HOW DOES RESILIENCE CHANGE OVER TIME?

TRACKING POST-DISASTER RECOVERY USING MOBILE PHONE SURVEYS

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Executive summary

Knowing how climate hazards affect people's resilience over time is crucial in designing more effective development and humanitarian interventions. This is particularly important in post-disaster contexts, where people's livelihood opportunities and wellbeing changes rapidly during the long road to recovery. Yet, to date, our knowledge of resilience is largely guided by snap-shots: one-off surveys taken at a single point in time. This in turn guides how resilience-building interventions are designed and risks neglecting important temporal dimensions of resilience. Greater insights into the evolving nature of resilience are therefore desperately needed.

In this paper, we track post-disaster recovery and changes in levels of resilience over time using a number of methodological innovations. Drawing on BRACED's Rapid Response Research (RRR) project, we collect information on how households in eastern Myanmar recover from a series of extensive flood events using a mobile phone panel survey of 1,200 individuals. The paper also makes use of new ways of measuring resilience using people's perceptions of their own risk, repeated collecting Subjectively Evaluated Resilience Scores (SERS) roughly every two months. Importantly, we use the flexibility of the SERS approach to measure the impact of the flooding on households' resilience to a range of overlapping threats (not just a single hazard), which we term 'overall resilience'.

There are a number of important findings from the RRR. Here we highlight four that have particular importance for research, policy and practice.

1. Levels of overall resilience change considerably over time. Though it may not be surprising that overall resilience levels drop dramatically after flooding, it is interesting to note the length of time needed for recovery. Most households in the RRR witness a sharp reduction in resilience for six months after the flood events. Average resilience scores then rebound up to ten months later (though at somewhat lower levels than where they started). Not only does this provide invaluable insight into the depth and breadth of the flood's impact on overall resilience, but showcases the potential for these methodological innovations to allow development and humanitarian actors to track the effectiveness of resilience-building interventions.

2. The effects of flooding have a dramatic impact on all nearby households – not only those directly in harm's way but those who self-report as not being affected by the floods. Indeed, both directly and indirectly affected households appear to show similar resilience trajectories, with scores dipping sharply before starting to rise again six months after the floods. This highlights the extensive nature of climate impacts on wider populations – in this case likely owing to a range of negative spill-overs and the interconnected nature of livelihoods and markets. More importantly, it means development actors must be aware of these wider effects in their targeting strategies: limiting resilience-building interventions to those physically affected by climate hazards may put those living around them at considerable risk.

3. The negative consequences of flooding on resilience are felt in similar ways across most social groups. Many factors commonly associated with resilience (such as education and poverty) show few differences in the depth and breadth of impact on overall resilience over time relative to baseline

levels. In other words, although poor and marginalised groups may be disproportionately at risk to start with, this risk is not further magnified after a disaster takes hold. Resilience-building interventions may therefore have even benefits across social groups. One clear exception is female-headed households, which show a marked and sustained drop in resilience levels compared with male-headed households. This suggests that development actors may wish to pay particular attention in targeting female-headed households, both in disaster risk reduction initiatives and in post-disaster recovery support.

4. Falling back on personal financial buffers is by far the most frequent coping strategy in response to flooding. Use of savings and immediate sale of household assets accounts for half of all reported coping strategies reported by households in the RRR. This is followed by reliance on family and relative with just over a quarter of total coping strategies. These insights underline the importance of safeguarding household assets from the impacts of climate hazards as well as provision of social safety nets (such as social protection mechanisms). It also highlights opportunities for development and humanitarian actors to promote social capital as a means of promoting disaster risk reduction and management – a factor rarely considered within resilience-building interventions.

Together findings from the RRR paint a picture of resilience as a property in flux; one that can be drastically influenced by external threats (whether climate or non-climate related). Accordingly, development actors must be conscious of the evolving nature of people's resilience, moving away from traditional conceptualisations of resilience as static. Most importantly, the RRR highlights the potential of innovations in resilience measurement to reveal new insights into resilience

and post-disaster recovery. While the opportunities for collecting cheap and near-real time information on resilience are clearly showcased by the RRR, more can be done to establish the merits and limitations of mobile survey technology and the use of subjective evaluations of overall resilience. We hope that this initiative spurs on further innovations by researchers, practitioners and donors alike and contributes to a more holistic understanding of resilience on the ground.

1. INTRODUCTION

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Ensuring that people and communities are able to deal with the evolving mix of environmental and socioeconomic pressures they face is a key development priority. Accordingly, many global development commitments have placed resilience at their core. The Sustainable Development Goals (SDGs), for example, embed the target of building resilience to climate extremes and disasters (Target 1.5) in their headline goal of ending poverty in all its forms (SDG 1).[1] It is here that resilience measurement plays a key role.

1 Under SDG 1, 'End poverty in all its forms everywhere', Target 1.5 aims to achieve the following: 'By 2030 build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters' (https://sustainabledevelopment.un.org/sdg1).

Cheap, timely and accurate tools for measuring resilience are needed not only to understand where resources should be targeted but also to track progress and establish whether resilience-building interventions are providing adequate value for money. Resilience measurement can also serve as a useful tool in holding governments and other development actors to account with regard to the pledges made in supporting resilience at local and national levels.

Unfortunately, measurement has thus far proven difficult. It is a process fraught with definitional ambiguities, methodological uncertainties and high data collection costs. To date, the vast majority of resilience measurement tools have followed the same basic steps. Technical experts or development practitioners are often tasked with designing a resilience framework to guide the measurement approach. They then create a large list of indicators that matches the various components of the resilience framework. Indicators can include anything from a household's assets to its distance from critical infrastructure. Collectively, these indicators are compiled into an index to form an overall score of resilience for the household or community in question (Schipper and Langston, 2015). Finally, nearly all resilience measurement tools rely on face-to-face household surveys for data collection. While these offer clear benefits, they can be difficult to coordinate and costly (in terms of both time and resources). Such drawbacks pose particular challenges when trying to collect multiple rounds of survey data to see how people and communities are responding to disaster risk over time.

Given the restrictive assumptions underlying traditional measurement approaches, there is great eagerness to find new tools to assess resilience. In this respect, BRACED's Rapid Response Research (RRR) in Myanmar aims to add to the

emerging field of resilience measurement. The RRR examines the utility of two important innovations. The first is the use of subjective evaluations of resilience. Rather than assuming that technical experts know all about someone else's household resilience, subjective assessments seek to capture people's own understanding of how they can deal with the many risks they confront. The RRR is therefore trialling a number of survey modules that allow respondents to self-evaluate in terms of their own capacity to manage risk. Resilience-capacity scores can then be calculated based on their perceptions.

The second innovation is the use of mobile phone technologies to collect near-real-time data on resilience and disaster recovery. Given the recent proliferation of mobile phones across all regions of the globe, mobile surveys can make it possible to feed back information to researchers and practitioners frequently and in a cost-effective way. They also present unique opportunities for data collection in post-disaster areas that may be difficult for survey teams to access, or where people are continually on the move. Crucially for the RRR, given that subjective assessment modules are far shorter than traditional 'objective' ways of measuring resilience, their questions can be delivered via mobile phones and used to track changes in resilience over time. Despite the potential these two innovations offer, though, few examples of their use in understanding resilience have been documented to date.

To shed light on the opportunities subjective evaluations and mobile surveys present, we document early lessons learnt from a post-disaster mobile phone panel survey in Hpa An district, eastern Myanmar. As part of the BRACED Myanmar Alliance, the RRR conducted 1,212 household interviews across 8 neighbouring villages in June 2017. At the end of each interview, respondents received a mobile phone and a solar charger. Roughly a month

later, the area was affected by a series of heavy flood events that inflicted large negative impacts on the livelihoods and well-being of the local population. Using a remote call centre set up explicitly for the project, the RRR used mobile phone surveys to remotely gather valuable information on how households responded to the flooding. Information was collected roughly every two months, generating unprecedented insights into the post-disaster recovery process on the ground: from immediate coping mechanisms to the slow process of recovery and rehabilitation. Importantly, we use the RRR approach to measure the impact of the flooding on households' resilience to a range of overlapping threats (not just a single hazard), which we term 'overall resilience'.

This paper makes full use of the advantages subjective evaluations of resilience and mobile surveys present to explore three main questions:

1. What coping mechanisms are households employing in response to climate hazards?
2. How do levels of overall resilience change over time after a disaster?
3. How long does it take for people to feel they have fully recovered from a hazard?

Drawing on data collected from six separate rounds of RRR surveying (lasting from June 2017 to May 2018), we provide insights in relation to each of these questions and discuss the relevance of the RRR findings for resilience research, policy and practice.

Importantly, this paper does not stand in isolation. The analysis below builds on insights gathered from earlier BRACED papers on the RRR's methods and its approach. In particular, we draw

on the conceptual and methodological foundations presented in the paper New methods in resilience measurement: early insights from a mobile phone panel survey in Myanmar using subjective tools. This earlier paper also provides a snapshot of general levels of subjectively evaluated resilience, as well as how levels differ across social groups. These serve as a useful starting point for this analysis, and we repeatedly refer back to this baseline analysis in the sections that follow.

In many ways, this paper represents a snapshot of initial findings from the panel, as data collection is ongoing. Most of the results are therefore descriptive, and act merely to showcase the depth and breadth of information collected. Follow-up work will aim to take these findings forward and will conduct more advanced statistical analysis once all rounds of RRR data collection are complete. The findings presented here do, however, shed important light with regard to the research questions above and provide new evidence on the nature of resilience and post-disaster recovery.

2. FROM CONCEPTUALISATION TO MEASUREMENT

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2.1 Challenges in defining and conceptualising resilience

Resilience measurement is challenging for a number of reasons. For a start, there is little consensus on how resilience should be defined. At its core, resilience is concerned with the ability of a system to respond to shocks and stresses. Yet, reviewing the available literature, it is quickly apparent that many different interpretations of resilience exist. Much of this confusion stems from the fact that resilience has been applied across a range of different fields, from engineering and ecology to its recent adoption within the social sciences (Alexander, 2013).

Many earlier interpretations consider resilience to be the ability of an entity – whether a person, community or socio-ecological

system – to absorb change or disturbance in order to maintain the same core functions (Holling, 1973; Walker et al., 1981). This essentially boils down to whether a system can 'bounce back' to a normal state in the face of an external threat. This works well with respect to attempting to understand ecological systems, but, as the term spread across the social sciences, a number of authors came to stress that simply bouncing back might not be sufficient or desired. Societies should also be able to gradually adapt their core functions in order to deal with changing threats (Carpenter et al., 2001).

More recently, researchers and practitioners have argued that resilience should include the capacity of systems to transform their states entirely, particular in light of global challenges such as climate change (Kates et al., 2012; Aldunce et al., 2015). For example, under this interpretation, a resilient household may be one that can readily shift from a livelihood dependent on subsistence agriculture (in response to increasingly variable rainfall, perhaps) to one less vulnerable to fluctuations in weather, such as tourism or petty trade. While this makes intuitive sense, it is clear that thinking about resilience in this manner takes it a long way from its original principles. Indeed, the properties that allow a community to bounce back to the same state may not be the same as those that allow it to transform core socioeconomic structures in order to deal with changing threats and opportunities.

In the context of this paper, we steer clear of debates on how resilience should be defined and what does or does not constitute a resilient system. Instead, we recognise there is a plethora of different interpretations and that approaches to resilience measurement should try to accommodate this. For a start, more can be done to promote transparency in the definitions and characterisations of resilience used

in evaluations. Development actors should also encourage greater diversity in how resilience-related information is gathered, analysed and used.

Our focus is on a particular type of resilience: household resilience to climate hazards. While we recognise that resilience is made up of many overlapping scales – a household's resilience is dependent not only on the individual people within it but also on the wider community within which it is situated – the household is where many important decisions are made. Indeed, it is often at the household level that choices are made as to how a family or set of individuals will prepare and respond and adapt to risks posed by the climate and others (Toole et al., 2016).

2.2 Conceptualising the relationship between resilience and disasters over time

Our current understanding of how people's resilience changes over time is poor. Indeed, many assessments simply gather information on resilience at one moment in time (see Schipper and Langston, 2015). This use of a snapshot helps reinforce the idea that resilience is static – yet this viewpoint is hard to sustain. In theory, people's resilience can and should change drastically as a threat takes hold, new vulnerabilities emerge or opportunities to strengthen disaster response arise (Luthar et al., 2000). A household affected by a flood is likely to see its ability to deal with current and future risks immediately reduce as a result of the flooding (e.g. important infrastructure such as roads or communication networks may be destroyed) or the coping mechanisms adopted (e.g. selling off household assets). Resilience, we argue, is therefore best conceived as a dynamic and continual process: households

need to repeatedly undergo adaptations and responsive actions as the threats around them evolve.

