Resisting El Niño

An investigation into coping strategies to flood-related disasters in the Rímac river basin, Peru

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Abstract

Flood-related disasters pose one of the greatest contemporary challenges to development. Analysing and developing effective local coping strategies to flood-related disasters is crucial if at-risk communities are to successfully mitigate the impact of natural hazards whilst not compromising long-term development objectives.

This thesis utilises a combination of household surveys and key informant interviews to investigate the coping strategies taken by communities in the Rímac river basin in response to the 2017 *El Niño Costero*. This thesis then explores how the actions of the Peruvian state affected local coping capacities, and the repercussions of the coping actions implemented for future local development and disaster risk.

This thesis demonstrates that the low coping capacity of affected communities and an ineffective state response led to the widespread adoption of erosive coping strategies. The societal-wide lack of long-term vision and a desire to return to normalcy as quickly as possible resulted in coping strategies that were simply reactive and failed to address the underlying drivers of risk. As such, the coping strategies implemented following the 2017 disaster amplified disaster damages whilst simultaneously hindering the building of resilience and the long-term socio-economic development of affected communities.

Key words: Flood-related disasters; Disaster risk management; Disaster risk reduction; Coping strategies; Coping capacity; El Niño Costero.

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Acronyms

CENEPRED	National Centre for Disaster Risk Estimation, Prevention and Reduction
COEL	Centro de Operaciones de Emergencia Local
CRED	Centre for Research on the Epidemiology of Disasters
DRM	Disaster risk management
DRR	Disaster risk reduction
ENSO	El Niño Southern Oscillation
INDECI	National Institute of Civil Defence
IPCC	Intergovernmental Panel on Climate Change
MINDEF	Ministry of Defence
PLANAGERD	Plan Nacional de Gestión del Riesgo de Desastres 2014-2021
SENAMHI	National Meteorology and Hydrology Service of Peru

Glossary of key terms

Due to the contested nature of certain terms in the disaster risk management field, presented below are the definitions utilised by this paper.

Coping capacity: The ability of people, organizations and systems, using available skills and resources, to manage adverse conditions, risk or flood disasters. The capacity to cope requires continuing awareness, resources and good management, both in normal times as well as during disasters or adverse conditions (Thywissen, 2006).

Disaster risk management (DRM): The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of a disaster occurring (UNISDR, 2009).

Disaster risk reduction (DRR): The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness for adverse events (UNISDR, 2009).

Ex-ante phase: The period prior to a disaster event.

Ex-post phase: The period following a disaster event, including recovery and response (see below).

Flood-related disaster: A serious disruption of the functioning of the community involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community to cope using its own resources (UNISDR, 2009).

Flood resilience: The ability of a system, community or society to pursue its social, ecological and economic development and growth objectives, while managing its disaster risk over time in a mutually reinforcing way (Keating et al., 2016).

Huayco: Andean term for debris flows and flash flooding caused by high rains.

Quebrada: Andean term for a ravine.

Recovery: The actions taken after a disaster (either in the short- or long-term) to help people cope with disaster impacts, reconstruct damaged physical systems (e.g., homes, roads, damaged flood protection structures) and restore services.

Response: The actions taken during and immediately after a disaster to contain or mitigate disaster impacts, including evacuation, search and rescue, first aid and emergency relief distribution.

Risk activity: Actions taken by individuals that increase their disaster risk.

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Introduction

Flood-related disasters pose one of the greatest contemporary challenges to development. Between 1998 and 2017, two billion people around the world were affected by flooding, with dire implications for livelihoods and social development. Indeed, flooding has become the leading global source of disaster losses and damages (CRED UNISDR, 2018). Managing the impacts of flood-related disasters is therefore of clear global importance (Balgah et al., 2019).

The catastrophic nature of contemporary flooding has been driven by rapidly increasing risk. As Figure 1 demonstrates, risk is a function of hazard, exposure and vulnerability. In Peru, a country with a long history of disasters, flood risk is especially high due to a multitude of factors.
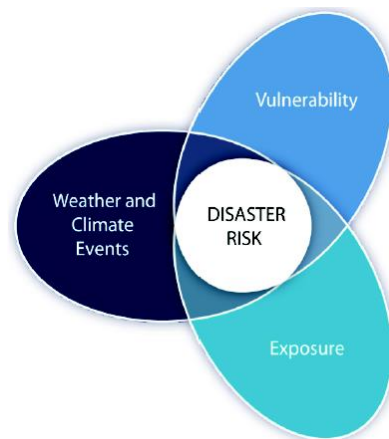
Figure 1: Disaster risk as a function of natural hazard, vulnerability and exposure. Source: IPCC (2012)

Flood hazards

Peru has a 'multi-hazard landscape', but is especially at risk from flood-related disasters stemming from the El Niño Southern Oscillation (ENSO) (Venkateswaran et al., 2017: i). French and Mechler (2017) describe Peru as a 'global hotspot for El Niño-related disaster risks' (p. 4) after severe events in 1982-83, 1997-98 and 2017 that all caused devastating loss of life and assets.

The ENSO is a natural fluctuation of the global climate system in the tropical Pacific (Philander, 1990). It is notoriously unpredictable and frequently described as Earth's strongest source of inter-annual climatic variability (Cane, 2005; McPhaden et al., 2006). An El Niño event (depicted in Figure 2) occurs when the Southeast trade winds reverse or weaken. Anomalously warm waters accumulate off South America's Pacific coast and the subsequent low pressure and rising, warm air can cause intense rainfall in coastal areas (Echevin et al., 2018).

El Niño event

Descending air and high pressure brings warm, dry weather

Southeast trade winds reverse or weaken

Warm water flows eastward, accumulating off South America

Cold upwelling reduced or absent due to weakened trade winds

Low pressure and rising warm, moist air associated with heavy rainfall
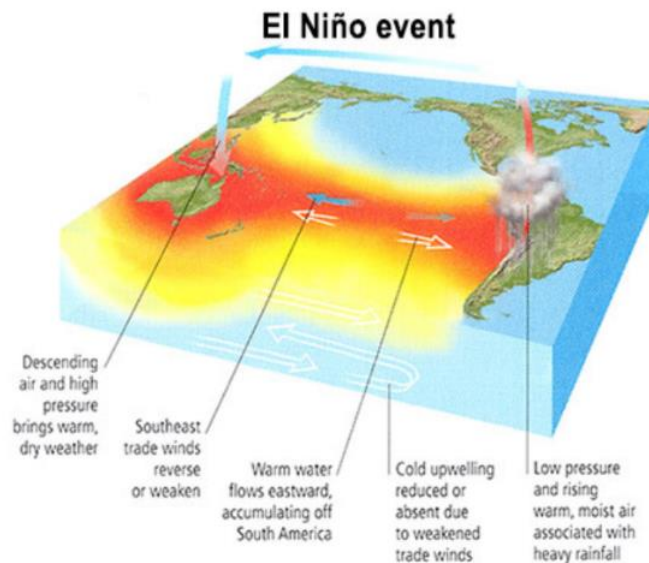
Figure 2: Depiction of an El Niño event. Source: Mann & Kump (2015)

This heavy precipitation frequently causes devastating riverine flooding and debris flows (locally known as *huaycos*) of steep, unstable terrain in the Peruvian Pacific slope (French et al., 2020). This has monumental impacts on local development.

Peruvian monitoring capabilities to predict events have drastically improved since the 1997-98 disaster. Simultaneously, there have been significant increases in funding allocated to disaster risk management (DRM) initiatives addressing El Niño-related risks (French et al., 2020). However, future events may become even more difficult to forecast due to climate change. Previous studies suggest that since the millennium, meteorological disaster events are more frequent and severe in Latin America (see French et al., 2020). Though it is yet unclear how increasing greenhouse gases may affect the ENSO, sea surface temperatures will be affected (Yeh et al., 2009). This has resulted in medium confidence in more frequent El Niño events (IPCC, 2012).

Whilst the impacts of climate change on the ENSO are uncertain, a 1.5°C rise in global mean temperature could double the frequency of extreme events (Cai et al., 2014; Wang et al., 2017). Given that recurrent events have caused significant damages in coastal Peru, reducing exposure and vulnerability of at-risk communities is vital (French et al., 2020). Climate change's slow onset impacts are predicted to aggravate existing disaster vulnerabilities (Adger & Brooks, 2003). Examining how to reduce the risk of extreme meteorological events is thus of clear interest to climate change adaptation initiatives.

The 2017 disaster

Whilst there have been several severe El Niño events in recent history, the scale of destruction in 2017 was unprecedented (see Figure 3). It was Peru's 'worst disaster in two decades' (French et al.,

2020: 1). A so-called 'coastal El Niño' (*El Niño Costero*) this highly localised event was the first recorded in Peru since 1925 (Ramírez, 2017). It occurred during a season when the Oceanic Niño Index values were close to neutral (Rodríguez-Morata et al., 2019).[1] This meant that the rapid warming off the Peruvian coast, and the intense precipitation averaging 8mm/day that followed, took governmental agencies and the scientific community by complete surprise (Echevin et al., 2018; Ramírez, 2017). Additionally, the 2017 event occurred just after one of the strongest El Niño events in recorded history in 2015-2016, which never developed beyond moderate intensity in Peru and was described as a 'non-event' (French & Mechler, 2017: 4). With the ENSO usually following a 2-7-year cycle, this *El Niño Costero* was completely unexpected.

The event lasted around 3 months.

Affected over 1.7 million people, causing 162 deaths.

Destroyed or damaged over 400,000 homes.
Damaged over 13,000km of highways and hundreds of schools and health posts.

Total economic losses were estimated at US$3.1 billion.
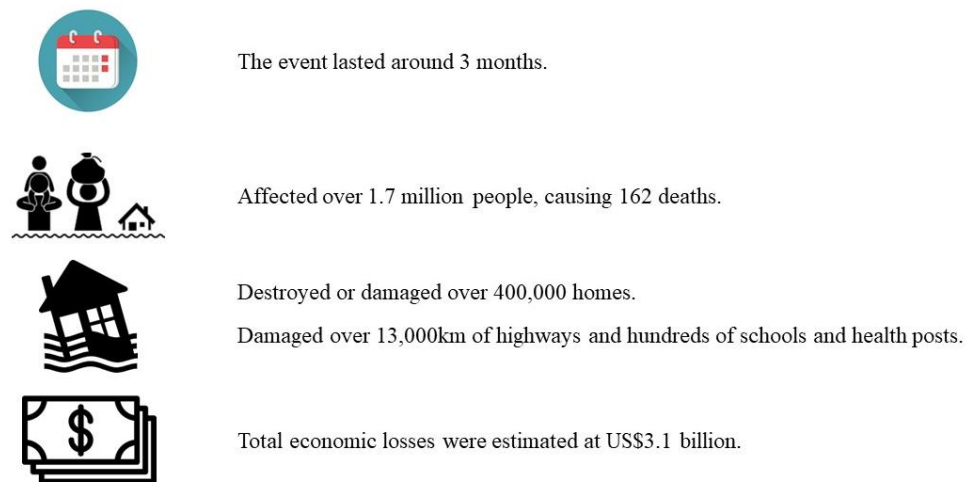
Figure 3: Impacts of the 2017 El Niño Costero.

Sources: Venkateswaran et al. (2017), French et al. (2020), Leon & Kraul (2017)

The geophysical conditions prompting an *El Niño Costero* are still relatively unstudied due to the event's rareness (Echevin et al., 2018). Given its unpredictability and the scale of destruction that has pushed countless households further into poverty, it is thought that the potential impacts of another disaster in the near future could be 'beyond devastating' (Venkateswaran et al., 2017: iii). As such, simply recovering from the 2017 disaster is not enough. Rather it is paramount that the reconstruction and recovery phase is reducing disaster risk whilst building community resilience to future El Niño events (ibid).

Flood exposure

The biggest global driver of increasing disaster risk is increasing exposure i.e. more 'people, property, systems or other elements present in the hazard zone' (UNISDR, 2009). Indeed, the current global rate of exposure to a flood event has overtaken population growth, whilst in many developing

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[1] Oceanic Niño Index values are one of the main indicators used to monitor the ENSO and predict El Niño events.

countries growth of disaster risk now exceeds economic growth (Miller et al., 2008; UNISDR, 2011, 2015). The predominant driving force behind this is urbanisation, clearly apparent in Peru.

One of the areas worst hit by the 2017 disaster was the Rímac river basin. Comprising a total area of 3504 km^2 the Rímac descends from 5500m in the Andes to the Pacific Ocean, passing through Peru's capital Lima on its course (Stern & Echavarria, 2013). The upper catchment is heavily controlled, with numerous large-scale hydropower dams. The lower catchment in downtown Lima is highly regulated too, with strong riverside embankments that very rarely overflow. However, the arid transition zone in the middle catchment (marked on Figure 4) that stretches from the eastern outskirts of Metropolitan Lima (*Lima Este*) to the Andean foothills is severely unregulated. Here the riverbed and steep surrounding hillsides are easily eroded. The climate and topography of the middle catchment therefore render local communities extremely exposed to flood-related disasters (Venkateswaran et al., 2017).
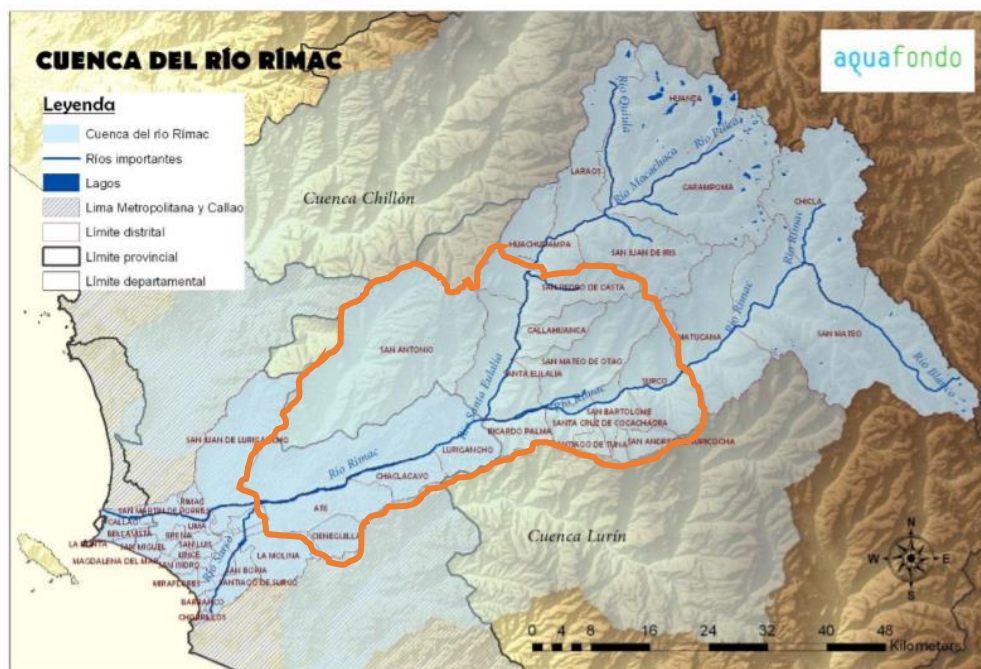
Figure 4: The arid transition zone of the Rímac river basin. Source: Stern & Echavarria (2013)

Large-scale neoliberal reforms, centralism and the city's progressive commercial development, alongside a violent national armed conflict in the 1980s and 1990s, resulted in unprecedented mass migration towards metropolitan Lima (García et al., 2015; Allen et al., 2017). Since 1960, Lima's population has grown tenfold to almost 10 million inhabitants – over 30% of the national population (Keating et al., 2017). Migrants have been drawn into this arid transition zone and forced to settle in high-risk, marginal areas (García et al., 2015; Keating et al., 2017). Approximately half of Lima's current population now live in the poor peri-urban areas of *Lima Este* and *Lima Norte*, meaning that

Peru's disaster risks are not geographically or socially even, and exposure to flood-related disasters has been consistently increasing alongside urbanisation (Allen et al., 2017).

Flood vulnerability

The global rapid growth of megacities, such as Lima, has created highly vulnerable urban communities (IPCC, 2012). The rapid urbanisation of the Rímac basin has increased flood exposure whilst simultaneously increasing local vulnerabilities i.e. the characteristics of people and assets that makes them 'susceptible to the damaging effects of the hazard' (UNISDR, 2009). Though the process of urbanisation itself does not always increase flood vulnerability, the type of urbanisation and the local context are critical (Douglas et al., 2008). Altering the natural environment through infrastructure can obstruct natural channels, and drainage systems can quicken surface run-off into riverways increasing the likelihood of overflow. Additionally, rapidly growing urban communities can limit state capacity to cope with extreme events due to the inability to provide adequate infrastructure to manage the hazard (UN-HABITAT, 2009).

Governmental actions, or lack thereof, have further exacerbated the vulnerability of Rímac communities. Lima's rapid expansion has occurred with no formal urban planning, poorly functioning land markets and few housing policies (Hallegatte et al., 2017; Lambert & Allen, 2017). A lack of official land zoning and authorities frequently overlooking land invasions has led to the large-scale occupation of high-risk areas (French et al., 2020). Lozano-Cortijo describes this phenomenon as 'vertical expansion' (in Lambert & Allen, 2017), as the urban poor are forced to settle around hillside ravines (*quebradas– see Figure 5)* with the hope of gaining future land titles and access to core services.

Figure 5: A quebrada in the arid transition zone. A combination of poverty and poor governance is forcing the most vulnerable in Peruvian society to occupy high-risk areas, surrounded by steep, arid slopes and loose rock with hopes to better their quality of life. Photo: Author's own.

