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Assessing vulnerability of remittance-recipient and non-recipient households in rural communities affected by extreme weather events: Case studies from south-west China and northeast India

Abstract

Migration is one way in which rural households can seek to reduce their vulnerability to climate change. However, migration also carries risks and costs, such that vulnerability may not be reduced. This article constructs an index of rural households' vulnerability to extreme weather events, in order to explore how key components of vulnerability relate to migration. Applied to case studies in India and China, the study finds that the impact of remittances is non-linear. While overall, in Assam few differences were found in the vulnerability of households that did and did not receive remittances, in Yunnan, remittance recipient households were found to have less adaptive capacity in response to drought. However, those who had received remittances over longer periods were found to have improved adaptive capacity in both case studies, and in Yunnan, their exposure to such events was also lower. Meanwhile in Assam, longer-distance migration was associated with reduced exposure to flooding, and with specific forms of adaptation. The vulnerability index developed has capacity to be used in assessments of effects of migration on vulnerability elsewhere.

Keywords

Vulnerability, Climate Change, Migration, Remittances, India, China.

Introduction

Both scientific discussion and public discourse around migration and climate change have shifted in recent years, from a focus on how environmental shocks and stressors might induce large-scale displacement and out-migration, particularly in developing countries (see El Hinnawi, 1985; Jacobsen 1988), to an understanding that migration may represent a form of adaptation to climate change, in light of the positive impacts of migration on sending households and origin communities due to financial remittances sent back by migrant workers, skills brought back by returnees, and diaspora effects on investment and support (see McLeman & Smit, 2003; Black, Bennett, Thomas, & Beddington, 2011; ADB, 2012). Whereas the Intergovernmental Panel on Climate Change's First Assessment Report in 1990 stated that 'the gravest effects of climate change may be those on human migration as millions will be displaced' (IPCC, 1990, p.20), the United Nations Framework Convention on Climate Change's Cancún Adaptation Framework of 2010 recognised for the first time that migration can be used by migrants as an adaptation strategy (ADB, 2012), whilst the Sendai Framework for Disaster Risk Reduction: 2015-2030 acknowledged that knowledge, skills, and capacities of migrants will be useful in the design and implementation of disaster risk reduction, which contributes to the resilience of communities and societies (Assembly, 2015). Indeed, the Summary for Policymakers of IPCC's AR5 suggested that expanding opportunities for human mobility could reduce the vulnerability of populations that were at risk of displacement (IPCC, 2014b).

Despite these gradual shifts at the global level, the role of human mobility in climate change adaptation largely remains at the fringe of climate change discourse in national planning. For example, a review of National Adaptation Plans of Action (NAPAs) by Sward (2012) found that discussion of migration in these plans varied widely, and even where it was recognised, activities were often focused on reducing autonomous migration flows rather than capitalising on any potential benefits for vulnerable people. Similarly, Warner et al. (2015) found that although migration emerged as a theme in NAPAs, they usually lacked detail on strategies to engage with migration.

Given that references to migration as a form of adaptation to climate change now stretch back over two decades (see McLeman & Smith, 2003; Tacoli, 2009; Black et al., 2011; Warner et al., 2012; Gemenne & Blocher, 2016), and have been implicitly or explicitly endorsed by several major donors as a lens to engage with migration and climate change (Barnett & Webber, 2009; ADB, 2012) the question arises as to why it should be the case that this idea still has so little traction in public policies at the national and regional level. Certainly, the migration and climate change adaptation discourse is not lacking its critics. Some stakeholders have considered migration to be a failure of adaptation or an option of last resort (e.g. Baro & Deubel, 2006; Renaud, Bogardi, Dun, & Warner, 2007); and some have suggested that migration is a mismatched strategy, which is unsuitable to address structural determinants of vulnerability to climate change (e.g. Felli & Castree, 2012). At the same time, the impact of remittances itself is a contested issue (Orozco, 2013), with some authors pointing towards unintended 'consumption' impacts, a lack of productive utilization of remittances overall and indeed a reduction in investment or steering of investments to urban areas (Castelhano, Lin Lawell, Summer, & Taylor, 2016; Griffiths, 2016; Manic, 2016), even if there are counter-examples that suggest a more positive role (Lokshin, Bontch-Osmolovki, & Glinskaya, 2010; Housen, Hopkins, & Earnest, 2012; Javaid, 2017).

Yet perhaps the key issue is that the 'migration as an adaptation' and 'migration as a failure of adaptation' approaches have arrived at a normative judgement largely based on an assessment of the drivers and motivations of migration, but lacking an in-depth analysis of effects of migration specifically on the vulnerability of those left behind in origin communities who are at risk from extreme weather events. Whilst remittances clearly may be spent on procuring relief in the aftermath of a flood, how are we to understand whether the *vulnerability* of a remittance-recipient household to floods is different than that of a non-recipient household? It is necessary to build an evidence base about migration consequences in context of climate change adaptation to inform policy.

Such an analysis is the core purpose of this paper, in which we use a multi-criteria decision analysis (MCDA) approach to characterise the vulnerability of remittance-recipient and non-recipient households affected by extreme weather events. Our approach differs from previous studies on environmental change and migration in that it not only aims to understand how the choices on remittance usage made by households might shape climate change adaptation; but it also constructs an index to compare vulnerability of migrants and non-migrants using a consistent framework in different locations. The analysis is applied to case studies from drought affected rural households in Baoshan County in the Upper Mekong-Salween sub-basins of China and flood affected rural households in Upper Assam in the Eastern Brahmaputra sub-basin of India. The two regions are part of a multi-country study of adaptation in the face of climate change; whilst both regions are experiencing significant out-migration, both environmental stressors and the wider socio-political context varies significantly across the two regions.

