Evaluating Shocks: A panel study of impacts of and responses to COVID-19 in coastal small-scale fishing communities

Thesis submitted by

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[2] Further details of contributions are included at the beginning of each data chapter

Chapter Three collaboration

Chapter Three is adapted from a report and subsequent paper which was the result of a collaborative effort led by Dr. Jacqueline Lau, with significant contributions to the conceptualisation, data management, data analysis, and writing from me (see preface). As such, I have used the pronoun “we” throughout the chapter to reflect the collaborative nature of the work.

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Generative AI technology was not used in the preparation of any part of this thesis.

Outputs and other contributions

Related to PhD thesis

Peer reviewed publications

Lau, J., **Sutcliffe, S.,** Barnes, M., Mbaru, E., Muly, I., Muthiga, N., ... & Cinner, J. E.., 2021. COVID-19 impacts on coastal communities in Kenya. *Marine policy*, *134*, 104803.

Sutcliffe, S., Lau, J.D., Barnes, M., Mbaru, E., Wade, E., Hungito, W., Muly, I., Wanyonyi, S., Muthiga, N., Cohen, P. J., Cinner, J. (2023) COVID-19 impacts on food systems in fisheries-dependent island communities. *Ecology and Society* 28(1).

Sutcliffe, S., Lau, J.D., Barnes, M., Mbaru, E., Muly, I., Wanyonyi, S., Muthiga, N., Cinner, J.. Harnessing adaptive capacity: Insights from the COVID-19 pandemic. *In prep.*

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Book chapter

Lau, J., & **Sutcliffe, S.**, 2021. Of Isolation and Atolls: Coping with COVID-19 in Manus, Papua New Guinea. In *COVID in the Islands: A comparative perspective on the Caribbean and the Pacific* (pp. 385-401). Palgrave Macmillan, Singapore.

Conference presentations

Sutcliffe, S., Lau, J.D., Barnes, M., Mbaru, E., Muly, I., Wanyonyi, S., Muthiga, N., Cinner, J., 2022. Western Indian Ocean Marine Science Association Scientific Symposium, Port Elizabeth, South Africa, "Adapting to the impacts of COVID-19 on livelihoods and food systems in coastal Kenyan fishing communities."

Sutcliffe, S., Lau, J.D., Barnes, M., Mbaru, E., Wade, E., Hungito, W., Muly, I., Wanyonyi, S., Muthiga, N., Cohen, P. J., Cinner, J., 2020. The International Association for the Study of the Commons Conference, Arizona State University, online, "COVID-19 policy impact pathways and feedbacks: a food systems analysis in small-scale fishing communities."

Media

Mbaru, E., Lau, J., & **Sutcliffe, S.,** 2022. **"**How COVID affected markets and livelihoods in Kenya's fisheries sector," *The Conversation.*

Lau, J., & **Sutcliffe, S**., 2020. "'We didn't have money or enough food': how COVID-19 affected Papua New Guinean fishing families," *The Conversation.*

Other publications, reports, and presentations during candidature

Simmance, F. A., Cohen, P. J., Huchery, C., **Sutcliffe, S.**, Suri, S. K., Tezzo, X., ... & Phillips, M. J., 2022. Nudging fisheries and aquaculture research towards food systems. *Fish and Fisheries*, *23*(1), 34-53.

Datta, A., Barnes, M.L., Chaffin, B., Floyd, T., Morrison, T., **Sutcliffe, S**., 2022. Big events, little change: Extreme climatic events have no region-wide effect on Great Barrier Reef governance. *Journal of Environmental Management, 320,* 115809.

Barnes, M. L., Wang, P., Cinner, J. E., Graham, N. A., Guerrero, A. M., Jasny, L., **Sutcliffe, S**.,... & Zamborain-Mason, J., 2020. Social determinants of adaptive and transformative responses to climate change. *Nature Climate Change*, *10*(9), 823-828.

Sutcliffe, S., & Barnes, M. L., 2018. The role of shark ecotourism in conservation behaviour: Evidence from Hawaii. *Marine Policy*, *97*, 27-33.

O'Meara, L., Cohen, P.J., I'ilu Kafa, R., Wate, J.T., Albert, J., Bogard, J., Bonis-Profumo, G., Burkhart, S., Delisle, A., Diffey, S., Eria, T., Farmery, A., Fukofuka, K., Mangubhai, S., Mitchell, M.E.V., Na'ati, E., Nyemah, J.N., Pickering, T., Sutcliffe, S., Swanepoel, L., Thilsted, S.H. and Lam, F.V. 2023. Pacific food systems – The role of fish and other aquatic foods for nutrition and health. Apia. https://doi.org/10.4060/cc5796en

Cohen P. J., Simmance F., Thilsted S. H., Atkins M., Barman B., Bunting S,. Byrd K., Chimatiro S., de Bruyn J., Dubois M., **Sutcliffe, S.** et al., 2021. Advancing research and development outcomes with fish in regional food systems. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2021-18.

Lau, J., Sutcliffe, S., Barnes, M., Mbaru, E., Muly, I., Muthiga, N., Wanyonyi, S. & Cinner, J. (March, 2021) COVID-19 impacts on coastal communities in Kenya. Report.

McDougall, C., Akester, M. J., Notere, B. D., Choudhury, A., Hasiba, Z., Karisa, H. C., **Sutcliffe, S**.... & Thilsted, S., 2020. Ten strategies for research quality in distance research during COVID-19 and future food system shocks. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems Program Brief: FISH-2020-11.

Lau, J., **Sutcliffe, S.,** & Hungito, W., 2020. Lived experiences of COVID-19: Impacts on an Atoll Island community, Papua New Guinea. Report.

Kleiber, D., et. al, 2019. Gender-inclusive facilitation for community-based marine resource management. An addendum to "Community based marine resource management in Solomon Islands: A facilitators guide" and other guides for CBRM. Penang, Malaysia: CGIAR Research Program on Fish Agri-Food Systems. Program Brief: FISH-2019-08

Sutcliffe, S. & Barnes, M., 2022. International Network for Social Network Analysis Sunbelt Conference, Cairns, Australia, "Social networks facilitate fishers' adaptations to environmental changes." *Conference presentation.*

ARC Centre of Excellence for Coral Reef Studies Annual Symposium, James Cook University, Australia, Panel member, "The future of coral reef research."