Moreover, due to the severe lack of social housing and poor credit access, the vast majority of new houses constructed in these areas (an estimated 70% of new constructions) are self-built by residents, following no building codes (Collyns, 2017; Douglas et al., 2008). These homes are liable to wash away during flood events (Collyns, 2017), especially those alongside the riverbank (see Figure 6). Therefore, alongside Lima's expansion has been the substantial increase of risk activities that have drastically increased local vulnerability. Indeed, previous studies have insinuated that precipitation volume during the 2017 event was significantly less than in 1982-83 or 1997-98, implying that the extensive damages were largely human-caused due to rapid contemporary urbanisation in high-risk areas (French et al., 2020). However, if flood-related disasters are largely human caused, then there can be human solutions (Venkateswaran et al., 2017).

Figure 6: Houses in the arid transition zone are often self-built, following no building codes, in extremely high-risk areas. Photo: Author's own.

Increasing flood risk in Peru and consequences for development

In summary, heavy precipitation in Peruvian coastal areas resulting from an El Niño event can be devastating due to the high exposure and vulnerability of local communities and infrastructure. Most affected are usually the most vulnerable in society, as they are most exposed to natural hazards. The unpredictable nature of the ENSO and the high exposure and vulnerability of populations in the arid transition zone of the Rímac river basin means that El Niño-related disasters regularly substantially setback development initiatives (Keating et al., 2016). Furthermore, the recurrent nature of these disasters are one reason why eradicating poverty is so difficult, as any advancements made in the fields of education, health, infrastructure or environmental sustainability are regularly washed away (Keating et al., 2017; Hallegatte et al., 2017).

Contemporary research suggests that climate change is increasing the frequency of extreme weather events, causing more frequent and higher magnitude floods (CRED, 2015; Munich Re, 2014; Swiss Re, 2015). This upsurge of flood-related disasters presents a 'terrifying reality' for Peru, posing a severe threat to natural, social, human, financial and physical capital (Balgah et al., 2019: 1). Combined with increasing exposure and vulnerability due to the actions of the state and those living in at-risk areas, there is an evident need to tackle growing disaster risk, and to develop effective coping strategies to build long-term disaster resilience (Serre et al., 2016).

The importance of coping strategies

Coping capacity is defined as a population's ability to anticipate, respond to and reduce the potential negative effects of a hazard (Saldaña-Zorrilla, 2007). Central to community coping capacities are the temporary measures adopted by the state, communities and individual households in the ex-post phase of a shock event to mitigate any negative societal impacts, known as coping strategies (Davies, 1993; Nelson et al., 2007).

Analysis of household coping strategies is vital to contemporary disaster risk reduction (DRR) research, as they have significant impacts on both household and community wellbeing (see Figure 7). Coping strategy choice can affect the schooling, nutrition, health, income and asset base of households, and lead to severe long-term community impacts including familial breakdowns, increased rates of crime and violence, weakened levels of community cohesion and individual transgressions of social, legal and personal norms. Household coping strategies thus strongly influence the ultimate societal impact of a disaster, as well as the longer-term resilience and vulnerability of the local population (Heltberg et al., 2012).
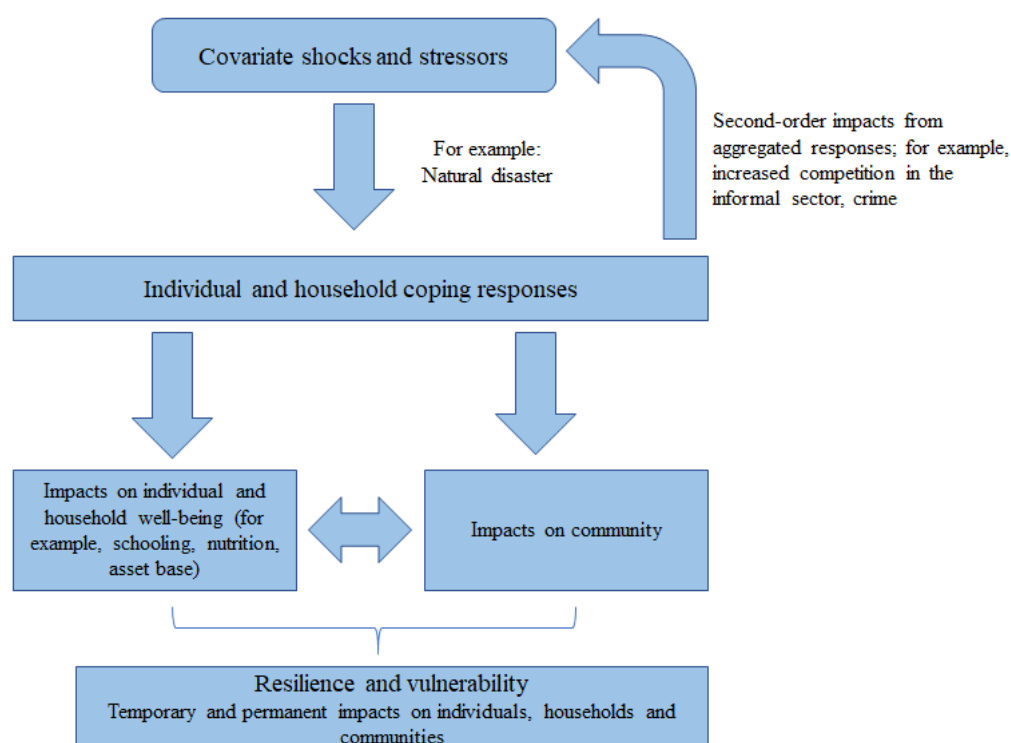

Figure 7: How coping strategies determine the ultimate impact of shocks. Adapted from Heltberg et al. (2012)

Coping strategies are therefore central to the development of at-risk communities. As shown in Figure 8, coping strategies and direct damages co-determine a disaster event's indirect losses. Alongside

reconstruction decisions, these all affect long-term development and a community's ability to adapt to recurrent disaster events (Keating et al., 2017; IPCC, 2012).
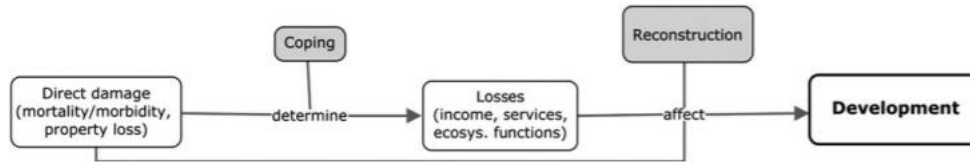
Figure 8: How coping strategies affect the long-term development of at-risk communities. Source: Keating et al. (2017)

In 1999, Adger described furthering understanding of coping strategies and long-term adaptation as 'one of the most important research issues within the area of global environmental change' (p. 250). Twenty years later, this is echoed by Kasei et al. (2019), who contend that the impacts of coping strategies are still poorly understood, particularly in informal urban settings. Analysing and developing effective local coping strategies to flood-related disasters worldwide is crucial if the Sustainable Development Goals' targets 1.5 and 13.1 in particular are to be met, as effective strategies can strengthen community disaster resilience whilst enabling collective agency and innovation (Tnum & Abubakari, 2019). Additionally, furthering knowledge of household coping strategies can be utilised for governmental priorities regarding DRR initiatives and the implementation of social safety nets (Skoufias, 2003). It is crucial that communities make 'no regrets choices' that effectively respond to hazards whilst simultaneously enabling the continued pursuit of long-term development objectives (Pasteur & McQuistan, 2016: 2).

Research aims

In order to strengthen DRM, past disasters must be examined with lessons learnt that can be applied to future resilience-building initiatives (Keating et al., 2016). However, previous ex-post disaster research has predominantly focused on state-level coping, frequently overlooking the actions taken by those actually living in vulnerable conditions (Blaikie et al., 2014). Whilst it is clearly important to examine how rural communities cope with disasters, due to the frequent lack of external support, this study also incorporates concerns that research must increasingly examine the adaptation of the urban poor to climate change and disaster risks, whose experiences are often under-reported (Douglas et al., 2008; Paul & Routray, 2010; Mavhura et al., 2013).

This study aims to contribute to the emerging works on coping strategies taken to reduce flood-related disaster risks at a local level. The vast majority of research to-date has been undertaken in Africa and

Asia[2]. By investigating the Rímac basin, this study provides fresh insight in the field and enables comparisons with other regions affected by similar flood-related risks. This study will reflect on the 2017 disaster, examining the coping strategies adopted by households and communities immediately prior to the disaster and during the ex-post stage and exploring why these particular approaches were adopted. This study will then analyse how state action may have affected the coping capacity of Rímac communities in 2017. Finally, this study will examine how the coping strategies implemented in response to the 2017 disaster may affect the future development of these communities and their disaster risk for future El Niño events. Thus, the research questions for this study are as follows:

1. *What coping strategies did communities in the Rímac river basin adopt in the wake of the 2017 disaster? Why did they adopt these strategies?*

2. *How did the actions of the state affect the ability of communities in the Rímac river basin to cope with the 2017 disaster?*

3. *How may the ex-post actions taken after the 2017 disaster have affected the future development of the communities in the Rímac river basin and their disaster risk for the next event?*

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[2] See for example: Amendah et al. (2014); Balgah et al. (2019); Braun & Aßheuer (2011); Opondo (2013); Osuret et al. (2016); Twum & Abubakari (2019).

Literature review

Disaster risk reduction research in Peru

Previous academic research on El Niño-related disasters in Peru has mainly focused on explaining why certain communities are particularly vulnerable to the associated flooding and *huaycos*. Only recently has investigation widened into the ex-post disaster stage and the long-term resilience building of at-risk communities. This research has highlighted the continued prevalence of corrective and reactive measures of DRM in Peru, and a lack of prospective DRM strategies. As demonstrated in Figure 9 below, corrective and reactive measures reduce existing vulnerabilities and minimise potential losses and damages. Prospective approaches prevent the emergence of new or increased risks (Lavell, 2014). Prospective approaches are particularly important in rapidly urbanising Lima, where risk activities in marginal urban areas continually create new risk scenarios.

Prospective management Intervenes on the future risk	Corrective management Intervenes on the existent risk	Reactive management Intervenes on the "residual" risk which is not reduced
Measures and actions of development planning oriented towards the avoidance of new vulnerabilities Examples: • Norms and regulations • Land-use regulation plans that include risk management • Incorporation of risk analysis criteria in investment projects • Alternative use of endangered areas	Measures and actions that promote the reduction of existent vulnerabilities Examples: • Relocation of at-risk communities • Strengthening of vulnerable constructions and/or structures • Index based insurance to prevent future damage	Measures that minimise expected loss and damages Examples: • Measures that increase resilience and response capacity • Early warning systems • Response preparation • Conventional damage insurance

Figure 9: Prospective, corrective and reactive disaster risk management measures. Source: Lavell (2014)

The two Peruvian state agencies responsible for DRM, INDECI and CENEPRED, are suggested to be shifting towards an integrated approach comprising prospective, corrective and reactive DRM strategies (French & Mechler, 2017). However, research continually suggests a heavy focus on emergency response and the reduction of asset losses, rather than long-term approaches that address the underlying drivers of risk (Lavell & Maskrey, 2014; French et al., 2020). Continued investment in reducing existing risks rather than targeting the underlying drivers may have effective short-term outcomes after individual disasters (Lavell & Maskrey, 2014). However, a lack of prospective initiatives such as effective land zoning and urban planning will prevent the building of resilient communities in at-risk areas (French et al., 2020; Venkateswaran et al., 2017). Moreover, there have been reported cases where local officials have deliberately prevented the introduction of prospective approaches to garner political support. For example, by protesting the relocation of residents in high-risk areas or granting land titles in hazard zones (French et al., 2020). Lavell (2014) estimates that

over 500,000 new land titles were granted in Lima between 1996 and 2006 alone, with the vast majority in high-risk areas.

A predominant focus on visibility

Whilst highlighting the state's predilection for reactive and corrective measures, research has also noted a strong historic preference for high-visibility interventions. Contemporary DRR investment has predominantly been in infrastructural interventions, such as constructing embankments, improving drainage systems, channelizing riverways, and reconstructing roads and service facilities (French et al., 2020; Venkateswaran et al., 2017). These investments are often linked to electoral campaigns, with immediate visible outcomes offering substantial political capital for local governmental officials (French et al., 2020). As such, political logic frequently dictates the prioritisation of interventions. This has meant a lack of investment in societal DRM approaches, such as capacity building and awareness raising, equally necessary for building resilient communities, despite the fact that increasing local preparedness and response capacities generally requires small investments with substantial and clear benefits when the next disaster occurs (Venkateswaran et al. 2017; Maskrey, 2011).

The need for resilience building

It should be noted that globally DRM is generally given low priority and is substantially underfunded (UNISDR, 2015). Frequently it is an additional responsibility granted to the emergency management sector, which in its very nature predominantly focuses on short-term response and reconstruction rather than long-term risk reduction. This is despite the fact that full social recovery following a disaster can require more than a decade and can prevent the necessary political mainstreaming of DRM (French et al., 2020; Keating et al., 2017).

It might be suggested that Peru takes DRM seriously, recently founding CENEPRED in 2011, creating a national plan for DRM interventions and investment (PLANAGERD 2014-2021), and following the International Sendai Framework recommendations (UN, 2015). However, contemporary state initiatives are frequently undermined by weak local and regional capacities (UNISDR, 2015). Improving the capacities of local officials, civil society organisations and individual households is vital to effective long-term resilience building of at-risk communities and enabling a national shift towards prospective DRM measures (Maskrey, 2011).

Previous research on coping strategies

Recent research on coping strategies to flood-related disasters has vastly been cross-sectional case studies of individual communities, with little consideration of strategies across multiple sites (Balgah

et al., 2019). Whilst some argue that coping strategies are often universal across a river basin, analysing multiple sites identifies determinants robust over space and time (Speight et al., 2017). Furthermore, previous research has been predominantly rurally focused, due to flooding's severe implications for agricultural livelihoods.

There has been some academic debate on how to classify the various coping strategies that households can adopt. Sometimes 'coping strategies' is a term used when referring to all DRM measures as in Table 1.

Preventive measures	Taken prior to a disaster event
Mitigative measures	Taken during and immediately following a disaster event
Distress migration	Taken when all other coping strategies have failed

Table 1: Paul and Routray's (2010) classification of coping strategies.

However, it generally refers to the actions taken during and immediately following a disaster to *cope* with disaster impacts. Heltberg et al. (2012) therefore suggest that strategies should be classified by response type (see Table 2).

Behaviour-based strategies	e.g. reducing spending, reducing food consumption, working more hours, more members of the family working
Asset-based strategies	e.g. using savings, taking out a loan, selling essential or non-essential assets
Assistance-based strategies	e.g. governmental support, help from family or other members of the community, support from NGOs, mutual solidarity networks

Table 2: Behaviour-based, asset-based and assistance-based coping strategies. Source: Heltberg et al. (2012).

From this classification, it should be noted that behaviour-based strategies are normally not new, unusual behaviours, but rather an intensification of usual behaviours (Devereux, 1999).

Other recent studies suggest that coping strategies should be categorised into erosive and non-erosive strategies.[3] Erosive strategies are actions that may prove effective in the short-term in allowing households to return to normalcy after a disaster event, but may have medium or long-term negative effects on social, human, natural, financial, or physical assets (Opondo, 2013; Van der Geest & Dietz, 2004; Keating et al., 2014). In contrast, non-erosive strategies are actions that are effective short-term and pose no threat to long-term development or livelihoods (Jones et al., 2010). Some examples of potentially erosive coping strategies can be seen in Table 3.

Coping strategy	How this strategy may be erosive
Sale of productive assets	Loss of essential assets needed for livelihoods
Altering food consumption (e.g. reducing amount or quality of food)	Compromising health

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[3] Also referred to as reversible and irreversible/crisis/survival strategies (see Jones et al., 2010).

Forgoing healthcare	Compromising health
Taking children out of school or erratic attendance	Reduction of future human and social capital
Taking out a loan, often with high interest rates	Creation of a debt burden reducing long-term financial capital
Exploiting natural resources	Loss of long-term natural capital
Sale of property	Reducing household asset base

Table 3: How coping strategies can be erosive. Adapted from Heltberg et al. (2012); Keating et al. (2014); Opondo (2013).

What determines coping strategies?

Household coping strategy choice can depend on multiple key factors. Firstly, the severity of the disaster event; the more severe, the more likely households are to choose an erosive strategy (Heltberg et al., 2012). How a household perceives the potential flood threat determines the coping responses undertaken (Hochrainer-Stigler et al., 2011). The nature and effectiveness of the strategy chosen is dependent on the flood event's characteristics, such as the height and duration (Paul & Routray, 2010).

Secondly, the household's socio-economic status. Poverty can highly influence a household's ability to mitigate hazard impacts. The options available following a disaster can be severely limited, thus fundamentally determining the decision-making process (Balgah et al., 2019). This often renders erosive coping strategies more likely, particularly actions involving violence, extortion or exploitation (Jones et al., 2010). Berman et al. (2014) found in Uganda that household age, education and wealth were particularly crucial socio-economic factors determining coping strategy choice. Paul and Routray (2010) argue similarly, suggesting that a household's income, education, occupation and indigenous knowledge affects their ability to implement suitable coping strategies.

Thirdly, local community characteristics. This includes the distance of households from the riverbank, which determines flood severity, and levels of social capital (Paul & Routray, 2010; Braun & Aßheuer, 2011). Strong community cohesion can prevent individual household coping and instead promote an organised, effective community-wide coping response (Douglas et al., 2008). An additional important characteristic is urban or rural location. Urban households face different pressures to rural communities, which can influence coping strategy choice (Twum and Abubakari, 2019). For example, the urban poor are more likely to have poorer housing, higher income variability and lack basic services such as health care and emergency services (Fernandez & Sanahuj, 2012). However, urban areas, in megacities especially, are often higher priority areas for governmental DRR spending which can render rural communities more vulnerable to hazards (IPCC, 2012; Cross, 2001). These urban and rural differences can affect community coping capacity and therefore household coping strategies.