Building a vulnerability index

Circular labour migration and vulnerability to extreme weather events

The environmental migrant centric approach places the focus of analysis on those who have been driven to migrate by environmental stressors and shocks (including climatic factors). However, if we are to consider whether and how migration reduces vulnerability to climate change, we also need to include in our analysis those whose decision to move has not been influenced by the environmental stressors – since they may also support climate change adaptation among families left behind. Taking this into account, in the analysis which follows, the household in the place of origin is used as the unit of analysis. Though a household occupies a specific geographical location, through circular labour migration households are often connected to one or more geographic locations through the migrant worker(s) or in-flow of remittances. Migrant-sending households can be viewed as using an autonomous strategy to temporarily substitute perceived and real structural constraints in origin communities, which impede their welfare, with perceived and actual structural opportunities provided by the destination communities (e.g. alternative income opportunity and access to cash income). This could permit the household in origin community to sustain itself despite the impacts of extreme weather events.

Our focus is on internal labour migration, as this is the predominant form of migration in both Baoshan County and Upper Assam[1], with migrants from the former going to major cities within the province, and migrants from the latter moving both within Assam, and also all over India. The financial costs of internal migration are usually relatively lower than international migration, and this allows low-income and marginalised social groups also to migrate in search of employment. Similar to the structural constraints confronted by the rural households in the sending region, migrant workers could experience a wide range of challenges in the destination: difficult working and living conditions, low income, lack of access to social protection mechanisms, negative bias about migrants in the urban spaces, and psychological stress. Despite these challenges, the low

[1] The four districts of Dhemaji, Dibrugarh, Lakhimpur, and Tinsukia were considered to be one aggregated areal unit: Upper Assam.

entry threshold of employment in the informal sector in urban areas provides an opportunity to even some of the poorest rural households to diversify their livelihoods portfolio. Remittances supplement the income of recipient households in origin communities. ADB (2012) suggests that remittances might increase adaptive capacity and promptly indemnify property damaged due to extreme weather events for remittance-recipient families living in high-risk areas.

Calculating a vulnerability index

Reduction of a system's vulnerability to climate change and variability is an essential component of adaptation. Despite the terminological and methodological ambiguity with vulnerability and associated concepts (Hinkel, Schipper, & Wolf, 2010), there is a consensus that vulnerability is place-based and context-specific (Cutter, Boruff, & Shirley, 2003). The IPCC's Fifth Assessment Report (FAR) defines vulnerability as '[t]he propensity or predisposition to be adversely affected (IPCC, 2014a, p. 28).' The present analysis adopts the IPCC conceptualization of vulnerability as a function of three major components: exposure, sensitivity and adaptive capacity. The IPCC's FAR defines exposure as '[t]he presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected (IPCC, 2014a, p. 12). The same assessment defines sensitivity as '[t]he degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise) (IPCC, 2014a, p. 24)'. In turn, adaptive capacity is defined as '[t]he ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014a, p. 2)'.

Given a fixed (or indeed growing) level of exposure of households to climate change and variability, a reduction in sensitivity and/or enhancement of capacity to adapt is required to reduce the vulnerability of a system to an extreme weather event. In this analysis, we adopt a bottom-up and indicator-based approach to assess the vulnerability of households to major extreme weather events (droughts or floods). The indicator-based approach provides a framework to characterize the vulnerability of different groups (e.g. remittance-recipient and non-recipient households) and helps to standardize assessment. Indicator-based approaches have been widely used in developing nations, especially where there is a lack of impact data (Adger, Brooks, Bentham, Agnew, & Eriksen, 2004). They measure the present state of a system to assess its vulnerability to a stressor (Hinkel et al., 2010). However, they have not to date been used to consider the effects of migration on vulnerability.

Drawing on the adaptation (e.g. Agrawal & Perrin, 2008; Below et al., 2012), adaptive capacity (e.g. Vincent, 2007; Sharma & Patwardhan, 2008; Aulong et al., 2012), and vulnerability literature (e.g. Eakin & Bojórquez-Tapia, 2008; Hahn, Riederer, & Foster, 2009; Gerlitz et al., 2016), a vulnerability framework was conceptualized that could be applied to the specific circumstances of each case study (Figure 1). The framework has five levels in total, of which three are represented in Figure 1, these being the levels that are likely to be of importance in any case study. The overall aim of this analysis is represented at the top level: it is to reduce vulnerability of a household to a specific extreme weather event. The second tier is comprised of the major components of vulnerability. To reduce a household's vulnerability to drought or flooding, the aim is to reduce exposure and sensitivity and/or enhance adaptive capacity. The sub-dimensions of exposure, sensitivity and adaptive capacity are represented in the third tier.

[INSERT FIGURE 1 HERE]

The fourth tier of the hierarchy is comprised of attributes that make up each of the sub-dimensions in a particular place. In our two case study areas, these attributes were identified during focus group discussions (FGDs) in 2013, and hence they internalise the experience of local residents. They were then supplemented by inputs from a literature survey and the feedback of local experts. The attributes selected were those which could be considered autonomous in nature. For example, structural changes to houses to in response to flooding are manageable by a household. But the household would have little influence on the alignment of a river embankment, which is a responsibility of the government institutions. The attributes were then categorised according to the vulnerability framework.

Once attributes of vulnerability were identified, a key task was to construct an 'index of vulnerability' against which migrant households could be assessed. Here, we draw on the Hahn et al. (2009) methodology for estimating vulnerability. First, attributes were standardized on a scale from 0-1, with 1 being more sensitive, more exposed, or less adaptive. Like Hahn et al. (2009), we adapt the equation of the life expectancy index in the

Human Development Index (HDI) to standardise these attributes. The difference between the actual value of attribute for a household and minimum value of attribute in the sample is divided by the difference between the maximum and minimum values of the attribute in the sample. Certain attributes are measured as an index (e.g. crop diversification index and communication device diversification index), and are inverse in nature. A few attributes such as the 'household with exterior walls built from weak construction material' or 'household that did not have access to farm mechanisation' are binary categorical (No 0, Yes 1). These attributes were then averaged to calculate the value of respective sub-dimension (see equation *I*).