Barnes, M., & **Sutcliffe, S**.. "Shark tourism can change your mind about these much-maligned predators," *The Conversation.*

Sutcliffe, S.. "Shark ecotourism," 2ser Radio- Drive (radio interview). https://2ser.com/shark-ecotourism/, September 18, 2018

Preface

The work presented here draws on data collected as part of a rapid-response research effort to document the initial impacts of COVID-19. While I was one of the main researchers on the project from the start, it was not originally intended to be my PhD thesis project. I started my PhD in 2018 and planned to use a positive deviance analysis to identify strategies for improving nutritional outcomes in PNG. Before the onset of COVID-19, I had already conducted a scoping trip and pilot study for that work, and had plans for three more fieldtrips, as the specific method I planned to use required repeat measures. When international borders closed and overseas fieldwork became logistically unfeasible, I took a leave of absence from my PhD, in the hope that the pandemic would be over in a matter of months, and I would be able to resume my planned data collection in early 2021.

In the meantime, I was hired on part time joint contract with JCU and WorldFish to develop a research protocol for investigating the impacts of the pandemic in coastal fishing communities in collaboration with Professor Cinner, Associate Professor Barnes, Dr. Lau, and Dr. Cohen. We then opportunistically implemented the protocol in several communities where Prof. Cinner, Prof. Barnes and Dr. Lau had long-term research partnerships. At the time, we did not plan for the work to be the basis of my PhD. As such, the research was very much a collaborative effort, with Dr. Lau and me sharing responsibility for most project management tasks; survey development; training and overseeing field workers; and data analysis; and writing up the initial outputs from the project, with oversight and contributions from Professor Cinner, Prof. Barnes, Dr. Mbaru, Dr. Muthiga, Dr. Wade and other project partners. The goal of our early data analysis and outputs from the project was to quickly identify key issues that had arisen as a result of the pandemic and communicate them with in-country partners and decision makers, so we initially focused on producing summary reports. These were subsequently modified for academic publication and then again adapted into Chapter Three of this thesis and the book chapter presented in Appendix One. Dr. Lau was the lead author for both publications, but I made a significant contribution to each phase of their development, and they were a core part of the overall project which later chapters draw on, which is why my advisors and I have decided to include them in my thesis.

By the end of 2020, it was clear that the pandemic was going to continue for some time, and I would not be able to resume my original research plans. I decided in collaboration with my advisors and the other project partners that it would be appropriate for me to use the data from the project as the basis of my thesis, and then I led the work presented in Chapters Four, Five and Six, with appropriate oversight and contributions from my PhD advisory team.

The less-than-ideal circumstances in which this research was developed and implemented has had a significant effect on the final thesis. For example, we were forced to draw on somewhat opportunistic sampling when selecting research sites and recruiting participants; and Chapter Three is based on a report written as a joint effort (Lau et al. 2021b, Mbaru 2021), rather than a theory-forward paper led only by myself. However, I am still proud of this work and feel that I have made a significant contribution to theory in my field in addition to contributing to the pandemic research effort.

Positionality Statement

It is critical that as a social scientist, particularly one working with qualitative data based on the experiences of people from different ethnicities, ages, nationalities, genders, religious backgrounds, and economic statuses to my own, that I acknowledge the influence of my own background in my interpretation of other people's life stories. I am a white, mono-lingual, third-generation Australian woman. Prior to mid-2023, I had only ever lived in Australia, and then moved to the United Kingdom. I come from a highly educated, upper-middle class family: both my parents and sister have a university education; my mother also has a PhD. I grew up as an active participant in a Presbyterian church. I am single and do not have any children.

My undergraduate degree is in Advanced Marine Biology (2014-2016) and focused heavily on quantitative, positivist, natural-science theories and research methods. I re-oriented towards environmental social science and developed my social science research skills, including qualitative data analysis, through an undergraduate independent study conducted under the supervision of Dr. Barnes; my Honours thesis overseen by Dr. Cohen; several qualitative social science research methods intensive courses; and through my employment as Dr. Barnes' research assistant. Whilst I have been increasingly exposed to and influenced by critical theory and relativist thinking both personally and professionally in recent years, my approach to research is still most strongly embedded in my western, positivist scientific training and background.

Throughout my PhD process I have been highly aware of the implications of my physical and cultural separation from the people and communities who participated in this research. Prior to the outbreak of the COVID-19 pandemic, I had spent approximately seven weeks conducting fieldwork in Papua New Guinea, in the same community where we conducted the research presented here. I had intended to spend several months conducting research in Ahus Island in person, and to learn Tok Pisin so I could communicate and conduct research interviews without needing to work through a translator. However, this more embedded approach to research was prevented due to the pandemic, and the majority of the data I will present here was collected remotely and by research assistants. I was able to spend three weeks in Kenya, including two weeks in one of the five communities represented in this study in 2022, after the majority of our data was collected and after I had already begun data analysis. I have never been to St. Lucia or directly interacted with anyone from there. While my limited fieldwork experiences in Kenya and Papua New Guinea did provide me with important context which I found extremely valuable for my data analysis and interpretation, I very much bring an outsider perspective to this research. I relied heavily on my co-authors and local research assistants and data collectors, Stephen Wanyoni, Innocent Muly, Emmanuel Mbaru and Wilda Hungito for their

assistance in interpreting findings and identifying the implications of the research. Stephen Wanyonyi, Innocent Muly, and Emmanuel Mbaru are all Kenyan and live in Mombasa on the southern coast of Kenya (in the middle of the five study communities) and have worked extensively with the communities over several years. Wilda Hungito is Papua New Guinean and lives in Lae but has family connections in Manus province in a village adjacent to Ahus Island. We had bi-weekly online meetings throughout 2020-2022 to discuss the research project, including detailed discussions of aspects of the interviews I was unsure how to interpret or needed additional context to understand. The interviews were all conducted in the local language, and I relied completely on my local research assistants and co-authors to conduct and translate the interviews. On the one hand, this meant that research participants likely felt more comfortable in expressing their thoughts and feelings using colloquial language and shared experiences than if the interviews had been conducted by myself and/or my fellow Australian and American colleagues. However, this degree of separation between the interviewee and analyst inevitably results in a loss of nuance and introduces an additional source of bias.

It should be noted that I was conducting this research whilst also living through and being negatively impacted by the pandemic myself (particularly in regard to my mental health and wellbeing); but that my experience was very different to that of my research participants due to our respective backgrounds and contexts. Whilst I made significant efforts to identify and minimise the influences of my biases and assumptions, I acknowledge that my positionally will have inevitably influenced this research.

