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How does climate change affect human behavior?

Empirical evidence from three of the most exposed regions to rising sea-levels: Solomon Islands, Bangladesh, and Vietnam.

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Dokumentation der Ko-Autorenschaft

Die Kapitel 1 und 5 habe ich in Alleinautorenschaft verfasst.

Kapitel 2 wurde zusammen mit den Ko-Autoren Björn Vollan und Matthias Mayer konzipiert und verfasst. An der Konzeption der Studie waren alle Autoren beteiligt und die Datenerhebung, -aufbereitung und -analyse wurden von Matthias Mayer und mir durchgeführt. Das Kapitel wurde in Zusammenarbeit mit Matthias Mayer verfasst und mit Björn Vollan abgestimmt. Daher sind 50% der Autorenschaft dieses Kapitels mir anzurechnen.

Kapitel 3 wurde zusammen mit Adam Henry, Björn Vollan, Andreas-Egelund Christensen und Rebecca Hofmann konzipiert. Adam Henry hat das gemeinsam entwickelte Framework in einem Agenten basierten Modell umgesetzt und die Daten simuliert. Das Fallbeispiel wurde von Andreas-Egelund Christensen beigetragen. Der Rest des Artikels wurde in Zusammenarbeit mit Björn Vollan verfasst. Daher sind 20% des Artikels meiner Autorenschaft anzurechnen.

Kapitel 4 wurde zusammen mit Björn Vollan entworfen. Björn Vollan und ich haben die Studie konzipiert und die Experimente entworfen. Die Daten wurden von mir und in Zusammenarbeit mit Matthias Mayer erhoben. Die Datenanalyse wurde von mir durchgeführt und das Kapitel wurde von mir verfasst in Abstimmung mit Björn Vollan. Daher sind 90% dieses Kapitels meiner Autorenschaft anzurechnen.

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Notes: All participants and assistants that are shown in the picture were asked for their consent.

Zusammenfassung

Diese kumulative Dissertation umfasst vier Essays die sich mit dem komplexen Nexus der Klimamigration auseinandersetzen. Um sich mit der Komplexität auseinandersetzen zu können, wird eine verhaltensökonomische Perspektive eingenommen, welche die individuellen Entscheidungen in den Mittelpunkt der Analyse rückt um das Verhalten von Menschen, die besonders vom Klimawandel betroffen sind besser zu verstehen. Die vier Aufsätze in dieser Arbeit decken ein breites Spektrum von Methoden ab, einschließlich quantitativer Umfragen, ökonomischer Experimente und modellbasierten Simulationen. Die Daten wurden zwischen 2017 und 2019 in drei der am stärksten vom Meeresspiegelanstieg betroffenen Küstenregionen und tiefliegenden Inselstaaten erhoben: den Salomonen Inseln, Bangladesch und Vietnam. Eine der wichtigsten Innovationen, neben dem verhaltensökonomischen Ansatz, ist die Studie von Menschen, die sich bezüglich ihrer Exposition der Einflüsse des Meeresspiegelanstiegs unterscheiden. Die Umfragen und Experimente wurden mit Menschen innerhalb der jeweiligen Region durchgeführt, welche mehr und weniger von den Auswirkungen des Meeresspiegelanstiegs betroffen sind. Dieser Ansatz stellt sicher, dass die Teilnehmenden sich bezüglich anderer Merkmale (soziale, wirtschaftliche, kulturelle oder historische) nicht so stark unterscheiden. Ein solcher Ansatz ermöglicht es, die Realität der Klimamigration zu testen, indem er ein vollständiges Bild der Präferenzen, Motivationen, Lebensumstände und Handlungen von Menschen zeigt, die potentielle Klimamigranten sein könnten.

Der erste Aufsatz legt die konzeptionelle Grundlage für die vorliegende Dissertation. Es wird ein verhaltensökonomisches Framework zur Untersuchung der individuellen Anpassung an den Klimawandel vorgestellt, der auf zwei etablierten Frameworks aus dem Bereich der Psychologie- und Migrationsforschung basiert und verhaltensökonomische Erkenntnisse hinzufügt. Dieses Framework legt den Fokus auf Entscheidungsfindung und Informationsverarbeitung, um die Variabilität und Unterschiede aufzuzeigen, die bei Anpassungsentscheidungen bereits auf der individuellen Ebene auftreten können. Migration wird von uns als eine von vielen Anpassungsstrategien in einer dynamischen Welt, in der Rückkopplungseffekte von Anpassungsmaßnahmen auf verschiedenen Ebenen (lokal bis global) betrachtet werden. Ziel dieses Frameworks ist es, ein gemeinsames Verständnis des Anpassungsprozesses zu vermitteln, was Forschern hilft den komplizierten Zusammenhang zwischen Klimawandel und Anpassung in kleinere Fragestellungen zu zerlegen, die explizit untersucht werden können. Die empirischen Belege zeigen, dass Befürchtungen einer Massenmigration als Reaktion auf den Meeresspiegelanstieg wenig begründet zu sein scheinen, zumindest im asiatisch-pazifischen Raum. Daraus ergeben sich allerdings neue Herausforderungen, die es zu berücksichtigen gilt. Ein besseres

Verständnis der Verhaltenshindernisse für unterschiedliche Anpassungsmaßnahmen könnte politischen Entscheidungsträgern in den betroffenen Ländern helfen besser zu planen, welche Art von Hilfe sie wann, wie und wo leisten müssen.

Der zweite Aufsatz setzt sich mit der Thematik auseinander, welche positiven und negativen Einflüsse klimabedingte Migration auf die Umwelt und das Wohlbefinden der Menschen haben könnte. Um diese Auswirkungen zu verstehen, ist es entscheidend, Veränderungen in den Präferenzen der Menschen als Reaktion auf die Auswirkungen des Klimawandels zu untersuchen. Eine entscheidende Präferenz für die nachhaltige Nutzung natürlicher Ressourcen ist der Grad, in dem man die Zukunft diskontiert, d.h. wie viel mehr Wert man darauf legt Ressourcen heute zu nutzen als in der Zukunft. Empirische Ergebnisse zeigen, dass ungeduldigere Menschen eher dazu neigen natürliche Ressourcen zu übernutzen als geduldigere. In diesem Aufsatz wird untersucht wie sich Migration und ein stärkerer Gegenwartsfokus, welcher durch neue Informationen über die Verschlechterung der Lebensbedingungen durch den Meeresspiegelanstieg auf kleinen Inselgemeinschaften definiert wird, auf die Nutzung von natürlichen Gemeinschaftsressourcen auswirkt. Als Ansatz wird ein agentenbasiertes Model genutzt um diese Auswirkungen zu simulieren, welcher zusätzlich noch durch eine Fallstudie unterstützt wird und die Begebenheit einer Übernutzung von Gemeinschaftsressourcen auf den Salomonen zeigt. Die Ergebnisse zeigen, dass ein verstärkter Gegenwartsfokus als Reaktion auf Klimaveränderungen zu einer schnelleren Ressourcenerschöpfung führt. Migration erhöht den Druck auf natürliche Ressourcen in den Migrationszielen zusätzlich, insbesondere wenn die Leute langfristig ungeduldiger bleiben. Diese Erkenntnisse zeigen, dass ein erhöhtes Umweltbewusstsein nicht zwangsläufig nachhaltigere Verhaltensweisen fördert und Vorsicht bei der Kommunikation, sei es durch Medien oder die Regierung, von Klimaeinflüssen geboten sein sollte um einen Zusammenbruch der natürlichen Gemeinschaftsressourcen nicht noch zu beschleunigen.

Der dritte Aufsatz setzt sich mit der Thematik auseinander, wie der steigende Meeresspiegel sich auf pro-soziale Verhaltensweisen auswirkt und damit den Zusammenhalt in betroffenen Gemeinden beeinflusst. Pro-soziales Verhalten ist ein wesentlicher Faktor für die Zusammenarbeit in solchen Gemeinden um z.B. öffentliche Güter bereitzustellen oder die Nutzung von Gemeinschaftsressourcen zu kontrollieren. Wenn pro-soziale Verhaltensweisen unter potenziellen Klimamigranten zusammenbrechen würden, könnte dies zu Konflikten um natürliche und soziale Ressourcen führen und damit zu schnelleren Migrationsbewegungen führen. Um diese Fragestellung zu untersuchen, wurden Feldexperimente mit Betroffenen durchgeführt, die aufgrund des steigenden Meeresspiegels schon bald umsiedeln könnten. Die Forschungsstrategie ist dabei zweigleisig. Zuerst werden Personen untersucht, die mehr und weniger den negativen Auswirkungen des Meeresspiegelanstiegs ausgesetzt sind, basierend auf der geografischen

Lage und einer selbst bewerteten Risikoeinschätzung. Zweitens manipulieren wir experimentell die Präsenz der Auswirkungen und potentiellen Konsequenzen für die Teilnehmenden Diese schauen nach dem Zufallsprinzip entweder ein dreiminütiges Video, das die Auswirkungen und Folgen des Meeresspiegelanstiegs zeigt, oder ein neutrales Kontrollvideo.

Beide Ansätze zeigen, dass Betroffene pro-sozialer gegenüber anderen Menschen ihrer Gemeinschaft werden in Reaktion auf eine möglicherweise unausweichliche Umsiedlung. Dieser Verbundenheitseffekt ist stärker für Teilnehmenden die sich mehr mit ihrer Heimat identifizieren, abgeschwächt durch negative Emotionen und nicht getrieben von den Erwartungen, dass die Gemeinschaft zusammen umgesiedelt wird. Diese Ergebnisse haben zwei entscheidende Implikationen. Erstens scheint die Konzentration auf Weltuntergangsszenarien von sinkenden Inseln und Massenmigration nicht gerechtfertigt zu sein, zumindest momentan nicht als Reaktion auf einen steigenden Meeresspiegel im asiatisch-pazifischen Raum. Zweitens, während es gut ist, dass pro-soziale Verhaltensweisen nicht zusammenbrechen, könnte dies dazu führen, dass Menschen versuchen sich an Ort und Stelle anzupassen, obwohl dies nicht möglich ist. Dies könnte einen Teufelskreis schaffen, in dem Betroffene ihre begrenzten Ressourcen für Anpassungsmaßnahmen verwenden, was sie letztendlich von Hilfe von Außenstehenden abhängig machen könnte.

Der letzte Aufsatz ist ein experimenteller Beitrag, der sich mit dem Thema auseinandersetzt, wie sich eine verkürzte zeitliche Perspektive auf kooperatives Verhalten auswirkt. Oft leiden soziale Interaktionen darunter, wie z.B. hohe Fluktuationsraten in Unternehmen zeigen, wo Angestellte nicht mehr wirklich motiviert sind in den letzten Monaten bevor sie bei einem neuen Arbeitgeber anfangen. Empirische Ergebnisse mit Studierenden zeigen, dass mehr kooperiert wird, wenn es nicht bekannt ist, wann die soziale Interaktion endet. Diese Resultate stehen im Einklang mit der Theorie, in welcher dieser Effekt als "Schatten der Zukunft" bezeichnet wird. In diesem Beitrag wird ein sequentielles Dilemma verwendet, um Vertrauen und Vertrauenswürdigkeit unter zwei Bedingungen zu vergleichen. Erstens, wenn die Teilnehmenden wissen, dass sie nur einmal miteinander interagieren, und zweitens, wenn sie mehrere Interaktionen erwarten. Die wichtigste Neuerung dieses Aufsatzes ist, dass die Teilnehmenden tatsächlich Erfahrungen mit täglichen sozialen Interaktionen haben, die unter einem abnehmenden "Schatten der Zukunft" leiden. Dies hilft eine breitere empirische Basis zur Theoriebildung von menschlichem Verhalten zu schaffen, die über Studierendenpopulation aus einkommensstarken Ländern hinausgeht.

Die Ergebnisse zeigen, im Gegensatz zur Theorie und Empirie, dass Erwartungen von mehreren Interaktionen weder Vertrauen noch Vertrauenswürdigkeit erhöhen. Eine überzeugende Erklärung für diese Ergebnisse könnten die engen Beziehungen zwischen

den Teilnehmenden in den Feldexperimenten sein, was die Erwartung erhöhen könnte weitere Interaktionen außerhalb des Workshops zu haben. Allerdings verhalten sich die Teilnehmenden in Workshops mit einem höheren Anteil an Freunden und Verwandten nicht anders, als in Workshops mit weniger Freunden und Verwandten. Diese Ergebnisse liefern vorläufige Evidenz, dass rückwärtige Induktion als Mechanismus zur Entstehung von Kooperation nicht zwangsläufig relevant sein muss. Die Teilnehmenden scheinen weniger strategisch besorgt zu sein, was möglicherweise durch starke soziale Normen und ein anderes Zeitkonzept erklärt werden könnte. Dabei stellen diese Ergebnisse die Verallgemeinerbarkeit der vorhandenen Evidenz aus Ländern mit hohem Einkommen in Frage.

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Chapter 1: Synopsis – Challenging the climate change migration nexus

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1.1 Introduction

Human behavior has become the primary force in shaping the earth's environment since the industrial revolution. This lead researchers to conclude that we have entered a new geological epoch – the Anthropocene (Crutzen, 2006; Steffen et al., 2007). The challenges for the 21st century will be to deal with the changes already locked in by our past actions and to figure out how to use our influence on the world responsibly. There is compelling evidence that shows our impacts, for example, the rapid loss of wildlife (Ceballos et al., 2015), massive plastic patches in oceans (Cole et al., 2011) or our impact on water systems through dams (Haddeland et al., 2014). Most importantly, we altered the earth' atmosphere. Greenhouse gases we emitted over the last century are causing alterations of the world's climate (IPCC, 2014a, 2014b) that will require substantial efforts to protect the livelihoods of millions of people across the globe (Stern, 2008). Human behavior is not only central for causing these changes but also how we are going to respond and adapt to these changes. Climate has been historically the deciding factor for human development and migrations (Lamb, 1995) and will be ever more decisive in the future given people's increasing vulnerability to climate change impacts. Especially coastal areas have been identified as being vulnerable due to rising sea-levels potentially displacing millions of people (Church et al., 2013; Nicholls and Cazenave, 2010; Vitousek et al., 2017), with the most visually and emotional case of "sinking" low-lying islands in the near future (Storlazzi et al., 2018). According to the Internal Displacement Monitoring Centre, there have been 18 million people internally displaced by disasters (mostly storms) in 2018 (IDMC, 2019)

In the case of sinking islands, we can clearly identify that sea-level rise will be the primary driver for forced movements due to the degradation of the local environment, which threatens people's well-being and livelihoods. However, the identification of climate migrants is less evident in other regions where people are exposed to a mixture of climate and human-induced hazards. Migration is always a multi-complex decision problem of various push and pull factors, where climate change impacts add another layer of complexity. This complexity can be seen in the fuzziness and a multitude of terms and

definitions describing the same phenomenon[1]. In the following, I will use the term "climate migrant" when referring to movements related to climate change impacts. The International Organization for Migration (IOM) definition[2] of climate migrants is too broad ("movements within and across borders, fast and slow onset events, duration") and imprecise ("predominantly for reasons due to climate change"), that it is not a useful concept for analytical purposes, e.g. estimating and projecting climate migrants.

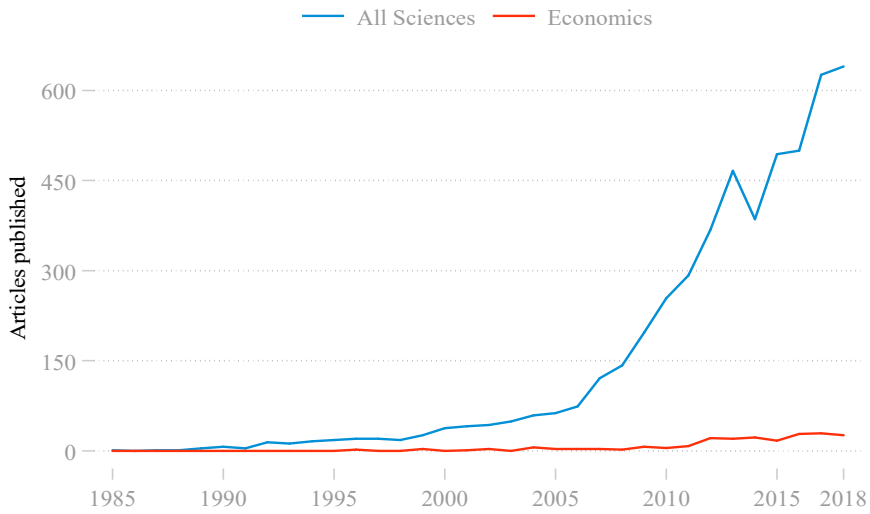
While the research of biophysical impacts of climate change has made tremendous progress over the past decades, much less is known about how climate change affects human behavior. The first projections of millions of "climate refugees" until 2050, put forward by environmental scientist Norman Myers (Myers, 2002, 1997; Myers et al., 1995) have been criticized for their methodological and conceptual foundations by many scholars (for an excellent overview of why his numbers do not add up, see Gemenne, 2011)[3]. Despite their flaws, Myers' estimates have gained significant authority in the research community, being among the most cited climate migrant numbers in articles to motivate research on the climate change migration nexus (CCM nexus). Over the years, these numbers have become, through repetition, a "scientific truth" and potentially contributed to the increasing research on CCM nexus. Figure 1.1 shows the growing research interest in the CCM nexus since 1985 for science in general, as well as economics in particular. The general research interest has sped up since the early 2000s peaking at 640 publications per year in 2018, while publications in economics were still scarce (29 in 2017).

[1] Environmental migrant is the overarching term used for any migration related to environmental degradation. For climate migration the following terms are or have been used among various actors and time: climate or climate change refugee, forced climate migrant, climate motivated migrant, climate displaced person, disaster refugee, ecological refugee to be, …

[2] The IOM working definition for "climate migration" reads as follow: "The movement of a person or groups of persons who, predominantly for reasons of sudden or progressive change in the environment due to climate change, are obliged to leave their habitual place of residence, or choose to do so, either temporarily or permanently, within a State or across an international border." (IOM, 2019). It is not a legal standard and used by the IOM to raise awareness of the issue.

[3] His predictions are based on exposure mapping (exposure to a hazard and population growth in exposed areas), assuming that everyone who will be exposed to an impact will automatically move away. Such a static view of society abstracts from people's willingness to adapt and their ability to invent adaptation strategies that raise the threshold for bearable limits of exposure.

Figure 1.1 Evolution of research interest in the CCM nexus



Notes: The data was retrieved from dimensions.ai covering research articles in all sciences and economics between 1985 and 2018. Abstracts and titles of articles were searched for the following combination of keywords: "Climate Change" and "Migration" or "displacement" or "resettlement" or "relocation".

Although more recently researchers carefully acknowledge that Myer's predictions are flawed and that the relationship in the CCM nexus is much more complex, many continue their research on the topic assuming a direct relationship between climate change and migration, producing new research articles without improving our understanding of the climate migration relationship. Ecologic fallacies, where one draws a conclusion from correlations at the national level for the individual (Piguet, 2010), are common in many studies using a macro-economic approach (Backhaus et al., 2015; Berlemann and Steinhardt, 2017; Cattaneo and Peri, 2016; Coniglio and Pesce, 2015). Such studies are informative about general equilibrium effects around the CCM nexus, but little can be learned about the individual level from these results. Such studies should not be the only cornerstone of economic research on the CCM nexus, as the people behind projected numbers are most likely not the same people that are actually suffering from the detrimental impacts. Therefore, it is also essential to understand the different motivations for why people are staying. When it comes to climate migration, we want to understand all the mediating, moderating, and enhancing factors at the individual level that are important for policymakers to develop the rights tools. This is of particular relevance, as approaches using abstract models of cross border climate migration seem at odds with the reality and concerns of people living in affected regions[4]. In case migration is inevitable, most

[4] In fact, case studies from coastal communities that experience an effective sea-level rise of over 1 meter due to land subsidence have been able to adapt and stay (Esteban et al., 2019). The case study by Jamero et al. (2017) shows that people from four Filipino islands that experience relative sea-level rise exceeding the projected interval of the IPCC (1 to 4 feet by 2100) because of land subsidence due to a large earthquake in 2013, prefer to stay and adapt in place. These people adjusted their lives to up to 135 flooding days a year, despite having the option to move to a relocation settlement on the mainland provided by the government.

movements have been theorized to be of short distance (Ravenstein, 1889) and recent estimates and projections show that most people will move within borders (Rigaud et al., 2018).

It is problematic when researchers continue to take alarmist numbers of climate migrants as scientific truths. Research findings are often communicated less critically by the media to the broader public[5]. Thereby, they are indirectly shifting the societal discussion and worldviews towards doomsday scenarios of mass migrations in response to climate change. Such a focus puts politicians in a position to suggest solutions, such as stricter immigration policies, to dampen fears of "waves" of climate migrants coming to high-income societies, in a time where immigration already led to a right-shift of political attitudes in high-income countries (Edo et al., 2019). In addition, alarmist projections by researchers have helped various actors to pursue their agendas, such as anti-asylum lobbies in high-income countries that push for stricter immigration policies using the concept of "environmental refugees" (Kibreab, 1997). But also, NGOs and intergovernmental organizations like the IOM, UN, and OECD have been using these numbers to raise awareness of the issue, which might not be a sustainable strategy in the long-term.

In this dissertation, I will present a behavioral approach, putting individual decision making at the center of the analysis. The four essays aim to break-down the complexity of the CCM nexus to derive specific and testable links between climate change and the decision to migrate or stay. They cover a wide range of methods, including quantitative surveys, economic experiments, and modeling techniques. The data has been collected as part of the Robert-Bosch funded research project[6] conceived by Björn Vollan. The fieldwork took place between 2017 to 2019 in three of the most affected coastal regions to rising sea-levels in the Asian-Pacific region: Solomon Islands, Bangladesh, and Vietnam. One of the major innovations, besides the behavioral approach, is to study populations at risks that differ in their exposure to sea-level rise (SLR). We conducted the surveys and experiments with people that are more and less exposed to the impacts of SLR in each region, but otherwise do not differ much regarding social, economic, cultural or historical aspects. Such an approach allows testing the reality of the CCM nexus by showing a complete picture of the preferences, motivations, livelihood circumstances, and actions of people who fulfill the apparent preconditions for being future climate migrants. In the following, I summarize each of the four papers and highlight their contributions to the literature.

[5] More news stories are now being published about climate change and migration focusing on a few key events (such as sinking small island states), for example by the Guardian, New York Times, CNN or BBC. For an overview of the news coverage of climate-induced migration in the major news outlets of the UK, see Mayer and Crépeau (2017).

[6] The project for the Robert-Bosch Junior Professorship is called "The shadow of the future and the shadow of the past: Studying the impact of climate change on human behavior".

1.2 A behavioral framework to study climate-change adaptations

The first paper – which is joint work with Matthias Mayer and Björn Vollan - builds the conceptual basis for the thesis. We argue that the existing research on climate-induced migration overemphasizes migration as a response to an exogenous risk (i.e. push) and pull factors at destinations. In this paper, we take on a people-centered approach with a particular focus on decision-making and information processing informed by psychology and behavioral economics to demonstrate the variability and differences that can already occur on the individual level. Our intent is not to ridicule the emphasis on macro-level changes, but rather to highlight the importance of the somewhat neglected individual at the micro-level.

The main contribution of this paper is to synthesize existing frameworks and insights from different studies to move beyond a static world view towards a dynamic representation of climate-induced adaptations. We introduce a behavioral framework to study climate change adaptation that builds on two established frameworks in the literature (Black et al., 2011; Grothmann and Patt, 2005) and add insights from behavioral economics (endogenous preferences). We consider migration as one out of many adaptation strategies in a dynamic world, where feedback effects of adaptation actions at different scales (individual to global) are considered. The goal of our framework is to provide a shared understanding of the adaptation process that helps researchers to break down the complicated relationship between climate change and adaptation into testable parts that can be rigorously investigated while having a template to clearly communicating the necessary assumptions and simplifications made.

In addition, we show empirical evidence to highlight the framework's predictive power in the context of rising sea-levels. We conducted surveys with 1325 people living on low-lying islands in the Pacific and coastal Deltas; 715 Solomon Islanders, 247 Bangladeshis, and 363 Vietnamese participated overall. We find that our behavioral models significantly out-perform baseline models that only include objective measures of risk exposure and socio-economic capacities in explaining climate change impacts and risk appraisal, as well as the intentions to move or stay and adapt locally. Indeed, most respondents intend to stay and adapt locally, especially the ones that are relatively more exposed to the adverse impacts caused by SLR. These intentions seem at odds with the respondent's high climate change impacts appraisal and to a lesser degree risk assessment. However, we identify intervening factors that can potentially explain this perception-intention gap, such as believes that outside organizations (government or NGOs) will help them deal with the impacts caused by climate change and respondents' strong attachment to their homes. Lastly, we show with the data from Solomon Islands that while migration can decrease vulnerability and increase access to better jobs and health facilities can lead to changes in culture and social cohesion.

This paper highlights the importance of behavioral and psychological factors shaping adaptation strategies. Fears of mass migration as a response to SLR then seem less substantiated, at least in the Asian-Pacific region, and different challenges arise that need to be considered. Understanding the behavioral hurdles to (non-) migration could help policymakers in affected countries to get a better grasp of what kind of assistance they have to provide. On the one hand, getting a better sense when, from where, and how many people in certain regions are planning for pro-active migration[7] helps policymakers to redirect investments (schools, housing, hospitals, jobs, etc.) to ease such movements. On the other hand, many people do not want to leave their homes and try to adapt in dangerous environments. This could potentially lead to a climate-induced poverty trap, where (1) people as a result of being struck by disaster lack the funds to migrate from highly exposed regions or where (2) less affluent people settle in risky areas as they become more affordable. In both cases, people's already limited capacities would be further diminished by repeatedly suffering from climate events over time. If cost-efficient adaptation strategies are available, these could be provided or promoted If relocation is inevitable, development of relocation programs must start well in advance in collaboration with affected communities to give justice to their needs and preferences. For government officials, this might be just one more administrative task, but for the people being resettled, this is probably one of the most critical decisions in their life's. Many governments in low- to medium income countries already struggle to provide access to quality public goods. Burden-sharing requires high-income countries to fulfill their pledges in climate finance towards the 100 billion-goal in 2020 and that they might need to re-think of allocating more than one-fifth of this budget for adaptation (OECD, 2016).

1.3 Influence of sea-level rise induced impatience on resource use and migration

People migrating in response to climate change may affect the natural systems people are migrating from and migrating to. In order to understand these impacts, it is crucial to study changes in preferences in response to climate change impacts. Traditionally, economists treat preferences as fixed. This implies that preferences stay unaltered in economic models, even if individuals witness life-changing events. However, recent empirical evidence shows that preferences are systematically affected by natural disasters (Brown et al., 2018; Callen, 2015; Cassar et al., 2017) or conflicts (Bauer et al., 2016; Callen et al., 2014). Beyond, preferences have been shown to be shaped by society, institutions and culture (Benjamin et al., 2010; Bowles, 1998; Fehr and Hoff, 2011; Wang et al., 2016). One crucial preference for the sustainable use of natural resources is the degree

[7] Most people move from rural areas to close by urban centers (Henderson et al., 2017; McGranahan et al., 2007).

to which people discount the future, i.e. how much more they value having resources today than in the future. For example, fishermen that are more impatient have been found to use fishnets with smaller mesh sizes, thereby exploiting the fishing grounds more intensively than more patient fishermen (Fehr and Leibbrandt, 2011).

In the second paper – which is joint work with Henry, Egelund-Christensen, Hofmann, and Vollan – we investigate how more substantial discounting of the future and stresses common-pool resources (CPRs) in small island communities. As a response to SLR, higher discounting can be a rational response due to the degradation of the environment that causes uncertainty whether the resources will be available in the future. We illustrate the importance of discounting through a theoretical agent-based model (ABM) of resource use in small-island communities. The intuition of the theoretical model is illustrated with a case study that shows the collapse of a CPR due to short-sighted behavior in Solomon Islands. Our simulation results show that higher discounting as a response to an information shock (e.g. an extreme weather event) is likely to speed depletion of the CPR and increase agents well-being in the short-term. This additive well-being could be used to finance migration to a physically safer place. Allowing agents to migrate away from their home island after experiencing the information shock, decreases pressures on the local CPR (fewer users) but increases them on the destination islands, even more so if the migrants bring their higher discount rates with them. Migration, thereby, accelerates the depletion of CPRs compared to the situation where they have to remain on their home island.

This paper highlights how changes in discount rates in response to climate change can fasten resource depletion. This, in turn, alters the timing and magnitude of migration patterns and environmental pressures in migration destinations. Such behavioral economic insights need to be accounted for in global climate change models (Nordhaus, 2014; Stern, 2008), as they otherwise provide policy-makers with biased predictions for decision-making. The theoretical ABM could be applied in order to understand real-world systems through parameterization (though a vast amount of data from field research would be required) and could be of interest for policymakers when one extrapolates these observations from a sample of islanders to entire regions encompassing many islands. Thereby, the model highlights the value of multi-method and interdisciplinary field research, as data to train these models can only come from such research. One could use, for example, lab-in-the-field experiments that are conducted with a representative subject pool to measure how preferences respond to climate change impacts. Additionally, survey methods could be used to collect data on social networks, desirable migration destinations, climate change perceptions and loss of cultural identity, social norms, and values. Lastly, contrary to the conventional wisdom that increased environmental awareness promotes more sustainable behaviors (Henry and Dietz, 2012; Stern et al., 1995), insights from the

theoretical model show that it could speed resource collapse. Thus, governments and organizations should be careful in the way they craft and communicate messages about climate change.

1.4 Pro-social behavior, displacement risk, and migration

Healthy communities are characterized by social norms of trust and cooperation as well as social networks that control individual resource extraction strategies (Ostrom, 1990). Pro-social behaviors are essential drivers of cooperation in communities to provide public goods and control natural resource use, such as managing mangroves forests or fisheries (Fehr and Leibbrandt, 2011; Ostrom, 1990; Rustagi et al., 2010). If pro-social behaviors would break-down among potential climate migrants, this could cause conflict over natural and social resources and thereby lead to faster migration. Understanding the effects on pro-social behaviors caused by the displacement threat can help us qualify people's readiness to migrate and whether the focus on "waves" of climate migrants in the media and public discourse is warranted.

The third paper – joint work with Björn Vollan – uses lab-in-the-field experiments to study whether pro-social behaviors are breaking down when people face the prospect of displacement. Our research strategy is twofold. First, we sample people that are more and less exposed to the adverse effects of SLR based on geographical location and self-evaluated exposure proxies. Second, we experimentally manipulate the salience of SLR impacts and consequences of participants. Participants are randomly assigned to either watch a three-minute video showing the impacts and consequences of SLR or a neutral control video.

Engaging in pro-social behaviors depends on the possibility for future interactions with other community members, reputations among them, and past interactions. The effect could go either way. On the one hand, game theory predicts that repeated interactions can promote cooperative behavior when there is uncertainty about the number of interactions, and people are sufficiently far-sighted (Fudenberg and Maskin, 1986). Laboratory experiments indeed show that people cooperate more under uncertainty (Blake et al., 2015; Dal Bo, 2005; Dal Bó and Fréchette, 2018). When people live under circumstances in which SLR threatens their homes, there is less uncertainty about the number of interactions with their fellow community members. Based on this line of argumentation, we would expect that pro-social behaviors break-down. On the other hand, we know that people are not always rational but guide their behavior based on emotions and social norms. Case studies highlight that people are strongly attached to their homes and communities, which makes them prefer local adaptation strategies to avoid resettlement (Esteban et al., 2019; Laurice Jamero et al., 2017). If these non-strategic factors outweigh the strategic and rational calculations, pro-social behaviors could be strengthened under the threat of SLR.

Our results show that pro-social behaviors do not break-down. Both participants who watched the video and live in more-exposed places are more pro-social towards their in-group. The effect is stronger for more attached participants, dampened by negative emotions and not driven by participants' expectations to be resettled together with their community. These results have two crucial implications. First, the focus on doomsday scenarios of sinking islands and mass migration in response to climate change seems not justified, at least in response to SLR in the Asia-Pacific region. Second, while it is a plus that pro-social behaviors do not break-down, this could lead to people trying to adapt in place when this is not feasible in the long-term. This could create a vicious cycle where people waste their limited resources on adaptation measures, stripping them of resources for adaptive migration that ultimately leads them to be dependent on outsiders (governments, NGOs) to help them resettle to avoid displacement. The priority must be to develop anticipatory regimes, provide compensation, and offer institutional support for those that are suffering from the adverse effects of climate change. Such schemes must be developed timely and adhere to the dignity and preferences of people who are not responsible for their situation to ensure both physical and social safety.

1.5 Cooperation and repeated interactions

Many social-interactions suffer from a short-lived time perspective which leads people to act in their self-interest, being it high turnover-rates in firms, politicians focusing on being re-elected or interactions on social media. The last paper challenges the findings of laboratory experiments that show that people cooperate more when they do not know when the social interaction ends. This effect is referred to as the "shadow of the future" (Axelrod, 1984) that relies on the concept of backward induction to make predictions about behavior. Repeated games like the prisoner's dilemma can only be solved from the final node if there is certainty about the length of the game. In line with economic theory, the experimental evidence shows that people cooperate more in the first interaction when the probability of future interactions is higher (Roth and Murnighan, 1978), even more so when they already played the game multiple times with different partners (see Dal Bó & Fréchette, 2018 for a meta-analysis).

In this paper, a binary trust game is used to compare the share of trust and trustworthiness under two conditions. First, when participants know they only interact once and, second, where they expect multiple interactions. The main novelty of this paper is that participants actually have experience with social interactions that suffer from a declining "shadow of the future" due to the risk of displacement by SLR. Compared to the student subjects from high-income countries on which the existing evidence builds, studying the behavior of Solomon Islanders helps us to develop broader theories of human behavior across cultures.

The results show that expectations of repeated interactions do not promote trust and trustworthiness. One compelling explanation for these results could be the in-group setting in the lab-in-the-field experiments compared to standard laboratory experiments with students. However, participants do not behave differently in sessions with a higher share of friends and relatives than in sessions with fewer friends and relatives. Another reason could be that participants with pro-social attitudes react differently to the information of repeated interactions than egoistic participants, as suggested by Van Lange et al. (2011). It is argued that pro-social people with their cooperative mindset do not assess the strategic aspect of the situation as much as egoists who are motivated by the chance of rewarding and punishing behavior in repeated interactions to maximize their earnings. I do not find evidence for this line of reasoning, as egoistic participants in this study do not behave differently in the repeated scenario than pro-social participants. These results provide some preliminary evidence that backward reasoning as the mechanism for promoting cooperation is not relevant for the participants in this study. Participants seem to be less strategically concerned, which could potentially be explained by strong social norms and a different concept of time. Thereby, these results question the generalizability of the existing evidence beyond student samples from high-income countries.

1.6 Outlook

The goal of this dissertation is to highlight the value of a behavioral approach for studying the CCM nexus. It shows that insights and tools from psychology and behavioral economics can enhance our understanding of how climate change affects adaptation behavior beyond a dichotomous view of migration or aggregate equilibrium effects. First, and foremost, this dissertation challenges the notion of mass migrations across borders in response to SLR in the Asia-pacific region. In addition, the four essays highlight the importance of a multimethod and interdisciplinary approach by combining economic lab-in-the-field experiments, focus group discussions, and quantitative surveys. All these data could be used to build agent-based models as proposed in the second paper. Such models could be combined with scenario analysis to provide policymakers with more accurate information on the timing and magnitude of migration in response to climate change. The first paper emphasizes that many affected people want to stay in their communities, which poses different challenges for policymakers that would profit from scenario analysis using ABMs. Based on the behavioral framework proposed in the first paper, a novel experimental approach was developed to study a pre-condition for climate migration – the break-down of pro-social behaviors. In line with the survey-based evidence, the results show that affected communities bound together, which increases their adaptation capacity. The strengthening effect of pro-social behaviors is in conflict with what economic theories predict rational individuals to do. Affected people seem to not incorporate all information

about a reduction in the shadow of the future in their decision making, as has been highlighted by the results of the repeated trust game in paper four.

Future research could apply the proposed behavioral framework to broaden the evidence on how other climate change hazards, both slow- and fast onset, affect adaptation strategies. In addition, experimentally measures of pro-social behavior capture only one dimension of the concept in a controlled but abstract environment. Further studies could investigate the willingness of people to engage in real-world (community) adaptation efforts, for example planting mangroves, that are time-consuming and require effort, to gain further confidence in the results presented here. Moreover, the research presented in this dissertation is limited to three countries in the Asia-pacific region in which lots of heterogeneity is found. Investigating other regions seems a logical next step, as the situation in Sub-Saharan Africa might be very different, given the colonial history, geographical closeness to the EU, different climate impacts (rainfall, droughts) and resource use systems.

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Chapter 2: People want to stay and adapt in place: A behavioral framework to study climate change adaptations

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Abstract

Climate change related hazards are a threat to the livelihoods of millions of people around the world. Understanding the needs of the most exposed and their willingness to leave their home or adapt in place is of fundamental importance to prevent sudden uncontrolled displacements; a scenario that is likely to result in social, political and economic conflicts and could lead to further environmental knock-on effects. We conducted household surveys with 1,428 people in three of the most exposed regions: low-lying islands in Solomon Islands and coastal Delta regions in Bangladesh and Vietnam. We show that: (1) people strongly favor local adaptations over relocation, despite being acutely aware of climate change and the potential of being displaced by its impacts; (2) If they have to relocate, they tend to stay as close to their home place as possible; And (3) this could potentially lead to a climate-induced poverty trap where disadvantaged people are deprived of their capacities. Current frameworks, depicting the decision to relocate as a cost-benefit consideration or as the result of push and pull factors, are insufficient to explain why highly exposed individuals make little to no plans for relocation. In this paper, we propose a behaviorally informed framework that is based on two established frameworks from different strands in the literature We take on a people-centered approach by including insights from information processing and decision-making rooted in behavioral economic theories. Models based on our framework do significantly better in explaining intentions to adapt and assessed climate change risks and perceptions. We believe our research can contribute in two important ways: first we synthesize existing knowledge into one compelling framework which does not end with the binary decision to stay or go but includes other adaptation actions, second, our empirical results highlight the disconnect of current political discussions of widely propagated threats of international "climate change refugees" from realities in the Asia-Pacific region. Climate change justice demands that our focus needs to shift towards the responsibility of high-income countries to assist local governments in developing relocation plans, investing in community's climate change resilience and preparing them for the worst.

Keywords: Climate change, migration, adaptation, information processing, behavioral framework.

2.1 Introduction

Humankind arrived in the Anthropocene, an age where for the first time ever humans fundamentally shape the world they live in (Crutzen, 2006; Waters et al., 2016). The challenges for the 21st century will be to deal with the changes already put into place by our past actions and to figure out how to use our influence on the world responsibly. Greenhouse gases emitted over the last century are causing substantial alterations of the world's climate that will already require substantial efforts to adapt to (Pachauri, Allen, Barros, & Broome, 2014; Stern, 2007). As human activities increasingly affect extremely complex systems, the analysis of these activities requires a framework that is doing these complexities justice. For example, we know that many people, especially those living in coastal regions, are highly exposed to climate change impacts. For many, their livelihoods are threatened by the consequences of climate change. These consequences may eventually result in their displacement (Church et al., 2013a; Nicholls & Cazenave, 2010). However, an oversimplified representation of this problem leads to inaccurate and misleading predictions. One of these oversimplifications found in the existing literature is the assumption of a static world. These overly simplistic approaches neglect people's ability and willingness to adapt in the place they live in. Therefore, factors alleviating the effect of climate change consequences on international migration are missed. One of these approaches neglecting dynamics is the one by Myers (1997, 2002). By assuming a deterministic link between climate change exposure and international migration it predicts up to 200 million climate migrants until 2050. Similarly, many empirical studies investigating climate-induced migration flows consider, except for income, only factors that could push people to leave their homes; again abstracting from the people's ability and willingness to adapt in place (for a review see Berlemann & Steinhardt, 2017).

The ceteris paribus assumption, i.e. a static world where nothing changes except the variable of interest, is useful to understand the effect of a specific component in a model. This approach is perfectly reasonable and great if, for example, we want to determine a drug's effectiveness at reducing blood pressure. In that case, we are only interested in the impact of this drug, not any other factors that might increase or decrease blood pressure in general. When it comes to climate change, however, we want to predict the overall outcome including all the mediating, moderating and enhancing factors. Abstract predictions focusing only on the likelihood of people migrating abroad seem to provide populists and selective media reporting with the "facts" to argue for stricter migration policies and countermeasures to prevent a seemingly impending wave of climate migrants[8], for whom

[8] The fear of migrants in rich countries is again based on the assumption that the world, in this case the economy and society, is a static system unable to change, despite us witnessing that change every day.

we still lack a precise definition[9]. One of the most significant insights in economics is the appreciation of the unpredictability of innovation and the understanding that other people might come up with new ideas we could never have thought of. Thus, assuming that people have only a given set of adaptation strategies, i.e. those that we consider feasible, disregards their ability to come up with solutions we could have never predicted because we lack the knowledge. Looking beyond abstract models and considering real-world examples, the predictions on international climate migration flows seem to be at odds with reality[10]. Recent projections suggest that the majority of affected people will move within borders, not abroad (Rigaud et al., 2018). In fact, case studies from coastal communities experiencing effective sea-level rise of over 1 meter due to land subsistence often resulting in a rapid change of flooding severity have been able to adapt to these changes, which seems puzzling given the severity of their situation[11] (Esteban et al., 2019; Jamero et al., 2017). Technical know-how and financial assistants seem to have played an important role in their successful adaptation strategies (Hinkel et al., 2018).

Understanding why and when people are willing to consider migration or staying and fortify their place is of fundamental importance to policymakers. Different consequences and challenges arise from staying or migrating that both respectively require very different responses by policymakers. On the one hand, policymakers have to plan for and ease the integration of people that move in anticipation of impacts to minimize the risk of social conflicts in dense urban centers. In this way, migration can reduce physical vulnerability and potentially can have positive additionalities; such as, migrants being able to send back remittances, which can be used for adaptation. On the other hand, not all people are willing and able to migrate, which implies that many people stay in affected regions. This potentially leads to a climate-induced poverty trap, where people are deprived by disaster of their resources necessary to migrate from highly exposed regions, or where less affluent people settle in risky areas as they become more affordable. In both cases, people's already limited capacities would be further diminished by repeatedly suffering from climate events over time. Policymakers need to identify such communities and

[9] The IOM working definition for "climate migration" is extremely broad and imprecise: "The movement of a person or groups of persons who, predominantly for reasons of sudden or progressive change in the environment due to climate change, are obliged to leave their habitual place of residence, or choose to do so, either temporarily or permanently, within a State or across an international border." (IOM, 2019). It is not a legal standard and used by the IOM to raise awareness of the issue.

[10] One prominent example is the case of the Carteret Islanders, a low-lying island group in Papua New Guinea. The islands community has been identified in the media as the first community to be entirely displaced by rising sea-levels with a complete inundation happening in 2015. However, the iconic status of the Carteret Islands due to the media focus is at odds with their reality – the islands still withstand rising sea-levels. So far only a handful of people have moved and the islands population is still increasing (Connell, 2016).

[11] The case study by Jamero et al. (2017) shows that people from four Filipino islands that experience relative SLR probably exceeding the projected interval of the IPCC (1 to 4 feet by 2100) because of land subsidence due to a large earthquake in 2013, prefer to stay and adapt in place. These people preferred to adjust their lives to up to 135 flooding days a year, despite having the capacity to move to a relocation settlement on the mainland provided by the government.

develop emergency and planned resettlement procedures in cooperation with the people who are affected. The ultimate goal is to prevent people from being trapped in hazardous environments, which could lead to sudden uncontrolled displacement; a scenario that is likely to result in social, political and economic conflicts and could lead to further environmental knock-on effects. Yet, not all communities are equally exposed or face the same restrictions. For many, it would be more beneficial if the government would assist them to strengthen their adaptive capacities than prematurely planning their relocation[12].

We argue that the existing research on climate-induced migration overemphasizes migration as a response to an exogenous risk (i.e. push) and pull factors at destinations. Thereby insufficient attention is payed to human behavior and especially the decision-making processes behind staying and adapting in place. In this paper, we take on a people-centered approach with a particular focus on decision-making and information processing informed by psychology and behavioral economics to demonstrate the variability and differences that can already occur on the individual level. Our intent is to downplay the focus on macro-level changes, but rather to highlight the importance of the somewhat neglected individual at the micro-level. We present a conceptual framework that integrates two widely applied frameworks in the climate change migration and adaptation literature and report empirical results of intended adaptation actions of people living in three sea-level rise hotspots: low-lying islands (Solomon Islands) and costal deltas (Bangladesh and Vietnam).

First, we build on the framework developed by Black et al. (2011), and extended by (Hunter, Luna, & Norton, 2015; R. A. McLeman, 2013; Rigaud et al., 2018), that focuses on the drivers at the macro-level, meso-level and individual (or household) level which influence the (binary) decision to stay or go. However, the framework neglects the complexity of human decision making, where people rely on mental shortcuts, habitual behavior, fall prey to cognitive biases, and adapt their preferences over time. Second, we include insights from the "Process Model of Private Proactive Adaptation to Climate Change" (MPPACC) framework by psychologists Grothmann & Patt (2005). Their work includes cognitive factors as determinants of the willingness to adapt, e.g. how people perceive environmental changes, risks, and their perceived capacity to deal with the impacts. These factors shape individual adaptation intentions, which could differ substantially from actual adaptation actions due to objective differences in capacities. In our framework, we include explanatory factors that have not been considered in the initial MPPACC framework (for a meta-study of factors, see Valkengoed & Steg, 2019) These

[12] We should be as careful when resettling people as when doctors are diagnosing a person with terminal illness. Being wrong about the displacement timing could lead to a reduction in trust in such predictions and general moral disengagement with climate change related risks, which in turn affects people's decision to move back into hazardous environments and erode trust into future disaster related warnings.

include the attachment to the community and the place where people are living which might reduce people's risk appraisal and willingness to relocate (Bonaiuto, Alves, De Dominicis, & Petruccelli, 2016; De Dominicis, Fornara, Ganucci Cancellieri, Twigger-Ross, & Bonaiuto, 2015; Neef et al., 2018). Lastly, we consider insights from behavioral economics to improve predictions. The endogeneity of preferences (risk, time or social attitudes) to changes in the environment, such as experiencing an environmental disaster can further alter the long-term impacts on development in general. The empirical evidence shows that experiencing such an event might make people more risk-averse in the long-term (Cameron & Shah, 2015; Cassar, Healy, & von Kessler, 2017) or increase risk-seeking temporarily directly after an environmental disaster (Eckel, El-Gamal, & Wilson, 2009). Consequently, this might affect the adaptation decision, whereas risk-averse individuals are more likely to migrate sooner from risky areas than risk-neutral individuals are. Additionally, time preferences might affect how far people plan into the future and how strongly they consider future threats in their decision-making today (Haushofer & Fehr, 2014).

The main contribution of this paper is to synthesize existing frameworks and insights from different studies to move beyond a static world view and present a dynamic representation of climate-induced adaptations. We depict migration as one of many adaptation strategies and consider the feedback effects at different levels. The goal of our framework is to provide a shared understanding of the adaptation process that helps researchers to break down the complex relationship between climate change and adaptation into testable parts that can be rigorously investigated while having a template to clearly communicating the necessary assumptions and simplifications made. We show how to deploy our framework in the field and highlight its predictive power in the context of sea-level rise induced displacement risk, by conducting surveys with 1,428 people living in highly exposed coastal areas; 818 Solomon Islanders, 247 Bangladeshis and 363 Vietnamese. We find that most respondents want to stay and adapt locally, especially those who are the most exposed to the adverse impacts caused by sea-level rise (SLR). These preferences seem at odds with respondents' high climate change impacts appraisal and to a lesser degree risk assessment. However, we identify intervening factors that may explain this perception-intention gap, such as believes that outside organizations (government or NGOs) will help them deal with the impacts caused by climate change and respondents place attachment. Overall, we find that our behavioral models significantly out-perform baseline models in predicting people's intended adaptation strategies. Lastly, we show with the data from Solomon Islands that while migration can decrease vulnerability and increase access to better jobs and health facilities, it can also lead to cultural and social changes that are not necessarily for the better.

The rest of the paper is structured as follows: In section 2.2, we lay the groundwork for our empirical applications by explaining in detail our conceptual framework and how it

fits into the broader picture of the climate-induced migration and adaptation literature; in section 2.3 we provide background information on the three study sites located in the Asia-Pacific region and describe how we operationalized, data gathering process and measurements, the empirical application of our framework; section 2.4 then shows the predictive power of our behavioral models, and we identify obstacles in the adaptation decision process; we then discuss our findings and the potential implications that could arise from a perception-intention gap in section 2.5 before we briefly conclude.