[redacted]

Where [redacted] is one of the sub-dimensions of sensitivity or adaptive capacity for a household *h*. [redacted] is the weight assigned to each indicator; and [redacted] = n. n is the number of attributes in each sub-dimension. Once the sub-dimensions were estimated, they were averaged using equation *II* to estimate the household-level vulnerability:

[redacted]

Where [redacted] is the household level vulnerability index for household *h*. The value of the vulnerability index ranges from 0 (least vulnerable) to +1 (most vulnerable).

Previous vulnerability assessments have addressed weights of indicators in two ways. A first approach considers all the indicators to be of equal weight based on the assumption that all are of equal importance (see Vincent, 2007; Hahn et al., 2009). The second approach is based on the underlying assumption that importance of an indicator will vary from one place to another depending on contextual factors, and uses a specific methodology to determine relative importance of different indicators (see Eakin & Bojorquez-Tapia, 2008; Eakin, Bojorquez-Tapia, Diaz, Castellanos, Hagger, 2011; Aulong et al., 2012). Since vulnerability is context specific, its constituents are unlikely to carry equal weight between contexts. This paper therefore adopts the Analytical Hierarchy Process (AHP), an MCDA tool, to assign weights to the major components, sub-dimensions, and attributes of vulnerability. Based on pairwise comparisons of criteria that characterise the alternatives under study (Saaty, 1980), AHP permits a complex decision making process to be decomposed into a hierarchical structure of sub-problems.

In order to operationalize the AHP design, one expert workshop was organised in Guwahati, India, in October 2015, and another in Kunming, China, in December 2015. The expertise of the workshop participants included climate change adaptation, disaster management, rural development, public policy, gender, migration, and livelihoods. The experts in Guwahati undertook 197 pairwise comparisons, and those in Kunming undertook 151 pairwise comparisons. Each expert had to select the most important asset within each pair of attributes, sub-dimensions, and major components based on a subjective assessment of their relative contribution in either reducing exposure and sensitivity or enhancing adaptive capacity, and in turn reducing vulnerability. This subjective judgement is influenced by the experience of an individual expert, which is an outcome of his/ her knowledge and familiarity with study area. Saaty (1980) recommends a 9-point scale to assess the relative importance between paired assets. These pairwise comparisons are transformed into ratio-scale numbers though the eigenvector method. The ratio-scale numbers represent the relative local weight and the global weights (Eakin & Bojorquez-Tapia, 2008). The local weight represents the relative importance of the attributes, sub-dimensions, and major component belonging to a specific nest in the hierarchy to the level immediately above. The relative importance of an attribute, sub-dimension, and major component to the overall goal is indicated by the global weight. These weights were combined with the standardised survey data to generate index values for each attribute and are documented in figures 2 and 3 for Baoshan County and Upper Assam respectively.

[INSERT FIGURES 2 AND 3 HERE]

Data collection

The analysis that follows is based on data collected through FGDs and surveys in the two regions. The FGDs were used to gain an understanding of the local context, contribute to the specification of the attributes of each sub-dimension of vulnerability, and to design survey questionnaires using specific indicators for each attribute that constitute the fifth tier of the hierarchical framework. FGDs were conducted in 10 villages in Baoshan County and 12 villages in Upper Assam. In each village, six FGDs were conducted with migrant workers (including recent returnees), women from migrant-sending households, men and women from poor and non-migrant households, and men and women from non-poor and non-migrant households. The household-level survey tools included a household schedule, drought or flood schedule, migrant schedule, and non-migrant schedule.[2] A village schedule was used to collect village-level information. Selection of households for survey involved a two-stage process. A list of all drought affected villages in Baoshan County and flood-affected villages in Upper Assam was prepared.[3] In the first stage, 30 drought affected villages of Baoshan County and 29 flood affected villages of Upper Assam were selected using a systematic random sampling procedure following the Probability Proportional to Size (PPS) approach. In the second stage, equal number of households (i.e. 20 households) was selected using systematic sampling within each selected village. Prior to the household selection, a house listing exercise was conducted in each study village to prepare separate lists of the migrant-sending and non-migrant households in the village. From the list of migrant-sending households, 10 households were selected through a systematic random sampling procedure. A similar process was adopted to select 10 non-migrant households. Sample size was calculated to compare the degree of vulnerability among migrant-sending and non-migrant households. In the absence of any prior evidence, it was assumed that 50 percent of households are vulnerable to extreme weather events. Further, sample size was estimated assuming a 5 percent margin of error with 95 percent confidence interval. The resulting sample size was inflated by 15 percent to accommodate non-response arising due to non-participation or refusal of respondents. Also, the sample size was inflated by a design effect of 1.3 to accommodate the increased variance due to use of complex sampling design. This resulted in a sample size of 574 households. This was rounded off to 600 households in each study area (i.e. 300 migrant-sending households and 300 non-migrant households). At the end of the survey, 608 households

[2] Drought and flood schedules were used in Yunnan and Upper Assam, respectively.

[3] If a village had experienced a riverine flood or flash flood at least once since 1984 then it was considered as a flood affected village. The non-flood affected villages had not been affected by a riverine flood or flash flood since 1984.

had been surveyed in Baoshan County (i.e. 302 migrant-sending households and 306 non-migrant households) and 578 households in Upper Assam (i.e. 289 migrant-sending households and 289 non-migrant households). Migrant-sending households that had received remittances are referred to as remittance-recipient households. Non-migrant households, which had not received remittances are referred to as non-recipient households.

In practice, indices of vulnerability were calculated, using both AHP and equal rates, as a sensitivity check on the results. In general, the significance of differences between the two approaches was negligible. However, where differences appeared, these are noted below.