Abstract

Global society has recently faced unprecedented changes and disruptions. Shocks like the COVID-19 pandemic and natural disasters have all had significant negative effects on livelihoods, food and nutrition security, and human wellbeing. As we face an uncertain future threatened by climate change, ongoing conflicts, and socio-economic inequalities, it is essential that we understand how shocks propagate through society to culminate in a range of positive and negative outcomes for different groups. Examining the effects of past shocks can help us to better prepare for shocks in the future. The study of shocks and how people respond to them has been a major focus of research from a wide range of disciplines in recent years. However, we do not yet have an integrated, multi-scalar framework which draws together this recent progress which can be utilised by researchers, policymakers, and practitioners to prepare for, understand, and respond to shocks as they happen.

In this thesis, I aim to progress our understanding of how shocks lead to diverse outcomes by applying three different interdisciplinary frameworks to the analysis of a unique, longitudinal, multi-national dataset to explore the impacts of, responses to, and outcomes of the COVID-19 pandemic. I draw on frameworks based in food systems theory, adaptive capacity theory, and multi-dimensional wellbeing to address four key research questions: 1) What can we learn about how people were impacted by and responded to COVID-19 using different theoretical framings? 2) What are the strengths and weaknesses of these theoretical framings, and how does that influence research findings and recommendations? 3) What are the benefits and/or drawbacks of utilizing or combining multiple frameworks to study the same shock? and 4) How can we apply the lessons of COVID-19 to strengthen proactive and reactive policies and interventions for future shocks, particularly from climate change?

I address these research questions through a mixed-methods case study of the impacts of COVID-19 on coastal small-scale fishing communities in Kenya, Papua New Guinea, and St. Lucia. I primarily draw on a series of interviews conducted with women and men at three time points through the first year of the pandemic. I use the High-Level Panel of Experts on Food and Nutrition Food Systems Framework to identify how the pandemic and policies put in place to contain it flowed through the interconnected actors and processes which make up the local food systems to determine food and nutrition security outcomes. I examine if and how people were able to respond to these impacts, and what factors facilitated or prevented them from responding using the Six Domains of Adaptive Capacity Framework. I then examine the overall impact of these processes and responses on different aspects of human wellbeing using the 3D Wellbeing Framework. I also draw on an additional series of socio-economic surveys from before, during, and after the pandemic to quantitatively determine the

wellbeing impacts of the pandemic and whether people have begun to recover now restrictions have lifted.

I found that COVID-19 disrupted fishery livelihoods through supply chain disruptions and reductions in market demand. This led to reduced income and purchasing power for fishers and led to food and nutrition insecurity and significant declines in multiple dimensions of human wellbeing. I found that while these general experiences were common across all the study communities, the underlying pathways and feedbacks which led to those impacts were context specific. As such, the most effective intervention points to mitigate the impacts are also likely to be context specific. I found that people's responses to the pandemic spanned a continuum from temporary coping strategies through more substantial adaptations to significant transformations. Some of the responses may have long-term positive benefits, but many changes were maladaptive. I not only found that all six domains of adaptive capacity (assets, flexibility, learning, organisation, socio-cognitive constructs, and agency) played a significant role in determining if and how people could respond; I identified multiple interdependencies between the six domains which collectively shaped peoples' responses. I identified a wide range of immediate negative material, relational, and subjective wellbeing impacts from the pandemic and its containment policies. However, I also identified subsequent recovery patterns once restrictions eased. I then compared the net change in wellbeing from shortly before the onset of the pandemic (2019) to after restrictions eased (2022), with changes in wellbeing in the three years prior (2016 to 2019) due to ongoing socio-economic and ecological processes. In eight of the nine indicators examined, I found either no statistically significant difference in the level of change in wellbeing, or that there was actually more of a net improvement or less of a decline over the 3 years encompassing the peak of the pandemic than in the three years before. In other words, I found compelling evidence that coastal fishing communities have the capacity to recover from the impacts of COVID-19.

In drawing together my specific findings, I argue that the diverse range of ways people are impacted by and respond to shocks is highly personalised and determined by a combination of the particular characteristics and mechanisms of the systems which they are imbedded in as well as their individual capacities. I propose an integrative framework for understanding how shocks lead to diverse outcomes which incorporates the key elements of each of the three frameworks I evaluated. This multi-scalar conceptualisation captures high-level system structures and processes, individual capacities and actions, and how they interact, as well as reinforcing the need for evaluating and addressing a more holistic range of wellbeing outcomes.

While my findings about the apparent ability of these communities to recover from the impacts of COVID-19 are encouraging, many of the devastating outcomes of the COVID-19 pandemic are likely to

occur again in the future due to climate-driven disasters and other significant shocks. It is critical that we learn from the successes and failures of COVID-19 so we can be more effective in re-shaping system structures and processes and increasing people's capacity to respond to shocks in ways that minimise negative wellbeing impacts in the future.

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Chapter 1: General introduction

The first quarter of the 21st century has been defined by a series of major social, economic, and environmental shocks, for example, 9/11 and the resulting ongoing conflict in the Middle East, the global food crisis of 2007, the economic crash of 2008, unprecedented technological development, and the increasing effects of climate change have all had significant impacts on global society (Addison et al. 2011, Ramay 2020, Roberts 2020, Rose 2021). In the last three years alone, we have faced multiple climate-driven natural disasters, the global ramifications of the Russian invasion of Ukraine, and of course, the COVID-19 pandemic.

Shocks are events which disrupt existing social-ecological system structures and processes, i.e., the complex, multi-scalar interactions between people, institutions and the ecosystems they are embedded in (Berkes et al. 2000, Van Assche et al. 2022)). Shocks can vary in scale, from relatively short and geographically limited events such as earthquakes, severe storms, or terrorist attacks (i.e. acute shocks) (Thomas et al. 2020, Thu et al. 2022), to more spatially and/or temporally extensive disruptions such as wars, droughts, or economic recessions (i.e. large-scale shocks or protracted crises) (Maxwell et al. 2012). Shocks can lead to diverse social and ecological outcomes, which often vary between different groups. Sometimes, the outcomes from a shock can be positive in some regards. For example, the COVID-19 lockdowns and travel bans significantly reduced carbon emissions and pollution levels in some areas (Shakil et al. 2020) and increased the use of digital collaboration tools and events which have persisted after restrictions eased. These changes will likely have ongoing positive implications for the environment as well as for equity and accessibility (Lichter et al. 2022, Skiles et al. 2022, Wu et al. 2022). In many cases however, shocks lead to devastating negative outcomes, especially for already marginalised groups, as they often reenforce social inequalities and poverty traps (Carter and Barrett 2006, Mendoza 2011, Reva 2012, Kabeer 2015, Barrett et al. 2019). It is estimated that the COVID-19 pandemic saw an additional 90 million people entering extreme poverty in 2020 alone (Mahler et al. 2022), increased inequality across the world (Berkhout et al. 2021), and significantly undermined progress towards achieving the Sustainable Development Goals (Clemente-Suárez et al. 2022, Bhattacharya and Bose 2023). In an increasingly globalised society, even seemingly localised shocks can have global ramifications; for example, the Russian invasion of Ukraine has undermined global grain markets and led to increased food prices, threatening food security in Africa and the Middle East in particular (Behnassi and El Haiba 2022, Ben Hassen and El Bilali 2022). Shocks frequently lead to sequential breakdowns in livelihoods, food and nutrition insecurity, and overall declines in human wellbeing, with devastating long-term consequences (Devereux 2007, Reva 2012). For example, poor nutrition in the first 1000 days of life can lead to impaired growth and cognitive development, increased risk of disease in adulthood, and poor mental health, which in turn