Finally, state influence and the availability of external assistance. Coping strategies are determined by the extent to which affected communities are 'horizontally' socially and politically integrated with nearby communities, and 'vertically' integrated with governmental and non-governmental actors to obtain necessary resources for disaster impact mitigation (Stehr, 2001). Local governments play a crucial role in determining local recovery and reconstruction processes, and their choices immediately prior to and following a disaster can determine how effectively residents cope with disaster impacts (ibid). Moreover, the lack of an effective public safety net system or poorly timed public relief efforts can render necessary the use of erosive strategies in affected areas with limited coping capacities (Skoufias, 2003; Paul & Routray, 2010).

Coping in Peru

Despite Peru's long history of destructive El Niño-related disasters, little research has examined the ex-post disaster phase. With the 2017 disaster being the first of its kind since 1925 and occurring very recently, investigations to-date have focused on its geophysical drivers, why the event was so damaging, and why certain communities were particularly affected. Studies have focused on either a national level of analysis or the worst-hit region of Piura, though there has been some research in the Rímac basin.[4] Very little attention has been given to the actions of affected households and communities. Indeed, previous studies of community and household coping strategies in Peru have focused on coping with the slow-onset impacts of climate change, rather than the effects of natural hazards. For example, Oft's (2009) research of farmers in Piura found that coping strategies used to mitigate the effects of climate change were dependent on the local socio-economic conditions of vulnerability and the driving forces of the degrading environment.

Furthermore, whilst contemporary research has examined the state response following the 2017 disaster and its effectiveness, there has been little consideration of the state's influence on household or community action and the associated long-term implications for social development and disaster risk. However, previous studies of the ex-post phase in Peru still offer valuable insights. McRae (2017) argues that the 2017 disaster clearly demonstrated Peru's social vulnerabilities and the need for longer-term thinking and action in at-risk areas rather than the current prevalence of short-term responses such as dredging canals and maintaining embankments. This further supports the contention that a focus on infrastructural and short-term response actions may be hindering the ability of communities to cope with hazards.

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[4] See for example French et al. (2020); Venkateswaran et al. (2017).

Other studies contend that severe flaws in governmental structure rendered the 2017 event particularly destructive. Institutional capacity is crucial to effectively responding to disaster impacts (Keating et al., 2016). However, state institutional capacity in 2017 was significantly reduced due to political centralisation (French et al., 2020). In recent decades, governmental authorities have become increasingly centralised with the intention of simplifying the lines of authority and leadership responsibilities during a disaster. CENEPRED and INDECI, once independent government ministries, are now a remit of the Ministry of Defence (MINDEF). Whilst MINDEF have previously played a significant role in immediate disaster response, they have little expertise in long-term risk reduction or recovery (ibid). Moreover, this transfer of responsibility has reduced international DRR funding, with donors reluctant to fund a national defence ministry (ibid).

Substantial organisational problems always arise during local recovery and reconstruction following any disaster, and often problems of coordination, political conflict and information transfers are exposed (Stehr, 2001). However, there was a significant lack of cooperation between distinct government entities such as INDECI and CENEPRED during the immediate response phase in 2017. Amplified by other sectoral ministries being recently granted increased responsibilities for DRM (such as the Ministry of Housing and the Ministry of Economy and Finance) that led to confusion over responsibilities during the ex-post phase, governmental bodies operated in institutional 'silos' that exacerbated community vulnerabilities and reduced the effectiveness of the national response (French et al., 2020). The then Peruvian Minister of Defence was even quoted describing the government itself as 'the disaster' in 2017 due to its poor emergency response efforts (ibid).

A lack of clearly designated responsibilities and intersectoral communication between state entities was exacerbated by national government officials' concerns of corruption at regional and local levels, and poor vertical integration. National decisions were often inflexible to local level needs and priorities, and regularly made without input from representatives from affected communities (Venkateswaran et al., 2017). Moreover, the actions of municipal and local-level authorities and non-government entities were often superseded by national bodies, producing political conflict and response redundancy (French et al., 2020). Local officials have historically been seen as poorly trained, underfunded and possessing little technical expertise (Ramírez, 2017; Stehr, 2001). Additionally, whilst many at-risk communities are meant to have a local emergency operations centre (COEL) to direct local response efforts, these are often inactive or not yet constructed (Ramírez, 2017). However, local actions were crucial in reducing disaster impacts in 2017. Civil defence groups (*brigadistas*) and localised early warning systems enabled quick, last-minute evacuations that were fundamental to reducing loss of lives in affected areas (Venkateswaran et al., 2017). Increasing local

capacities to respond to hazards and addressing coordination and communication issues between government bodies is crucial to reducing disaster risk in the Rímac river basin.

Where is the gap in coping strategy research?

In summary, previous academic studies have predominantly focused on why certain communities are so vulnerable to hazards, and explaining why disasters have been so destructive. Whilst many state a severe need to integrate prospective approaches into the current national DRM strategy, evidence suggests that governmental actions are not conducive to building long-term societal resilience. A heavy focus on short-term, high visibility interventions and multiple factors reducing national response effectiveness may have hindered community abilities to cope with past hazards, amplifying disaster damages. It is therefore highly important to analyse how state actions and influence may have impacted local level actions and the long-term resilience building of at-risk households and communities, and to understand how these communities may be able to take partial control of enhancing their own capacity to cope with disasters so as not to erode their development.

Furthermore, previous studies have overlooked the actions of households and communities and the potential of localised resilience-building in at-risk areas. Household coping strategies are crucial to building disaster resilience, as they heavily determine a disaster's societal impact. Indeed, if a community can cope with natural hazards then a disaster never occurs.[5] Previous worldwide academic research has detailed the key factors determining the choice of coping strategies, explained their relevance to DRR initiatives, and suggested how they can be categorised. However, there have been no previous studies that have specifically focused on local level coping strategies to El Niño-related disasters in Peru, or how the actions of households and communities may be affecting their long-term development and disaster resilience.

The 2017 disaster heavily impacted the Rímac communities, causing widespread destruction and forcing many households deeper into poverty. The potential impact of future disasters – which are likely to increase in frequency and severity due to increasing exposure and climate change - on affected communities presents a clear need to examine sustainable approaches for building disaster resilience. As Venkateswaran et al. (2017) state: 'recovery is not enough' (p. i). Both national and local level ex-post actions must not focus solely on recovering to the pre-shock state, but should intend to 'build back better' and increase community coping capacity to future disasters (ibid: 43). This study will contribute to the research field by examining often overlooked factors in disaster resilience building: the experiences of both rural and peri-urban areas, and the ex-post coping actions of affected households and communities.

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[5] See the definition of *Flood-related disaster* in Glossary of Key Terms.

Theoretical grounding

Unnatural disasters

This thesis is predicated on the contention that so-called 'natural' disasters are not natural at all (World Bank, 2010). Contemporary research still regularly describes disasters as outcomes of extreme natural events, despite the fact that political ecologists have argued since the 1970s that this is not the case. Rather, disasters arise from power imbalances and socio-economic differences created by unsustainable development processes that hinder the coping capacity of affected populations to hazards (Lavell & Maskrey, 2014; French et al., 2020). As Douglas et al. (2008) state: 'floods are natural phenomena, but the damages and losses from floods are the consequences of human action' (p. 187). This paradigm shift in how disasters are conceptualised is crucial if development is to be brought to the forefront of DRM (Keating et al., 2017).

International perspectives do appear to be evolving. For instance, the Sendai Framework (UN, 2015) and the Global Assessment Report 2015 (UNISDR, 2015) both highlighted that disasters are rooted in the vulnerability and exposure of populations and assets, rather than extreme geophysical occurrences (Keating et al., 2017). Particularly important has been the acknowledgement that certain social, economic and environmental policies surrounding issues such as land zoning and basic service provision have created highly localised areas of disaster risk. Whilst communities across a particular geographic region may experience the same hazards, disaster risk is locally moulded (Maskrey, 2011). How communities have transformed the natural environment, the configuration of infrastructure and the layout of key assets and households all combine to create locally specific levels of risk. Maskrey (2011) calls this the social territorialisation of disaster risk. Hazards are not experienced by communities in the abstract, but in specific places and times (ibid).

Flood-related disaster risk is particularly localised in urban areas, and especially in mega-cities in developing countries. The rapid and often unplanned expansion of the built environment due to urbanisation significantly alters the natural landscape, reducing river basin ecosystem's capacity to mitigate the effects of human actions (Fernandez & Sanahuj, 2012). Combined with rising socio-economic inequalities, increasing occupation of high-risk zones and a lack of governmental action, risk is increasingly becoming urbanised and localised to specific city areas (ibid). This can be seen in Lima's informal, peri-urban areas.

Recognising disasters as the products of localised contexts clearly shows that whilst hazards will inevitably occur due to their geophysical drivers, their effects can be mitigated thereby preventing a hazard transforming into a disaster event (Jones et al., 2010; Blaikie et al., 2014). The highly localised

nature of disaster risk renders thus necessary the use of locally grounded approaches to DRM if interventions are to be effective (French et al., 2020). Following this recognition of the localised societal construction of disasters, disasters must not be perceived as extreme unmitigable events, but instead as long-term human-influenced constructions that can be addressed with appropriate measures (Jones et al., 2010; Twigg, 2004). If human causes exist for disasters, human solutions must also exist (Venkateswaran et al., 2017).

The pathway to sustainable wellbeing

There is thus a need to think long-term in DRR with ex-post responses addressing the underlying localised drivers of disasters rather than simply enabling a return to societal norms with continued high disaster risk (Jones et al., 2010; IPCC, 2012). States must look beyond simply coping with fallout, and towards constructing long-term resilience. However, there is often great pressure for governments to rapidly reconstruct and enable quick societal recovery following an extreme disaster event (Stehr, 2001). This focus on 'returning to normalcy' as soon as possible by rapidly reconstructing damaged infrastructure and restoring livelihoods means that state recovery efforts often reconstruct or enhance existing vulnerabilities (IPCC, 2012: 75). Measures that may increase long-term community resilience, such as land zoning, retrofitting infrastructure or creating larger green spaces, are often overlooked in favour of measures that are effective in the immediate short-term recovery period (ibid). This is despite the fact that disasters significantly affect the vulnerability of populations to future events, impacting their resilience and coping capacity (IPCC, 2012).

This is especially the case for the poorest members of society. Generally the hardest hit by disasters due to low levels of capital, poor political representation and a lack of financial and social safety nets, resources that these communities depend on for their livelihoods are often damaged or destroyed, resulting in higher vulnerability to future events and reduced coping capacity (Morris et al., 2002; Cutter et al., 2006; Anttila-Hughes & Hsiang, 2013). This in turn increases the probability of these households having to take higher-risk choices, such as erosive coping strategies, that can further enhance their vulnerability and push them further into poverty (see Figure 10). This poverty may not always be chronic, but in situations of recurrent disasters without sufficient time and support for full economic recovery between events, households can find themselves in 'transient' poverty (Lipton & Ravallion, 1995). Without successful adaptation, households will be continually forced to use high-risk coping mechanisms that increase their vulnerability to future hazards (O'Brien & Leichenko, 2000).

Figure 10: The Poverty and Disaster Cycle. Source: Keating et al. (2014)

However, if communities are able to adapt and long-term resilience building measures are encouraged, then their coping capacity will increase. This will shift these communities onto the 'pathway to sustainable well-being' (see Figure 11). Crucial to enabling this shift are what the IPCC (2012) refers to as 'low-regrets strategies' (p. 16). These include early warning systems, utilising local knowledge during decision-making, increasing communication between governmental levels, land use zoning, enforcing strict building regulations, and ecosystem management.
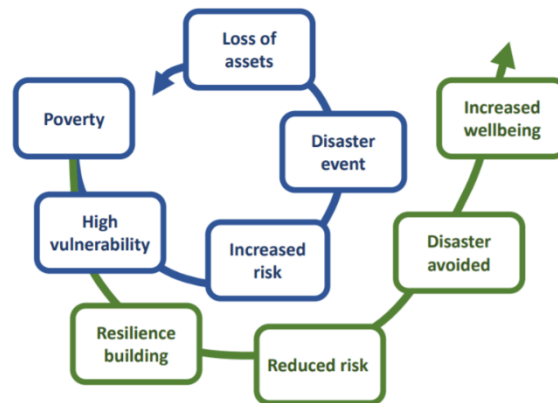
Figure 11: The Pathway to Sustainable Wellbeing. Source: Pasteur & McQuistan (2016)

A further vital part of enabling this shift is ensuring that households and communities are not implementing erosive coping strategies during the initial disaster response that might jeopardise their long-term development and resilience. Similarly, communities must not think about simply 'building back', but must 'build back better' or even 'bounce forward' (Mavhura et al., 2013: 38). The future asset base and well-being of households is dependent on their ability to anticipate and cope with extreme events and hazards (Validivia et al., 2003). It is therefore of the utmost importance, especially in the face of an unpredictable future, that communities make 'no regrets' choices following a disaster that build community disaster resilience and enable long-term sustainable development (Pasteur & McQuistan, 2016; Mechler et al., 2019).

The levee effect

It is widely understood that effective DRR programs incorporate both hard infrastructure measures such as embankments and debris nets, and soft social measures such as social capacity building and ecosystem management (IPCC, 2012). Social recovery must be seen to be as critical to DRM as the recovery and reconstruction of infrastructure and physical assets to prevent at-risk communities becoming more vulnerable to future disasters (Venkateswaran et al., 2017). However, the state's predominant focus on hard measures may be increasing the future vulnerability of at-risk populations, rather than reducing it.

Following recent disasters, significant funding has been pumped into reconstructing damaged roads and bridges, enlarging drainage systems and repairing protective infrastructure such as channels and embankments (ibid). With donors often in favour of visible and photographable hard infrastructure measures such as those in Figures 12 and 13 below, rather than societal approaches, this approach may increase the risk activities of the local population (Kellet & Caravani, 2013). This phenomenon is known as the 'levee effect' (White, 1945 - in Keating et al., 2017). Riverside embankments built to prevent overflow alter the river ecosystem's hydrology, reducing environmental capital whilst simultaneously creating an illusion of protection. Areas that would previously have flooded are seen as guaranteed safe zones due to the embankments' protection, which often results in rapid occupation and development. However, when a flood inevitably exceeds the embankments' capacity during an extreme event, disaster losses are significantly larger than they would otherwise have been (Keating et al., 2017).

Figure 12: Channelisation of the Rímac river in the arid transition zone. Photo: Author's own.

Figure 13: Construction of a rock wall in a quebrada in the arid transition zone. Photo: Author's own.

Therefore, whilst well-designed and maintained hard infrastructure measures can be effective in protecting physical assets from a flood hazard, they must always be viewed alongside their residual long-term risk (Venkateswaran et al., 2017; Keating et al., 2016). Furthermore, due to this residual risk that they create, hard measures must not be deliberately utilised by the state in order to further develop the local area, as this will just enhance local exposure (Venkateswaran et al., 2017). Floods are most damaging, both to physical assets and human lives, when the capacity of protective infrastructure is exceeded (ibid). This illusion of safety provided by hard infrastructure measures must be addressed to reduce risk activities in at-risk areas both by state actors and the local population.

Risk myopia

Alongside increasing risk activities is the theorisation that populations at-risk of recurrent disasters often become myopic about their disaster risk. Risk myopia is a tendency to think predominantly in short-term timescales and can lead to risks being downplayed (Tierney, 2014). It explains why individuals may be reluctant to invest right now in DRR measures that may only pay off during future disasters (ibid). Moreover, Patankar's (2015) study in areas of Mumbai subject to recurrent flooding suggests that households in high-risk zones are often well aware of local risks, but overlook these in favour of job opportunities, schools, health care services and social networks that exist there – what Hallegatte et al. (2017) call 'agglomeration externalities' (p. 26). This conscious choice to accept

disaster risk is often higher in urban environments, as the draw of potentially improving well-being often outweighs local risks (ibid).

Risk myopia may be preventing the implementation of effective DRM measures, such as the relocation of communities living in areas of unmitigable risk, as well as hindering long-term social development by maintaining high vulnerability to hazards. It may also lead to reduced pressure on local and national authorities to heavily invest in prospective and corrective DRM measures, with local preferences for the short-term provision of public services (Keating et al., 2014). Due to poverty and the subsequent constrained choice situation of many at-risk households, money may not be available for longer-term investments and proactive DRM at the household scale (Lawrance, 1991). Moreover, state support is often inadequate to enable the adoption of strategies that assist long-term building of coping capacity (Hallegatte et al., 2017). However, risk myopia, if it exists, must be addressed or there is a high probability that communities will continue to further occupy and develop high-risk zones.

Methodology

Site selection

By examining the coping strategies of multiple communities, this study enables comparisons of strategies across the high-risk zones of the Rímac basin and provides innovative insight into strategy effectiveness and predominance dependent on community features. The five communities for this study are all located in the Rímac's arid transition zone (see Figure 14). Due to the geographical proximity and small size of some communities, communities were sorted into three groupings (see Table 4). By including both peri-urban and rural communities at various stages of the middle course, results are representative for communities across the arid transition zone.