Results

A primary purpose of vulnerability analysis is to explore the principal components of vulnerability, and how these vary between different groups that are affected by climate change. Since vulnerability assessment is place-specific, it is not possible to make direct comparison between the overall vulnerability of populations in different places, but it is useful to compare the vulnerability of different groups within a place. Here, we focus our analysis on comparison of those who were receiving remittances from a household member, and those who were not; amongst those receiving remittances, we also compare the vulnerability to extreme events of those who had been receiving remittances for a longer or shorter duration[4], and longer versus shorter distance migration. In practice, whilst in Upper Assam we interviewed households who were receiving remittances from both within and beyond the state of Assam, in Baoshan County, no households in our sample were receiving remittances from outside Yunnan province.

Overall, our results find little evidence that migration per se has a positive impact on the aggregate vulnerability of households confronted by adverse impacts of climate stressors. In Upper Assam, households receiving remittances were not significantly less vulnerable to flooding, whilst in Yunnan, recipient households were actually found to be significantly more vulnerable to drought in aggregate terms (Table 1). A key to

[4] Duration of remittance receipt is the period between the first and latest instances of remittance receipt by the household. It is recorded as a continuous variable in the household survey. Since this variable does not follow a normal distribution, it is converted into a categorical form with two sub-categories: short-duration (i.e. below median value) and long-duration (i.e. above median value) remittance-recipient households.

understanding this is to unpack the different levels of vulnerability, and also the different dimensions of migration. In neither case was this found to change over time – households that had received remittances over a longer period showed no significant difference in aggregate vulnerability. Whilst it was not possible to distinguish 'long distance' from 'short distance' migrants in Baoshan County, in Upper Assam, households receiving remittances from family members outside northeast India were found to have significantly lower levels of vulnerability than those receiving remittances from family members within the region. This is consistent with a commonsense understanding of migration – those migrating over shorter distances are less likely to access opportunities that would materially improve their economic conditions, and hence have a positive impact on vulnerability. Indeed, put another way, long-distance movement may only be deemed worthwhile if it opens up the possibility of significantly greater earnings or opportunities.

[INSERT TABLE 1 HERE]

Turning to the three major components of vulnerability, in Upper Assam, no statistically significant differences were found in either exposure, sensitivity or adaptive capacity between recipient and non-recipient households. In Baoshan County, the higher level of vulnerability overall reflected a significantly lower level of adaptive capacity amongst those in receipt of remittances, although this group were also found to have significantly less 'exposure' – i.e. their experience of droughts was that they were of shorter duration, which had caused less financial damage, and required a shorter recovery time (Table 2).

However, more nuance emerges when we consider the intersection of the dimensions of migration and components of vulnerability. Thus, whilst overall the duration of remittance receipt was not associated with vulnerability, it was found to have a significant positive association with adaptive capacity to climate stressors in both Upper Assam and Baoshan County, whilst long-duration households were also less exposed to droughts in Baoshan County. Meanwhile, long-distance migrants were less vulnerable in Upper Assam at least in part because they had significantly less exposure to floods. This does not mean that they were less exposed because they were physically removed from Upper Assam, since analysis here is on the household which remained in situ. Rather, as with remittance-recipients in Baoshan County, the experience of floods was that they were of shorter duration, which had caused less financial damage, and/or took less time to recover from. In the following sections, we unpack each of these components to explore vulnerability at the attribute level.

[INSERT TABLE 2 HERE]

Exposure

The exposure of a household to a major extreme event is defined here as comprising three sub-dimensions: number of years between 1984 and 2013 when the household had experienced a particular extreme event (i.e. drought in Baoshan County and floods in Upper Assam), financial damages to the household during each episode of a specific extreme event between 1984 and 2013, and time taken by a household to recover from the damages caused during each episode of the extreme event between 1984 and 2013. The choice of these sub-dimensions reflects existing research that suggests that remittances are commonly used as one way to recover from extreme events (Rayhan, 2005) and indeed at a macro-level have been found to rise following disasters (Mohapatra, Joseph, & Ratha, 2009). Use of remittances in this way may also lead people to retrospectively report that they experienced fewer extreme events, as the financial buffer of remittances left them less exposed to the event's economic consequences.

In Baoshan County, our findings suggest that drought-related financial damages in particular were marginally lower for households that had received remittances than for those that had not. Also, households that had received remittances over a long period had experienced lower damages due to drought and recovered quicker than short-duration recipients (Table 3). Meanwhile, in Upper Assam, long-distance migrant households were much less likely to report that they experienced floods at all (Table 4). This suggests that migration, and especially long-distance migration, can have a positive effect in reducing exposure, although the way this was reported varied across our two case study sites.

[INSERT TABLES 3 AND 4 HERE]

Sensitivity

Existing literature suggests that there are a number of attributes of sensitivity to climate stressors that could be positively influenced by migration. For example, households that earn income from multiple sources can better manage risk (Ellis, 2000), and migration certainly opens the possibility of multiple income sources to rural households. Hassan and Nhemachena (2008) suggest that the sensitivity to climate stressors could be reduced through diversification from farming to non-farming activities, whilst Adger (1999) notes the particular risk of dependence on crop income, and hence the value of crop diversification to reduce sensitivity to climate stressors. Both of these could be enhanced by migration; in Assam, Mandal (2014) suggests that farmers have indeed adopted crop-diversification as a strategy to avoid crop losses due to frequent floods, although he does not address whether migration is linked to crop diversification in this case. Meanwhile Hahn et al. (2009) note the importance of time taken to collect drinking water as an element of sensitivity of a household to climate stressors. Remittances could reduce this time if invested in improved water supplies.

