(0.06)	(10.74)**
P sick people	-0.007	-0.003	-0.305	-0.073	0.042
	(0.07)	(0.03)	(2.13)*	(0.64)	(3.14)**
P of deaths	-0.236	-0.566	0.771	0.281	-1.009
	(0.15)	(0.40)	(0.43)	(0.16)	(6.00)**
P households in agriculture	-0.019	-0.028	0.065	-0.146	-0.063
	(1.00)	(1.56)	(2.41)*	(6.77)**	(25.16)**
P household with insufficient water	-0.098	-0.093	0.128	-0.016	-0.037
	(1.61)	(1.66)	(1.48)	(0.24)	(4.56)**
P household with no electricity	-0.515	-0.170	-0.483	-0.486	-0.091
	(1.70)	(0.61)	(1.12)	(1.43)	(2.22)*
Problem with poor soil	-0.041	0.008	0.095	-0.055	-0.020
	(0.81)	(0.17)	(1.34)	(0.98)	(3.08)**
Problem with labor shortage	0.104	0.088	0.034	0.120	-0.010
	(1.72)	(1.57)	(0.40)	(1.77)	(1.23)
Problem with crop planted	0.028	0.007	0.247	0.019	0.006
	(0.54)	(0.16)	(3.40)**	(0.32)	(0.82)
Problem with lack of knowledge	0.031	-0.018	-0.114	0.059	-0.010
	(0.57)	(0.36)	(1.48)	(0.96)	(1.40)
Problem with water shortage	0.090	0.070	0.354	0.170	-0.027
	(2.02)*	(1.69)	(5.59)**	(3.39)**	(4.47)**
Problem with inundation	0.081	0.059	0.252	0.087	0.014
	(1.44)	(1.14)	(3.15)**	(1.38)	(1.83)
Log flood index	0.033	0.016	0.091	0.032	0.007
	(4.41)**	(2.33)*	(8.63)**	(3.84)**	(6.85)**
Log drought index	0.046	0.036	0.185	0.067	-0.011
	(9.96)**	(8.43)**	(28.37)**	(13.07)**	(18.28)**
Constant	0.097	0.087	0.275	0.230	0.025
	(3.10)	(3.00)	(6.16)	(6.51)	(6.03)**
Observations	66,635	66,629	66,630	66,637	66,643
R-squared	0.01	0.00	0.03	0.01	0.04

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level

Table 4: Difference-in-difference estimates of community welfare: interaction models between education and climate shocks

	Food expense	Non-food expense	Agriculture input expense	Education expense	Income
P elementary & lower secondary	1.699	2.185	3.593	3.380	0.373
	(4.96)**	(6.89)**	(7.41)**	(8.76)**	(8.18)**
P upper secondary & higher	0.745	1.463	-0.100	2.728	0.592
	(2.18)*	(4.63)**	(0.21)	(7.09)**	(13.03)**
P female headed household	0.127	0.021	0.442	-0.144	-0.058
	(0.91)	(0.16)	(2.22)*	(0.91)	(3.10)**
P aged 0-14	3.234	2.287	9.568	6.326	-0.569
	(8.01)**	(6.11)**	(16.69)**	(13.89)**	(10.57)**
P aged 60 and over	1.209	1.036	4.672	1.391	-0.888
	(2.88)**	(2.67)**	(7.84)**	(2.94)**	(15.87)**
P disabled	-0.830	-0.428	-1.061	0.037	-0.785
	(1.47)	(0.82)	(1.33)	(0.06)	(10.43)**
P sick individuals	0.015	0.012	-0.315	-0.077	0.043
	(0.15)	(0.13)	(2.20)*	(0.68)	(3.19)**
P of deaths	-0.232	-0.581	0.718	0.295	-1.019
	(0.15)	(0.41)	(0.40)	(0.17)	(6.07)**
P households in agriculture	-0.024	-0.029	0.067	-0.147	-0.062
	(1.27)	(1.64)	(2.44)*	(6.72)**	(24.41)**
P household with insufficient water	-0.106	-0.100	0.105	-0.026	-0.036
	(1.74)	(1.78)	(1.22)	(0.37)	(4.46)**
P household with no electricity	-0.520	-0.171	-0.592	-0.506	-0.086
	(1.72)	(0.61)	(1.38)	(1.48)	(2.10)*
Problem with poor soil	-0.044	0.007	0.080	-0.062	-0.020
	(0.88)	(0.16)	(1.13)	(1.10)	(2.95)**
Problem with labor shortage	0.103	0.085	0.029	0.110	-0.010
	(1.70)	(1.51)	(0.33)	(1.62)	(1.27)
Problem with crop planted	0.027	0.006	0.240	0.019	0.006
	(0.52)	(0.13)	(3.31)**	(0.33)	(0.81)
Problem with lack of knowledge	0.027	-0.021	-0.115	0.059	-0.010
	(0.49)	(0.41)	(1.50)	(0.96)	(1.38)
Problem with water shortage	0.083	0.060	0.335	0.164	-0.026
	(1.87)	(1.47)	(5.30)**	(3.28)**	(4.37)**
Problem with inundation	0.074	0.055	0.244	0.084	0.014
	(1.31)	(1.06)	(3.06)**	(1.32)	(1.84)
Log flood index	-0.075	-0.069	0.317	0.013	-0.045
	(0.50)	(0.49)	(1.50)	(0.08)	(2.28)*
Log drought index	-0.275	-0.371	0.928	-0.236	-0.071
	(3.07)**	(4.46)**	(7.29)**	(2.33)*	(5.92)**
Log flood index*	0.112	0.070	-0.268	-0.001	0.056
P elementary & lower secondary	(0.71)	(0.48)	(1.21)	(0.00)	(2.69)**
Log flood index*	0.100	0.138	-0.141	0.074	0.048
P upper secondary & higher	(0.65)	(0.97)	(0.65)	(0.43)	(2.34)*
	0.244	0.363	-1.003	0.231	0.074