It should be clear, however, that this dynamic conceptualisation has important implications for how resilience should be approached, both empirically and theoretically.

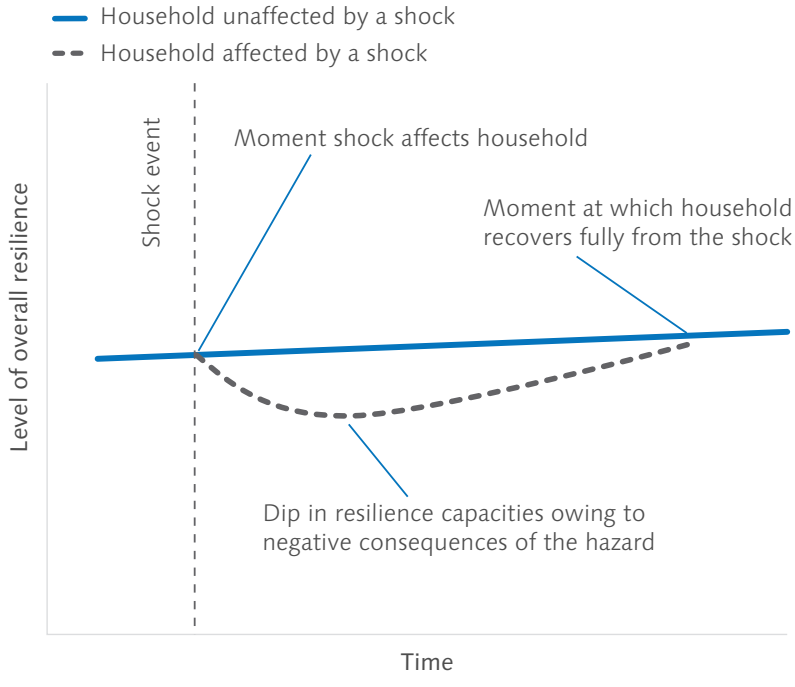
Empirically, it calls for research designs that go beyond the one-off snapshots that most resilience measurement exercises entail. Instead, there is a need to gather resilience data over time from within the same group of individuals.

Theoretically, it draws attention to the fact that few conceptual theories describe how resilience evolves after a disaster. The process is further muddied by disputes over whether resilience is best considered a process that supports an ultimate outcome (such as well-being) or whether resilience is an outcome in itself.

In an effort to provide some conceptual grounding, and drawing on available resilience literature, we present a stylised theoretical model (Figure 1) that depicts how disasters may affect a household's levels of resilience over time.[2] In this model, the black line represents a household that is unaffected by a shock event (i.e. the grey shock line does not apply). Here, the household's ability to deal with current or future threats is unlikely to fluctuate, assuming that such a property can be readily measured and boiled down into a single metric. If anything, there may even be a slight increase in resilience over time – assuming that households are located in areas where development gains are being made.

2 For the sake of simplicity, we steer away from defining the indicators and characteristics needed to devise a single metric for resilience. The diagram is illustrative and can be applied to any definition or framework of resilience based on the evaluator's objective.

Figure 1: Theoretical impact of a disaster on a household's overall resilience



The vertical line in Figure 1 represents the time at which a household is affected by a shock event[3] (e.g. a flood or the death of an income-generator). The grey dashed line shows the expected change in resilience directly after the shock. Here, resilience can be thought of as a property made up of a range of capacities (i.e. the suite of capacities needed to prepare and respond to threats). Thus, resilience levels in Figure 1 represent the mixture of a household's resilience-capacities and how they may change over time (we return to explore different resilience-related capacities in Section 3.1.1).

3 For the purposes of this figure we limit the model to rapid-onset events. Slow-onset events may well have similar characteristics but will manifest themselves over a much longer period of time, with greater fluctuations in resilience-capacity likely.

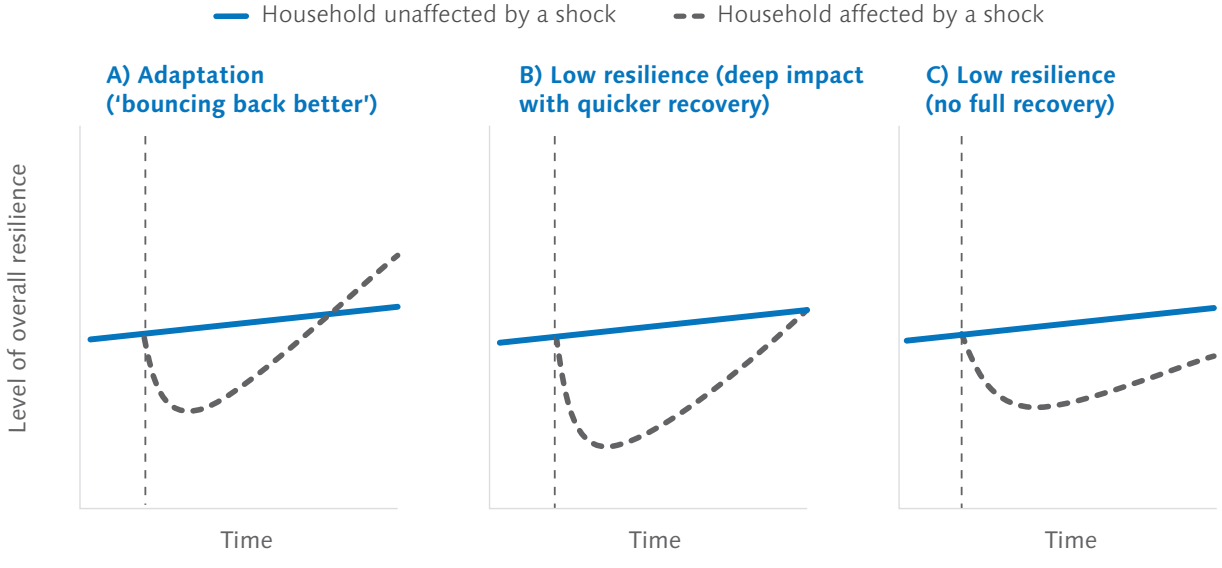
Initially, we expect a sharp decrease, as the event is likely to reduce the household's livelihood prospects and well-being. For instance, a flood may damage a family's dwelling and therefore place the household at greater physical risk from further climate- and non-climate-related hazards. This dip in capacity may persist over time if, for example, the flood has affected valuable farmland and therefore limited the household's ability to maintain a regular income.

While these impacts may have considerable negative consequences for the household's resilience and well-being, over time recovery is likely to set in. Assuming the household is not devastated by the shock, it may eventually return to a similar state of resilience-capacity to prior to the event. This model can also relate to many other aspects of the resilience process. For example, imagine that the shock-affected household depicted in Figure 1 does not return to the same level of resilience. Instead, factors such as a change in livelihood type, wider structural alterations or simply learning to prepare for future risks may enable the household to become more resilient than before. This scenario is depicted in Figure 2 (panel A) and relates closely to the concept of adaptive capacity (either incremental or transformative) whereby a household or the system around it changes in response to evolving risks (see Smit and Wandel, 2006).

Another variant on how levels of resilience may change in response to a shock can be seen in Figure 2B, in which a household experiences a much deeper immediate dip. This would mean the household's resilience lowers considerably compared with the scenario in Figure 2A. However, here, it is easily possible to imagine a quick recovery despite the steep initial loss – for example if the household can draw

on unexpectedly strong government aid and assistance. A third scenario, in Figure 2C, also envisages a household badly affected by a shock. However, unlike in Figure 2B, the household struggles to recover and fails to return to prior levels of overall resilience. Again, this scenario is easy to see happening in practice. For example, hazards such as cyclones and floods can have considerable lasting damage for key infrastructure like roads and bridges, as well as direct impacts on people's health and well-being. Each will have inevitable implications for people's ability to deal with current and future risk.

Figure 2: Alternative forms of resilience and their change over time



While we can conceptualise the relationship between resilience and disasters, and its change over time, this remains poorly researched and speculative. It is here that the RRR can shed considerable light. In collecting rapid assessments of people's resilience over time it is possible to examine how the relationship varies, both during times of relative stability and during (and after) disasters. Testing whether the scenarios presented above

play out in practice through analysis of real-world data will be key in improving our understanding of resilience and its evolution. More importantly, it may help us understand which groups are most at risk of experiencing prolonged periods of low resilience in response to disasters.

3. BACKGROUND TO BRACED'S RAPID RESPONSE RESEARCH

IMAGE: EMIL HELOTIE/FINNISH RED CROSS

The RRR was set up to track household recovery from climate hazards in Myanmar.[4] It was started under the BRACED Myanmar Alliance, a consortium led by Plan International with five partner agencies: ActionAid, World Vision, BBC Media Action, the Myanmar Environment Institute and the United Nations Human Settlements Programme (UN-Habitat). The BRACED Myanmar Alliance was operational from 2015 to early 2018, delivering a range of resilience-related activities in eight townships across the country. Through the RRR, one particular township was selected for the research: Hpa An in the east of the country. This site was chosen for a range of reasons,

4 In the context of the RRR, climate hazards are classed as heavy wind events; irregular/unseasonal rainfall; flooding; drought; cyclones; landslides; or crop diseases.

including its exposure to annualised flooding events, its decent penetration of mobile telephone networks and the ease of access for enumerators to conduct the baseline survey. In particular, the site is prone to heavily flooding during the monsoon season owing to its proximity to a major river, the Thanlyin (further details on site selection and risk profiles can be seen in Jones, 2018). Indeed, a month after the first set of baseline surveys was complete, Hpa An was subjected to a series of major floods that caused considerable damage to infrastructure and livelihoods in the area (see Section 3.2).

One of the primary objectives is to collect panel data on post-disaster recovery. Panel data is particularly important for monitoring resilience and disaster recovery as situations can change rapidly. Often, researchers and development practitioners are interested in knowing where hotspots of vulnerability are emerging after a disaster or what coping mechanisms people are employing in response to a threat at different periods of time. This kind of information can be readily collected through face-to-face surveying. However, considerable challenges exist, not only in terms of cost and timing but also related to more basic features such as accessing the site (if threats are still ongoing); finding the same individuals to interview (in cases where people flee or relocate their homes); and ensuring enumerators are safe (post-disaster areas can often present security risks as law and order can take time). It is for many of these reasons that most of our knowledge of resilience and disaster recovery comes from cross-sectional surveys – those carried out at a single point of time, often long after the disaster has occurred. This is where the RRR adds considerable value, shedding light on how resilience evolves over time and capturing a more holistic picture of post-disaster recovery on the ground.

3.1 How data is gathered in the RRR

The RRR uses two innovations to collect data on resilience and post-disaster recovery in Hpa An. The first is the use of mobile phones surveys to remotely collect near-real-time information. Here, the RRR is able to draw on the limited but growing literature on using mobile phone panels as a source of timely humanitarian data in volatile and high-risk environments (see Dabalen et al., 2016; Morrow et al., 2016).