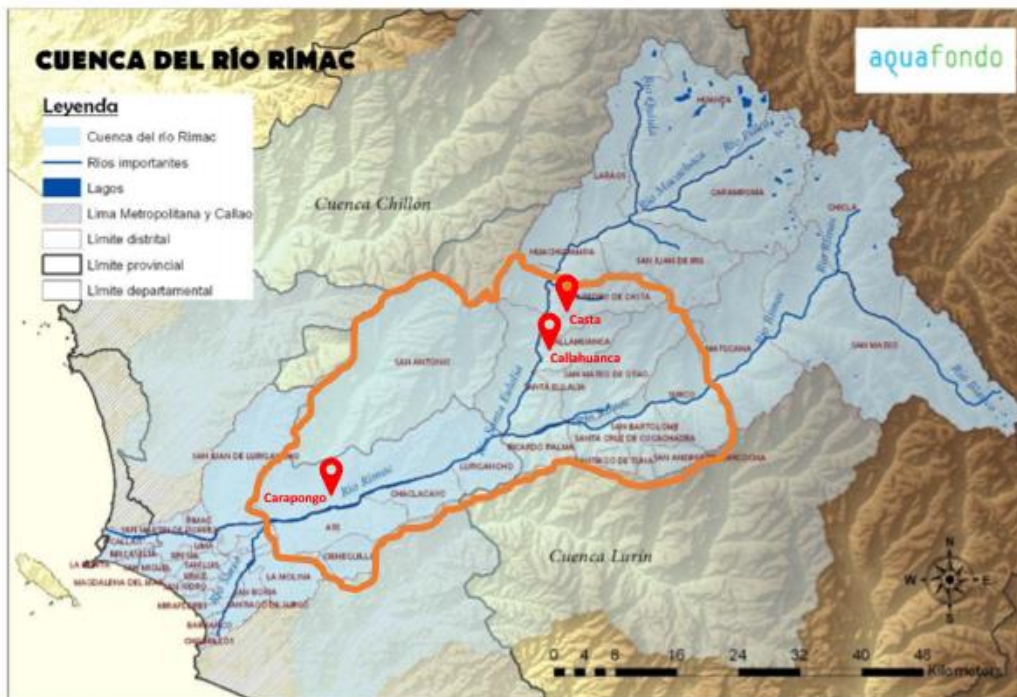*Figure 14: Location of research sites. Map source: Stern & Echavarria (2013)*

Name of grouping	Communities in grouping	Peri-urban/rural	Approximate number of households
Carapongo Faja Ribereña	Segovia, Medio and Bajo	Peri-urban	250
Callahuanca	Callahuanca	Rural	30
Casta	San Pedro de Casta	Rural	70

Table 4: Research sites and groupings.

Communities were chosen due to their strategic importance within the basin and their high vulnerability to flood-related disasters, demonstrated in 2017. Research of poor and vulnerable populations must ensure to incorporate their perspectives as active subjects rather than passive objects (Scheyvens, 2014). As such, Practical Action were utilised as a gatekeeper for this research. [6]

Conducting fieldwork through a gatekeeper organisation can be obstructive, affecting how you are perceived by the local population and accessibility (Hammett et al., 2014). However, being introduced either in person or via WhatsApp to various contacts and being affiliated with Practical Action, well known in the communities, certainly enabled access to respondents that would have never been possible solo. Using a gatekeeper allowed this 'foreign' empirical world to be accessed and my outsider status to be negotiated, enabling valuable local perspectives to be included (Funder, 2005).

Research design

This research was inspired by similar studies conducted elsewhere on disaster coping strategies.[7] A mixed methodology was adopted, combining household surveys with key informant interviews. I was originally sceptical of using a mixed methodology, as these approaches are often extremely time-intensive and require substantial amounts of data to be collected and analysed as well as multiple forms of analysis (Hammett et al., 2014). I was concerned that limited field-time would render me unable to collect the sheer volume of data needed. However, the possibility of using field assistants for household surveys made this feasible. I further ensured that my interview and survey questions were directly relevant to my research questions, in order to minimise the possibilities of redundant data and potentially wasting valuable field time (Bryman, 2006).

Household surveys

Quantitative methods are renowned for facilitating understandings of the 'big picture', and are especially useful for collecting data on attitudes, experiences and behaviours (Scheyvens, 2014; Hammett et al., 2010). Surveys particularly are highly useful for researchers collecting primary data on populations too large to directly observe (Babbie, 2010). In order to analyse societal trends and behavioural coping strategies, surveys were conducted in all three groupings (see Table 5).

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[6] Practical Action is a UK registered NGO that has worked with vulnerable populations in Peru since 1985 and who's projects include efforts to improve community flood resilience in the Rímac river valley and to raise the voices of local communities in decision-making processes. This research was undertaken in conjunction with the national office in Lima.
[7] Especially important were Helgeson et al.'s (2013) study on ex-post coping in Uganda; Paul and Routray's (2010) investigation into flood coping strategies in Bangladesh; and Mavhura et al.'s (2013) study of coping and flood resilience in Zimbabwe.

Name of grouping	Approximate number of households	Number of surveys conducted
Carapongo Faja Ribereña	250	56
Callahuanca	30	30
Casta	70	32

Table 5: Details of household surveys.

In total, 118 surveys were completed using Open Data Kit.[8] These were conducted in Spanish by paid local surveyors for multiple reasons. Firstly, to mitigate any potential language barriers and miscommunication issues. Secondly, to enable a far greater sample size than would have been possible solo, vastly increasing result representation. Finally, it was thought that respondents would answer honestly, rather than attempt to impress or mislead a foreign researcher. Surveys were conducted either early in the morning or in the evening, maximising chances of residents being home, and houses were randomly sampled across each community. Questions were kept simple and clear to avoid confusion and investigated what each household did during the ex-ante and ex-post stages of the 2017 disaster; what they have learnt from past events; how they were preparing for the upcoming rainy season and if they are now undertaking different actions; what measures they would ideally implement; and why they have chosen to adopt specific actions (full survey questions in Appendix 1).

All surveys were anonymous and as proxies were used to collect the household survey data, prior training was given to those involved to make certain that all participants knew why the survey was being carried out, for whom data was being collected and the overall research aims. This information was presented to each household, with oral consent required prior to the interview, so that no respondents were misled and to manage expectations.

Key Informant Interviews

The complementary use of qualitative methodologies allowed further meaning to be drawn out from the data and the chance to see beyond the responses (Hammett et al., 2014; Galasinski & Kozlowska, 2010). Interviewees were chosen due to their ability to provide complex understandings of issues and to voice multiple perspectives (Creswell & Poth, 2016). Creswell et al. (2007) states that it is vital to interview qualified respondents who will impart credible data and be open to sharing 'their story' (p.

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[8] Open Data Kit (ODK) is a free, open-source software that can be used for offline data collection via mobile devices in remote areas. This was ideal for research in rural areas of the Rímac river basin and was conducted using iPads provided by Practical Action Peru. (More information available at: www.opendatakit.org)

240). As such, purposive sampling was used to identify key informants that could provide knowledge saturation and representative results (Creswell & Poth, 2016).

In total, 11 key informant interviews were conducted in either English or Spanish, depending on which language the respondent felt most comfortable with, in order to empower respondents to voice their opinions and minimise power inequalities (Creswell & Poth, 2016). All interviews were conducted in a space chosen by the interviewee to minimise distractions, and questions were structured (see Appendix 2). This ensured adequate prior translation, though questions were open ended and tangents welcomed in order to analyse what interviewees believed to be important (Bryman, 2016).

Additionally, a group interview was conducted in Casta. Due to limited field time in the community an established and active community group was interviewed, responsible for local DRM initiatives. Full details of all interview respondents can be seen in Table 6. Interviews enabled the exploration of how state actions and influence might be shaping local household coping strategies.

Data collection method	Title	Quantity
Key informant interviews	Academic specialising in disaster risk reduction with experience in the Rímac river valley	2
	Representative from Practical Action (an NGO active in the Rímac river basin)	2
	Representative from CESAL (an NGO active in the Rímac river basin)	1
	Representative from Cáritas (an NGO active in the Rímac river basin)	1
	Representative from Plan International (an NGO active in the Rímac river basin)	1
	Local health worker	1
	Local government representative	1
	Member of the Network of Resilience Leaders for the Rímac River Valley (a civil society organisation made up of local residents)	1
	Head of Local Emergency Operations Centre (responsible for immediate community-level humanitarian response in the wake of a disaster event)	1

Group interview	Community leader	2
	Representative of Sub-Prefecture	1
	Lieutenant Governor	1
	First Councillor	1
	Council member	1
	Municipality representative	1
	Representative of Community Association	1
	Local nurse	1

Table 6: Details of key informant interviews

Data analysis

Household survey data was separated into community groupings and was analysed using descriptive statistics. This enabled comparisons to be drawn and an overall picture to be painted of actions across the arid transition zone. All interviews were analysed inductively, using open coding to identify major themes and commonalities from the responses (Creswell et al., 2007). See Appendices 3 and 4 for more details. The following triangulation enabled result credibility to be ensured, and the identification of themes spanning both data collection methods relevant to the research questions. Data saturation was perceived to be reached with the same themes being mentioned by participants after around 8 interviews.

Ethical considerations and potential limitations

This study involved researching some of the poorest members of Peruvian society and those most vulnerable to and affected by disasters. As a foreign university student, I wanted to ensure that my project did not become a so-called 'safari of the poor' (Hammett et al., 2014: 3). Scheyvens (2014) asserts that a fair portrayal is possible through showing genuine interest in the capacities of target communities through the design of research questions and methodologies, which further provides a more accurate understanding and demonstrates that the knowledge and experiences of these communities are highly valued. This research was thus designed to focus not only on existing vulnerabilities, but the positive agency and capacity of communities.

Working across two languages presented clear challenges, and issues of language and translation are heavily embedded in this research. Hammett et al. (2014) describe the multiple stages of encoding and decoding that exist when working across different languages and cultures, and explain how this can increase the likelihood of misinterpretation by either the researcher or respondent or miscommunication of responses. Due to logistical and funding issues, a household survey pilot test was not possible. Questions and response options were thus kept clear, simple and culturally sensitive to mitigate potential biases. The suitability of all questions and translation quality were then analysed by Practical Action's Community Relations Lead and any necessary alterations made prior to data collection.

Findings and analysis

Preventative measures

As Table 7 demonstrates, survey responses revealed that most households, especially rural households, undertook no preventative measures prior to the 2017 disaster. Measures that were implemented were extremely erratic with little consistency across communities. The use of sandbags and other low-cost asset protection measures is perhaps unsurprising due to constrained economic situations rendering low-cost actions particularly viable. The higher prevalence of hard infrastructure measures in rural communities might be attributed to stronger community cohesion, with households working collectively to increase local coping capacity in true *campesina* style.

Preventative measure taken in ex-ante stage to reduce potential hazard impact	Carapongo (peri-urban)	Callahuanca (rural)	Casta (rural)	% of total households adopting this strategy
Use of sandbags to protect houses and other key assets (such as transport or livestock)	39%	40%	58%	**44%**
Other low-cost asset protection measures (e.g. moving key assets upstairs or using flood-proof containers)	24%	47%	51%	**37%**
Hard infrastructure projects (e.g. raising floors or digging river channels to divert water)	25%	47%	62%	**41%**
Conservation of food supplies	27%	10%	13%	**19%**
Conservation of water	5%	10%	3%	**6%**
Accumulation of family savings	43%	20%	6%	**27%**
No preventative actions taken	43%	63%	63%	**53%**

Table 7: Preventative measures taken by individual households prior to the 2017 disaster.

With this lack of preparative action, all communities were unsurprisingly devastated by the 2017 disaster. 70% of households surveyed had property damaged by flooding and/or debris flows.

Carapongo was worst hit, with 80% of households damaged. With savings in peri-urban areas often tied up in assets, these damages made the 2017 disaster especially destructive. The widespread effects meant that 81% of all households were forced to adopt at least one coping action during the ex-post disaster stage, with a wide range of strategies implemented across the basin.

What coping strategies did communities in the Rímac river basin adopt in the wake of the 2017 disaster?

Behaviour-based coping strategies

By far the most common coping strategy adopted by households was modification to food consumption (see Table 8). This was despite emergency community food supplies existing in both rural communities; though Casta's community leaders did voice concerns about their vulnerability to flooding and hinted at their ineffectiveness following the disaster. Respondents in Carapongo were unsure if such supplies existed, with respondents evenly split 29 to 30. Even if they did, they were clearly insufficient to cope with necessary demand following the 2017 event. With a lack of financial capital, the vast majority of households had to alter their food consumption, often for more than a year following the disaster.

75% of survey respondents stated that they cannot continue working during the ex-post disaster stage. This is unsurprising given the local reliance on agriculture and transport, both heavily affected by flood events. The subsequent lack of employment within many households may partially account for the prevalence of reducing spending following a disaster event..

Working more hours, engaging in an extra-income activity or more family members was only a relatively common coping strategy in Callahuanca. Moreover, households appeared to not be actively employed in recovery and future prevention activities by the state. This could be due to a lack of necessary technical knowledge, but the lack of a surge of local manual labour employment in the river basin during the reconstruction phase is surprising.

Behaviour-based coping strategy	Carapongo (peri-urban)	Callahuanca (rural)	Casta (rural)	% of total households adopting this coping strategy
Modification to food consumption				
Reducing amount of food consumed (potentially erosive)	90%	80%	92%	**88%**
Reducing quality of food consumed (potentially erosive)	85%	50%	70%	**71%**
Reducing expenses				
Reduced household spending (potentially erosive)	64%	53%	16%	**48%**
Earning extra income				
Working more hours or engaging in extra income generating activities (non-erosive)	11%	47%	19%	**22%**
More family members working (potentially erosive)	11%	20%	3%	**11%**

Table 8: Behaviour-based coping strategies taken by households following the 2017 disaster.

Asset-based coping

Taking out a loan was the most common asset-based coping strategy. As shown in Table 9, 50% of households stated that they would borrow money in some way, the majority (70%) relying on a bank loan, and others from friends, relatives, or other community members. This predominance of formal lending is both surprising and worrying in communities due to such high levels of risk. However, it is noteworthy that reliance was not on high-interest money lenders which would be especially erosive.

Use of emergency savings was more prevalent in peri-urban areas, suggesting that they may have higher asset bases than rural areas. However, socio-economic data does not seem to support this.

Sale of assets was not a common coping strategy. 86% of households sold no assets at all, and of those that did only 9% sold potentially essential assets.[9] The remaining sales of non-essential assets were mostly of agricultural products and crops, understandable due to the prevalence of agriculture in this region.

Asset-based coping strategy	Carapongo (peri-urban)	Callahuanca (rural)	Casta (rural)	% of total households adopting this coping strategy
Taking out a loan (potentially erosive)	54%	57%	38%	**50%**
Sale of assets (potentially erosive)	9%	20%	16%	**14%**
Use of emergency savings (non-erosive)	52%	33%	22%	**39%**

Table 9: Asset-based coping strategies taken by households following the 2017 disaster.

Assistance-based coping

As demonstrated in Table 10, assistance-based coping strategies were extremely prevalent across the region, though from whom the assistance was sought greatly varied. In Carapongo, reliance on national and local government was particularly low. However, households in Carapongo were often reliant on assistance from family and NGOs. Assistance included everything from financial support to provision of food and water, emotional support to safe spaces for children.

Familial support levels were similar in Callahuanca, though in Casta just 16% of households were helped by family. However, assistance from NGOs and religious organisations was especially important in both rural communities.

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[9] Potentially essential assets include land, transport, property and livestock.

Assistance-based coping strategy (non-erosive)	Carapongo (peri-urban)	Callahuanca (rural)	Casta (rural)	% of total households adopting this coping strategy
National government	9%	37%	38%	**24%**
Local government	30%	53%	56%	**43%**
Family	46%	47%	16%	**38%**
Community	39%	67%	13%	**36%**
NGO	50%	90%	59%	**63%**
Religious Organisation	39%	77%	50%	**52%**
No assistance needed	4%	0%	6%	**3%**

Table 10: Assistance-based coping strategies taken by households following the 2017 disaster.

Distress Migration

Temporary migration was relatively common across all communities, with 39% of respondents stating that they relocated temporarily following the 2017 disaster. Permanent migration levels were significantly lower; in Casta and Carapongo only a singular household in each community and just 5 households (17%) in Callahuanca.

Why did they adopt these strategies?

The lack of preventative measures prior to the 2017 disaster can be explained by its surprise nature. Its rapid development alongside the fact that it followed the 'non-event' of 2015-2016 and the usual 2-7-year gap between events, meant that even state authorities were caught unawares (French & Mechler, 2017: 4). Interviews with representatives of local NGOs suggested a severe lack of state preparations in the build up to the 2017 rainy season. It is unsurprising that this percolated through societal levels, resulting in a lack of localised action by at-risk households.

This lack of household action may be further explained by local perceptions of who is responsible for DRR. 81% of respondents believed those most responsible for protecting at-risk areas were state authorities or community leaders. Only 12% thought that individual households were most responsible for managing their own disaster risk, simultaneously suggesting a perception that the responsibility of DRR may be beyond their reach. Additionally, households do appear to have been myopic regarding their disaster risk. Interviews suggested that households are often extremely passive in preparing for a disaster event. If there are no incentives to get involved with public initiatives, no

clear warning, or no state guidance for individual preparations, then few members of the community take interest in local DRR initiatives. As one interviewee stated, households rather just *"tend to watch the weather and wait for direction"*. Indeed, only 1 household in all communities studied took action based off government advice.

The sporadic nature of El Niño events may further encourage this passiveness. The fact that intense floods usually occur once every 5-7 years may reduce the perceived level of risk and increase the risk activities taken by local communities in-between events. Moreover, pressures of continuing rapid urbanisation and the constant arrival of new migrants to the region who are unaware of local disaster risks and are often deceived into inaction due to the desert climate may enhance myopia. With new areas of the river basin affected in 2017, residents cannot rely on previous events to determine their exposure and become passive if they have not yet been affected. As one interviewee responded: "*Peruvians need to be constantly reminded of their flood risks*". Another interviewee suggested that it is not just the sporadic nature of El Niño events causing community passiveness, but also the normalisation of disasters. The attitude of *"it will keep happening and we can't do anything"* may have contributed to a local mindset of inaction.

Of the households that did implement coping strategies following the 2017 disaster, only 37% believed their strategies to be either 'very effective' or 'slightly effective'. This begs the question as to why households chose these strategies. The predominance of behaviour and assistance-based coping is likely due to local socio-economic conditions, as suggested by Paul and Routray (2010) and Braun and Aßheuer (2011). Interviewees further highlighted that it is impossible for households to escape local socio-economic drivers. High levels of poverty, particularly in peri-urban areas, severely restricts the possibility of asset-based coping. The vast majority of families live day-to-day with little to no financial capital in case of emergencies. Priorities are often on more immediate concerns than DRR measures. When disaster threat is immediate and significant, households generally seek cheap and quick solutions, explaining the commonality of low-cost asset protection measures. A lack of financial capital additionally explains the most common strategies being intensification of existing behaviours (such as modifying food consumption and reducing expenditure) and reliance on external support and loans.