The overall analysis suggests that migration has little impact on sensitivity to extreme weather events in the two case studies. However, if we look at sensitivity at the attribute level (Tables 5 and 6), some significant differences emerge which suggest that the receipt of remittances, and their receipt over a long period or from a long-distance migrant destination does in some respects have an effect on sensitivity to climate stressors. For example, in Baoshan County, remittance-recipient households were less dependent on rain-fed farming, which is especially susceptible to drought; but these households also had access to fewer non-farm income sources, which perhaps indicates a dependence on remittances. The non-recipient households in Baoshan County were marginally more reliant on less-preferred food during drought than remittance-recipient households. In Upper Assam, recipients had less crop diversification, although they were also less dependent on crop income. Meanwhile, recipient households in Baoshan County were found to take significantly less time collecting water, but in Upper Assam, recipient households spent longer collecting water than non-recipients.

To explore differences among recipient households based on how long they had been receiving remittances, attributes of sensitivity were disaggregated into whether they were adopted before or after the first episode of migration, since only the latter are likely to have been influenced by remittances. In Baoshan County, long-duration recipients had smaller rain-fed farms than short-duration. However, they were also significantly more reliant on less-preferred food during drought, dependent on unprotected or open water sources in general, and less likely to have stored water for consumption during droughts. In Upper Assam, nearly twice the number of long-duration households (40%) reported a reduction in agricultural assets (e.g. land, livestock, seeds, or tools) due to floods compared to short-duration households (22%). However, in this location, more long-duration recipients had placed tube-wells and ring-wells above the flood line, a key factor in preventing flood water from contaminating these drinking water sources (Das, Chutiya, & Hazarika, 2009). Meanwhile, in relation to dependence on environmental resources for cooking fuel, which may increase a household's sensitivity to climate stressors (Sharma & Patwardhan, 2008; Rajesh, Jain, Sharma, & Bhahuguna, 2014), our survey shows that fewer long-duration households were dependent on environmental resources for cooking fuel in both case study regions. The differences between short- and long-distance households in Upper Assam were also significant for several attributes of environmental dependence. Long-distance households grew more types of crop, were more dependent on crop income, had access to more non-farm income sources than short-distance households; and fewer long-distance households had lost agricultural assets due to floods. This reinforces the conclusion that long-distance migration has had a positive impact in reducing sensitivity to floods in this region.

[INSERT TABLES 5 AND 6 HERE]

Adaptive capacity

The overall analysis of adaptive capacity shows this is reduced for remittance-recipient households in Baoshan County, but increased amongst longer-duration recipients in both case studies. However, again important perspectives emerge at the attribute level (Tables 7 and 8). In the case of Baoshan County, the lower adaptive capacity of remittance-recipient households reflects in particular that fewer households had changed farming practices including mechanization and storage, and fewer alternative livelihoods for this group, all of these representing strategies that could increase adaptive capacity (see Hassan & Nhemachena, 2008; Below et al., 2012; Agrawal & Perrin, 2008). In Upper Assam, the level of farm mechanization was also lower amongst remittance-recipient households, although this group did have access to more livelihood opportunities nearby, and also had better access to communication devices, which can help improve adaptive capacity (see Ellis, 2004; Wisner, Blaikie, Cannon, & Davis, 2004; Mohapatra et al. 2009).

Turning to changes over time, households in Baoshan County which had received remittances over a long period had smaller farm sizes or fewer had invested in mechanization. However, more long-duration households had made other changes to farm practices in response to drought (including reduction in land area under crops, reduction in number of cattle or poultry, or changes in farming calendar). They also had significantly more access to assistance and loans during drought. As a result, adaptive capacity overall was marginally higher for this group. Meanwhile, in Upper Assam, households that had received remittances over a longer time period were found to have better adaptive capacities than short-duration households in almost every respect – with the exception of access to flood assistance and alternative livelihood activities in the local area. In terms of distance between origin and destination communities, long-distance households in Upper Assam had larger farm size, more livestock, and fewer of them had needed to change their agricultural practices in response to floods. These households also had less need to access to loan and storage during floods, and few had participated in collective flood preparedness.

[INSERT TABLES 7 AND 8 HERE]

Discussion

Whilst there is growing acceptance of the notion that migration can be a form of adaptation in the face of climate change, there are few existing studies that take a comprehensive approach to whether adaptive capacity, as well as exposure and sensitivity to climate change, are improved in communities that have significant levels of migration. The vulnerability index outlined here provides such a comprehensive assessment of vulnerability respectively for a drought-affected county in China and a flood-affected region of India, both within the Hindu-Kush Himalaya region. Focusing on receipt of remittances by households within these two regions, the analysis does not suggest that migration contributes to a reduction in vulnerability to climate change overall; indeed, in the case of China, it suggests it is associated with *reduction* in adaptive capacity. However, when we drill down to the specific sub-dimensions and attributes that go together to make up vulnerability, as well as to how migration varies over time and space, a different picture emerges – one in which long-distance migration in particular is associated with reduced sensitivity and increased adaptive capacity in the face of climate stressors.

A number of caveats need to be raised in relation to this. First, the nature of the vulnerability index constructed here on the basis of existing literature and local knowledge on climate change adaptation is that it is biased towards vulnerability in relation to natural resources, rather than in relation to non-farm activities, in particular non-farm activities at a distant location such as urban areas. Whilst it is well established that the impacts of future climate change are likely to be most severe on those predominantly dependent on natural resources (Burton, Huq, Lim, Pilifosova, & Schipper, 2002; Simms, Magrath, & Reid, 2004), this is not the only form of vulnerability that poor people face. To take a concrete example, our analysis shows remittance-recipient households in Baoshan Country seem to consider farming as a 'back-up' livelihood strategy to migration, rather than the other way around. Indeed, in China, urban residence permits for large cities are still hard to obtain, and many migrants are unwilling to leave the land altogether since this would imply returning it to the state (Tao & Xu, 2007). As a result, rural households in China are unlikely to leave agriculture entirely (Taylor, Rozelle, & De Bauw, 2003) with agriculture seen as an option of 'last resort' (Yang & Zhou, 1999). Moreover, the relatively young age at first migration suggests that agricultural workers may have a relatively short association with agriculture prior to migration. Young educated migrants are unlikely to value farming as much as older and less educated workers in rural areas, and this may explain why they are not so concerned to invest in farm-based capacities.