can impact school performance and future income potential (Almond and Currie 2011, Richter et al. 2017). When this occurs across society, it reduces overall financial and human capital and reinforces inter-generational poverty cycles (Tafere 2016, Richter et al. 2017, Gatti et al. 2023).

Global shocks of all kinds are becoming more frequent. For example, we have already bypassed the 1°C global warming threshold and are projected to reach 1.5°C between 2030 and 2052 (IPCC 2022b). We are already experiencing increased frequency and severity of climate-driven disasters including floods, droughts, wildfires, mass bleaching events and storms, which will only worsen as global temperatures continue to rise (IPCC 2022a). Given the inevitability of future shocks, we therefore need to attempt to mitigate the negative impacts of shocks by ensuring individuals and institutions can rapidly respond to shocks as they occur and effectively identify and address medium- and long-term outcomes afterwards. This will require proactively building resilience (the ability to resist, absorb, and recover from the effects of shocks (UNSDR 2009, Field et al. 2012, Lei et al. 2014)) and adaptive capacity (the ability to minimise, cope with, take advantage of, and recover from the changes they experience (Adger and Vincent 2005, Gallopín 2006)) (Adger et al. 2003). To effectively manage the outcomes of shocks, we also need to be able to evaluate what the outcomes are and how those outcomes come about.

Shocks are a focus of study in a diverse range of disciplines across the social and environmental sciences, including disaster studies, economics, social-ecological systems research, sociology, psychology, geography, and more (Kreps 1984, Rose 2007, Tierney 2007, Alexander 2018, Bergman-Rosamond et al. 2022). Each of these disciplines has developed different theories to conceptualise the relationship between shocks and various outcomes**,** which are based on different ontologies, that is, different understandings of the causal agents and mechanisms behind social phenomena (Mahoney 2004). Different theoretical framings have different strengths and weaknesses based on what the theories prioritise or minimise, which shape what and how research is conducted, how data is interpreted, and the recommendations which come out of it (Mahoney 2004, Geels 2010). For example, the study of resilience and adaptation to shocks within the social sciences is largely agreed to have originated in psychology, with early research in the field focusing on internal factors and personality traits as the key determinants of the individual outcomes of adverse events, independent of any exogenous influencing factors. In addition to quickly being proven insufficient in explaining observable differences in social outcomes, this narrow approach led to problematic victim-blaming of marginalised groups for not being “gritty” enough to cope with shocks (Waller 2001). On the other hand, conceptualisations of resilience and adaptation to shocks grounded in ecology fundamentally incorporate consideration of multi-scalar interactions and the influence of exogenous forces on

complex systems. However, when applied to social or social-ecological systems, conceptualisations based on ecological systems theories do not adequately incorporate fundamental ideas around power dynamics, human agency, politics, and innovation; and the focus on the persistence and stability of systems as a whole can perpetuate and exacerbate inequalities within those systems (Cote and Nightingale 2012, Brown 2014, Bush and Marschke 2014). While theories based on contradictory assumptions and logics may initially seem incompatible, the specific focus of one theory can fill in gaps in another, and drawing together the conclusions of research with different disciplinary origins and perspectives through a process of conceptual triangulation can lead to richer and more holistic understandings of complex phenomena (Thurmond 2001, Geels 2009, Bush and Marschke 2014, Foran et al. 2014, Denzin 2017).

Three theoretical frameworks applicable to studying the relationship between shocks and outcomes have gained prominence in interdisciplinary environmental social science research in recent years; the High Level Panel of Experts (HLPE) Sustainable Food Systems Framework (HLPE 2020), the Six Domains of Adaptive Capacity framework developed by Cinner and Barnes (2019), and the 3D Wellbeing framework (Gough and McGregor 2007). While not the only frameworks conceptualising food systems, adaptive capacity, and wellbeing, they are widely used and broadly representative of dominant theory in their respective subject areas. Each of these frameworks draw on concepts from multiple disciplines, and thus lend themselves well to exploring the potential of multi-paradigm research (Gough and McGregor 2007, Cinner and Barnes 2019).

1.1 The HLPE Sustainable Food Systems Framework

Food security, defined by the Food and Agriculture Organisation of the United Nations as a situation that exists “when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 1996), is critical for lifelong health and human flourishing. However, its inverse, food insecurity, is one of the most common and most detrimental outcomes of shocks, as food security is dependent on multiple structures and processes which are potentially vulnerable to disruption (Fraser et al. 2005). Of particular relevance to the study of how shocks influence food security outcomes is food systems theory. Food systems theory is based on the premise that the availability, accessibility, stability and utilisation of food are the outcomes of a complex social-ecological system, that is, a set of activities controlled by multiple actors and social, economic, environmental, and political drivers across multiple scales (Ericksen 2008). Proponents of the theory argue that a holistic understanding of food systems that encompasses the whole food supply chain; from production through to consumption, the food environment, and consumer behaviour, is essential to achieving food and

nutrition security (HLPE 2017). Additionally, the food security of a household, and the comparative food security of individual household members, can be strongly influenced by external drivers which must be accounted for, for example social norms, such as those governing the respective roles and rights of different genders (Ingram 2011). Food systems theory states that failing to recognise and account for variation in political, economic, socio-cultural, and biophysical drivers can cause well-intentioned interventions to mitigate the food security impacts of shocks which have succeeded in some contexts to fail in others (Mutunga 2012).