2.2 Conceptual framework

The link between climate change exposure and choosing adaptation strategies is complex, context-depended and interconnected with many other issues, beliefs, and values people have to weigh against each other. An abstract representation of this decision-making process, such as a conceptual framework, can help to organize and integrate ideas, concepts, and findings from different disciplines to develop the basis for a shared vocabulary of terms to study adaptation in the face of climate change. In a most minimalistic framework, we would assume a deterministic relationship between climate change exposure and migration. Norman Myers widely cited prediction of up to 200 million climate migrants until 2050 (Myers, 2002), falls in this line of reasoning. Myers (2002) overlaid environmental degradation estimates on a population distribution map, assuming that all people who might be affected will migrate away, neglecting people's potential to adapt[13]. In economics, push and pull factors are usually at the core of most migration models (Berlemann & Steinhardt, 2017). Richard Black and colleagues (2011) developed a framework where environmental change is depicted as a push factor for migration. In this framework, environmental change, e.g. caused by climate change, drives the decision to migrate through manipulating drivers that have been identified in empirical studies, i.e. not only social and economic factors but also macro factors such as environmental, political and demographic factors. Black et al. (2011) also mention preferences[14] in their framework. However, they understand them to be independent of environmental change. By ignoring insights from behavioral economics, Black et al. (2011) overlook that experiencing a natural disaster can change people's preferences. The empirical evidence shows that experiencing such an event might make people more risk-averse in the long-term (Cameron & Shah, 2015; Cassar et al., 2017) or increase risk-seeking temporarily directly after an

[13] This methodological approach, never intended to be a precise prediction but rather to serve as an illustration of the magnitude of problem we are facing, has been widely criticized by many scholars. Nevertheless, through repeated citations and use by many intergovernmental, such as the UN and IOM, and non-governmental organizations Myers prediction achieved the status similar to a "scientific truth" (see Gemenne, (2011) for a detailed discussion).

[14] We understand preferences as related to an individual's attitude towards a set of options, alternatives or objects, which are ordered based on the enjoyment, gratification, happiness, satisfaction or utility resulting from choosing that alternative.

environmental disaster (Eckel et al., 2009). Consequently, this would affect the adaptation decision, whereas risk-seeking individuals are more likely to invest in physical and human capital (Shaw, 1996) or to migrate (Jaeger et al., 2010). Additionally, time preferences might affect how far people plan into the future and how strongly they consider future threats in their decision-making today. Place attachment, i.e. how attached a person is to their home, is the only behavioral aspect Black et al. (2011) mention that might be influenced by a changing environment. To summarize, the conceptual framework developed by Black et al. (2011), which was adapted in the Foresight Report (R. Black et al., 2011) and by Hunter et al. (2015), and build upon by the World Bank's Groundswell Report (Rigaud et al., 2018), represents an extension of the most minimalistic framework, by adding capacities, which can be affected by environmental change. Yet, behavioral aspects of decision-making are missing. Through all the evolutions of this framework, capacities are distinguished at the macro-level, meso-level and individual (or household) level with several subcategories each. Research in sociology highlights the importance of greater integration of context and the interaction between and within capacities (Hunter et al., 2015). Models based on frameworks that include people's capacity to adapt are much better at predicting migration flows caused by environmental changes than one without ever could (Kniveton, Smith, & Wood, 2011; Smith, 2014).

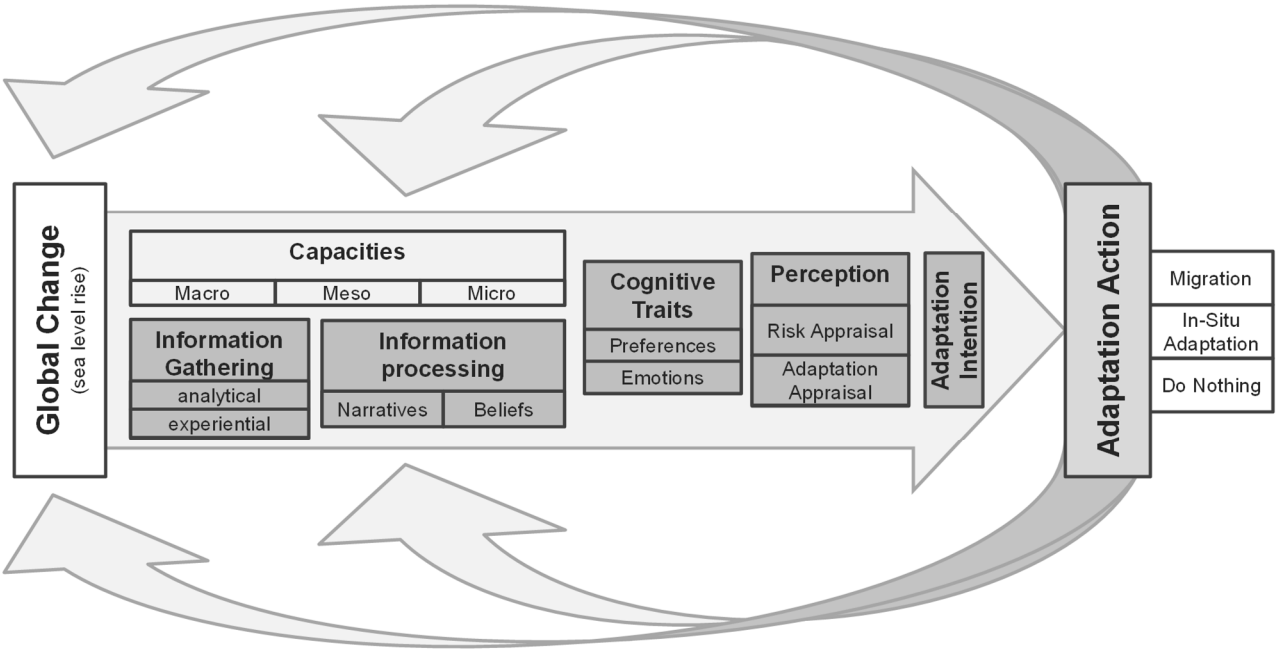
Frameworks developed by psychologist, such as the Process Model of Private Proactive Adaptation to Climate Change (MPPACC) by Grothmann & Patt (2005), approach the black box on the decision to migrate (or to stay), by including insights from cognitive and social psychology. The migration decision is not merely depicted as a binary decision between staying or going but instead viewed as one of many possible adaptation strategies. By including human cognition as the driving factor in the decision process, the MPPACC Model offers two key contributions: First, the inclusion of perception, e.g. how people perceive environmental changes, the risks that come with these changes and adaptation options available to them; and second, the insight that climate change risk appraisal, determined by the perceived probability and severity of risks, and adaptation appraisal, determined by perceived adaptation and self-efficacy), drive adaptation intentions. Furthermore, the MPPACC model introduces heuristics and biases into the decision-making process, allowing for a more realistic depiction of human behavior where mental shortcuts and simplified versions of reality are used for decisions making. The human brain, unable to process all available information, depends on these simplifications to function. Neglecting this insight would make it difficult to understand why people tend to be present biased (DellaVigna, 2009), overestimate rare events (Tversky & Kahneman, 1992) and often seem to ignore relevant information (Kunda, 1990). Finally, the MPPACC framework makes the critical distinction between intended and actual adaptation behavior. As Ajzen (1991) established in his theory of planned behavior, intended behavior does not

necessarily translate into actual behavior. This becomes especially important for research using self-reported intentions to migrate as outcome variables.

2.2.1 A behavioral framework to study climate change adaptation

We present a conceptual framework (Figure 2.1) bringing together insights from economics, sociology, and psychology to illustrate our understanding of how people develop livelihood strategies and make adaptation decisions in the face of global changes, that could be environmental changes, such as sea-level rise, but also demographic, economic or social changes. Here we focus on sea-level rise (SLR) as the global change and how people highly vulnerable to hazards caused by SLR adapt to it. We especially highlight the process of seeking information, the narratives people use to structure and contextualize this information, the perception of risk derived from this information and the role of underlying cognitive traits (e.g. time, risk and social preferences) that might affect decision-making. Moreover, we deem it crucial to go beyond depicting the decision between staying and going as a binary decision and instead focus on the decision-process behind choosing an adaptation strategy more generally. This could be everything from local adaptations (e.g. building sea walls, restoring shorelines, cultivating mangroves, or investing in flood prove buildings) to migration or doing nothing at all, which might sometimes be the only "strategy" available. Our goal is not to create something fundamentally new, but rather to build upon and integrate previously established frameworks while adding additional insights from behavioral economics we deem necessary for understanding people's decision-making in response to climate change. We highlight the importance of these extensions by showing supportive empirical evidence from three of the most exposed regions to climate change hazards especially SLR: Bangladesh, Solomon Islands, and Vietnam.

Figure 2.1 Conceptual Behavioral Framework



Source: Own creation.

2.2.2 Capacities

Our framework presents a people-centered approach to understand adaptation behavior, consequently putting less emphasize on macro and meso-level factors driving the decision to adapt. For most of our respondents, macro and meso-level capacities are the same within each study region. Thus, we distinguish mainly between (1) individual capacities that are different for every household (e.g. income, education, health, quality of land owned) and (2) collective capacities that affect more than just one single household (e.g. institutions, norms, power relations). On the individual level, a person's financial capacity is arguably the most evident restriction on the feasibility of adaptation strategies. However, human, social, natural and physical capacities play an equally important role in enabling and constraining strategies. On the collective level, we consider the political, legal and social framework, which incorporates institutions, norms (formal and informal), and power relations, as the most important capacities. For additional information on how climate change might affect capacities we recommend the conceptual framework from Black et al. (2011) and its detailed discussion in the Foresight Report (R. Black et al., 2011) and by Hunter et al. (2015) as well as the extended version presented in the Groundswell Report (Rigaud et al., 2018). The distinction between macro-, meso- and household-level in these frameworks is very informative. Nevertheless, in this version of our framework we distinguish only between individual and collective capacities to keep it as transparent and straightforward as possible. Yet, the framework can easily be extended to include a more

detailed distinction of capacities whenever necessary, e.g. for comparing individuals between countries.

2.2.3 Information gathering & processing

For people to act on any sort of changes, here sea-level rise, they first have to be aware of it. We consider two ways of learning: experiential and analytic processing (Marx et al., 2007). Experiential processing includes personal experiences, such as witnessing sea levels exceeding previous records, observing changes in one's exposure and detecting changes in the capacities available to deal with SLR. Hence, we see a change in capacities as a source of information for individuals to learn from and the available capacities themselves as a determinant for the adaptation actions feasible to an individual. In turn, choosing an adaptation (in)action will affect one's future capacities. However, people can also be exposed to global changes without knowing they are. This is especially true for slow-onset events, such as sea-level rise and droughts, where the risk is masked by incremental changes that reach dangerous levels only gradually over time. This is where analytic processing plays a crucial role. People do not necessarily have to experience a change themselves to know they are at risk. They can also learn about risks (and opportunities) from peers, social networks or external agents, such as the media, government officials, NGO workers[15] or religious organizations.

These two ways of acquiring knowledge, experiential and analytical, often overlap and are interlinked since people usually receive information from multiple sources. Moreover, some people might actively try to get information while others do not. Most importantly, we know from a diverse set of literature that one and the same information might often lead to different conclusions, and in extreme cases even in opposing ones (Hastorf & Cantril, 1954; Kahan et al., 2012; Lord, Ross, & Lepper, 1979). Relatedly, humans are prone to several biases when it comes to searching for new information and forming beliefs. First, humans generally are reluctant to change their attitudes and beliefs, especially when they are important to them (Albarracin & Shavitt, 2018). Additionally, when people are searching for information, they tend to be biased towards information that reinforces their existing (or preferred) beliefs and worldviews (Hart et al., 2009; Kunda, 1990; Nickerson, 1998; Rabin & Schrag, 1999). Even though it is often assumed, that an exchange of beliefs between individuals will bring them closer together, this is not always the case. Talking to other people can also reinforce polarization, especially so when individuals start seeking out peers who share their beliefs and avoid others who do not (Sunstein, 2001). Second, people tend to overestimate the likelihood of extreme events, e.g. flight crashes, nuclear disaster or terrorism attacks, while underestimating the risks of

[15] For example, NGOs that provide educational workshops about climate change impacts for local communities.

regularly occurring events, e.g. driving a car or unhealthy nutrition (Tversky & Kahneman, 1992). Third, people may fall prey to an expert bias or political motivated reasoning (Kahan, 2013), as they put too much trust in beliefs supported by their peer group. In both cases, the source of information (expert or peer group) is trusted and endorses values important to the individual making it more likely that the information is accepted as truth without questioning it.

2.2.4 Narratives

One possibility of understanding potentially biased information processing is by investigating narratives people use to make sense of the world they live in. Humans have a strong wish to uphold a consistent, meaningful narrative about themselves and the world around them, providing justification for their every (in)action. Narratives specify what elements and processes are related to each other, how to structure and contextualize experiences, and what the future is most likely to bring (Nowak, Kacprzyk-Murawska, & Serwotka, 2017). New information is embedded continuously in existing narratives to provide new meaning, as humans need to rationalize why specific events happened to them, or not. Information and knowledge are sometimes treated as equivalents, assuming that people will adapt their behavior whenever new information emerges. This assumption overlooks, however, the necessary transformation of information into knowledge before any behavioral change can happen (Nowak et al., 2017). We believe that understanding narratives, which play a key role in this transformation process, helps understanding how people perceive risks about their changing environment, how they construct new knowledge and beliefs related to those changes and ultimately how they decide between adaptation strategies. Narratives are not necessarily restricted to personal experiences. They can also emerge from shared experiences, where actors share their observations and stories with each other, merging them together into a shared understanding of an event (Bruner, 1990). According to Nowak et al. (2017) individuals may internalize experiences of others in this process which in turn may influence their decision-making and actions. Narratives can be highly illogical and improbable at times, but they are also an essential element of self-structure, shaping the identity[16] of individuals and localities where such stories are being told (Polkinghorne, 1991; Singer, 2004) and provide a common ground for values and norms to develop (Gergen & Gergen, 1988). Such narratives do not emerge in isolation but are embedded in a complex social world, including norms, practices, institutions, worldviews, and stereotypes that condition and shape the stories we tell others and ourselves. Importantly, these social realities also affect the perceived and actual

[16] Our understanding of identities is based on (Akerlof & Kranton, 2000), who define an identity as a set of social categories (i.e. gender, age, class, race), which carry behavioral prescriptions (norms, stereotypes, etc.), which have costs and benefits.

capacities of individuals to perform certain responses to rising sea levels. For example, some livelihood strategies and adaptation actions might not be considered feasible simply because they do not fit the narrative or are in conflict with a certain norm. However, this relation is also possible in the other direction. Knowing, for example, that a certain adaptation strategy (e.g. moving away) is unfeasible (e.g. no money), one might choose a narrative that supports the "decision" to stay. Thus, capacities might be over- or underestimated from an outsider perspective if social realities are not considered.

2.2.5 Preferences

We expect that people are more likely to choose strategies they believe will bring them a higher amount of enjoyment, gratification, happiness, satisfaction, or utility than other strategies. Preferences express themselves in this inner ranking of what people would prefer to have, to do or to be. Given a pool of feasible options, there is a clear distinction to be made between what we want, e.g. a particular state of the world, and what we are willing to give up to achieve that outcome, e.g. taking specific actions. Thus, one might prefer one outcome to another but will end up in the later if she is unable (or unwilling) to commit enough to achieve it. Quite often, the outcome we aspire is actually achievable, but we fail to commit to the actions that would bring us there. This is what is called the intention-action divide, where the intention, e.g. buying weather insurance, is given but the action, e.g. going to the insurance broker and signing the contract, is missing.

We believe preferences, often neglected in other frameworks, play a critical role in choosing adaptation strategies. Preference parameters are used by economists as inputs in their models for measuring welfare and conducting policy analysis. A vast body of literature has documented the predictive power of the three main economics preferences: risk, time, and social attitudes. Risk-seeking individuals are more likely to invest in physical and human capital (Shaw, 1996) and to migrate (Jaeger et al., 2010). Patience influences educational investments (Thaler & Benartzi, 2004) , saving and borrowing decisions (Meier & Sprenger, 2010), employment decisions (Burks, Carpenter, Goette, & Rustichini, 2009) and even resource use decisions (Fehr & Leibbrandt, 2011) (Fehr and Leibbrandt, 2011). Pro-social preferences, e.g. altruism, fairness, reciprocity, and inequity aversion, influence a wide range of behaviors from fairness at the workplace, paying taxes, voting, helping others in need, donating to charities, volunteering to co-operating for public goods or common-pool resources (Alpizar, Carlsson, & Johansson-Stenman, 2008; Chen, Harper, Konstan, & Li, 2010; Frey & Meier, 2004; Rustagi, Engel, & Kosfeld, 2010; Shang & Croson, 2009).

Until recently, most economists have assumed that these preferences are exogenous, which means that they take individuals "as they are" without asking how they come to want and value things (Bowles, 1998). This simplifies efficiency analysis of policy interventions

or predictions about behavior in response to changes in the environment. We consider these preferences to be endogenous to changes in the environment, which means that we assume they are not given and stable but are affected by external factors. Preferences are interdependent, in part determined by social institutions and subject to learning and habit formation through past-experiences. Increasing experimental evidence highlights that preferences are indeed often endogenous, as behavior is shaped by market integration (Henrich et al., 2005), religion (Henrich et al., 2010) exposure to different political systems (Brosig-Koch, Helbach, Ockenfels, & Weimann, 2011), production technologies (Leibbrandt, Gneezy, & List, 2013), conflict (Bauer et al., 2016) and natural disasters (Brown, Daigneault, Tjernström, & Zou, 2018; Callen, 2015; Cassar et al., 2017; Hanaoka, Shigeoka, & Watanabe, 2018; Whitt & Wilson, 2007). These studies report remarkable evidence in favor of both long-term and short-term endogenous preference formation. Abstracting from these essential insights could lead to very different adaptation predictions, which might provide policymakers for example with misleading information on the number and timing of migrant flows.

2.2.6 Feedback effects

Finally, we think it is important to not look at a static world, but include dynamics through feedback effects that result from the choices made. Above, we discussed the interconnectivity between narratives and capacities. A similar relationship might also exist between narratives and behavior, where narratives influence behavior and vice-versa. If people, for whatever reason, decide not to invest in any adaptation strategy, they might be more inclined to develop narratives that justify this behavior. For example, by depicting climate change as an intervention by God to punish the unfaithful or by questioning the existence of climate change itself one might become more content with not investing in any adaptation strategies. Moreover, the decision to migrate from a remote area to an urban center will undoubtedly change the collective capacities, e.g. institutions and markets, are available to a person. Similarly, deciding to stay, while others decide to leave, might also affect an individual's capacities, e.g. by reducing the number of neighbors on whom one can rely. Yet, that same person might consequently also have new diasporic links available getting information from people who moved away or even receive remittances from household members who left enhancing their own adaptive capacity. Thus, it has been proposed by some researchers that migration and local innovation are complementary rather than substitutive mechanisms empowering the community that stays behind (Ng'ang'a, Bulte, Giller, McIntire, & Rufino, 2016; Nguyen, Raabe, & Grote, 2015). Likewise, there is the possibility that the sum of individual decisions might lead to changes beyond the micro and meso-level and affect macro level or even global changes. For example, if not just one village but multiple communities decide to migrate to one specific

place, they could have a severe impact on the economy, environment, and natural resources at that place. Potentially leading to even more migrants. Ultimately, climate change as a whole is the result of millions of people making decisions that drive greenhouse gas emissions. With the inclusion of feedbacks to the global level, we would like to close the circle between global changes and individual decision-making highlighting the continuous interconnectivity between adaptation and change. There are no steady states in nature. The natural state of nature is the adaptation to previous changes and the recovery from the last disaster. Adaptation to SLR is a continuous process, not a onetime decision between staying and moving away. Staying and trying to adapt requires continuous actions while migrating puts the individual in an entirely different context creating new opportunities and problems. As we have mentioned above, migration itself can again lead to ecological, economic and social problems by overloading resources at the new destination.

2.2.7 Application

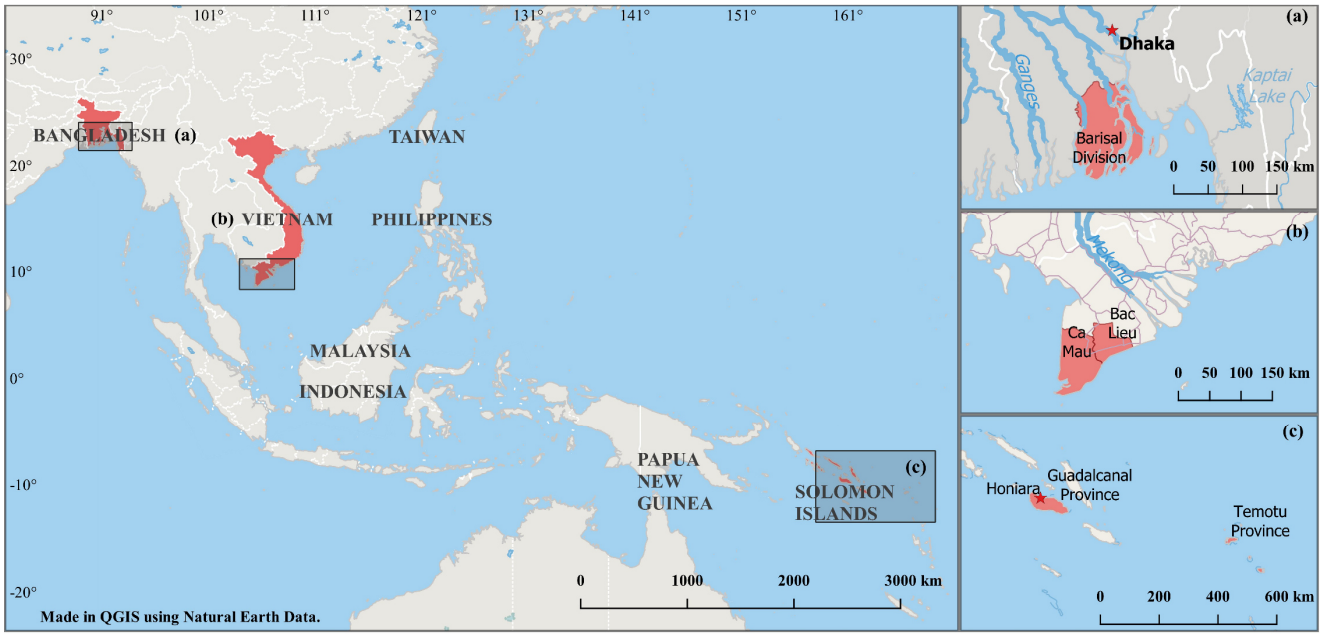
The goal of this framework is to incorporate and combine knowledge from different fields of research to develop a shared understanding of the complex relationship between SLR and adaptation strategies. Rarely is it possible to test such a complex relationship as a whole and derive any meaningful conclusions. Thus, this complexity has to be broken down into more testable parts that can be rigorously investigated; or as Paul Cilliers puts it: "Engaging with complexity entails engaging with specific complex systems" (Cilliers, 2005). Yet, simplifying a complex system requires a deep understanding of that system to recognize the implications of simplifying assumptions made. For example, as we have discussed above abstracting from people's ability to adapt in place would lead to a drastic overestimation of migration numbers in response to climate change. The framework helps by serving as the backbone to identify implicit and explicit assumptions made for testing specific hypotheses. We hope the framework presented here can guide researchers in forming meaningful research questions, which can be anything from qualitative (interviews, participatory rural appraisal, etc.) to quantitative methods (surveys, economic experiments, etc.). Indeed, scant research has been done on the black-box of decision making behind the formation of adaptation strategies in response to climate change. How people actually learn about climate change, make sense of it by using narratives and their identities, and how all of this transfers in specific adaptation strategies are not well understood as of yet. In addition to econometric analyses, one could use, for example, agent-based modeling (ABM) to predict emerging adaptation choices and feedback effects at different scales. ABM provides a method to study the complicated relationship between climate change and adaptation strategies, given a set of assumptions about the drivers of people's (agents) behavior on how to adapt. Such an approach could be used to make ceteris paribus comparisons by changing one variable of interest at the time, such as the strength

of the impact (for example, one could use the scenarios in the IPCC assessment reports), policy interventions or particular economic preferences and predict its influence on downstream factors, i.e. adaptation strategies. These models could be informed by both qualitative and quantitative data and could yield valuable insights for policymakers as a basis for developing options and assess their efficiency. The presented framework highlights the complexity of climate change adaptation to policymakers and researchers, helping them to understand why specific interventions are (not) working. For example, an awareness-raising campaign might increase knowledge about impacts, but knowledge does not necessarily transfer easily to intentions and actions to adapt, given all the behavioral and psychological intervening factors.

2.3 Methods & data

We conducted household surveys with 1,428 people between 2017 and 2019 in three study regions, Solomon Islands, Bangladesh, and Vietnam (Figure 2.2). In the following, we will provide background information regarding exposure to climate change hazards for all three regions, socio-economic summary statistics across the three samples, and give an overview of the empirical measurements that we elicited to measure components of the framework and layout our estimation strategy.

Figure 2.2 Research sites



Notes: The areas highlighted in red in panels (a), (b) and (c) show the provinces where the research has been conducted.

2.3.1 Background: climate change impacts & sampling

Global sea levels are expected to rise between 0.54±0.19 meters and 0.71±0.28 meters until the end of the 21st century (Becker et al., 2012; Church et al., 2013b).

Regionally, however, changes can be up to 20 percent higher in tropical regions (Slangen et al., 2014). Moreover, the estimated 10 to 20 cm of sea-level rise until 2050 could already more than double the number of extreme water level events in the tropics, such as large waves, storm surges and coastal flooding (Vitousek et al., 2017). Therefore, some researchers conclude that many atoll islands will be uninhabitable by the mid-21st century (Storlazzi et al., 2018). We conducted 716 surveys in Solomon Islands in three different settings. We interviewed 252 people living in the capital Honiaraon hills up to three kilometers away from the shoreline. We classified this group as relatively less exposed to sea-level rise compared to our other samples. Our second sample consists of 464 people living on very remote group of atoll islands, Reef Islands. Finally, we interviewed 102 atoll islanders who already migrated from their atolls (Reef Islands or Ontong Java) to the capital and are living now in settlements located directly at the coast. The sample of atoll migrants is only used for the analysis of feedback effects caused by migration in section 2.4.3, since it is debatable how exposed towards sea level rise they actually are compared to other two samples in Solomon Islands. For all study sides, we constructed complete household lists from which we randomly select participants. In the analysis presented in 2.4.3, we will refer to the three samples as main islanders, atoll migrants and atoll islanders, where atoll islanders are the people most exposed to SLR impacts.

Bangladesh's flat topography, it is located in a low-lying coastal plain with 230 rivers and their branches, it's climatic features, high population density even in rural areas and socio-economic situation make it one of the most vulnerable countries in the world. People are threatened by cyclone generated coastal floods, river floods, riverbank erosion, salinization of grounds, droughts which are expected to worsen with SLR and land subsidence (Auerbach et al., 2015). Rising sea levels are expected to increase coastal flooding during storm surges (Bhuiyan & Dutta, 2012), tsunamis (Li et al., 2018), and increase coastal erosion and salinization (Nicholls & Cazenave, 2010). On average, respondents stated to have experienced about 2.5 extreme events (floods, droughts, cyclones) over the past five years and 34 percent in our sample report to already have lost land due to erosion. We randomly selected a total of 12 villages in three purposefully selected unions in the Barisal region in southern Bangladesh. The sample consists of 247 participants who were randomly selected within each village by following a random walk procedure[17]. The research was conducted in cooperation with BRAC Institute of Governance and Development (BIGD) at BRAC University, which provided us with

[17] Groups of enumerators were given a randomly selected starting address from which they headed off in different directions choosing either the left or right side of the street, interviewing a person from every third household, and taking a left turn on every second corner. For a critical discussion of this method and how such instructions can systematically affect survey results, see Bauer (2016).

experienced enumerators and data on the affectedness of the different unions guiding our preselection.

Vietnam, like Bangladesh, is one of the countries most vulnerable to climate change, ranking 6th in the Global Climate Risk index in 2019 (Eckstein, Hutfils, & Winges, 2019). The Mekong Delta especially is highly exposed to SLR due to its extremely flat topography; most of the Delta lies less than 2 meters above current sea levels. In addition, the Delta itself seems to be sinking. Subsidence between 0.35 to 1.4 meters on top of SLR of 0.07 to 0.14 meters is expected until 2050 (Erban, Gorelick, & Zebker, 2014). On average, respondents stated to have experienced about three extreme events in the past five years, and 13% of the sample already lost land due to erosion. We interviewed 363 people living in Ca Mau and Bac Lieu province in the Mekong Delta. Sampling was conducted by (1) identifying a list of potential research sites in Ca Mau and Bac Lieu province, (2) randomly selecting 8 villages from the list of potential sites and (3) selecting potential participants following a random walk procedure in each village. In both Vietnam and Bangladesh, survey participation was voluntary, and some people did not want to be interviewed[18]. In Solomon Islands, most people were eager to participate, and only few people in the capital denied our request.

2.3.2 Summary statistics

Table 2.1 provides an overview of the socio-economic characteristics across all three samples. On average, the respondent's gender is relatively well balanced. However, this is because the relatively low female participation rate in Solomon Islands (39%) is canceled out by the much higher rate in Vietnam (61%). This represents the situation in the field, wherein Solomon Islands (especially on the atolls) women are busy during the day in the fields, caring for the children and preparing food whereas men are mainly responsible for fishing which takes place early in the morning or evening, while in Vietnam women are more likely to stay at home during the day. The majority of respondents is married (73%) and on average about 39 years old. Respondents in Vietnam tend to be a bit older, with the average being 45 years. Despite our respondents in Vietnam being slightly less educated they are nevertheless able to generate much more cash income compared to our other participants. On average, respondents in Vietnam (PPP adjusted $17 per day) have about three times as much money available every day than in Bangladesh (PPP $5.5 per day), and even more than six times as much as in Solomon Islands (PPP $2.6 per day). In Solomon Islands, purchasing power is much lower, as price levels for basic needs are high due to its remote location. In addition, Atoll Islanders have almost no cash income at all and mainly

[18] Unfortunately, we do not have any exact information on the survey response rate.

rely on subsistence fishing and gardening as well as on remittances (mostly in-kind transfers such as rice, canned food, and flour) from their social-networks that extend up to the capital. Despite the differences between samples, they all share the risk of losing their homes to SLR in the near future.

Table 2.1 Summary statistics

	(1)	(2)	(3)	(4)
	Solomon Islands	Bangladesh	Vietnam	Pooled
Variable	Mean/SD	Mean/SD	Mean/SD	Mean/SD
Female (=1)	0.39	0.46	0.61	0.46
	[0.49]	[0.50]	[0.49]	[0.50]
Married (=1)	0.68	0.79	0.79	0.73
	[0.47]	[0.41]	[0.41]	[0.44]
Age	36.98	34.89	45.12	38.82
	[14.78]	[12.10]	[14.09]	[14.66]
Education in years	7.96	7.45	6.27	7.40
	[3.33]	[4.59]	[4.19]	[3.90]
Household size	5.88	5.11	3.95	5.21
	[2.64]	[1.80]	[1.36]	[2.36]
Born at current place (=1)	0.68	0.67	0.74	0.69
	[0.47]	[0.47]	[0.44]	[0.46]
Prayers at least once a week (=1)	0.78	0.95	0.02	0.60
	[0.41]	[0.22]	[0.14]	[0.49]
Monthly income (in PPP adjusted USD)	78.10	164.79	521.05	215.51
	[193.45]	[228.67]	[396.93]	[330.46]
Monthly household income (in PPP adjusted USD)	246.61	648.05	1279.49	604.42
	[427.75]	[1902.78]	[939.98]	[1098.81]
Extreme events in the past 5 years	.	2.45	2.95	.
		[3.50]	[3.41]	
Lost land due to erosion (=1)	.	0.34	0.13	.
		[0.48]	[0.34]	
N	716	247	363	1326

Notes: The Solomon Islands sample does not include the 102 atoll migrants. Monthly incomes are converted using purchasing power parity conversion rates from the time the data was collected (2017-2019) to eliminate differences in price levels between countries.

2.3.3 Empirical measurements

Table 2.2 provides an overview of the primary outcome and explanatory variables of interest and how they were constructed to be comparable across study sites. The list of measurements is only an excerpt of potential empirical measures one could use to operationalize the framework. It is by no means complete, nor do we propose that everyone who wants to apply this framework needs to elicit these exact variables. The aim is to provide an idea of how behavioral components in the framework can be measured in the field and to show their importance for decision making. The measures themselves could, and most likely will further develop over time.

The primary outcome variable of interest is people's adaptation strategies in response to the future risks caused by SLR. Using survey methods, we were limited to confront respondents with a hypothetical SLR-scenario in which sea levels would rise by 2 foot (61 cm) within the next five years and asked them what they would recommend affected people, in their country, to do today to prepare themselves. We explicitly asked respondents what they would recommend others not what they would do themselves. This allows us to avoid biases related to self-reported behavioral intentions and enables participants to express their preferences for different adaptation measures without being affected by their personal (lack of) capacities. In addition, respondents did not see any predefined answer categories, to reduce demand effects which could arise from researchers providing them with a list of adaptation strategies. The different adaptation strategies were determined in pretests and then checked by enumerators during the data collection and added all "new" adaptation strategies mentioned by respondents on their tablets. We take the average of recommended adaptation strategies and categorize recommendations in four unique categories: do nothing; only local adaptation strategies (seawalls, beach nourishment, planting mangroves (trees), moving within the same village), only migration or a combination of local strategies and migration.

In addition, the proposed behavioral framework highlights the importance of understanding how people learn about impacts and assess their risks. First, to understand learning, we need an outcome measure of how strongly respondents perceive that climate change caused changes in their environment. Perceptions of past and future climate change changes in the environment were measured using five-point Likert-type scales to assess respondent's agreement whether the following impacts have happened or will happen in the future: droughts, cyclones, heavy rainfalls, sea-level rise in general, coastal erosion and intrusion of salt-water. The six answers regarding past and future impacts were then averaged into one combined index for past perceptions and one for future perceptions of climate change impacts. Second, we need a measure that captures whether respondents believe that these (perceived) impacts are cause for concern. To measure risk appraisal, we asked respondents in Solomon Islands whether they believe they have to relocate in the next five years due to SLR, a dichotomous measure for their risk assessment due to SLR. In Bangladesh and Vietnam, we used two more fine-grained measures, 11-point Likert-scales, to assess both risk of damages to their livelihoods and the likelihood of relocation due to SLR impacts.

The main explanatory variables represent the factors that were identified as crucial in the conceptual framework: information gathering, information processing, and cognitive traits. Individual capacities, such as education, age or income, are already discussed in the previous section. To understand how perceptions about climate change and risk assessments come about, we need to measure how people gather information and how it is

then processed. First, we elicited how much respondents value different sources from which they obtain information about climate change. Again, we construct indexes out of several five-point Likert-scale questions that measure how much respondents trust information from their local network (family, friends, etc.), outsiders (government, NGOs, researchers, etc.) and the media (TV, radio, newspaper, etc.). How information from different sources is then processed, depends on the beliefs people have. Respondents had to think about who should help them deal with the consequences of climate change impacts. Based on this open response question, we use a binary categorization of whether respondents would only rely on outsiders or also on their social network and themselves. In addition, we use single Likert-scales to measure beliefs about knowledge about climate change, self- and outcome-efficacy. Lastly, we measured a set of cognitive traits that are important for decision-making in general. To elicit respondents risk and pro-social attitudes, we rely on established measures in experimental economics that were incentivized using the local currency. For these measures, the research assistants were instructed to hand over the tablet to the respondent and give them space to make their decision. Incentives and private decision-making make these measures less prone to hypothetical bias and social desirability bias compared to standard survey measures. In addition, we used established psychometrics scales and measures to elicit respondents place attachment (Williams & Vaske, 2003), discounting of the future (Falk, Becker, Dohmen, Huffman, & Sunde, 2016) and negative emotions (Thompson, 2007).

In section 2.4.2, we investigate the role of people's social networks for migration. Social networks can play an essential role in the adaptive capacity to deal with the impacts of SLR and other CC impacts (Adger, Hughes, Folke, Carpenter, & Rockström, 2005). A strong social network may give people the means to migrate in response to climate change impacts, as people can rely on their networks to help them in case of temporary or permanent displacement. To get a grasp on the respondent's social networks, we asked them where they would go and on whom they would rely temporarily in case of a sudden environmental disaster and also permanently if their home would become uninhabitable. We illustrate these data using migration-flow maps created in QGIS, which show how far people potentially would move temporarily or permanently in case of displacement.

Table 2.2 Measured framework components

Measure	Solomon Islands	Bangladesh	Vietnam
Information gathering			
Exposure	Binary identifier of exposure to SLR impacts based on the geographical location. Atoll Islanders are categorized as more exposed, i.e. exposure=1, and Main Islanders are less exposed. Atoll Migrants are not considered, as their exposure is not clearly identifiable.	Binary identifier of exposure to SLR impacts based on self-stated data from the respondents whether they experienced flood damages, had to rebuild their house in order to assess their exposure to these impacts. We divide respondents into two groups; the less affected group stated not to have lost any land so far due to erosion and the highly affected group that already lost land due to erosion.	
Information sources (importance/trust)	How important are the following sources where you hear or read about the topic of climate change? On a scale from 1 to 5, where one means "not important at all" and five "very important".	On a scale from 1 to 5, where 1 means "strongly distrust" and 5 "strongly trust" to what extent do you trust or distrust the following groups to tell you the truth about climate change?	
Internal	Index based on the average over three Likert-scale items on the importance of the following internal information sources: Family, friends, neighbors, teachers, community leaders.	Index based on two Likert-scale items on the trust in the following internal information sources: Family, friends, other people from your village.	Index based on two Likert-scale items on the trust in the following information sources: Family, friends, other people from your village.
External	Index based on the average over three Likert-scale items on the importance of the following external information sources: government officials, NGO workers, scientists.	Index based on the average over two Likert-scale items on the trust in the following external information sources: government officials, NGO workers, scientists.	Based on one Likert-scale item regarding how much they trust NGOs and scientists[19].
Media	Index based on the average over four Likert-scale items on the importance of the following media information sources: television, internet, newspapers, radio	Based on one Likert-scale item regarding how much they trust the media in general (television, internet, newspapers, radio).	Based on one Likert-scale item regarding how much they trust the media in general (television, internet, newspapers, radio).

[19] Due to the political situation in Vietnam, we could not ask respondents to state how much they trust the government.

Information processing: Narratives & Beliefs			
Reliance on outside help	We categorized respondents as either relying only on outside help (governments or NGOs) to deal with the consequences of SLR impacts (=1) or 0 if they would rely also rely on their social networks and themselves. Categorization is based on the question: "Considering the future effects of climate change (sea-level rise, heavy rainfall, floods, droughts), whom do you believe should help you to deal with the consequences?". We did not provide respondents with answer categories, and multiple answers were possible.		
Outcome-efficacy	.	Likert-scale ranging from 1 to 5, where higher values imply lower perceived outcome efficacy of successfully adapting to climate change: "Please rate the extent to which you agree with the following statement on a scale from 1 to 5, where 1 means "strongly disagree" and 5 "strongly agree". I feel that climate change is too big for me to be able to adapt."	
Self-efficacy	.	Likert-scale ranging from 1 to 5, where higher values imply lower perceived self-efficacy of successfully adapting to climate change: "Please rate the extent to which you agree with the following statement on a scale from 1 to 5, where 1 means "strongly disagree" and 5 "strongly agree". I feel uncertain about the best options to adapt to climate change."	
Knowledge about CC	.	Normalized between 0 and 1 base on the following Likert-type question: "Would you say you understand what climate change is and how it affects you? On a scale from 1 to 7 where 1 means "I have no idea what climate change is" and 7 "I know exactly what climate change is and how it affects me"."	Normalized between 0 and 1 base on the following Likert-type question: "Would you say you understand what climate change is and how it affects you? On a scale from 0 to 10 where 0 means "I have no idea what climate change is" and 10 "I know exactly what climate change is and how it affects me"."

Cognitive traits			
Place attachment	Z-score of the psychometric scale developed by Williams and Vaske (2003) that measures people's place attachment (dependence and identity). Higher values imply a stronger place attachment.	Z-score of the psychometric scale developed by Williams and Vaske (2003) that measures people's place attachment (dependence and identity). Higher values imply a stronger place attachment.	Z-score of the psychometric scale developed by Williams and Vaske (2003) that measures people's place attachment (dependence and identity). Higher values imply a stronger place attachment.
Patience	Z-score of discrete variable ranging between 1 to 32 based on the staircase time preference survey measure developed by Falk et al. (2016). Smaller values imply higher impatience, while larger values are associated with stronger patience. A value of 1 on the non-standardized scale implies that the respondent preferred the money immediately instead of the highest amount offered in 12 months (discount rate > 110%).		Z-score of discrete variable ranging between 1 to 32 based on the staircase time preference survey measure developed by Falk et al. (2016). Smaller values imply higher impatience, while larger values are associated with stronger patience. A value of 1 on the non-standardized scale implies that the respondent preferred the money immediately instead of the highest amount offered in 12 months (discount rate > 220%).
Risk attitudes	Z-score from three incentivized choices between a lottery and a sure amount. Higher values imply more risk aversion.	Z-score from staircase measure of risk attitudes developed by Falk et al. (2016). Higher values imply more risk aversion.	Z-score of the amount not invested in a risky lottery similar to Gneezy and Potters (1997). Higher values imply more risk aversion.
Pro-social attitudes	Z-score from social value orientation (R. O. Murphy, Ackerman, & Handgraaf, 2011). Higher values imply more giving to the in-group.	Z-score from dictator game. Higher values imply more giving to the in-group.	Z-score from dictator game. Higher values imply more giving to the in-group.
Negative emotions	.	Z-score based on the short-form of the negative affect schedule (PANAS) developed by Thompson (2007). Negative emotions include: afraid, nervous, upset, ashamed and hostile. Higher values imply stronger negative emotions.	Z-score based on the short-form of the negative affect schedule (PANAS) developed by Thompson (2007). Negative emotions include: afraid, nervous, upset, ashamed and hostile. Higher values imply stronger negative emotions.

Perceptions (perceived need to adapt)		
CC perception: past & future	To measure people's perceptions about CC impacts, we use self-reported assessments of droughts, cyclones, heavy rain falls, sea-level rise in general, coastal erosion and intrusion of salt-water in the past 10 years and in the future. Twelve questions in total, six for past[20] and six for future[21] perceptions were answered by the respondents. They reported their beliefs on 5-point Likert-scales which ranged from 1 "definitely has not (will not)" to 5 "definitely has (will)". The six answers about past (future) impacts are then averaged into one combined score with assigning equal weights to all six items. Higher scores imply stronger agreement that the event already happened (will happen). Using exploratory factor analysis to identify one single factor yields comparable results, but gives more weight to highly correlated items such as the SLR perceptions (higher, more erosion and more saltwater intrusion) and less weight to new information that the SLR perceptions do not.	
Relocation belief due to SLR	The relocation belief is based on two questions: (1) whether people believe they have to relocate in the next 5 years due to SLR ("absolutely certain"); (2) relocate sometime in the future due to CC ("uncertain when") and "very unlikely" if neither of the two questions was affirmed	The relocation belief is based on an 11-point Likert-scale which measures the likelihood to relocate permanently due to floods and erosion: 0-2 = very unlikely, 3-7 = uncertain when and 8-10 = absolutely certain.
Relocation likelihood due to SLR		The risk perception for livelihoods is based on an 11-point Likert-scale, which measures the likelihood of damages to their livelihoods due to floods and erosion: "How likely do you think it is that you have to relocate permanently from the place you currently live at due to floods or rising sea level? Please indicate your opinion on a scale from 0 to 10, where 0 means "impossible" and 10 means "absolutely certain"."
Risk perception for livelihoods by SLR	.	The risk perception for livelihoods is based on a single 11-point Likert-scale which measures the threat of damages to their livelihoods: "Do you think that floods and sea-level rise are threats to your livelihoods? Please indicate your opinion on a scale from 0 to 10, where 0 means "no threat at all" and 10 means "extreme threat"."

[20] Considering the PAST UNTIL NOW, did the following events already happen at the place you are currently living over the past 10 years? To what extent do you believe that […] already did happen?

[21] In the FUTURE, do you think the following events will happen at the place you are currently living. To what extent do you believe that […] will happen within the next 5 years?

Adaptation intentions	
Adaptation strategies	We did not ask directly what respondents would do to adapt themselves but rather what they would recommend other people to do. This helps us to avoid biases related to self-proclaimed behavior. The question was asked as an open question. We did not provide any answer categories but determined different adaptation measures in pre-tests that were then checked by the research assistants during the data collection. We identified the following adaptation measures to be relevant: sea-walls, planting mangroves, restoring the beach, moving within community boundaries and migration. Multiple answers were possible, and assistants wrote down other adaptation strategies if these were mentioned[22]. "Suppose sea levels will increase by 2 feet within the next five years. This would mean that waves become much stronger, more land will be lost to the sea, and saltwater will come further into the land on high tides. What would you recommend people living on low-lying islands (Solomon Islands) or in low-lying coastal areas (Bangladesh and Vietnam) to do today to prepare themselves?" Based on this question, we construct four different adaptation strategies.
Number of adaptation actions	Sum of all mentioned adaptation strategies. Ranges between 0 and 6.
Do nothing	The respondent did not mention any adaptation strategy.
Only local adaptation	The respondent mentioned at least one local adaptation strategy (sea-wall, mangroves, beach restoration, or moving within the community), but not migration.
Only migration	The respondent only recommended migration as a viable adaptation strategy to rising sea-levels.
Combination of local and migration	The respondent recommended both migration and at least one local adaptation strategy.

Notes: The complete surveys for all three data collections are available on request.

[22] 14 respondents mentioned other adaptation measures. In Bangladesh respondents mentioned for example that "People should be aware all the time", "Village people should stick together", "stay alert" or "Create a group in the village to discuss issues". In Vietnam, three respondents mentioned to increase the floor of their house as a viable way to adapt to higher sea-levels. When applicable, these responses were categorized as either local adaptation, migration or do noting (for example one respondent said "Wait until it comes".)

2.3.4 Estimation strategy

We apply a quantitative approach using survey data analyzed with econometric techniques. The objective of this application is to highlight the explanatory power of behavioral models in comparison to baseline models that include only physical capacities. We want to test whether behavioral models improve our understanding of why people adapt the way they do. We estimate two models using ordinary least squares, one baseline (1) and one behavioral model (2), of the following form for this comparison (as an example for the number of intended adaptation strategies, but all reported estimations follow a similar logic):

$$n\_adapt_i = \alpha_1 + \beta_1 exposure_i + \beta_2 X_i + \varepsilon_{i1} \quad (1)$$

$$n\_adapt_i = \alpha_2 + \beta_1 exposure_i + \beta_2 X_i + \beta_3 Z_i + \beta_4 + \varepsilon_{i2} \quad (2)$$

In the baseline model, we explain the number of intended adaptation actions (n_adapt_i) by a set of objective factors only: an exposure dummy ($exposure_i$) and a vector of socio-economic capacities (X_i) that include gender, marital status, age, education, household size, and household income. The behavioral models add a vector of explanatory variables (Z_i) that includes facilitating and intervening behavioral and psychological factors. These include risk appraisal (perceptions of future climate change impacts as a threat to one's livelihoods and cause for relocation), beliefs (help from outsiders, self- and outcome-efficacy, knowledge about CC) and cognitive traits (place attachment, pro-social attitude, patience, risk aversion, and negative emotions). We then compare how much of the variation, i.e., the (adjusted) R-squared in the number of intended adaptation actions are explained by the behavioral model in comparison to the baseline model. In addition, we use joint F-tests to evaluate the explanatory power of certain groups of facilitating and intervening factors to identify single factors that have the most influence on the outcome variable, i.e., the number of adaptation actions.