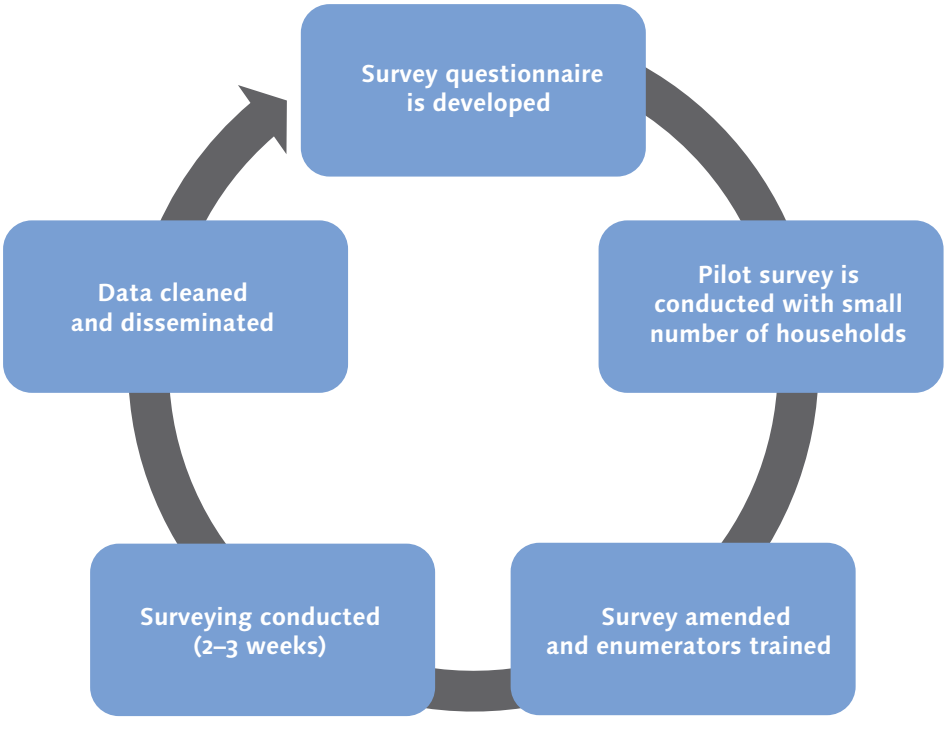
The RRR first involved collecting baseline information using a traditional face-to-face survey. This was carried out with all 1,212 households across the 8 villages (essentially constituting a census of the surveyed area). Survey respondents spoke to one member of the main bread-winning couple in each household, with a 50/50 gender split between heterosexual couples. A team of eight enumerators asked individuals questions relating to the household's socioeconomic status as well as a range of resilience-related queries.[5] After completion of the survey, each household was handed a mobile phone and a solar charger (irrespective of whether they were in possession of a phone already). Any other phone numbers of household members, as well as immediate neighbours, were collected (in case respondents were unable to be contacted). This made it possible to contact respondents for the mobile surveys that form the basis of the next phase of the RRR.

While the face-to-face surveys were being conducted, a call centre was set up in the city of Yangon. Call centre enumerators were individuals who had carried out the initial survey and were trained in the use of computer-aided systems – automated dialling and the completion of online forms. Once set up, the

5 Jones (2018) presents a full list of socioeconomic questions.

call centre was used to contact each of the 1,212 households individually via the mobile phones distributed (or alternative numbers collected). The process of survey completion followed the pattern outlined in Figure 3.

Figure 3: Cycle of production for RRR resilience and post-disaster surveys



The questionnaire for each mobile phone survey round consists of two parts. First is a set of resilience-related questions posed during each interview (i.e. the same questions are used throughout). Second is a set of questions on the specific 'theme' of the survey round, for example gender, social networks or access to early warning systems.

Once the draft questionnaire has been designed, a pilot exercise is conducted for each round, to test whether respondents understand the questions correctly and if any respondents

or enumerators want to suggest additional questions. Once the pilot is complete, the questionnaire is finalised and enumerators are trained in the correct ways to administer the questions and to familiarise themselves with potential responses (or queries on the part of respondents).

Remote surveying takes place over the course of the next two to three weeks. Numbers in the database are automatically dialled and patched through to an enumerator when respondents answer the phone. In instances where respondents are unable to complete the survey when phoned, an alternative time is arranged. Respondents are also given a small financial incentive to take part in the survey, in the form of $0.50 of airtime credit delivered remotely to the mobile phone after completion. As previous research has shown, even such small incentives can help keep response rates at acceptable levels (see Leo et al., 2015). In total, surveys last around 10–12 minutes in duration – any longer and the risk of drop-out and survey fatigue is too great. Finally, after all accessible households have been contacted (a small number of households remain uncontactable or choose to opt out of the survey), the survey team cleans the remaining dataset and disseminates the data back to the research team. In total, the process takes between four and eight weeks to complete and is subsequently repeated on an ongoing basis with information feeding into the panel dataset (see Figure 3).

The RRR's second innovation is the use of subjective methods for evaluating household resilience. To date, the vast majority of resilience measurement tools have focused on objective evaluations – with external experts largely responsible for identifying indicators and survey questions that are thought to best reflect the resilience of people on the ground. While these can provide valuable information, they fail to take into account the wealth of information that people have about

their own resilience-capacities. Subjective evaluations take a very different approach (Jones and Tanner, 2017). They involve people self-evaluating as to whether they are able to deal with risk and deliberately solicit judgement and perceptions. While the potential for subjective evaluations of resilience to complement more traditional objective measurement has been well documented (Maxwell et al., 2015; Béné et al., 2016, Jones and Tanner, 2017; Claire et al., 2018), very few subjectively oriented surveys have focused on resilience and post-disaster recovery. More importantly, little is known about the validity and robustness of subjective evaluations and how they compare with our current understanding of the properties of resilience.

3.1.1 Subjective measurement of resilience using the SERS model

Within the RRR survey, resilience is measured using the Subjectively Evaluated Resilience Scores (SERS) methodology. The full approach is explained in Jones (2018) and builds on earlier insights from surveys in Tanzania– see Jones et al. (2017). Importantly, the metric measures a household's overall resilience (its ability to deal with a range of overlapping risks) rather than one specific hazard.[6]

As outlined above, we view resilience as comprising a series of resilience-related capacities. SERS therefore uses a series of nine perception-based questions that each relate to a distinct resilience-related capacity – see Table 1 for a full list of questions. It is for this reason that we refer to SERS outputs as *resilience-capacity* scores (as opposed to levels of resilience). More specifically, SERS relates to an individual's subjective evaluation

6 Hazard-specific variants of the SERS model exist and are detailed in Jones et al. (2017) and Jones (2018).

of a combination of resilience-related capacities that support their household in dealing with current and future risk.

All questions are answered using the same five-item bipolar responses scale, ranging from Strongly Agree to Strongly Disagree. Scores are then converted numerically[7] and the average across all nine questions is used to form a single resilience score ranging from 0 (not at all resilient) to 1 (fully resilient). The method allows for some degree of flexibility as users can choose which capacity-questions to include in the score depending on their respective resilience framework of choice – though doing this should be anchored in a strong theoretical basis. Users can also choose to use different weightings for each capacity, using either a simple equalled weighted average or more advanced statistical procedures.

In line with BRACED's framework for resilience, the RRR uses the 3As model (Bahadur et al., 2015) as a subset of the full SERS method. This includes three capacities out of the nine: absorptive capacity; adaptive capacity; and anticipatory capacity (named the SERS-3A model and highlighted in bold in Table 1). For the purposes of this paper, all SERS-3A scores are calculated using an equal weighting. In addition, the SERS questions are non-hazard-specific: they refer to overall resilience rather than a particular hazard. This is done to recognise the multifaceted nature of resilience (people rarely respond to a single threat, rather to multiple overlapping threats that co-evolve over time). It also helps prevent framing bias: drawing attention to a specific hazard may bias people's recollections and perceived impacts of the threat (OECD, 2013). Moreover, the questions explicitly make

7 This assumes cardinal comparability, an aspect that is relatively widespread in related fields such as subjective well-being (OECD, 2013), with some evidence to suggest the practice is robust (Kristoffersen, 2017).

no reference to resilience in the question structure, in order to limit confusion with many different interpretations of resilience. For full details on the approach see Jones (2018).

Table 1: List of nine resilience-related capacity questions used in the SERS model of overall resilience

RESILIENCE-RELATED CAPACITY	QUESTION	REFERENCES
Preamble: 'I am going to read out a series of statements. Please tell me the extent to which you agree or disagree with them.' [Read out each statement and ask] 'Would you say that you strongly agree, agree, disagree, strongly disagree or neither agree nor disagree?'		
Absorptive capacity[8]	**Your household can bounce back from any challenge that life throws at it**	Béné et al. (2012) Bahadur et al. (2015)
Transformative capacity	During times of hardship, your household can change its primary income or source of livelihood if needed	Béné et al. (2012) Kates et al. (2012)
Adaptive capacity	**If threats to your household became more frequent and intense, you would still find a way to get by**	Jones et al. (2010) Béné et al. (2012) Bahadur et al. (2015)
Financial capital	During times of hardship, your household can access the financial support you need	Mayunga (2007) Birkmann (2006)
Social capital	Your household can rely on the support of family and friends when you need help	Cox and Perry (2011) Sherrieb et al. (2010)
Political capital	Your household can rely on the support of politicians and government when you need help	Birkmann (2006) Magis (2010) Renschler et al. (2010)
Learning	Your household has learnt important lessons from past hardships that will help you better prepare for future threats	Folke et al. (2002) Cutter et al. (2008) O'Brien et al. (2010)
Anticipatory capacity	**Your household is fully prepared for any future natural disasters that may occur in your area**	Paton (2003) Foster (2007) Bahadur et al. (2015)
Early warning	Your household receives useful information warning you about future risks in advance	Thywissen (2006) Twigg (2009) Kafle (2012)

8 This definition of transformation used here is based largely on the ability of a household to modify livelihood activities when and if required – see Béné et al. (2012) and Kates et al. for more (2012).

The next section showcases key findings from the RRR panel survey. These highlight the mobile survey's unique ability to track how households are coping with disasters over time and the nature of people's changing perceptions of their household's ability to deal with current and future risks.

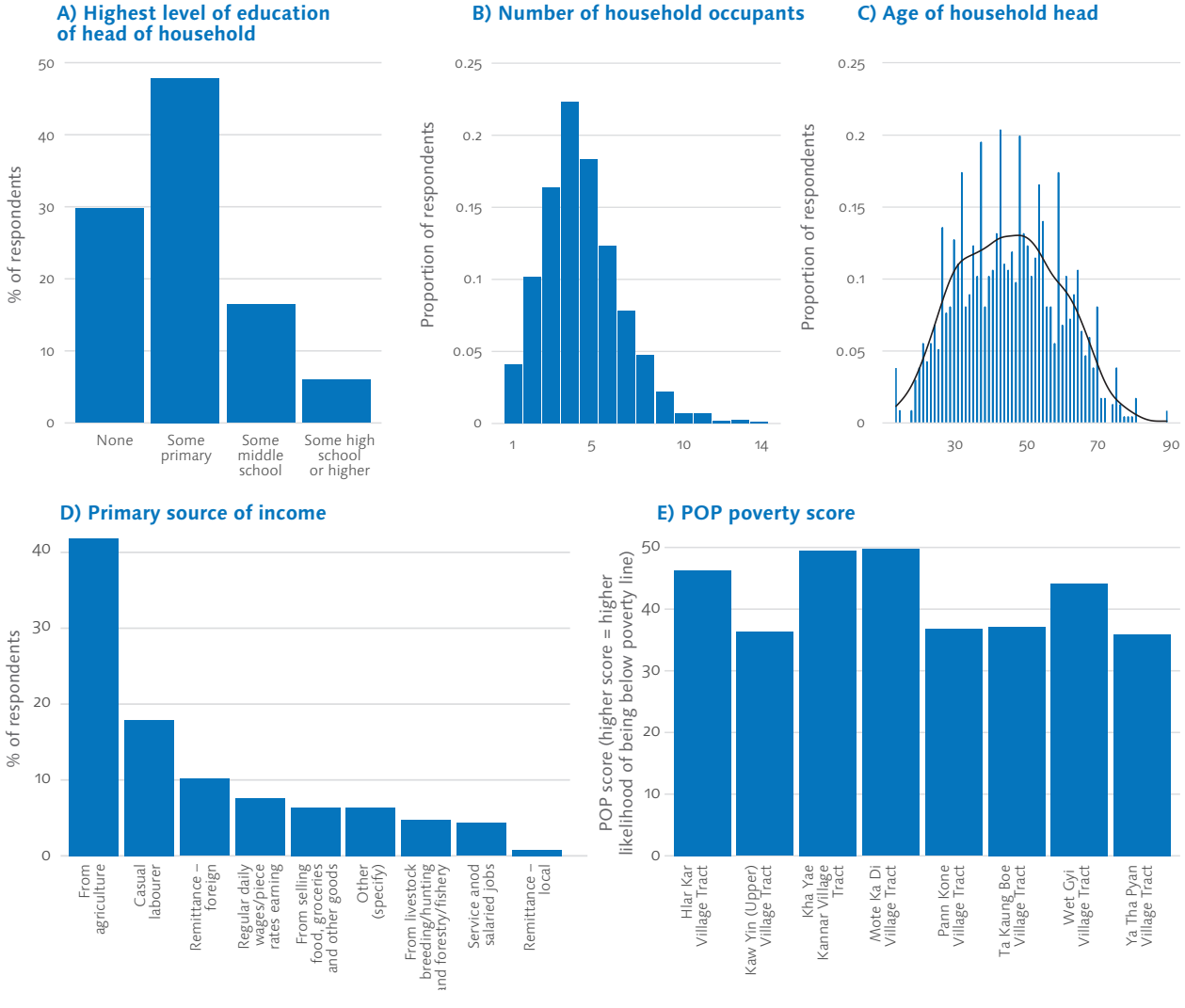
3.2 Understanding context and livelihoods in Hpa An

Below we use insights from the RRR face-to-face baseline survey and the wider literature to describe the socioeconomic conditions of life in Hpa An and the eight RRR villages sampled in the survey. Hpa An is located in Kayin state and contains a range of ethnic groups. Like many areas of the country, Kayin has experienced long periods of conflict, with considerable implications in relation to livelihoods and poverty. Most of the population is dependent on agriculture, with major crops being rice, rubber, sugarcane and other vegetables (UNHCR, 2014). Infrastructure and public services are underdeveloped, and this is exacerbated in large part by protracted civil unrest, which has knock-on implications for the quality of education, health and transportation services. Hpa An acts as the state capital for Kayin and has a population of roughly 50,000.