Multiple conceptual frameworks have been developed based on food systems theory (Ericksen 2008, Ingram 2011, Global Panel on Agriculture and Food Systems for Nutrition 2016, HLPE 2017, 2020), but the Sustainable Food Systems Framework, originally developed by the FAO High Level Panel of Experts on Food and Nutrition in 2017 (HLPE 2017), then revised in 2020 (HLPE 2020), is arguably the most comprehensive and widely accepted (**Fig. 1**). The framework is centred on five key, tightly linked components: 1) *systems supporting food production,* for example health, economic and ecosystems, which provide inputs into the food system; 2) *food supply chains,* or production and distribution networks, which consist of processes and actors involved in producing, processing, distributing and marketing food and disposing of food waste; 3) *consumer behaviours*, or the knowledge and decision making processes which shape food acquisition, preparation and consumption practices; and 4) *diets,* including the quality, quantity, diversity, safety and adequacy of the food people consume. These four components are shaped by 5) *food environments,* which consist of the social, political, economic, and physical contextual factors that determine the accessibility, affordability, and safety of food as well as consumer preferences. These five components determine *the nutrition and health outcomes* of people in the food system, as well as *economic, social, and environmental outcomes.* The five food system components, and therefore food system outcomes, are influenced by diverse *drivers of change* and *policy and governance systems* at various scales; including things like changes in natural and built environments, social dynamics, market processes, and formal and informal rules and norms, including those developed in response to social-ecological shocks (HLPE 2017, 2020).

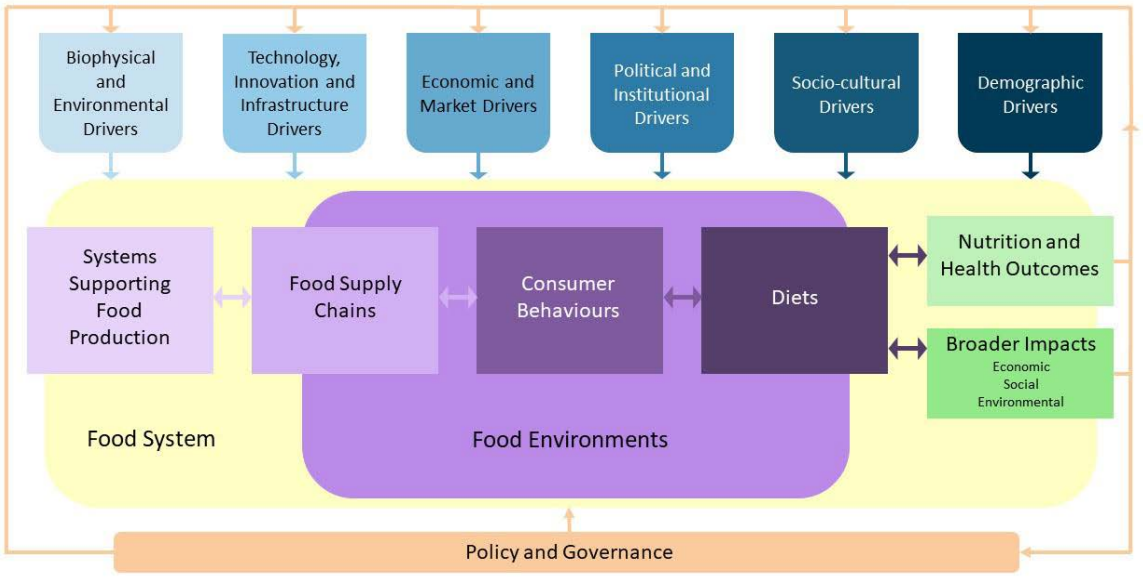

Figure 1. Sustainable Food Systems Framework. Source: Food and Agriculture Organisation of the United Nations. Adapted with permission.

Conceptual frameworks based on food systems theory, including the HLPE framework, are often used to map out "business as usual" structures and processes for long term governance and development interventions at global or national scales (Béné et al. 2019). However, because they explicitly describe the relationship between external drivers, connected actors and processes, and food and nutrition outcomes, they can also be useful for tracing the impact pathways of shocks, and identifying potential strategic intervention points to mitigate negative outcomes (Ingram 2011, Béné 2020, Devereux et al. 2020, Steenbergen et al. 2020a). Additionally, while large-scale analyses are helpful for understanding big picture trends and patterns, food systems theory can and should also be applied at smaller scales to capture the effects of, and interactions between shocks and the various elements of the food system within specific local contexts (Béné et al. 2019). Local-scale food systems analysis can expose bottlenecks resulting from the specific local conditions practices and reveal inequities in food distribution and allocation which are masked by large-scale analysis (Carlsson et al. 2017).The complexity and variability of the myriad of factors feeding into a food system results in locally unique food systems and therefore food system outcomes during both periods of stability and during and after shocks (Béné et al. 2019).

In short, food systems theory, and the HLPE sustainable food systems framework in particular, conceptualise the outcomes of shocks as a function of how shocks flow through a series of locally specific interlinked processes and actors and drivers, potentially creating cascades and feedback loops which eventually lead to diverse outcomes across different parts of the system (**Fig. 2**).

Figure 2. Conceptual link between shocks and outcomes in the HLPE Sustainable Food Systems Framework

1.2 The Six Domains of Adaptive Capacity Framework

In light of recent shocks and the looming climate crisis, the international community has become increasingly conscious of the need to understand the extent to which different groups will be affected by shocks, and their ability to withstand those impacts. Researchers from various disciplines have developed different theories to explain how different people are affected by shocks, often centred around the related concepts of vulnerability, resilience, and adaptive capacity (Adger et al. 2005b, Miller et al. 2010). Different disciplines have various definitions of those concepts, as well as different understandings of the interactions between them (Gallopín 2006, Brown and Westaway 2011, Lei et al. 2014, Cinner and Barnes 2019). However, despite the ongoing debate, the foundational premise of this body of work is that the outcomes of shocks for a particular group or individual are a function of their vulnerability, which is based on 1) the level of exposure and sensitivity to the particular shock, and 2) their ability to respond to it, which is variously defined as resilience, adaptive capacity, or a combination of both (Gallopín 2006, Smit and Wandel 2006, Marshall et al. 2010, Lei et al. 2014). In general, resilience relates to the capacity to resist, absorb, and recover from the effects of shocks whilst maintaining essential structures and functions in a timely and efficient manner (UNSDR 2009, Field et al. 2012, Lei et al. 2014). Finally, adaptive capacity is the set of latent factors that determine an individual or community's ability to minimise, cope with, take advantage of, and recover from the changes they experience (Adger and Vincent 2005, Gallopín 2006).[3]