Second, the findings from the two case studies suggest a growing importance of remittances in relation to adaptive strategies within source areas over the migration cycle. Yet in part, this represents a shift from dependence on agriculture to dependence on remittances: remittance-recipient households in Baoshan County earn income from fewer sources overall than non-recipient households, whilst long-duration households in Upper Assam have access to fewer non-farm income sources than short-duration households. Due to this progressive increase in remittance dependency, remittance-recipient households are likely to be more sensitive to non-climate hazards. Most of the remittance senders in Upper Assam and Baoshan County are wage employees in informal sector. Despite comparatively easy entry into non-farm jobs in the informal sector for semi-skilled or unskilled workers in both India and China, these jobs often do not provide social security benefits (e.g. pension, provident fund, or insurance) nor job security in either country. As a result, migrants who become informal sector workers may exchange climate risks for non-climate risks such as sudden termination of employment, market downturns, or social unrest in host community, without any improvement in their social status. In turn, any disruption in remittance supply would also have an adverse effect on remittance-recipient households' welfare.

However, countering this possible remittance dependency, the analysis here suggests that migration may also have more positive effects on exposure, sensitivity and adaptive capacity in the face of climate change over time within rural areas. Indeed, previous research suggests that basic consumption needs, loan repayment, and children's education are usually addressed first by migrant workers, and only afterwards, households use the savings from remittances to purchase land or a house, hire labour, invest in farm mechanisation, or establish a small business (Lipton, 1980; Massey, Alarcón, Durand, & González, 1987). In the specific cases of Baoshan County and Upper Assam, remittances are commonly invested in food, health care, community activities, consumer goods, education, and transport. But long-duration households in Upper Assam were found to have started to address flood risks as well as have better access to financial assistance and loans, whilst long-duration households in Baoshan County had better access to drought assistance and had also started to modify farming and livestock rearing practices. This manifests a household's prioritisation of expenditure over time.

A third caveat relates to causation – in short, demonstrating an association between the access to remittances, or the length of time or distance over which migration takes place and changes in sub-dimensions of a vulnerability index, we cannot necessarily conclude that there is a causal relationship. For example, it is clear worldwide that migration is often highly selective in terms of age, education and wealth, especially in its early stages of development and over longer distances (Massey at al., 1993); if less vulnerable households were more likely to have sent family members out as migrants, then this in itself could explain their lower sensitivity and adaptive capacity. In our two case studies, however, migration is quite well-established and mostly internal in nature, and there is less reason to believe that it is particularly selective, especially in relation to existing levels of vulnerability. Where we do consider long-distance migration, we do so in relation to shorter-distance migration, and consider adaptations made *after* the first incidence of migration for work from a household.

Finally, an interesting comparison can be made between attributes and sub-dimensions that are shown as important areas of difference in the structure of vulnerability between remittance-recipients and non-recipients, or long and short-duration recipients, and those that were 'weighted' as importance in the MCDA process that designed the AHP weights. In Yunnan, expert analysis suggested that financial, human and natural assets were the most important aspects of adaptive capacity, whilst water was the key element of sensitivity, especially the storage of drinking water for consumption during drought. However, our analysis suggests that physical assets are of particular importance in distinguishing the adaptive capacity of different groups. Meanwhile, our analysis suggests that water is a key factor for long-duration recipients, but that the level of farm diversification is also an important distinguishing feature between recipients and non-recipients.

In Upper Assam, expert analysis suggested that financial assets were the key element of adaptive capacity, with formal financial institutions of particular importance, whilst the risk of reduced health expenditure was the most important element of sensitivity. However, our analysis suggests that long-duration migrants are much more likely to invest in both formal financial institutions and insurance, whilst they also invest in flood preparedness and changed agricultural practices. Also, whilst health was of some importance in distinguishing long and short-term recipients, other factors, including protection of water resources, and improving house construction to withstand flood are of much greater significance.

Conclusion

Extreme weather events will continue to pose a challenge to the well-being of rural households. Access to remittances could provide an alternative income source that is less sensitive to the impacts of extreme weather events in origin communities. In a context in which there is limited empirical knowledge regarding the effects of migration outcomes (e.g. remittances) on the vulnerability of remittance-recipient households in areas of origin, this paper presents an indicator-based assessment of rural households' vulnerability to major extreme weather events. The findings suggest that whilst remittance-recipient households are not necessarily less vulnerable to extreme weather events overall, when this vulnerability is unpacked into the different elements that form part of an overall vulnerability index, and migration is explored over different temporal and spatial scales some clearer patterns can be identified – notably that longer-distance migration in Assam appears to be associated with reduced exposure to extreme weather events, whilst in both cases, those who received remittances over longer periods had improved adaptive capacity.

One drawback of a location-specific vulnerability index is that it does not allow for comparison of vulnerability across different places. Nonetheless, changes in household-level vulnerability of remittance-recipient and non-recipient households could be assessed if this study is repeated in the same locations over time, without the need to return to the same respondents. Future research could also add new attributes to the vulnerability framework, particularly indicators regarding a household's access to government, non-government, and customary institutions could be refined.

The methodology applied here to generate weights makes the vulnerability assessment more context specific, but also more context-relevant. The method used provides a mechanism for comparing expert analysis of the significance of different elements of vulnerability with survey evidence, a comparison that could act as a useful input into the prioritization of public policy interventions. At the same time, the process in which the participation of experts was built into the study establishes a transdisciplinary approach that makes these findings meaningful for policymakers. This process also has the potential to accommodate perspectives of migrant workers, female members of migrant-sending households and youth.