2.4 Results

The first part of the results (section 2.4.1) shows that respondents are highly aware of climate change impacts, especially SLR, and perceive the risk of climate-induced relocation as high within the near future, especially among the most exposed. Analyzing adaptation actions proposed by respondents shows their preference for local adaptation strategies and their reluctance to consider migration as adaptation at all. We use regression analyses to get a better understanding of the behavioral factors that shape perceived CC impacts, risks of relocating, and adaptation intentions. We test the explanatory power of our proposed behavioral model compared to a baseline model controlling for objective capacities. In section 2.4.2, we show that many people do not seem to have an option to migrate in case of temporary and permanent displacement. For those who do, the majority

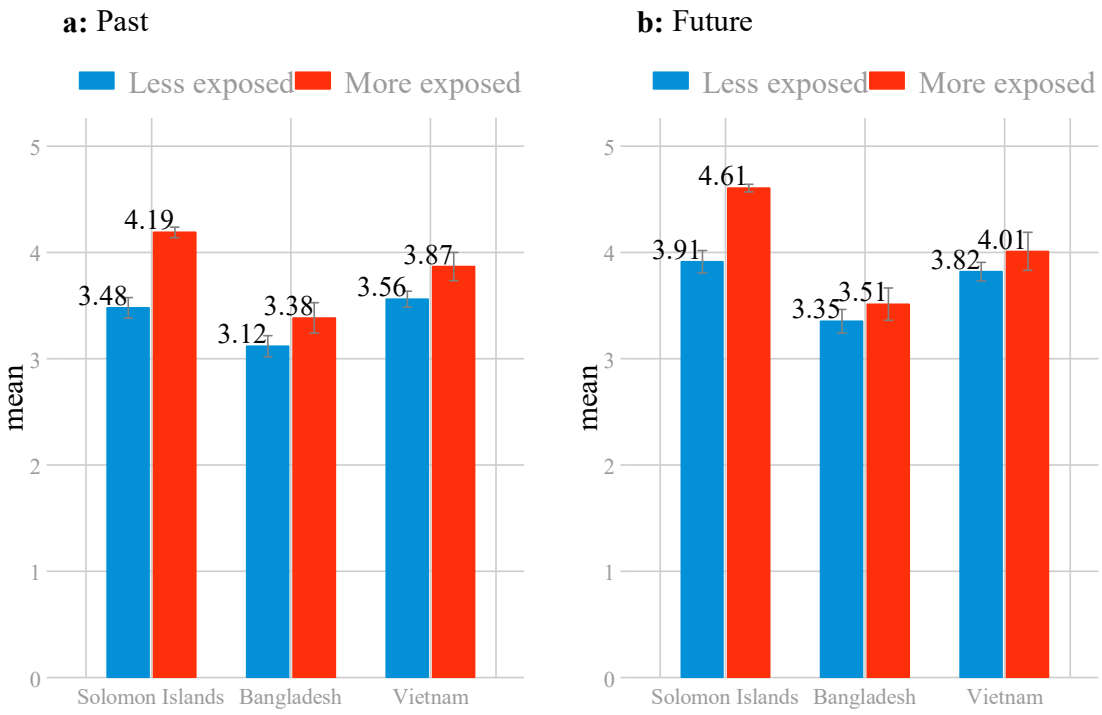
would migrate internally, moving to places close by. In the second part (section 2.4.3), we use the migrant-data from Solomon Islands to identify feedback effects on people's customs, norms, and traditions that might arise from migration.

2.4.1 Climate change perceptions and intentions to adapt

In terms of our proposed behavioral model, people can either learn directly through experiencing and observing changes in their environment due to climate change or through other information sources such as their social network, NGO's or the media. Additionally, people's beliefs (reliance on outside help, self-efficacy, and outcome-efficacy), narratives and identities (place) act as filters to any new information about CC, helping them categorize, interpret and process that information. This implies that people from the same area can have very different CC perceptions, even though they objectively face the same exposure. One might evaluate that her environment changed dramatically because of the observations she made, the news she listened to, and the beliefs she holds, while others do not.

Figure 2.3 shows people's perception of past climate change impacts (panel a) and their evaluation of the likelihood that these impacts will also occur in the future (panel b). Overall, we see that people are acutely aware of both past and future CC impacts, especially more exposed respondents living on low-lying islands. On average, more exposed respondents are not only more aware of changes in the past (Mann-Whitney U Test, z=-15.18, p=0.000), but also perceive them as more likely to happen in the future than less exposed respondents (Mann-Whitney U Test, z=-15.60, p=0.000). Across all three study sides, future climate change impacts are perceived to be even stronger than what respondents recall happened over the past 10 years (T-test average diff.=-0.33, p=0.000). With respect to sea-level rise impacts only, we find that 6.9% (n=42) of the more exposed respondents in our sample do not agree that sea-level will be higher and will cause more erosion and salinization of soils in the future.

Figure 2.3 Past & Future perception of CC impacts

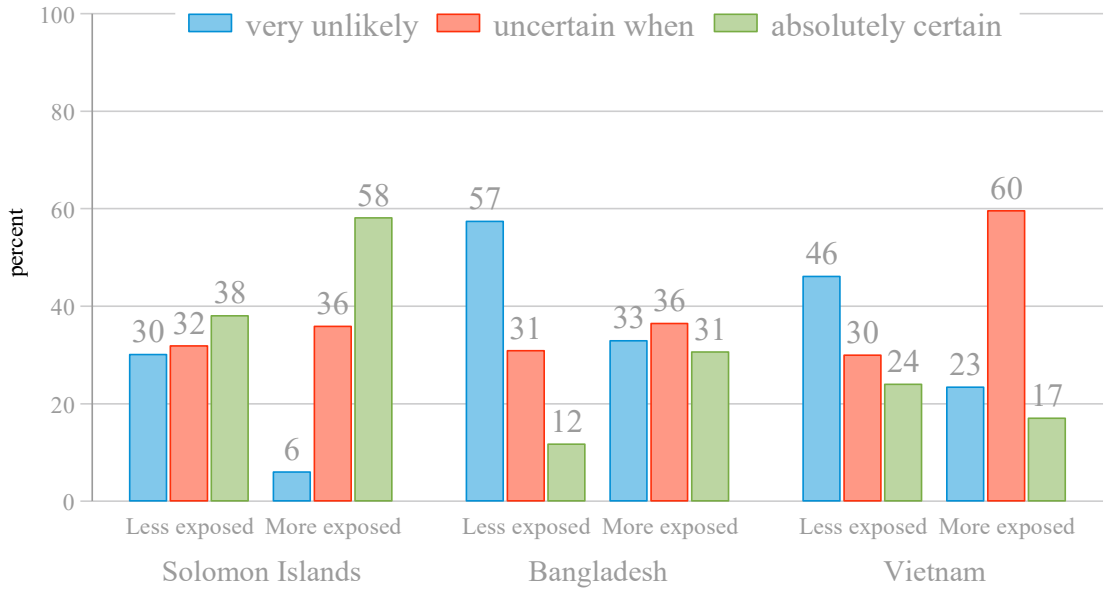


Notes: We measured agreement with the different impacts of climate change (higher sea level, more coastal erosion, droughts, heavy rains, salinization, and cyclones) on five-point Likert-scales ranging from "definitely has occurred/will not occur" to "definitely has occurred/will occur" for past and future CC perception respectively. We then take the average over all six impacts as a measure of people's general perception of climate change impacts.

Exposure to SLR seems to be the main factor that shapes the perception of climate change impacts. Regression analyses show that models based on our proposed behavioral framework are better in explaining variation in the perception of CC impacts (supplementary materials (SM), Table S1.1). The behavioral models that we can estimate for the Bangladesh and Vietnam samples, explain about 30% more of the variance in both past (R^2=0.15 vs. R^2=0.11) and future (R^2=0.15 vs. R^2=0.09) perceptions of CC impacts than the baseline model. Joint significance tests indicate that the set of socio-economic factors yield explanatory power for neither past nor future perceptions. In the behavioral model, importance placed in different information sources (internal, external and the media) and beliefs (outside help, CC knowledge, self-efficacy, outcome-efficacy, place attachment) are jointly significant throughout all model specifications. The most crucial factor for the past perception of impacts remains exposure (increases average past and future perceptions between 0.13 to 0.51 points). Higher values placed on internal information sources, lower self-efficacy and believed CC knowledge all increase the perception of past CC impacts. Perception of future CC impacts increases with self-proclaimed CC knowledge as well as lower outcome and self-efficacy. Interestingly, respondents who believe that outsiders (government, NGOs or rich countries) should help them deal with the impacts caused by CC have a significantly lower future perception of impacts.

While SLR impact appraisals are high throughout all samples, respondents differ noticeably in their perceived risks of having to relocate. On average, the more exposed respondents are significantly more convinced that they have to relocate because of SLR impacts than less exposed respondents ($Chi^2(2)=120.14$ p=0.000), see Figure 2.4. Nearly 60% of the highly vulnerable atoll islanders believe to be displaced within the next 5 years. Surprisingly, 38% of main islanders also say so. It is unclear why so many people on the higher-lying island believe to be displaced by SLR. Potential explanations could be the media and how they promote doomsday narratives of sinking islands states, the presence of NGO's that educate people about climate change or interviewer demand effects[23]. Overall, only 6% of more exposed respondents think they will not have to relocate compared to 30% in the less exposed sample. The proportion of people unsure about the risks is similar in both more and less exposed settings with 36% and 32% respectively.

Figure 2.4 Perceived risk of relocation



Notes: For Solomon Islands the relocation belief is based on two questions: (1) whether people believe they have to relocate in the next 5 years due to SLR ("absolutely certain"); (2) relocate sometime in the future due to CC ("uncertain when") and "very unlikely" if neither of the two questions was affirmed. In Bangladesh and Vietnam, the relocation risk is assessed on a single 11-point Likert-scale which measures the perceived likelihood to relocate permanently due to floods and erosion: 0-2 = very unlikely; 3-7 = uncertain when; 8-10 = absolutely certain.

In Bangladesh and Vietnam, people are generally less likely to believe that SLR impacts will force them to migrate. Even among the more exposed respondents, only 31%

[23] When including interviewer dummies as explanatory variables for the relocation belief, we find that agreement is significantly higher (about 18pp) when the interview was conducted by female research assistants, with similar effect sizes across more and less exposed areas. Assuming the interviewer effects are constant over time, the differences between less and more exposed people should be unbiased as the same research assistants conducted the interviews in both areas. However, the absolute share of people thinking they have to relocate within the next 5 years should be interpreted with caution and as an upper bound.

in Bangladesh and 18% in Vietnam are absolutely certain, while a large share of respondents is uncertain. One-third of the more exposed respondents in both countries believe that relocation is very unlikely, which seems to be at odds with the expected SLR impacts resulting in a discrepancy between the perceived strength of SLR impacts and relocation risks.

To analyze the determinants and potential factors that might reduce perceived relocation risks, we compare baseline models that only include objective factors (i.e., exposure and socio-economics) to models that are informed by our behavioral framework. The regression results for these models are reported in the SM, Table S1.2. We find that the behavioral models outperform the baseline models in all three samples, explaining 7% to 15% of the variation in relocation beliefs while the baseline models only explain 3% to 7%. Exposure, the major explanatory factor in all models, increases the perceived risk of relocation within the next five years by about 18pp (coeff.=0.18, p=0.075, 95CI=-0.02, 0.37) in Solomon Islands, by 2 points on the 11-point Likert-scale in Bangladesh (coeff.=2.09, p=0.000, 95CI=1.15, 3.02) and by 1 point in Vietnam (coeff.=1.02, p=0.049, 95CI=0.01, 2.03). Socio-economics only have explanatory power in the Bangladesh sample and are jointly insignificant throughout all other models. The importance placed in information sources are jointly significant in the Solomon Islands and Bangladesh samples, whereas they play no role in Vietnam ($F(4, 591)=1.15$, p=0.55). In Bangladesh, more religious people, measured by going to worship at least once per week, have a significantly higher relocation risk perceptions (coeff.=2.14, p=0.001, 95CI=0.93, 3.35), while there seems to be no difference in the other samples. In Solomon Islands importance of media as a source of information lowers risk perceptions (coeff.=-0.09, p=0.004, 95CI=-0.15, -0.03), given the data and modeling assumptions that we have made.

Beliefs of self- and outcome-efficacy of adapting successfully to CC impacts, reliance on outsiders, perceived CC knowledge, and place attachment are jointly significant ($F(5, 591)=3.10$, p=0.003). Self-stated reliance on outside help seems to decreases perceived future impacts, and it also reduces the perceived relocation risk (coeff.=-0.81, p=0.007, 95CI=-1.40, -0.22). In addition, respondents that are more attached to their homes seem to be more reluctant to perceive SLR impacts as a threat for relocation. A one standard deviation increase in place attachment decreases the perceived risk by 0.46 points (coeff.=-0.456, p=0.002, 95CI=-0.74, -0.17).

Result 1: *While people are acutely aware of CC impacts in all three study regions, this does not translate equally into the belief that SLR impacts will cause displacement. The behavioral models are better at explaining variation in CC risk assessment. We identify reliance on outside help and place attachment as intervening behavioral factors that potentially explain the gap between risk appraisal and adaptation intentions.*

Next, we will analyze the respondents intended adaptation actions to accelerated SLR derived from a hypothetical scenario where sea levels would rise by 2 foot (61 cm) within the next five years. Table 2.3 shows differences across groups in the intended adaptation strategies. On average, respondents mentioned about two adaptation strategies. More exposed respondents mentioned 13% more strategies than less exposed respondents ($Chi^2(5)=24.25$, p=0.000). Only 5% (n=63) of respondents did not mention any adaptation strategy, whereas less exposed respondents are slightly more likely to recommend nothing ($Chi^2(1)=5.39$, p=0.020). Overall, the majority with 54% (n=729) recommends local adaptation measures, where the most often named measure are sea-walls (82%) followed by planting mangroves (50%) and moving within the community boundaries (42%). Least preferred (33%) are beach nourishment measures that try to counteract erosion. The descriptive results on these adaptation actions can be found in the SM, Figure S1.1.

Table 2.3 Adaptation intentions

	Total	Solomon Islands	Bangladesh	Vietnam
Do nothing	4.69	1.12	10.12	7.87
Only local	54.24	46.23	50.20	71.92
Only migration	12.13	19.41	5.67	2.62
Local & migration	28.94	33.24	34.01	17.59
Total	100.00	100.00	100.00	100.00

Notes*:* Own data collection. All numbers represent percentages.

More exposed respondents tend to recommend local adaptation ($Chi^2(1)=6.27$, p=0.012) and are less likely to recommend migration only ($Chi^2(1)=6.61$, p=0.001) compared to the less exposed respondents. The intentions of more exposed respondents to predominantly adapt locally seems counterintuitive at first glance, as we have shown before that they have higher climate change appraisal. About one-third of respondents recommend a combination of local strategies and migration, highlighting the preference of people to fortify in place as long as possible and prolong the time until relocating. No one wants to give up their land, as land is a highly contested resource in all three study sites. Especially in Solomon Islands, where over 90% of the land is owned under customary law, and it is a fundamental part of traditional island culture. Therefore, many people are reluctant to sell their land in fear of giving away the future of their children. As a result, it is almost impossible for atoll islanders to find land to relocate to on their own without any help by the government[24].

[24] The government of Solomon Islands has recently started their first investigations for a national relocation program that could help affected atoll islanders to find suitable land to resettle to and provide them with the resources they need. This plan is, however, still far away in the future and given the history of ethical tensions due to land rights issues and the problems associated with the customary land tenure system, it remains questionable whether they will be successful (source: conversations with members of the Solomon Island ministry of environment, climate change and disaster management during the field research in 2017.)

We use the identified behavioral and cognitive factors from our proposed behavioral framework to explain the divergence between assessment of impacts and risks and the strategies to adapt using regression analyses. The detailed multivariate regression outputs are reported in the SM, Table S1.3 to Table S1.6. We compare behavioral models that additionally include CC assessment, beliefs and individual preferences (pro-social behavior, patience, risk aversion) to baseline models, which include socio-economics and objective exposure to the impacts caused by SLR. Again, the behavioral models are significantly better in explaining variation in the number of recommended adaptation actions and the likelihood of recommending migration (both only migration and a combination of local and migration).

Regarding the total number of recommended adaptation actions (SM, Table S1.3), the behavioral models explain between 12% to 33% of the variation compared to 4% to 6% of the socio-economic baseline models. While F-tests indicate that socio-economics are jointly significant, they play a minor part in explaining the number of recommended adaptation actions. The before mentioned CC assessment, perception of future impacts and relocation risk, are jointly significant and increase the number of intended adaptation actions. One major intervening factor is the reliance on outsiders to help in case of CC impacts. Respondents who rely only on outsiders mention nearly one adaptation strategy less than respondents who say they also rely on themselves, their communities or social networks to adapt (coeff.=-0.926 p=0.000, 95CI=-1.03, -0.82). The effect is most substantial in Solomon Islands but remains highly significant in the other two samples as well. Surprisingly, the measured economic preferences do not add any explanatory power in the Bangladesh sample at all. In Vietnam only risk aversion is significant, where respondents who are more risk-averse by one standard deviation recommend 0.13 adaptation actions less (coeff.=-0.128 p=0.013, 95CI=-0.23, -0.03).

For recommending staying versus going (SM, Table S1.4), i.e., the respondent mentioned migration as one of the adaptation strategies; the behavioral models explain between 8% to 15% of the variation compared to 4% to 10% of the socio-economic models. Socio-economics seem to play no role in the Solomon Islands sample, while they remain jointly significant in the behavioral models for Bangladesh and Vietnam. On average, more exposed respondents are about 16 percentage points less likely to recommend migration (coeff.=-0.165 p=0.000, 95CI=-0.23, -0.10), with stronger effects in Solomon Islands compared to Bangladesh and no effect in Vietnam[25].In reverse, more exposed respondents recommend local adaptation actions. Regarding the reliance on outside help, the effects differ across samples. While reliance promotes recommending migration in Solomon

[25] This could be because respondents in the Vietnam sample are more equally exposed to the impacts of CC than in Bangladesh or Solomon Islands. In total, we could only identify 47 respondents to be clearly more exposed than others in Vietnam.

Islands (coeff.=0.10 p=0.005, 95CI=0.03, 0.17), it has the opposing effect in Bangladesh (coeff.=-0.15 p=0.011, 95CI=-0.27, -0.04) and no effect in Vietnam. Again, the set of preferences do not add much to the understanding of why people intend to stay or move; they are jointly insignificant in Bangladesh ($Chi^2(4)=2.13$, p=0.72) and Vietnam ($Chi^2(4)=4.93$, p=0.30).

Result 2: *Most respondents want to stay and adapt locally, notably respondents who are more exposed. The behavioral models highlight heterogeneity across samples and contexts in the explanatory factors of adaptation actions. Reliance on help from outside seems to be the main intervening factor for respondents to consider more adaptation actions. The most exposed respondents seem to put a higher on local adaptations and less on migration.*

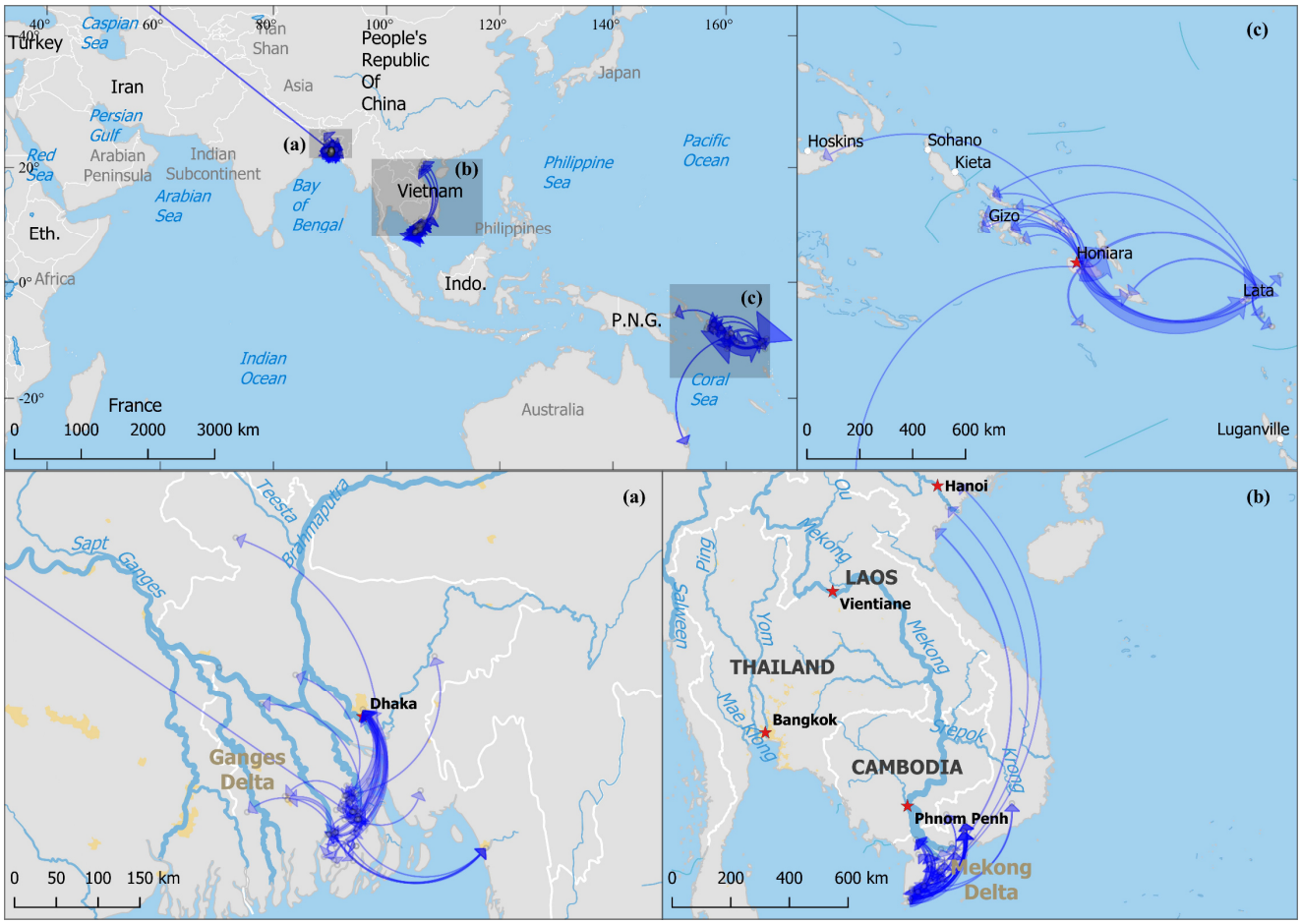
In the next section, we will analyze where respondents would move to in case they have to relocate temporarily and permanently because of a sudden environmental disaster or slow onset events that render life impossible at the current place of residence.

2.4.2 The role of social networks for migration

In this section, we focus on the social networks that respondents could rely on, which can be interpreted as a form of adaptive capacity people invest in and offers insights into the feasibility of (international) migration as adaptation. Between 40% to 50% of respondents across all three research areas have no place to go in case of permanent displacement, as they do not anyone they could rely on outside their place of residence[26]. The arrows in the map (see Figure 2.5) show where people who have an option would move to in case of permanent displacement due to SLR. These options are almost exclusively within borders. The most likely migration destinations are close-by urban centers. In Bangladesh and Solomon Islands these are the capitals (Dhaka and Honiara), while in Vietnam, the closest urban center to the research area is Ho Chi Minh City. In addition, short movements within the same province to bigger cities are also likely. Most strikingly, however, is that almost none of the participants have the means to migrate across borders. Only three respondents report having the option to move to Australia, Papua New Guinea or the USA.

[26] In Solomon Islands we only asked 425 respondents these questions (halft the sample), where 49% of them reported to have no one they could rely on in case of permanent displacement. In Bangladesh (39%) and Vietnam (37%) the share of people with no option was slightly lower.

Figure 2.5 Migration flows of people who have an option in case of permanent displacement



Notes: Map (a) shows Bangladesh, (b) Vietnam and (c) Solomon Islands. All flow maps were created in QGIS. The thickness of each flow between origin and destination is adjusted to the share of all respondents who have an option. Thicker arrows indicate that more people from one place would go to one specific migration destination in case of permanent displacement.

In Bangladesh and Vietnam, we directly asked how far respondents would move in case of temporary and permanent displacement from their current home. In the temporary displacement scenario, respondents would move on average within 30 kilometers (30.4 ± 112.7) from their current home, while in the permanent scenario respondents would move about 131 kilometers (131.6 ± 282.1) on average. Yet, these averages mask substantial heterogeneity in responses, as 90% of respondents would temporarily (permanently) move within 60 (350) kilometers. Over 50% would stay within the community by only moving up to 3 kilometers in the temporary scenario, while about 25% would stay in the same community in the permanent scenario.

Result 3: *In case of permanent displacement there would be many people that have no option to move to. Even if they have an option, this would be close-by and probably also exposed to the hazards in the magnitude as proposed in the hypothetical scenario. Only three respondents seem to have an option to migrate across borders.*

2.4.3 Feedback effects of migration on social cohesion in Solomon Islands

In this section, we use the full sample from Solomon Islands to explore potential feedback effects of migration on cultural values and more generally social cohesion. Resettlements due to various reasons (development projects like dams, war, natural disasters, etc.) can be detrimental for mental health (Fullilove, 1996) and can lead to cultural losses (Adger, Barnett, Brown, Marshall, & O'Brien, 2013). The data allows us to compare atoll migrants to their traditional peer-group, atoll islanders, and new peer-group, main islanders. As has been discussed, migration is always a multi-complex decision problem, and people that already migrated rarely point out environmental factors as the main driver for the movement. Nevertheless, we believe that studying the effects of past voluntary migration-flows yields valuable (lower-bound) insights on what cultural impacts people might experience in more extreme scenarios of forced displacement or organized resettlements. Table S1.9 in the SM shows that respondents differ significantly in socio-demographic aspects, which suggests selection in terms of what people decide to move from the atoll to the capital. We find that migrants are more similar to their new peer-group in terms of observable characteristics compared to their traditional peer-group. They are on average younger, better educated, less likely to be married, less religious, and have higher cash income's than atoll islanders. Therefore, we also rely on variations in the time spent at the new location within the migrant's samples, to get an idea about the selection of people that decide to move to the capital.

The adaptive potential of migration, or more general mobility, is nothing new for indigenous island communities which used migration or more generally mobility for centuries to adapt to population and environmental pressures (Andreas E. Christensen & Mertz, 2010; Andreas Egelund Christensen & Gough, 2012). On the one hand, migration has the potential to ensure physical safety by moving to locations that are less impacted and risky. On the other hand, it could also destabilize social safety by disrupting the livelihood strategies people rely on and eroding social cohesion of communities at both migration origin and destination. We concentrate the analysis on six survey questions that aim to capture this phenomenon to some degree. The first set of questions focuses on the normative and empirical expectations about practices that were identified as very important for an islander's self-identification: language, keeping in touch, and lifestyle changes. Expectations were elicited using binary response questions on whether the respondent agreed or disagreed with the behavior in the statement (see panel a, Figure 2.6). The second set of questions elicit the participation in community activities and the adherence to a hypothetical community decision, which serves as a proxy for social cohesion. This is also seen as an essential part of the islander's identity (see panel b, Figure 2.6). The questions about the respondent's participation in collective actions and expected punishment in case of not participating in those were collapsed into binary measures due to clustering of

observations in two answer categories. We want to raise caution about the interpretation of our findings, as the observed differences could be affected by a self-serving bias. Respondents might want to maintain a positive self-image by stating, for example, that it is not wrong to adopt a new lifestyle or that it is acceptable to ignore a group decision. We tried to minimize this issue by asking respondents whether they think it is acceptable for others to people engaging in this behavior and not directly about their own behavior, whenever possible.

We compare the share of migrants and atoll islanders that agree to these statements. Within the migrant sample, we additionally distinguish between first- and second-generation migrants from the atolls, as about 50% of them were born in the migrant's settlement. Thereby, we are able to investigate whether expectations of social practices and social cohesion potentially erode over time (generations). With regard to social practices, we observe gaps in normative expectations between second- and first-generation migrants, but not as much between first-generation migrants and atoll islanders (see panel a, Figure 2.6). Only 18% of second-generation migrants agree that it is wrong for migrants not to visit their island, significantly less than for fisrt-generation migrants and atoll islanders (Fisher's exact[27], $p<0.01$ respectively) who share very similar expectations on this topic (Fisher's exact, $p=0.17$). Second-generation migrants are more optimistic that they do not forget their traditional language (only 36%), while first-generation migrants and atoll islanders, 70% and 60% respectively, are much more likely to say this as a problem (Fisher's exact, $p<0.05$ respectively). This result could be driven by the before mentioned self-serving bias, that second-generation migrants do not want to accept that they cannot correctly speak their traditional languages anymore[28].

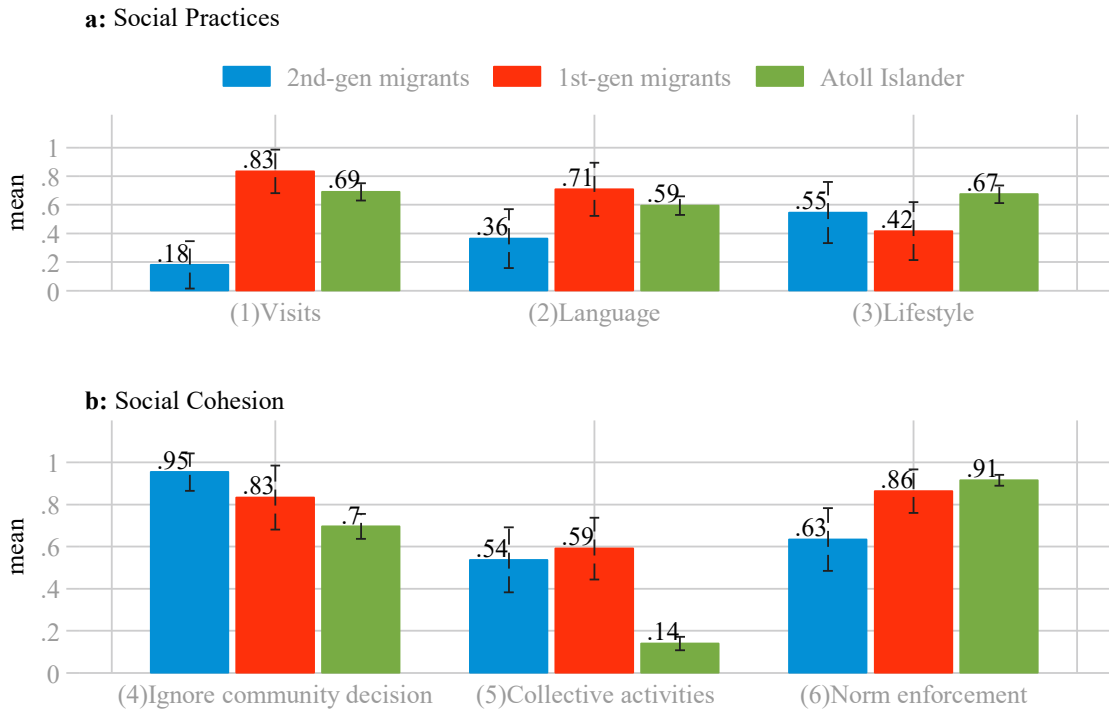
The main occupation of the small islands inhabitants is gardening and fishing. People there have no need to earn money to sustain their livelihoods. Therefore, the small-island lifestyle is very different from everyday life in the capital. On average, 40% of migrants prefer island life to a job and earning money in the capital. The majority of respondents do not think it is acceptable to adopt the city lifestyle. Only first-generation migrants tend to be less likely to agree with this statement than atoll islanders (Fisher's exact, $p=0.02$), but not second-generation migrants (Fisher's exact, $p=0.56$). To sum up our findings of social practices, we find that second-generation migrants have distinct normative and empirical expectations that are different from both first-generation migrants and atoll islanders.

We will now focus on the effects of migration on social cohesion, by comparing the self-stated frequency of participation in collective activities, the expectations of getting

[27] We use Fisher's exact tests, as the frequency in some cells of the 2x2 contingency table is lower than five. Results are robust to using chi-squared tests.
[28] In line with this argument, participants in our focus groups discussion said that younger generations lost traditional skills and knowledge, such as the ability to build, use and navigate with dugout canoes.

punished for not participating in those collective activities and whether they would ignore community decisions or not (see panel b, Figure 2.6). Collective activities and their enforcement through sanctioning or criticism are essential determinants for reaching common development goals and the foundation for building trust and cooperation within a community.

Figure 2.6 Erosion of social practices & cohesion



Notes: Number of observations for the first four questions: 2nd-generation migrants N=22, first-generation migrants N=24, and atoll islanders N=227. For questions (5) and (6): 2nd-generation migrants N=41, first-generation migrants N=44, and atoll islanders N=458. The wording for the questions shown in panel **a**, is: (1) "Do you think it is wrong, that some people who moved to the capital never visit the island they originally came from?" (yes/no) (2) "Do you think that people who move to Honiara forget their traditional language and start to speak only Pidgin and English?" (yes/no), (3) "Do you think that it is wrong for people who move to the capital to copy the lifestyle of other people living in the capital?" (yes/no) and in panel **b**: (4) "Suppose your community is strongly affected by climate change. Would you consider relocating even if all of your community decides to stay?" (yes/no) (5) "Altogether, how many times in the past 12 months did you participate in community activities for common development goals? (1 = at least a couple of times per year; 0 =never) (6) "How likely is it that people who do not participate in community activities will be criticized or sanctioned? (1 = likely; 0 = not likely). 95%-confidence intervals are indicated by the dashed lines.

We find that participation in collective activities is much less common among atoll migrants compared to non-migrants. About 41% of first and 46% of second-generation migrants participated only a couple of times in collective activities in the past 12 months. On the atolls, people are much more likely to cooperate for common development goals (Fisher's exact, $p<0.01$ compared to both migrant groups), as over 80% did take part in such activities, while 25% say they contribute on weekly or even daily basis. The lower participation in collective activities by migrants could be driven by lower expectations to get punished for not participating. However, we find that this mechanism could only apply

to seocnd-generation migrants, as a significantly lower share of them think punishment is likely compared to first-generation migrants (Fisher's exact, $p<0.05$) and atoll islanders (Fisher's exact, $p<0.01$). It could be that collective actions are deemed less important in migrant settlements as people shift their focus on earning money and report to have many more friends from outside their tribe. Additionally, second-generation migrants are much more likely to consider relocating even if their whole community unanimously decides to stay compared to atoll islanders (95 vs. 70 per cent; Fisher's exact, $p<0.01$).

In sum, it seems that migration has the potential to erode social practices over time, and migrants tend to value collective actions and community decisions less. So far, we have only compared simple averages across groups and did not control for the observed differences between groups. It could be the case that differences, for example, in the acceptability not to visit your home island, are driven by income. Some people might not be able to afford going back to their home islands. We tackle these robustness issues in the SM (Table S1.7) where we use multivariate probit regressions that control for socio-demographics. Our findings are robust to controlling for differences in socio-demographics, and we identify marital status, income and worship as determinants of social practices and cohesion in our models. Additionally, we regress models only with the migrant sample (SM, Table S1.8) and plot the predictive margins of these estimations over the fraction of lifetime spent in the capital to visualize the impact of time on social practices and cohesion (SM, Figure S1.2). These models predict that people who spent a higher fraction of their lifetime in the settlement are less likely to think it is wrong not to visit one's home island, are more likely to ignore a community decision and are less likely to expect any punishments for not participating. Interestingly, participation in collective activities drops the moment one arrives in the capital, which could be a further indication for the lower prevalence of such actions in the settlements.

Result 4: *Atoll islanders that voluntary migrated to the capital due to various reasons adapt their customs and norms to their new peer-group, highlighting the potential of cultural and social impacts that involuntary displacements and planned resettlements can have.*

2.5 Discussion

Many atoll islanders who participated in our study were strongly convinced that their island will completely erode in the near future (85%) and most of them thought their island was already getting smaller (76%). Once we showed them satellite pictures depicting changes in shorelines of their island since the 1970s, they seemed to realize that their island

did not get smaller yet[29]. This information was genuinely new for most participants in focus group discussions we conducted. While higher sea levels can increase the strength of currents and waves, that might erode islands, these stronger currents and waves can also increase the amount of sediments deposited on the islands, increasing their size (Birk, 2014; Paul S. Kench, Ford, & Owen, 2018; P.S. Kench, Thompson, Ford, Ogawa, & McLean, 2015; Mann & Westphal, 2014; Woodroffe, 2008). The doomsday narrative of inundated islands and displaced people due to rising sea levels was so dominant in participant's minds that they overlooked that their island actually did not start to erode yet.

The empirical application of our conceptual framework in three regions most vulnerable to rising sea levels highlights the differences in adaptation behavior that can already occur at the individual level. Our results are in line with the presented framework (see Figure 2.1) and show that objective displacement threats do not necessarily translate into migration. First and most importantly, the results show that people have a substantial perception-intention gap, which cannot be explained by socio-economics. Although respondents seem to be highly aware of the impacts, and many perceive themselves to be at risk to relocate, higher risk appraisals seem to dampen intentions to migrate. Moreover, the most exposed respondents seem to be the least likely to consider migration as adaptation. Second, we identify several psychological and behavioral factors that shape perceptions of impacts, relocation risk, and intentions to adapt in predictable ways. In almost every occasion, the behavioral models outperform the baseline models in explaining risk appraisal and adaptation intentions. Perceptions of future climate change impacts are shaped by how people learn about them (both experiential and analytical) and beliefs (outside help, self- and outcome-efficacy, knowledge of CC). Reliance on outsiders to help respondents deal with climate change impacts is identified as a significant impeding factor for risk appraisal and adaptation intentions. The most important objective factor throughout all models is exposure to SLR impacts. It increases risk appraisal, tends to reduce intentions to migrate, and promotes local adaptation actions. Contrary to our predictions, preferences, and emotions seem to play only a subordinate role. Place attachment, social attitudes, and risk preferences are only occasionally significant explanatory factors in explaining respondent's adaptation intentions. The results presented here are highly context depended and do not necessarily convey to other social contexts, climate change impacts, and regions. They mainly serve as an illustration of the importance of people-centered approaches and to illustrate the variability at the individual level that cannot be predicted with socio-

[29] According to a study from Birk, (2014), none of the islands in our sample experienced any net loss in size. Some of the neighbouring islands, not included in our study sample actually increased. Islanders who visited these islands recently and remembered how they used to look in the past confirmed the findings by Thomas Birk that despite rising sea levels these islands did not suffer from erosion but actually became larger in size over the last 50 years. Further, checking up to date satellite pictures we found no significant changes from 2005 to 2019.

economics alone. It remains to be studied how perceptions and intentions to adapt vary across different global changes in different regions. For example, adaptation actions could be affected by the temporal dimension of impacts; as sudden events such as floods or storms are much more visible due to their immediate impacts than slow-onset events like SLR or droughts. There is some evidence that points in the direction that perceived impacts of fast-onset events (floods, storms) lead to more internal migration and slow-onset events (droughts, salinization) to more local adaptation, at least in Vietnam (Koubi, Spilker, Schaffer, & Bernauer, 2016). This is in line with the empirical results shown here, where local adaptation actions in response to SLR are by far the most favored strategy in Vietnam.

Studying decision-making at the micro-level requires substantial efforts in collecting primary data by the researcher and relies on the voluntary participation of people. Although finding people willing to participate in Solomon Islands was not an issue some people in Bangladesh and Vietnam preferred to not take part in the survey. We are aware that survey-based instrument might not necessarily be the best measurements for some of the behavioral aspects we measured, especially preferences. However, we implied monetary incentives whenever possible and only used survey items that have already been tested before[30]. Survey data is known to be prone to hypothetical biases and demand effects (Mummolo & Peterson, 2019; J. J. Murphy, Allen, Stevens, & Weatherhead, 2005). We tried to avoid this as much as possible. For example, by explicitly asking respondents not what they would do to adapt to rising sea levels but instead what they would recommend other highly exposed people to do. Consequently, we measure adaptation expectations, not adaptation behavior. One might argue that measuring expectations abstracts from people's personal capacities and thus socio-economic capacities explain unsurprisingly little in our empirical models. This argument would, however, imply that capacities do not affect expectation; an assumption we find highly debatable. Moreover, we do find that respondents, notably those who are more exposed, are more likely to recommend multiple adaptation strategies. It seems the more affluent and less affected people are, the more likely they are to name only migration as an adaptation strategy. On the other hand, the result that people prefer local adaptation strategies over migration could be due to the fact that respondents believe that migration is outside their realm of possible actions and conversely adjust their narratives and preferences (Bruckner, 2009; Nowak et al., 2017). Since intentions to adapt already do not translate well into actual adaptation behavior (Ajzen, 1991), we have little illusions about how well recommended strategies translate into personal behavior. Thus, we see our results on adaptation recommendations less as behavioral predictions and more as a measurement of what adaptation strategies respondents consider.

[30] Either by other researchers or in pre-tests we conducted with a separate sample at each study side.

2.6 Conclusion

The focus in the climate (environment) induced migration literature has been mostly on objective factors, such as exposure, institutions, power relations and socio-economic capacities, to determine adaptation actions in a simplistic or even deterministic way. The presented conceptual framework takes a people-centered approach to draw attention to subjective factors, i.e. psychological or behavioral, that shape perception, adaptation intentions, and actual adaptation strategies. Nevertheless, we recognize that meso- and macro-level factors (R. Black et al., 2011; Rigaud et al., 2018), historically embedded cultures of disaster management (Bankoff, 2003) and economic and political contextual factors (R. McLeman & Gemenne, 2018) are essential for enabling and impeding specific adaptation strategies. We see, however, our main contribution as conceptual by integrating insights from different disciplines and highlighting factors that have received little to no attention in much of the migration literature. The people-centered empirical application presented here shows that these subjective factors are indeed crucial for understanding adaptation strategies in response to climate change, in addition to the contextual factors at higher scales. While we chose to study SLR impacts to illustrate the behavioral framework, it can easily be adapted to other climate change impacts (including rapid onset events), environmental impacts in general or demographic, economic and political stressors.

We bring together insights from two existing frameworks, the Foresight, and the MPPACC framework. First, the Foresight framework developed by R. Black et al. (2011) depicts the decision to migrate as a binary decision between staying or going. We do not think that this dichotomous view gives justice to the reality of people adapting to extreme changes in their environment, as many case studies have shown (Esteban et al., 2019; Jamero et al., 2017). Second, we consider psychological factors identified in the MPPACC framework by Grothmann & Patt (2005) that have been largely ignored in the environmental migration literature, and add additional facilitators that were identified in a recent meta-study to drive adaptation decisions (Valkengoed & Steg, 2019), such as the long-known but often neglected role of place attachment (Devine-Wright, 2013; Feitelson, 1991). Third, R. Black et al. (2011) assume that individual preferences are not systematically affected by environmental changes. However, there is emerging empirical evidence in economics that experiencing natural disasters indeed changes underlying economic preferences such as patience, risk and pro-social attitudes (Brown, Daigneault, Tjernström, & Zou, 2018; Callen, 2015; Cassar et al., 2017; Hanaoka, Shigeoka, & Watanabe, 2018; Whitt & Wilson, 2007). Not including such changes in preferences, but merely viewing them as mediators in the decision process, would lead to biased predictions of migration figures. Lastly, we consider feedback effects to include dynamics that emerge from people (not) adapting to highlight the interrelation between individual actions and global changes. Ultimately, changes at the regional and even global scale are the result of

millions of people making decisions on how to adapt. For example, movements of many communities to one migration destination can create pressures there, which could spark conflicts. A static framework, reducing adaptation to a binary decision of staying vs. going, could not account for the interrelation between migration and adaptation. Migrants who find work, or create new jobs, in near urban centers are able to send back remittances and acquire knowledge that can be transferred back and to be utilized to reduce vulnerability (Ng'ang'a et al., 2016; Nguyen et al., 2015).

We believe that studying migration in unison with other adaptation actions that are available in place and understanding the psychological and behavioral barriers to adaptation could move the climate migration debate away from fatalistic scenarios of mass migrations. These insights are equally important for policymakers, as different challenges arise from migration and staying. Migration will most likely lead to increased urbanization (Henderson, Storeygard, & Deichmann, 2017; McGranahan, Balk, & Anderson, 2007). Understanding when people will move can help policymakers to facilitate such movements by redirecting investments, e.g., in schooling or housing. If cost-efficient adaptation strategies are available and viable, these need to be provided and promoted. If relocation is inevitable, development of relocation programs must start well in advance in collaboration with affected communities to give justice to their needs and preferences. For government officials, this might be just one more administrative task, but for the people being resettled, this is probably one of the most important decisions in their life. Many governments in low- to medium income countries already struggle with the task of providing essential public goods. This might be one issue where assistance from high-income countries could be extremely effective. High-income countries should take responsibility for the emissions emitted over the last two centuries that is changing today's climate. The projected 67 billion of financial assistance, where only one-fifth is planned for adaptation, in 2020 (OECD, 2016) is not enough.

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Chapter 3: Influence of sea level rise on discounting, resource use, and migration in small island communities: An agent-based modelling approach

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Abstract

Time discounting—the degree to which individuals value current more than future resources—is an important component of natural resource conservation. As a response to climate change impacts in island communities, such as sea level rise, discounting the future can be a rational response due to increased stress on natural resources and uncertainty about whether future generations will have the same access to the same resources. By incorporating systematic responses of discount rates into models of resource conservation, realistic expectations of future human responses to climate change and associated resource stress may be developed. This paper illustrates the importance of time discounting through a theoretical agent-based model of resource use in island communities. A discount rate change can dramatically change projections about future migration and community-based conservation efforts. Our simulation results show that an increase in discount rates due to a credible information shock about future climate change impacts is likely to speed resource depletion. The negative impacts of climate change are therefore likely to be underestimated if changes in discount rates and emerging migration patterns are not taken into account.

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3.1 Introduction

Climate change will have widespread impacts on human and natural systems on small islands, as sea levels rise and natural disasters become more frequent. The Fifth Assessment Report of the IPCC projected that global mean sea level will continue to rise by 52-98 cm by the year 2100 (Church et al. 2013). A modelling approach by Nicholls et al. (2011) estimated that a 0.5 - 2.0 m rise in sea level would cause displacement of 1.1 - 2.2 million people from the islands in the Caribbean, Indian Ocean and Pacific Ocean alone. Sea level rise (SLR) has been three to four times more severe in Solomon Islands compared to the global average, with about 8mm per year since 1993 (Becker et al. 2012). These projections highlight the risks faced by island communities in the Pacific, as many may become uninhabitable in the future.

Since investments in adaptation or mitigation made today only accrue benefits in the future, individuals and societies often cater to needs that are more immediate and urgent. Even if there are well-considered plans about what ought to be done in the future, people may give in to temptation and abandon the pre-determined plans when the future finally arrives (Hoch & Loewenstein 1991; O'Donoghue & Rabin 1999). The tradeoffs an individual makes between costs and benefits at different points in time may be summarized by the concept of discount rate. An individual's discount rate is the amount of additional future income or happiness that can compensate for the loss of one unit of income or happiness today. Discount rates are an essential concept when thinking about the conservation of common-pool resources (CPRs), since lower levels of CPR exploitation today can increase future yield. Economic theory suggests that people who value the future relatively more will exploit a CPR less. For instance, fishermen with higher discount rates exploit a CPR more intensively than fishermen with lower discount rates (Fehr & Leibbrandt 2011).

Traditional economics treats preferences as given and fixed for individuals—in other words, preferences are generally assumed to be exogenous to models of behavior. With exogenous preferences, there is no persistent shift in preferences due to exposure to external shocks, institutions or culture. On the other hand, it is likely that certain types of preferences—including discount rates—are endogenous to the behavior of real-world actors. This would have important implications for resource conservation on small islands, as these are especially prone to SLR. Albert et al. (2016) highlight the impact of rising sea levels and wave exposure on small islands in Solomon Islands using aerial time series and satellite images from 1947 to 2014. Out of 33 studied reef islands, five islands were already inundated and a further six are severely eroded. There are already entire villages resettling in Solomon Islands and the Pacific.

People living on atolls who anticipate this potential scenario might realize that the resource they are conserving for the future is losing its future benefits. However, if future

benefits cannot be realized—because individuals have to migrate and find a new economic occupation elsewhere—it becomes rational to stop conserving for the future and increase harvesting until resources are fully depleted. Moreover, this has important implications for migration. Migration is one of the most salient experiences of island life in Oceania, and mobility is the basis for institutionalized tribute and clan networks between islands (Malm et al. 2007). With increased resource stress, migration will continue to supplement local resources and serve as an insurance policy in times of distress. Often people can rely on relatives on other islands or in the Pacific diaspora to receive food and material or to find temporary refuge when disaster hits (Alkire 1965; Peter 2000). We turn next to a discussion of the theory of discount rates and resource exploitation, as well as a grounded example of overexploitation at work in an island setting.