Recent research emphasizes that vulnerability, resilience, and adaptive capacity are multidimensional and socially differentiated (Béné et al. 2016a, Cinner et al. 2018a, Thomas et al. 2019). Women and men across different cultures and intersecting identities (such as class, age, and ethnicity) experience different levels and types of vulnerability (Rao et al. 2019a), different capacities to adapt and innovate rather than just absorb or ride out disruptions (Cohen et al. 2016), and face different opportunities and barriers to access mitigation and adaptation strategies (Novak Colwell et al. 2017). In addition,

[3] Note that there is significant overlap in the various definitions of resilience and adaptive capacity, some researchers combine the concepts or use them interchangeably

local biophysical contexts (e.g. ecosystem health) and culture (including social norms and moral values) will dynamically shape how people and communities navigate changes (Schill et al. 2019). In light of this complexity and the growing global agenda to support adaptation, there has been an increasing move towards frameworks and approaches that incorporate a wider range of dimensions of adaptive capacity, and to examining how place-based context and culture limits or enhances the ability to adapt to change, or a community or individual's adaptive capacity (Brown et al. 2018). Relating back to the overarching research focus of this thesis, this body of work frames the relationship between shocks and outcomes as mediated by the adaptive actions of individuals and groups in response to the shock, as determined by their multidimensional adaptive capacity (**Fig. 3**).

Figure 3. Conceptual link between shocks and outcomes in the Six Domains of Adaptive Capacity framework

One theoretical framework which attempts to conceptualise the various social factors which determine how people respond to shocks is the Six Domains of Adaptive Capacity framework developed by Cinner and Barnes (2019). This framework draws on resilience and adaptive capacity theory from across a range of research disciplines to outline six interconnected categories or domains of attributes which can facilitate or act as barriers to various adaptive responses (**Fig. 4**). These domains are 1) *assets* which are the financial, technological and service resources which people can individually or collectively draw on to support adaptation (Cinner et al. 2009a, McClanahan and Cinner 2011); 2) whether people have the *flexibility* to switch between a range of different strategies (Cinner et al. 2018a); 3) *social organisation,* or the relationships between individuals, institutions, communities and governance structures which facilitate or inhibit individual and collective responses (Adger 2003a, Barnes et al. 2017, Cinner et al. 2018a); 4) peoples capacity for *learning,* that is their ability to access and process information, make causal attributions, evaluate potential response options and manage uncertainty (Fazey et al. 2007, Cinner and Barnes 2019); 5) *socio-cognitive constructs,* which include mental frameworks such as risk attitudes, social norms and cognitive biases which shape people's perceptions of shocks and potential responses (Mortreux and Barnett 2017); and 6) *Agency*, or the power to exercise free choice in determining whether or not to make changes, and if so, which ones and how (Brown and Westaway 2011, Cinner et al. 2018a). Importantly, these six domains are theorised to be highly interconnected, though these interactions are relatively understudied to date (Cinner and Barnes 2019).

Figure 4. Six Domains of Adaptive Capacity framework. Developed by Cinner and Barnes (2019), used with permission

1.3 The 3D Wellbeing Framework

A key, but often overlooked, element of understanding the relationship between shocks and outcomes is what outcomes to actually consider. Historically, the impacts of shocks have been measured in terms of how they compromise material needs, for example food security and livelihood disruptions, particularly in fields like disaster studies and human development research, and of course, economics (Dercon and Hoddinott 2004, Gaiha and Imai 2004, Baulch 2011, Akter and Basher 2014). This focus has had a significant impact on disaster relief efforts and broader development interventions, which have similarly prioritised material needs (Deaton 1997, McGregor and Sumner 2010, Markhvida et al. 2020). Economic and food security are, of course, essential for survival. However, there is increasing recognition that they are not the only things required for overall human wellbeing, and in fact, economic indicators can often be a poor indicator of life satisfaction (Graham 2005). Wellbeing can instead be more broadly defined as “a state of being with others, where human needs are met, where one can act meaningfully to pursue one's goals, and where one enjoys a satisfactory quality of life" (McGregor 2007). This definition is then further complicated by the fact that what wellbeing looks like in practice is itself subjective and varies between individuals and cultures (Narayan et al. 2000, Camfield and McGregor 2005, White 2015). Consequently, the goals of disaster response interventions, and development overall, has begun to shift away from securing “objective” wellbeing through eliminating economic poverty to achieving or securing multidimensional human wellbeing (Camfield and McGregor 2005, Gough et al. 2006, Ben-Arieh 2007,

Camfield et al. 2009). As such, researchers from fields like disaster studies, human development, economics and social-ecological systems research who are studying the effects of shocks on people are increasingly drawing on concepts from fields like sociology, anthropology psychology and happiness studies and utilising a wider range of methodologies to integrate various psychosocial factors into their impact assessments (Camfield et al. 2009, White 2015). The general contribution of this body of research to understanding the relationship between shocks and outcomes is less about the causal mechanisms involved than it is about ensuring that impact assessments evaluate how specific outcomes of shocks affect overall wellbeing **(Fig. 5).**

Figure 5. Conceptual link between shocks and outcomes in the 3D Wellbeing framework

Much of the recent work trying to take a more holistic approach to studying the impacts of shocks on wellbeing draws on the work of the Wellbeing in Developing Countries ESRC Research Group (WeD) at the University of Bath. They developed a framework for wellbeing, generally referred to as the 3D Wellbeing framework, based on three interconnected dimensions: material wellbeing, relational wellbeing, and subjective wellbeing (Gough and McGregor 2007, White 2008, McGregor and Sumner 2010, White 2010) **(Fig. 6)**. It is based on the premise that wellbeing is socially and culturally constructed based on sociological context (McGregor 2007). Material wellbeing refers to the factors associated with classical ideas of poverty and wealth, that is, objective factors like income and expenditure, assets, access to welfare, and health (White 2010). Relational wellbeing is based on the relationships which a particular individual has with others at multiple scales (e.g., family, friends, peers, institutions etc.) (Coleman 1988, White 2010, Charles et al. 2012). Social relationships shape people's sense of power, culture, and identity, and the way they make meaning from their experiences (Seel 1997). Relational wellbeing is closely related to social capital and incorporates things like trust and the capacity for collective action (Michaelson et al. 2009). Subjective wellbeing can be thought of as people's experience and perceptions of their material life, as seen through the lens of their culture, identity and social relationships (White 2010). People with the same objective level of material wealth can interpret that state differently based on their context, and therefore have different levels of satisfaction and happiness (Sen 1999, Coulthard et al. 2011). Subjective wellbeing is tied to people's sense of agency and purpose, their ideologies and beliefs and their general satisfaction and contentment with life (Aked et al. 2008, McGregor and Sumner 2010).