Low levels of permanent migration and relatively high levels of temporary migration can be attributed to Hallegatte et al.'s (2017) concept of 'agglomeration externalities'. Interviewees frequently stressed that many local inhabitants own other land or have the option to occupy other areas with significantly lower risk. However, this section of the Rímac offers comparably preferable features, such as access to main roads and public transport into central Lima, making land here a precious asset. Though certain structural reasons such as cheap and available land and poor law enforcement have encouraged

settlement in high-risk zones, the local population are also consciously remaining in these areas due to their perceived benefits. Thus, permanent migration is rarely adopted as a coping strategy even though it could be the most effective method of significantly reducing local exposure and vulnerability to disasters.

How did the actions of the state affect the ability of communities in the Rímac river basin to cope with the 2017 disaster?

State actions definitely enhanced the coping capacity of certain communities, reducing the 2017 disaster's effects, despite the fact that not all actions were implemented specifically for increasing resilience to that particular event. Most effective were the technological interventions introduced prior to the expected large 2015/16 El Niño event. These included installing geodynamic meshes (see Figure 15) and early warning systems in extremely high-risk districts such as Chosica and Ate.
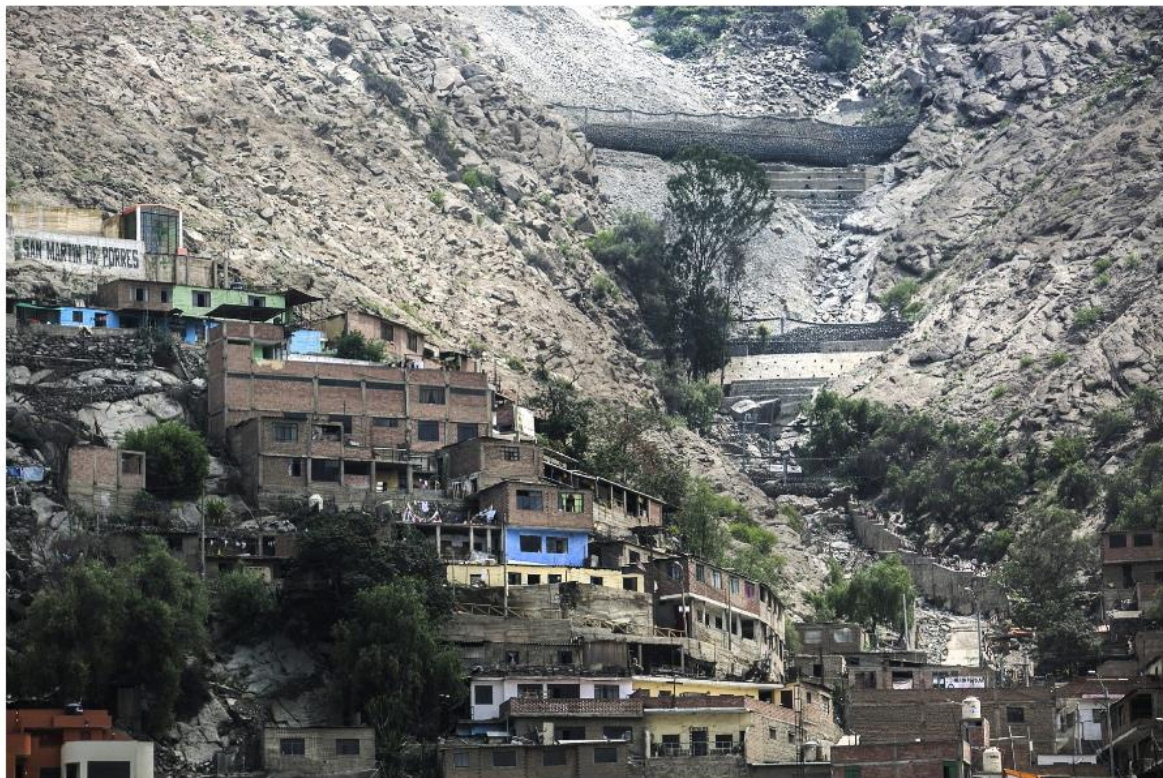
Figure 15: Geodynamic meshes in the quebradas above Chosica, introduced prior to the El Niño event of 2015/16. Credit: Practical Action

These measures were extremely costly. Venkateswaran et al. (2017) estimated around US$6.5 million was invested in the geodynamic meshes, funded by the Ministry of Agriculture. Other initiatives such as early warning systems required technical and monetary support from international development agencies such as the Korea International Cooperation Agency (KOICA). However, interviewees highly praised their effectiveness. The meshes successfully prevented numerous large debris flows,

protecting households and infrastructure, and whilst the early warning systems were often too last-minute to protect assets and livelihoods, the areas covered had no loss of life by enabling evacuations.

The only specific state actions taken immediately prior to the 2017 disaster in order to mitigate impacts were the so-called 'cleaning' of *quebradas* (i.e. dredging river channels to remove debris) and prepositioning heavy machinery in extremely high-risk areas. Whilst the 'cleaning' was rather redundant given the high levels of riverine overflow, prepositioning equipment was effective. It allowed the *carretera central* to be cleared in less than three hours.[10] During past events this had taken up to three days. The subsequent impacts on access to affected areas vastly improved the state's ability to assist communities with coping with disaster impacts. Thus, whilst state preparations that were made were generally effective, they were few and highly localised. The majority of communities affected in 2017 could not benefit from these measures, relying instead on their own coping strategies to mitigate disaster impacts.

Moreover, ex-post state actions vastly improved community coping capacity when a collaborative approach was undertaken alongside local authorities. In Casta, the municipality worked alongside community leaders to coordinate initiatives to clear exposed roads, dig drainage canals and infiltration ditches, designate evacuation points and build up community food reserves. The *campesina* nature of Casta may have enabled this approach, with a longstanding history of community collaboration and cohesion. However, similar benefits of state actors collaborating with local officials were evident in peri-urban Chosica. The local emergency operations centre's (COEL) cross-sectoral working relationships with vital services such as fire brigades and health clinics enabled a collective, coordinated approach, vastly increasing the effectiveness of state action and community coping capacity. Multiple interviewees suggested that the state intends to further empower local and regional governments. If COELs are well funded and organised, they could be crucial for building disaster resilience and ensuring successful implementation of national objectives at a local level.

However, certain aspects of the state's ex-post response severely diminished the coping capacity of affected communities and increased disaster impacts in 2017.

Firstly, the lack of clear governmental leadership and organisation. Whilst this is relatively normal during disasters due to their extreme nature and the immense pressure they place on governmental actors, it undoubtedly hindered the effectiveness of local response actions. Previous research highlighted that individual government entities operated in institutional 'silos', and that national actors frequently overstepped regional and local authorities resulting in action redundancy (French et

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[10] The *carretera central* is the main highway connecting Lima Metropolitana to rural communities higher up the river valley.

al., 2020: 10). This study similarly contends that the lack of state direction and priorities clearly reduced the coping capacity of households. Poor vertical communication from national to local authorities meant that warnings were often transmitted extremely late to relevant local actors and that emergency broadcasts did not work effectively. Confusion over roles in the national response and little to no government advice given to households inspired inaction and further highlights the necessity of community involvement in national response directives. At-risk households were simply not aware of how to react to the imminent threat and how to respond to disaster impacts. As one interviewee stated: *"the households were not going to organise themselves"*. Moreover, a lack of clearly designated evacuation zones, official shelters, community disaster plans and information from government bodies lead to conflict between community leaders and households. This state failure to quickly take control of the disaster response and confusions of responsibility drastically decreased the coping capacity of affected communities.

Secondly, state response actions were often heavily delayed. Prepositioning machinery to clear vital roads was effective in Chosica. However, in other areas such as Carapongo and Santa Eulalia where this measure was not taken, main roads were blocked for up to four days. This prevented access to emergency services and response efforts and hugely increased the strain on communities to cope with disaster impacts without the support of national and regional authorities. This isolation undoubtedly decreased the coping capacity of communities and increased adoption of erosive strategies.

Moreover, the dispersion of crucial financial resources for local response initiatives was slow and ineffective. Interviews with governmental officials and NGO representatives stated that concerns over potential corruption at the regional and local level resulted in the very late declaration of the highest level of national emergency by the Peruvian president that made financial capital available to these authorities. This delay meant that the necessary resources to initiate a rapid and effective local response in affected communities were accessible at the time they would have been most effectively utilised, pushing community members towards erosive coping strategies.

Thirdly, the dominance of response actions by inexperienced actors. Past research has revealed that recent centralisation has resulted in the responsibility of DRM falling under the agenda of ministries with no experience of disaster response (French et al., 2020). These assignations clearly reduced the effectiveness of the state response following the 2017 disaster. As one interviewee put it, their lack of training and knowledge meant that their "*good intentions were not enough*". However, these inexperienced actors were not only national ministries. Once it was apparent that local authorities were overwhelmed by the disaster, the state deployed military police to assist response efforts. Whilst this helped to address certain logistical issues, their lack of experience and expertise meant that they

were unable to augment the abilities of local and regional actors to implement an effective disaster response.

Finally, the short-term focus of state actions. State authorities are often under severe pressure to enable a rapid 'return to normalcy', reconstructing vital infrastructure and restoring livelihoods as quickly as possible (IPCC, 2012; Stehr, 2001). However, full recovery of communities as vulnerable as those in the Rímac basin can take much longer. This was particularly apparent in peri-urban Carapongo, where survey data revealed that it took 71% of households over 1 year to economically and socially recover from the 2017 disaster. In rural Casta and Callahuanca this figure was not quite as extreme, but 37% and 41% of households respectively still also required over 1 year. State assistance from national and regional actors lasted between just 3-6 months depending on the severity of impact. After this, recovery was the responsibility of individual households. This absence of long-term state support meant that households had no option but to fall back on the only coping strategies available to them, which in many cases were highly erosive.

How may the ex-post actions taken after the 2017 disaster have affected the future development of the communities in the Rímac river basin and their disaster risk for the next event?

Ex-post actions taken by households and the state can significantly impact local socio-economic development and vulnerability to future disaster events. In the Rímac basin, the ex-post actions adopted following the 2017 disaster certainly appear be hindering local development and preventing the construction of disaster resilience in at-risk areas for a variety of reasons.

Short-term focus

As previously explained, ex-post actions, particularly state actions, are often targeted at enabling a return to societal and economic normalcy as quickly as possible. The underlying localised drivers of disasters are often overlooked in favour of rapidly reconstructing infrastructure and financing livelihood restoration. Ex-post actions therefore frequently restore or enhance disaster vulnerabilities (IPCC, 2012). Data from this study certainly supports this contention. The actions taken by both the state and households following the 2017 disaster were hugely focused on short-term livelihood restoration with a lack of consideration of long-term vulnerabilities.

Interviewees noted that the vast majority of affected households did not think beyond restoring their home and ensuring continued access to key services such as electricity, water and sewage. With many families living day-to-day it can be difficult for them to think in longer timescales. As one interviewee pointed out: "*it is a First World perception that people have a life plan*" for concerns such as disaster

risk. Due to the poor socio-economic status of households, concerns such as access to food and basic services often far outweigh concerns of disasters. Thus, households generally do not take any actions except last-minute preparations, despite the need for a permanent focus on risk mitigation, presenting a conscious disregard of long-term concerns over short-term necessities. Another interviewee posited that this short-term focus results from *"a lack of information and awareness on how households can effectively mitigate disaster risks"*. With a lack of education, households are understandably only concerned with immediate solutions and rapid restoration, despite the fact that this may be enhancing their future vulnerability.

Whilst some interviewees suggested that community perspectives are shifting towards more long-term outlooks, the lack of long-term state action appears to be encouraging community passiveness. Multiple respondents stressed that state funding for recovery projects following a disaster is often time-bound and very short-term. This can hugely restrict project potential and prevent long-term resilience building initiatives. The predominant state focus on rapidly reconstructing infrastructure and restoring the economy has further resulted in a lack of long-term financial assistance for affected households. This is despite lengthy recovery times; as seen in Table 11 below, over one third of rural households and 75% of peri-urban households stated that it took over 1 year to fully recover financially following the 2017 disaster.

Time to recover financially	Peri-urban households	%	Rural households	%
Less than 3 months	7	*12.5*	25	*40.5*
Less than 1 year	7	*12.5*	9	*14.5*
More than 1 year	42	*75*	26	*42*
Don't know	0	*0*	2	*3*
Total	56	*100*	62	*100*

Table 11: Answers to the survey question: How long did it take you to recover financially after the worst flood in the last 10 years, for example as a result of building repairs or lost income?

This lack of long-term state support is further echoed in household assistance-based coping strategies, with high reliance on NGOs, religious organisations and family members and low reliance on the national and local government. Both interviewees and survey respondents strongly insinuated a need for increased local participation in long-term DRR initiatives and for households to become protagonists for their own development without reliance on state action. However, due to the prevalence of erosive coping mechanisms, the predominant short-term state focus, and minimal long-term state support mechanisms for affected households, ex-post actions appear to have maintained or even enhanced local disaster vulnerabilities.

Prevailing focus on visible solutions

Despite studies showing the benefits of a dual DRM approach combining technological interventions with societal resilience building, Peruvian focus remains predominantly on the former. Furthermore, it is often short-term technological interventions that show immediate results that are prioritised following a disaster, as contended by the IPCC (2012). Instead of investing in societal capacity building, creating green spaces, supporting the relocation of those living in areas of unmitigable risk, or creating no-construction zones to increase local coping capacities and prevent the continual build-up of risk, the state has kept a prevailing focus on reconstructing and repairing infrastructure that will be just as vulnerable during the next disaster event.

This is largely a perception and funding issue. Respondents stated that highly visible projects that deliver rapid tangible changes are much more prone to funding, and donors generally prioritise response rather than prevention measures. This supports Tierney's (2014) suggestion that state and international donors are often unwilling to heavily invest in measures that may only pay-off in later years. Local media outlets may be supporting this prioritisation. Interviewees revealed that Peruvian media often only focuses on *"superficial stuff that is easy to measure, for example how much money the state has spent on building walls"* i.e. tangible and financially quantifiable responses rather than improvements to factors such as societal disaster risk awareness.

However, this myopic short-term focus also results from the demands of at-risk communities. Whilst the implementation of emergency brigades and disaster simulations have been relatively well-received across the basin, support is much higher for technological interventions. When questioned as to what DRR measures they would like to see in their community, 39% of households wanted more hard infrastructure projects such as protective rock walls and river channelization. Only in Callahuanca were requests for societal initiatives higher. Interviewees further acknowledged a local predilection for technical solutions. One suggested that this is especially true in peri-urban areas due to the desire for community members to be upwardly mobile in society and considered more developed: "*pouring concrete feels like development*" rather than nature-based or societal interventions. This viewpoint may be strengthened by Peru's long history of technological interventions to flood-related disasters, such as river dredging and constructing retention walls. Another interviewee stated that because technical interventions often utilise foreign technology and imply expertise they can further elicit community support.

This prevailing technical focus could become even more a danger following the relative success of certain communities during the 2017 disaster, a prime example being the community of Chosica. The costly installation of 16 geodynamic meshes in *quebradas* around Chosica was criticised after they

weren't activated during the 2015/16 event. However, in 2017 these interventions undoubtedly reduced disaster impact, with no loss of life in these areas and less infrastructural damage. Whilst this is obviously a positive outcome, it encourages local perceptions of technology as the answer to addressing disaster risk. It also supports the continued illusion of safety of technical interventions and inspires community passiveness with ideas that these interventions will effectively mitigate flood impacts. Hochrainer-Stigler et al. (2011) argue that the coping responses taken by households depend on how they perceive a potential disaster threat. This could be seen during 2017 in the areas of Carapongo and Huaycoloro. Due to the construction of a new stretch of the Ramiro Prialé Highway through these communities and repairs to river channels, local inhabitants assumed that they were no longer at-risk or that their risk level was minimal. When the capacity of these interventions was exceeded in 2017, the lack of local preparation hugely increased the impact of the event. Thus, the persistence of the ideology that infrastructure frees households from disaster risk means that continued construction of protective infrastructure may result in increasingly passive communities, rendering communities even more vulnerable to future events. There must be a change in thinking by both state and local actors to view hard infrastructure measures alongside their residual long-term risk, as suggested by Keating et al. (2016) and Venkateswaran et al. (2017).

Erosive coping strategies reducing coping capacity for future events

Central to building resilience and encouraging socio-economic development following a disaster is ensuring that those affected adopt non-erosive coping strategies (Keating et al., 2016). However, the lack of an effective public safety net system and badly timed public relief efforts often render erosive coping strategies necessary in communities with limited resources (Skoufias, 2003; Paul & Routray, 2010). Clearly the 2017 disaster greatly overwhelmed the majority of at-risk communities. Delays to the state response, poor organisation, response redundancy, the dominance of inexperienced actors and a short-term state focus do appear to have contributed to affected households adopting a variety of erosive coping mechanisms that may hinder their future development and disaster risk.

As demonstrated earlier, the most common coping strategy adopted by affected households was alterations to food consumption. Whilst this could be largely non-erosive if short-lived, the lengthy recovery times of affected households means that sustained alterations could have serious long-term health impacts, particularly for children, directly reducing the future human capital of households and communities, and indirectly reducing future financial capital. Whilst households do not appear to be selling essential assets and the use of savings was particularly high in peri-urban Carapongo, the reliance on loans poses further cause for concern. The lack of a public safety net combined with the general inability of households to continue working for weeks after the event, meant that 50% of households rely on loans to repair damaged property and restore their livelihoods. Whilst these are

predominantly from banks rather than high-interest money lenders, a household debt burden is still being created that is significantly reducing their long-term financial capital and increasing financial vulnerability to future events. This adoption of high-risk coping strategies can be suggested to be leading to the maladaptation of affected communities. Houses that were already poor are now poorer. Without the elimination of the 'transient' poverty that will be maintained by reliance on formal loans, and without sufficient time between disasters for full economic recovery, households will be restricted to erosive coping strategies that maintain or enhance their vulnerability to future disaster events (Lipton & Ravallion, 1995; O'Brien & Leichenko, 2000).