The standard assumption in economics is that discount rates, as well as other preferences, are fixed attributes of individuals. There also exists a large body of research on discount rates and the way they vary across people and contexts. For instance, laboratory evidence suggests that discounting is greater in the immediate future than in the farther future. This is illustrated in Thaler & Shefrin (1981), where the median subject is indifferent between $15 now and $20 in one month (annual discount rate of 345%) and between $15 now and $100 in ten years (annual discount rate of 19%). This time inconsistency is not explained by inflation, which devalues future benefits and opportunity costs of investments or the inherent uncertainty of the future.

These varying annual discount rates may be a result of self-control problems, where people are tempted to do things they know are not good for them in the long run (Mischel et al. 1989). For instance, when individuals look into the far future they may plan to make important and difficult changes to their behavior, such as starting an exercise program or to stop smoking later in time. But when "later" arrives, discounting increases and individuals may procrastinate further rather than follow through with their plans. Recent research provides evidence on how experimental measures of discount rates can predict lifetime outcomes and individual behavior. These include, for example, smoking, alcohol use, exercise, doing homework and managing deadlines, health behavior, credit card borrowing, or defaulting on retirement plans (Khwaja et al. 2006; Chabris et al. 2008; Meier & Sprenger 2010, 2013; Castillo et al. 2011; Sutter et al. 2013;). Explanations for such behaviors have been argued to be deeply rooted in our neural system, in that payoffs in the present activate different neural systems from decisions involving only future payoffs (McClure et al. 2004). Some theoretical models even assume multiple personalities: a present "me" and a future self. While the future self is unknown and has unknown needs, one is concerned with satisfying the needs of the present me (Fudenberg & Levine 2006).

Similarly, game theory predicts that cooperation is driven by the possibility of future interactions, which prevent or limit opportunistic behaviors. This is supported by

experimental studies that compare the results from infinitely repeated games with the results from finitely repeated games to test whether cooperation depends on the shadow of the future, as theory predict (Dal Bo 2005, Blake et al. 2015). Humans have evolved well-functioning institutions of property rights to allow resource users to reap the future benefits of their investments. The strength of such institutions and norms of cooperation are also shaped by society (Hofstede 2001).

The idea that preferences may be endogenous questions the foundations of standard economic theory, as preferences are fundamental drivers of economic growth mediated through consumption, investment and saving behaviors. Preferences do respond systematically to economic shocks, natural disaster or conflict (Voors et al. 2012; Callen 2015; Cameron & Shah 2015; Bauer et al. 2016) and are shaped by society, institutions, and culture (Bowles 1998; Benjamin et al. 2010; Fehr & Hoff 2011; Wang et al. 2016). Ultimately, if preferences change with social institutions and other events, economists would need to focus more on cultural and political context when implementing their policies. If an economic policy or an exogenous shock affects the process of preference formation, then an analysis of the policy or the shock that takes preferences as given will yield erroneous conclusions (Bar-Gill & Fershtman 2005). For example, a range of empirical studies could show how incentives set by policies backfire as they change the pro-social preferences of individuals within that institutional context (Bénabou & Tirole 2003; Bowles 2008). Mattauch & Hepburn (2016) illustrate that the costs of mitigating climate change may decrease as preferences are shifted towards less carbon intensive goods and services with policies advocating e.g. vegan food or sustainable urban transportation systems.

3.1.1 An illustration: The rise and fall of sea cucumber trade on Ontong Java, Solomon Islands

A grounded example from Solomon Islands helps to illustrate the importance of discounting, and how a common pool resource (CPR) may become over-exploited due to the shortsighted and egoistic profit maximizing behavior due to technological change and a lack of adaptive local institutions to align current and future needs (Christensen 2011). This case focuses on the rise and fall of sea cucumber (Actinopyga echinites; common name bêche-de-mer) trade over forty years.

In the early 1970s, harvesting of sea cucumbers began on Ontong Java, a low-lying Polynesian outlier atoll in Solomon Islands. For over 30 years, this marine resource had been harvested in a sustainable manner. There were several reasons for this. First, the local management was strong, outlining rules that sea cucumbers could only be harvested every second year in order to sustain regeneration of the population. Second, this local management was possible because livelihood strategies were diversified, combining

income from sea cucumbers with income from copra production along with subsistence farming and fishing. Third, the technology used for harvesting sea cucumbers was based on free-diving and locally produced spears, ensuring that only select sea cucumbers were harvested. Taken together, these factors allowed for the sustainable use of this marine CPR.

In the year 2000, a group of men on Ontong Java invented a new technology—a simple trawling net—which soon proved to be crucial for the transformation of the atoll community. This new technology made it possible to trawl the lagoon bottom for sea cucumbers which led to immense amounts of sea cucumbers harvested both in quantity and diversity (Christensen 2011). As a result, however, by 2005 the population of sea cucumbers dramatically declined. These unsustainable practices were only stopped by government intervention, when a total ban on sea cucumber trade was imposed (Bayliss-Smith et al. 2010; Christensen 2011). This export ban caused a collapse of the atoll cash economy almost overnight. The atoll community responded immediately, adapting to this new situation. Almost one third of the atoll population migrated to the capital in search for new income opportunities while those staying behind returned to or continued traditional practices of Taro cultivation and intensive fishing (Christensen & Gough, 2012; Christensen & Mertz 2010).

This example illustrates how fast a tragedy of the commons (Hardin 1968) may materialize due to short-sighted and egoistic behavior and how migration can be one option to adapt.

The first objective of our paper is to examine these dynamics using an agent-based model of natural resource use in island communities. Developing realistic models of natural resource use is difficult, particularly because conservation outcomes are the result of the behaviors of free individuals, and even relatively simple behaviors can produce unexpected emergent outcomes at the aggregate level (Schelling 2006). Agent-based models provide a method for representing such complex systems, and coupled human-natural systems to be modelled given a set of assumptions about the basic drivers of human (agent) behavior (Rai & Henry 2016). Our second objective is to make ceteris paribus experimentation to see how change in one variable (such as discount rates) may influence downstream factors such as future pressures on ecological systems and human well-being. Thereby our model helps to develop a better understanding of how an endogenous change in discount rates may affect cooperation behavior and migration in a small island context. We next provide a detailed explanation of the theoretical agent-based model, discussion of results, and implications of incorporating endogenous discount rates and migration into models of natural resource use.

3.2 Methods: Agent-based modelling of natural resource use

3.2.1 Collective action in the island context

We start with a simplification of island communities as a series of independent CPRs, each of which contains a collection of agents that depend upon a shared natural resource (i.e., a common fishery or taro garden) for survival, and where the existence of the resource depends on the existence of the island. As in the real world, we assume that the resource is renewable if it is not over-harvested, and it is possible to both extract a renewable harvest from this resource and meet the basic needs of all community members. Also in the real world, however, agents are assumed to face a dilemma where any single agent may choose to overharvest this resource, and thereby enjoy the benefits of other agents' sustainable harvesting behavior without paying the costs of sustainable harvesting. The model of CPR proceeds over a series of time periods t, where the resource stock of a given CPR at time t is S_t. The common pool resource grows at some fixed rate g, such that if no resources are harvested at time t, the resource stock at time $t+1$ will be $S_{t+1} = S_t + (g*S_t)$. As one looks toward future resource stocks, a sustainable harvest h without discounting would be equal to the growth rate g, such that resource stock S is stable across all time periods indefinitely. Thus, resource stock at time $t+1$ will be $S_{t+1} = S_t$, at time $t+2$ the stock will be $S_{t+2} = S_{t+1} = S$ and generalizes to $S_t = S_{t-1}$.

We also assume, however, that future resource stock may be discounted by some amount. In other words, one particular resource unit today (i.e. a single sea cucumber or a single fish) is worth more to resource users than a future resource unit. Decreasing resource stocks may therefore also satisfy a sustainability criterion—provided that agents share some non-zero discount rate d for future resource stocks. In this case the sustainability criterion requires that resource stocks in the next time period are equal to the current resource stock, less some discounted quantity. In general, at time t resource stock will be $S_t = \frac{S_{t-1}}{1+d}$, again assuming a sustainable harvest of $h = g$. Therefore, this sustainability criterion implies that a single agent (i) may harvest at time t an amount $h^*_{i,t}$ where

$$h^*_{i,t} = \left(\frac{S_t}{N_t}\right)\left(1 - \frac{1}{(1+d_t)(1+g)}\right) \quad (1)$$

and N_t denotes the number of agents in the community, who are also extracting from the same CPR. More details on the derivation of equation (1) and the model setup in general are provided in the supplementary materials section S2.1.

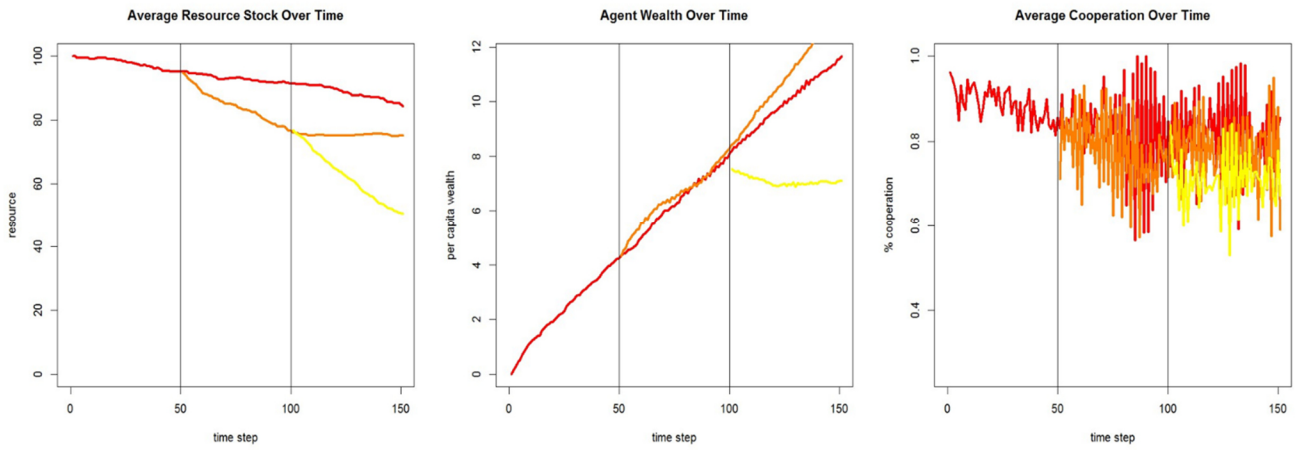
Agents may choose to extract the sustainable amount—this benefits the CPR and the community as long as all other agents extract only this amount—or an agent may choose to extract some amount greater than the sustainable harvest. In the model we limit agent's harvest to some fixed upper bound h^{max} representing, for example, technological limitations in harvesting a resource (such as the absence of trawling nets for the large-scale harvest of sea cucumbers).

Following the basic decisions rules outlined in another agent-based model of collective action (Henry & Vollan 2012), we assume that agents make a stochastic decision to either harvest the sustainable amount h^* (play the strategy cooperate) or harvest the maximum amount h^{max} (play the strategy defect) with probability proportional to the marginal benefit of defection—that is, the expected benefits if one plays defect versus cooperate. It should be noted also that playing defect only means that the agent attempts to harvest h^{max}; as is true in many societies that self-govern natural resources, we assume that defectors face some chance that they will be sanctioned by the community for taking more than their fair share. This yields an expected payoff for defection that is a function of technological limitations as well as community monitoring and sanctions.

3.3 Results

Figure 3.1 illustrates the predicted dynamics of CPR use over time across a number of hypothetical CPRs. The lines track modeled changes over time in three evaluative criteria: resource stock (i.e., the average health of CPRs, left panel), average amount of resources accumulated by agents (i.e., human well-being, center panel), and average levels of cooperation in each CPR (right panel). The red lines in Figure 1 depict the change over time in the three evaluative criteria under two conditions: (1) agents have an exogenously-determined discount rate of zero, and (2) agents are assumed to remain in their own CPR throughout the simulation. This provides a baseline scenario of resource use, against which we may compare alternative scenarios where discount rates are allowed to change, and where agents are allowed to migrate to other islands.

Figure 3.1: Simulated resource stock, agent well-being, and cooperation over time



Notes: Red lines indicate baseline scenario, without discounting or migration. Orange lines indicate changes from the baseline in scenario 2, where discount rates increase in a single randomly-chosen CPR at t=50. Yellow lines indicate changes from scenario 2 in scenario 3, where agents in the randomly-selected CPR have increased discount rates at t=50 and are allowed to migrate to other CPRs at t=100.

3.3.1 Incorporating endogenous time preferences and migration

Based on the sustainability criterion, in order for a resource to be maintained indefinitely it is necessary for discount rates $d_{i,t}$ to be zero. This means that resource users harvest in such a way that there is as much resource available tomorrow as there is today. Another possibility for the resource to be maintained indefinitely is a situation where the number of agents is very small compared to the size of the resource, so that a limited number of agents who are limited in their possible harvest sizes due to technology constraints (h^{max}) are not able to deplete the resource, even if they have very high discount rates. While there are numerous real-world examples of sustainable CPR use, these are typically in relatively small communities where this special case may hold (Henry & Dietz 2011). As noted above, however, there are many reasons why agents might have non-zero discount rates such that future resources are perceived to be less valuable than current resources. Most salient to island communities, one of these possible reasons is facing a perceived risk from climate change. If island communities are threatened by climate change impacts to the extent that islands (and especially atolls) become uninhabitable, then agents truly do have a reason to devalue future resources. For this reason, it is possible that trusted information about future climate impacts might have the result of increasing an agent's discount rate *d*. The result would be a higher sustainable yield, and a more rapid depletion of the resource.

This intuition is supported by the simulation results in Figure 1, where orange lines depict outcomes over time when one CPR in the system experiences an information shock that causes the discount rate to increase for all agents on the island. This shock is introduced at a prescribed point in time (after 50 time steps) for a single, randomly-selected CPR. At this time, discount rates for the affected agents are changed to 0.05, such that resources in the next time step are only valued at 95% of current resources. Afterwards the simulation proceeds normally as described above. In the real world this information shock might be the result of an extreme weather event that creates the belief on that island that the resource has become unstable or may disappear, or it may be the result of new information provided, for example, by a governmental organization attempting to increase awareness about climate change. Whatever the cause, this increase in discount rates is likely to speed resource depletion and increase average agent well-being, at least in the short term. Indeed, that behavior is reflected in the model, with more rapidly-diminishing resource stocks when some agents increase their discount rates (orange lines) versus when discount rates remain fixed at zero (red lines).

A third set of simulations explore the added complexity of allowing agents to migrate away from their island after experiencing an information shock. This scenario represents a likely corollary to increasing discount rates, namely that island residents will choose to leave their island altogether or even be forced to relocate by an external authority. From

the natural systems perspective, this migration can have a positive impact on the threatened CPR since there will be fewer agents harvesting this resource. But it will increase pressures on surrounding islands as the population of agents extracting from that resource grows—note in equation (1) that $h^*_{i,t}$ is decreasing in N_t while h^{max} remains fixed, and therefore the marginal benefits and the probability of defection will increase as populations increase as a result of migration. Moreover, migrating populations may also bring with them their increased discount rates, leading to an even more rapid depletion of resources in their new homes. These dynamics are illustrated in the yellow lines in Figure 3.1, where resource depletion—and overall agent well-being—decreases much more rapidly than would be expected if we did not consider the migration of affected island populations. At least two alternative models of migration may be considered. First, agents are required to pay a cost to migrate from their CPR, and second, agents do not travel with their discount rates but rather adopt the discount rates in the CPR they migrate to. Both of these alternative models are discussed in the supplemental information, see section S2.3. The net effect of migration cost and conformity to local discount rates is a slowing of resource depletion after migration, however the overall patterns discussed here still hold—if migration is allowed, resources tend to deplete faster than if agents are assumed to remain in their CPR.

3.4 Discussion

Global climate change models (GCMs) abstract from preferences of individuals and its impacts on decision making, thereby underemphasizing the actual extraction path of natural resources and the timing of potential migration flows. Estimates of the social costs of future climate impacts highly depend on the discount rate used to train the model. For example, Stern (2007) used a low discount rate of 1.4%, which puts a high price on future damages to motivate strong actions now, while Nordhaus (2014) argues for a higher discount rate between 3-5% as used by most economist that justifies only moderate actions be taken today. This is a matter of judgment as to how much weight is put on moral obligations towards future generations.

However, the anticipation of future climate change may directly and indirectly affect the pattern of resource use. As a direct effect, individuals will migrate away from the threatened environment (i.e. low lying atolls) thereby creating environmental pressures elsewhere. The indirect effect however, might be more severe. The anticipation of climate change may alter discount rates towards a stronger valuation of the present needs compared with future benefits from conservation. Thus, resource extraction from the atolls will increase and may even carry over to other places if people keep their newly formed discount rates. If individual discount rates systematically respond to SLR, then societal choices may be affected by this, and scenarios that inform policy making based on GCMs will fail to account for these behavioral economic insights.

It should be noted that this theoretical model may be applied to understand real-world systems, though the parametrization of the model would likely be a non-trivial undertaking. A full parameterization would require detailed knowledge of ecological conditions of islands within a particular region, as well as valid measures of agents' discount rates, tendencies towards cooperation versus defection, as well as local institutions to monitor recourses and sanction non-cooperative behavior. Coupled with information about the spatial geography—and with it, knowledge of where agents may migrate to—it would be possible to build detailed predictive simulations of environmental stress as a result of human adaptions to climate change. At the same time, however, this model also underscores the potential value of field research for understanding these complex systems. Two relatively simple research questions may profoundly influence predications about system-level outcomes: first, whether agents adjust discount rates as a function of information or experience, and second, whether agents systematically migrate to locations that are less prone to environmental shocks. For these reasons, a better understanding is needed of how discount rates change, the circumstances under which they change, and how people migrate between and beyond island communities as a result of changes in discount rates. This understanding will ultimately come from research emphasizing multi-method, interdisciplinary approaches to research (Connell 2008, 2010; King 2009; Christensen & Gough 2012). While model predictions show a decrease in cooperation with increases in discounting, there is considerable evidence that Pacific Islanders' reactions towards current environmental transformations are often less agitated than might be expected, given scientific climate change prospects (Lata & Nunn 2011; Farbotko & Lazrus 2012; Rudiak-Gould 2013). Changes in behavior will ultimately lead to altered individual preferences, such as time, risk and social preferences (both pro- and anti-social). These preferences are measurable, for example by using artefactual field experiments that are conducted with a representative subject pool. Measured parameters have strong predictive power for individual behavior and can be used to inform the model presented here. For example, risk-seeking individuals are more likely to migrate between labor markets (Jaeger et al. 2010). Additionally, survey methods could be used to train our model by collecting data on social networks, desirable migration destinations, climate change perceptions and loss of cultural identity, social norms and values. These factors that shape migration decisions, could then be used to train computational models that extrapolate these observations from a sample of islanders to entire regions encompassing many islands.

Individual responses to environmental change are shaped by physical as well as socio-cultural factors, and Oceanic islands are highly dynamic in their geo-physical setup. They are subject to tectonic and associated volcanic processes, to short-term and long-term climatic conditions, as well as anthropogenic environmental changes such as mangrove cutting, sand mining, or changing coastlines due to built infrastructure (Peterson 2009).

Mann & Westphal (2014), for instance, show that shorelines of nine small islands on Takú atoll (Papua New Guinea) are highly dynamic and experienced large changes in the period from 1943 to 2012. Overall a total loss of nearly 50 percent of beach-areas is reported and shorelines of these islands are volatile due to seasonal variations and tropical storms in the short-term. Overall this demonstrates that people living on small islands are accustomed to a highly dynamic environment in which beaches come and go, or in which coastlines shift within a certain range even seasonally. Slow-onset events like SLR may therefore be masked by other events and, as a result, not given full attention.

These studies, coupled with future research, should suggest concrete recommendations for organizations in the public, private, and nonprofit sectors that are interested in climate change mitigation and adaptation. Providing people with information about climate change associated risks could potentially bond people together and increase their in-group bias. It has been documented in a recent review article by Bauer et al. (2016) for a range of post-war settings that war affected people increase their membership in social and civic organizations, take up leadership positions and are more pro-social in experimental laboratory games. However, people might not be eager to learn about a life changing event like relocation in advance even though they could make better decisions, as the anticipated disutility over the years from such an event could be higher than how the actual event is turning out (Schweizer & Szech 2016). Our hypothesis rests on the assumption of economic rationality where education campaigns are "cheap talk" and do not change the inherent incentive structure. In reality this might be questioned although information campaigns in many countries rather change problem awareness than actual behavior, see Staats et al. (1996).

Insights from the theoretical model presented here suggest that better information about risks of climate change might spur undesirable patterns of resource use. Nunn (2013) concludes that rising sea levels for almost 200 years now, will cause an end to today's Pacific Islander's lifestyle. Fundamental changes to cultural identities, resettlements and society at large will be unavoidable and impacts can only be attenuated by efforts at the local level rather than by increased dependence on the international community. Thus, organizations should be careful in the way they craft and communicate messages about climate change. An emergent and unexpected outcome of our model is that having education about—or experience with—local climate change impacts might increase the likelihood of resource collapse.

3.5 Conclusion

Our model results are contrary to the common wisdom that increased environmental awareness promotes more sustainable behaviors (Stern et al. 1995; Henry & Dietz 2012). Indeed, presenting resource users with catastrophic, doomsday scenarios might work against resource sustainability at a larger scale and over time. This is not to say that people should not have access to better information about climate change impacts, however it is important to also deliver positive, empowering messages that encourage continued cooperation and responsible stewardship of natural resources.

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Chapter 4: Do pro-social behaviors break-down with the prospect of displacement by rising sea-levels?

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Abstract

Impacts caused by rising sea-levels have the potential to disrupt the livelihoods and displace millions of people in the 21st century. We conduct incentivized experiments and survey experiments with 917 participants in the Pacific on Solomon Islands and coastal regions in Bangladesh and Vietnam who differ in their exposure intensity to sea-level rise impacts. They make decisions on sharing resources to measure their pro-social attitude, as an indication for the breakdown of cooperation, which may ultimately inform about potentials for adaptation, migration, or even conflicts. We randomly assigned participants to watch a video about the impacts and consequences of rising sea levels. Here we show that pro-social behaviors do not break down. Both participants who watched the video and live in more-exposed places tend to be more pro-social towards their in-group. The effect is stronger for more place attached participants, dampened by negative emotions and not driven by participants' expectations to be resettled together with their community.

Keywords: Climate change, displacement, sea-level rise, lab-in-the-field experiment, pro-social behavior.

4.1 Introduction

Climate change impacts, especially sea-level rise (SLR) (Storlazzi et al., 2018; Vitousek et al., 2017), have the potential to disrupt the livelihoods (Jevrejeva et al., 2018) and displace millions of people in coastal regions (Church et al., 2013; Neumann et al., 2015; Nicholls et al., 2011). Media reporting in high-income countries has shifted away from being purely about climate change towards alarming about climate migration (or even "climate refugees") reinforced by projections of climate mass migrations (Myers, 2002, 1997), while climate justice has never been a high priority. Rightly, these predictions have been criticized by scholars for being over-simplistic and abstracting from people's ability to adapt (Gemenne, 2011). The majority of climate migration takes place and is projected to take place within borders (Rigaud et al., 2018). From people staying or moving short distances within borders, arise different challenges for societies. These challenges are at odds with solutions that are currently being on the agenda in public debates in high-income countries that often focus on climate migration as a problem and security threat (Gemenne et al., 2014). From this point of view, more rigid immigration control measures are required (Hartmann, 2010), whereas the projections of internal migration instead suggest that affected communities need assistance for adaptation and in the worst-case resettlements. Economists indirectly contribute to the former focus by predominantly studying the causal link between climate change and international migration (Berlemann and Steinhardt, 2017; Cattaneo and Peri, 2016; Coniglio and Pesce, 2015) or asylum applications (Missirian and Schlenker, 2017) at the macro-level. Such an approach does not inform about the challenges that arise from people staying within borders. It is limited to aggregate estimates of climate migration, that will most likely not include the people who are actually dealing with the adverse effects caused by climate change (Piguet, 2010). Causal relationships at the national level should not be used to draw conclusions about the decision making at the individual level (Robinson, 1950).

Here we explore the capacity of people that are exposed to hazards caused by climate change to deal with these impacts and discuss the different consequences that could arise. Opposite to the approaches described above, we take on a people-centered perspective of decision-making and focus on how pro-social behaviors are affected if people face the risk of displacement caused by SLR impacts. We specifically examine pro-social behaviors, as they spur cooperation in intact communities which are characterized by their ability to engage in community-based activities to provide public goods and control natural resource use (Ostrom, 1990). Empirical evidence highlights the predictive power of pro-social behaviors for a broad range of activities: resource use, cooperating for public goods and common-pool resources, helping people in need, volunteering or donations (Falk et al., 2018; Frey and Meier, 2004; Leibbrandt, 2012; Rustagi et al., 2010). If pro-social behaviors would break-down, this could degrade social capital (Karlan, 2005), the crucial component

of successful community governance (Bowles and Gintis, 2002). This could result in the overuse of resources increasing vulnerability and relative poverty (Henry et al., 2017; Ostrom, 2000). Additionally, the adaptive capacity of communities strongly depends on their willingness to engage in collective actions to implement adaptation measures (Neef et al., 2018). In case of weak states that fail to provide adequate assistance, all these factors could contribute to higher risks of violent conflicts (Barnett and Adger, 2007). Ultimately, if pro-social behaviors decline at the place of origin, this would lead to the degradation of place-specific resources, both social and physical, which reduce the opportunity costs of migrating (Adger, 2000; Haug, 2008; McLeman, 2013).

We derive two opposing predictions drawing on theory and empirical evidence from economics, as well as behavioral economics and psychology. First, the break-down prediction is derived from economic theory that takes on a rational and strategic approach to pro-social behavior. Theoretically, repeated interactions can promote cooperative behavior when there is uncertainty about the number of interactions, and people are sufficiently far-sighted (Fudenberg and Maskin, 1986). This effect is referred to as the "shadow of the future" in the literature (Axelrod and Hamilton, 1984). Intuition and laboratory experiments show that cooperative behavior is indeed promoted and can be sustained in repeated interactions compared to settings with a fixed number of interactions (Blake et al., 2015; Dal Bo, 2005; Dal Bó and Fréchette, 2018). Based on this line of argumentation, we would expect that pro-social behavior would break-down in expectation of displacement, i.e. a reduction in the duration of potential interactions with other people in the community. If people expect to be displaced in the near future, it becomes rational to invest less in local social capital and extract as many resources as possible to prepare for relocation.

Second, based on research in psychology and behavioral economics we know that people also have strong emotional bonds to the place and community they come from (Adger et al., 2013), develop social norms and networks of trust and solidarity (Ostrom, 2000). Case studies highlight the importance of place attachment and people's preferences for local adaptation strategies (Esteban et al., 2019; Laurice Jamero et al., 2017). Philippine islanders that experienced over half a meter of effective SLR due to earthquake-subsidence preferred to stay and managed to cope with over 100 flood days a year, i.e. uninhabitable from a rational outside perspective, by somehow adjusting to the situation relying upon a combination of hard and soft adaptation measures (Jamero et al., 2017). Additionally, affected people might already experience high levels of poverty-induced stress from struggling with daily life that could lead to more short-sighted and habitual behavior (Haushofer and Fehr, 2014). Experiencing undesirable life-changing events (Baumeister et al., 2001) or expecting an undesirable future event (Baumgartner et al., 2008) can reinforce stress levels by triggering strong negative emotions, which in turn influence behavior.

Stress and negative emotions would then lead to a focus on more pressing issues and behaviors that people are used to. For example, engaging in pro-social behaviors has been shown to be an effective strategy to reduce negative emotions and lower stress levels (Raposa et al., 2016). If these non-strategic factors outweigh the strategic and rational calculations, pro-social behaviors could be strengthened when people face the risk of displacement that threatens the entire community.

To test these two opposing predictions, we conducted lab-in-the-field and survey experiments with participants in three of the most exposed areas to SLR, a low-lying island state (Solomon Islands, n=412) and in coastal regions of two major river deltas (Bangladesh, n=203, and Vietnam, n=305). We measure pro-social behavior with a social-value orientation task and dictator games, see Methods. Our research strategy is twofold. First, we sample people that are more (n=317) and less (n=603) exposed to the adverse effects of SLR based on geographical location and self-evaluated exposure proxies. As we sample people within regions that are more and less exposed, they mainly differ in their exogenously determined impacts of SLR and other stochastic environmental changes and not with regard to social, economic, cultural and historical aspects. This approach could still suffer from potential selection effects, as people with a priori different pro-social and risk attitudes might select into more and less exposed areas, or people are forced out of poverty to live in more exposed areas where land is cheaper (McCaughey et al., 2018). Therefore, we also experimentally manipulate the salience of SLR impacts and consequences of participants. Participants are randomly assigned to either watch a three-minute video showing the impacts and consequences of SLR (n=486) or a neutral control video (n=434). Further, we investigate how the strength of place attachment and negative emotions are related to the effects on pro-social behavior. A compelling explanation for finding a strengthening of pro-social behaviors is that people expect to be resettled together with their entire community by the government. To challenge this notion, we manipulate participants' relocation belief in Vietnam towards individual relocation (n=99), community resettlement (n=90) and keep a control group without any manipulation (n=116). Detailed information on sampling, treatment videos and scenarios, measurement of explanatory factors and balancing across treatments are reported in the Methods and supplementary materials (SM sections S3.1 and S3.2). An explanation of the empirical strategy is provided in the Method section, complete regression outputs and all additional analysis supporting the reported results can be found in the SM (section S3.3).

The novel approach presented in this study provides a testable way of the linkage between climate change and pro-social behavior which shape adaptive capacities and thereby the likelihood of migration or even conflicts. We do not find evidence that climate change exposure leads to the break-down of pro-social behaviors, as economic theory and the empirical laboratory evidence suggests. Contrary, we find evidence in line with the

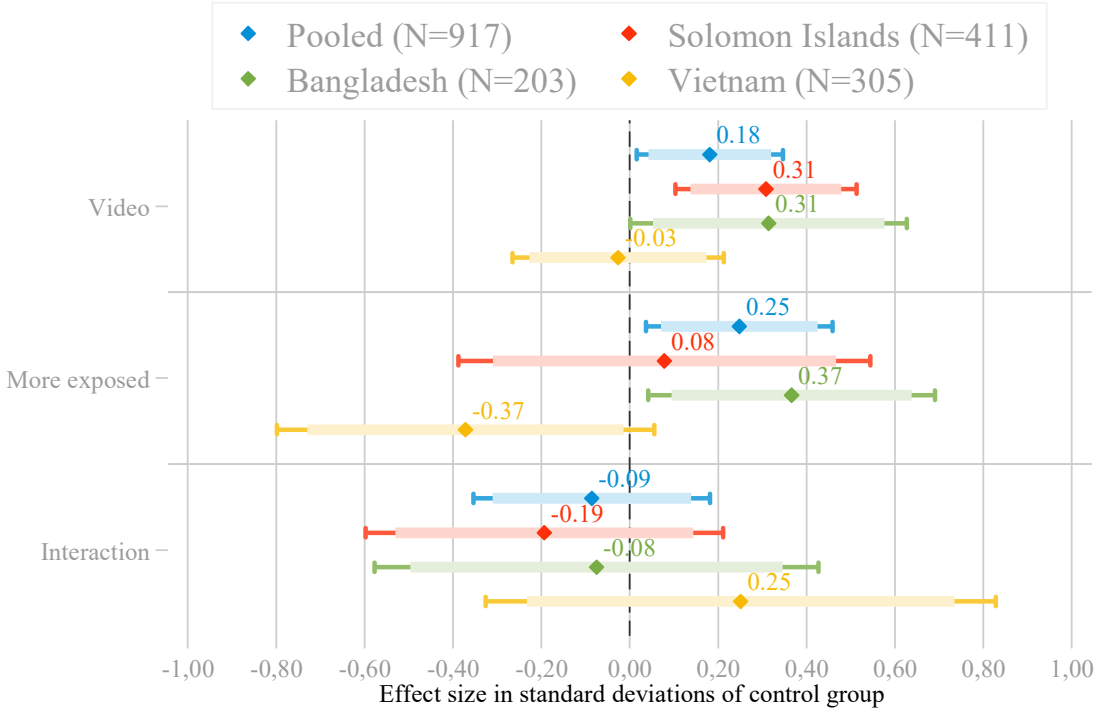
strengthening prediction of pro-social behaviors, potentially increasing capacities to deal with the impacts in place through collective adaptation. Our results challenge the notion of climate doomsday scenarios of resource collapse, conflicts and ultimately (international) mass migrations. Furthermore, we add to the emerging literature on how the experience of (past) climate-induced disasters shapes prosocial behaviors (Becchetti et al., 2017; Cassar et al., 2017; Fleming et al., 2014).

4.2 Exposure and treatment effects on pro-social behavior

First, we analyze if the prospect of displacement caused by rising sea-levels (real-world exposure and experimental video variation) affects pro-social behaviors using ordinary least-square regressions. While the pre-condition for the break-down prediction of the "shadow of the future" scenario is given (see climate change appraisal across samples in the SM, Table S3.10), we find no evidence for the break-down of pro-social behaviors (Figure 4.1). In fact, people that live in more exposed areas and people who watched the video about SLR are more pro-social towards their in-group.

In the pooled sample, we find that the video increases giving by 0.18 standard deviations (SD) (coefficient=.181; p=.032; 95% CI=.016, .346) and more exposed participants give about 0.25 of a SD more (coefficient=.248; p=.021; 95% CI=.037, .459). The most likely estimates, given our sample and modeling assumptions, are around 0.2 SD increases in pro-social behavior, which is a sizeable increase in (monetary) giving to someone from the same community by roughly 7 percentage points. More exposed participants watching the SLR video do not react significantly different than less exposed participants (interaction coefficient=-.086; p=.528; 95% CI=-.354, .182). These results suggest that pro-social behaviors do not break-down in anticipation of displacement caused by SLR but rather increase and strengthen, given our data and modeling assumptions.

Figure 4.1 Pro-social behavior: video and exposure effects



Notes: Increasing values of the dependent variables indicate changes in standard deviations of giving to another person from the same community. Estimates from pooled and country-specific ordinary least squares regressions with heteroscedasticity-robust 95% (thin lines) and 90% (thick lines) confidence intervals are reported. In all regressions, we control for: gender, age, marital status, years of education, household size, standardized income, past and future perception of SLR impacts. For the Solomon Islands regressions, we cluster standard errors at the session-level on which the treatment was assigned. Complete regression outputs are reported in Supplementary Table S3.11.

However, the pooled results mask substantial heterogeneity across study regions. While the treatment effects in the Solomon Islands and Bangladesh samples are higher in magnitude and the exposure estimates point in the same direction as the pooled results, participants in Vietnam seem to react more in line with the break-down prediction. The treatment has no significant average effect (coefficient=-.026; p=.828; 95% CI=-.265, .212) and more exposed Vietnamese participants tend to be less pro-social (coefficient=-.372; p=.088; 95% CI=-.799, .055), but potentially react differently to the treatment (interaction coefficient=0.251; p=0.393; 95% CI=-.326, .828). For Vietnam, we cannot draw any precise conclusions on the interaction with exposure, as most participants in our sample are similarly exposed and differences between more and less exposed individuals are smaller (supplementary Table S3.3). We classified only 37 participants as more exposed (control n=14, treatment n=23) in Vietnam, which is reflected in the uncertainty of the point estimates.

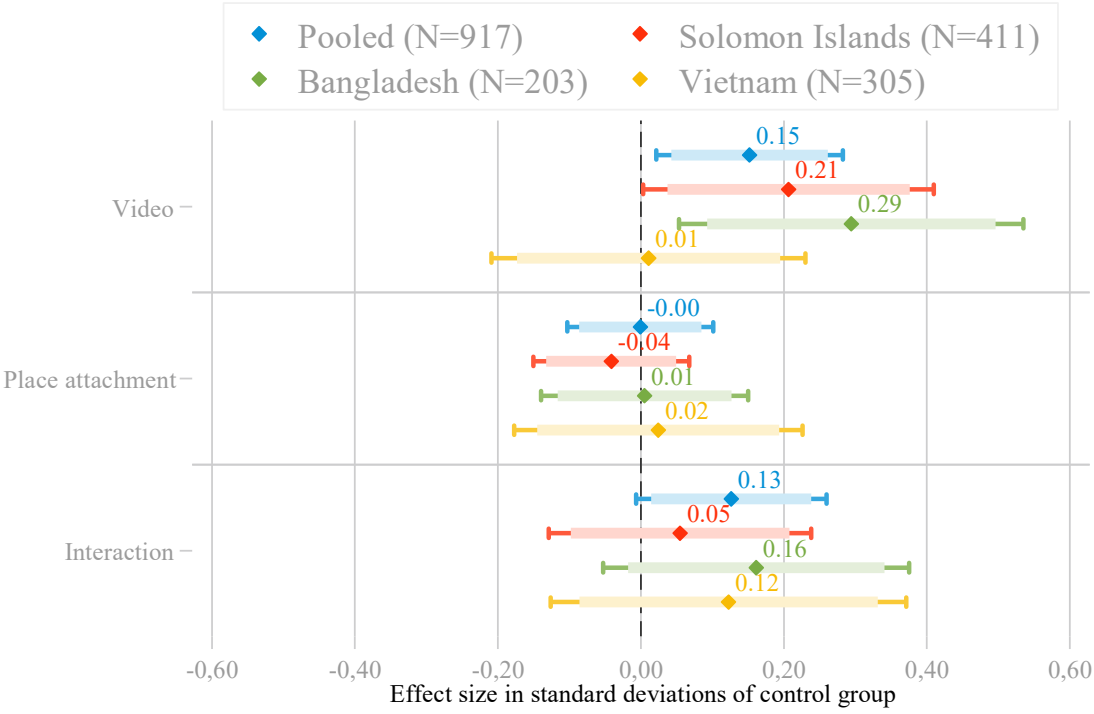
4.3 The importance of place attachment

In the pooled sample, additional heterogeneity could arise from the fact that participants are differently attached to their homes and community. Thus, more attached

participants might react more strongly to the visual impacts shown in the video than less attached participants.

Case studies from island states in the Pacific (Connell, 2016) and the Philippines (Jamero et al., 2017) have shown the impact of place attachment on behavior and adaptation preferences. We measure place attachment quantitatively using a two-dimensional, identity and dependence, place attachment scale (SM Table S3.2). The video does not significantly change place attachment compared to the control group (Mann-Whitney U-Test; z=-.705; p=.481). Figure 4.2 shows that, on average, more attached people are not more pro-social, but they react more strongly to the video. The pooled regression suggests that a one SD increase in place attachment additionally raises giving by 0.13 SD (interaction coefficient=.126; p=.063; 95% CI=-.007, .260), given our sample and modeling assumptions. The video (coefficient=.152; p=.023; 95% CI=.021, .282) and exposure (coefficient=.185; p=.023; 95% CI=.025, .345) effects remain robust to the inclusion of place attachment. The interaction effects between place attachment and the video point in the same direction across all samples, but they fail to reach significance at conventional levels.

Figure 4.2 The effect of place attachment



Notes: Increasing values of the dependent variables indicate changes in standard deviations of giving to another person from the same community. We standardized the place attachment index on which higher values imply stronger place attachment. Estimates from pooled and country-specific ordinary least squares regressions with heteroscedasticity-robust 95% (thin lines) and 90% (thick lines) confidence intervals are reported. In all regressions, we control for: exposure, gender, age, marital status, years of education, household size, standardized income, past and future perception of SLR impacts. In the pooled regressions, we additionally control for general trust and patience, as treatments were imbalanced on these variables. For the Solomon Islands regressions, we cluster

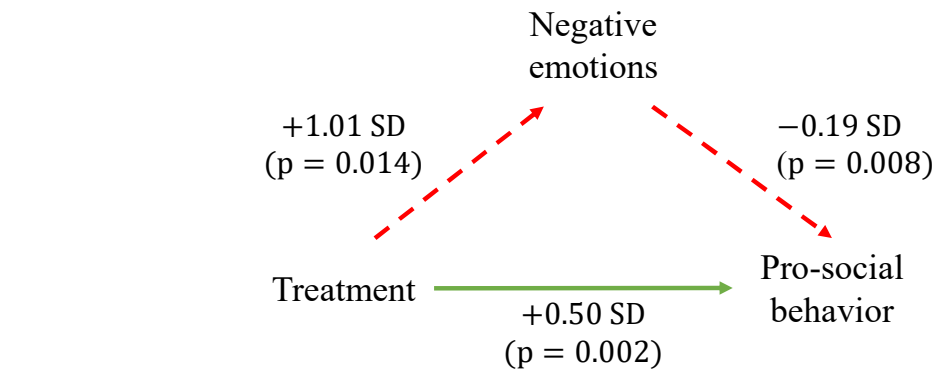
standard errors at the session-level on which the treatment was assigned. Complete regression outputs are reported in Supplementary Table S3.13.

4.4 Mediating effects by negative emotions

In addition, the prospect of displacement is a highly distressing event that can have psychological effects, such as evoking strong negative emotions people have to cope with. As discussed in the introduction, stress and negative emotions could lead to more short-sighted and potentially pro-social behavior (Haushofer and Fehr, 2014; Raposa et al., 2016). We expect the video to evoke strong negative emotions, which could be one mechanism behind the strengthening of pro-social behaviors.

In the survey experiments, we elicited the participant's emotional response to the treatment video. Participants in the treatment group are in a more negative mood compared to the control group directly after watching the videos (SM Figure S3.4). Hence, the video has a direct causal effect on both pro-social behavior and negative emotions. We use linear structural equation models (LSEM, see methods) to estimate to what degree negative emotions mediate the treatment effect on pro-social behavior as reported in Figure 4.3. We report the insignificant mediation results for Vietnam in the SM (Figure S3.5), as negative emotions were not significantly correlated with pro-social behavior, and there were no average treatment effects, to begin with. The mediation highlights that the average total effect (ATE=.31 SD; p=.041, 95% CI=.01, .62) as estimated before, can be dismantled into two opposing effects (see, Figure 4.3). Firstly, a large average direct effect (ADE) that is 0.19 SD larger than the ATE estimated before (ADE=.50 SD; p=0.002; 95% CI=.18, .82) caused by higher awareness about the future impacts and consequences by SLR through the video, and secondly, an opposing average causal mediation effect (ACME) through increased negative emotions. The ACME (ACME=-.19 SD; p=0.007; 95% CI=-.37, -.05) brings the ADE down by 0.19 SD to its average effect. The negative ACME lessens the otherwise much stronger strengthening effect of the video on pro-social behavior.

Figure 4.3 Negative emotions dampen the direct strengthening effect



$$ADE = 0.50\ SD\ (p = 0.002; 95\%\ CI[0.18, 0.82])$$
$$ACME = \text{-}0.19\ SD\ (p = 0.008; 95\%\ CI[-0.33, -0.05])$$
$$ATE = ADE + ACME = 0.31\ SD\ (p = 0.041; 95\%\ CI[0.01, 0.62])$$

Notes: The dependent variable is standardized pro-social behavior. The coefficients are the point estimates and in brackets are the corresponding heteroscedasticity-robust confidence intervals. In both regressions, we control for: exposure, interaction of treatment and exposure, gender, age, marital status, years of education, household size, standardized income, past and future perception of SLR impacts. Full regression outputs and robustness checks are reported in Supplementary Table S3.15.

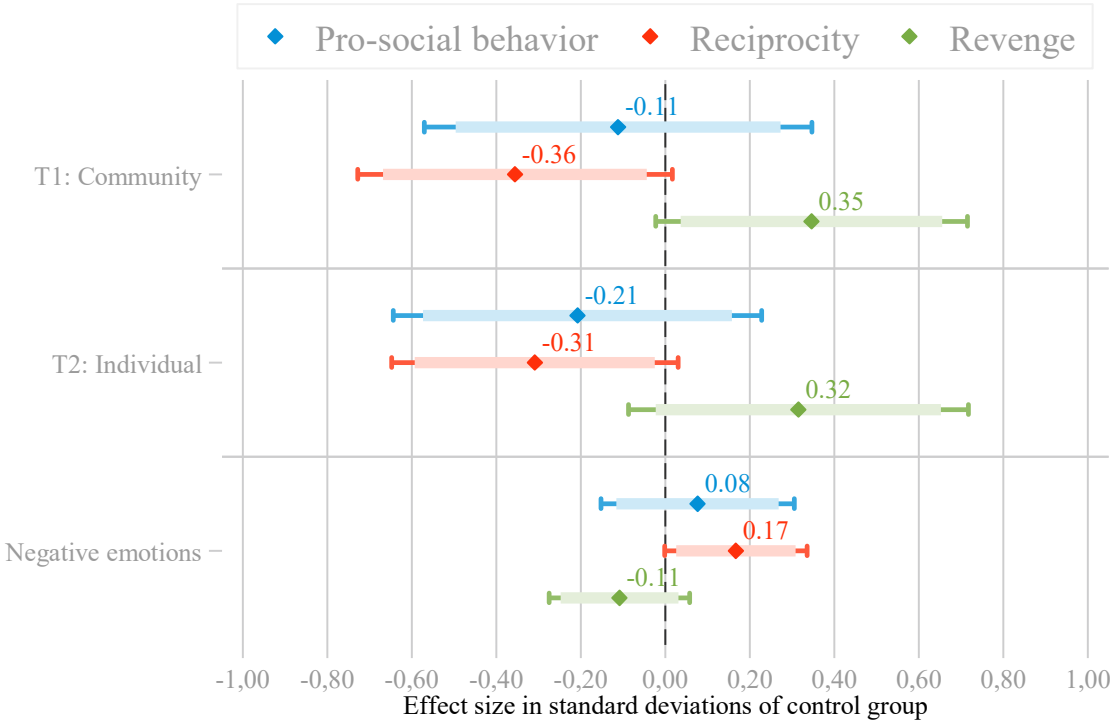
4.5 Vietnam: The effect of community resettlement beliefs

Another compelling explanation for the strengthening effect could be that participants believe to be resettled together by the government or an NGO. We investigated this mechanism by manipulating the resettlement believes of participants in Vietnam. Our survey evidence suggests that the vast majority of participants believe that it is the government's (mentioned by 91%) and NGO's (45%) responsibility to help them deal with the consequences of climate change impacts. If people rely on outside help to relocate their entire community, it makes sense for them not to abandon their ties with fellow community members.

To test this explanation, we introduced two treatments where participants had to imagine either a community resettlement (T1: community) or individual relocation (T2: individual) scenario after watching the video about SLR in Vietnam (see Methods). Additionally, we elicited two non-monetary social behaviors (reciprocity and revenge) using survey questions to substantiate the external validity of our incentivized pro-social behavior measure. The individual treatment significantly lowered participant's expectations that the government or NGO's will assist them to relocate compared to the community treatment (Mann-Whitney U-Test; z=2.94; p=0.003) and control group (Mann-Whitney U-Test; z=2.02; p=0.044). On average, participants in the community treatment and control group share the belief that it is "moderately" likely to receive outside assistance for resettlement (Mann-Whitney U-Test; z=-0.94; p=0.35), substantiating our prior belief that people rather expect to be resettled together. We find no evidence that participants in the community

treatment are more-social than participants in the individual treatment (Figure 4.4). Neither of the treatments has significantly different effects on incentivized pro-social behavior nor survey measures of reciprocating favors or engaging in costly revengeful acts when mistreated. That there is no difference between the individual and community treatment increases our trust that the main pooled results are not driven by the expectation of continued interactions with fellow community members after resettlement. However, we cannot exclude the possibility that participants in the other two samples might react and behave differently under the same treatments – even though the video content is otherwise the same across study sites.

Figure 4.4 Community versus individual relocation



Notes: Increasing values of the dependent variables indicate changes in standard deviations of (1) giving to another person from the same community, (2) increase in willingness to return a favor and (3) increase in willingness to engage in costly revenge when mistreated. Estimates from ordinary least squares regressions with heteroscedasticity-robust 95% (thin lines) and 90% (thick lines) confidence intervals are reported. we control for: exposure, gender, age, marital status, years of education, household size, standardized income, past and future perception of SLR impacts and interviewer effects. Complete regression outputs are reported in Supplementary Table S3.16.

At first glance, it seems that there are significant treatment effects regarding our survey measures of reciprocity and revenge. However, all direct treatment effects are almost entirely offset by an opposing indirect effect through negative emotions. Both treatments significantly increased negative emotions by about 1.8 SD relative to the control group with no significant differences between the community and individual treatment (Mann-Whitney U-test; z=0.52; p=0.61). So the relocation manipulation seems to make participants less reciprocal and more revengeful, but with increasing negative emotions, participants tend to be more likely reciprocate favors (coefficient=.167; p=.052; 95% CI=-.002, .336) and less

likely to revenge when mistreated (coefficient=-.109; p=.200; 95% CI=-.275, .058). Given that the direct treatment effects are almost entirely outweighed by more reciprocity and less revengefulness, this analysis highlights the potential of engaging in pro-social and avoid anti-social behavior to cope with negative emotions.