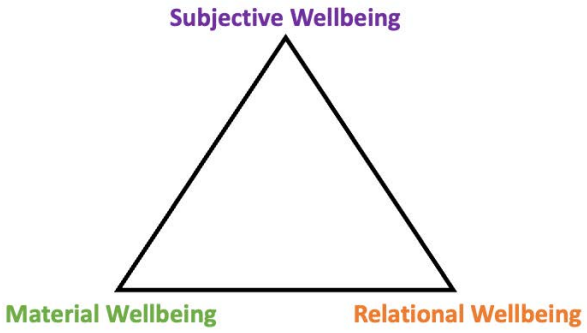

Figure 6. The 3D wellbeing framework. Adapted from White (2010)

Material, relational and subjective wellbeing are fundamentally interdependent (Gough and McGregor 2007). For example, relationships can facilitate access to goods and services needed to achieve material wellbeing, and social connections are strongly associated with life satisfaction and contentment, as well as shaping people's sense of identity, cultural values, ideologies, and beliefs, i.e., their subjective wellbeing (White 2015). Additionally, an individual's subjective wellbeing is often contingent on whether their friends and family have their material needs met as well as their own (White 2015).

1.4 Study objectives

The general objective of this thesis is to explore the applicability, strengths, weaknesses, and potential complementarities of these three different theoretical frameworks to studying shocks, to further develop our theoretical understanding of the relationship between shocks and diverse social outcomes. This overarching objective is broken down into four aims (**Fig. 7)**:

1) Examine the relationship between shocks and social outcomes,

2) Explore the application of different theoretical frameworks to studying shocks,

3) Explore the interactions between different domains of adaptive capacity,

4) Evaluate the relevance of studying COVID-19 to future shocks, particularly climate disasters.

Note that Aim 3 specifically relates to the Six Domains of Adaptive Capacity framework. The interaction between the domains, has been identified as potentially important but understudied (Cinner and Barnes 2019) and I therefore sought to contribute to theory by developing this concept further. Specifically, I aimed to determine if and how the six domains influenced the adaptive actions people made in response to COVID-19 independently, or whether there were interdependencies between the domains where one or more domains facilitated the others. Interactions between some

factors associated with each domain have been independently studied, for example, we know that social networks can facilitate access to assets and learning opportunities (Barnes et al. 2017), but there has yet to be a systematic examination of interactions across all six domains.

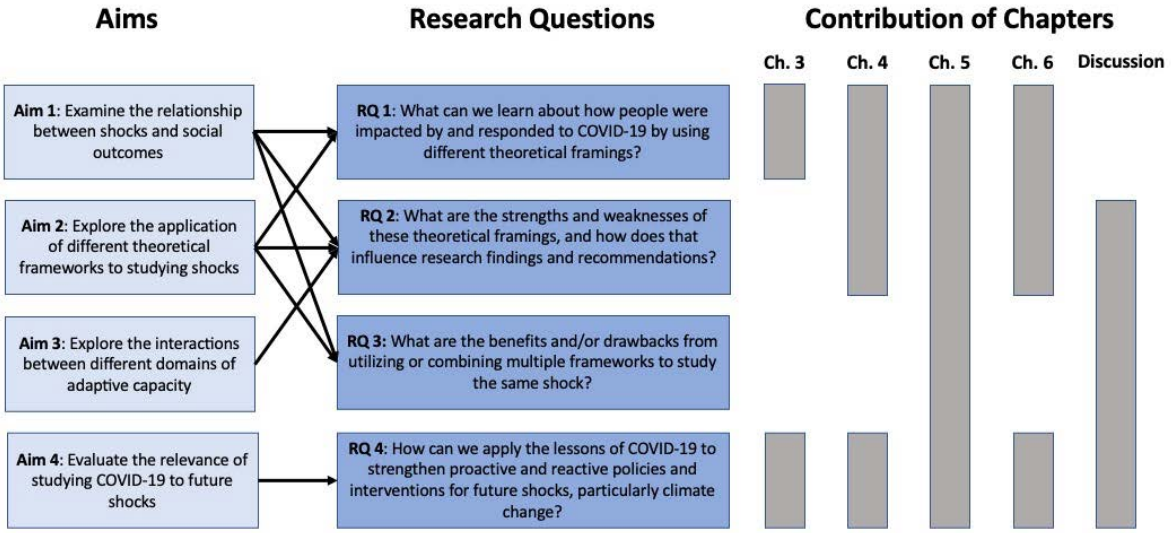

Figure 7. Aims, research questions and contribution of chapters

I address these aims through a case study of the impacts of COVID-19 on coastal small-scale fishing communities (SSF). Since the onset of the pandemic, researchers have proposed that studying the impacts of COVID-19 could be useful for informing preparations for and responses to future shocks, particularly climate change (Klenert et al. 2020, Manzanedo and Manning 2020)**.** The pandemic and policies to contain the spread of the virus caused a wide range of complex flow-on social, economic, and environmental impacts. While some of the disruptions experienced are relatively specific to pandemics, such as the extreme within-community isolation caused by the containment policies (Ganesan et al. 2021) and the short- and long-term health ramifications of the disease itself (Del Rio et al. 2020, Seyed Alinaghi et al. 2021), many of the impacts were similar to what occurred during previous shocks and are expected to happen increasingly frequently under climate change. For example, decreased regional and global mobility, disruptions to food production supply chains, increased unemployment, and breakdowns in infrastructure and support systems (Manzanedo and Manning 2020, Cooper and Nagel 2021, Negev et al. 2021, Pelling et al. 2021). The comparison between COVID-19 and climate change is particularly appropriate due to similarities of scale. While some of the direct consequences of climate change will be an increased frequency and severity of acute shocks in the form of natural disasters; many will be long-term changes, such as sea-level rise, extended droughts, and changes in the agricultural productivity of large areas (IPCC 2022b, a). The collective impacts of both multiple acute events and long-term changes will be felt world-wide for

decades to come, even if emissions are curbed in the next few years (IPCC 2022b, a). Whilst there are many similarities in the social, economic, and environmental impacts of different kinds of shocks across spatial and temporal scales, there are some relatively unique characteristics of large-scale, protracted shocks which are important to consider and make them harder to address (Maxwell et al. 2012). Protracted crises like pandemics, armed conflicts, and famines are more likely to be entangled with a complex set of social and economic processes and inequalities, leading to poverty traps and increased vulnerability to other co-occurring shocks; there are conceptual limitations to how people frame shocks which work well for understanding, planning for, and responding to acute shocks which do not translate well to the much slower process of addressing more complex, drawn out changes; and the scale of investment and long-term commitments required to adequately address them can make it hard for public and private actors constrained by short budgetary and planning cycles to meaningfully engage (Pingali et al. 2005, Maxwell et al. 2012, Quak 2018). In the case of geographically wide-scale shocks, even normally well-resourced national and international support systems and institutions can face logistical barriers to offering assistance, and are likely to become overstretched or redirected towards solving issues "at home" rather than in more-distant places, even if they are worse-affected and less-able to respond (Paras et al. 2020, Kobayashi et al. 2021). In short, as a multi-year disruption, the COVID-19 pandemic can provide insights into the effects of and responses to more protracted shocks but was also short enough to study recovery patterns. As a global shock, it provides a unique opportunity to employ multi-site longitudinal analysis to investigate how different communities are impacted by and respond to the same kinds of shocks based on specific local physical and social characteristics, and how the global community does or does not respond collectively.