Log drought index*					
P elementary & lower secondary	(2.56)*	(4.10)**	(7.39)**	(2.15)*	(5.85)**
Log drought index*	0.580	0.589	-0.152	0.547	0.029
P upper secondary & higher	(6.42)**	(7.03)**	(1.19)	(5.37)**	(2.43)*
Constant	0.116	0.098	0.310	0.243	0.022
	(3.68)**	(3.36)**	(6.93)**	(6.84)**	(5.34)**
Observations	66,396	66,391	66,392	66,398	66,405
R-squared	0.01	0.01	0.04	0.01	0.04

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level

Table 5: Difference-in-difference estimates of income: effects of government financial assistance

	Main model	Interaction model
P elementary & lower secondary	0.362	-0.140
	(3.75)**	(1.42)
P upper secondary & higher	0.480	0.011
	(5.09)**	(0.11)
P female headed household	0.015	-0.102
	(0.46)	(2.32)*
P aged 0-14	-0.571	-0.598
	(-5.76)**	(6.08)**
P aged 60 and over	-0.678	-0.662
	(-6.90)**	(6.70)**
P disabled	-1.190	-0.253
	(-6.47)**	(1.70)
P sick individuals	0.036	-0.014
	(0.94)	(0.35)
P of deaths	0.514	-0.627
	(1.07)	(1.31)
P households in agriculture	-0.125	-0.114
	(-15.99)**	(14.42)**
P household with insufficient water	-0.025	-0.027
	(-1.82)	(1.95)
P household with no electricity	-0.061	-0.080
	(-0.76)	(0.96)
Problem with poor soil	-0.019	-0.011
	(-1.63)	(0.92)
Problem with labor shortage	-0.010	-0.022
	(-0.72)	(1.54)
Problem with crop planted	-0.002	0.019
	(-0.16)	(1.63)
Problem with lack of knowledge	-0.004	-0.007
	(-0.34)	(0.52)
Problem with water shortage	-0.014	-0.019
	(-1.38)	(1.79)
Problem with inundation	0.014	0.008
	(1.10)	(0.61)
Log flood index	0.020	0.006
	(1.24)	(0.39)
Log drought index	-0.015	-0.015
	(-9.24)**	(9.49)**
Log financial aid for flood	0.017	-0.020
	(4.01)**	(1.65)

Log financial aid for drought	0.002	-0.003
	(2.35)**	(0.28)
Log financial aid for flood*		0.037
P elementary & lower secondary		(3.07)**
Log financial aid for flood*		0.054
P upper secondary & higher		(4.71)**
Log financial aid for drought*		0.005
P elementary & lower secondary		(0.43)
Log financial aid for drought*		0.008
P upper secondary & higher		(0.69)
Constant	-0.212	-0.244
	(-3.41)	(3.89)**
Observations	19,682	19,611
R-squared	0.03	0.03

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level