4.6 Discussion

The narrative of doomsday scenarios and international migration in response to climate change impacts might not represent the reality in which most of the people who have to experience these adverse impacts live. Our preliminary finding that pro-social behaviors do not break-down but instead seem to strengthen by the prospect of displacement turns the focus on another potential problem that arises from people trying to fortify in hazardous environments

When we asked participants how they intend to adapt to SLR in the heights projected well within the IPCC interval until 2100 (Church et al., 2013), the majority of them with 53% only mentions local adaptation measures and not migration, especially the most exposed participants (these data are analyzed in detail in Chapter 2:). While it can be seen as positive that pro-social behaviors are strengthened, such behavior has the potential to create a climate-induced poverty trap. People that are attached to the place and community spend their limited capacities and resources on local adaptation measures trying to prevent or at least prolong the duration until displacement, as the case-study by Jamero et al. (2017) has shown. However, they could be fighting an already lost battle, given the projections of SLR in our study regions (Schmidt, 2015; Storlazzi et al., 2018). Such a vicious cycle would strip already worse positioned people from precious resources, trapping them in hazardous environments. This argumentation is in line the findings from Cattaneo and Peri (2016) who find that long-term increases in temperature reduce the probability of rural people migrating (internally and across borders), whereas people from middle-income countries are more likely to migrate. This could also be a compelling explanation for the different results in the Vietnam sample, where participants are on average much better off (PPP adjusted $17 per day) than in Bangladesh (PPP $5 per day) and Solomon Islands (PPP $2.8 per day), see SM (Table S3.5).

While we believe that our novel approach of measuring the effects of exposure to SLR impacts on pro-social behaviors is an effective way to approximate the likelihood of large-scale climate-induced international migration, we want to address some limitations of this study. While the experimental variation of the saliency of SLR impacts allows us to overcome potential selection issues from which our correlational results and other observational study suffer, the former can never fully replicate the feelings and emotions of the severity of SLR impacts and consequences in reality. Additionally, experimental measures of pro-social attitudes might lack external validity and only capture decision-

making with regard to specific monetary trade-offs. Future research should study how willing people are to engage in real-world (community) adaptation efforts, for example planting mangroves, that are time-consuming and require effort, to gain further confidence in the results presented here. We do our best to limit these concerns by incentivizing all tasks and additionally rely on non-monetary survey measures of social behaviors (Figure 4.4) and conduct the research with people that are actually highly affected by SLR impacts, compared to studies conducted with students. However, one should be cautious about generalizing the findings beyond the Asia-Pacific region, as there is already a lot of heterogeneity within the reported three samples. The situation in Sub-Saharan Africa might be very different, given the colonial and migration history, geographical closeness to the EU, different climate impacts (rainfall, droughts) and resource use systems.

4.7 Concluding remarks

The most affected people are not able and do not want to leave their homes, even though they perceive SLR impacts as a significant risk. We believe that the selective focus in many high-income countries on worst-case doomsday prophets and climate-induced international migration is conceptually flawed and potentially harmful because resources are focused on immigration counter-measures. This is not to say that we should not take any actions at all, but that resources and efforts should be invested where they are needed. The priority should be the assistance of governments in affected countries to develop anticipatory regimes, provide compensation, and offer institutional support for those that are suffering from the adverse effects of climate change. Such schemes must adhere to the dignity and preferences of people who are not responsible for their situation to ensure both physical and social safety. Given the evidence that SLR impacts vary drastically within regions (Kench et al., 2018), investment into better monitoring systems to track erosion and inundation over time could be a valuable tool for policymakers to develop appropriate adaptation strategies where and when needed.

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4.8 Methods

In incentivized experiments, participants make decisions in a controlled environment where one can make predictions about behavior based on game theory. They are less prone to hypothetical bias and social desirability bias due to the use of material, most often monetary, incentives and decision making in an anonymous environment (Smith, 1982). This gives the researcher control of the decision context and the possibility to change one variable in the decision environment at a time to estimate its causal effect on behavior.

4.8.1 Research design

To estimate the real-world correlation between exposure and pro-social behavior, we sample in each study region, people that are more and less affected by the adverse impacts caused by SLR. In Solomon Islands, we conducted our research in 12 villages on low-lying atolls, as well as in four neighborhoods in the capital on a higher-lying volcanic island. Thereby, we have a clear-cut definition of more exposed and less exposed participants, which is one of the only cases where people face climate-induced displacement mainly caused by SLR.

In the coastal regions of the Mekong and Ganges delta in Vietnam and Bangladesh identification of who is more affected is less obvious, as people face not only adverse impacts caused by SLR but also other "natural" disasters such as storms, droughts and self-inflicted issue, for example, excessive use of groundwater which causes land subsidence and accelerated effective SLR. Thus, we have to rely on self-reported measures of affectedness to identify more and less affected individuals. Supplementary Table S3.3 and

Table S3.4 show the differences in these measures between the two groups. The reader can find a detailed description of the sampling strategy in the supplementary section S3.1.5.

Due to the before-mentioned selection-problems of participants in more and less exposed areas, we also rely on the established methodology of priming from experimental psychology to measure the causal effects of a reduction in the shadow of the future on pro-social behavior. Priming can be generally described as the exposure to a stimulus (video, text, audio, etc.) which activates a specific mental concept in the participant's mind which

has an effect on subsequent decision making. In this study, we use an explicit prime in the form of a three-minute-long video to make the impacts of SLR (land erosion, floods, stronger high-tides; saltwater intrusion, loss of harvest) salient for participants using testimonials of people that are in a comparable situation. Between study regions, we hold the style and content of the videos constant and vary to what degree migration as a way to adapt is shown. In Vietnam, we additionally introduced two hypothetical scenarios at the end of the video to experimentally vary the relocation belief – either individual relocation or community resettlement. Details on the content of the videos can be found in supplementary Table S3.1, and all videos will be made available on GitHub after publication. In pre-tests conducted in Solomon Islands, we show that people exposed to the video become more future-oriented than the control group. Supplementary section S3.3.1 shows the results of the priming check where we measured how much weight participant's put on present over future needs (Strathman et al., 1994) and how participants perceive the impacts of SLR. In Vietnam, we additionally checked whether both treatments (individual and community) were perceived as equally realistic and whether it changed the beliefs regarding government resettlements. Results of these priming checks are reported in Supplementary Figure S3.7.

The video treatment was randomly assigned on the session level in the experimental workshops and at the individual level in the survey experiments. In Solomon Islands, we decided against showing a neutral video in the control sessions due to the difficulty of finding content that would not affect behavior in the following in any direction. Thus, we cannot exclude the possibility of any video effects per se driving the results in Solomon Islands. However, the findings from the survey experiments, where we used a neutral video for the control group, make us optimistic that results are not driven by pure video effects such as pleasure from watching a video per se independent of the content. Directly after participants watched the video, they participated in the pro-social behavior task. In Solomon Islands, we used an incentivized version social value orientation task developed by Murphy et al. (2011), which consists of six dictator choices. Participants were matched within-session in small communities between 20 to 80 households on the atolls. In the survey experiments, we used single choice dictator games, where participants could decide how much of their endowment they wanted to send to another person from the same community. Villages in the Bangladesh and Vietnam sample were a bit larger compared to Solomon Islands with an average size of about 200 households, but people would still know most of their fellow community members. Thus, we measure in-group pro-social behavior in all three samples. Instructions for the pro-social behavior tasks and further details can be found in the supplementary materials section S3.1.1 and S3.4.

In Solomon Islands, participants took part in three more incentivized behavioral tasks (risk, trust, and spite) and in all three samples they had to answer an extensive survey

on socio-demographics, adaptation actions, climate change perceptions, and cognitive attributes. Before the payment of participants, they were debriefed (for example in Solomon Islands we showed examples of how other small island communities (Carteret Islands) are dealing with the prospect of displacement), and participants had the chance to ask questions or give feedback. All earnings are converted using the purchasing power parity (PPP) conversion factor from the World Bank at the time when the research was conducted. On average, participants in the three to four-hour workshops earned $10.7±1.6, while for the survey experiments (on average 45 minutes) participants earned $3.6±1 in Bangladesh and $7.3±2.6 in Vietnam. Payments were adjusted to the length of participation and to the earnings of daily laborers in each study site. Detailed summary statistics of all outcome and explanatory variables, as well as balancing tests across treatments are reported in the supplementary section S3.2. We find some slight imbalances on covariates in the pooled sample (see SM Table S3.6). We control for these covariates in all pooled analysis reported in the results section.

4.8.2 Ordinary least-squares regressions

For the pro-social behavior results, we rely on linear ordinary least square (OLS) regressions, which we visualize the main effects using the Stata user-written program coefplot (Ben Jann, 2013). As we measured pro-social behavior in the experimental workshops and survey-experiments differently, we had to homogenize the outcome variable and standardized it to be comparable across study regions. How we constructed our pro-social behavior outcome, as well as additional explanatory variables, is described in SM Table S3.2. Additionally, we had to exclude 72 participants, as they did not pay attention to the priming video or reported that the content of the video does not apply for them. Including these participants would bias the priming effect by adding noise to the data. There are no significant differences in exclusion across samples. We report the exact identification of non-primed participant's in supplementary sectionS3.1.3 and run all regressions with the full sample as a robustness check (see supplementary section S3.3).

The results visualized in the main manuscript are based on variations of the following equation (an example for the pooled estimates shown in Figure 4.1):

$$pro\text{-}social\ behavior_i = \alpha_1 + \beta_1 treated_i + \beta_2 exposure_i + \beta_3 (treated_i * rexposure_i) + \beta_4 X_i + \varepsilon_{i1}$$

We regress pro-social behavior on the variables of interest: a treatment dummy, an exposure dummy and the interaction between the two, and additionally control for a vector of explanatory variables (X_i). The estimate $\widehat{\beta_1}$ can be interpreted as the priming effect for the less affected sample, while the estimate $\widehat{\beta_2}$ represent the effect of real-world variation in exposure without priming. The interaction between exposure and priming can be interpreted from estimate $\widehat{\beta_3}$, and we can learn whether more exposed participants react

differently to the prime. For the country-specific regressions, we cluster standard errors at the session level in Solomon Islands to account for treatment assignment at the session level and use heteroscedasticity robust standard errors for the survey experiment regressions.

4.8.3 Mediation analysis

After conducting our research in Solomon Islands, we suspected that the priming treatment might also increase negative emotions (mediator), which in turn could have a dampening (Drouvelis and Grosskopf, 2016) or strengthening (Raposa et al., 2016) effect on pro-social behavior. We propose two mechanisms that affect pro-social behavior, a direct effect of the priming treatment through increased awareness of the future consequences of SLR, and an indirect effect through increased negative emotions caused by thinking about the distressing event of displacement. The goal is to decompose the average priming effect into these two potentially opposing direct and indirect effects. We use LSEM to estimate the ACME of negative emotions on the differences in pro-social behavior between control and video treatment. First, we regress the mediator on the priming treatment and a set of potential pre-treatment confounders (X_i), such as age and gender, using a linear regression, see equation (1). Secondly, we regress our pro-social behavior measure on the priming treatment, negative emotions and the set of pre-treatment confounders using another linear regression, see equation (2). Based on these two equations, we can estimate the direct (ADE), indirect (ACME) and total effect (ATE).

(1) $$negative\ emotions_i = \alpha_1 + \beta_1 primed_i + \theta_1^T X_i + \varepsilon_{i1}$$

(2) $$pro\text{-}social\ behavior_i = \alpha_2 + \beta_2 primed_i + \gamma_2\ negative\ emotions_i + \theta_2^T X_i + \varepsilon_{i2}$$

$$ACME = \hat{\beta}_1 * \hat{\gamma}_2$$

$$ADE = \hat{\beta}_2$$

$$ATE = ADE + ACME = \hat{\beta}_2 + (\hat{\beta}_1 * \hat{\gamma}_2)$$

As a robustness check, we also conduct the causal mediation analysis as proposed by Imai et al. (2010) and check how sensitive our mediation results are to the violation of the sequential ignorability assumption. The causal estimation analysis produced similar results using the Imai methods, see supplementary Table S3.15 and Figure S3.6 for the sensitivity analysis.

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Chapter 5: Solomon Islanders do not trust more in repeated interactions - Experimental evidence from a binary trust game

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Abstract

Many social-interactions suffer from a short-lived time perspective which leads people to act in their self-interest, being it high turnover-rates in firms, politicians focusing on being re-elected or interactions on social media. Here, I study how trust is affected in communities which are facing exodus due to climate change impacts. I report results from a binary trust game with 477 Solomon Islanders, comparing behavior wherein one condition participants know they only interact once with behavior where participants expect multiple interactions. About 40% of participants do trust and reciprocate trust in the single interaction, but neither is promoted in the repeated condition. On average, I find that pro-socials are more trusting than individualist, but they do not behave significantly different in anticipation of multiple interactions. These results question the importance of backward reasoning for supporting jointly beneficial interactions in repeated games beyond student samples.

Keywords: experimental economics, repeated games, lab-in-the-field, trust, trustworthiness.

5.1 Introduction

Previous research has shown that people cooperate more in repeated interactions when the end of the interaction is uncertain. The literature refers to this effect as "the shadow of the future" coined by Axelrod (1984). The predictions of this effect heavily rely on the concept of backward induction. One can apply backward reasoning to solve the game only when there is certainty about its length. A growing number of experimental studies have examined the shadow of the future in laboratory settings, mostly using the prisoner's dilemma. In line with economic theory, the first wave of studies finds that participants cooperate more in the first interaction when the probability of future interactions is higher (Roth and Murnighan, 1978). These effects are more pronounced when participants already played the game multiple times with different partners (see Dal Bó & Fréchette, 2018 for a meta-analysis). Related studies by psychologists find that even the mere expectation of interacting increases cooperative outcomes among children (Blake et al., 2015) and individualists but not pro-socials (Van Lange et al., 2011).

This study is, to the best of my knowledge, the first to explore the shadow of the future in a field setting. I am studying a unique set of participants from Solomon Islands that is not only culturally different from standard subject pools but also experiences an actual decline in the shadow of the future due to the impacts of rising sea levels. I use a binary version of the trust game to measure participant's trust and trustworthiness. I compare the share of trust and trustworthiness in the first interaction under two conditions, firstly, where subjects know they only interact once and, secondly, where participants expect multiple interactions with uncertainty about the actual number of interactions. The game was not played with multiple partners which would enable learning effects; however, participants have experience with real-world interactions that suffer from a shortening of the time-horizon.

I find that (1) the expectation of repeated play does not increase the share of trusting and trustworthy participants; (2) pro-socials are indeed more trusting than individualists, but the latter do not react significantly different to the repeated treatment than pro-socials.

5.2 Experimental design and procedures

I conducted the experiments with people in the capital of Solomon Islands and a remote low-lying atoll group (Reef Islands) between April and June 2017. Overall, 40 lab-in-the field workshops were conducted with 12 participants each. The sample consists of 477 islanders[31] that differ in their risk of displacement. As most participants knew the

[31] Three participants left before finishing the post-experimental survey and were excluded from the analysis.

majority of the other workshop participants[32], the results refer to in-group measures of trust and trustworthiness.

In the trust game, players were randomly assigned to play as either the trustor or trustee. The trustor had to decide between splitting his endowment of 20 SBD equally (10,10) and end the game, or put trust in his partner by sending his full endowment. In the latter case, the amount was doubled by the experimenter, and the trustee had to decide whether to split equally (20,20), being trustworthy, or keep most of the money for himself (5, 35). The strategy method was used for the trustees to be able to elicit their preferences even if the trustor ended the game. Hence, the trustees had to make their decision, assuming that the trustor put trust in them. If the trustor didn't trust the trustee, the endowment would have been split equally (10,10) and the game ended. I vary the continuation probability δ that the game continues for another round at the session-level. In the one-shot treatment, δ is equal to zero, and only one round is played. In the infinitely repeated treatment, the game continues for another round with probability $\delta = \frac{2}{3}$, putting the expected number of rounds being played at three. Participants were matched with the same partner and kept their roles throughout the game. At the start of every new round, participants received feedback about their partner's previous decision. More details on the experimental procedures are reported in section S4.1 of the supplementary materials (SM).

After this experiment, participants completed a social value orientation task and answered questions on socio-demographics and climate change perceptions. I categorize people as either individualists or pro-socials based on an incentivized version of the social value orientation task developed by Murphy & Ackermann (2014)[33]. On average, participants earned 10.5 USD for the entire workshop, a substantial amount, given that the average monthly income in the sample is around 80 USD. I pool observations from all workshops for the analysis. Participants share similar observable socioeconomic characteristics across both treatment conditions (SM Table S4.2).

5.3 Results

I find no support that the expectation of repeated interaction promotes trust and trustworthiness. Panel (a) in Figure 5.1 shows the average trust (38%) and trustworthiness (40%), which are not significantly different between the two treatment conditions (for trust $Chi^2(1)=0.072$, $p=0.79$, and trustworthiness $Chi^2(1)=0.006$, $p=0.94$). A compelling reason

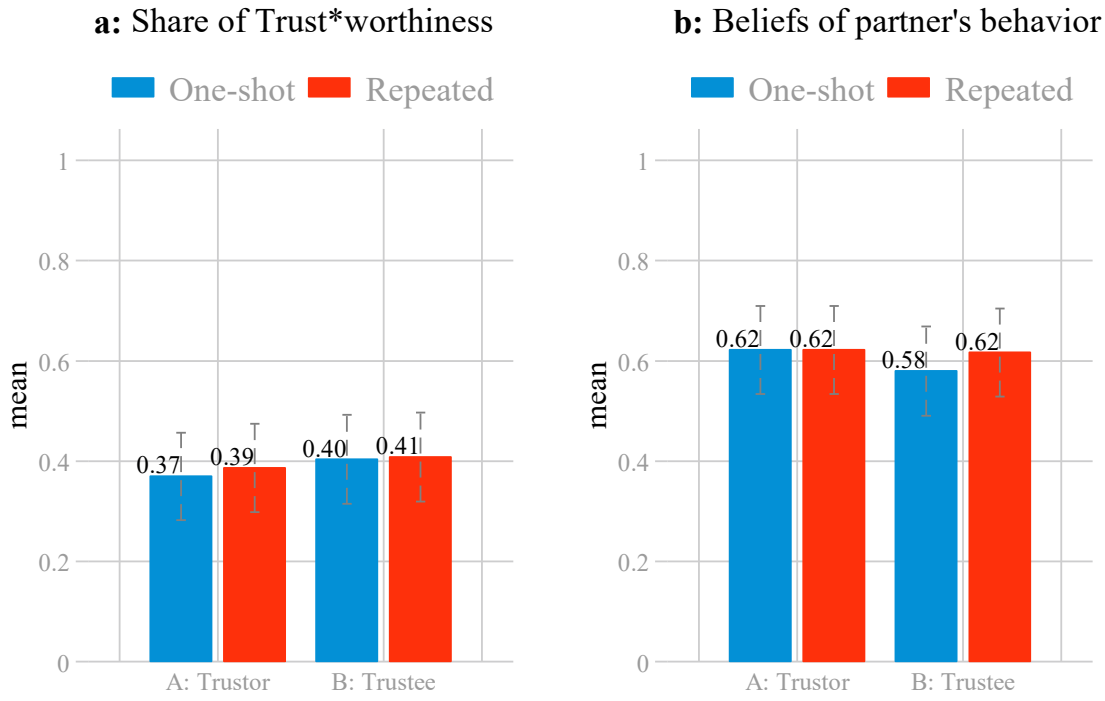
[32] The workshops were conducted in small communities on atolls with up to 80 households and in dense settlements in the capital where people know each other. On average participants reported to be related with 3.7 and/or friends with 3.8 out of the 11 other workshop participants.

[33] The six item version of their task gives a continuous scale that measures the degree of other regarding preferences and allows categorizing in competitive, individualist, pro-social and altruistic types. For the analysis presented here I only consider individualists and prosocials, as there were only 11 competitors and three altruists.

for the null result could derive from the in-group setting her, as participants might consider continued interactions outside the experiment. However, I do not find that participants behave differently in sessions with a higher share of friends and relatives[34] (SM Figure S4.2).

Panel b, Figure 5.1 reports the binary beliefs about their partner's behavior. I find a significant gap between expected behavior (60% believe their partner will be trustworthy or trusting) and actual behavior in this anonymous setting. Interestingly, expectations and actual behavior are only significantly correlated for trustors ($Chi^2(1)=6.2$, $p=0.013$) but not for trustees. The fact that I used the strategy method for trustees might explain the lack of correlation between expectations and decisions. They might feel and act differently, knowing to have reached a particular information set, compared to potentially reaching it. Analysis of repeated play also shows that only trustors are using conditional strategies but not trustees (SM Table S4.5).

Figure 5.1: Treatment effects



Notes: Panel a shows the share of trust (one-shot N=119; repeated N=119) and trustworthiness (one-shot N=119, repeated N=120). Panel b reports the binary expectations of what trustors and trustees expect their partner will do in the first round. Only the first round for the repeated game is reported here.

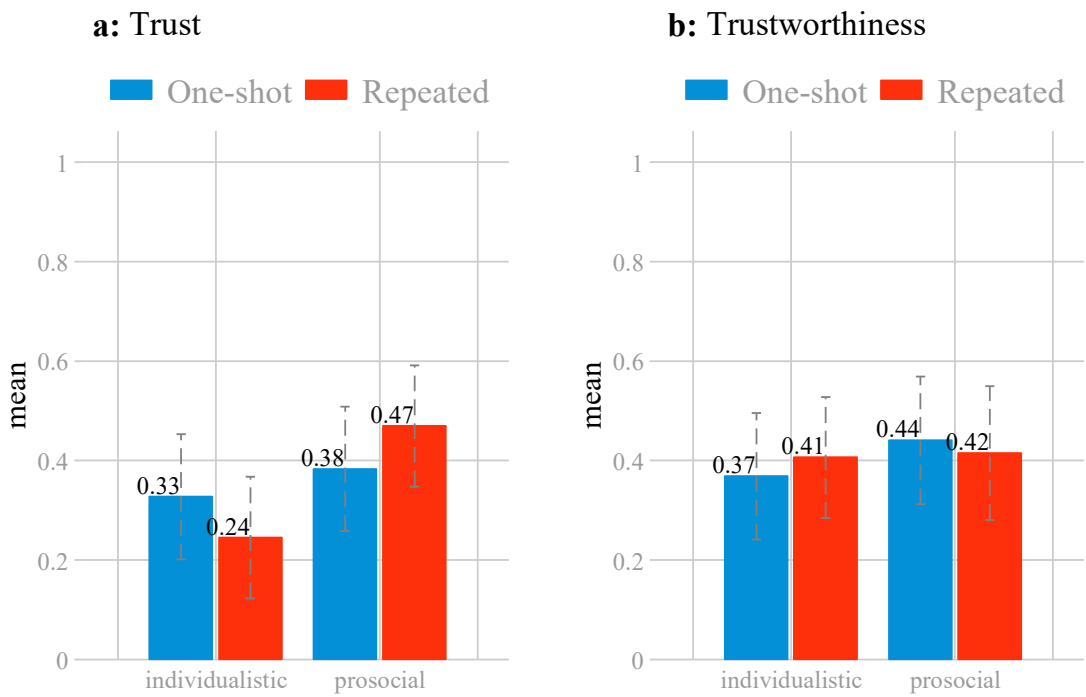
Controlling for expectations, socioeconomics, the number of social ties within the session and understanding of the game does not change the main result (SM Table S4.3). In line with the null treatment effect, I find that displacement risk appraisal does not affect trust and trustworthiness (SM Figure S4.3).

[34] In workshops conducted with atoll islanders or migrants, participants reported to be related or friends with twice as many other participants than in sessions conducted with main islanders.

Another compelling explanation could be the larger share of pro-socials in this sample compared to experiments conducted with students. Van Lange et al. (2011) argue that pro-socials with their cooperative mindset do not assess the strategic aspect of the situation as much as individualists who are motivated by the chance of rewarding and punishing behavior in repeated interactions to maximize their earnings. This argumentation might explain why the many economic lab-experiments[35] which not control for pro-social preferences, find that infinitely repeated play promotes cooperation through the mechanism of backward induction.

On average, pro-socials are 14 percentage points more likely to trust than individualists (Chi2(1)=4.82, p=0.028), but they are not significantly more trustworthy nor do they differ in their expectations of what their partners will do. Figure 5.2 shows that individualists do not react stronger than pro-socials to the repeated treatment. If at all, individualists seem to be slightly less trusting by 8pp ($Chi^2(1)=0.86$, p=0.36) while the opposite holds true for pro-socials (d=0.09, $Chi^2(1)=0.86$, p=0.36). The results do not change if I only look at the bottom quantile of individualists and top quantile of pro-socials (SM Figure S4.4). The number of social ties participants have within the session is neither significantly correlated with the decision to trust or being trustworthy ($Chi^2(11)$ p=0.15 and p=0.64, respectively).

Figure 5.2: The role of pro-social preferences



Notes: Panel A shows the share of trust by treatment, and prosocial preference type (pro-socials N=126, individualists N=104) panel B shows the same results for trustworthiness (pro-socials

[35] The meta-study by Engel (2011) shows that students are more selfish than non-students, i.e. they give less on average and are much more likely to give nothing in dictator games.

N=112, individualists N=121). Pro-socials and individualists are equally distributed across treatments.

5.4 Concluding remarks

Drawing on a unique subject pool, I cannot replicate the findings from the laboratory literature that find positive effects of the shadow of the future. It does neither promote trust nor trustworthiness. Moreover, in contrast to Van Lange et al. (2011), I do not find evidence that the anticipation of interactions promotes cooperative outcomes more for individualists than pro-socials. Backward reasoning seems irrelevant for participants here. Solomon Islanders seem to be less strategically concerned, potentially due to strong social norms[36] and having a different concept of time for monetary interactions (SM Table S4.1). The knowledge gathered from laboratory experiments with students might only apply to a small subset of humans. Through repeated play, we might teach participants, by design of the rules and incentives in the experiment, the behavior we actually want to see. In line with this interpretation are the findings by Levitt et al. (2011) who show that even players that excel in backward reasoning do rarely play according to equilibrium predictions derived by backward induction in cooperative games. However, students who played multiple games do (Dal Bó & Fréchette, 2018).

In future research, we should embrace more diverse subject pools to test the generalizability of our measures. Are these tools really measuring what we want them to measure? In the end, we want to learn about decision making outside laboratory settings for a broad set of human beings.

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[36] Solomon Islanders have a so called "wantok" system that implies favoritism towards the in-group based on the common expectation of fulfilling a series of reciprocal exchanges such as sharing food or providing shelter. It is very much based on the concept of trust and trustworthiness and works as a social security system for Islanders.

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Supplementary materials

S1 Chapter 2

S1.1. What factors shape the perception of climate change impacts and displacement risk?

Table S1.1 Determinants of CC perceptions

VARIABLES	Recall of past CC impacts				Perception of future CC impacts			
	Pooled (1)	Pooled (2)	BD & VN (3)	BD & VN (4)	Pooled (5)	Pooled (6)	BD & VN (7)	BD & VN (8)
More exposed	0.51***	0.45***	0.28***	0.25***	0.46***	0.43***	0.18**	0.13*
	(0.04)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.07)	(0.07)
Information sources								
Info: internal [0,5]		0.06***		0.06***		0.08***		0.09***
		(0.02)		(0.02)		(0.02)		(0.03)
Info: media [0,5]		-0.10***		0.02		-0.01		0.05
		(0.03)		(0.04)		(0.02)		(0.04)
Info: governments, NGOs, scientists [0,5]		-0.01		0.01		0.00		-0.01
		(0.03)		(0.03)		(0.03)		(0.04)
Worship at least once a week		0.10		0.16		0.11*		-0.03
		(0.06)		(0.13)		(0.06)		(0.17)
Beliefs								
Reliance on outsiders		0.06		-0.08		-0.12***		-0.11*
		(0.04)		(0.06)		(0.04)		(0.07)
Outcome-efficacy [1,5]				0.03				0.06**
				(0.03)				(0.03)
Self-efficacy [1,5]				0.05**				0.05*
				(0.02)				(0.03)
Perceived knowledge about CC [0,1]				0.18**				0.25**
				(0.09)				(0.10)
Place attachment (std.)				0.04				0.02
				(0.03)				(0.03)
Constant	3.57***	3.62***	3.15***	2.43***	4.16***	3.81***	3.36***	2.56***
	(0.11)	(0.17)	(0.17)	(0.28)	(0.11)	(0.19)	(0.19)	(0.35)
Socio-economics	Y	Y	Y	Y	Y	Y	Y	Y
F-test(socio) sig.	0.52	0.82	0.57	0.19	0.58	0.70	0.70	0.88
F-test(infos) sig.		0.00		0.02		0.00		0.00
F-test(beliefs) sig.		0.12		0.01		0.00		0.00
Observations	1,325	1,325	610	610	1,325	1,325	610	610
R-squared	0.25	0.27	0.11	0.15	0.30	0.31	0.09	0.15
Adj. R-squared	0.24	0.26	0.10	0.13	0.29	0.31	0.08	0.13

Notes: The dependent variable in column (1) to (4) is the recall of past CC impacts. Column (5) to (8) show determinants of the future perception of CC impacts. We control for socio-economics (gender, marital status, age, education, household size and household income) and include country dummies in all models. Robust standard errors clustered at the individual level are reported in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table S1.2 Determinants of relocation beliefs

	Solomon Islands		Bangladesh		Vietnam	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
More exposed	0.19**	0.18*	2.04***	2.08***	0.91*	1.02**
	(0.09)	(0.10)	(0.45)	(0.47)	(0.50)	(0.52)
CC future perception		-0.07		0.32		-0.65**
		(0.05)		(0.28)		(0.27)
Information sources						
Info: internal		-0.06		0.02		-0.10
		(0.06)		(0.18)		(0.21)
Info: media		-0.09***		0.17		0.08
		(0.03)		(0.22)		(0.28)
Info: governments, NGOs, scientists		0.01		0.32		-0.28
		(0.04)		(0.26)		(0.21)
Worship at least once a week		0.01		2.14***		0.96
		(0.07)		(0.61)		(1.67)
Beliefs						
Reliance on outsiders		0.04		0.46		-1.85***
		(0.05)		(0.44)		(0.42)
Outcome-efficacy [1,5]				-0.05		0.54**
				(0.18)		(0.22)
Self-efficacy [1,5]				0.18		-0.23
				(0.16)		(0.21)
Perceived knowledge about CC [0,1]				0.94		-0.76
				(0.66)		(0.73)
Place attachment (std.)				-0.29		-0.43**
				(0.20)		(0.20)
Constant			3.97***	-2.19	4.22***	7.33***
			(1.18)	(1.99)	(1.19)	(1.84)
Socio-economics	Y	Y	Y	Y	Y	Y
F-test(socio) sig.	0.81	0.90	0.00	0.05	0.12	0.19
F-test(infos) sig.		0.02		0.00		0.55
F-test(beliefs) sig.		0.52		0.20		0.00
Observations	346	346	247	247	363	363
(Pseudo) R-squared	0.03	0.07	0.10	0.15	0.03	0.15
Adj. R-squared			0.07	0.08	0.01	0.10

Notes: The dependent variable in models (1) and (2) is the belief to be forced to relocate within the next 5 years due to sea-level rise impacts. It takes the value one if the respondent thinks she will have to relocate and zero otherwise. The average marginal effects from probit regressions are reported. In models (3) to (6) the dependent variable is an 11-point Likert-scale that measures the likelihood of relocation due to erosion and floods, ranging from 0 "absolutely unlikely" to 10 "absolutely certain". Socio-economic controls are: gender, marital status, age, education, household size and household income. OLS estimates are reported for models (3) and (4). Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

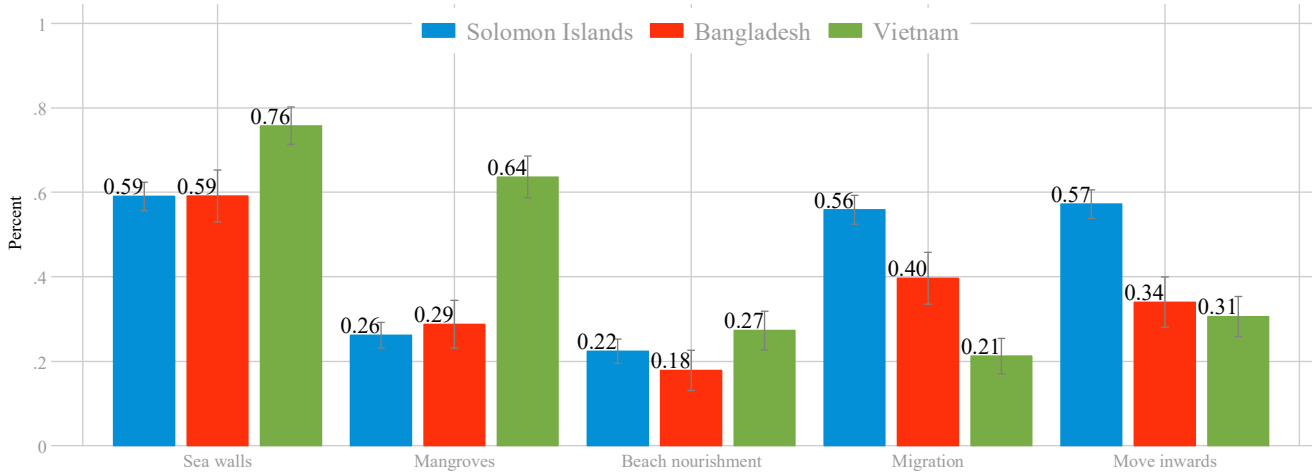
S1.2. Determinants of adaptation intentions

Figure S1.1 shows the averages across the different adaptation actions that were mentioned to the hypothetical SLR scenario[37]. The mentioned adaptation strategies can be described as either technical and most often costly solutions (seawalls, beach nourishment), retreat out of harm's way (within village or further movements) and soft measures such as planting mangroves or elevated gardening beds. The most preferred adaptation action across all three samples are seawalls, a technical solution that aims at armoring the coast and reducing erosion. Seawalls were mentioned significantly more often in Vietnam (76%)

[37] We do not illustrate "other strategies" that were mentioned, as they only represent a small fraction (below 3% of the pooled sample)

than in both Bangladesh (59%) and Solomon Islands (59%). Seawalls are followed by retreat within the same community further away from exposed areas, which is most often mentioned in Solomon Islands (57%). Respondents in Vietnam consider planting and maintaining mangroves as the second most important adaptation measure, which is significant less popular in the other two samples (<30%). Beach nourishment, a less hard measure than seawalls that requires to repeatedly add sand to eroding beach patches, is the least popular local adaptation measure (<30%). Retreat to another place out of harm's way, was most often mentioned by Solomon Islands (56%), followed by Bangladesh (40%) and only mentioned by one-fifth of the respondents in Vietnam.

Figure S1.1 Overview of adaptation intentions across samples



Notes: Based on own data collection.

Table S1.3 Determinants of number of intended adaptation actions

	Pooled		Solomon Islands		Bangladesh		Vietnam	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
More exposed	0.26***	0.20***	0.12	0.37***	-0.11	-0.29*	0.27*	0.03
	(0.07)	(0.07)	(0.13)	(0.13)	(0.14)	(0.15)	(0.15)	(0.15)
Future perception of CC [1,5]		0.19***		0.08		0.20**		0.20***
		(0.04)		(0.06)		(0.09)		(0.07)
Risk perception of SLR impacts [0,10]						0.04		0.04*
						(0.03)		(0.02)
Relocation likelihood due to SLR [0,10]						0.00		0.03**
						(0.02)		(0.02)
Reliance on outside help		-0.93***		-1.21***		-0.52***		-0.57***
		(0.05)		(0.07)		(0.13)		(0.12)
Outcome-efficacy [1,5]						-0.01		-0.10
						(0.06)		(0.07)
Self-efficacy [1,5]						0.01		-0.07
						(0.04)		(0.07)
Perceived knowledge about CC [0,1]						0.20		0.40*
						(0.20)		(0.21)
Place attachment (std)						0.04		0.12**
						(0.07)		(0.06)
Pro-social behavior (std)						0.05		0.01
						(0.07)		(0.05)
Patience (std)						-0.01		0.06
						(0.07)		(0.05)
Risk aversion (std)						-0.02		-0.13**
						(0.07)		(0.05)
Negative affect (std)						0.01		-0.02
						(0.07)		(0.05)
Constant	1.91***	1.45***	2.33***	1.97***	1.40***	0.74	1.88***	1.34***
	(0.19)	(0.23)	(0.26)	(0.31)	(0.41)	(0.58)	(0.37)	(0.48)
Socio-economics	Y	Y	Y	Y	Y	Y	Y	Y
F-test(socio) sig.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
F-test(CC appraisal) sig.						0.01		0.00
F-test(beliefs) sig.						0.00		0.00
F-test(Preferences) sig.						0.97		0.11
Observations	1,325	1,325	715	715	247	247	363	341
R-squared	0.04	0.24	0.05	0.33	0.08	0.19	0.07	0.28
Adj. R-squared	0.04	0.23	0.04	0.33	0.06	0.12	0.05	0.23

Notes: The dependent variable is the number of intended adaptation actions that the respondent mentioned. Estimates from linear regression models are reported which include country dummies in model (1) and (2). We do not account for differences in sample sizes between countries. Socio-economic controls are: gender, marital status, age, education, household size and household income. Robust standard errors clustered at the individual level are reported in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table S1.4 Migration

	Pooled		Solomon Islands		Bangladesh		Vietnam	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
More exposed	-0.18***	-0.16***	-0.31***	-0.32***	-0.07	-0.13*	-0.04	-0.01
	(0.03)	(0.03)	(0.05)	(0.06)	(0.06)	(0.07)	(0.06)	(0.06)
Future perception of CC [1,5]		-0.04**		-0.04		0.01		0.02
		(0.02)		(0.03)		(0.04)		(0.03)
Risk perception of SLR impacts [0,10]						0.01		-0.02***
						(0.01)		(0.01)
Relocation likelihood due to SLR [0,10]						0.01		0.03***
						(0.01)		(0.01)
Reliance on outside help		-0.02		0.10***		-0.15**		-0.05
		(0.03)		(0.04)		(0.06)		(0.04)
Outcome-efficacy [1,5]						0.02		0.02
						(0.02)		(0.03)
Self-efficacy [1,5]						0.02		-0.04
						(0.02)		(0.02)
Perceived knowledge about CC [0,1]						0.10		0.02
						(0.09)		(0.08)
Place attachment (std)						0.02		0.01
						(0.03)		(0.02)
Pro-social behavior (std)						-0.04		0.04**
						(0.03)		(0.02)
Patience (std)						-0.01		-0.00
						(0.03)		(0.02)
Risk aversion (std)						-0.01		-0.01
						(0.03)		(0.02)
Negative affect (std)						0.01		0.01
						(0.03)		(0.02)
Socio-economics	Y	Y	Y	Y	Y	Y	Y	Y
F-test(socio) sig.	0.00	0.00	0.56	0.61	0.05	0.11	0.01	0.04
F-test(CC appraisal) sig.						0.47		0.00
F-test(beliefs) sig.						0.08		0.56
F-test(preferences) sig.						0.71		0.29
Observations	1,325	1,325	715	715	247	247	363	341
Pseudo R-squared	0.10	0.10	0.07	0.08	0.04	0.09	0.06	0.15

Notes: The dependent variable takes the value of one if the respondent intends to migrate in order to adapt to SLR. The average marginal effects from a probit regression are reported. Socio-economic controls are: gender, marital status, age, education, household size and household income. Robust standard errors clustered at the individual level are reported in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table S1.5 Only migration

VARIABLES	Pooled (1)	Pooled (2)	Solomon Islands (3)	Solomon Islands (4)	Bangladesh (5)	Bangladesh (6)	Vietnam (7)	Vietnam (8)
More exposed	-0.10***	-0.11***	-0.14***	-0.20***	-0.10**	-0.17***	0.03	0.04***
	(0.02)	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)	(0.02)	(0.01)
Future perception of CC [1,5]		-0.02*		-0.02		-0.02		0.01
		(0.01)		(0.02)		(0.02)		(0.01)
Risk perception of SLR impacts [0,10]						-0.00		-0.01**
						(0.00)		(0.00)
Relocation likelihood due to SLR [0,10]						0.01		0.01**
						(0.00)		(0.00)
Reliance on outside help		0.11***		0.24***		-0.00		0.00
		(0.02)		(0.03)		(0.02)		(0.01)
Outcome-efficacy [1,5]						0.03**		0.00
						(0.01)		(0.01)
Self-efficacy [1,5]						0.02*		-0.02***
						(0.01)		(0.01)
Perceived knowledge about CC [0,1]						-0.13***		-0.01
						(0.04)		(0.02)
Place attachment (std)						0.00		-0.01
						(0.01)		(0.01)
Pro-social behavior (std)						-0.02		0.00
						(0.01)		(0.01)
Patience (std)						-0.00		-0.00
						(0.01)		(0.01)
Risk aversion (std)						-0.01		-0.01
						(0.01)		(0.01)
Negative affect (std)						0.03**		0.04***
						(0.01)		(0.01)
Socio-economics	Y	Y	Y	Y	Y	Y	Y	Y
F-test(socio) sig.	0.01	0.03	0.04	0.08	0.02	0.01	0.00	0.22
F-test(CC appraisal) sig.						0.29		0.00
F-test(beliefs) sig.						0.00		0.00
F-test(preferences) sig.						0.15		0.00
Observations	1,325	1,325	715	715	247	247	363	341
Pseudo R-squared	0.15	0.20	0.09	0.19	0.14	0.32	0.11	0.47

Notes: The dependent variable takes the value of one if the respondent considered only migration to adapt to SLR. The average marginal effects from a probit regression are reported. Socio-economic controls are: gender, marital status, age, education, household size and household income. Robust standard errors clustered at the individual level are reported in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table S1.6 Only local adaptation measures

VARIABLES	Pooled (1)	Pooled (2)	Solomon Islands (3)	Solomon Islands (4)	Bangladesh (5)	Bangladesh (6)	Vietnam (7)	Vietnam (8)
More exposed	0.18***	0.15***	0.32***	0.32***	-0.00	0.06	0.05	0.01
	(0.03)	(0.03)	(0.05)	(0.06)	(0.07)	(0.07)	(0.07)	(0.06)
Future perception of CC [1,5]		0.05***		0.03		-0.01		0.02
		(0.02)		(0.03)		(0.05)		(0.03)
Risk perception of SLR impacts [0,10]						-0.01		0.02***
						(0.01)		(0.01)
Relocation likelihood due to SLR [0,10]						-0.02**		-0.02***
						(0.01)		(0.01)
Reliance on outside help		-0.00		-0.10***		0.08		0.00
		(0.03)		(0.04)		(0.06)		(0.05)
Outcome-efficacy [1,5]						-0.02		-0.01
						(0.02)		(0.03)
Self-efficacy [1,5]						-0.02		0.02
						(0.02)		(0.03)
Perceived knowledge about CC [0,1]						-0.11		-0.04
						(0.10)		(0.09)
Place attachment (std)						-0.01		0.02
						(0.03)		(0.02)
Pro-social behavior (std)						0.04		-0.04*
						(0.03)		(0.02)
Patience (std)						-0.01		0.00
						(0.03)		(0.02)
Risk aversion (std)						0.01		-0.01
						(0.03)		(0.02)
Negative affect (std)						0.01		-0.01
						(0.03)		(0.02)
Socio-economics	Y	Y	Y	Y	Y	Y	Y	Y
F-test(socio) sig.	0.04	0.04	0.73	0.75	0.23	0.24	0.04	0.36
F-test(CC appraisal) sig.						0.10		0.00
F-test(beliefs) sig.						0.51		0.87
F-test(preferences) sig.						0.84		0.42
Observations	1,325	1,325	715	715	247	247	363	341
Pseudo R-squared	0.08	0.09	0.07	0.08	0.03	0.06	0.04	0.11

Notes: The dependent variable takes the value of one if the respondent considered only local adaptation measures to adapt to SLR. The average marginal effects from a probit regression are reported. Socio-economic controls are: gender, marital status, age, education, household size and household income. The p-values from joint significance F-tests are reported for specific groups of explanatory variables. Robust standard errors clustered at the individual level are reported in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

S1.3. Determinants of social practices and collective actions

Our main explanatory variables of interest are the group dummies, where atoll islanders are used as the reference group. Within the migrant sample, we additionally distinguish between first and second generations migrants from the atolls. All models in Table S1.7 report the average marginal effects of a probit regression controlling for socio-demographics. We find that second-generation migrants are over 60 percentage point less likely to agree that it is wrong for migrants not to visit their home than atoll islanders (see model (1) in Table S1.7). Interestingly, first-generation migrants do not share this belief, highlighting the potential influence of time people stay in the city. However, it is not the case that the second-generation completely forgets their roots. We estimate that they are

about 40 percentage points less likely to agree that migrants forget their traditional languages and only speak English or Pidgin than atoll islanders.

In line with these preferences, we estimate that first-generation migrants differ from atoll islanders w.r.t. the acceptability of copying the lifestyle of people living in the capital. While second-generation migrants are not significantly more likely to agree that such behavior is acceptable, atoll migrants are about 30 percentage points more likely to agree (see model (3), in Table S1.7).

In model (4) we estimate the acceptability to ignore a community decision to not relocate in a scenario where the community is strongly affected by climate change. Again, we find that first-generation migrants have on average the similar opinions as atoll islanders, while second-generation migrants are 25 percentage points more likely to agree that ignoring is acceptable behavior. Findings reported in model (5) show that second-generation migrants are nearly 50 percentage points less likely to participate in collective activities than first-generation migrants.