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Annex

Table 1 Overall vulnerability and the impact of migration

	Upper Assam		Baoshan County	
Receipt of remittance	Non-recipient households	Recipient households	Non-recipient households	Recipient households
	0.5984	0.6001	0.8056	0.8547***
Duration of remittance receipt	Short duration households	Long duration households	Short duration households	Long duration households
	0.5546	0.5754	0.6031	0.5468
Distance to destination	Short distance households	Long distance households	Short distance households	Long distance households
	0.5967	0.5346**	n/a	n/a

Table 2: Components of vulnerability and the impact of migration

Criterion		Upper Assam		Baoshan County	
		Non-recipient households	Recipient households	Non-recipient households	Recipient households
Receipt of remittance	Exposure	0.2850	0.2836	0.0369	0.0348**
	Sensitivity	0.5482	0.5942	0.3775	0.3722
	Adaptive capacity	0.6422	0.5869	0.6515	0.7019***
		Short duration households	Long duration households	Short duration households	Long duration households
Duration of remittance receipt	Exposure	0.3095	0.3370	0.3046	0.2724**
	Sensitivity	0.1726	0.2322	0.4414	0.4970
	Adaptive capacity	0.7278	0.5685***	0.4218	0.3926*
		Short distance households	Long distance households	Short distance households	Long distance households
Distance to destination	Exposure	0.3595	0.2956***	n/a	n/a
	Sensitivity	0.2110	0.1901	n/a	n/a
	Adaptive capacity	0.6650	0.6334	n/a	n/a

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01.
Source: Computed by author from Migration Dataset.

Table 3: Attributes of exposure by household status, Baoshan County, Yunnan Province, Upper Salween Mekong Sub-basin*

Attributes	Non-recipient households	Recipient households	Short duration households	Long duration households
Damage due to droughts between 1984 and 2013	0.0284	0.0188**	0.0495	0.0227***
Experienced drought years between 1984 and 2013	0.6160	0.5966	0.6146	0.5922
Time required to recover from drought impacts between 1984 and 2013	0.1894	0.1828	0.2439	0.1746***

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01
Source: Computed by author from Migration Dataset

Table 4: Attributes of exposure by household status, Upper Assam, Eastern Brahmaputra Sub-basin *

Attributes	Non-recipient households	Recipient households	Short duration households	Long duration households	Short distance households	Long distance households
Damage due to floods between 1984 and 2013	0.0661	0.0560	0.1181	0.1271	0.1233	0.1263
Experienced floods between 1984 and 2013	0.5694	0.5838	0.5372	0.5877	0.6483	0.4896***
Time required to recover from flood impacts between 1984 and 2013	0.0366	0.0615**	0.0733	0.0462	0.0704	0.0491

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01
Source: Computed by author from Migration Dataset

Table 5: Sub-dimensions and attributes of sensitivity by household status, Baoshan County, Yunnan Province, Upper Salween Mekong Sub-basin*

Sub-dimension	Non-recipient households	Recipient households	Short duration households	Long duration households
Well being	0.0510	0.0409	0.2380	0.2812
Reduced clothes expenditure due to drought	0.1053	0.1113	0.7027	0.7647
Relied on less preferred food items due to drought	0.0997	0.0607*	0.0769	0.4545**
Water	**0.1373**	**0.1353**	**0.0344**	**0.0551*****
Average time to collect drinking water for a normal day	0.0365	0.0230*	0.0217	0.0211
Did not store drinking water for consumption during drought	0.7174	0.7165	0.6061	0.7941*
Did not filter or boil drinking water for consumption during drought	0.9529	0.9109**	-	-

Dependency on unprotected or open water sources	0.2327	0.2591	0.1847	0.3034**
Environmental dependence	**0.0688**	**0.0812***	**0.0841**	**0.0865**
Above median income from crop sale	0.0070	0.0023	0.0532	0.0509
Crop diversification index	0.3891	0.3747	0.3487	0.3578
Non-farm income diversification index	0.5381	0.7140***	0.6511	0.6983
Rain-fed farm size diversification index	0.8107	0.8871***	0.8550	0.8876*
Reduction in agricultural assets due to drought	0.0360	0.0405	0.0382	0.0207
Dependence on environmental resources for the primary source of cooking fuel	0.4958	0.5284	0.5732	0.4690*

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01
Source: Computed by author from Migration Dataset

Table 6: Sub-dimensions and attributes of sensitivity by household status, Upper Assam, Eastern Brahmaputra Sub-basin

Sub-dimension	Non-recipient households	Recipient households	Short duration households	Long duration households	Short distance households	Long distance households
Health	**0.1339**	**0.1480**	**0.0071**	**0.0294***	**0.0220**	**0.0131**
Reduced health expenditure due to flood	0.1339	0.1480	0.0071	0.0294*	0.0220	0.0131
Well being	**0.0586**	**0.0655**	**0.0074**	**0.0115**	**0.0117**	**0.0070**
Reduced educational expenditure due to flood	0.1246	0.1480	0.0142	0.0184	0.0184	0.0131
Reduced clothes expenditure due to flood	0.2077	0.2471	0.0321	0.0404	0.0441	0.0263
Sold or mortgaged household assets due to flood	0.3458	0.3359	0.0428	0.0919*	0.0919	0.0460
Water	**0.1151**	**0.1169**	**0.1655**	**0.1586***	**0.1566**	**0.1674*****
Average time to collect drinking water for a normal day	0.1477	0.1712**	0.1673	0.1623	0.1631	0.1580
Did not store drinking water for consumption during inundation	0.7975	0.8050	0.9500	0.9632	0.9412	0.9737
Did not filter or boil drinking water for consumption during inundation	0.4268	0.4150	0.9143	0.8676	0.8456	0.9408***
Did not raise height of the wall surrounding the well or height of the tube-well in response to flood	0.5888	0.5830	0.8928	0.7353***	0.7647	0.8750**
Food	**0.0728**	**0.0771**	**0.0290**	**0.0324**	**0.0317**	**0.0294**
Relied on less preferred food items due to flood	0.3068	0.2992	0.0214	0.0551*	0.0588	0.0164**
Restricted food consumption among adults due to flood	0.5327	0.5772	0.0536	0.0993*	0.0919	0.0559
Collected wild food due to flood	0.2321	0.2780	0.0286	0.0073	0.0220	0.0131