Lack of desire to relocate

The lack of desire of at-risk communities to relocate is certainly maintaining disaster vulnerabilities and restricting socio-economic development. Whilst 39% of households temporarily migrated following the 2017 disaster, its impacts were not enough to encourage more than 7 households across the basin to permanently migrate out of high-risk areas. This may be explained by the economic situation of many of these households, or via the 'agglomeration externalities' of these areas (Hallegatte et al., 2017). People see Lima as an opportunity for a better way of life and appear to be willing to trade disaster risk for a chance at improving their livelihoods. Furthermore, relocation options are often overcrowded, derelict apartment buildings in other areas of Lima that are not enticing prospects. However, interviewees regularly stated that resettling communities such as Carapongo may be the only way to effectively mitigate disaster risks and break households out of transient poverty.

Resettlement is never simple. It is multi-faceted and involves much more than just moving households (Venkateswaran et al., 2017). Crucially, households must be active and willing participants to stand a chance of success (ibid). Interviews revealed that whilst resettlement of severely at-risk populations might be theoretically possible, it is another question whether it would be politically viable. A substantial long-term commitment would be needed from the state to enable relocated populations to thrive, as well as ensuring adequate service provision and housing. With the current short-term state focus and poor organisation and leadership in 2017, this seems unlikely. Furthermore, household surveys suggested that households do not want to relocate, but desire technical interventions to reduce their disaster risk. However, it is clear that even if resettlement is not possible, state actors must do more to prevent the rapid influx of new migrants to areas of high-risk and the ongoing urbanisation of the area. Issues created by previous state policies that have overlooked this large-scale migration must be addressed to prevent risk continually increasing in these communities.

2017 as a turning point

The 2017 disaster may have been a turning point for DRR in the Rímac basin. Household surveys revealed that 67% of households did not feel better prepared for the upcoming *huayco* season, despite data showing that households in all areas were undertaking significantly more preventative actions than in the months prior to the 2017 event. This was especially the case in Carapongo, where the percentage of households implementing no preventative actions changed from 63% prior to 2017 to just 13%. Most common were identifying safe zones for evacuation, conservation of food and water and protection of assets. Whether these actions are effective will only be demonstrated during the next disaster event, but interviewees were extremely positive that actions taken since the 2017 disaster have significantly increased the coping capacity of at-risk communities.

Some interviewees attributed this increase in proactive addressing of disaster risk by households to the shear damage of the 2017 event. Its hugely destructive nature in comparison to other events in recent history was suggested to reveal to households just how vulnerable they are. One interviewee highlighted the media's positive impact regarding this, arguing that widely circulated videos such as that depicting a woman crawling out of a mudflow after being swept miles downstream (see The Guardian, 2017) have stuck in people's minds and demonstrated that they cannot just rely on state warnings. Long recovery times and lasting emotional damage has prompted increased social organisation. Communities have become more cohesive, with evacuation routes planned, increased participation in simulations and increased education in schools on what to do in the case of a disaster. Local residents also claimed that vertical integration between local representatives and the municipality has increased following the 2017 event, and that local media channels have helped to increase awareness and educate households on their disaster risk. These changes imply that societal coping capacity is increasing, which could be encouraging a shift onto the pathway to sustainable well-being.

The most effective DRR initiatives combine societal capacity building with technological interventions. From a technical point of view, the focus of initiatives in the Rímac basin is on early warning systems, not geodynamic meshes despite their relative success in 2017. SENAMHI (The National Meteorology and Hydrology Service of Peru) is currently implementing a basin-wide system, with 7 new tracking stations being installed this year. Given that in the past, early warning systems were a person shouting out of a moto-taxi this is undoubtedly an improvement to local coping capacities. Whilst this focus is understandable given their significantly lower costs, it must be questioned whether this is an effective long-term risk reduction method. If they operate successfully, early warning systems will reduce loss of life in at-risk areas. However, they will not prevent the large-scale damage of infrastructure and assets that made the 2017 disaster so destructive.

Whilst communities appear to be more aware of their disaster exposure since the 2017 event and the state is implementing new initiatives, risk myopia continues to be apparent. As one interviewed academic noted, the translation from knowledge to action is a huge issue in the DRR sector. Representatives of local NGOs suggested that community members are still only interested in DRR initiatives when there is an incentive or pressing need, likely due to other more urgent demands. Thus, whilst awareness may have changed, risk reduction has not yet become a mentality. Many households continue to possess an attitude of passivity even if they live in close proximity to a source of danger. The state's future role in these communities should include guiding local actions towards prevention instead of response and encouraging more households to be proactive in increasing their coping capacity.

Furthermore, effort redundancy still exists and whilst new state projects are being implemented, such as constructing early warning systems, efforts continue to fail to address the root causes of disaster vulnerability. As one interviewee stated, Peru's DRM system looks good on paper but in reality the lack of internal communication between governmental bodies alongside high staff turnover make effective long-term planning difficult. Without state initiatives that prevent the ongoing growth of communities in at-risk areas, the lack of land regulations and the unstoppable forces of urbanisation will continue to maintain or enhance levels of disaster vulnerability. A continued lack of effective state support would mean that households will remain forced to adopt high-risk coping strategies following a disaster that will keep them trapped in poverty and fail to build long-term disaster resilience. Therefore, whilst this study shows that societal coping capacities are somewhat increasing and changes can be seen since 2017, not enough is currently being done to effectively support the long-term development of communities and significantly reduce their disaster risk for the next inevitable event.

Discussion

Erosive coping

This study provides the first investigation into coping strategies to flood-related disasters in the Rímac river basin, and explores how household actions and the state influence may be affecting the long-term development and disaster resilience of at-risk communities. Through examining the ex-ante stage of the 2017 disaster, a severe lack of state preparatory action was evident across the basin due to its unexpected and severe nature. This passivity percolated through societal levels, inspiring inaction in exposed communities. Where household preventative actions were taken they were last-minute, cheap solutions. This combination of disaster severity and poor preparation undoubtedly contributed to the devastating nature of the 2017 disaster and resulted in the coping capacity of exposed communities being greatly exceeded. This led to high rates of post-event temporary distress migration for substantial periods of time, and rendered necessary the adoption of various coping strategies that were often erosive to future local development.

The most common household coping strategy was alteration to food consumption, supporting Devereux's (1999) assertion that coping often involves intensifying existing behaviours. With little financial capital, this was an easy expense to reduce and whilst not necessarily erosive if short-lived, the staggering length of time of this alteration (often for more than a year) rendered this strategy highly erosive to local development.

Evidence of non-erosive coping was apparent through analysing assistance-based coping. Local asset bases appeared stronger in peri-urban areas with the use of savings, and rural communities much more likely to seek assistance from local government, NGOs, or religious organisations than family or community members. In rural areas, assistance appeared to be sought from whoever could provide it. With the vast majority of households unable to work for significant time periods following the disaster, without this assistance the adoption of erosive coping mechanisms would certainly have been higher.

Furthermore, poor local socio-economic conditions were plain to see in the lack of asset-based coping. Whilst this meant low levels of selling essential assets, it appears to have resulted in a high reliance on formal lending that is concerning in such high-risk areas.

The influence of the Peruvian state on local coping strategies

State actions such as installing geodynamic meshes and prepositioning equipment certainly increased the coping capacity of a few select communities (such as Chosica) for the 2017 event. However, the

prevalence of institutional 'silos', effort redundancy and governmental confusion over roles in the response, alongside numerous inexperienced actors, inspired further state inaction during the ex-post phase. The vast majority of affected communities were therefore left isolated with significantly reduced coping capacities, frequently necessitating the use of erosive coping strategies.

The need for localised resilience building

Effective state preparatory actions were few and highly localised, and generally required technical expertise and substantial funding, exactly what is not present in these communities. Without coordinated state initiatives utilising experts and international donors it is highly unlikely that other communities will benefit from corrective DRM measures. Moreover, it can be questioned whether technical measures should be prioritised. Whilst no lives were lost in the communities they protected in 2017, there was still significant loss of assets. Long-term development gains of the local community were still washed away, and with such low asset bases this could be similarly devastating. State actions prior to the event can therefore be argued to have merely reduced disaster damages rather than addressed the local underlying drivers of risk.

The sheer scale of the 2017 disaster may have necessitated a quick recovery. However, the state's short-term focus on returning to normalcy and the lack of long-term support for affected households certainly meant a neglect of underlying risk drivers in the ex-post disaster stage too. Whilst the priorities of both the state and households understandably focused on rapid reconstruction of infrastructure and livelihoods, if the state isn't addressing these drivers then how are individual households expected to when their socio-economic situations necessitate concern with the immediate present.

Moreover, the state ex-post actions have not been conducive to constructing long-term disaster resilience. Without a shift to prospective DRR methods such as effective land zoning, coping capacities of exposed communities will remain low. French et al. (2020) contend that the highly localised nature of risk means that DRR initiatives must be equally contextually specific. Just as Maskrey (2011) states that risk is moulded at the local level, it appears as though coping strategies should be too. Only when state entities collaborated with local officials did ex-post actions effectively increase the coping capacities of target communities. This was seen through the collaboration between the municipality and local leaders in Casta and the cross-sectoral collaboration of the COEL in Chosica. This demonstrates the necessity of a long-term state vision to empower local and regional entities if national objectives are to be successfully articulated at the local level.

A devolution of responsibility for DRM and emergency response to the local level, coordinated by the national expertise of CENEPRED and INDECI, could prove more effective than the current heavily centralised approach. Thus, further research should explore the potential benefit of shifting focus from national to local DRM planning and localised resilience building. A shift to community-based DRM that is highly local and emphasises local empowerment and understanding of hazards may increase self-protection, and therefore local coping capacities to cope with disasters whilst not simultaneously eroding local development (see Wisner, 2006).

Continual risk myopia

The 2017 event may have been a turning point, demonstrating just how vulnerable exposed households are. However, little appears to have changed since. National and international donors are still generally unwilling to finance interventions that do not produce quick, tangible results. Technical interventions are prioritised that do not appear to be viewed alongside their residual risk, as Keating et al. (2016) and Venkateswaran et al. (2017) claim is vital. This phenomenon has been enhanced by local media streams, resulting in continual risk myopia and a reluctance to invest in potential future benefits. This myopia is exacerbated by the periodic nature of El Niño events, and must be addressed to encourage the initiation of more simultaneous societal approaches if resilience levels are to be effectively increased.

This continued prioritisation of technical DRR measures over societal approaches could prove extremely costly. The desire of local households for technical approaches, as revealed in household surveys, and the danger of the relative "success" of communities such as Chosica in 2017 means that if technical measures are implemented, exposed communities may assume that they are completely protected from harm. This presents a clear danger of an enhanced levee effect. Exposure and vulnerability will continue to increase, leading to further increases in local disaster risk. Therefore, when the capacity of this technology is eventually exceeded, the resulting disaster damages will be even greater. With the lack of desire of the local population to relocate and the complications of resettlement, future actions must focus on reducing the continual increase of exposure and vulnerability in the river basin and supporting the long-term socio-economic development of at-risk households.

Furthermore, with the prevalence of hard infrastructure measures in the river basin and concerns over how effective technological measures may be in an era of drastic climatic change, research should investigate possibilities of green solutions such as afforestation and the creation of artificial wetlands. The potential outcome of the coping capacities of infrastructural measures being exceeded should also be studied. This may further strengthen the argument for combining societal resilience building

measures alongside technical solutions. The fact that disasters are human constructions means that effective resilience building initiatives must include a human element. This is especially true if coping capacities to flooding are to be increased and prevent the occurrence of another major disaster.

Conclusion: from reactive to proactive coping

As demonstrated in Figure 16, the low coping capacity of affected communities and an ineffective state response led to the widespread adoption of erosive coping strategies across the Rímac river basin following the 2017 disaster. Combined with the high severity of the event and associated damages, this resulted in significant indirect losses across all exposed communities. The lack of long-term vision and desire to return to normalcy as quickly as possible at all societal levels, alongside continual household risk myopia and the predominant focus of state action on reducing damages, means that ex-post actions were simply reactive. As such, these ex-post actions have maintained or even enhanced local levels of disaster risk by failing to address underlying drivers. The focus on short-term, high-visibility interventions and multiple factors reducing the effectiveness of the national response means that the current approach of the state is thus not only not supporting effective coping at the local level, but actively hindering it and amplifying disaster damages, simultaneously hindering resilience building and the socio-economic development of local communities.
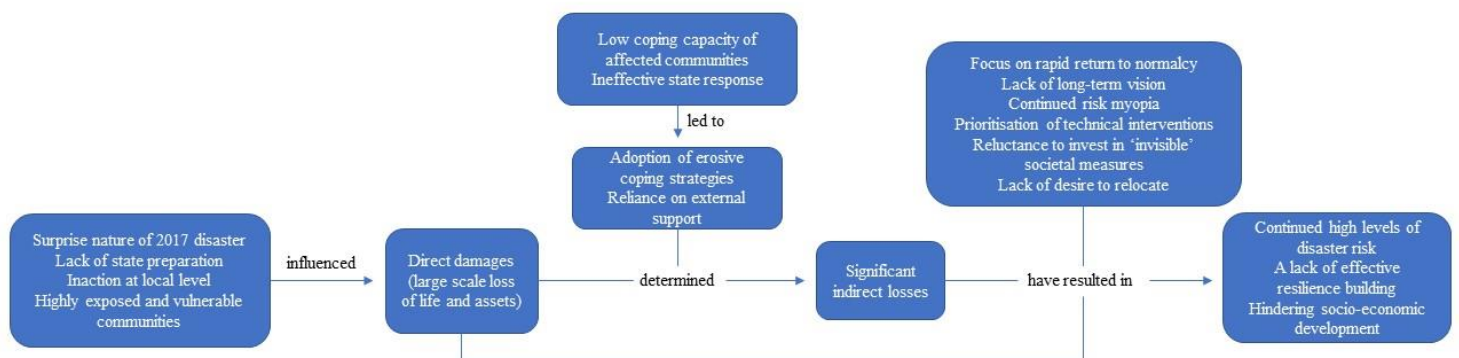

Figure 16: How the actions taken during the ex-post stage of the 2017 disaster have led to continued high levels of disaster risk, prevented the building of resilience, and hindered the socio-economic development of communities in the Rímac river basin. Source: Author's own.

It should be the state's mandate to be proactive in increasing local disaster resilience and encouraging the long-term socio-economic development of at-risk communities. If coping strategies in the river basin are to become proactive and communities are to be shifted onto the pathway to sustainable wellbeing, then the fatalistic attitude of exposed communities, high levels of risk myopia, and the lack of societal capacity building must be addressed.

The state must consider the long-term residual risk of their actions. The current focus on a rapid return to normalcy is having adverse effects on Peru's future. The state must now set a new tone. With the

degree of centralisation in the country, changes at a national level will undoubtedly percolate down to regional and local levels. However, more responsibility and funding must be granted to local governments. Their potential effectiveness was proven in 2017, and the highly localised nature of disaster risk means that they could be vital to effectively coping with disaster impacts whilst not sacrificing long-term development gains. If things do not change then flood-related disasters will continue to be one of the greatest contemporary challenges to development in Peru.

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Appendices

Appendix 1: Household survey questions.

The household surveys for this research were conducted alongside surveys by Practical Action Peru as part of their work for the Zurich Flood Resilience Alliance measuring the flood resilience of communities in the Rímac river basin. The surveys thus had a dual purpose and two sets of questions were asked to every household. The questions from the Flood Resilience Measurement for Communities (FRMC) survey used by Practical Action were still highly useful to this thesis. Those questions and their response options are detailed below, followed by the questions designed specifically for my research.