For the purposes of the RRR survey, efforts are concentrated on eight villages surrounding Hpa An: Hlar Kar, Kaw Yin, Kha Yae Kannar, Mote Ka Di, Pann Kone, Ta Kaung Boe, Wet Gyi and Ya Thae. While the area is characterised by high levels of poverty compared with the rest of Myanmar, socioeconomic conditions and levels of disaster risk across the eight villages are heterogeneous – see Jones (2018) for more insights from the RRR baseline survey. Figure 4A shows that close to 50% of household heads across the RRR villages have some form

of primary-level education, with 30% of respondents reporting no formal education. Sources of income (Figure 4D) are considerably varied, albeit with agriculture forming the mainstay of livelihood generation within the villages (42%). Significant contributions are also derived from casual labour and remittances from abroad (typically from individuals seeking temporary employment in countries like Thailand).

Figure 4: Socioeconomic characteristics of households across the eight RRR villages

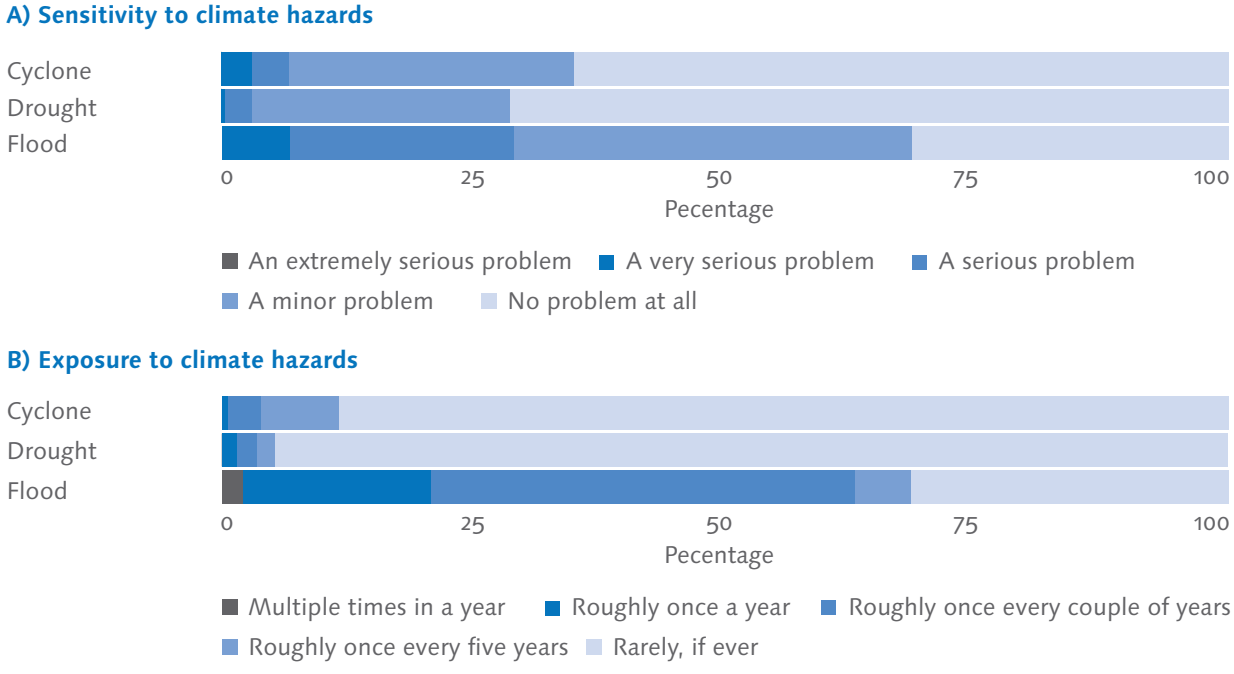


Levels of poverty also vary across villages, with Kha Yae Kannar and Mote Ka Di exhibiting the highest likelihood of average poverty, calculated using the Progress Out of Poverty (POP) score, measured from 0 to 100: a higher POP score represents a higher likelihood of poverty.[9] As Figure 4B shows, the majority of households have four or five members, though there is considerable variation, with some households consisting of more than twelve individuals. Most heads of household are between 40 and 50 years of age, though here too there is a large amount of heterogeneity, with the range stretching from 18 to 88 years.

During the baseline interview, respondents were asked a number of questions related to their exposure and sensitivity to a range of climate hazards. Figure 5B shows that, while the area is occasionally affected by drought and cyclones, floods are by far the most frequently occurring climate hazard out of the three. More than one in five respondents in the RRR panel reported being hit by floods at least once a year (20.8%). Another 42.1% of households are affected by floods every couple of years. Considerable variability exists across village, however. For example, all of the 56 respondents living in Kha Yae Kannar said floods affected their household at least once a year; this contrasts with just 1 of the 39 respondents in Ta Kaung Boe.

9 POP is a statistical approach that matches household survey data with census data to derive a likelihood of a household being below or above a poverty line. It is particularly useful as it allows for robust assessment of the likelihood of poverty using simple and low-cost methods. For more see Desiere et al. (2015).

Figure 5: Self-reported sensitivity and exposure to cyclones, droughts and floods in Hpa An



Households are asked about the impact of hazards on livelihood and well-being (Figure 5B); their responses reinforce the finding that flooding is by far the biggest issue facing respondents in Hpa An. Our findings also show differences between socio-demographic groups. Here we see that 36.8% of those with a lower likelihood of poverty (below the median POP score) see flooding as posing 'no problem at all'. In contrast, the same response is given by only 25.6% of those in households with a higher likelihood of being in poverty (above the median POP score). In other words, those who are more likely to live in poverty see themselves as being at greater risk than less poor groups of experiencing negative consequences from flooding.

Insights from the baseline survey paint a varied picture of disaster risk as well as socioeconomic conditions across the eight villages

surveyed in Hpa An (for further information see Jones, 2018). This considerable heterogeneity notwithstanding, much of the nuance in terms of how disasters are likely to affect households on the ground can be gleaned only through repeated observations over time. Taking full advantage of the RRR dataset, we now present findings from across the various rounds of the panel.

4. FINDINGS FROM THE RRR MOBILE PANEL SURVEY

IMAGE: EMIL HELOTIE/ FINNISH RED CROSS

We concentrate our analysis on the three main research questions posed at the onset, looking at how households experience climate hazards on the ground; how levels of resilience change over time; and how long it takes households to recover from climate hazards.

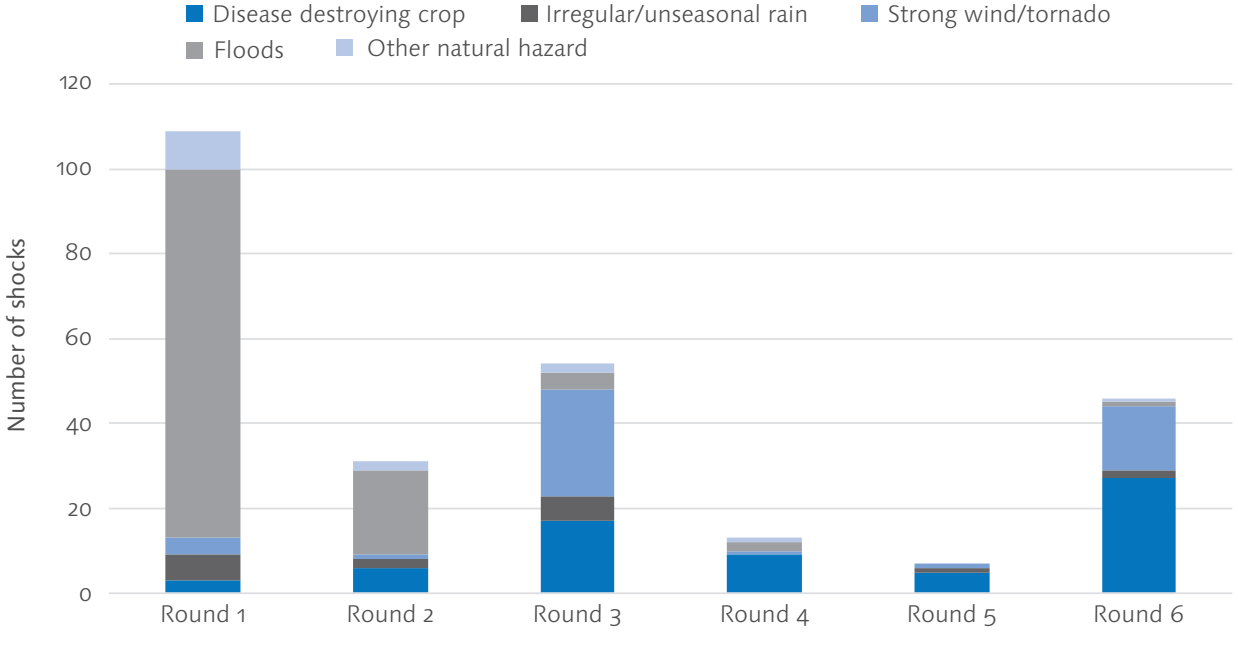
4.1 Risk and exposure to climate hazards in Hpa An

As outlined above, Hpa An was chosen in part because of the high frequency and scale of its exposure to climate hazards. Indeed, the findings from the RRR panel show just how vulnerable households in Hpa An are to different hazards. During the first six mobile phone survey rounds – lasting from July 2017

to May 2018 – respondents reported a total of 260 separate climate hazards. As Figure 6 shows, the frequency and nature of these varied greatly across time.

In the weeks prior to the first phone interview round, Hpa An saw a series of heavy flood events, affecting 87 households (7% of all households in the RRR panel). In this round, floods make up the largest share of reported climate hazards. Indeed, by Round 2, flooding continued to cause hardship among RRR respondents, with 20 households self-reporting as being affected by flooding. Flood frequency eventually dropped off sharply from Round 3 onwards, with heavy wind events (such as tornados) and severe crop losses owing to pests and diseases having a marked effect on the area.

Figure 6: Number and type of self-reported shocks across households in the RRR survey



Note: Shocks are new events. A household reports a hazard only once, after which the impacts are tracked over time.

Given the considerable impact of flooding on Hpa An during the first two rounds of the RRR survey, we confine our analysis here to households reporting a climate hazard during these two initial periods. We also remove any households that report disasters in any subsequence rounds of the survey to limit the influence of further shocks biasing resilience scores.

4.1.1 Which households were most affected by climate hazards?

When climate hazards struck during the first two survey rounds, some of the RRR households were more exposed than others. Those whose livelihoods depend primarily on agriculture were twice as likely to be hit by floods as those whose livelihoods do not depend on agriculture: 11.7% of the 503 farmers in the RRR panel reported that their household had been affected by floods in the previous month compared with a mere 5.6% among non-farmers.

Furthermore, poverty levels appear to be somewhat linked to exposure to climate hazards, albeit in an unexpected direction. Households with a lower likelihood of poverty (defined as being above the median POP score for all households across the eight villages) were more likely to be hit by a climate hazard during or prior to the first two survey rounds. Much of this is reflected in the geographical distribution of the households across the various RRR villages. It turns out that most of the severe floods that happened around the first two phone survey rounds took place in two of the eight villages: Pann Kone and Ta Kaung Boe. In these two villages, one in five households reported having been hit by floods (21.0% and 20.5%, respectively). In contrast, the proportion of those affected in the remaining six villages remained far lower.