Table S1.7 Social practices and collective actions

VARIABLES	Wrong to not visit home? (1)	Migrants forget their traditional language (2)	Acceptable to adopt capital lifestyle? (3)	Ignore community decision? (4)	Collective Activities (5)	Norm Enforcement (6)
Second-generation Atoll Migrants	-0.63***	-0.40***	0.17	0.25***	-0.47***	-0.37***
	(0.10)	(0.11)	(0.14)	(0.06)	(0.09)	(0.11)
Atoll Migrants	-0.05	-0.06	0.32**	0.11	-0.49***	-0.15
	(0.16)	(0.13)	(0.15)	(0.08)	(0.09)	(0.09)
Male	-0.06	-0.16***	0.01	-0.02	0.03	-0.01
	(0.06)	(0.06)	(0.06)	(0.06)	(0.04)	(0.02)
Age	0.00	0.00	0.00	-0.00*	-0.00	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education (years)	0.00	0.00	0.00	0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
HH size	-0.01	0.01	0.00	-0.02	0.02**	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Married	0.08	-0.18**	-0.14*	0.10	0.09*	-0.02
	(0.09)	(0.08)	(0.09)	(0.08)	(0.05)	(0.02)
Worship (weekly)	0.01	-0.31***	-0.02	0.07	0.12**	0.09**
	(0.08)	(0.07)	(0.08)	(0.08)	(0.06)	(0.04)
Melanesian (=1)	0.11	0.07	0.04	0.25***	0.11**	0.01
	(0.09)	(0.10)	(0.09)	(0.09)	(0.06)	(0.03)
Monthly income in SBD divided by 100	0.01**	0.00***	-0.00	0.00	-0.00**	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	273	273	273	273	543	543
Pseudo R-squared	0.11	0.08	0.04	0.09	0.16	0.12

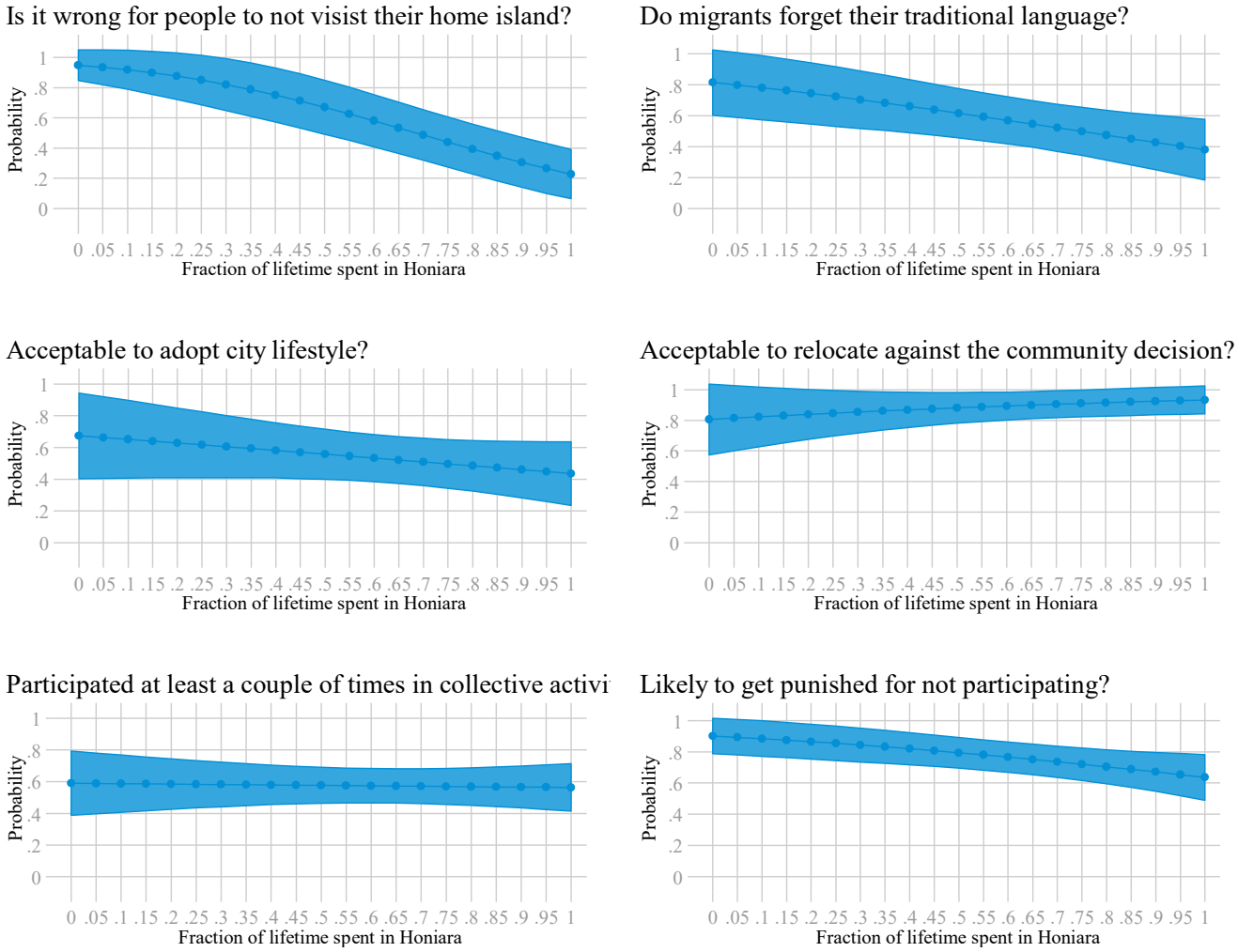
Notes: The wording for the dependent variables were as follows: (1) "Do you think it is wrong, that some people who moved to Honiara never visit the island they originally came from?" (yes/no) (2) "Do you think that people who move to Honiara forget their traditional language and start to speak only Pidgin and English?" (yes/no) (3) "Do you think that it is okay for people who move to Honiara to copy the lifestyle of other people living in Honiara?" (yes/no) (4) "Suppose your community is strongly affected by climate change. Would you consider relocating even if all of your community decides to stay?" (yes/no) (5) "Altogether, how many times in the past 12 months did you participate in community activities for common development goals? (1 = at least a couple of times per year; 0 = never) (6) "How likely is it that people who do not participate in community activities will be criticized or sanctioned? (1 = likely; 0 = not likely). All probit regressions control for the respondent's gender, age, education, household size, marital status, worship regularity, ethnicity and monthly income in SBD divided by 100. Estimates are average marginal effects with robust standard errors in parentheses clustered at the individual level: *** p<0.01, ** p<0.05, * p<0.1

Table S1.8 Does the length of stay correlate with the erosion of beliefs?

VARIABLES	Wrong to not visit home? (1)	Migrants forget their traditional language (2)	Acceptable to adopt capital lifestyle? (3)	Ignore community decision? (4)	Collective Activities (5)	Norm Enforcement (6)
Years living in the capital	-0.03**	-0.03***	-0.01	0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Male	0.14	-0.13	-0.32	0.00	0.04	0.00
	(0.21)	(0.21)	(0.20)	(0.05)	(0.12)	(0.05)
Age	0.00	-0.02**	0.02**	-0.01**	-0.01*	-0.01
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)
Education (years)	-0.02	0.03	0.04	-0.00	-0.02	-0.01
	(0.04)	(0.04)	(0.04)	(0.01)	(0.02)	(0.01)
HH size	-0.03	-0.01	-0.02	-0.02*	0.03*	0.00
	(0.02)	(0.03)	(0.02)	(0.01)	(0.02)	(0.01)
Married	0.19	0.14	-0.10	0.04	0.10	0.07
	(0.20)	(0.24)	(0.20)	(0.08)	(0.13)	(0.07)
Worship (weekly)	-0.06	-0.27	-0.15	0.04	0.22*	0.02
	(0.15)	(0.17)	(0.18)	(0.07)	(0.12)	(0.05)
Monthly income in SBD	0.01***	0.00	-0.00	0.00	-0.00*	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	46	46	46	46	82	82
Pseudo R-squared	0.51	0.40	0.14	0.23	0.09	0.22

Notes: The wording for the dependent variables were as follows: (1) “Do you think it is wrong, that some people who moved to Honiara never visit the island they originally came from?” (yes/no) (2) “Do you think that people who move to Honiara forget their traditional language and start to speak only Pidgin and English?” (yes/no) (3) “Do you think that it is okay for people who move to Honiara to copy the lifestyle of other people living in Honiara?” (yes/no) (4) “Suppose your community is strongly affected by climate change. Would you consider relocating even if all of your community decides to stay?” (yes/no) (5) “Altogether, how many times in the past 12 months did you participate in community activities for common development goals? (1 = at least a couple of times per year; 0 = never) (6) “How likely is it that people who do not participate in community activities will be criticized or sanctioned? (1 = likely; 0 = not likely). All probit regressions control for the respondent’s gender, age, education, household size, marital status, worship regularity and monthly income in SBD divided by 100. Estimates are average marginal effects with robust standard errors in parentheses clustered at the individual level: *** p<0.01, ** p<0.05, * p<0.1.

Figure S1.2 Predictive margins over rootedness



Notes: Own creation in Stata.

S1.4. Solomon Islands: Summary statistics

Table S1.9 reports the differences across all three groups w.r.t. socio-demographics. Overall, we see that migrants are more similar to their new peer group at the migration destination than to people in their home region. Interestingly, we find that nearly 50 per cent of atoll migrants in our sample are already second generation migrants that are still stuck in an illegal settlement, which illustrates the problem of social immobility for internal migrants in the capital. Nevertheless, we find that migrants gain access to income-generating work and more education by over 2 years. Monthly self-reported income is nearly a tenfold compared to what average atoll islanders earn, who predominantly live from subsistence farming and fishing. However, longer times spent living in the capital are even associated with slightly lower income (Pearson correlation $r(77)=-.23$, $p<.05$; four extreme income outliers were removed) and less education (Pearson correlation $r(82)=-.25$, $p<.05$). It seems that people who migrated more recently from the atolls are better educated and wealthier than people that have been stuck in the settlement for a longer time. Second generation migrants are on average even seven months less educated than first-generation

migrants, which is not statistically significant (Mann-Whitney U, z=1.2, p=.23, n=85). Additionally, migrants are on average younger, less likely to be married, live in bigger households and got to church less often than atoll islanders but not main islanders.

Table S1.9 Differences across groups in socio-economics

	(1)	(2)	(3)			
VARIABLES	Main Islanders	Atoll Migrants	Atoll Islanders	Mean Differences across groups		
	Mean/SD	Mean/SD	Mean/SD	(1)-(2)	(1)-(3)	(2)-(3)
Male (=1)	0.60	0.59	0.62	0.02	-0.01	-0.03
	[0.49]	[0.50]	[0.49]			
Age	30.45	32.26	41.15	-1.81	-10.70***	-8.89***
	[9.67]	[10.45]	[15.63]			
Education in years	10.37	8.79	6.61	1.58***	3.76***	2.18***
	[2.56]	[2.68]	[2.96]			
Household size	7.32	8.00	5.03	-0.68	2.29***	2.97***
	[2.70]	[4.09]	[2.01]			
Born at this place (=1)	0.70	0.48	0.82	0.22***	-0.12***	-0.34***
	[0.46]	[0.50]	[0.39]			
Married (=1)	0.49	0.67	0.79	-0.18***	-0.30***	-0.12**
	[0.50]	[0.47]	[0.40]			
Worship weekly or more (=1)	0.59	0.56	0.89	0.03	-0.30***	-0.32***
	[0.49]	[0.50]	[0.32]			
Melanesian (=1)	0.96	0.92	0.81	0.04	0.15***	0.11**
	[0.19]	[0.28]	[0.39]			
Monthly income in SBD	1365.84	1248.45	181.33	117.39	1184.51***	1067.12***
	[2201.92]	[1471.73]	[365.10]			
N	154	85	458			

Notes: Own data. We used t-tests to test differences in means across groups. Results do not change if we use chi-squared or Fisher's exact test for binary variables and non-parametric Mann-Whitney U tests for ordinal, continuous and categorical variables.

S2 Chapter 3

The ABM presented in this chapter is a gridded model of CPR use across multiple independent systems, where outcomes become interdependent due to the potential for agents to migrate between CPRs. There are three major moving parts, or "submodules," including: 1) a model of the individual CPR (see S2.1), 2) a model of how agent discount rates change endogenously (see S2.2), and 3) a model of migration between CPRs (see S2.3). The model is coded in *R* and is available upon request for interested readers.

S2.1. Overview of ABM: A model of resource use

Any given grid in the model represents a single CPR, where, at each time step, agents make decisions to harvest a certain number of units from a shared resource. This is modeled as a collective action problem in the sense that agents may make decisions that are cooperative (or not), and the payoffs from these decisions are dependent upon the decisions of all other agents in the CPR.

S2.1.1. CPR-level (grid-level) variables

At the CPR level, we keep track of the following variables. Each of these grid-level variables may vary over time:

S_t, resource stock at time t. This is the total number of resource units available for harvesting and is a function of the initial stock (declared by the user), the growth rate of the resource, as well as prior harvesting decisions by agents.

$g_t = g$, growth rate of the resource stock at time t. Resource growth rates are assumed to be static over time, and across grid cells.

N_t, number of agents in grid at time t. On model initialization, a fixed number of agents (declared by the user) are allocated uniformly and at random to grid cells. The number of agents may change as a result of migration, or births and deaths (births and deaths are yet to be implemented).

$m_t = m$, the monitoring parameter. This value is the expected loss of a defector's harvest if they are caught. More explanation is given below; it should be noted that this one value has several possible interpretations, including the strength of monitoring and the severity of sanctions.

$a_t = a$, the altruism parameter /in [0,1]. This parameter makes cooperation more likely even if the benefits of non-cooperation are large. See below for more details.

S2.1.2. Agent-level variables

Within the CPR we also have a number of agent-level variables (varying by agent and over time) that must be kept track of. These include:

$c_{i,t}$, cooperative decision of the ith agent at time t. This variable takes on a binary value, either $c_{i,t}=1$ if the agent cooperates or $c_{i,t}=0$ if the agent defects (does not cooperate).

$d_{i,t} = d_t$, the discount rate of the ith agent at time t. This value indicates the degree to which the agent de-values future payoffs as explained further below. While this is allowed to change over time (see the second submodel focused on changing discount rates), at the moment discount rates are assumed to be shared across all agents. So discount rates are currently time-varying, but invariant across agent.

$h^{max}_{i,t} = h^{max}$, the maximum number of units the ith agent is able to take out of the CPR at time t. For simplicity this is currently assumed to be a static, global variable – the same for all agents, over time and over grid cells. The maximum harvest represents technological limitations faced by agents, and also acts as a constraint to keep defectors from (unrealistically) depleting the entire resource too quickly.

$k_{i,t} = k$, the subsistence cost of the ith agent at time t. This is the cost of living; the minimum harvest that one must gain such that one's wealth does not decrease. Currently this is assumed to be the same for all agents, over time, and across CPRs.

$w_{i,t}$, wealth of the ith agent at time t. This is the total of all prior harvesting decisions made (i.e., harvesting a single resource unit always increases an agent's wealth by one—so the resource units in this model are direct representations of "wealth"), minus the subsistence cost that must be paid in each time step.

S2.1.3. Model initialization

With these variables in place we are ready to examine the behavior of the model—that is, transitions between time steps. At model initialization the following tasks are performed:

1. The user specifies a number of grids, and a total number of agents.
2. Agents are assigned uniformly at random to grids (yielding a random outcome for N_0 across grids).
3. The CPR in each grid is "initialized" by setting (according to user input):
    3.1. Initial resource stock (S_0),
    3.2. Resource growth rate (g),
    3.3. Monitoring (m), static over time and grid cell,
    3.4. The altruism parameter (a), making cooperation more likely *ceteris paribus*,
    3.5. The initial discount rate for all agents across all CPR grids (d_0),
    3.6. The maximum harvest (h^{max}),
    3.7. Subsistence cost (k),
4. Further, the following initial values are assumed:
    4.1. $c_{i,0} = 1$ for all i. In the decision functions discussed below, expectations of other agent's behavior are based on behavior in the prior round. Setting this initial

value to *cooperate* for all agents starts simulations off on the right foot; agents will generally assume that others will "play nice."

4.2. $w_{i,0} = 0$ for all i. This means that agents must work to pay their subsistence cost!

S2.1.4. Model dynamics: What happens, in what order?

At each time step the following occur, in this order:

1. Agents make harvesting decisions based on expected payoffs,
2. Agents extract from the resource and add to their existing wealth – note that payoffs may differ from harvesting decisions if the resource is completely depleted,
3. Agents pay their subsistence cost.
4. Optionally, discount rates are updated.
5. Optionally, migration occurs.
6. Each resource grows at the established rate.

These steps are explained in turn, focusing in on a particular CPR grid.

S2.1.5. To cooperate or not cooperate?

We begin with a definition of the maximum sustainable yield, MSY, of a resource. The MSY of a given CPR is the total amount that may be extracted such that the amount available tomorrow (time *t+1*) is the same as the amount available today (time *t*). A fully cooperative group of agents will seek to collectively extract exactly the MSY at any given time step. Extracting more would be unsustainable, while extracting less would be inefficient in that agents lose an opportunity to live better than mere subsistence.

What is the MSY? We start by noting again that MSY_t is the optimal harvest at time t, and each cooperator will gain an equal share of MSY such that:

$$MSY_t = \sum_i h^*_{i,t} \quad (1)$$

where $h^*_{i,t}$ is the optimal cooperator's harvest for agent i at time t.

Since MSY_t gives a sustainable resource yield, after extracting the MSY at time *t* we should have (after resource growth) the amount available in time *t+1* as was available at time *t*, such that $S_{t+1} = S_t$. However, let us not forget discounting! Due to the discount rates of the agents, future stocks are de-valued such that S_{t+1} may be less than S_t for "sustainability" to be achieved. This gives our sustainability criterion:

$$S_{t+1} = \frac{S_t}{1+d_t} \quad (2)$$

where d_t is the agents' collective discount rate at time *t*.

Due to the growth rate of the resource (*g*), extracting MSY_t at time t will yield the following resource stock at time t+1:

$S_{t+1} = (S_t - MSY_t) + g * (S_t - MSY_t)$, or

$$S_{t+1} = (1+g)(S_t - MSY_t). \quad (3)$$

Applying (1) to (3) gives:

$$S_{t+1} = (1+g)(S_t - \sum_i h^*_{i,t}). \quad (4)$$

We can now apply to sustainability criterion (2) to equation (4) to solve for the optimal cooperator's harvest h^* as a function of existing resource stock (S_t), growth rate (g), current discount rate (d_t), and the number of agents in the system (N_t):

$\frac{S_t}{1+d_t} = (1+g)(S_t - \sum_i h^*_{i,t})$, or

$\frac{S_t}{1+d_t} = (1+g)(S_t - N_t h^*_{i,t})$, since cooperators get equitable payoffs, or

$$h^*_{i,t} = \left(\frac{S_t}{N_t}\right)\left(1 - \frac{1}{(1+d_t)(1+g)}\right) \quad . \quad (5)$$

Equation (5) gives the optimal sustainable harvest for all agents *i* at time *t*.

Now we are ready to evaluate payoffs for a given harvesting decision. We assume that agents will either *cooperate* ($c_{i,t}$=1) or *defect* ($c_{i,t}$=0) and cooperators will attempt to harvest $h^*_{i,t}$ while defectors will attempt to harvest as much as their technology will allow, h^{max}. If the resource is plentiful then they will actually harvest what they attempt to harvest. However, if the resource is depleted then agents may not be able to harvest what they attempt to harvest. More formally, let $h_{i,t}$ be the actual harvesting decision made by each agent *i* at time *t*. Then the payoff to agent *i* in time *t* is $P_{i,t}$ such that:

$$P_{i,t}(c_{i,t}) = \begin{cases} h^*_{i,t} - \omega, & c_{i,t} = 1 \\ h^{max} - p - \omega, & c_{i,t} = 0 \end{cases},$$

$$\text{where } \omega = \begin{cases} 0, & \sum_i h_{i,t} \le S_t \\ \frac{\sum_i h_{i,t} - S_t}{N_t}, & \sum_i h_{i,t} > S_t \end{cases}, \quad (6)$$

and where *p* (for "punishment") is the result of a random draw, where h^{max} is drawn with probability *m* and 0 is drawn with probability *1-m*. In this case, *m* may be interpreted as the probability that a defector will be caught and forced to pay sanction h^{max} (such that their payoff in that round is zero, notably less than the subsistence cost).

From the above payoff function, agents will typically get either the equitable, sustainable yield if they cooperate, or the maximum harvest if they defect. If the total harvest exceeds the stock (e.g., if many agents defect), then the deficiency will be shared equally by all the agents. That is, no agent is able to move before all the other agents and capture the whole resource.

How do agents choose their strategy? Each agent will begin by assessing their expected payoff if they choose *defect*, and their expected payoff if they choose *cooperate*. Since these expected payoffs are conditional on the strategies of others, agents will use strategies from the prior round as assumptions about how agents will behave in the current round. The difference between the expected payoffs from defection and cooperation is called the *marginal benefit of defection*, or MBD. The choice to cooperate is a stochastic

decision, where the probability of defection is proportional to the ratio of MBD and the expected payoff of cooperation:

$$Pr(c_{i,j} = 1) = \frac{1}{e^{(1-a)\left(\frac{MBD}{P_{i,t}(1)}\right)}} \quad (7)$$

This probability is also affected by the altruism parameter *a*. As *a* tends towards one, then the negative effect of MBD on making defection a tempting option will be attenuated – that is, larger values of a have the effect of shrinking the perceived MBD. If *a*=1, then all agents are unconditional cooperators. The following gives a sense of how likely cooperation is, given different marginal benefits of defection in a "purely rational" world where a=0:

Table S2.1: Probabilities of cooperation given varying expected payoffs of cooperation and defection

Expected payoff of cooperation	Expected payoff of defection	MBD	How much larger is the marginal defection payoff?	Probability of cooperation without altruism (a=0)
1	1	0	0	1.00
1	1.5	0.5	50%	0.61
1	2	1	100%	0.37
1	2.5	1.5	150%	0.22
1	3	2	200%	0.14

S2.2. A model of endogenous discount rates

In this model it is possible to assume discount rates that are endogenous to the agent, and that change over time. In the models presented in the main paper, agents are assumed to start in a world where all discount rates are zero; in other words, agents' sustainability criterion is to maintain a given resource stock indefinitely.

To model the effect of discount rates changing during this process for a select group of agents, the user is able to specify a "shock" to be applied to one grid cell, selected uniformly and at random, where discount rates will become non-zero for all agents in that cell. In simulations presented in the main paper, discount rates for the affected agents are changed to 0.05, such that resources in the next time step are only valued at 95% of current resources. After this shock occurs, the simulation proceeds normally as described above.

S2.3. A model of migration

It is also possible to assume that agents are free to move between grid cells. While the effects of changing discount rates are relatively predictable from equations (5) and (7), adding migration to the model can potentially introduce complex dynamics of resource growth and exploitation throughout the entire system.

In this model, migration is introduced as a follow-on the shock introduced in one random grid cell, where agents in that cell increase their discount rates. If migration is to be modeled, then those same agents are allowed to migrate to other grid cells—chosen uniformly and at random by each agent—at some time step after the change in discount rates. This will have the effect of reducing CPR pressures on the grid cell where discount rates were increased, however it will also distribute a population of agents with relatively higher discount rates throughout the system.

Introducing migration raises at least two important questions related to the migration decision, and the effect of migration on one's behavior. The first question is whether or not the model assumes that agents incur a cost of migration, (and if so, how much this migration cost is); the second question is whether agents adjust their discount rates after moving to a new grid cell. These situations may be dealt with as special cases in the model.

S2.3.1. Migration special case #1: Migration is costly

In the real world, migration may involve significant transaction costs. Not only does this mean that agents may have to pay a cost of migration—in the language of this model, agents may choose to trade some of their wealth in order to migrate—but in many cases the option of migration may not be available to some agents if they cannot pay the associated cost.

In this model, it is possible to assume that agents must pay a cost of migration by specifying a logical indicator that "invokes" this special case, as well as a constant *migration_factor* that specifies the cost of migration. If the special case is invoked, two steps are added to the model when agents in a given grid cell are allowed to migrate. First, they assess the cost of migration in terms of their own wealth. If an agent's wealth at the time migration is allowed is less than *migration_factor* times the subsistence cost k, then the agent has no migration option. Second, if the agent can pay the migration cost, and if they choose a grid cell that is not their own grid cell to migrate to, then the migration cost is subtracted from their overall wealth before moving to the new grid.

S2.3.2. Migration special case #2: Agents change their discount rates after migration

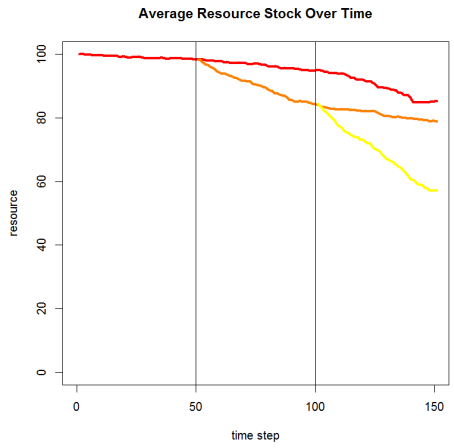
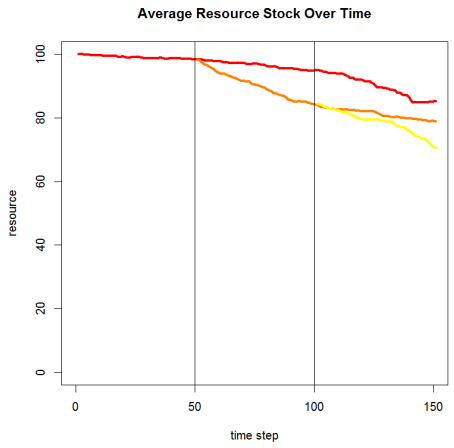
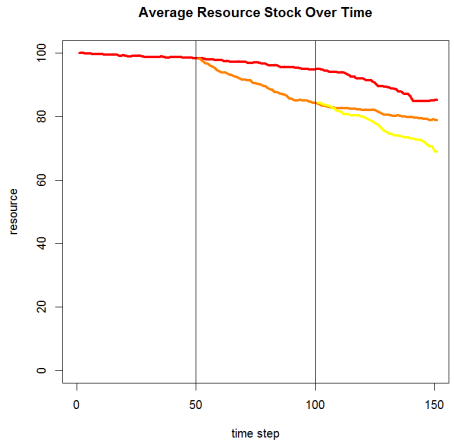
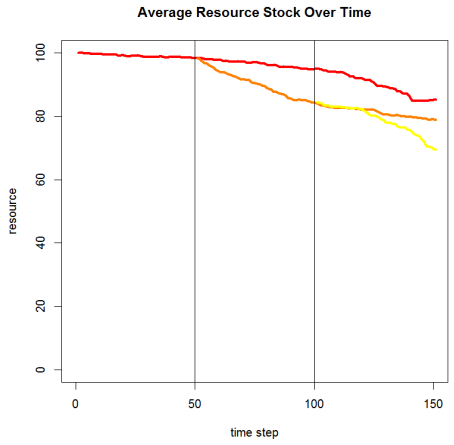
As noted above, it is possible that migration can have a negative effect on resource conservation due to the effect of increasing average discount rates across all individual CPRs. This assumes that agents with higher discount rates due to some information shock will keep these higher discount rates even after they depart their affected CPR. On the other hand, it is possible that agents will adopt the "better" discount rates of the destination CPR—that is, that agents will conform to the average behaviors in their new home. So

while resource stress will increase due to increasing populations, this stress will not be compounded by the higher discount rates of migrant agents.

Figure S2.1 provides an illustration of how both special cases in the migration process alter system-level outcomes. In this figure, red lines show changing resource stocks (vertical axis) over time (horizontal axis) for a typical simulation, when agents are assumed to have fixed discount rates and do not migrate between CPRs (a "baseline" scenario). The orange lines represent deviation from the baseline scenario when agents in one randomly-selected CPR experience an information shock that leads them to increase their discount rates (the "endogenous discounting" scenario). Yellow lines represent deviation from the endogenous discounting scenario when agents who increased their discount rates are allowed to then migrate later in the process (the "migration" scenario).

These simulation results illustrate how both special cases result in the same general pattern, however with an attenuated amount of resource decay after migration occurs. This is expected since both special cases should have the effect of slowing down overall resource extraction. For instance, requiring that agents pay a cost of migration will effectively reduce the overall levels of migration in the system, putting less population pressure on other CPR grids. Allowing migrating agents to adopt the lower discount rates of their destination CPRs will keep overall discounting low, leading to more sustainable, future-minded resource harvesting behaviors. And unsurprisingly, combining both special cases result in an even slower depletion of resources than the baseline case.

Figure S2.1: Typical simulation results for special cases in migration

	Does migration incur a cost? NO	**Does migration incur a cost?** YES
Do agents adopt the discount rate of the CPR they migrate to? NO		
Do agents adopt the discount rate of the CPR they migrate to? YES		

Notes: Results from typical simulations over 100 time steps of the described models in R.

S3 Chapter 4

The supplementary materials are organized as follows: Section S3.1 provides further details on the methods and implementation in the field. In section S3.2we report summary statistics by sample and balancing tables across the experimental treatments. The complete regression tables behind the graphical visualizations in the main manuscript and additional analysis are reported in section S3.3. In section S3.4, the reader can find the experimental instructions.

S3.1. Methodological details

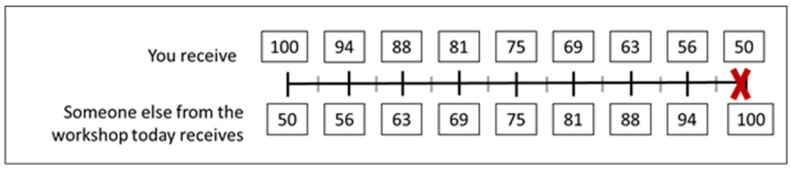
S3.1.1. Survey experiments: Dictator game

The dictator game is a well-established tool to measure other-regarding preferences in the experimental literature and needs no further detailed description. Participants could send any positive integer amount of their endowment to someone else from the same community. For ease of implementation in the field, the amount sent to another community member was paid out to the next survey participant. The exact wording that our research assistants used to explain the dictator decision is reported in section 4.

S3.1.2. Experimental workshops: Social value orientation task

We use the primary items from the social-value-orientation task designed by Murphy et al. (2011) to elicit in-group pro-social behavior. Participants have to decide on six different allocations of money between themselves (sender) and another person (receiver) from the same experimental workshop. For each allocation, participants are asked to indicate the distribution they prefer most by marking their preferred allocation on the slider. They also had to write down how much they and the other person would earn given what they indicated on the slider. This gives us an ex-post control of understanding in addition to the understanding questions that we asked before participants took their decisions. Based on these six decisions, we can calculate a continuous outcome measure of pro-social behavior (in the form of angles within the self-other allocation plane). An altruist tries to maximize the other person's outcome in each decision (see example Figure S3.1), while prosocial oriented individuals try to maximize the sum of their own and the other person's payoffs. Individualists try to maximize their own payoffs and participants with competitive preferences try to maximize the difference between their payoff and the other person's payoff. Based on the calculated angle (ranging between -16.26° up to 61.39°), participants can be classified into four main social value groups: Altruistic, prosocial, individualistic and competitive.

Figure S3.1 Slider example



Notes: Illustration based on Murphy et al. (2011). Altruists maximize the following utility function: $U(p^{self}; p^{other}) = p^{other}$. In the shown allocation decisions, they would prefer the distribution (50, 100).

One decision was randomly chosen to be relevant for payout at the end of the workshop. In order to be able to elicit pro-social behavior for all participants, we introduced uncertainty about the role of senders and receivers. Thus, all participants made decisions about allocations as senders, and we randomly chose at the end of the workshop their role (sender or receiver). This could potentially lead to more pro-sociality, i.e. higher transfers, but the observed distribution of SVO angles is only slightly skewed towards stronger other-regarding preferences compared to studies conducted with students in the lab (Murphy et al., 2011). These differences could also be explained by the strong collective social norms in Solomon Islands and not necessarily by the role uncertainty.

S3.1.3. Priming

Table S3.1 shows the content of the priming videos in all three study sites. After watching the video, participants had to summarize the content of the video they had just watched and assistants ticked off whether crucial aspects to the "what" questions in Table S3.1, were mentioned by the participant. Respondents that did not recall or at least said that the video showed the impacts of SLR are excluded from the analysis, as we can't be sure that they really paid attention to the treatment video and considered these future consequences. In total, we exclude 72 participants (between 10 to 15% of the treatment groups), with no significant differences between the three study sites (Chi2=1.98; p=0.371). As a robustness check, we run all regressions with the full dataset which does not change the main results. These regression tables are reported in section S3.

Table S3.1 Priming videos

	Solomon Islands: CC impacts	**Bangladesh: CC impacts & migration**	**Vietnam 1: CC impacts & community relocation**	**Vietnam 2: CC impacts & individual relocation**
Who?	An indigenous person from the Carteret's islands that is showing and reporting on the impacts Local language with English subtitles	Testimonials from multiple people living in similar coastal regions Plain video of impacts with atmospheric background music Local language, English subtitles	Testimonials from multiple people living in similar coastal regions Plain video of impacts with atmospheric background music Local language, Vietnamese / English subtitles	
What impacts?	Sea-level rise Land erosion Stronger high-tides Saltwater flooding Loss of harvest, food shortages "There will be no island in the future."	Land erosion and floods, especially in coastal regions People lose their homes and basis of living such as impaired farming opportunities Higher sea level, saltwater intrusion Destruction of houses due to erosion and flooding	Land erosion and floods, especially in coastal regions People lose their homes and basis of living such as impaired farming opportunities Higher sea level, saltwater intrusion Destruction of houses due to erosion and flooding	
What adaptation strategies?	Sea-walls are not enough to stop high tides Explicitly not shown migration as an adaptation option	People are forced to leave their home and migrate away "move together" "Many already moved multiple times"	Sea-dykes not enough, "eventually we had to leave" *Hypothetical scenario underpinned with pictures and text recorded in Vietnamese:* "Imagine the place where you currently live becomes permanently uninhabitable due to the reasons shown in the video. This would mean that you will never be able to come back to this place, nor you can show it to your children / grandchildren. In this scenario, your only option is to relocate to another place."	

Relocation belief?	Not touched upon	Probably community	Community relocation: "Because it was already anticipated, there was a plan in place to resettle the whole community. Land was set aside for your community to resettle to. This means that you and everyone else in your community can move together to this new place and stay there permanently. In the end, you end up in a new place far away from where you currently live, but you still have all your friends around you."	Individual relocation: "Because no one anticipated it to happen that fast, there was no plan in place to resettle the whole community. No land was set aside for your community to resettle to. To save yourself, you might have to abandon some of your friends and social connections. This means that you and everyone else are on their own to find a new place to stay there permanently. In the end, you end up in a place where you might not know anyone, and many of your friends live far away at different places."
Where?	Carteret Islands in Papua New Guinea, close to Solomon Islands Small low-lying atoll, max. elevation 1.5m above sea level Similar culture and life-style	All material used for the video is from coastal regions in Bangladesh Similar culture and lifestyle	All materials used for the video are from coastal regions in the Mekong Delta in Vietnam Similar culture and lifestyle	
Length	2:30 minutes	2:40 minutes	2:41 minutes	3:00 minutes
Source	Tulele Peisa in cooperation with United Nations University.	Own creation from multiple sources.	Own creation from multiple sources.	Own creation from multiple sources.

Notes: In Solomon Islands, we decided not to show any video to the control group. To be able to identify any effect of watching a video per se, we decided to use a neutral video in Bangladesh and Vietnam. This control video showed a 1:15 minute neutral documentary about how little noise owls are making while flying. This video was identified not to arouse positive or negative emotions in pretests, but still interesting enough so participants were paying attention. All videos and materials will be made available on GitHub after publication.

S3.1.4. Variable construction

Table S3.2 provides an overview of the outcome and explanatory (additional to the reported socio-demographics) variables that we elicited and how they were transformed to be comparable across study sites.

Table S3.2 Across sample variable construction

Variable	Solomon Islands	Bangladesh	Vietnam
Pro-social behavior	Z-score from social value orientation (Murphy et al., 2011). Higher values imply more giving to the in-group.	Z-score from dictator game. Higher values imply more giving to the in-group.	Z-score from dictator game. Higher values imply more giving to the in-group.
Reciprocity		Z-score based on an 11-point Likert-scale of the survey statement: "When someone does me a favour, I am willing to return it." Higher values imply higher willingness to return a favour.	Z-score based on an 11-point Likert-scale of the survey statement: "When someone does me a favour, I am willing to return it." Higher values imply higher willingness to return a favour.
Revenge		Z-score based on an 11-point Likert-scale of the survey statement: "If I am treated very unjustly, I will take revenge on the first occasion, even if there is a cost to do so." Higher values imply higher willingness to engage in costly revenge.	Z-score based on an 11-point Likert-scale of the survey statement: "If I am treated very unjustly, I will take revenge on the first occasion, even if there is a cost to do so." Higher values imply higher willingness to engage in costly revenge.
SLR perception: past & future	To measure people's perceptions about SLR impacts, we use self-reported assessments of sea-level rise in general, coastal erosion and intrusion of salt-water in the past 10 years and in the future. Six questions in total, three for past[38] and three for future[39] perceptions were answered by the respondents. They reported their beliefs on 5-point Likert-scales which ranged from 1 "definitely has not (will not)" to 5 "definitely has (will)". The six answers about past (future) impacts are then averaged into one combined score with assigning equal weights to all six items. Higher scores imply stronger agreement that the event already happened (will happen).		
Exposure	Binary identifier of exposure to SLR impacts based on the geographical location. Atoll Islanders are categorized as more exposed, i.e. exposure=1, and Main Islanders are less exposed. Atoll Migrants are not considered, as their exposure is not clearly identified.	Binary identifier of exposure to SLR impacts based on self-stated data from the respondents whether they experienced flood damages, had to rebuild their house in order to assess their exposure to these impacts. We divide respondents into two groups; the less affected group stated not to have lost any land so far due to erosion and the highly affected group that already lost land due to erosion.	

[38] Considering the PAST UNTIL NOW, did the following events already happen at the place you are currently living over the past 10 years? To what extent do you believe that […] already did happen?

[39] In the FUTURE, do you think the following events will happen at the place you are currently living. To what extent do you believe that […] will happen within the next 5 years?

Relocation belief	The relocation belief is based on two questions: (1) whether people believe they have to relocate in the next 5 years due to SLR ("absolutely certain"); (2) relocate sometime in the future due to CC ("uncertain when") and "very unlikely" if neither of the two questions was affirmed. In Bangladesh and Vietnam	The relocation belief is based on a single 11-point Likert-scale which measures the likelihood to relocate permanently due to floods and erosion: 0-2 = very unlikely, 3-7 = uncertain when 8-10 = absolutely certain.	
Place attachment	Z-score of the psychometric scale developed by Williams and Vaske (2003) that measures people's place attachment (dependence and identity). Higher values imply a stronger place attachment.	Z-score of the psychometric scale developed by Williams and Vaske (2003) that measures people's place attachment (dependence and identity). Higher values imply a stronger place attachment.	Z-score of the psychometric scale developed by Williams and Vaske (2003) that measures people's place attachment (dependence and identity). Higher values imply a stronger place attachment.
Survey patience	Discrete variable ranging between 1 to 32 based on the staircase time preference survey measure developed by Falk et al. (2016). Smaller values of the scale imply higher impatience, while larger values are associated with stronger patience. A value of 1 implies that the respondent preferred the money immediately instead of the highest amount offered in 12 months (discount rate > 110%).		Discrete variable ranging between 1 to 32 based on the staircase time preference survey measure developed by Falk et al. (2016). Smaller values of the scale imply higher impatience, while larger values are associated with stronger patience. A value of 1 implies that the respondent preferred the money immediately instead of the highest amount offered in 12 months (discount rate > 220%).
Risk attitudes	Z-score from three incentivized choices between a lottery and a sure amount. Higher values imply more risk aversion.	Z-score from staircase measure of risk attitudes developed by Falk et al. (2016). Higher values imply more risk aversion.	Z-score of the amount not invested in a risky lottery similar to Gneezy and Potters (1997). Higher values imply more risk aversion.
Trust	Z-score of the Likert-scale "Most people can be trusted." (1-5), where higher values imply higher trust.	Z-score of the Likert-scale "I assume that people have only the best intentions." (0-10), where higher values imply higher trust.	Z-score of the Likert-scale "I assume that people have only the best intentions." (0-10), where higher values imply higher trust.

S3.1.5. Sampling

Solomon Islands

We randomly selected households, asking people to participate in a household survey (data from the household survey are used for the analysis in Chapter 2:). At the end of each survey, we invited another person from the household whose birthday was coming up next to participate in our workshop. This person had to be over 18 and must not be the same person who completed the survey. If either of these requirements was not met, the person whose birthday was coming up next was invited.

Capital

Our sample consists of two different groups we call *main islanders* and *atoll migrants*. Main islanders are people who are residents in Honiara, living on the hills. These people are not directly affected by sea-level rise. Atoll migrants are people who migrated from very low-lying atolls to Honiara and now live in settlements directly at the coast but could adapt by moving locally. We selected the two main settlements for our research: Lord Howe Settlement and Reef Island Settlement from the two main low-lying atolls in Solomon Islands.

To select our sample of main islanders, we first had to rule out any wards that were too small. This eliminated Cruz and Naha, with only 232 and 356 residents respectively. Next, we eliminated any wards where more than 60% of residents were born outside of the ward. Since people do not often move between wards, this indicates that people migrated recently from another island to this ward. Based on our threshold we eliminated Vavaea, Vuhokesa, and Panatina, with 64%, 86% and 100% respectively. Additionally, we excluded Rove/Langakiki because we pretested our survey and workshop with people from this ward. Moreover, our research team stayed in this ward for the duration of our research and many people knew us personally. For the remaining wards, Nggossi, Mbumburu, Mataniko, Kola'a, Kukum, Vura and Panatina, we used population percentages to assign tickets from 1 to 100. Drawing two random tickets, we obtained Mataniko and Vura.

Every ward is further separated into enumeration areas (EAs). Mataniko consists of 9 EAs. We excluded EA 1 because it covers the Lord Howe Settlement, which is already included in our atoll migrant sample and also EA 2, 3 and 4 because these neighborhoods contain mainly Chinese migrants and foreign experts. From the remaining EAs, we randomly selected EA 6 and EA 7. Our second ward Vura consist of 20 EAs. EA 20 was excluded because it is positioned directly at sea next to a settlement of atoll migrants. Out of the remaining 19 EAs, EA 13 and EA 14 were drawn at random. We drew up a complete household list for all six research sited, EA 6 and 7 in Mataniko, EA 13 and 14 in Vura, Lord Howe Settlement and Reef Island Settlement. Based on these household lists, we randomly selected households from which we invited another person at random to the workshop after the household survey was completed.

Atoll islands

Reef Islands is a very remote island group in Santa Cruz province. We visited every village with at least 14 households that were located either directly on the beach or on one of the tiny island. Our sample includes the villages Malapu, Malubu, Matema, Ngadeli, Ngawa, Nifiloli, Nola, Pileni, Tanga and Tuwo. In every village, we drew up a complete household list from which we randomly selected households. Again, after the survey was completed, we invited at random another person from the same household to the workshop.

Bangladesh & Vietnam

In Bangladesh, we randomly selected a total of 14 coastal villages in three unions in the Barisal region in southern Bangladesh from a list of all villages in these unions. Unfortunately, we could not get a complete village list from the local statistics office in Vietnam, so we had to rely on google maps to create a list of coastal villages from which we randomly drew eight villages. Following the initial stage of purposive sampling, we randomly selected between 20 to 40 participants within each village using the established random walk procedure (Bauer, 2016). Each interviewer was assigned with a random starting location and direction within the village and instructed to select every fifth household on the right side of the street and to turn left and right on intersections alternately. Interviewers stopped their random walk when the predefined number of households they had to interview was reached. Randomly assigning starting points to interviewers should minimize the risk of over-representing households in certain spatial areas within villages which would occur when all interviewers start, for example, at the local market place within each village. This procedure should reduce the risk that not every household has an equal chance of being sampled in a village.

To identify more and less affected participants in our survey experiment, we use self-stated data from the respondents whether they experienced flood damages, had to rebuild their house or lost land to erosion in order to assess their exposure to these risks. We divide respondents into two groups; the less affected group stated not to have lost any land so far due to erosion and the highly affected group that already lost land due to erosion.

Table S3.4 and Table S3.3 show the differences between more and less exposed respondents in Bangladesh and Vietnam. Respondents that already lost land state to be more exposed to the risk of flooding, as measured by how often they had to rebuild their house, how long it took, and how much it cost. Additionally, they believe more strongly that floods and erosion are a threat to their livelihoods and that they might have to relocate permanently because of this. In the sample from Vietnam, we generally find not as many more exposed respondents (n=37, about 12% of the sample compared to 36% in Bangladesh) and the ones that did, are more similar compared to the other study regions.

Table S3.3 Exposure Vietnam

Variable	(1) less exposed Mean/SD	(2) more exposed Mean/SD	t-test Difference (1)-(2)
Number of extreme events (last 5 years)	2,57	3,59	-1,02*
	[3,53]	[3,05]	
Number of times rebuild house at the current place	0,44	1,05	-0,61
	[2,31]	[2,61]	
Rebuild time after disaster (in days)?	30,52	31,16	-0,64
	[25,13]	[23,94]	
Rebuild costs converted to USD	3662,87	3269,93	392,94
	[4136,52]	[4786,77]	
Perceived threat on livelihoods (0=no threat; 10=extreme threat)	7,53	7,86	-0,34
	[3,12]	[3,07]	
Likelihood to relocate permanently (0=impossible; 10=absolutely certain)	3,35	4,32	-0,97
	[3,48]	[3,15]	
N	268	37	

Table S3.4 Exposure Bangladesh

Variable	(1) less exposed Mean/SD	(2) more exposed Mean/SD	t-test Difference (1)-(2)
Number of extreme events (last 5 years)	2,50	2,42	0,08
	[3,35]	[3,63]	
Number of times rebuild house at the current place	0,95	1,55	-0,60***
	[1,42]	[1,54]	
Rebuild time after disaster (in days)?	19,94	34,69	-14,75
	[74,31]	[68,43]	
Rebuild costs converted to USD	394,33	1044,64	-650,31***
	[844,22]	[1865,25]	
Perceived threat on livelihoods (0=no threat; 10=extreme threat)	6,55	8,14	-1,58***
	[2,98]	[2,22]	
Likelihood to relocate permanently (0=impossible; 10=absolutely certain)	3,30	5,07	-1,77***
	[3,34]	[3,39]	
N	129	74	

S3.2. Sample characteristics and treatment balance

Table S3.5 gives the basic descriptive statistics of the non-standardized measured outcome and control variables of the study participants.

Table S3.5 Summary statistics

Panel A: Outcomes	Total	Solomon Islands	Bangladesh	Vietnam
Pro-social behavior				
SVO angle (-12 to 63 degree)	19,64	19,64	.	.
DG (percent of endowment)	0,45	.	0,35	0,53
Reciprocity (0 to 10)	9,29	.	8,99	9,49
Revenge (0 to 10)	1,42	.	2,39	0,76
Panel B: Controls				
Socio-demographics				
Female (=1)	0,46	0,32	0,49	0,62
Married (=1)	0,70	0,59	0,79	0,80
Age in years	38,01	33,85	35,09	45,57
Years of education	7,46	8,37	7,66	6,08
Household size	5,50	6,81	5,14	3,97
Income in PPP-adjusted USD (monthly)	247,02	83,69	159,04	525,67
Household income in PPP-adjusted USD (monthly)	708,10	342,91	540,93	1310,91
Cognitive measures				
Staircase time preferences (1, 32)	6,66	5,10	4,77	10,05
General trust (1 to 5 likert)	2,90	2,35	2,91	3,65
Place attachment (12, 60)	47,55	45,99	49,23	48,54
Negative affect (10-item PANAS)	11,02	.	10,32	11,50
LoT-score (optimism)	18,09	15,50	23,35	.
Climate change appraisal				
Future impacts of SLR (1 to 5 index)	4,20	4,62	3,29	4,24
Past impacts of SLR (1 to 5 index)	3,99	4,41	3,01	4,08
Flood threat (0 to 10 likert)	7,39	.	7,13	7,57
Relocation probability (0 to 10 likert)	3,66	.	3,95	3,47
Relocation due to SLR in next 5 years (=1)	0,58	0,58	.	.
Extreme weather events (past 5 years)	2,61	.	2,47	2,70
Land lost to erosion (=1)	0,22	.	0,36	0,12
N	920	412	203	305

Notes: The reported values are the means for each sample.

Table S3.6 shows the balance between the control and treatment group across all three study regions. A joint test for orthogonality of treatment assignment to check whether randomization was successful in balancing on covariates suggests slight differences between people in the control and treatment group. Using a linear probability model to explain treatment assignment ($F(9, 917)=2.66$, $p=0.0048$) we find that people in the treatment group have slightly higher general trust and the set of variables explains 1.6% of the variation in the probability to be assigned to treatment (adjusted $R^2=0.016$). Pairwise t-tests additionally suggest that people in the treatment group are on average older by 1.6 years, earn more money and are more patient. This suggests some imbalance in covariates; we have to check whether these imbalances would generate bias in the association treatment and our outcomes of interests. They will only generate bias if the covariates that differ are associated with pro-social behavior and adaptation actions. Correlations between our pro-social measures and

income and age are slightly positive correlated (pairwise Pearson correlation coefficients between 0.08 to 0.28). Patience, trust, income and age are also mildly correlated (pairwise Pearson correlation coefficients between 0.05 to 0.18) with the share of people that do not recommend migration as adaptation. We control for these covariates in all results reported in the main manuscript.

Table S3.6 Overall treatment balance

Variable	(1) control Mean/SD	(2) treated Mean/SD	t-test Difference (1)-(2)
Female (=1)	0,43	0,48	-0,04
	[0,50]	[0,50]	
Married (=1)	0,70	0,71	-0,01
	[0,46]	[0,46]	
Age in years	37,14	38,79	-1,65*
	[14,48]	[14,54]	
Years of education	7,48	7,44	0,04
	[3,89]	[4,17]	
Household size	5,76	5,27	0,49**
	[3,35]	[2,93]	
Income in USD (monthly)	109,31	130,80	-21,49**
	[139,41]	[159,08]	
Staircase time preferences	5,91	7,34	-1,43**
	[9,56]	[10,88]	
General trust	2,73	3,06	-0,32***
	[1,41]	[1,37]	
Place attachment	47,38	47,70	-0,31
	[8,12]	[8,24]	
N	434	486	
F-test of joint significance (F-stat)			2,66***
F-test, number of observations			917

Notes: The reported values are the means for each sample. The dependent variable took the value of one when the participant was assigned to treatment and zero otherwise for the joint F-test of orthogonality.

Table S3.7 to Table S3.9 show treatment balancing within each sample. We find no randomization imbalances on elicited covariates; all imbalances occur by pooling the data.