Context Questions

¿En cuál de los siguientes grupos de edad se encuentra usted? Si usted es menor de 15 años, será necesario hablar con otro informante clave en esta familia	15-25 / 26-50 / Más de 50
¿Cuál es su género?	Femenino / Masculino / Otro
En el caso de una inundación, le sería difícil realizar alguna de las siguientes actividades: - ¿Caminar aproximadamente 100 metros (330 pies) para evacuar? - ¿Escuchar una alarma de inundación? - ¿Ver, debido a una discapacidad visual?	Sí a uno o más / No a todos / No sé
¿Cuántos niños menores de 15 años viven en este hogar la mayor parte del tiempo?	
¿Cuál es su nivel más alto de educación concluido?	Nunca asistió a la escuela / Asistió a la escuela primaria pero no concluyó / Terminó la escuela primaria / Asistió a la escuela secundaria pero no concluyó / Terminó la escuela secundaria / Escuela profesional o formación / Título o grado de formación profesional / Título universitario
¿Cuánto tiempo han vivido los miembros de la familia en la comunidad?	Al menos un adulto de la familia tiene una larga historia familiar aquí, muchas generaciones / Al menos un adulto de la familia nació en la comunidad / Los miembros de la familia se mudaron aquí hace más de 20 años / Los miembros de la familia se mudaron aquí entre 5 y 20 años atrás / Los miembros de la familia se mudaron aquí hace menos de 5 años / No sé
¿Cuáles son las formas en que los miembros de esta familia obtienen ingresos en efectivo? Marque todas las opciones que correspondan.	Salarios (jornal, paga) por el trabajo agrícola en la tierra de otras personas / Agricultura: ingresos de la venta de productos agrícolas propios / Trabajador por cuenta propia en trabajos no agrícolas (por ejemplo, posee una tienda u otro negocio) / Empleado de gobierno, empresa privada u ONG / Pagos de ayuda social gubernamental / Apoyo de la familia, la iglesia u ONG / Dinero enviado por la familia que trabaja fuera de la comunidad / Ingresos procedentes de activos tales como propiedades (renta) u otras inversiones / Otras fuentes de ingreso / Sin fuentes de ingreso / No sé

¿Cuál es la mayor fuente de ingresos para esta familia?	Salarios (jornal, paga) por el trabajo agrícola en la tierra de otras personas / Agricultura: ingresos de la venta de productos agrícolas propios / Trabajador por cuenta propia en trabajos no agrícolas (por ejemplo, posee una tienda u otro negocio) / Empleado de gobierno, empresa privada u ONG / Pagos de ayuda social gubernamental / Apoyo de la familia, la iglesia u ONG / Dinero enviado por la familia que trabaja fuera de la comunidad / Ingresos procedentes de activos tales como propiedades (renta) u otras inversiones / Otras fuentes de ingreso / Sin fuentes de ingreso / No sé
Comparado con el ingreso mensual promedio nacional, ¿esta familia gana significativamente menos, aproximadamente lo mismo, o significativamente más por mes?	Significativamente más que el ingreso mensual promedio nacional / Aproximadamente lo mismo que el ingreso mensual promedio nacional / Significativamente menos que el ingreso mensual promedio nacional / No sé/ Preferiría no decir
En los últimos 10 años, ¿cuántas veces ha habido inundaciones en su comunidad?	0 inundaciones en los últimos 10 años / 1 inundación en los últimos 10 años / 2 inundaciones en los últimos 10 años / 3 inundaciones en los últimos 10 años / 4 inundaciones en los últimos 10 años / 5 inundaciones en los últimos 10 años / Más de 5 inundaciones en los últimos 10 años / No he vivido aquí por tanto tiempo. / No sé/ No me acuerdo
Mientras usted ha vivido en esta comunidad, en los últimos 10 años, ¿cuántas inundaciones han llegado a su casa?	
Mientras usted ha vivido aquí, en los últimos 10 años, ¿cuántas veces un miembro de su familia se ha lesionado o perdido la vida en una inundación?	
Mientras usted ha vivido aquí, en los últimos 10 años, ¿cuántas veces los miembros de la familia han sufrido daños en su propiedad por una inundación?	
Piense en la peor inundación que ha experimentado mientras ha vivido aquí durante los últimos 10 años, ¿cuánto tiempo le tomó recuperarse financieramente, por ejemplo, por las reparaciones en construcciones o pérdida de ingresos?	No he sido impactado por una inundación en esta comunidad / Menos de una semana / Menos de un mes / Menos de tres meses / Menos de un año / Más de un año / No sé

Assets

¿Qué acciones realizan las personas de la comunidad para proteger sus hogares, propiedades, vehículos, objetos de valor o equipos de trabajo contra daños en caso de una inundación? Estas acciones podrían hacerse con anticipación a la inundación, no justo antes de que ocurra.	El encuestado mencionó 2 o más acciones realistas / El encuestado mencionó 1 acción realista / El encuestado mencionó 0 acciones realistas
¿Alguien en la familia ya ha realizado alguna medida para proteger su hogar o propiedad ante una inundación?	Sí / No / No sé
¿Qué acciones podrían realizarse para reducir los impactos de las inundaciones en esta comunidad? Marque todas las opciones que apliquen.	Construcción de protecciones físicas como diques o terraplenes / Plantación de árboles y vegetación / Modificaciones en casas y edificios / Mover los bienes de la zona de inundación / Otras acciones / No identifica ninguna acción
Si no se toman medidas, ¿cree que las inundaciones en el futuro serán mejores, iguales o peores de lo que son ahora?	Las inundaciones en el futuro serán mejores o peores (el riesgo de inundación cambiará) / Las inundaciones en el futuro serán iguales / No sé
¿Qué medidas adopta usted en su casa para mantener su propiedad y bienes a salvo de las inundaciones? Marque todas las opciones que apliquen.	Barreras para inundaciones o sacos de arena / Muros alrededor de la vivienda / Viviendas elevadas / Pisos elevados al interior de la vivienda / Desviar el agua de inundación (ejemplo: canal de desvío) / Mover la casa / Otra / Ninguna de las anteriores
En su casa, para reducir las pérdidas durante las inundaciones, ¿qué medidas adopta? Marque todas las opciones que apliquen.	Utilizo la planta superior para almacenar / Construcción a prueba de inundaciones / Almacenamiento/ contenidos a prueba de inundaciones / Edificios construidos/ actualizados con el último código de construcción / Puedo sacar rápidamente mis bienes importantes cuando llega la inundación / Guardo los bienes en cajas/ contenedores a prueba de inundaciones / Otra / Ninguna de las anteriores
Si una inundación destruye su propiedad, ¿cómo planea restaurarla? Marque todas las opciones que correspondan.	Usaré seguro contra inundaciones. / Usaré mi propio dinero del ahorro para emergencias. / Venderé los bienes no esenciales reservados para emergencias. / Obtendré un préstamo o un subsidio a través de un programa gubernamental / Voy a obtener un préstamo de mi banco / Obtendré un préstamo de un amigo o pariente fuera de la comunidad / Obtendré un préstamo de un pariente en la comunidad / No tengo planes de restaurar. / Otro

Governance

En los últimos 2 años, ¿los líderes locales (formales o informales) han facilitado oportunidades para fortalecer el conocimiento de la comunidad en general sobre la resiliencia ante inundaciones a través de la abogacía, las oportunidades de participación ciudadana o el liderazgo entre pares?

Sí / No / No sé

En los últimos dos años, ¿cuántas oportunidades han facilitado los líderes locales (formales o informales) para fortalecer la resiliencia comunitaria ante inundaciones?

Un alto número de oportunidades / Un número moderado de oportunidades / Un número bajo de oportunidades / Un número muy bajo de oportunidades / No sé

¿Los líderes locales (formales o informales) tienen un conocimiento general sobre la resiliencia ante inundaciones?

Tienen un alto grado de conocimiento sobre la resiliencia ante inundaciones / Tienen un grado moderado de conocimiento sobre la resiliencia ante inundaciones / Tienen un grado bajo de conocimiento sobre la resiliencia ante inundaciones / No sé

Life and Health

¿Ha recibido información sobre el agua potable limpia y cómo protegerse y proteger a su familia de una inundación?

Sí / No / No sé

Si hubiera una inundación en la comunidad, ¿sabría cómo asegurarse de tener agua potable limpia y evitar que usted y su familia se enfermen?

Sí / No / No sé

¿Existen actividades comunitarias (formales o informales) relacionadas con la prevención, la preparación y la respuesta a las inundaciones?

Sí / No / No sé

¿Está involucrado en actividades (formales o informales) relacionadas con las inundaciones en su comunidad?

Sí / No / No sé

¿Con qué frecuencia usted participa en actividades relacionadas con las inundaciones?

Frecuentemente participa / Ocasionalmente participa / Rara vez participa / Nunca participa / No sé

¿Las actividades relacionadas con las inundaciones incluyen tanto a hombres como a mujeres y a todos los grupos vulnerables (física, social o económicamente)?

Una alta proporción de las actividades relacionadas con las inundaciones es incluyente / Una proporción moderada de las actividades relacionadas con las inundaciones es incluyente / Una baja proporción de las actividades relacionadas con las inundaciones es incluyente / Una muy baja proporción de las actividades relacionadas con las inundaciones es incluyente

¿La comunidad tiene acceso a servicios externos de respuesta a inundaciones?

Una alta proporción de la comunidad tiene acceso / Una proporción moderada de la comunidad tiene acceso / Una baja proporción de la comunidad tiene acceso / Una muy baja proporción de la comunidad tiene acceso / No sé

¿La comunidad tiene acceso a servicios externos de recuperación ante inundaciones?

Una alta proporción de la comunidad tiene acceso / Una proporción moderada de la comunidad tiene acceso / Una baja proporción de la comunidad tiene acceso / Una muy baja proporción de la comunidad tiene acceso / No sé

En caso afirmativo, ¿qué tan satisfecho está usted con la calidad de los servicios externos de respuesta y /o de recuperación ante inundaciones?

Servicios altamente eficaces / Servicios medianamente eficaces / Servicios ineficaces / Servicios muy ineficaces / No sé o no se proporcionan servicios

Lifelines

¿Cuál de estos medios de transporte son esenciales para que su familia acceda a la comunidad y lleve a cabo sus actividades diarias (ir al mercado, ir a las localidades vecinas, visitar amigos y vecinos, ganarse la vida)? Marque todas las opciones que apliquen.

La única carretera / Las múltiples carreteras / Caminos / Ferrocarril / Embarcación / Puente / Otro / No tengo ninguno disponible / No sé

¿Cuál de estos medios de transporte esenciales se verán afectados / destruidos y, por lo tanto, serán inaccesibles para su familia durante las inundaciones? Marque todas las opciones que apliquen.

La única carretera / Las múltiples carreteras / Caminos / Ferrocarril / Embarcaciones / Puente / Otro / No tengo ninguno disponible / No sé

¿Cuáles de estos medios de transporte son seguros durante las inundaciones y permanecerán totalmente funcionales para su familia? Marque todas las opciones que apliquen.

La única carretera / Las múltiples carreteras / Caminos / Ferrocarril / Embarcación / Puente / Otro / No tengo ninguno disponible / No sé

¿Cuáles de estos medios de comunicación son esenciales para que su familia se comunique con la comunidad (reporte accidentes o enfermedades, comunicarse con amigos o familiares, para los medios de vida, etc.)? Marque todas las opciones que apliquen.

Teléfono móvil (celular) / Teléfono fijo / Radio / Televisión / Internet / Periódico / Discusiones locales / Nuestra familia no tiene acceso a este tipo de medios de comunicación / Otro / No sé

¿Cuál de estos medios de comunicación se verá afectado / destruido y, por lo tanto, no estará disponible para su familia durante las inundaciones? Marque todas las opciones que apliquen.

Teléfono móvil (celular) / Teléfono fijo / Radio / Televisión / Internet / Periódico / Discusiones locales / Nuestra familia no tiene acceso a este tipo de medios de comunicación / Otro / No sé

En su opinión, durante y después de las inundaciones, ¿la comunidad puede mantener medios de comunicación de emergencia a través de uno o varios de los siguientes? Marque todas las opciones que apliquen.

Teléfono móvil (celular) / Teléfono fijo / Radio / Televisión / Internet / Periódico / Discusiones locales / Nuestra familia no tiene acceso a este tipo de medios de comunicación / Otro / No sé

En el caso de una inundación, ¿la cantidad y calidad de los alimentos que usted consume cambia o se reduce significativamente?

La comida para nuestra familia no se reduce ni en cantidad ni en calidad / La comida para nuestra familia se reduce en calidad pero no en cantidad / La comida para nuestra familia se reduce en cantidad pero no en calidad / La comida para nuestra familia se reduce en cantidad y en calidad / No sé

¿Las instalaciones de su cocina quedan destruidas, dañadas o inservibles durante y después de una inundación?

No, nuestras instalaciones para cocinar no se ven afectadas por las inundaciones / Sí, algunas instalaciones para cocinar se ven afectadas / Sí, ninguna de las instalaciones para cocinar está disponible para nuestras familias después de las inundaciones / No sé

En el caso de una inundación, ¿la comunidad ayudaría a proporcionar suministros de alimentos de emergencia para aquellas familias que pudieran necesitarla?

Sí, la comunidad cuenta con planes para proporcionar suministros de alimentos de emergencia / Sí, la comunidad generalmente proporciona suministros de alimentos de emergencia, pero no sigue un plan detallado / No, la comunidad no cuenta con un plan para proporcionar suministros de alimentos de emergencia / No sé

Durante las inundaciones, ¿cuál de las siguientes fuentes de agua limpia puede verse afectada en su hogar? Marque todas las opciones que apliquen.

Agua potable para beber / Agua potable para las actividades de subsistencia / Agua de pozo para beber / Agua de pozo para las actividades de subsistencia / Fuentes de aguas abiertas (ríos, lagos) para beber / Fuentes de aguas abiertas (ríos, lagos) para las actividades de subsistencia / Camión de agua u otros servicios remotos para beber / Camión de agua u otros servicios remotos para las actividades de subsistencia / No tengo acceso a agua limpia / Ninguna de las fuentes de agua será afectada / No sé

¿Qué precauciones toman en su familia con respecto a las fuentes de agua potables que se ven afectadas por las inundaciones? Marque todas las opciones que apliquen.

Usamos tabletas de cloro / Hervimos el agua / Filtramos el agua / No podemos tomar ninguna medida contra el agua contaminada / Nuestra agua no estará contaminada / No sé

¿Usted puede usar las instalaciones sanitarias con normalidad durante y después de las inundaciones?

Sí / No / No tenemos instalaciones sanitarias / No sé

¿Qué problemas ocurren con las instalaciones sanitarias en su hogar durante las inundaciones? Marque todas las opciones que apliquen.

No tenemos problemas con nuestras instalaciones sanitarias durante las inundaciones / Se dañan / Se destruyen / Se obstruyen / Contaminarán el entorno / No tenemos instalaciones sanitarias / No sé

Si hay una inundación, ¿puede continuar trabajando y / o mantener sus ingresos?

Sí, mi trabajo o mis ingresos no se ven afectados cuando hay una inundación. / Sí, tengo trabajo o fuente de ingresos alternativos durante una inundación / Sí, tengo trabajo o fuente de ingresos alternativos que puedo hacer en otro lugar / No, mi trabajo e ingresos se ven interrumpidos hasta que termina la inundación / No, mi trabajo e ingresos se verían interrumpidos indefinidamente / No sé

Natural Environment

¿Qué se podría hacer con respecto al medio natural o a los ecosistemas para poder ayudar a proteger a esta comunidad de las inundaciones?

El encuestado nombró al menos una acción con respecto al ambiente natural que podría ayudar a proteger a la comunidad de inundaciones / El encuestado no nombró ninguna acción con respecto al ambiente natural que podría ayudar a proteger a la comunidad de inundaciones / No sé

Social Norms

¿Existe un alto nivel de representación de los diferentes grupos vulnerables en los órganos comunitarios de toma de decisiones ante inundaciones?

Sí / De forma parcial / No / No sé

¿Los planes de preparación, respuesta o recuperación ante inundaciones (formales o informales) consideran a las personas de la comunidad por sus necesidades específicas como edad, género, estado social, nacional o étnico, discapacidad u otros factores relacionados?

Sí, los planes consideran a las personas de la comunidad con necesidades específicas / Los planes consideran parcialmente a las personas de la comunidad con necesidades específicas / No existen planes de desastre por inundaciones / No sé

¿Hay algún grupo social excluido del proceso de planificación comunitaria de inundaciones?

Los diferentes grupos sociales no están excluidos del proceso de planificación comunitaria de inundaciones del proceso de planificación comunitaria de inundaciones / Los diferentes grupos sociales están parcialmente excluidos del proceso de planificación comunitaria de inundaciones / No existe un proceso de planificación comunitaria de inundaciones / No sé

¿Existe una estructura inter-comunitaria formal o informal (por ejemplo, un comité) para la coordinación de inundaciones?

Sí / No / No sé

Si existe una estructura formal o informal (por ejemplo, un comité) responsable de la coordinación inter-comunitaria de inundaciones, ¿es efectiva en términos de contar con planes de preparación y respuesta adecuados y canales de comunicación con las comunidades vecinas?

La coordinación inter-comunitaria es altamente efectiva / La coordinación inter-comunitaria es moderadamente efectiva / La coordinación inter-comunitaria es de baja efectividad / No existen mecanismos inter-comunitarios / No sé

Si existe una estructura formal o informal (por ejemplo, un comité) responsable de la coordinación inter-comunitaria de inundaciones, ¿incluye tanto hombres como mujeres y a todos los grupos vulnerables (física, social o económicamente)?

Existe un alto grado de inclusión de hombres y mujeres y de todos los grupos vulnerables / Existe un grado moderado de inclusión de hombres y mujeres y de todos los grupos vulnerables / Existe un bajo grado de inclusión de hombres y mujeres y de todos los grupos vulnerables / No existen estructuras formales o informales inter-comunitarias responsables de la coordinación de inundaciones / No sé

Below are the household survey questions designed specifically for this study and the information stated to every respondent prior to data collection.

Este estudio busca identificar los factores de resiliencia con que cuentan las comunidades ante de las inundaciones y huaicos saber cómo afectan sus medios de vida. La información que nos den las familias será usada para comprender la relación entre inundaciones y desarrollo además serán usadas en una tesis de investigación de posgrado. Estrategias antes y después de un desastre y su efecto en la resiliencia de los hogares y la comunidad.