Table 2: Percentage of households reported as affected by climate or natural hazards in first two rounds of the RRR survey

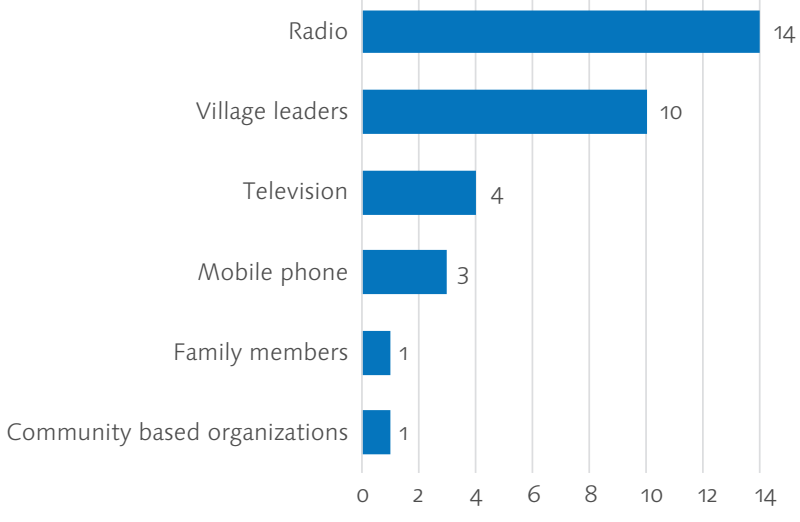
Schooling of household head	None	11.90%
	Some schooling	9.70%
Gender of household head	Male	11.30%
	Female	8.80%
Likelihood of poverty	Higher likelihood	8.10%
	Lower likelihood	12.80%
Occupation	Farmer	13.90%
	Non-farmer	8.00%
Remittances as primary source of livelihood	Yes	9.20%
	No	10.60%

The fact that Pann Kone and Ta Kaung Boe are among the more affluent of the eight villages explains the initially negative relationship between affluence and disaster vulnerability. Consequently, this relationship disappears when we look only at households in Pann Kone (the larger of the two villages). The above illustrates the enormous added value of the census-like sample of the RRR panel. Having fine-grained information about the respondents' geographical location allows us to run detailed analyses at various levels of aggregation and to explore how even small differences in location can affect vulnerabilities to specific disasters. As another case in point, all of the 11 instances of landslides reported in the first two survey rounds happened in a single village, Ta Kaung Boe.

Results also show that about a quarter of the households that reported a climate hazard in the first two rounds had received

some kind of early warning message (23.6%) – in most cases delivered either by means of a radio broadcast or by the village leader (see Figure 7). If we look specifically at floods – the most frequently occurring climate hazard in the first two rounds – we find that about one in four households had received some form of advance notice (25.2%).

Figure 7: Sources of early warning messages received by households affected by a climate hazard in Rounds 1 and 2



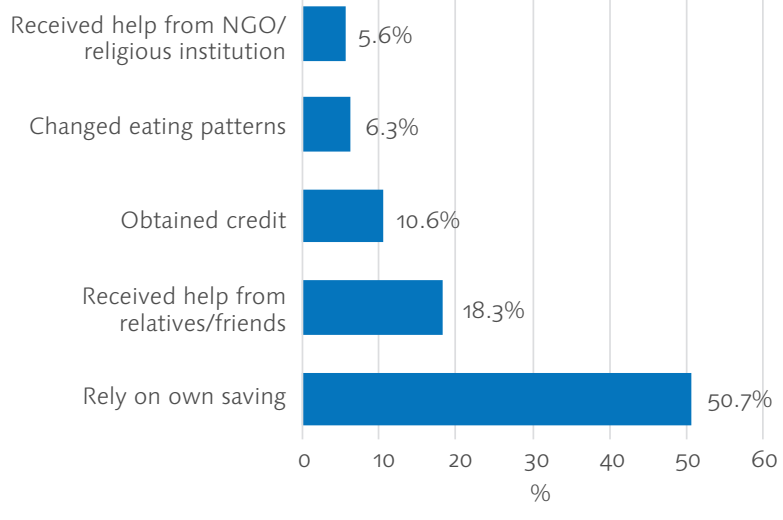
4.1.2. What coping strategies did households employ?

To better understand how households are dealing with climate hazards, each household affected by a new hazard in the month prior to the interview – or those that had not yet recovered from an earlier shock – was asked to list up to three coping strategies employed in the direct aftermath of the shock. These responses provide a rich resource for exploring different ways people coped with the disasters that hit them during the first two survey rounds.

Analysis of these responses suggests that falling back on personal financial buffers is the single most frequent coping capacity. In just over half of all reported climate hazards during the first two rounds of the survey respondents had to turn to their own savings in order to cope with the threat (50.7%). Availability of social support networks was also important. Roughly one in five households affected by a hazard (18.3%) relied on some form of help from relatives or friends in the weeks and months after the disaster. One in ten coping strategies involved taking out some form of credit (10.6%). In only a limited number coping strategies did the severity of the situation necessitate a reduction in the frequency and/or the quality of family meals (6.3%).

Interestingly, these coping patterns do not differ substantially between major livelihood types, such as between farmers and non-farmers. Equally, comparing the results of those with a higher and those with a lower likelihood of poverty does not reveal much difference in the relative frequency of employed coping mechanisms.

Figure 8: Frequently employed strategies in coping with climate hazards during the first two survey rounds



4.2 How do levels of resilience change over time?

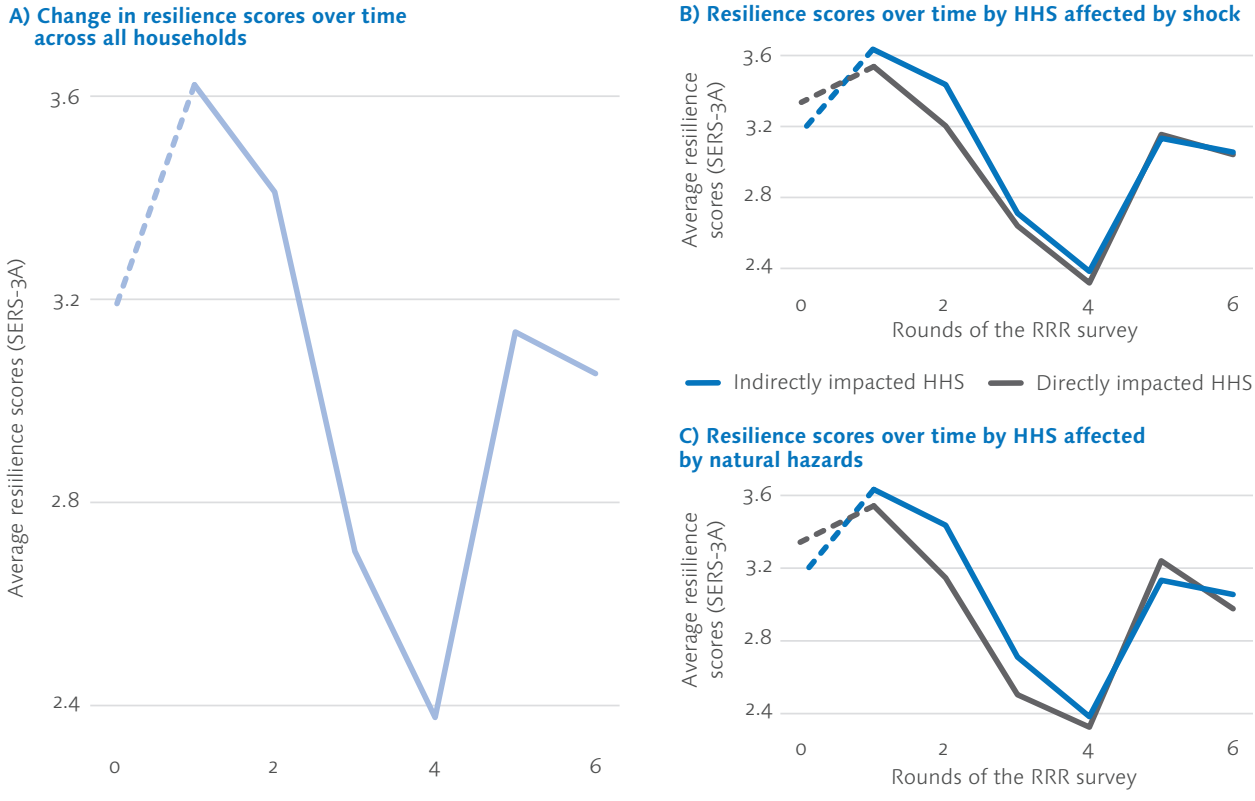
One of the biggest questions that the RRR hopes to answer relates to how a household's resilience changes over time. Having repeatedly collected people's subjective evaluations of their household's resilience, the RRR panel survey is now able to uncover a number of interesting insights that may help shed light on these dynamics.

Figure 9A shows average levels of subjectively evaluated resilience (using the SERS-3A model) over the course of six rounds of data collection (each round is approximately two months in length). It shows large fluctuations in the levels of overall resilience over the six rounds of the RRR survey with a large dip occurring up until Round 4 – an average decrease of 1.2 points on a score ranging from 1 to 5). This is followed by a slight surge upwards in subsequent rounds (though levels remain slightly lower than in Round 1). Here it is important to point out that the first dot (marking Round 0) and dashed lines across all graphs in Figure 9 represent values from the baseline survey. Given that these measurements were collected using a different method (face-to-face surveys as opposed to mobile surveys), we have chosen to mark these as separate, given the potential for biases in comparing the two data collection techniques. Caution should therefore be taken in drawing comparisons across time that include the baseline. However, the figure does provide a useful guide for pre-shock levels and – assuming that any differences between face-to-face and phone survey collection methods affect everyone equally – can allow for some degree of comparison between groups during the same period of time.

To make sense of the large changes in resilience scores across the various rounds (amounting to a 35% reduction between Round 1 and Round 4), it is important to recognise the series of hazards that affected Hpa An over the course of the survey, in particular the large flooding events in July 2017. Figure 9B separates households that self-reported as being directly affected by a disaster between the baseline and the first round of the RRR survey (grey line) from those that were indirectly affected[10] (light blue line). Here we clearly see that households that reported a disaster have lower overall resilience scores than others. This separation lasts for up to three subsequent rounds of the RRR survey before levels appear to match. Indeed, it is interesting that levels of overall resilience were slightly higher during the baseline survey for those that eventually reported a disaster in Round 1 of the survey. This may suggest that those affected were slightly better off (at least in resilience terms) to begin with, and further underlines the significance of the drop in resilience scores once the disaster had hit by Round 1.

10 Given that the RRR is a census with households in close proximity, households that do not report being directly affected by flooding are considered indirectly affected, given the extent of localised flooding as well as the spill-over of negative effects that affect the wider community.

Figure 9: Changing levels of subjectively evaluated resilience over time across RRR households



Note: The first dot and dashed lines represent values from the baseline survey (face-to-face) compared with all other values (mobile phone survey).

We can look in even more detail to isolate the impact of the climate hazards on households' resilience scores – something of particular interest to BRACED. Figure 9c compares households that were affected by climate hazards (as opposed to non-climate related hazards such as loss of a job or family bereavement) with those that reported no disaster affecting them during Round 1 of the RRR survey. Here the gap between directly and indirectly affected is even larger, as resilience scores show clear differences across the two groups. Similar to Figure 9b, however,

scores appear to gradually align over time, and closely match after Round 4 of the survey.

Perhaps the most interesting thing to note is that resilience scores seem to drop dramatically after the flood events for all households (both those self-reporting a hazard and those that saw no such hazard) up until a recovery in Round 4. Indeed, if we were to follow the theoretical models presented in Figures 1 and 2, then we would expect those indirectly affected by hazards to report relatively stable resilience scores over time. How should we interpret this discrepancy? In reality, there are many potential reasons: floods may be negatively affecting other households in the area by destroying communal infrastructure; negative spill-overs may be having an impact on indirectly affected households through draining of limited community resources or harming local markets; it may be that some households are more inclined to report a hazard than others; or, simply, resilience levels may fluctuate considerably over time (either randomly or for other internal/external reasons). What is clear is that, given the nature of the RRR survey – that is, it covers eight villages in close proximity – it would be ill-advised to consider households self-reporting as unaffected by a hazard as a valid control group. Instead, they may be best thought of as households that are less exposed to the hazard in question. We return to examine this issue and potential reasons for it in more detail in Section 5.1.1.