Did not spend savings to buy food due to flood	0.4626	0.4556	0.9428	0.8529**	0.8456	0.9539***
Begged for food due to flood	0.2835	0.3224	0.0000	0.0588***	0.0368	0.0197
Environmental dependence	**0.0803**	**0.0798**	**0.0835**	**0.0813**	**0.0842**	**0.0816**
Above median income from crop sale	0.3489	0.2625**	0.2643	0.2794	0.2059	0.3487***
Crop diversification index	0.4994	0.5504**	0.5598	0.5293	0.6174	0.4764***
Non-farm income diversification index	0.3890	0.4089	0.3911	0.4228**	0.4375	0.3821***
Reduction in agricultural assets due to flood	0.3645	0.3784	0.2245	0.4042*	0.4444	0.2143**
Household with exterior walls made of weak construction material	0.7382	0.7722	0.8214	0.6912**	0.7500	0.7566
Dependence on environmental resources for primary source of cooking fuel	0.8959	0.8842	0.9286	0.8456**	0.8676	0.9079

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01
Source: Computed by author from Migration Dataset

Table 7: Sub-dimensions and attributes of adaptive capacity by household status, Baoshan County, Yunnan Province, Upper Salween Mekong Sub-basin*

Sub-dimension	Non-recipient households	Recipient households	Short duration households	Long duration households
Financial assets	**0.1967**	**0.2056**	**0.1993**	**0.2059**
Did not have access to formal financial institution	0.0083	0.0081	0.0127	0.0069
Did not have a crop or livestock insurance	0.8282	0.8663	0.8344	0.8690
Natural assets	**0.1526**	**0.1643****	**0.1050**	**0.0957***
Farm size diversification index	0.7812	0.8348***`	0.7861	0.8400***
Livestock diversification index	0.3233	0.2908	0.2566	0.2539
Did not make changes in farming practices in response to drought	0.6787	0.7935***	0.4286	0.1739**
Did not make changes in livestock rearing practices in response to drought	0.5540	0.5506	0.3789	0.2174*
Social assets	**0.1719**	**0.1780**	**0.1532**	**0.0801*****
Did not have access to drought assistance	0.2548	0.2712	0.3376	0.1862***
Did not have access to financial borrowing during drought	0.6260	0.6194	0.4324	0.2143**
Did not participate in collective agreement on water sharing	0.8476	0.8907	-	-
Human assets	**0.3306**	**0.3662*****	**0.0892**	**0.0889**
Communication device diversification index	0.3147	0.3201	0.3181	0.3244
Did not have access to alternative livelihoods opportunity in locality or nearby areas	0.7978	0.8947***	0.1143	0.0000
Physical assets	**0.2316**	**0.2526*****	**0.2300**	**0.2575****
Did not have access to irrigation	0.5734	0.6113	0.5185	0.5111
Did not mechanize farming	0.7479	0.8340**	0.7707	0.8690**

Did not have access to storage options during drought	0.8476	0.9271***	0.5405	0.7778**

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01
Source: Computed by author from Migration Dataset

Table 8: Sub-dimensions and attributes of adaptive capacity by household status, Upper Assam, Eastern Brahmaputra Sub-basin *

Sub-dimension	Non-recipient households	Recipient households	Short duration households	Long duration households	Short distance households	Long distance households
Financial assets	**0.1826**	**0.1563**	**0.1850**	**0.1293****	**0.1666**	**0.1484**
Did not have access to formal financial institution	0.3029	0.2510	0.3071	0.1985**	0.2720	0.2303
Did not have an insurance	0.6916	0.6293	0.6928	0.5662**	0.6470	0.6381
Natural assets	**0.1452**	**0.1528**	**0.2076**	**0.1914**	**0.2147**	**0.1861*****
Farm size diversification index	0.6498	0.6859*	0.6860	0.6790	0.7497	0.6201***
Livestock diversification index	0.2903	0.2765	0.2654	0.2702	0.3145	0.2278**
Did not make changes in agricultural practices in response to flood	0.7476	0.7452	0.7846	0.4677***	0.5333	0.7183**
Social assets	**0.1236**	**0.1200**	**0.1282**	**0.1181**	**0.0954**	**0.1388****
Did not have access to flood assistance	0.0934	0.1081	0.0857	0.1250	0.0735	0.1184
Did not have access to financial borrowing during floods	0.6542	0.5946	0.7391	0.5472**	0.5510	0.7170*
Did not participate in collective action on flood relief, recovery, or preparedness	0.2243	0.2548	0.8667	0.5000***	0.5591	0.7921***
Human assets	**0.2827**	**0.2635****	**0.5480**	**0.5512**	**0.5396**	**0.5661**
Communication device diversification index	0.4687	0.4452*	0.9714	0.9853	0.9669	0.9901**
Did not have access to alternative livelihoods opportunity in the locality or nearby areas	0.7414	0.6757*	0.3778	0.2000*	0.2381	0.3488
Physical assets	**0.0872**	**0.0910**	**0.1726**	**0.0944*****	**0.1250**	**0.1469***
Did not make structural changes in the house due to flood	0.1994	0.1853	0.2637	0.1192***	0.3828	0.4711
Did not mechanize farming to address flood impacts	0.6106	0.6988**	0.6364	0.2708***	0.5172	0.4138
Did not have access to boats or rafts during flood	0.1776	0.1776	0.8989	0.7013***	0.7711	0.8617
Did not have access to storage options during flood	0.6698	0.6795	0.7742	0.5517***	0.6083	0.7218*

* The sub-dimensions and attributes have been standardised. Legend: * p<.1; ** p<.05; *** p<.01.
Source: Computed by author from Migration Dataset