Antes de las inundaciones de 2017, ¿tomó su hogar alguna de las siguientes medidas preventivas? (marque todas las que correspondan) Please tick all options that apply.	Seguro privado contra desastres / Conservación de alimentos / Protección de bienes y servicios / Ahorros familiares / Almacenamiento de agua dulce / Limpieza de materiales inservibles / Identificar zonas seguras / Diversificación de cultivos o producción agrícola / Diversificación de las fuentes de ingresos / Nuestro hogar no tomó medidas preventivas / Otros (por favor escriba detalles)
Después de las inundaciones de 2017, ¿Su hogar hizo algo de lo siguiente? (Marque todas las que correspondan) Please tick all options that apply.	Se ha cambiado el consumo de alimentos (por ejemplo, comer menos comidas cada día, comprar alimentos más baratos) / Utiliza ahorros / Reducir el gasto / Sacar un préstamo / Saque a los niños de la escuela / Mas miembros de familia trabajan (Si es así, ¿quiénes?) / Deja el área donde vivías / Trabajar más horas o participar en actividades adicionales generadoras de ingresos / Venta de activos (por ejemplo, artículos para el hogar, ganado, tierras) / Nuestra casa no hizo nada / No sé
Si abandonaste el área donde vivías, era esto:	Temporal / Permanente / Nuestra casa no se fue
Si su hogar vendió activos, ¿qué vendió? (marque todas las que correspondan) Please tick all options that apply.	Artículos de lujo / Transporte / Tierra / Propiedad / Ganadería / Otro (por favor escriba detalles) / Nuestro hogar no vendía ningún activo
Después de las inundaciones de 2017, ¿de que instituciones/organizaciones tu familia recibió apoyo? (marque todas las que correspondan) Please tick all options that apply.	Gobierno nacional / Gobierno local / Familia / Amigos / Comunidad / ONG / Organización religiosa / Nuestro hogar no necesitaba apoyo / Otro (por favor escriba detalles)
¿Has notado algún cambio en los preparativos de la comunidad para la temporada de lluvias desde el desastre de 2017?	Sí, y la comunidad ahora está mejor preparada. / Sí, pero la comunidad no está mejor preparada. / No, no he visto ningún cambio. / No sé
¿Qué tan efectivas crees que las acciones preventivas y de respuesta de tu hogar han sido en el pasado?	Muy eficaz / Ligeramente eficaz / No muy eficaz / No es eficaz en absoluto / No sé
¿Quién cree que es el más responsable de la prevención y respuesta a desastres en su comunidad?	Hogares individuales / Líderes comunitarios / ONG / Gobierno nacional / Gobierno local / Otro (por favor escriba detalles) / No sé
¿Qué está haciendo su hogar para prepararse para la temporada de lluvias de este año? (marque todas las que correspondan) Please tick all options that apply.	Seguro privado contra desastres / Conservación de alimentos / Protección de bienes y servicios / Ahorros familiares / Almacenamiento de agua dulce / Limpieza de materiales inservibles / Identificar zonas seguras / Diversificación de cultivos o producción agrícola / Diversificación de las fuentes de ingresos / Nuestro hogar no tomó medidas preventivas / Otros (por favor escriba detalles)
¿Por qué haces esto? (marque todas las que correspondan) Please tick all options that apply.	Porque es fácil / Experiencias exitosas / Limitaciones financieras / Coste-efectividad / Asesorado por departamento gubernamental / Asesorado por ONG / Aconsejado por otra persona en la comunidad / Otro (por favor escriba detalles) / Nuestro hogar no está haciendo nada / No sé
¿Hay algo que su hogar o comunidad le gustaría poder hacer pero usted no puede hacer? Si es así, ¿qué te gustaría hacer y por qué no puedes?	

Appendix 2: Key informant interview guides.

This interview is a part of the research for my master's thesis. I'm studying the strategies taken before and after a disaster and their effect on the resilience of households and the community. It will last approximately 45 minutes and it is anonymous. Is it okay if I record this interview and take notes? (If interview was in Spanish) My Spanish is not perfect, so please speak slowly. Do you have any questions before we begin?

Esta entrevista es parte de la investigación para mi tesis de maestría – Estoy estudiando las estrategias tomadas antes y después de un desastre y su efecto en la resiliencia de los hogares y la comunidad. Debe tomar aproximadamente 45 minutos. Es anónimo ¿Está bien para mí para grabar y tomar notas? Mi español no es perfecto, así que por favor hable despacio ¿Tienes alguna pregunta antes de empezar?

Questions asked to academics specialising in risk with experience in the Rímac river basin

What is your role at ___?

In which communities in the Rímac river basin have you had experience?

Despite the extensive preparations just a year earlier, why were the effects of the 2017 disaster so great in the Rímac river basin?

Was the 2017 disaster unique?

What do you think determines the coping strategies that households/communities in the Rímac river basin are taking?

In what ways might coping strategies vary for different sections of the river basin?

To what extent do you think that poor communities in vulnerable conditions actively consider their disaster risk?

How can technological solutions lead to an illusion of security for at-risk communities?

Do you think that a focus on concrete and photographable reconstruction may be preventing adequate resilience building? If so, how could this change?

Do you think that relocation is a viable option for communities in the Rímac river basin?

Do you think that Peru is moving beyond an 'emergency' mindset towards prevention?

Do you think flood-related disasters are becoming increasingly urban in the Rímac river basin?

In what ways might disaster risk management strategies in the Rímac river basin need to change with continuing urbanisation and population growth?

How effective do you think that the current disaster risk management system in Peru is?

What do you think can be done to help communities in the Rímac river basin transition onto a pathway to sustainable wellbeing and disaster resilience?

What is your role at___?

How long have you worked at___?

What role do you think that NGOs play in the DRM sector of Peru?

How did ___ assist local households after the 2017 disaster?

What are the biggest problems that ___ has in these communities?

What do you think determines the strategies that homes/communities are taking before and after a disaster in the Rimac River Basin?

In what ways do you think that the actions communities can take after a disaster are limited? Why do you think this is?

How can these strategies vary for different sections of the basin? (For example, peri-urban and rural areas)

How effective do you think preparation measures were for the 2017 disaster in the Rímac river basin?

Do you think communities in the Rimac River basin actively consider their risk of disaster?

Do you think there is an illusion of safety in the Rimac River basin from technological interventions? (e.g. rock walls, geodynamic meshes)

Do you think flood disasters are becoming more urban in Peru?

How might disaster risk management strategies in the Rimac River basin have to change with continued urbanization and population growth?

Do you think Peru is moving beyond an "emergency" mentality?

Do you think the current disaster risk management system in Peru is too decentralized?

What do you think can be done to help communities in the Rimac River basin get out of the cycle of poverty?

Since the 2017 disaster, have you noticed any changes in community actions or preparedness for another disaster?

Do you think that community members think long-term about their actions in the wake of a disaster event?

What are the biggest problems you face when trying to increase the disaster resilience of communities in the Rímac river basin?

Do you think that relocation is a viable option for communities in the Rímac river basin?

In what ways might disaster risk management strategies in the Rímac river basin need to change with continuing urbanisation and population growth?

How effective do you think that the current disaster risk management system in Peru is?

What do you think can be done to help communities in the Rímac river basin transition onto a pathway to sustainable wellbeing and disaster resilience?

If you could make any changes to your programs in the Rímac river basin, what would you do?

Questions asked to local health worker

What is your position or role?

How many years have you had experience with this community, either by living here or working with this community?

What percentage of households take appropriate individual flood protection measures?

To assess the range of protection measures available to the households in that community, what typical flood protection measures are households taking?

What percentage of adults in the community have attended first aid training in the last 10 years?

What percentage of women in the community would you know how to respond if someone is was seriously injured?

What percentage of men in the community would you know how to respond if someone is was seriously injured?

Where are the healthcare facilities that provide services to this community located with respect to flood zones?

If the healthcare facilities are affected by flooding, what would happen to the buildings and the services provided?

When flooding occurs in this community, would people be able to receive healthcare by accessing the corresponding healthcare facilities?

Is there a high level of representation from different vulnerable groups in community flood decision making bodies?

Do flood preparedness plans (formal or informal) take into account people in the community with specific needs due to their age, gender, social, national or ethnic status, disability or other related factors?

Are any social groups excluded from the community flood committee?

Questions asked to local government representative and in group interview

How long have you lived in this area?

In local communities, what are the most common actions that people take to prepare for a flood?

What do you think determines these actions that households are taking before and after a disaster?

Do you think that community awareness of flood disaster risks is changing in your community? If so, why?

Who coordinates community preventative actions?

How often do flood disaster simulations take place? Who is involved?

What actions do you advise households to take to prepare for a potential disaster?

How do you think community flood disaster resilience can be increased in the Rímac river basin?

Do you think that communities in the Rímac river basin are becoming more vulnerable to flood related disasters?

Do you think that communities in the Rímac river basin think long-term about their development? Why?

Why do you think that communities in the Rímac river basin are so vulnerable to flood-related disasters?

What do you think can be done to help communities in the Rímac river basin transition onto a pathway to sustainable wellbeing and disaster resilience?

Questions asked to member of the Network of Resilience Leaders for the Rímac River Valley

How long have you lived in the Rímac river valley?

How long have you worked with the Network of Resilience Leaders?

What are the responsibilities of the Network in your community?

In your communities, what are the most common actions that people take to prepare for a flood?

What do you think determines these actions that households are taking before and after a disaster?

Do you think that community awareness of flood disaster risks is changing in your community? If so, why?

Who coordinates community preventative actions?

Who is responsible for coordinating post-disaster immediate response and relief in your community?

How often do flood disaster simulations take place? Who is involved?

What does CENEPRED/INDECI advise houses in your community to do to prepare for a disaster?

How do you think community flood disaster resilience can be increased in the Rímac river basin?

Do you think that communities in the Rímac river basin are becoming more vulnerable to flood related disasters?

Do you think that communities in the Rímac river basin think long-term about their development? Why?

Why do you think that communities in the Rímac river basin are so vulnerable to flood-related disasters?

What is the role of the COE?

How long has it existed?

What is your role with the COE?

How long have you worked for the COE?

How did the 2017 disaster affect this community?

What actions did the COE take to minimise the impacts of the 2017 El Niño?

Why were those actions chosen?

How effective do you think preparation measures were for the 2017 disaster in the Rímac river basin?

How did the COE assist local households after the 2017 disaster?

Was the response managed by the local or national government?

Do you think that community members think long-term about their actions in the wake of a disaster event?

What information do you provide to communities to try and increase their disaster resilience?
      e.g. leaflets, posters, workshops, advertisements

What are the biggest problems the COE has in these communities?

Do you think that communities in the Rímac river basin are becoming more vulnerable to flood related disasters?

Do you think that community awareness of flood disaster risks is changing? If so, why?

How do you think community flood disaster resilience can be increased in the Rímac river basin?

Why do you think that communities in the Rímac river basin are so vulnerable to flood-related disasters? How do community actions affect this/what role do community actions play in disaster vulnerability?

Do you think that there has been a national shift of focus towards prevention instead of response? If so, why do you think this shift has occurred?

Appendix 3: Demonstration of coding table.

Research Question	Sub-codes	Codes	Themes
1	• Poverty cycle • Group thinking • Inexperienced population • Ineffective warning systems • Risk myopia • Geographical determinants of risk • Everyday risks • Increasing risk activities • Temporary vs permanent migration • Community approach vs individual households	➢ Socio-economic conditions of risk ➢ Community lethargy ➢ Structural factors ➢ Conscious choice to live in high-risk areas ➢ Environmental determinants of exposure	➢ Surprise nature of event ➢ Localised conditions of risk ➢ Passive communities ➢ Constrained choice situations
2	• State preparations • Lack of leadership • Lack of organisation and structure • Ineffective communication between government levels • Lack of awareness • Response delays • Short-term focus • Fears of corruption • Inexperienced state actors • Prioritisation of aid • Poor land controls • Shift to prospective DRR	➢ Poor vertical/horizontal integration ➢ Effects of 2015/16 non-event ➢ Technological effectiveness ➢ Historical learning ➢ Importance of local actors ➢ Effects of centralisation ➢ Peri-urban vs rural differences ➢ State influence of risk activities	➢ Ex ante vs ex post actions ➢ Rural cohesion ➢ Lack of clear direction ➢ Institutional 'silos' ➢ Predominant short-term focus
3	• Short-term focus • Technological/visible focus • Societal transition • Changing point • Need for land controls • Erosive vs non-erosive strategies • Vulnerability of key services • Event timing • Importance of community involvement • Long time-scale for recovery • Exception of Chosica • Levee effect • Need for relocation	➢ Rapid return to normalcy ➢ Underlying localised drivers of risk ➢ Shift to long-term thinking ➢ Lack of public safety net ➢ Difficulty of relocation ➢ Holistic responsibility	➢ High-risk choices ➢ Disasters not a priority ➢ Lengthy recovery period ➢ Lack of long-term vision ➢ Visibility vs necessity ➢ 2017 as a turning point

Appendix 4: Demonstration of hand coding.

1. *What do you think determines the strategies that homes/communities are taking before and after a disaster in the Rimac River Basin?*

Their strategies are determined by whether they have been places where prevention or preparation projects have been worked
- these projects have been implemented by public and private institutions, but do not cover all areas affected by flooding
- many affected sites that have not been considered for the delivery of these projects maintain the same or worse conditions of vulnerability to new flooding.

[handwritten: PRIORITISATION OF AID]

Some communities experience disasters more than others. Practical Action works with communities in higher frequency areas. If intense floods are only every 5-7 years – community increasing risk activities in these areas → higher exposure to disasters → when an intense flood does happen the damage is much greater *[handwritten: ↑RISK ACTIVITIES]*

Institutional response - communication – when population is affected and isn't doesn't receive support. *[handwritten: LACK OF GOVT COMMUNICATION]*

Education and information are most important for influencing community actions – responsibility of municipality

[handwritten: LACK OF STRUCTURE] Responsibilities of municipality/organisations is murky

History of land invasions into dangerous areas – squatters rights (10 years if someone else claims land, 5 years if no one does) *[handwritten: POOR LAND CONTROL]*

2. *How can these strategies vary for different sections of the basin? (For example, peri-urban and rural areas)*

There are areas in the middle of the basin (Carapongo and Huaycoloro) where the flood was related to irrigation infrastructure that came out of the river towards agricultural field
- in these areas the inhabitants have assumed that when these were repaired and the construction of the new road (second stretch of the Ramiro Prialé Highway) they are no longer at risk or that the risk has decreased and are not taking forecasts for new events *[handwritten: LACK OF AWARENESS/ ↑RISK ACTIVITIES]*
- In the part near Chosica, where flooding is more recurrent the population tends to take preparation processes more seriously in the face of seasonal flooding.

In rural areas in the Sant Eulalia sub-basin, producers, most of the time have their farmland in spaces less exposed to flooding. *[handwritten: ↑AWARENESS IN RURAL AREAS]*

[handwritten: POOR LAND CONTROLS] In the area of Callahuanca and Santa Eulaila the banks of the river have been occupied by local weekend fun, country recesses, or cottages of people coming from Lima
- those buildings have invaded the river channel and many of them were destroyed in 2017
- despite this they are being rebuilt in the same place occupying even more river grounds taking advantage of the government's prevention works having built a channel in the central part of the floodplain. *[handwritten: GOVT POLICY ↑RISK ACTIVITIES]*

3. Do you think communities in the Rimac River basin actively consider their risk of disaster?

RISK MYOPIA

Some communities, especially those linked to agriculture and communities exposed to seasonal hazards, but the other communities, which are only affected by floods related to extreme hydrometeorological events, which are regularly 3, 5 or more years old, do not consider their risk of disasters actively

4. Do you think there is an illusion of safety in the Rimac River basin from technological interventions? (e.g. rock walls, geodynamic meshes)

LEVEE EFFECT

Yes. Even in areas exposed to seasonal events, (every rainy summer) the idea persists that infrastructure works, many of them deficient or designed for minor events, free them from risk, often the agenda of leaders and politicians local is to increase the construction of preventive infrastructure, walls, dykes, rock walls on the margin of the river etc

5. Do you think flood disasters are becoming more urban in Peru?

POOR LAND CONTROLS

Yes. The growth of cities is not being planned, the old urban nuclei, usually located in areas of low risk of flooding (hills, headlands, plateaus etc.) expand from that center to spaces that were not occupied in the past by their distance or by their proponsion to floods or land instability

Now those spaces make an urban contunium, the little control of the use of land is not only in the occupation of risky areas but also in the very condition of the buildings, which do not conform to local conditions and do not provide safety to their occupants. **LACK OF REGULATION / ENFORCEMENT**

6. How might disaster risk management strategies in the Rimac River basin have to change with continued urbanization and population growth?

There is currently no strategy to for the Rimac basin

LOCALISED CONDITIONS OF RISK

If there was it would have to differentiate the urban areas from the middle and lower and the rural areas of the upper basin, formulate sub-strategies for each environment and monitor its level of progress and implementation. **NEED FOR LOCAL APPROACHES**

What does currently exist are isolated initiatives that try to see the integrality of the problem, but there are situations such as district division that prevent the implementation of plans that go beyond unarticulated local elements **INEFFECTIVE COMMUNICATION ACROSS GOVT LEVELS**

7. Do you think Peru is moving beyond an "emergency" mentality?

(not related to the concept)

8. Do you think the current disaster risk management system in Peru is too decentralized?

POOR LAND CONTROL/ REGULATION

It is not decentralized, it is a disaggregated system. The different responsibilities have been distributed into a number of institutions of various levels where the ultimate responsibility for, for example, the declaration of an area as a HIGH RISK NOT MITIGABLE, never gets there. And after this declaration, the execution of actions on that territory is attributed to the municipalities or local governments to which these areas correspond. The system is not effectively articulated to achieve results. **LACK INSTITUTIONAL SILOS**

9. *What do you think can be done to help communities in the Rimac River basin get out of the cycle of poverty?*

LAND VALUE

Not all flood-exposed communities in the Rimac river basin are in poverty. Many of these communities are made up of people who have other land or have the option to occupy other less risky areas, but the rivers of the rimac river offer comparatively higher features than others as accessibility to the main roads, that makes them a precious asset

CONSCIOUS CHOICE TO LIVE IN HIGH-RISK AREAS

POOR LAND CONTROLS

Therefore, despite the fact that many of the families are informal or illegal occupants of those lands (they occupy some lands cattle filling the river with building materials from other areas, other families occupy the grounds of the margial girdle of the river that is land belonging to the State and that is there as an area of public domain) it is for this reason that families occupy very precariously those lands, subjected to conditions of poverty and little access to public services such as drinking water, drains or public cleaning services.

INCREASING RISK ACTIVITIES

It is necessary for the State at its various levels of government to prevail the risk rating of the land adjacent to the river and to initiate a process of relocation and/or eviction of the occupants. From this the risk of the areas not surrounding the river that were flooded in 2017 would reduce as the bed of the river could be reduced so that it does not flood into upcoming events of heavy rains.

NEED FOR RELOCATION