4.2.1 Are there differences in resilience scores across social groups?

While it interesting to learn how shocks are affecting levels of resilience over time, this information is of little practical use without a thorough understanding of the impacts on different social groups. Using data collected during the

baseline survey, we can disaggregate households according to a range of socioeconomic characteristics and see whether there are differences in gaps between those directly and indirectly affected by disasters.

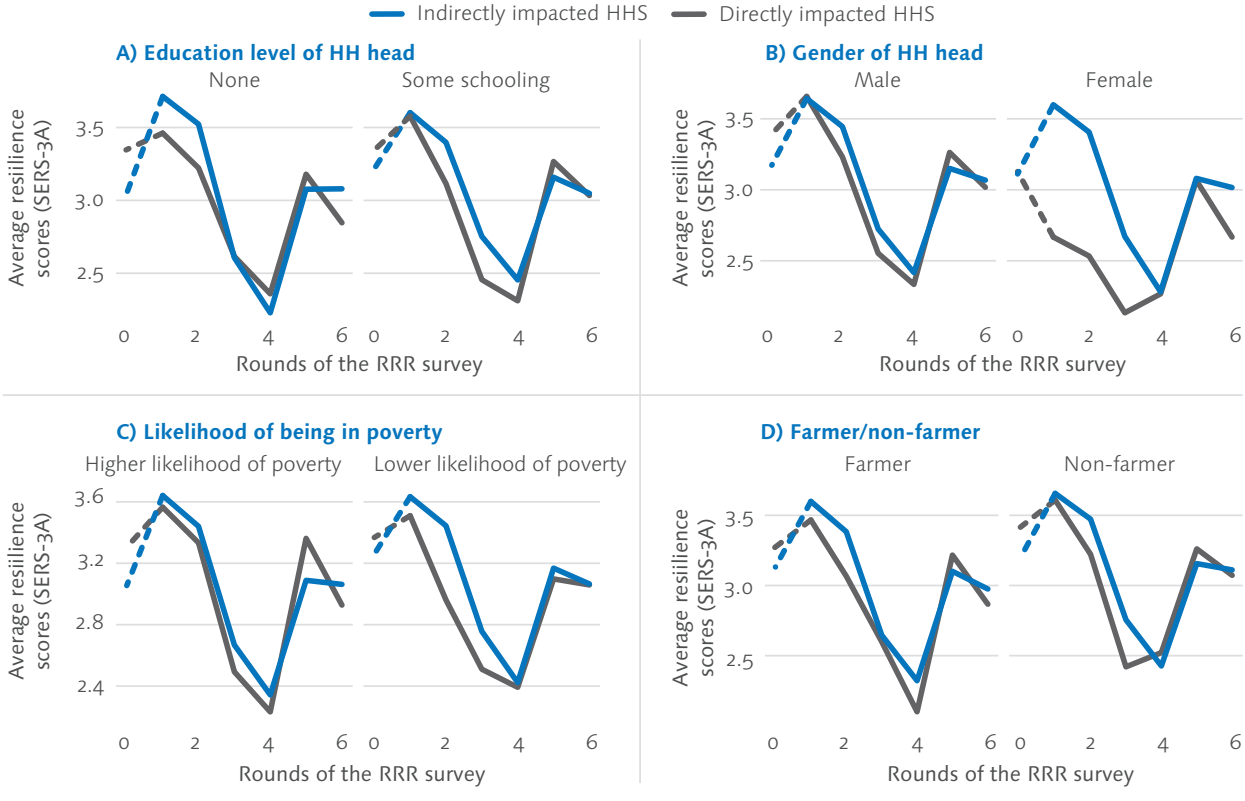
Figure 10 presents changes in subjectively evaluated resilience scores (using the 3As model) broken down by highest level of education and gender of the household head; likelihood of poverty; and whether the household derives its livelihood primarily from farming or not. The figures show remarkable consistency, with those directly affected by disasters reporting lower scores then those indirectly affected across the board. For education (Figure 10A), there appears to be little noticeable difference between those that have received some form of formal schooling and those that have not.[11] While this may be somewhat surprising, given the emphasis on the importance of education for resilience in some of the literature, this parallels wider findings on subjective resilience reported by Jones and Samman (2016) and Jones (2017). The same holds for households that derive a livelihood from farming, with non-farmers showing a slightly larger gap between directly and indirectly affected households. In all cases, results converge after about eight months (Round 4).

When it comes to poverty and livelihoods (Figures 10C and 10D), there also appears to be a weak trend. In fact, less poor households somewhat surprisingly show more of a contrast in scores than poorer households. However, it is important to note that baseline figures for households directly and indirectly affected by climate hazards are higher for poorer households. In other words, prior to any hazards being reported in the area, households that were eventually affected in Round 1 exhibited

11 Note that the sample size for household heads with no formal schooling is far smaller than for those with schooling.

slightly higher resilience scores than those indirectly affected (seen in the differences between the blue and grey dots in Round 0). When factoring this in, the difference between households with higher and lower likelihood of poverty is negligible.

Figure 10: Changes in subjectively evaluated resilience by socio economic characteristics

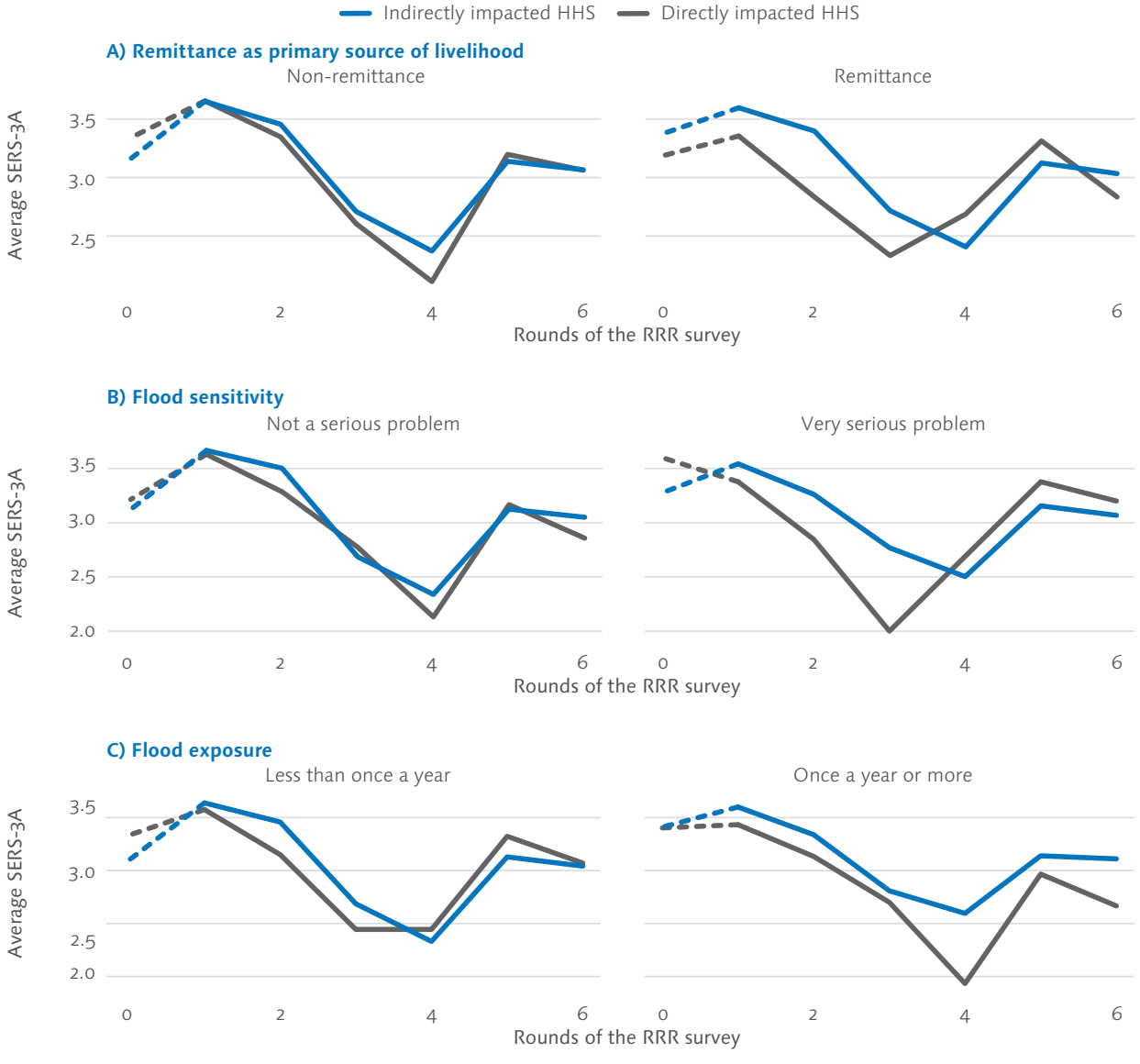


Perhaps the most interesting finding relates to differences in scores between male- and female-headed households (Figure 10B). While there is a discernible decrease in resilience scores for male-headed households directly affected by a climate hazard compared with those not directly affected, the gap is far more pronounced for female-headed households. Indeed, though there is an uptick in scores for female-headed households

after Round 4, the gap between directly and indirectly affected households does not appear to converge even after Round 6 of the survey. This may suggest that the impacts of climate hazards are more severely felt by households headed by a female. Interestingly, this is despite the fact that female-headed households reported slightly higher levels of overall resilience during the baseline (when no prior hazards were reported) than did male-headed households.

Another interesting disparity concerns differences between households that rely on foreign remittances as a primary source of livelihood and those that derive their livelihood elsewhere. Figure 11A shows how those that are remittance-dependent have lower comparative resilience scores, though this difference rebounds sharply after Round 4. This may be explained in part by the fact that households reliant on remittances tend to be without the main bread-winner and are more commonly headed by a single head of household or older members. Differences in flood exposure and sensitivity also show useful outcomes. As with remittances, those that report high sensitivity to flooding (i.e. households that believe flooding is a serious problem in their day-to-day life) have lower relative resilience scores up until Round 4, when scores converge. In the case of exposure, while there do not appear to be large differences in resilience scores for the first few rounds, households that report high incidence of annual flooding never appear to converge with those that are less frequently affected across the entire six rounds of the survey.

Figure 11: Changes in subjectively evaluated resilience by further socioeconomic characteristics



4.3 How long does it take people to feel they have recovered from a climate hazard?

Alongside changes in resilience rates over time, important insights can be gleaned from how long it takes households to feel as though they have fully recovered. As such, households that reported a hazard were asked the following question in the surveys that succeeded: 'Do you feel that your household has fully recovered from the impacts [of the shock event] compared with your household's circumstances before the event?' Households were asked this in continual rounds of the survey up until the point that they reported having fully recovered. The length of time taken was then used as a marker of perceived recovery rates.

Though related, perceived recovery rates are conceptually different to resilience scores. More specifically, the length of time it takes for a household to feel as though it has recovered may not be the same as the length of time it takes for resilience scores to return to prior levels. The former is likely to relate to current sentiments of whether the household has regained normalcy related to well-being and livelihood outcomes. The latter, however, is more closely associated with the capacity to respond to current and future threats (and hence likely to be a longer-term perspective). Irrespective, a comparison of the two metrics can yield valuable information related to post-disaster recovery changes in resilience over time.

Table 3 showcases the length of recovery for all households affected by a hazard (note that the distance between each wave is roughly equivalent to two months). It also disaggregates between those affected by climate and non-climate related

hazards.[12] Overall, we observe that 43% of households recovered within a month, and 37% in two months. By disaster type, we observe that households tend to recover faster from a climate hazard compared with non-climate related ones. As such, 46% of households that experienced a climate hazard recovered in a month, compared with 36% of those that suffered an non-climate related hazard. For both types of hazards, a non-negligible 15% of households have yet to fully recover four months or more after the initial threat.

Table 3: Recovery time of households that experienced a disaster in Wave 1

RECOVERY TIME	DISASTER TYPE		
	Climate	Non-climate	Total
	%	%	%
1 wave	46	36	43
2 waves	31	47	37
3 waves	18	15	17
4+ waves	5	2	4
Total	**100**	**100**	**100**

We can also break this down by important socioeconomic characteristics (Tables 4–8). Across all markers we still find faster recovery times for climate hazards. However, an interesting pattern emerges, with households with no formal education and female-headed households appearing to recover more quickly one round after the initial shock. Caveats are important here.