Table S3.7 Treatment balance Solomon Islands

Variable	(1) control Mean/SD	(2) treated Mean/SD	t-test Difference (1)-(2)
Female (=1)	0,30	0,34	-0,03
	[0,46]	[0,47]	
Married (=1)	0,59	0,58	0,01
	[0,49]	[0,49]	
Age in years	33,69	34,03	-0,34
	[14,04]	[13,59]	
Years of education	8,44	8,30	0,15
	[3,13]	[3,26]	
Household size	7,10	6,49	0,60
	[4,06]	[3,85]	
Income in USD (monthly)	77,77	86,52	-8,75
	[128,43]	[141,60]	
Staircase time preferences	4,62	5,62	-1,00
	[7,58]	[8,71]	
General trust	2,26	2,44	-0,18
	[1,20]	[1,26]	
Place attachment	45,82	46,17	-0,35
	[8,87]	[8,46]	
N	214	198	
F-test of joint significance (F-stat)			0,94
F-test, number of observations			411

Notes: The reported values are the means for each sample. The dependent variable took the value of one when the participant was assigned to treatment and zero otherwise for the joint F-test of orthogonality.

Table S3.8 Treatment balance Bangladesh

Variable	(1) control Mean/SD	(2) treated Mean/SD	t-test Difference (1)-(2)
Female (=1)	0,50	0,47	0,03
	[0,50]	[0,50]	
Married (=1)	0,80	0,78	0,02
	[0,40]	[0,42]	
Age in years	35,23	34,95	0,28
	[12,39]	[11,79]	
Years of education	7,52	7,81	-0,29
	[4,44]	[4,89]	
Household size	5,13	5,15	-0,03
	[1,79]	[1,81]	
Income in USD (monthly)	64,22	64,53	-0,31
	[103,16]	[88,90]	
Staircase time preferences	4,55	5,01	-0,46
	[8,88]	[9,82]	
General trust	2,75	3,08	-0,33
	[1,51]	[1,37]	
Place attachment	48,93	49,55	-0,61
	[6,16]	[6,68]	
N	104	99	
F-test of joint significance (F-stat)			0,38
F-test, number of observations			203

Notes: The reported values are the means for each sample. The dependent variable took the value of one when the participant was assigned to treatment and zero otherwise for the joint F-test of orthogonality.

Table S3.9 Treatment balance Vietnam

	(1)	(2)	(3)			
	Control	Community	Individual	Mean differences		
Variable	Mean/SD	Mean/SD	Mean/SD	(1)-(2)	(1)-(3)	(2)-(3)
Female (=1)	0,61	0,59	0,65	0,02	-0,03	-0,06
	[0,49]	[0,49]	[0,48]			
Married (=1)	0,81	0,76	0,84	0,05	-0,03	-0,08
	[0,39]	[0,43]	[0,37]			
Age in years	45,22	45,14	46,35	0,08	-1,13	-1,21
	[13,97]	[14,27]	[14,00]			
Years of education	5,66	6,71	6,01	-1,06*	-0,35	0,70
	[4,03]	[4,21]	[4,55]			
Household size	3,86	4,08	4,00	-0,22	-0,14	0,08
	[1,25]	[1,38]	[1,33]			
Income in USD (monthly)	207,63	224,05	200,85	-16,42	6,78	23,20
	[140,15]	[192,63]	[148,30]			
Staircase time preferences	9,52	9,33	11,33	0,19	-1,80	-1,99
	[12,23]	[12,40]	[12,91]			
General trust	3,59	3,63	3,75	-0,04	-0,16	-0,12
	[1,27]	[1,33]	[0,99]			
Place attachment	48,88	48,70	48,00	0,18	0,88	0,70
	[7,70]	[8,14]	[8,86]			
N	116	90	99			
F-test of joint significance (F-stat)				0,76	0,67	0,67
F-test, number of observations				205	213	188

Notes: The reported values are the means for each sample. The dependent variable took the value of one when the participant was assigned to treatment and zero otherwise for the joint F-test of orthogonality.

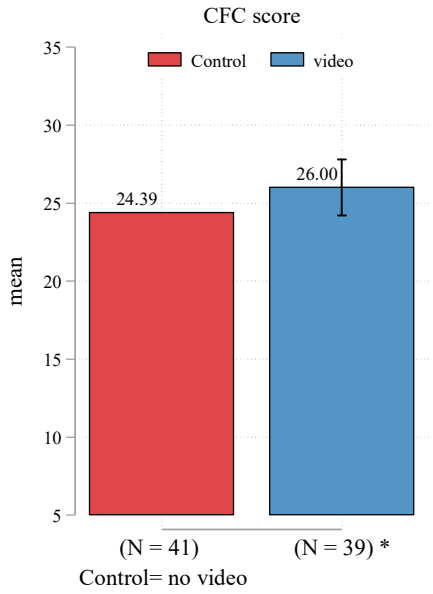
S3.3. Additional analysis

In this section, we report priming checks from pretests, full regression tables with all explanatory variables and additional analysis for the results reported in the main manuscript.

S3.3.1. Pretests: Priming checks

We use six items, two for future[40] and four for immediate[41] orientation, from the consideration of the future scale to measure whether the video made the consequences of SLR impacts salient for participants, as a check of whether the prime effectively changed the future-orientation. Figure S3.2 shows the results from our pretests run in Solomon Islands with 80 participants. We find that participants who watched the video are more concerned about the consequences of their behavior today relative to the control group (diff.=1.6;1 p=0.079; 95% CI=-0.19, 3.42).

Figure S3.2 priming check



Notes: Own data collected in pretests that we conducted in March 2017 in Solomon Islands. Error bars show 95% confidence intervals. Regressions control for interviewer effects. Stars indicate the following significance level: *** p<0.01, ** p<0.05, * p<0.1

Table S3.10 shows the effects of the priming video on the perception of impacts and consequences caused by SLR. We find that participants exposed to the priming video perceive that more impacts were already caused by SLR and that impacts are perceived to

[40] "I consider how things might be in the future, and try to influence those things with my day to day behavior."; "I think it is important to take warnings about negative outcomes seriously even if the negative outcome will not occur for many years."

[41] "I only act to satisfy immediate concerns, figuring the future will take care of itself."; "My behavior is only influenced by the immediate (i.e., a matter of days or weeks) outcomes of my actions."; "Because I can't predict the future, there is little point in making plans."; "Since my day to day work has specific outcomes, it is more important to me than behavior that has distant outcomes."

be significantly stronger in the future. The differences w.r.t. the risk of livelihoods and displacement are not significantly different between control and treatment, but all point into the same direction. This could be explained by the fact that in the data gathering process, these questions were asked with a significant delay to the treatment and priming effects might have already attenuated.

Table S3.10 Effect of priming on SLR impacts and risk perceptions

		(1)		(2)	t-test
		control		treated	Difference
Variable	N	Mean/SD	N	Mean/SD	(1)-(2)
Past impacts of SLR (1 to 5 index)	434	3,92	486	4,06	-0,15**
		[1,13]		[0,98]	
Future impacts of SLR (1 to 5 index)	434	4,12	486	4,27	-0,15**
		[1,12]		[0,92]	
Perceived threat on livelihoods (0=no threat; 10=extreme threat)	220	7,15	288	7,58	-0,42
		[3,21]		[2,83]	
Likelihood to relocate permanently (0=impossible; 10=absolutely certain)	220	3,51	288	3,77	-0,26
		[3,63]		[3,32]	
Relocate in the next 5years due to SLR?	214	0,56	198	0,61	-0,05
		[0,50]		[0,49]	

S3.3.2. Pro-social behavior: Main treatment effects

Table S3.11 reports the regression output, including all explanatory variables that we controlled for in the main manuscript. We identify education and monthly income to be predictive of pro-social behavior. We find that on average wealthier participants tend to give more, a one SD increase in monthly income increases in Bangladesh by .34 SD (p=.035; 95% CI=.023, .650) and in Vietnam by .1 SD (p=.087.; 95% CI=-.014, .211). An additional year of education increases giving by .09 SD in Bangladesh (p=.000; 95% CI=.053, .116) and by .05 SD in Vietnam (p=.002; 95% CI=.018, .079).

There seem to be no significant effects by wealth or education on pro-social behavior in Solomon Islands, where models explain less of the variation in pro-social behavior. In the experimental workshops, we additionally control for the number of friends, relatives and people they had a conflict with in the past. While conflicts with other participants had no significant effect on pro-social behavior, the number of friends is negatively, and the number of relatives is positively associated with giving to in-group. Any differences in the number of friends and relatives between communities in the capital and on the atolls should, therefore, cancel out by these opposing effects.

Table S3.11 Main treatment effects

VARIABLES	Pooled (1)	Solomon Islands (2)	Bangladesh (3)	Vietnam (4)
Treatment	0.181**	0.308***	0.314**	-0.026
	(0.084)	(0.101)	(0.159)	(0.121)
Exposure	0.248**	0.078	0.366**	-0.372*
	(0.107)	(0.230)	(0.164)	(0.217)
Treatment*Exposure	-0.086	-0.193	-0.075	0.251
	(0.136)	(0.200)	(0.255)	(0.293)
Past perception of SLR	-0.057	-0.114	-0.093	0.053
	(0.052)	(0.109)	(0.072)	(0.088)
Future perception of SLR	-0.006	0.060	-0.062	-0.088
	(0.053)	(0.109)	(0.071)	(0.087)
Bangladesh	-0.084			
	(0.101)			
Vietnam	0.051			
	(0.109)			
Female	-0.108	-0.132	-0.137	0.042
	(0.070)	(0.122)	(0.167)	(0.112)
Married	0.054	-0.002	0.121	-0.018
	(0.086)	(0.129)	(0.204)	(0.148)
Age	0.006**	0.006	0.011	0.005
	(0.003)	(0.004)	(0.007)	(0.004)
Years of education	0.039***	-0.017	0.085***	0.049***
	(0.010)	(0.018)	(0.016)	(0.015)
Household size	0.003	-0.006	-0.019	0.154***
	(0.012)	(0.013)	(0.036)	(0.040)
Income in USD (std.)	0.067*	-0.050	0.335**	0.098*
	(0.039)	(0.072)	(0.158)	(0.057)
Survey time preferences	0.004			
	(0.003)			
General trust (std.)	-0.022			
	(0.038)			
Friends in session		-0.043**		
		(0.018)		
Relatives in session		0.035*		
		(0.017)		
Conflict with other session participants		-0.070		
		(0.045)		
Constant	-0.476*	0.157	-0.706	-1.012**
	(0.260)	(0.450)	(0.465)	(0.477)
Cluster	Individual	Session (n=40)	Individual	Individual
Observations	917	411	203	305
R-squared	0.049	0.054	0.278	0.103
Adj. R-squared	0.033	0.020	0.236	0.069

Notes: Increasing values of the dependent variables indicate changes in standard deviations of giving to another person from the same community. For the Solomon Islands regressions, we cluster standard errors at the session. Standard errors in parentheses refer to the following significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table S3.12 reports the same analysis using the full sample, including all 72 participants that we identified as not primed. All main findings remain significant; effects tend to be slightly smaller and noisier as with the cleaned and reduced dataset.

Table S3.12 Main treatment effects: Full sample

VARIABLES	Pooled (1)	Solomon Islands (2)	Bangladesh (3)	Vietnam (4)
Treatment	0.161**	0.271**	0.253*	-0.086
	(0.081)	(0.110)	(0.149)	(0.115)
Exposure	0.233**	0.066	0.305**	-0.414*
	(0.107)	(0.225)	(0.151)	(0.242)
Treatment*Exposure	-0.101	-0.185	-0.051	0.312
	(0.132)	(0.195)	(0.227)	(0.293)
Past perception of SLR	-0.034	-0.124	-0.034	0.106
	(0.050)	(0.102)	(0.073)	(0.082)
Future perception of SLR	-0.020	0.078	-0.067	-0.085
	(0.050)	(0.108)	(0.070)	(0.092)
Bangladesh	-0.082			
	(0.096)			
Vietnam	0.042			
	(0.104)			
Female	-0.113*	-0.179	-0.039	0.013
	(0.067)	(0.114)	(0.164)	(0.106)
Married	0.056	-0.015	0.178	0.069
	(0.082)	(0.121)	(0.189)	(0.144)
Age	0.006**	0.006*	0.013*	0.003
	(0.003)	(0.004)	(0.007)	(0.004)
Years of education	0.033***	-0.021	0.082***	0.047***
	(0.009)	(0.018)	(0.016)	(0.015)
Household size	0.005	-0.007	-0.049	0.130***
	(0.012)	(0.013)	(0.033)	(0.036)
Income in USD (std.)	0.067*	-0.043	0.284*	0.168**
	(0.036)	(0.067)	(0.151)	(0.069)
Survey time preferences	0.005			
	(0.003)			
General trust (std.)	-0.034			
	(0.036)			
Friends in session		-0.042**		
		(0.018)		
Relatives in session		0.034*		
		(0.017)		
Conflict with other session participants		-0.057		
		(0.046)		
Constant	-0.478*	0.155	-0.636	-0.558
	(0.247)	(0.423)	(0.514)	(0.515)
Cluster	Individual	Session (n=40)	Individual	Individual
Observations	989	435	217	339
R-squared	0.042	0.053	0.336	0.197
Adj. R-squared	0.027	0.022	0.279	0.146

Notes: Increasing values of the dependent variables indicate changes in standard deviations of giving to another person from the same community. For the Solomon Island regressions, we cluster standard errors at the session. In the regressions using the experimental survey data, we additionally control for interviewer effects by including dummies for each interviewer (the coefficients are not reported for brevity). Standard errors in parentheses refer to the following significance levels: *** p<0.01, ** p<0.05, * p<0.1.

S3.3.3. Heterogeneous treatment effects: Place attachment

The place attachment measurement consists of two dimensions, firstly how strongly people identify with the place they consider home, and secondly, how strongly they depend on it. Figure S3.3 shows place attachment across all three study regions and treatments. We find no significant effects of the priming video on place attachment. Participants in Solomon Islands are slightly less attached than in Bangladesh and Vietnam (Kruskal-Wallis Test; Chi^2=26.72; p< 0.01).

Figure S3.3 Place attachment

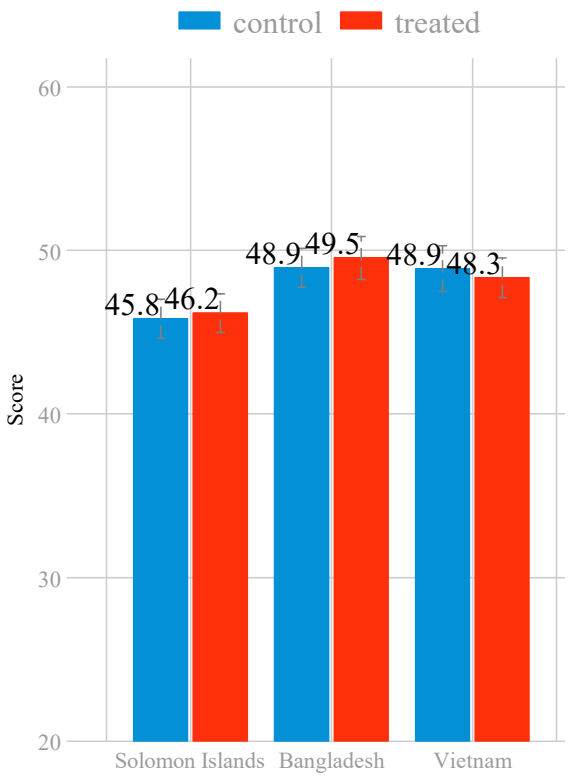


Table S3.13 shows the regression results for the different treatment effects caused by place attachment and Table S3.14 shows the same analysis with the full sample, including participants that were not primed, as a robustness check.

Table S3.13 Place attachment heterogeneous effects

VARIABLES	Pooled (1)	Solomon Islands (2)	Bangladesh (3)	Vietnam (4)
Treatment	0.152**	0.207**	0.294**	0.011
	(0.066)	(0.101)	(0.122)	(0.112)
Place attachment (std.)	-0.001	-0.041	0.005	0.024
	(0.052)	(0.054)	(0.073)	(0.103)
Treatment*Place attachment	0.126*	0.055	0.161	0.123
	(0.068)	(0.091)	(0.108)	(0.126)
Exposure	0.185**	0.000	0.346***	-0.205
	(0.081)	(0.188)	(0.129)	(0.151)
Past perception of SLR	-0.052	-0.105	-0.111	0.070
	(0.052)	(0.108)	(0.073)	(0.088)
Future perception of SLR	-0.011	0.056	-0.055	-0.106
	(0.052)	(0.109)	(0.072)	(0.085)
Bangladesh	-0.083			
	(0.100)			
Vietnam	0.055			
	(0.108)			
Female	-0.093	-0.126	-0.121	0.029
	(0.069)	(0.123)	(0.164)	(0.111)
Married	0.052	-0.019	0.128	-0.030
	(0.086)	(0.127)	(0.202)	(0.145)
Age	0.005*	0.006	0.010	0.004
	(0.003)	(0.004)	(0.007)	(0.004)
Years of education	0.041***	-0.017	0.086***	0.049***
	(0.010)	(0.018)	(0.016)	(0.016)
Household size	0.001	-0.007	-0.017	0.137***
	(0.012)	(0.013)	(0.037)	(0.041)
Income in USD (std.)	0.067*	-0.043	0.318**	0.093
	(0.038)	(0.071)	(0.155)	(0.058)
Survey time preferences	0.004			
	(0.003)			
General trust (std.)	-0.028			
	(0.038)			
Friends in session		-0.042**		
		(0.018)		
Relatives in session		0.034*		
		(0.018)		
Conflict with other session participants		-0.073		
		(0.046)		
Constant	-0.451*	0.168	-0.698	-0.893*
	(0.259)	(0.451)	(0.469)	(0.477)
Cluster	Individual	Session (n=40)	Individual	Individual
Observations	917	411	203	305
R-squared	0.057	0.053	0.293	0.115
Adj. R-squared	0.040	0.017	0.248	0.079

Notes: Increasing values of the dependent variables indicate changes in standard deviations of giving to another person from the same community. We standardized the place attachment index on which higher values imply stronger place attachment. Estimates from pooled and country-specific ordinary least squares regressions with heteroscedasticity-robust confidence intervals are reported. For the Solomon Islands regressions, we cluster standard errors at the session-level on which the treatment was assigned. Standard errors in parentheses refer to the following significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table S3.14 Place attachment heterogeneous effects: full sample

VARIABLES	Pooled (1)	Solomon Islands (2)	Bangladesh (3)	Vietnam (4)
Treatment	0.128**	0.176*	0.239**	-0.047
	(0.064)	(0.099)	(0.116)	(0.107)
Place attachment (std.)	0.002	-0.044	0.006	-0.051
	(0.052)	(0.054)	(0.070)	(0.098)
Treatment*Place attachment	0.131**	0.037	0.150	0.191
	(0.066)	(0.080)	(0.107)	(0.118)
Exposure	0.151*	-0.006	0.286**	-0.183
	(0.079)	(0.178)	(0.118)	(0.145)
Past perception of SLR	-0.031	-0.117	-0.053	0.115
	(0.050)	(0.102)	(0.076)	(0.081)
Future perception of SLR	-0.023	0.074	-0.058	-0.084
	(0.050)	(0.107)	(0.070)	(0.089)
Bangladesh	-0.084			
	(0.096)			
Vietnam	0.037			
	(0.102)			
Female	-0.102	-0.178	-0.036	-0.009
	(0.067)	(0.115)	(0.159)	(0.106)
Married	0.055	-0.027	0.182	0.034
	(0.082)	(0.122)	(0.187)	(0.145)
Age	0.005*	0.007*	0.013*	0.002
	(0.003)	(0.004)	(0.007)	(0.004)
Years of education	0.034***	-0.020	0.083***	0.048***
	(0.009)	(0.018)	(0.015)	(0.015)
Household size	0.002	-0.007	-0.049	0.116***
	(0.012)	(0.013)	(0.033)	(0.036)
Income in USD (std.)	0.068*	-0.038	0.272*	0.164**
	(0.036)	(0.066)	(0.148)	(0.070)
Survey time preferences	0.005			
	(0.003)			
General trust (std.)	-0.043			
	(0.035)			
Friends in session		-0.041**		
		(0.017)		
Relatives in session		0.033*		
		(0.018)		
Conflict with other session participants		-0.059		
		(0.046)		
Constant	-0.433*	0.167	-0.599	-0.522
	(0.246)	(0.422)	(0.516)	(0.515)
Cluster	Individual	Session (n=40)	Individual	Individual
Observations	989	435	217	339
R-squared	0.051	0.052	0.349	0.206
Adj. R-squared	0.035	0.018	0.290	0.154

Notes: Increasing values of the dependent variables indicate changes in standard deviations of giving to another person from the same community. We standardized the place attachment index on which higher values imply stronger place attachment. Estimates from pooled and country-specific ordinary least squares regressions with heteroscedasticity-robust confidence intervals are reported. For the Solomon Islands regressions, we cluster standard errors at the session-level on which the treatment was assigned. In the regressions using the experimental survey data, we additionally control for interviewer effects. Standard errors in parentheses refer to the following significance levels: *** p<0.01, ** p<0.05, * p<0.1.

S3.3.4. Mediating effect: Negative emotions

Emotions are commonly experienced and expressed by people. However, their consequences on economic behavior have received only limited attention in the literature. It has been found that pro-social behaviors are sensitive to emotions and angry subjects

contribute, on average, less than happy subjects (Drouvelis and Grosskopf, 2016). Emotions drive our thoughts and behavior, help us to engage in or avoid behaviors and help us cope with distressing events. The prospect of displacement due to the adverse effects caused by SLR, is a highly distressing event, most likely evoking strong negative emotions such as being afraid, distressed or upset. It has been shown that engaging in pro-social behavior might be an effective strategy for reducing the impact of stress on emotional functioning (Raposa et al., 2016).

From our study in Solomon Islands, we learned that negative emotions might play an important moderating role on pro-social behavior. To measure negative emotions in response to the treatment video, we use the five-item negative affect short-form developed by Thompson (2007), which has been validated across countries and age groups (Humboldt et al., 2017). Figure S3.4 shows that the video significantly increases the negative emotions people feel compared to the control group in both Bangladesh (Mann Whitney U test: diff=-5.34; z=-8.14 ; p=0.00) and Vietnam (Mann Whitney U test: diff=-9.70 ; z=-14.42; p=0.00). So there are potential mediating effects on pro-social behavior caused by negative emotions that we so far did not address in the analysis. We will use linear structural equation models to estimate the average causal mediation effect (ACME), which can be decomposed into the direct and indirect treatment effect.

Figure S3.4 Negative emotions

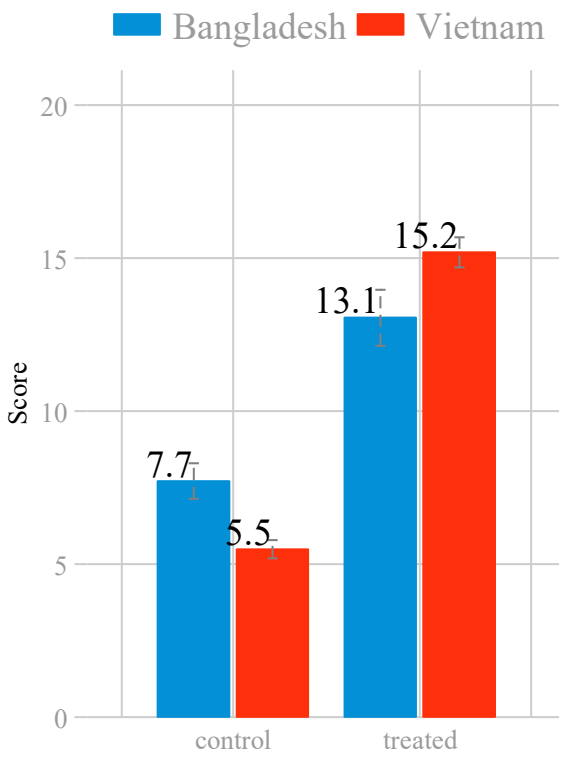
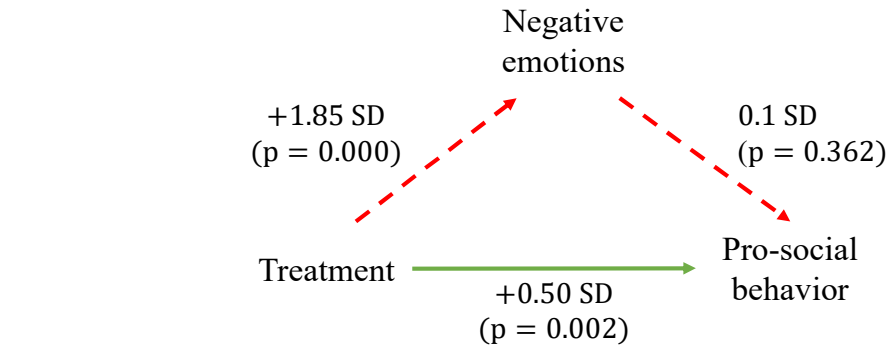


Figure S3.5 shows the insignificant causal mediation results for Vietnam. We find no evidence that negative emotions are related to pro-social behavior nor is there a direct priming effect on giving.

Figure S3.5 Causal mediation results Vietnam



$ADE \quad = -0.20\ SD\ (p = 0.347; 95\%\ CI[-0.62, 0.22])$

$ACME \quad = 0.18\ SD\ (p = 0.362; 95\%\ CI[-0.20, 0.55])$

$ATE \quad = ADE + ACME = -0.02\ SD\ (p = 0.825; 95\%\ CI[-0.26, 0.21])$

Notes: The dependent variable is standardized pro-social behavior. The coefficients are the point estimates and in brackets are the corresponding heteroscedasticity-robust 95% confidence intervals. In both regressions, we control for: exposure, interaction between exposure and treatment, gender, age, marital status, years of education, household size, standardized income, past and future perception of SLR impacts.

Table S3.15 shows the full regression output for the second stage of the causal mediation analysis using LSEM and as a robustness check the proposed method by Imai et al. (2010) was used. Only the standard errors and thereby significance levels change slightly between the two methods, but the main results are robust.

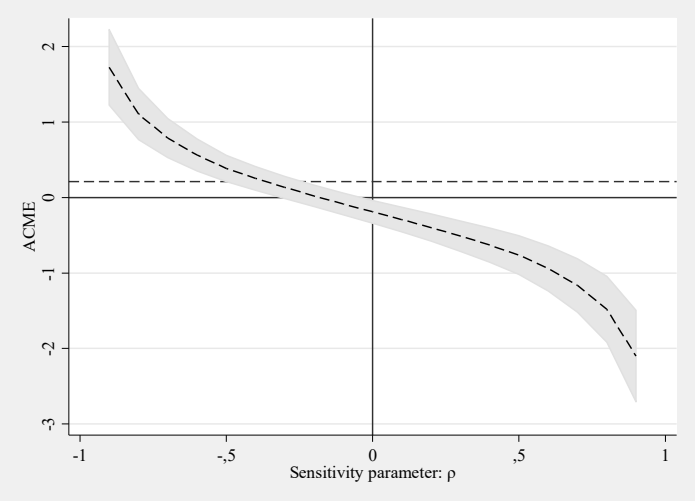
Table S3.15 Causal mediation - SEM versus IMAI

VARIABLES	Pooled		Bangladesh		Vietnam	
	(1)	(2)	(3)	(4)	(5)	(6)
	LSEM	IMAI	LSEM	IMAI	LSEM	IMAI
Treatment	0.250**	0.250*	0.504***	0.504***	-0.202	-0.202
	(0.126)	(0.128)	(0.164)	(0.169)	(0.215)	(0.219)
Negative emotions (std.)	-0.088	-0.088	-0.187***	-0.187**	0.095	0.095
	(0.060)	(0.060)	(0.071)	(0.073)	(0.104)	(0.106)
Exposure	0.036	0.036	0.371**	0.371**	-0.369*	-0.369*
	(0.128)	(0.129)	(0.155)	(0.160)	(0.213)	(0.217)
Treatment*Exposure	0.076	0.076	-0.024	-0.024	0.275	0.275
	(0.184)	(0.186)	(0.243)	(0.251)	(0.290)	(0.296)
Past perception of SLR	0.004	0.004	-0.079	-0.079	0.040	0.040
	(0.055)	(0.055)	(0.070)	(0.072)	(0.087)	(0.089)
Future perception of SLR	-0.044	-0.044	-0.058	-0.058	-0.083	-0.083
	(0.055)	(0.055)	(0.069)	(0.071)	(0.085)	(0.087)
Female	-0.060	-0.060	-0.120	-0.120	0.041	0.041
	(0.085)	(0.086)	(0.161)	(0.166)	(0.110)	(0.112)
Married	0.088	0.088	0.115	0.115	-0.038	-0.038
	(0.111)	(0.112)	(0.195)	(0.201)	(0.146)	(0.149)
Age	0.008**	0.008**	0.010	0.010	0.005	0.005
	(0.003)	(0.004)	(0.007)	(0.007)	(0.004)	(0.004)
Years of education	0.059***	0.059***	0.087***	0.087***	0.051***	0.051***
	(0.011)	(0.011)	(0.015)	(0.015)	(0.015)	(0.015)
Household size	0.058**	0.058**	-0.025	-0.025	0.150***	0.150***
	(0.026)	(0.026)	(0.035)	(0.036)	(0.040)	(0.041)
Income in USD (std.)	0.153***	0.153***	0.297**	0.297*	0.105*	0.105*
	(0.046)	(0.047)	(0.150)	(0.155)	(0.057)	(0.058)
Constant	-1.085***	-1.085***	-0.846*	-0.846*	-0.854*	-0.854*
	(0.300)	(0.303)	(0.444)	(0.458)	(0.500)	(0.510)
ACME	-0.137	-0.142	-0.190**	-0.191**	0.175	0.174
ADE	0.250**	0.254*	0.504***	0.502***	-0.202	-0.203
ATE	0.113	0.112	0.314**	0.312**	-0.026	-0.029
Observations	508	508	203	203	305	305
R-squared		0.127		0.302		0.105

Notes: Reported are the second regressions from the causal mediation analysis. Models (1), (3) and (5) use linear structural equation models (SEM) to estimate ACME, ADE and ATE. Models (2), (3) and (6) are based on the mediation package by Hicks and Tingley (2011) using the methodology developed by Imai et al. (2010). We used linear regressions and ran 2000 simulations to estimate the quasi-Bayesian approximation of parameter uncertainty. The results from the first regression on the mediator (negative emotions) are not reported here for brevity. Robust standard errors in parentheses refer to the following significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Figure S3.6 shows the results of the sensitivity analysis to the violation of the sequential ignorability assumption to identify the ACME. The value of the sensitivity parameter ρ determines how large the impact of an unobserved confounding variable must be so that the point estimate of the ACME would become zero. We find that for any error correlation bigger than $\rho = -0.171$, the ACME would go away completely.

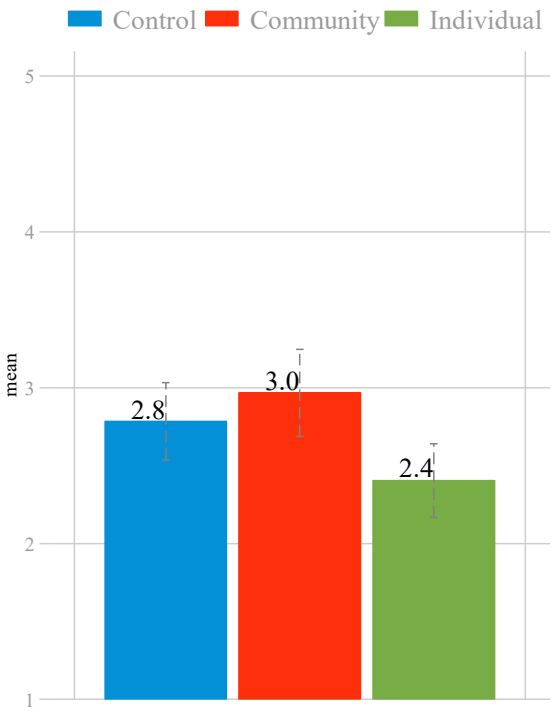
Figure S3.6 Sensitivity analysis of ACME



S3.3.5. Vietnam: Community-resettlement belief

Here we report the priming checks for whether the group and individual treatments actually altered the relocation beliefs of participants. Overall, over 80% of participants in both treatments perceive the scenario at least as moderately likely, where 20% (11%) perceived the individual (community) scenario as very much likely. The individual relocation scenario is perceived slightly more likely than the community resettlement one (Mann-Whitney U-Test; z=-1.73; p=0.084). Figure S3.7 shows that participants in the community treatment, on average, they perceive help by government or NGO's for relocation as moderately likely, similar to the control group (Mann-Whitney U-Test; z=-0.94; p=0.35). Participants exposed to the individual scenario are significantly less confident that they will receive help in case of displacement compared to the control group (Mann-Whitney U-Test; z=2.02; p=0.044). It seems more likely that participant's belief to be relocated as a community, as the control group beliefs are similar to the beliefs in the community scenario.

Figure S3.7 Assistance by the government for relocation



Notes: Reported are the answers to a 5-point Likert-scale, ranging from 1, “not at all”, to 5, “very much”, to the question: “In case you have to relocate, how likely do you think it is that anyone else (e.g. government, NGO) will provide land for you to resettle to?”.

Table S3.16 shows regression results for the community and individual treatments on (1) pro-social behavior, (2) reciprocity and (3) revenge.

Table S3.16 Community vs individual resettlement

VARIABLES	Pro-social behavior (incentivized) (1)	Reciprocity (survey) (2)	Revenge (survey) (3)
T1: community	-0.112	-0.356*	0.346*
	(0.233)	(0.189)	(0.187)
T2: individual	-0.208	-0.309*	0.315
	(0.222)	(0.172)	(0.204)
More exposed	-0.134	-0.010	0.059
	(0.161)	(0.098)	(0.132)
Negative affect (std.)	0.076	0.167*	-0.108
	(0.116)	(0.086)	(0.084)
Place attachment (std.)	0.037	0.046	-0.055
	(0.063)	(0.042)	(0.041)
Past perception of SLR	0.062	0.000	0.078
	(0.085)	(0.057)	(0.065)
Future perception of SLR	-0.063	-0.064	-0.075
	(0.095)	(0.062)	(0.068)
Female	-0.022	-0.122	0.083
	(0.109)	(0.078)	(0.077)
Married	0.047	-0.019	-0.143
	(0.150)	(0.106)	(0.120)
Age	0.003	-0.008**	-0.007**
	(0.005)	(0.004)	(0.003)
Years of education	0.055***	0.007	0.010
	(0.015)	(0.012)	(0.009)
Household size	0.118***	0.028	0.020
	(0.040)	(0.027)	(0.026)
Income in USD (std.)	0.157**	0.007	0.010
	(0.076)	(0.034)	(0.047)
Constant	-0.383	0.655*	-0.354
	(0.549)	(0.372)	(0.355)
Observations	305	305	305
R-squared	0.196	0.203	0.234
Adj. R-squared	0.133	0.141	0.174

Notes: Increasing values of the dependent variables indicate changes in standard deviations of (1) giving to another person from the same community, (2) increase in willingness to return a favour and (3) increase in willingness to revenge when mistreated. Estimates are from ordinary least squares regressions with heteroscedasticity-robust 95% confidence intervals. We control for interviewer effects by including dummies for each enumerator which are not shown here for brevity. Standard errors in parentheses refer to the following significance levels: *** p<0.01, ** p<0.05, * p<0.1.

S3.4. Experimental instructions

The complete experimental surveys (Bangladesh and Vietnam) are available upon request and the post-experimental workshop survey can be found in section S4.4.3.

S3.4.1. Instructions: SVO task

During this task, you will have the chance to earn points, which will be converted into cash at the end of today's session, using an exchange rate of 10 Points = $1 SBD.

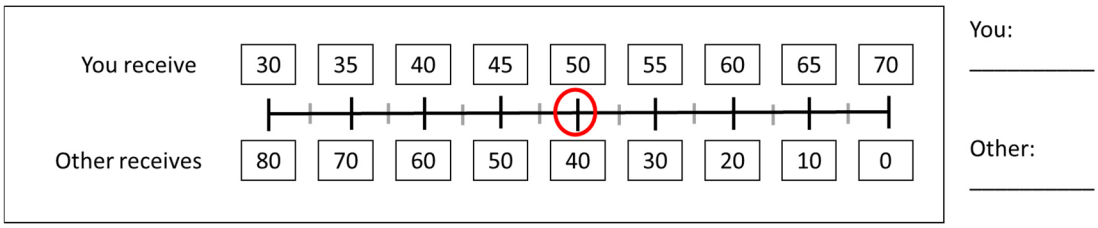
In this task, you will be paired with another person, whom we will refer to as the other for now. You will not learn the identity of the other person you are paired with, and

vice versa the other person will never learn about your identity. [ASK GROUP] Have you understood this part?

In this task, you will be making a series of decisions about allocating resources between you and another person. For each of the questions, we will ask you to indicate the distribution you prefer most by circling the respective position along the midline. You can only make one circle for each question. [ASK GROUP] Do you understand this?

In the end, one decision will be chosen randomly to be relevant for payoff for you and the other person by drawing a card from this bag [SHOW BAG]. It will be randomly decided by the main experimenter whether you are a sender or receiver [ASK GROUP] Do you understand this?

Your decisions will yield money for both yourself and the other person [SHOW EXAMPLE ON POSTER].



[ASK GROUP] How much would you earn in this example, and how much will the other person earn if you would circle here [CIRCLE FOR 50/40 distribution]? Here you would receive 50 points, while the other person receives 40 points [GO ON WITH 2-3 MORE EXAMPLES]. There are no right or wrong answers; this is all about personal preferences. After you have made your decision, write the resulting earnings for you and the other person on the spaces to the right. As you can see, your choices will influence both the amount of money you receive as well as the amount of money the other receives. You will get more information about your partner shortly in the individual instructions.

If you have any questions, you may ask them now. Otherwise, we will call you one by one and ask some questions to check if you have understood the game or not. Therefore, please tell us if we need to repeat the examples or not. [IF YES, REPEAT THE EXAMPLES IN THE SAME ORDER.]

[CALL PARTICIPANTS ONE BY ONE TO THE EXPERIMENTERS.]

INDIVIDUAL INSTRUCTIONS

Control Questions

[ASK FOLLOWING QUESTIONS AND FILL ANSWERS INTO QUESTION FORM. USE EXAMPLE POSTER FOR ILLUSTRATION]

We kindly ask you now to answer some questions about the game. Do not worry if you are not able to answer all questions correctly immediately. You will have the chance to ask me questions before you make your decision, and we will make sure that you understand the game.

1. How many points would you earn in this example? [Answer: 50 points]
2. How many points would the other person earn in this example? [Answer: 40 points]
3. How do you indicate you preferred distribution between you and the other person [Answer: By circling it on the midline of the slider.]
4. What payoff does your choice affect? [Answer: My own payoff as well as the other's payoffs]

[RECORD ANSWERS. FOR THOSE WHO DID NOT ANSWER CORRECTLY, REPEAT EXPLANATIONS AND REPEAT QUESTIONS. RECORD ANSWERS FOR SECOND AND THIRD TIME.]

DECISION TASK

Please remember that from now on your decision will affect your earnings and the two other person's earnings. For each of the following distributions, you are asked to indicate your favorite allocation of points between you and another person. This other person is someone from the same workshop today.

As shown in the example, you have to indicate on the midline which distribution of points you prefer by marking the respective position along the midline [SHOW DECISION CARD]. You have to make twelve decisions about distributing points between you and two other people in total. Remember that you can only make one mark for each question. [GIVE SUBJECT TIME AND SPACE TO MAKE THEIR DECISIONS]

Have you marked your choice on the midlines for each of the six decisions and wrote down how much you and the other person earn?

[SEND PARTICIPANT BACK TO HIS SEAT, REMIND HIM OF NOT TALKING TO OTHER PARTICIPANTS AND CALL NEXT PARTICIPANT ON YOUR LIST]

S3.4.2. Instructions: Dictator game

The standardized explanation for survey respondents by local research assistants:

"You will get 25000 (120) Dong (Taka) from us at the end of the survey. Your task now is to decide how many Dong (Taka) you want to keep for yourself and how much you would like to give to someone else from the village. You don't know who exactly this other person is. The remaining Dong (Taka) will be paid out for real to you at the end of the survey, while the other person will be paid at the end of the day.

Do you have any questions? Otherwise, we would like you to use the slider on the tablet to decide how much Dong (Taka) you want to transfer to the other person. If you are done, please click next and hand the tablet over to the assistant. [ASSISTANTS: HAND OVER THE TABLET AND LET PARTICIPANT DECIDE ON THEIR OWN – DO NOT OBSERVE THEIR DECISION]

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S4 Chapter 5

The supplementary materials are organized as follows: Section S4.1 provides details on the experimental design and sampling procedure. In section S4.2, the reader can find summary statistics of the socio-economics and perceptions of sea-level rise impacts between the three samples. Multivariate regressions accounting for the treatment assignment on the session-level and additional control variables, as well as robustness checks, are reported in section S4.3. In section S4.4, the reader can find the experimental protocol, which includes the decision cards used for participants in the trust game, as well as the post-experimental questionnaire.

S4.1. Experimental design: further information

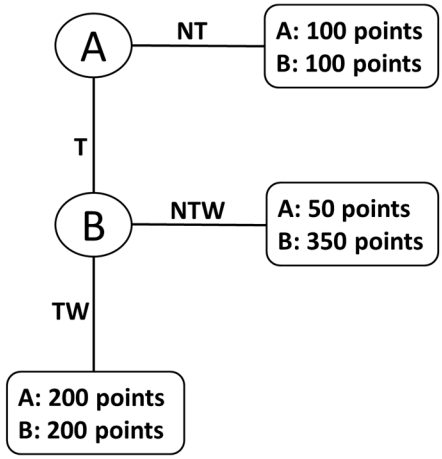
The game is played as follows (see game-tree, Figure S4.1). The trustor has to decide between trusting (T) the trustee or not (NT). If the trustor chooses NT the game ends and both players receive an equal amount. Otherwise, if the trustor chooses to risk parts of his endowment, the money gets doubled by the experimenter, and the outcome depends on the trustee. The trustee decides, assuming that the trustor played T, whether he or she wants to split the money equally (trustworthy = TW) or keep most of the money for herself (not trustworthy = NTW). Only the primary experimenter knew the exact matching procedure and could infer choices by individual participants. All workshops were held in the local language and explained with the help of illustrative posters by the same local experimenter to ensure comparability across all sessions.

The exact wording for the participants in the two treatments was as follows:

- One-shot treatment: "You will be playing **only one round** together with your partner today, and you will be either in the role of Player A or Player B."
- Repeated treatment: "You might play **more than one round** with the **SAME** partner today. The number of rounds you will be playing today will be determined by throwing a dice."

For all $\delta \geq \frac{3}{5}$ the cooperative outcome is a subgame perfect Nash equilibrium (SPNE), as the discounted stream of gains sufficiently large. Using backward induction one can calculate that a one-time deviation from the cooperative outcome in the second stage is not profitable for the trustee given the chosen payoff structure, assuming the players use the non-forgiving grim trigger strategy. Grim strategy inequality condition: $\frac{20}{1-\delta} \geq 35 + 10\frac{\delta}{1-\delta}$, which simplifies to $\delta \geq \frac{3}{5}$.

Figure S4.1: Game tree



Notes: Points were converted into real money at a rate of 100 points equal to SBD 10. On average, participants earned about SBD 83 ±13 (SD) for the whole three-hour workshop, including a show-up fee of SBD 20, which converted to about USD 10.5 at the time. This is quite a substantial amount

of money considering the average self-stated monthly income within the sample was only SBD 626, and many atoll islanders reported nearly no cash income at all.

In general, there are two reasons why people discount the future. Firstly, people are unsure whether the future realizes and therefore prefer a payoff today rather than tomorrow. An additional reason lies in people's pure time preferences of valuing a payoff now more than in the future. In the trust game, I exogenously vary the probability that the game continues for another round, i.e. the participant's belief regarding the possibility of future interactions. Pure time preferences should play no role in this experimental setting where payments were realized on the same day[42].

The unique Nash equilibrium in the one-shot treatment is that the trustors choose NT, even though Pareto increasing payoffs are available in the second stage of the game. Any T choices indicate the prevalence of unconditional trust, as by design, participants cannot use reputation building, commitment contracts or punishment threats to build trust and achieve mutual gains. Additionally, as participants played simultaneously, trustors could not deliberately use the act of sending their endowment as a forward signal of trust. Social norms of sharing or whom to trust could provide a guideline for participants on how to behave in this new setting, even though rewards or sanctions are absent. As participants in our sample strongly identify with their in-group and have social sharing norms, it is possible that these norms were used as guidelines in the trust game which could potentially explain the high share of T and TW choices in the one-shot treatment.

The grim trigger implies that trustors keep placing trust in their partner as long as their partner keeps reciprocating and vice versa for the trustee. If one player deviates from this strategy, the other player will punish him by playing NT or NTW for the remainder of the repeated game. In other words, players have the chance to use repeated interactions under the "shadow of the future" to build trust and reputation by rewarding plays of T and TW. This yields a second mechanism, additional to internalized social norms that could increase the share of T and TW compared to the one-shot treatment.

S4.1.1. Implementation

After the trust game was explained to the whole group by the primary assistant, all assistants went to participants individually to ask five control questions to make sure they

[42] One could argue that participants did not belief that the experiment would go on forever and that the experimenter would stop the game after a certain amount of rounds. If that was the case, participants' belief of future interactions (the role of the dice) would be reduced by the belief that the experimenter ends the game prematurely without rolling the dice. I think this line of argument did not apply in the current study, as no participants showed any sign that they believed the experimenter would end the game without throwing a dice. Indeed, Dal Bo (2005) showed that the majority of participants in his study correctly estimated the exact number of expected rounds for different continuation rules. Unfortunately, I did not elicit the participant's estimate of how many rounds they expect to play. But I know from the control questions whether they understood that they only interact once in the one-shot condition and potentially multiple times in the repeated one.

understood the game. In case of issues, the assistants would explain the trust game again. Only when all understanding problems were corrected, participants made their choices anonymously using pen and paper (see materials in section S4.4). In the repeated treatment, continuation was determined by the participant seated in the first row on the right-hand side by throwing a dice. If a one or six was thrown the game ended, otherwise it went on for another round. One randomly selected round was relevant for payoff at the end of the workshop, which was common knowledge. In the one-shot treatment, only one round was played and therefore relevant for payment.

Additionally, participants had the chance to earn money in three other experimental tasks (social value orientation, risk attitudes and spite) which are not reported in this paper. To conceal the partner's decision and avoid endowment effects, we pay the show-up fee and the sum of all earnings from the experimental tasks and do not disclose decisions between tasks. This procedure reduces the possibility that participants can trace back the decision of their partner and potentially retaliate outside the workshop.

S4.1.2. Sampling

We randomly selected households, asking people to participate in a household survey (results from the household survey are not reported in this paper). At the end of each survey, we invited another person from the household whose birthday was coming up next to participate in our workshop. This person had to be over 18 and must not be the same person who completed the survey. If either of these requirements was not met, the person whose birthday was coming up next was invited.

In the capital Honiara, the sample consists of two different groups we call main islanders and atoll migrants. Main islanders are people who are residents in Honiara, living on the hills. These people are not directly affected by sea-level rise. Atoll migrants are people who migrated from very low-lying atolls to Honiara and now live in settlements directly at the coast. We selected the two main settlements for our research: Lord Howe Settlement and Reef Island Settlement.

To select our sample of main islanders, we first had to rule out any wards that were too small. This eliminated Cruz and Naha, with only 232 and 356 residents respectively. Next, we eliminated any wards where more than 60% of residents were born outside of the ward. Since people do not often move between wards, this indicates that people migrated recently from another island to this ward. Based on our threshold we eliminated Vavaea, Vuhokesa, and Panatina, with 64%, 86% and 100% respectively. We excluded Rove/Langakiki because we pretested our survey and workshop with people from this ward. Moreover, the research team stayed in this ward for the duration of our research and many people knew us personally. For the remaining wards, Nggossi, Mbumburu, Mataniko,

Kola'a, Kukum, Vura and Panatina, we used population percentages to assign tickets from 1 to 100. Drawing two random tickets, we obtained Mataniko and Vura.

Every ward is further separated into enumeration areas (EAs). Mataniko consists of 9 EAs. We excluded EA 1 because it covers the Lord Howe Settlement, which is already included in our atoll migrant sample, and EA 2, 3 and 4 because these neighbourhoods contain mainly Chinese migrants and foreign experts. From the remaining EAs, we selected EA 6 and EA 7 at random. Our second ward Vura consist of 20 EAs. EA 20 was excluded because it is positioned directly at sea, including another settlement of atoll migrants. Out of the remaining 19 EAs, EA 13 and EA 14 were drawn at random.