12 The full list of non-climate related hazards is as follows: sudden loss of livestock; social unrest; fall in the price of goods sold by the household; increase in food prices; medical emergency; serious accident; death of income-generator; sudden loss of productive assets; and loss of job.

For example, in the case of gender, although female-headed households have higher levels of early recovery, this pattern is not entirely consistent across time periods. The number of households headed by women is also far lower, and this should be taken into account as well. Irrespective of these cautions, the fact that female-headed households appear to perceive themselves as having recovered quicker than male-headed households contrasts sharply with the changes in resilience outlined in Figure 10B. Again, a number of factors may be at play here; we explore these in more detail in Section 5.2.

Table 4: Recovery time of households that experienced a disaster in Wave 1 by level of education

	LEVEL OF EDUCATION OF HOUSEHOLD HEAD			
	None		Primary or higher	
	Disaster type		Disaster type	
Recovery time	Climate	Non-climate	Climate	Non-climate
	%	%	%	%
1 wave	53	27	43	40
2 waves	22	53	36	45
3 waves	17	20	19	13
4+ waves	8	0	3	3
	100	**100**	**100**	**100**

Table 5: Recovery time of households that experienced a disaster in Wave 1 by gender of household head

	GENDER OF HOUSEHOLD HEAD			
	Male		Female	
	Disaster type		Disaster type	
Recovery time	Climate	Non-climate	Climate	Non-climate
	%	%	%	%
1 wave	42	35	65	43
2 waves	37	48	5	43
3 waves	16	15	25	14
4+ waves	5	2	5	0
	100	**100**	**100**	**100**

We note few differences in the recovery time of a household when disaggregated by the likelihood of poverty. However, the overall pattern still holds, with households recovering faster from Climate than from non-climate related hazards, irrespective of their likelihood of poverty. The analysis by remittances indicates that households that do receive remittances recover faster than those that do not, irrespective of the disaster (Table 6).

Table 6: Recovery time of households that experienced a disaster in Wave 1 by remittances and likelihood of poverty

LIKELIHOOD OF MONETARY POVERTY				HOUSEHOLD HAS REMITTANCES AS MAIN SOURCE OF INCOME			
Low		High		No		Yes	
Disaster type		Disaster type		Disaster type		Disaster type	
Climate	Non-climate	Climate	Non-climate	Climate	Non-climate	Climate	Non-climate
%	%	%	%	%	%	%	%
47	40	49	36	38	33	41	36
33	40	28	54	31	50	35	45
17	16	21	11	31	17	18	18
3	4	3	0	0	0	6	0
100	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Lastly, we analyse the recovery rate of households by their sensitivity and exposure to flooding. As a reminder, the former relates to how much of an issue flooding is to the household's overall well-being and the latter refers to how frequently the household is affected by flooding. As expected, households that are sensitive to flooding tend to recover much slower than those that are not sensitive; this pattern is exacerbated when looking by type of disaster. The same pattern is also apparent with regard to exposure, albeit somewhat less pronounced.

Table 7: Recovery time of households that experienced a disaster in Wave 1 by sensitivity and exposure to flooding

	SENSITIVITY TO FLOODING				BEING AFFECTED BY A FLOODING			
	No		Yes		No		Yes	
	Disaster type		Disaster type		Disaster type		Disaster type	
Recovery time	Climate	Non-climate	Climate	Non-climate	Climate	Non-climate	Climate	Non-climate
	%	%	%	%	%	%	%	%
1 wave	51	29	36	48	48	33	40	50
2 waves	24	56	44	33	35	53	20	25
3 waves	19	15	17	14	12	14	36	17
4+ waves	6	0	3	5	5	0	4	8
	100	**100**	**100**	**100**	**100**	**100**	**100**	**100**

5. WHAT DO THE RRR FINDINGS MEAN FOR RESEARCH, POLICY AND PRACTICE?

IMAGE: EMIL HELOTIE/ FINNISH RED CROSS

Findings from the RRR shed light on how climate hazards manifest on the ground, as well as their effects on households, in ways that have previously not been possible. Use of mobile phones has made it possible to feed near-real-time information back with much higher frequency than can usually be expected through traditional face-to-face surveys (at a fraction of the cost). As highlighted above, households in Hpa An have been affected by a large number of climate hazards – ranging from floods and irregularly timed rainfall to landslides and heavy wind events. It is also important to note that the nature of the RRR has allowed the panel survey to maintain a retention rate of close to 95% across its six rounds – a considerably high figure compared with other panel surveys, and important in weighting the credibility of the findings.

Significant localised flooding appears to have had the largest collective impact on households in the survey – especially during the first few rounds of data collection. This is well reflected in the fact that close to 30% of households affected by a climate hazard suffered some form of minor physical damage to their property and assets, and over 6% received significant damage. While data collected is self-reported (and any interpretations should factor in the typical caveats that go with subjective sources of data), it is corroborated by external sources, including a number of media reports (see ADRA Myanmar, 2013; The Global New Light of Myanmar, 2017). Satellite data compiled by the Myanmar Information Management Unit also shows extensive flooding in and around Hpa An over the period of 7–26 July and (to the south-east of the country) as well as the rest of Myanmar.

Clearly, these floods markedly affected livelihoods and resilience in Hpa An. Indeed, findings from the RRR document not only how flood occurrence evolved over the six rounds of data collection but also varying coping mechanisms used in dealing with floods and other climate hazards that affected the area at the time. High reliance on the sale and use of personal financial assets (50% of all coping mechanisms) is particularly telling, and correspondents well with the wider literature on climate resilience. During times of need, households often resort to the sale of assets in order to respond to immediate needs arising as a result of the negative impacts of a climate hazard – such as to seek medical supplies or emergency food rations – or rely on savings to cover an inability to return to normal livelihood-generating activities (Zheng and Byg, 2014).

High dependence on family and friends as a primary coping mechanism is also telling (close to 18% of affected households). Again, this is in keeping with existing resilience literature: the importance of social capital and family/friendship ties is well

documented (Adger, 2010). Kin and close friends are often the most reliable and closest source of support (whether financial, emotional or otherwise) during times of need – especially in rural and developing country contexts with strong family and social bonds. It is often also a symptom of poor government or other external support networks, which may be deemed unreliable or weak. This latter point is underlined by the fact that less than 2% of all households reported relying on local or national government for support in dealing with a hazard (not a single household reported this as their primary coping mechanism). Support from non-governmental organisations (NGOs) was somewhat higher (close to 4%), though still relatively insignificant.

These findings not only underline the potential for development and humanitarian actors to provide greater support and strengthen social capital as a means of promoting post-disaster recovery but also point to considerable limits in terms of capacity and outreach on the part of government, NGOs and other external actors in Hpa An that typically serve as essential mediators of disaster risk in other contexts. The fact that coping mechanisms do not seem to differ substantially between social groups may also have important policy implications. In large part, this suggests that policies aimed at strengthening coping mechanisms and post-disaster recovery have uniform impacts across the community; no individual social group will benefit more than the others.

Another point of interest relates to early warning and sources of information that people receive in anticipating climate hazards. As in many other rural African and Asian contexts (Mtambanengwe et al., 2012), findings from the RRR suggest that radio is critically important as a channel for disseminating early warning. Tellingly, village leaders emerge as the second

most common source of warning information. This underlines the importance of working through established community structures and institutions. Development actors may wish to pay closer attention to accessing and empowering important local brokers as a vehicle for communicating risk-related information. Interestingly, mobile phones make up a small (but important) portion of information sources, likely as a consequence of the rapid proliferation of mobile phones across the country since the opening up of privatised telephone networks in 2013. Indeed, focus group sessions in Hpa An during the collection of the baseline dataset suggested that many households receive information via sources such as Facebook, either through the spread of information from family and friends or directly from Facebook pages associated with a well-known weather forecaster, Tun Lyn. Again, these findings can help development actors, like BRACED and others, in targeting more appropriate sources for early warning delivery and outreach with local communities in Myanmar.

5.1 Comparing resilience theory with real data

One of the main advantages of the RRR is that it collects resilience data over a number of time periods, making it possible to compare real-life outcomes with resilience theory for the first time. Before delving into the results, it is important to recognise that contrasting any concept (like resilience or well-being) with data collected in the field is challenging. The real world is invariably complex, and it is difficult to isolate how one event may be affecting a household, given the many threats and stresses that people experience in their day-to-day lives. Despite these caveats, insights from the RRR survey highlight a number of interesting points.

Perhaps the most important aspect to consider is how resilience theory, represented by Figure 1, matches up with resilience in practice, represented by Figure 9B. By tracking how subjectively evaluated levels of resilience change over the course of the RRR, Figures 9B and 9C clearly show how resilience scores across all households drop considerably over the course of the first four rounds. Scores then rise up and level off through to Round 6. It is particularly interesting to note that scores do not appear to return to the same levels as prior to Round 1 – suggesting that, in the case of climate hazards affecting Hpa An at the start of the survey, impact may be long-lasting and meaningful (we explore further explanations and caveats below).

Moreover, the fact that households that self-reported as having been affected by a climate hazard between Rounds 0 and 1 exhibit lower resilience scores than those that did not report a hazard is reassuring – at least in a methodological sense. This trend closely matches what we would expect, given that a climate hazard is likely to reduce a household's ability to deal with ongoing or future risk. The fact that there are also further disparities between important socioeconomic and environmental groupings (female-headed households, by livelihood type, by exposure to flooding) also provides some confidence that results from the RRR match (to some extent at least) common assumptions of how resilience manifests at the local level.

Another reassuring property evident from the time series is that scores seem gradually to converge – that is, differences in subjectively evaluated resilience scores between directly and indirectly affected households gradually diminish until roughly Round 4 of the survey. This finding seems to be consistent across most social groups, and suggests that the impact of the hazards started to reduce in size for those affected over time when compared with indirectly affected households. Again,

this matches strongly with what would be expected in the wider risk and resilience literature, as is broadly consistent with the models presented in Figures 1 and 2.

Indeed, if we compare households that have been hit by more than one climate hazard with those that have been hit by a single or no climate hazards over the course of the RRR, we see an even more pronounced dip in resilience scores (equivalent to a dip of roughly 0.3 and 0.2 on the SERS-3A score relative to single and no hazards, respectively). Collectively, these findings hint at the notion that the SERS scores may be capturing some aspects of a household's 'true' resilience. Moreover, they suggest analysis of the temporal change in subjectively evaluated resilience scores may be a useful guide to understanding which socioeconomic groups are doing worse/better than others. It may also provide a rough indication of when a household or community is starting to recover from the impacts of a large shock or stress. In the case of Hpa An, this appears to be four to five rounds after the start of the flooding events.

5.1.1 Exploring anomalies and potential sources of bias

While the points above are reassuring, there are a number of surprising findings. For one, the lack of a clear difference in trends between different poverty groups is somewhat surprising, particularly as this contrasts sharply with results from the baseline dataset. In this initial round of the RRR, poorer households exhibited lower resilience scores than less poor households (Jones, 2018). This same trend can be seen in Figure 10C, which shows poorer households indirectly affected by a climate hazard exhibiting a slightly lower starting level of resilience than less poor households. Yet this is where the real power of panel data is of such use, as it helps tell a more nuanced story. While the snapshot provided from the baseline suggests that poorer households

are worse off, this comparative trend does not necessarily play out when we track relative differences in scores over time.

Though these findings may not immediately hint at strong policy implications, they tentatively suggest that poverty may not be a significant differentiator when it comes to changes in resilience-capacity scores over time. While poverty seems to be a key driver in determining subjectively evaluated resilience levels, it may not have such a strong role in determining how resilience levels change over time compared with other socioeconomic and risk-related factors. In other words, even though poverty may influence base levels of resilience, poor and less poor households appear to be affected relatively equally to their starting point. If true then resilience-building interventions may have even benefits across social groups. Here, it is important to note that these findings are based primarily on simple comparative scores. More advanced analysis will certainly be needed to adequately account for the differences in starting resilience levels between those directly and indirectly affected by hazards, as will controlling for confounding factors, in order to be able to draw firm conclusions – analyses that will feature in subsequent RRR reports.

Another interesting point to note is that resilience levels dip significantly after Round 1 not only for households that reported a hazard but also for those that did not report a threat. Assuming that resilience operates according to model outcomes in Figure 1, we would not necessarily expect this to be the case. There may be a number of reasons for this. First, as mentioned earlier, households that do not self-report being affected by a climate hazard are not a perfect control group (and hence are not suitably represented by the black line in Figure 1). Moreover, given that the RRR is a census of eight adjacent villages, each close to the Thanlyin river, as well as the fact that flooding was by far the

largest reported hazard during the first round of the survey, it is easy to see that the impacts of the climate hazards are likely to have affected all households in the area. Even those not directly exposed to flooding are likely to have felt indirect negative consequences. For example, there may have been damage to key community infrastructure such as road networks, or wider impacts on livelihoods through reduced access to markets and/or higher commodity prices. Qualitative evidence to test this theory with key informants will be collected in upcoming rounds of the RRR project.

Another reason may relate to negative spill-over effects. Given that flooding affected a large number of households, this likely had implications for localised productivity and attentional resources. The majority of affected households drew heavily on family, friends and neighbours for support during times of need; it is thus not inconceivable that this collective assistance had an impact on non-affected households. If this were to be the case, then the control group can be better thought of as households that are less directly affected than those that self-report a hazard (the same would also apply for the first proposition).

A third potential explanation may be found in relation to how people think about themselves and the world around them in the form of cognitive biases. As the RRR is reliant on self-evaluations (both for resilience scores and for recovery times), it is certainly possible that cognitive biases may be affecting the results. For a start, two people exposed to the same threat may perceive it very differently: one may see it as a grave danger and the other less so, owing to differences in risk perception or cultural attitudes. This may even be the case for different individuals within the same household. Lastly, it is possible that perceived (as well as true) levels of resilience fluctuate considerably over time. Little to no evidence has been collected on how resilience

levels change temporally. It is therefore hard to rule out that the collective dip and rise may be an artefact of other factors (whether random or internally/externally induced).

For each of reasons outlined above it is important not only to recognise that caveats in data collected under the RRR, but difficulties in comparing resilience theory with resilience practice. Having said this, findings from the survey are a useful first guide, and shed light on a number of important distinctions in relation to how resilience-capacities may change over time. Indeed, looking at the various explanations provided above, we believe it is most likely that the collective dip is caused by a combination of the wider-spread extent of flooding in the area and negative spill-overs. As more information is gathered, including examples of further large-scale hazards, it is hoped that firmer conclusions can be drawn, allowing us to build on these initial speculations.

Most importantly, the fact that resilience-capacity scores dip for both directly and indirectly affected households suggests that the impact of flooding was extensive and had negative implications for the wider population (not just for those that felt the physical consequences). If shown to be robust, this conclusion has considerable policy implications. It means that resilience-building interventions should be conscious of the indirect impacts of climate hazards. Support should therefore not be concentrated solely on those directly harmed. Households located in close proximity, or connected by local networks and markets, may suffer similarly large negative consequences and also require external assistance. While help to indirectly affected households may need to be in a different form to help to those directly impacted (e.g. livelihood support rather than physical shelter and reconstruction), their needs should be noted and are considered no less significant.

5.2 Comparing changes in subjectively evaluated resilience with perceived recovery rates

One useful comparison brought about by the RRR panel is between changes in subjectively evaluated resilience scores over time (covered in Section 4.1) and the length of time it takes people to perceive that they have fully recovered (covered in Section 4.2). In some ways, these scores can be seen as picking up on related aspects of resilience. As such, we would expect there to be a number of similarities across the two variables. Indeed, to some extent this is what we see reflected in the data. For example, resilience scores and recovery rates both show similar trends in relation to differences among a number of important social groups and risk factors, such as likelihood of poverty (no apparent difference); education (few differences with no clear trend); reliance on remittances (slight difference, with those reliant on remittances taking slightly less time to recover and converge); and sensitivity and exposure to flood risk (those with greater exposure and sensitivity take longer to recover and converge).

Interestingly, large differences between female- and male-headed households are also apparent across both outcomes of interest – though they manifest in slightly different ways (see Figure 10B). On the one hand, resilience scores for female-headed households appear to drop markedly after the first round relative to those for households indirectly affected by a hazard. The gap then persists up until Round 4 of the survey. Male-headed households, on the other hand, show a much slighter difference in scores between directly and indirectly affected households, with a similar bounce-back after Round 4. Contrastingly, when it comes to perceived recovery rates (i.e. when households believe

they have recovered fully from the climate hazard), we see that a much higher percentage of female-headed households report a full recovery after a single round of the survey. However, this trend is reversed over time, with female-headed household respondents taking noticeably longer to recover from hazards.

Perhaps the most notable contrast between changes in resilience-capacity and perceived recovery rates relates to the point at which households seem to bounce back. While the vast majority of households perceive themselves to have fully recovered after two rounds of the survey (70% of affected households), a much slower trend is noted for the resilience-capacity scores. Here, Figure 9C shows how the gap between those affected by hazards and those indirectly affected is largest between Rounds 1 and 2, after which point scores start to converge until roughly four full rounds of the survey have taken place. Indeed, this trend of reduced resilience-capacities up until Round 4 is apparent not only for households affected by climate hazards but also for those that do not report a hazard.

What could explain this apparent contradiction? There are a number of possibilities. First, the two scores are inherently different: the SERS-3A score measures changes in capacity to cope with current and future risk; the perceived recovery rate, on the other hand, tracks the moment at which people feel as though they have fully recovered in relation to their immediate livelihood and well-being outcomes (recovery rates). It is certainly possible for a household to perceive that its livelihood and well-being have fully recovered two months after a specific hazard and at the same time to have a somewhat reduced capacity to deal with future risk for a number of months to come. There is therefore also an element of 'comparing apples with pears'. Moreover, while the temporal change in resilience-capacities is measured largely in relation to those that have not experienced

a disaster, this comparison is not possible for recovery rates. By their very nature, those that do not report a hazard cannot be asked whether they feel that they have fully recovered (as they have not been affected by such a hazard, in their view).

There may also be a range of socio-cultural norms, cognitive biases and differences in physiologies that account for some of these effects. For example, returning to the example of how men and women perceive risk, there is a considerably body of literature dedicated to gender and risk perception. This work typically notes that women and men see risk in slightly different ways, with women tending rate environmental risks slightly higher than men (Flynn et al., 1994). Yet it is interesting to note a somewhat different trend in the RRR example: higher proportions of female-headed households than male-headed households perceived themselves to have fully recovered after one month. Indeed, while the literature on gender and risk perception is well accounted for, sparse quantitative evidence exists on the links between gender and disaster-recovery and temporal changes in resilience. This is where the RRR may be able to provide useful insights, though these will require further analysis and nuance before firm conclusions can be drawn for policy.

We have noted differences between the two resilience measures, as well as accounting for potential biases, but a valid question remains in relation to understanding how either can and should be used for policy. While both offer considerable potential, we believe that, for the purposes of monitoring disaster recovery, it is the tracking of perceived resilience levels that may prove the most relevant and insightful. Not only does this provide a useful comparison with wider groups – specifically groups that may not have been affected by a hazard – but also, in not directly referring to the climate hazard in question (the resilience-

capacity relates to overall resilience and is not hazard-specific), it reduces the likelihood of priming. Recovery rates may also present a greater risk of recall and social desirability biases (Bertrand and Mullainathan, 2001). Having said this, there may be considerable utility in asking questions related to perceived recovery. This is particularly the case in instances where surveys may be pressed for space or where researchers and development actors are interested in tracking the impact of one particular hazard. Choice of metric should therefore be determined by the objectives, organisational capabilities and local context associated with the survey initiative.

6. CONCLUSIONS

IMAGE: EMIL HELOTIE/ FINNISH RED CROSS

The RRR is first survey of its kind to combine innovations in mobile survey technology with subjective evaluations of resilience and post-disaster recovery. While the findings presented here are preliminary and will be followed by more advanced statistical analysis, they point to a number of potentially important research and policy implications. First, levels of resilience change considerably over time. Development actors must therefore be conscious of the evolving nature of people's resilience-capacities. This means moving away from treating resilience as a static property to think of it as fluid and dynamic. Most importantly, resilience levels are affected by climate hazards in ways that are consistent and intuitive: in general, those most affected by disasters exhibit a sharp drop in their resilience scores (relative to those less affected), with

scores slowly converging over time. If this finding is shown to robust, then it heralds a new and important area of resilience research – one that presents to governments, NGOs and donors a complementary method for evaluating the depth and breadth of a shock event over time. Key to doing this is the use of mobile surveys that make it possible to relay cheap and near-real-time information back to evaluators as a disaster is unfolding on the ground.

Another strong finding relates to the impact of climate hazards on both directly and indirectly affected households. Resilience-capacity scores dropped significantly after the flooding events not only for those directly in harm's way but also for those who did not report being affected. Indeed, both sets of households appear to show similar resilience trajectories, with scores dipping sharply before rebounding after Round 4. This highlights the wide-ranging implications of climate hazards for the wider population – likely owing to spill-overs and connections between local livelihoods and markets – and means development actors must be aware of these in their targeting strategies. Limiting resilience-building interventions to those physically affected by climate hazards may put those living around them at considerable risk.

Perhaps somewhat surprisingly, in the RRR most socioeconomic groups appear to show little difference in breadth and depth of how flooding affects resilience scores over time. This suggests that, while various socioeconomic groups may start off with very different levels of overall resilience, the impacts of disasters are somewhat even (relative to these baseline levels). In other words, although poor and marginalised groups may be disproportionately at risk to start with, this risk is not further magnified after a disaster takes hold. This finding is similar to recent analysis by the World Bank assessing post-disaster recovery and objectively-evaluated resilience to flooding

in Ghana (Erman et al. 2018). If proven robust, then this may suggest that development efforts to promote resilience-building may have even benefits across social groups. Groups also appear to take similar lengths of time to perceive that they have experienced full recovery from the initial shock. The one clear exception to all this is female-headed households, which show a marked and sustained drop in resilience levels compared with male-headed households, with levels failing to converge even after six rounds of the RRR survey (though we note that this difference is less pronounced in relation to perceived recovery rates). This suggests that it may be most useful for development actors to target female-headed households, both in disaster risk reduction initiatives and in post-disaster recovery support. This is the case even though households with a female head in the RRR show slightly higher levels of overall resilience prior to the shock event.

The RRR also reveals that falling back on personal financial buffers is by far the most frequent coping strategy in response to flooding. Use of savings and immediate sale of household assets accounts for half of all reported coping strategies reported by households in the RRR. This is followed by reliance on family and relative with just over a quarter of total coping strategies. These insights underline the importance of safeguarding household assets from the impacts of climate hazards as well as provision of social safety nets (such as social protection mechanisms). It also highlights opportunities for development and humanitarian actors to promote social capital as a means of promoting disaster risk reduction and management – a factor rarely considered within resilience-building interventions.

Lastly, the RRR showcases the opportunities that innovations such as subjective evaluations and mobile surveys offer resilience measurement. While more can be done to examine the merits

and limitations of mobile and subjective options, this project highlights how considerable room exists for development actors to promote experimentation in resilience measurement. Indeed, insights from related fields such as behavioural economics, big data analysis and remote sensing may offer a wealth of opportunities in monitoring resilience that remain untapped to date. Crucially, the RRR will continue to operate until March 2019, collecting further vital panel data to help understand the dynamics of resilience and post-disaster recovery over time. In doing so, the project hopes to shed light on a novel area of research interest and inspire further innovations in resilience measurement and practice.

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BRACED aims to build the resilience of up to 5 million vulnerable people against climate extremes and disasters. It does so through a three year, UK Government funded programme, which supports 15 consortiums, working across 13 countries in East Africa, the Sahel and Southeast Asia. Uniquely, BRACED also has a Knowledge Manager consortium.

The Knowledge Manager consortium is led by the Overseas Development Institute and includes the Red Cross Red Crescent Climate Centre, the Asian Disaster Preparedness Centre, ENDA Energie, Itad and Thomson Reuters Foundation.

The BRACED Knowledge Manager generates evidence and learning on resilience and adaptation in partnership with the BRACED projects and the wider resilience community. It gathers robust evidence of what works to strengthen resilience to climate extremes and disasters, and initiates and supports processes to ensure that evidence is put into use in policy and programmes. The Knowledge Manager also fosters partnerships to amplify the impact of new evidence and learning, in order to significantly improve levels of resilience in poor and vulnerable countries and communities around the world.

For more information on the Rapid Response Research and to access to real-time data and visualisations from the surveys, please visit the Resilience Dashboard:

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