We drew up a complete household list for all six research sites, EA 6 and 7 in Mataniko, EA 13 and 14 in Vura, Lord Howe Settlement and Reef Island Settlement. Based on these household lists, we randomly selected households from which we invited another person at random to the workshop after the household survey was completed.

Reef Islands is a very remote island group in Santa Cruz province. We visited every village with at least 14 households that were located either directly on the beach or on one of the small islands. Our sample includes the villages Malapu, Malubu, Matema, Ngadeli, Ngawa, Nifiloli, Nola, Pileni, Tanga and Tuwo. In every village, we drew up a complete household list from which we randomly selected households. Again, after the survey was completed, we invited at random another person from the same household to the workshop.

S4.2. Summary statistics & treatment balance

Table S4.1 shows the differences in socio-economic characteristics and sea-level rise perception across all three samples. One can see that atoll islander are significantly different compared to people living in the capital, both migrants and main islanders. Atoll islanders are on average older, less educated, live in smaller households, are more likely to be married, a larger share is living in the same community for their whole life, and they have about seven times less cash income. Concerning SLR perceptions, I find that atoll islanders are most likely to think that sea-levels will be higher, more saltwater intrusion will happen and also more coastal erosion. With respect to impatience, I find that all participants tend to be rather highly impatient as 71% reach the nod that implies a discount rate of at least 114% in the staircase time preference task designed by Falk et al. (2016). Atoll islanders tend to be slightly less impatient than the other participants.

Table S4.1: Summary statistics

Variable	(1) Main Islanders Mean/SD	(2) Atoll Migrants Mean/SD	(3) Atoll Islanders Mean/SD	Mean differences (1)-(2)	(1)-(3)	(2)-(3)
Female	0.32	0.43	0.33	-0.11*	-0.01	0.10*
	[0.47]	[0.50]	[0.47]			
Age(years)	28.23	28.97	39.11	-0.74	-10.88***	-10.14***
	[10.48]	[9.60]	[15.22]			
No school	0.02	0.02	0.09	-0.00	-0.08***	-0.07**
	[0.12]	[0.14]	[0.29]			
Primary (6 years)	0.15	0.25	0.55	-0.10*	-0.40***	-0.30***
	[0.35]	[0.43]	[0.50]			
Secondary (more than 6 years)	0.84	0.74	0.36	0.10**	0.48***	0.37***
	[0.37]	[0.44]	[0.48]			
Household size	7.80	9.12	4.91	-1.32**	2.89***	4.21***
	[3.21]	[5.48]	[2.11]			
Married	0.33	0.49	0.75	-0.16**	-0.42***	-0.26***
	[0.47]	[0.50]	[0.44]			
Born here	0.43	0.50	0.82	-0.07	-0.39***	-0.32***
	[0.50]	[0.50]	[0.39]			
Monthly income in USD	132.54	146.84	21.26	-14.30	111.28***	125.58***
	[178.47]	[141.78]	[45.50]			
Staircase time preferences [1 to 32]	4.08	3.63	6.22	0.45	-2.14**	-2.59***
	[7.21]	[7.76]	[8.71]			
Perception of SLR: higher, salinization and coastal erosion	4.10	4.64	4.92	-0.54***	-0.82***	-0.28***
	[1.20]	[0.61]	[0.29]			
Relocate in the next 5years due to SLR?	0.45	0.74	0.59	-0.29***	-0.14***	0.14**
	[0.50]	[0.44]	[0.49]			
N	131	106	240			
F-test of joint significance				7.43***	53.88***	36.80***
F-test, number of observations				236	371	345

Notes: The reported values are the means for each sample. The variables female, no school, primary, secondary, married and born here are all binary.

Table S4.2 shows the balance across both treatments. A joint F-test for orthogonality shows that there are no differences on average w.r.t. to the observables reported here (F(11, 464)=1.42, p=0.161). Participants allocated to the one-shot treatment seem to be slightly more concerned about the future impacts of SLR (Mann-Whitney U test, z=2.21, p=0.027)

Table S4.2: Treatment balance

Variable	(1) One-shot Mean/SD	(2) Repeated Mean/SD	t-test Difference (1)-(2)
Female	0.35	0.35	-0.00
	[0.48]	[0.48]	
Age(years)	34.67	33.07	1.61
	[14.12]	[13.75]	
No school	0.05	0.05	0.00
	[0.23]	[0.23]	
Primary (6 years)	0.38	0.36	0.03
	[0.49]	[0.48]	
Secondary (more than 6 years)	0.56	0.59	-0.03
	[0.50]	[0.49]	
Household size	6.53	6.75	-0.22
	[3.77]	[3.96]	
Married	0.55	0.59	-0.04
	[0.50]	[0.49]	
Born here	0.61	0.67	-0.05
	[0.49]	[0.47]	
Monthly income in USD	84.00	75.20	8.80
	[140.60]	[124.85]	
Perception of SLR: higher, salinization and coastal erosion	4.71	4.56	0.15**
	[0.68]	[0.90]	
Relocate in the next 5years due to SLR?	0.58	0.59	-0.00
	[0.49]	[0.49]	
N	238	239	
F-test of joint significance (F-stat)			1.24
F-test, number of observations			476

Notes: The reported values are the means for each sample. The dependent variable took the value of one when the participant was assigned to treatment and zero otherwise for the joint F-test of orthogonality.

S4.3. Additional analysis

S4.3.1. Treatment effects: Robustness analysis

The main driver of trust (see AME in model 2, Table S4.3) in the first round is the expectation that the partner will be trustworthy. This belief increases the likelihood that trust is chosen by player A by about 19 percentage points, while smaller effects of 6 pp up to larger effects of 30pp are compatible with the data given the model assumptions (p=0.002, 95CI=0.07, 0.31). The set of socio-economic controls is jointly significant at the 10% level (Pearson $Chi^2(8)=18.91$, p=0.04) in explaining the likelihood of choosing trust in the sample. Overall, the model can explain about 10% of the variation in trust choices, while the model for trustworthiness can only explain about 5% of the variation.

Table S4.3: Probit models and AME of trust and reciprocity in the 1st round

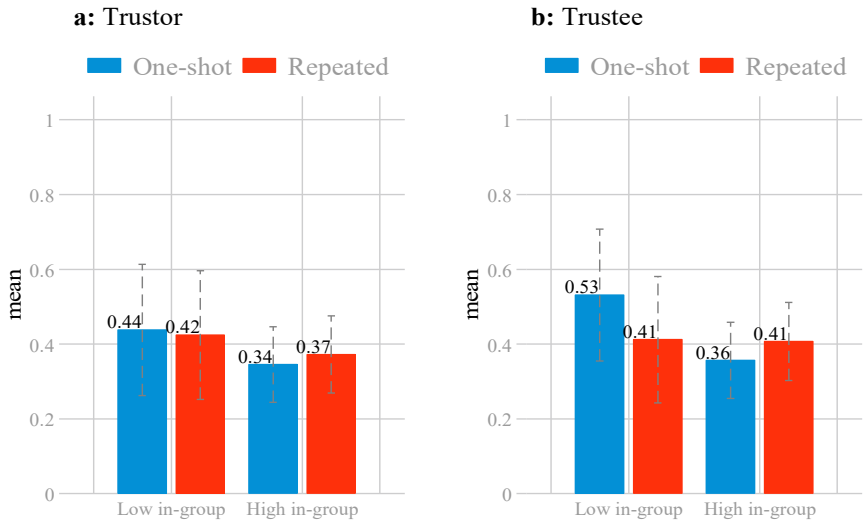
	Trust		Trustworthiness	
	(1)	(2)	(3)	(4)
	Probit	AME	Probit	AME
Treatment: Repeated	-0.002	-0.001	0.042	0.015
	(0.166)	(0.056)	(0.183)	(0.067)
Atoll Migrants	-0.106	-0.037	-0.401	-0.149
	(0.217)	(0.075)	(0.284)	(0.103)
Atoll Islander	-0.224	-0.077	-0.336	-0.126
	(0.257)	(0.089)	(0.294)	(0.109)
Expectation	0.554**	0.185**	-0.208	-0.077
	(0.195)	(0.061)	(0.158)	(0.059)
Constant	0.724		0.946	
	(0.720)		(0.682)	
Socio-economic controls	Y	Y	Y	Y
Session composition & understanding	Y	Y	Y	Y
Session cluster	Y	Y	Y	Y
Pseudo R^2	0.101		0.049	
Observations	238	238	238	238

Notes: I control for the socio-economics (age, gender, education, marital status, household size, monthly income) reported in Table S4.2, the number of friends, relatives and people the respondents had conflicts with in the past in the workshop and whether the respondent needed further clarifications regarding the main treatment, i.e. how fast they understood how many rounds are potentially being played. Standard errors clustered at the session level in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

S4.3.2. Treatment effects over in-group setting

A compelling explanation for the null result could be that participants believe in interacting outside the experimental setting, due to the high number of friends and relatives within sessions. As the workshops were conducted both in the capital and on remote atoll islands, this offers a compelling test of the in-group explanation. In the atoll migrant settlements and on the atoll islands, participants reported to be related or friends with twice as many other participants in the same session. Figure S4.2 shows, however, that participants in sessions with fewer relatives and friends do not behave significantly different than participants in sessions with a higher in-group degree. Importantly, repeated interactions neither significantly promote more trust and trustworthiness in low (Pearson Chi^2-Tests; $p>0.30$) or high in-group (Pearson Chi^2-Tests; $p>0.40$) sessions.

Figure S4.2: Treatment effects by in-group setting

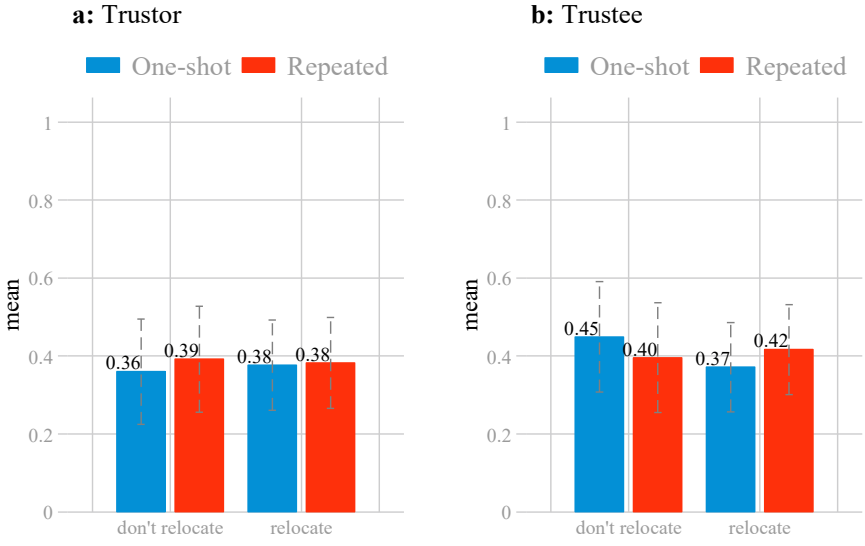


Notes: Binary categorization into low and high in-group setting based on where the workshops were held. Atoll islands and atoll migrants live in much denser and interconnected communities, which explains why they have more friends and relatives in the same session than main islanders.

S4.3.3. Treatment effects over relocation beliefs

Figure S4.3 shows the share of trust and trustworthiness for people who believe to be displaced by rising sea levels within the next five years or not. Beliefs of having a limited duration of interactions outside the laboratory experiment do not significantly affect trust nor trustworthiness.

Figure S4.3: Treatment effects over relocation belief



Notes: The relocation belief is based on the question: "Do you believe you have to relocate due to rising sea levels in the next 5 years?" (yes/no). Each bar is based on 48 or more observations in the above figure.

S4.3.4. Trust & trustworthiness by social preference types

Table S4.4 reports the average marginal effects after probit regressions for trust and trustworthiness. In models (1) and (3) treatment effects for prosocial participants are

reported, while in models (2) and (4) show the results for individualists. When controlled for socio-economics, session composition and understanding results do not significantly change compared to the results in the main manuscript.

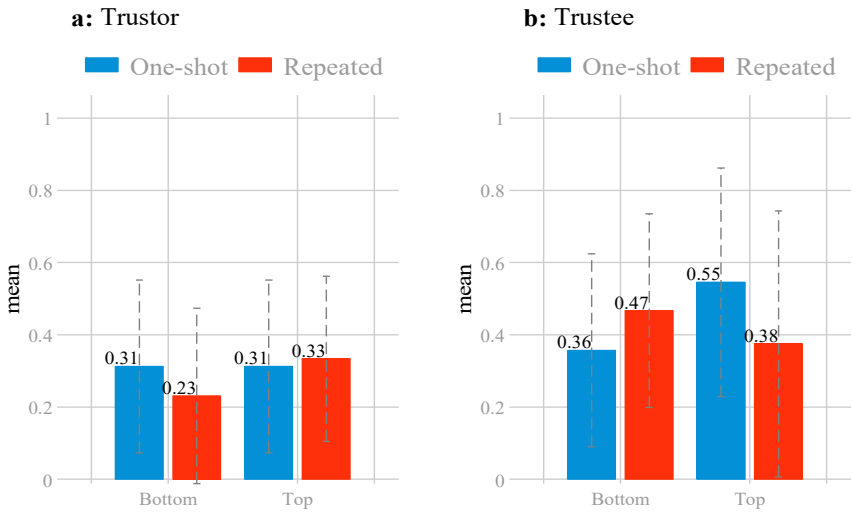
Table S4.4: Average marginal treatment effects by social types

VARIABLES	Trust		Trustworthiness	
	Prosocials	Individualist	Prosocials	Individualist
	(1)	(2)	(3)	(4)
Treatment: Repeated	0.09	-0.09	-0.02	0.10
	(0.08)	(0.07)	(0.10)	(0.10)
Atoll Migrants	-0.05	-0.03	0.09	-0.31**
	(0.13)	(0.12)	(0.14)	(0.14)
Atoll Islander	-0.06	-0.16	-0.09	-0.24
	(0.13)	(0.14)	(0.16)	(0.15)
Expectation	0.22***	0.13*	-0.01	-0.13
	(0.08)	(0.07)	(0.10)	(0.08)
Socio-economic controls	Y	Y	Y	Y
Session composition & understanding	Y	Y	Y	Y
Session cluster	Y	Y	Y	Y
Pseudo R^2	0.160	0.214	0.098	0.131
Observations	126	104	111	121

Notes: I control for the socio-economics (age, gender, education, marital status, household size, monthly income) reported in 0, the number of friends, relatives and people the respondents had conflicts within the past in the workshop and whether the respondent needed further clarifications regarding the main treatment, i.e. how fast they understood how many rounds are potentially being played. Standard errors clustered at the session level in parentheses: * p < 0.1, ** p < 0.05, *** p <0.01

Figure S4.4 shows the robustness check for the results based on other-regarding preferences. I only consider the bottom 25% of individualists and the top 25% of pro-socials to test whether the results remain robust. The results do not change with this reduced dataset and are in line with the results from the full dataset reported in the main manuscript.

Figure S4.4: Bottom & top quantile of individualists and pro-socials

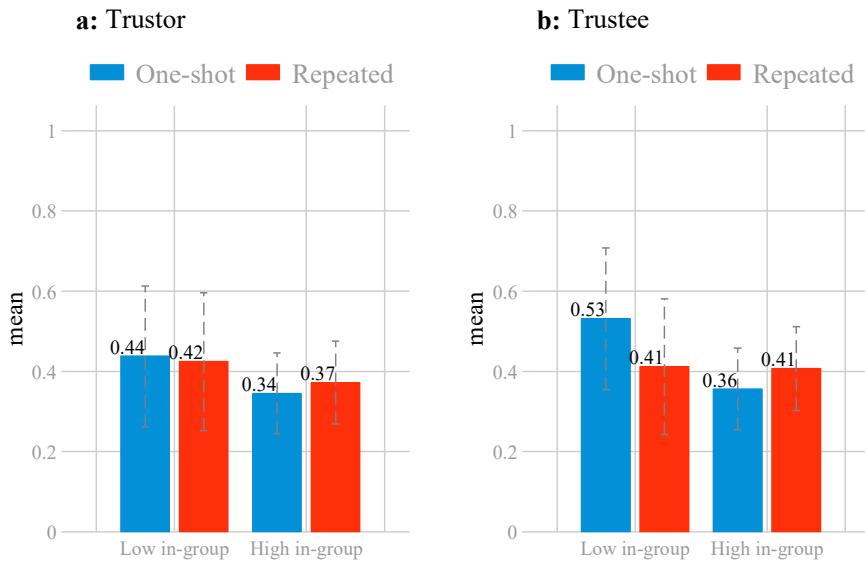


Notes: The bottom and top 25% of individualists and pro-socials are identified using the angles derived from the social value orientation task. I identified n=58 bottom 25% individualists and n=53 top 25% pro-socials, roughly equally distributed across both treatments.

S4.3.5. Repeated play behavior

On average, both trustors and trustees tend to stick to their previous actions, as they are significantly more likely to cooperate (i.e. choices of T and TW) if they cooperated in the previous round independent of their partner's behavior in the previous round (Pearson Chi^2, p=0.000 respectively). Conditional on their partner cooperating in the previous round and independent of their own behavior previously, only trustors are about 20 pp more likely to trust their partner ($Chi^2(1)=46.92$, p=0.000), while this is not the case for trustees (diff=0.09, p=0.13). Strangely enough, even when in previous rounds neither players cooperated (playing NTW and NT), 19 percent of trustors would play T in the current round, and even 35 percent of trustees would be trustworthy. On average, trustors change their behavior in the current round conditional on both their own behavior and their partner's behavior in the previous round. If the trustor did not place trust in their partner in the previous round, but their partner would have been trustworthy, trustors are about 15 pp more likely to trust their partner in the current round on average (Pearson Chi^2, $p < 0.05$). Similarly, if trustors trusted their partner in the previous round, but their trust was exploited by their partner, they are about 22 pp less likely to trust their partner in the current round (Pearson Chi^2, $p < 0.05$). These conditional behaviors do not apply to the same degree for trustees. In case trustees were trustworthy in the previous round, they are as likely to be trustworthy again independent of the choice of their partner in the previous round (Pearson Chi^2, p= 0.9). They are about 16 pp more likely to be trustworthy again if they received the information that their partner trusted them in the previous round (Pearson Chi^2, $p < 0.1$).

Figure S4.5: Conditional behavior in the repeated treatment



Notes: Shown are the pooled share of trust and reciprocity in the repeated treatment as a function of their own and partner's behavior in the previous round. I have 279 observations for both trustors and trustees respectively from 142 individuals. Dotted lines indicate 95 percent confidence intervals.

Now, I will explore some of these dynamics using more rigorous multivariate regression models (see Table S4.5). These results should be interpreted with caution, as the experiment was not designed to analyze the repeated behavior. I have used pooled OLS regressions for estimation with the unbalanced and limited panel data available. Overall, 71 pairs played more than one round in the repeated treatment giving a total of 558 observations. Due to the fact that some participants always made the same choice across all rounds, I decided not to use fixed effects regressions as this would result in a loss of further observations.

I find only suggestive evidence of conditional play by trustors but not by trustees. Even if players did not expect their partner to cooperate, and they didn't cooperate in the previous round, trust and trustworthiness are significantly different from zero (constant is significant in both models). The average share of trust and reciprocity is significantly higher in the current round when players cooperated (T, TW) in the previous round compared to the situation where neither player trusted and reciprocated (NT, NTW) in the previous round (joint F-test, $p<0.1$ for both trustors and trustees). The interaction effect itself, however, is not significant, indicating that achieving the payout maximizing outcome (T, TW) does not promote additional trust and reciprocity in the current round. That is a first sign that players are not making their choices conditional on available information[43].

Trustors (model 1) base their choices of trust on what they expect their partner will do and what they did in the previous round. If the trustor trusted in the last round, but the partner did not reciprocate, he is still 37 pp more likely to trust in the current round compared to when he did not trust in the previous round. If trustors did not trust in the previous round, they are slightly more likely by 12 pp to trust in the current round if their partner would have reciprocated in the previous round (coeff=0.12, $p=0.108$). That is a sign that at least some trustors use conditional strategies such as tit for tat by reacting to what their partner did in the previous round. Trustees (model 2) on the other hand, mainly base their decision whether to reciprocate in the current round on what they expect their partner will do and the model explains less variation than the one for trustors (Adj. R^2 0.06 vs 0.24). They are 14 pp more likely to reciprocate if they expect their partner will trust them. Additionally, current round expectations are only weakly correlated for trustors (Pearson correlation: $r=0.17$, $p<0.01$) but not for trustees ($r=0.4$, $p>0.1$). These are further indications that trustees did not use conditional strategies in the repeated game.

[43] Controlling for the level of understanding, as measured by the difficulty of answering the control questions nor does the exclusion of respondents that could not immediately answer how many rounds they would play affects these results. Misunderstanding of the strategic structure of the game and the anticipated number of interactions participants have, explain the observed non-strategic behavior.

Table S4.5: Conditional behavior

VARIABLES	Trust (1)	Reciprocity (2)
Expectation	0.20***	0.14*
	(0.07)	(0.08)
First lag (own)	0.37***	0.11
	(0.09)	(0.08)
First lag (partner)	0.12	-0.02
	(0.07)	(0.10)
Lag(own)*Lag(partner)	0.06	0.20
	(0.11)	(0.16)
Constant	0.16**	0.27***
	(0.07)	(0.09)
Joint F-test: lag(own)+lag(partner)+interaction	F(3, 70)=15.26, p < 0.01	F(3, 70)=2.41, p=0.08
Observations	279	279
R-squared	0.27	0.09
Number of ids	71.00	71.00
Adj. R-squared	0.24	0.06

Notes: Pooled OLS regressions were used to calculate both linear probability models. I control for round effects using dummies which are not reported here for brevity. F-tests were used to test for the joint significance of the round dummies. Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

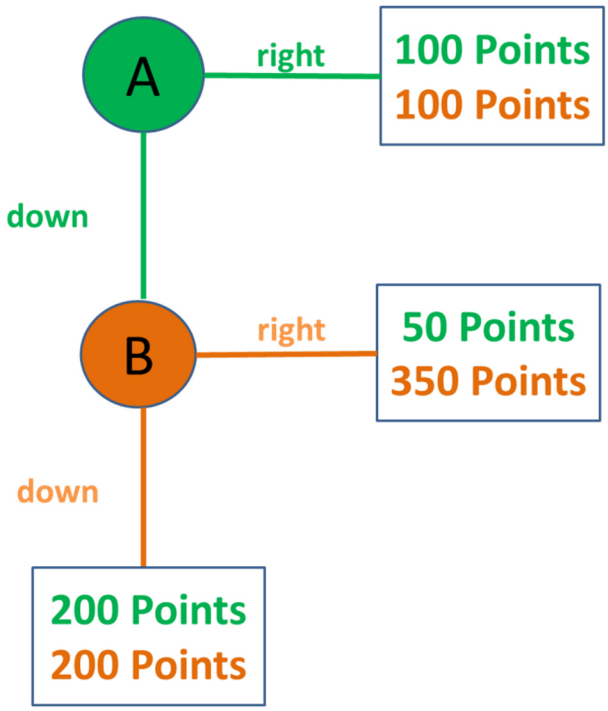
S4.4. Experimental protocol & Questionnaire

All materials that are reported here were translated into the local language Pidgin and then back-translated to English to ensure that the meaning did not change. The questionnaires were facilitated by local research assistants with the use of tablets.

S4.4.1. Experimental protocol

We will now start with the first game. During this game, you will have the chance to earn points, which will be converted into cash at the end of today's session, using an exchange rate of 10 Points = $1 SBD.

We will use this poster to help explain the game. [SHOW GAME-TREE ON POSTER]



In this game, you are either in the role of Player A (green) or Player B (orange). The other player is someone else in the room. Every player can choose "right" or "down". First, Player A (green) chooses whether he or she wants to move down or right on the "game tree" *[SHOW ON GAME TREE]*. If he or she decides to move right then, both players A and B receive 100 points, and the game ends here *[SHOW ON GAME TREE]*. If Player A (green) decides to play "down" then the result depends on the choice of Player B (orange). If Player B (orange) chooses "down" as well, both of you earn 200 points *[SHOW ON GAME TREE]*. If Player B (orange) chooses "right" Player A (green) earns 50 points, and Player B (orange) earns 350 points.

You will not learn the identity of the person you are matched with, and vice versa, your partner, will never learn about your identity. Only Ivo will know who your partner is, but he will not tell anybody, neither now nor after the end of the workshop. *[ASK GROUP]* Have you understood this part?

I will now give you some examples

• Suppose Player A (green) decides to move right. Player B (orange) does not make any decision. Player A (green) and Player B (orange) will earn 100 points.

• Suppose Player A (green) decides to move down, and Player B (orange) moves down as well. Then, both of you will earn 200 points.

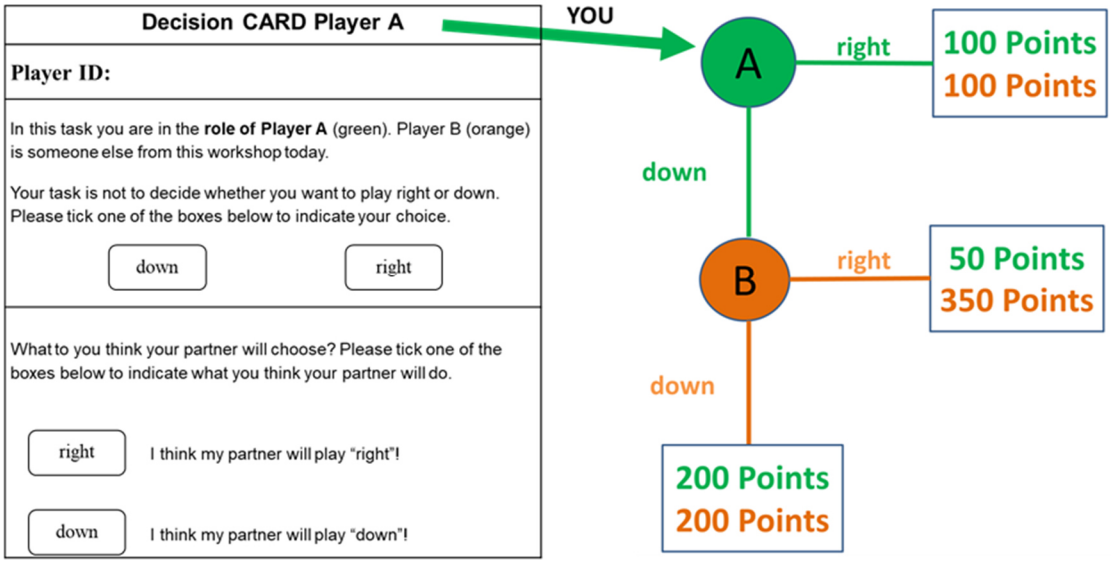
• Suppose Player A (green) moves down and Player B (orange) moves right. Player A (green) will earn 50 points, while Player B (orange) gets 350 points.

If you have any questions, you may ask them now. [IF YES, REPEAT THE EXAMPLES IN THE SAME ORDER.]

[LOOK AT RANDOMIZATION SHEET FOR TODAYS SESSION; THEN CONTINUE WITH CORRECT TREATMENT]

IF TREATMENT 1 [ONE-ROUND] – GROUP INSTRUCTIONS

To play the game, you will get one of the following two DECISION CARDS depending on whether you will be in the role of Player A or Player B *[SHOW THEM]*. You will be playing only one round together with your partner today, and you will be either in the role of Player A or Player B. This round will be relevant for the payoff, but you will only learn your earnings at the end of the workshop.



Before you make your decision, please write down your player number in the row labelled "ID number". Then you have to decide whether you want to choose "right" or "down" by marking your preferred choice on the DECISION CARD *[SHOW THEM]*.

You are also asked to estimate whether your partner will choose "right" or "down" by marking your expectation on the DECISION CARD *[SHOW THEM]*. If you expect him or her to choose "RIGHT" "I expect my partner to choose right". Otherwise, you have to choose "DOWN" "I expect my partner to choose down".

[ASK GROUP] Do you have any questions? Otherwise, we will call you one by one and ask some questions to check if you have understood the game or not.

[CALL PARTICIPANTS ONE BY ONE TO THE EXPERIMENTERS.]

INDIVIDUAL CONTROL QUESTIONS

We kindly ask you now to answer some questions about the game. Do not worry if you are not able to answer all questions correctly immediately. You will have the chance to ask me questions before you make your decision, and we will make sure that you understand the game.

[ASK FOLLOWING QUESTIONS AND FILL ANSWERS INTO QUESTION FORM.]

1. How many points do both Players receive if Player A (green) chooses "right" at the beginning of the game? *[Answer: 100 each]*

2. How many points do both players get if Player A (green) chooses "down" in the beginning, and Player B (orange) also chooses "down"? *[Answer: 200 each]*
3. What is the highest amount Player A (green) can earn? *[Answer: 200]*
4. What is the highest amount Player B (orange) can earn? *[Answer: 350]*
5. How many rounds do you play today? *[Answer: one]*

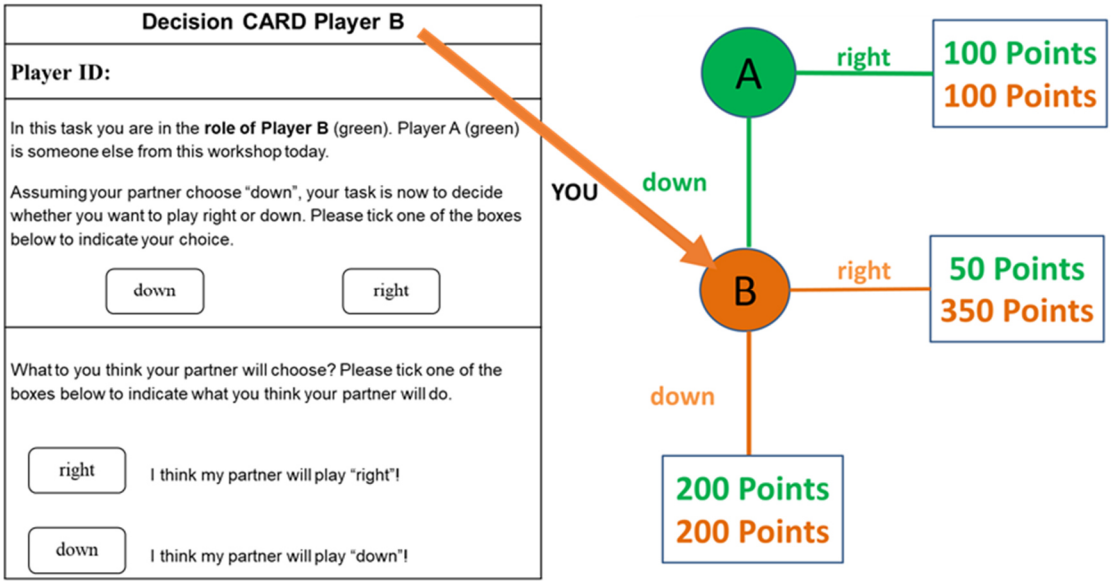
[RECORD ANSWERS. FOR THOSE WHO DID NOT ANSWER CORRECTLY, REPEAT EXPLANATIONS AND REPEAT QUESTIONS. RECORD ANSWERS FOR SECOND AND THIRD TIME.] [SEND PARTICIPANT BACK TO HIS SEAT]

GROUP INSTRUCTIONS

OKAY. Before we start, please don't forget that you are not allowed to communicate! Please remember that you will learn you're earning from this part of the workshop only when we have finished the questionnaire at the end of this workshop. After you have made your decision, we ask you to remain seated. We will collect your DECISION CARDS and then continue with the next game.

IF TREATMENT 2 [AMBIGOUS ROUNDS] – GROUP INSTRUCTIONS

To play the game, you will get one of the following two DECISION CARDS depending on whether you will be in the role of Player A or Player B *[SHOW THEM]*.



You might play more than one round with the SAME partner today. The number of rounds you will be playing today will be determined by throwing a die. After the end of the first round, we will throw a die, and the game will continue for another round if not a "one" or "six" is rolled. If the game continues for another round, you will play with the same partner in the same role again. Before you make your decision, you will be informed about your partner's decision in the previous round with a card like this where we mark your partner's decision in the last round [SHOW THEM FEEDBACK CARD]. One of the rounds will be chosen randomly at the end of the workshop to be relevant for payoff by choosing a card from this opaque bag [SHOW BAG].

Before you make your decision, please write down your player number in the row labelled "ID number". Then you have to decide whether you want to choose "right" or "down" by marking your preferred choice on the DECISION CARD [SHOW THEM].

You are also asked to estimate whether your partner will choose "right" or "down" by marking your expectation on the DECISION CARD [SHOW THEM]. If you expect him or her to choose "RIGHT" "I expect my partner to choose right". Otherwise, you have to choose "DOWN" "I expect my partner to choose down".

[ASK GROUP] Do you have any questions? Otherwise, we will call you one by one and ask some questions to check if you have understood the game or not.

[CALL PARTICIPANTS ONE BY ONE TO THE EXPERIMENTERS.]

INDIVIDUAL CONTROL QUESTIONS

We kindly ask you now to answer some questions about the game. Do not worry if you are not able to answer all questions correctly immediately. You will have the chance to ask me questions before you make your decision, and we will make sure that you understand the game.

[ASK FOLLOWING QUESTIONS AND FILL ANSWERS INTO QUESTION FORM.]

1. How many points do both Players receive if Player A (green) chooses "right" at the beginning of the game? *[Answer: Both 100 points]*
2. How many points do both players get if Player A (green) chooses "down" in the beginning, and Player B (orange) also chooses "down"? *[Answer: Both 200 points]*
3. What is the highest amount Player A (green) can earn? *[Answer: 200 points]*
4. What is the highest amount Player B (orange) can earn? *[Answer: 350 points]*
5. How many rounds do you play today? [Answer: not decided yet, depends on the outcome of the thrown number with the die]

[RECORD ANSWERS. FOR THOSE WHO DID NOT ANSWER CORRECTLY, REPEAT EXPLANATIONS AND REPEAT QUESTIONS. RECORD ANSWERS FOR SECOND AND THIRD TIME.] [SEND PARTICIPANT BACK TO HIS SEAT]

GROUP INSTRUCTIONS

OKAY. Before we start, please don't forget that you are not allowed to communicate!

Please remember that you will learn you're earning from this part of the game only when we have finished the questionnaire at the end of this workshop.

After you have made your decision, we ask you to remain seated. We will collect your DECISION CARDS and then throw a die to determine whether we play another round.

[IF NUMBER THROWN IS A "2", "3", "4" or "5"] The outcome of the throw was a [...], and we continue with the task. We will shortly handout the decision cards again and provide you with information about your partner's decision in the previous round. After you have made your decision, we ask you to remain seated. We will collect your DECISION CARDS and then throw a die to

determine whether we play another round. [BRING DECISION CARDS TO IVO. THEN REPEAT SAME PROCEDURE IF MATERIALS ARE READY]

[IF NUMBER THROWN IS A "1" or "6"] There will be no more round played today. We will collect your DECISION CARDS and then continue with the next game.

S4.4.2. Control question form

Player ID _____

TICK IF ANSWERS ARE CORRECT! [IF ANSWER IS CORRECT THE FIRST TIME, TICK "Answer 1" and so on…]
EXPLAIN AND REPEAT QUESTIONS IF NOT CORRECT!

Questions	Answer 1	Answer 2	Answer 3
How many points do both players get if Player A (green) chooses "right" at the beginning of the game? Answer: Both get 100 points	□	□	□
How many points do both players get if Player A (green) chooses "down" in the beginning, and Player B (orange) also chooses "down"? Answer: Both get 200 points	□	□	□
What is the highest Amount Player A (green) can earn? Answer: 200 points	□	□	□
What is the highest amount Player B (orange) can earn? Answer: 300 points	□	□	□
How many rounds do you have to play in this game today? Answer IF TREATMENT=ONE ROUND: Only one round. Answer IF TREATMENT=AMBIGUOUS ROUNDS: Not decided yet, depends on the outcome of the dice throw.	□	□	□

S4.4.3. Post-experimental questionnaire

QUESTIONNAIRE

Date and Place of experiment [TO BE FILLED IN BY INTERVIEWER]			
Day : |__|__|	Month: |__|__|	Player-ID:	Place:

Module A: Personal characteristics

1. **What is your gender?**	1. □ Male 2. □ Female
2. **What is your marital status?**	1. □ Single 2. □ Married 3. □ Separated 4. □ Widowed
3. **How old are you?**	_____years
4. **What is the highest level of education you completed?** [Only choose one]	1. □ No school 2. □ Primary 3. □ Form 3 4. □ Form 5 5. □ Form 6 6. □ Form 7
7. **Do you have a college or university degree?**	1. □ College, specify_____ 2. □ Bachelor, specify_____ 3. □ Masters, specify_____ 4. □ Doctoral, specify_____ 5. □ None
8. **Including yourself, how many people live in your household? Please consider only people who live for more than 6 months a year in your household.**	_____ people
9. **Since when have you been living at this place?**	□ All my life *[GO TO QUESTION A12]* □ Since _____ *(year)*
10. **Where do you come from?** *[ISLANDS & PROVINCE]*	Place:_____ Province:_____
11. **What place do you consider your home?** *[ISLANDS & PROVINCE]*	Place:_____ Province:_____
12. **What ethnic group to you identify with?**	1. □ Melanesian 2. □ Polynesian 3. □ Micronesian 4. □ Other, specify: _____
13. **What is the language you use on a day-to-day basis?**	1. □ Pidgin 2. □ English 3. □ Melanesian language 4. □ Polynesian language 5. □ Other, specify: _____
14. **How often do you go to worship / prayer?**	1. □ Daily 2. □ Weekly

	3. □ Monthly 4. □ Other, specify: _____

Module B: Opinions

Please be as honest and accurate as you can throughout. Try not to let your response to one statement influence your responses to other statements. There are no "correct" or "incorrect" answers. Answer according to your own feelings, rather than how you think "most people" would answer.

How well do the following statements describe your personality?	Strongly Disagree	Disagree a little	I neither agree nor disagree	Agree a little	Strongly Agree
B1. In uncertain times, I usually expect the best.	□	□	□	□	□
B2. It's easy for me to relax.	□	□	□	□	□
B3. If something can go wrong for me, it will.	□	□	□	□	□
B4. I'm always optimistic about my future.	□	□	□	□	□
B5. I enjoy my friends a lot.	□	□	□	□	□
B6. It's important for me to keep busy.	□	□	□	□	□
B7. I hardly ever expect things to go my way.	□	□	□	□	□
B8. I don't get upset too easily.	□	□	□	□	□
B9. I rarely count on good things happening to me.	□	□	□	□	□
B10. Overall, I expect more good things to happen to me than bad.	□	□	□	□	□
Each of the following statements refers to the place where you currently live. Please tick the answer on the right that best matches your own personal response to each statement.	**Strongly Disagree**	**Disagree a little**	**I neither agree nor disagree**	**Agree a little**	**Strongly Agree**
B11. I feel that this place is a part of me.	□	□	□	□	□
B12. This place is very special to me.	□	□	□	□	□
B13. I identify strongly with this place.	□	□	□	□	□
B14. I am very attached to this place.	□	□	□	□	□
B15. Being at this place says a lot about who I am.	□	□	□	□	□
B16. This place means a lot to me.	□	□	□	□	□
B17. This place is the best place for what I like to do.	□	□	□	□	□
B18. No other place can compare to this place.	□	□	□	□	□
B19. I get more satisfaction out of being at this place than at any other.	□	□	□	□	□
B20. Doing what I do at this place is more important to me than doing it in any other place.	□	□	□	□	□
B21. I wouldn't substitute any other area for doing the types of things I do at this place.	□	□	□	□	□
B22. The things I do at this place I would enjoy doing just as much at a similar site.	□	□	□	□	□

B23. Please tell me, in general, how willing are you to give up something that is beneficial for you today in order to benefit more from that in the future? Please tell us on a scale of 0-10, where 0 means "completely unwilling to do so" and 10 means "very willing to do so".

Completely Unwilling to do so — **Very willing to do so**

0	1	2	3	4	5	6	7	8	9	10
□	□	□	□	□	□	□	□	□	□	□

B24. Please tell me, in general, how willing or unwilling you are to take risks. Please tell us on a scale of 0-10, where 0 means "completely unwilling to take risks" and a 10 means you are "very willing to take risks".

completely unwilling to take risks										very willing to take risks
0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

B25. Do you feel happy in general? Please imagine your global estimation and general feelings and not your present state when taking your decision. Tick the number which seems best to describe your feeling on a scale of 0-10, where 0 means "not happy at all" and 10 means "very happy overall".

Not happy at all										very happy overall
0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

C1. In general, do you agree or disagree with the following statements:	Disagree strongly	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree strongly
C1a. Most people can be trusted.	☐	☐	☐	☐	☐
C1b. Most people who live in this community can be trusted.	☐	☐	☐	☐	☐
C1c. I only trust people from my family.	☐	☐	☐	☐	☐

C2. Altogether, how many times in the past 12 months did you participate in community activities for common development goals, such as building a well, repairing a road or maintaining a community center?
1. ☐ Every day
2. ☐ Once a week
3. ☐ Once a month
4. ☐ Couple of times a year
5. ☐ Never

C3. How likely is it that people who do not participate in community activities will be criticized or sanctioned?
1. ☐ Very likely
2. ☐ Somewhat likely
3. ☐ Neither likely nor unlikely
4. ☐ Somewhat likely
5. ☐ Very unlikely

C4. What were three main community activities in the past 12 months? Was participation in these voluntary or required?	Voluntary	Required
1.	☐	☐
2.	☐	☐
3.	☐	☐

C5. Suppose your house got damaged during the last big storm. Who would help you rebuild your house? [MULTIPLE ANSWERS POSSIBLE]
1. ☐ Family members
2. ☐ Neighbors
3. ☐ Other villagers
4. ☐ Other, specify:_____

MODULE C: Climate change perception / trust / collective action

C6. Have you heard of climate change?
1. ☐ Yes
2. ☐ No

C7. Do you think that climate change has caused any changes in your life?
1. ☐ Yes
2. ☐ No
3. ☐ Don't know

C8. Do you think that, due to climate, you will need to move in the future?
1. ☐ Yes
2. ☐ No
3. ☐ Don't know

C9. As a result of climate change, to what extent do you believe the following events <u>have already happened</u> to your home community?

On a scale from 1 to 5, where one means "definitely has not" and five "definitely has". To what extent do you believe that […] has already happened?	Definitely has not	Maybe has not	Unsure	Maybe has	Definitely has
C9a. Droughts occurred more often.	□	□	□	□	□
C9b. Droughts were shorter than they used to be.	□	□	□	□	□
C9c. Cyclones occurred more frequently.	□	□	□	□	□
C9d. Heavy rains occurred more often.	□	□	□	□	□
C9e. Floods were less severe.	□	□	□	□	□
C9f. Saltwater from the sea comes further into the land than it used to.	□	□	□	□	□
C9g. Sea level is higher than it was 5 years ago.	□	□	□	□	□
C9h. Coastal land was lost to the sea.	□	□	□	□	□

C10. As a result of climate change, to what extent do you believe the following things <u>will happen</u> to your home community within the next 5 years?

On a scale from 1 to 5, where one means "definitely will not" and five "definitely will". To what extent do you believe that […] will happen?	Definitely will not	Maybe will not	Unsure	Maybe will	Definitely will
C10a. Droughts will occur more often	□	□	□	□	□
C10b. Droughts will become shorter than they used to	□	□	□	□	□
C10c. Cyclones will occur more frequently	□	□	□	□	□
C10d. Heavy rains will occur more often	□	□	□	□	□
C10e. Floods will be less severe	□	□	□	□	□
C10f. Saltwater from the sea will come further into the land	□	□	□	□	□
C10g. Sea level will be higher	□	□	□	□	□
C10h. More coastal land will be lost to the sea	□	□	□	□	□

C11. Droughts are shorter than they used to be.	□ Yes □ No
C12. Do you think that things like climate change happen for a good reason, and that being faithful and going to church will help to prevent such events?	□ Yes □ No

C13. How important are the following sources where you hear or read about the topic of climate change?

On a scale from 1 to 5, where one means "not important at all" and five "very important". How important do you think [...] is / are?	Not important at all	Somewhat unimportant	Neither important nor unimportant	Somewhat important	Very important
C13a. Family, friends and neighbors	□	□	□	□	□
C13b. Teachers	□	□	□	□	□
C13c. Television	□	□	□	□	□
C13d. Internet	□	□	□	□	□
C13e. Newspapers	□	□	□	□	□
C13f. Radio	□	□	□	□	□
C13g. Community leaders	□	□	□	□	□
C13h. Local priest	□	□	□	□	□
C13i. Government officials	□	□	□	□	□

C13j. NGO workers	☐	☐	☐	☐	☐
C13k. Researchers	☐	☐	☐	☐	☐

Module D: Economic situation

D1. How much do <u>you</u> earn in an ordinary month?	$_____SBD
D2. What is the approximate total income of your <u>household</u> in an ordinary month?	$_____SBD
D3. Considering your household's current financial situation in comparison to other households in your community, would you say that you are…	1. ☐ Better off than most other households 2. ☐ Worse off than most other households 3. ☐ Neither better nor worse off
D4. Please tell me how many of each kind of livestock your <u>household</u> possesses:	**Number of animals**
D4a. Pigs	
D4b. Chicken / Poultry	
D4c. Others (specify)	

Does your household own the following asset at present? [*TICK EITHER YES OR NO]*

D5. IMMOVABLE ASSETS	**YES**	**NO**
1. Agricultural land	☐	☐
2. Non-agricultural land	☐	☐
3. House	☐	☐
4. Other buildings	☐	☐
D6. MOVABLE ASSETS	**YES**	**NO**
1. Radio	☐	☐
2. Television	☐	☐
3. Cell phone / mobile phone	☐	☐
4. Generator	☐	☐
5. Solar power	☐	☐
6. Fridge / Refrigerator	☐	☐
7. Sound system	☐	☐
8. Stove (electric, paraffin, gas, kerosene)	☐	☐
9. Sewing machine	☐	☐
10. Chainsaw	☐	☐
11. Fiberglass boat/canoe	☐	☐
12. Wooden boat/canoe	☐	☐
13. Outboard engine	☐	☐
14. Car	☐	☐
15. Motor cycle / scooter	☐	☐
16. Bicycle	☐	☐
17. Plough	☐	☐

Module E: Social Network, Migration

E1. How many of the other 11 participants in today's session are…

- *[THE MAXIMUM NUMBER IS 19, THE MINIMUM IS ZERO]*

E1a. Close friends of you	

E1b. Relatives of you	
E1c. You have had an argument/ fight in the past with	
E2. What lifestyle would you rather prefer?	1. Having a secure job and earning money in Honiara 2. Live the island life and do some fishing and gardening
E3. IF it were only your choice, would you rather lone on an atoll or in a settlement in Honiara	1. atoll 2. settlement
E4.	3.
E5. About how many close friends do you have these days? These are people you feel at ease with, can talk to about private matters, or call on for help. *[Number of people]*	Same tribe: _____ Other tribe:_____ TOTAL:_____
E6. How often in one year do you visit friends and family at the place you considered home earlier?	_____ [Number of times per year]
E7. How often in one year do you have friends and family visiting you at the place you currently live?	_____ [Number of times per year]
E8. If there was a sudden disaster to hit the place where you currently stay, such as a tsunami or cyclone and you were forced to evacuate <u>temporarily</u>, where would you go? [WRITE DOWN PLACE & PROVINCE]	Place:_____ Province:_____
E9. Imagine that the place where you currently stay will be uninhabitable in the future, for example, due to sea level rise. Where would you go <u>permanently</u>? [WRITE DOWN PLACE & PROVINCE]	Place:_____ Province:_____
E9a. In choosing a place to go, what are the <u>three most important</u> reasons to go to that place?	1. Reason 1:_____ 2. Reason 2:_____ 3. Reason 3:_____

E10. IF you had to leave the place where you are currently living, who could host you? Please list the <u>three most important people</u> who can host you and the place they live.

Place #	**Name of place**. *[WRITE DOWN PLACE AND PROVINCE]*	• **Relationship to person.**	**Would you go to this place permanently to live?**
1)	Place:_____ Province:_____	□ Family □ Friend □Other, specify:_____	□ Yes □ No
2)	Place:_____ Province:_____	□ Family □ Friend □Other, specify:_____	□ Yes □ No
3)	Place:_____ Province:_____	□ Family □ Friend □Other, specify:_____	□ Yes □ No

References

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