Studying the impacts of COVID-19 specifically on small-scale fishing communities is valuable because they are 1) a critical source of food and income for an estimated 113 million people involved in SSF value chains worldwide, and therefore in need of protection and investment (World Bank 2012, Beveridge et al. 2013, Béné et al. 2015, FAO et al. 2023); 2) often underrepresented in social-ecological research and development interventions (Chuenpagdee et al. 2016, Smith et al. 2021, Simmance et al. 2022, FAO et al. 2023); and 3) they can be particularly vulnerable to complex social-ecological shocks like COVID-19. This is because SFF communities are often economically, politically, and geographically isolated, experience low incomes and limited livelihood diversity, have poor infrastructure, limited government support, and a lack of reserve capital, access to insurance, and social support (Bennett et al. 2016, Bennett et al. 2020, FAO 2020a). Understanding how the unique characteristics of these communities influenced how they were affected is important for improving COVID-19 response and recovery strategies and designing tailored policies to bolster their ability to respond to future shocks, including climate disasters. Additionally, while the exact series of events in these communities may

not be universal, they can be useful for testing the applicability of broader theories of how people respond to shocks.

In my examination of COVID-19 in SSF communities, I sought to answer four research questions, tied to my research aims (**Fig. 7**):

1) What can we learn about how people were impacted by and responded to COVID-19 using different theoretical framings?
2) What are the strengths and weaknesses of these theoretical framings, and how does that influence research findings and recommendations?
3) What are the benefits and/or drawbacks of utilizing or combining multiple frameworks to study the same shock?
4) How can we apply the lessons of COVID-19 to strengthen proactive and reactive policies and interventions for future shocks, particularly climate change?

The four aims and research questions do not directly line up with each other and one of each of the four data chapters. Rather, the data chapters each seek to address Aims 1, 2 and 4, and Research Questions 1, 2 and 4 using a different theoretical framework. The four data chapters are drawn together in the general discussion to address Research Question 3. Aim 3 is specifically addressed in Chapter Five, which is based on the Six Domains of Adaptive Capacity framework (**Fig. 7**).

1.5 Thesis outline

I address my aims and research questions through four-data based chapters (the first two of which are adapted from peer-reviewed publications) based on interviews and surveys with women and men in coastal small-scale fishing communities during the first year of the pandemic. Chapter Two consists of an explanation of the study sites and methods used in the four data chapters. In Chapter Three I present an overview of the initial impacts of COVID-19 in coastal small-scale fishing communities in Kenya. As this research was conducted during the pandemic, which presented a clear and present threat, the initial focus of myself and my colleagues involved in the project this thesis is based on was to rapidly analyse and disseminate the data from our interviews to people working on the ground to support communities during COVID-19, rather than academic outputs. As such, the first few outputs of the project were in the form of stakeholder reports. One of these was re-written and published as an academic paper and then adapted into Chapter Three (Lau et al. 2021a, Lau et al. 2021b, Mbaru 2021). Another was very similar to the work in Chapter Three but focused on the early impacts of the pandemic in Papua New Guinea and was also later published as a book chapter (Lau and Sutcliffe 2020a, Lau and Sutcliffe 2021). This work did not fit with the overall narrative of this thesis, which

primarily focuses on Kenya, and so it has been included as an appendix rather than a data chapter (**Appendix 1**). In Chapter Four, I draw on the HLPE Food Systems Framework to examine and compare the initial impact pathways of COVID-19 restrictions in Kenya, Papua New Guinea, and St. Lucia. In Chapter Five, I examine how people in Kenya responded to the restrictions and apply the Six Domains of Adaptive Capacity framework to determine the factors which facilitated or limited their responses. Finally, Chapter Six is based on the 3D wellbeing framework and examines changes in wellbeing as a result of the pandemic, and also the extent to which the communities have begun to recover after restrictions eased. Chapter Seven draws together the findings of my four data chapters to address the overarching aims and research questions.

Chapter Two: General methods

2.1 Preface

The data presented in this thesis was collected as part of two larger, ongoing projects. One project, for which I am a co-principal investigator, assessed the impacts of COVID-19 on coastal fishing communities in three countries. The other project examined the responses of fishers in coastal Kenya to various sources of social and environmental change: this was led by Associate Prof. Michele Barnes[4]. While I participated in the data collection for both projects, they were group efforts, and as such I will use "we" for the sections discussing data collection. With the exception of Chapter Three, which is based on a report and paper which I worked on but was led by my secondary advisor Dr. Jacqueline Lau, the analyses presented here are primarily my own work, so when discussing data analyses in the methods sections of Chapters Four, Five and Six, I will use "I".

2.2 Outline

Here I will outline what data I draw on for each chapter, briefly describe the study communities, and then present the general methods for how the survey and interview data was collected. I draw on three sources of data for this thesis: 1) semi-structured interviews conducted via mobile phone with fishers, fish traders and leaders in small scale fishing communities in Kenya (three rounds), Papua New Guinea and St. Lucia (one round each) during the first year of the COVID-19 pandemic; 2) short phone surveys with fishers in Kenya, also from three time points in the first year of the pandemic; and 3) surveys of Kenyan fishers conducted before and after the peak of the pandemic in 2016, 2019 and 2022 (**Fig. 8**). I will go into specific details about how the relevant data was analysed in the methods section of each chapter. I will describe the methods for the surveys during the pandemic and the surveys which were collected in 2016, 2019 and 2022 for the longitudinal research project led by Associate Prof. Michele Barnes in Kenya in the methods section of Chapter Six, as that is the only chapter which draws on that data.

[4] See the Statement of Contributions for further details

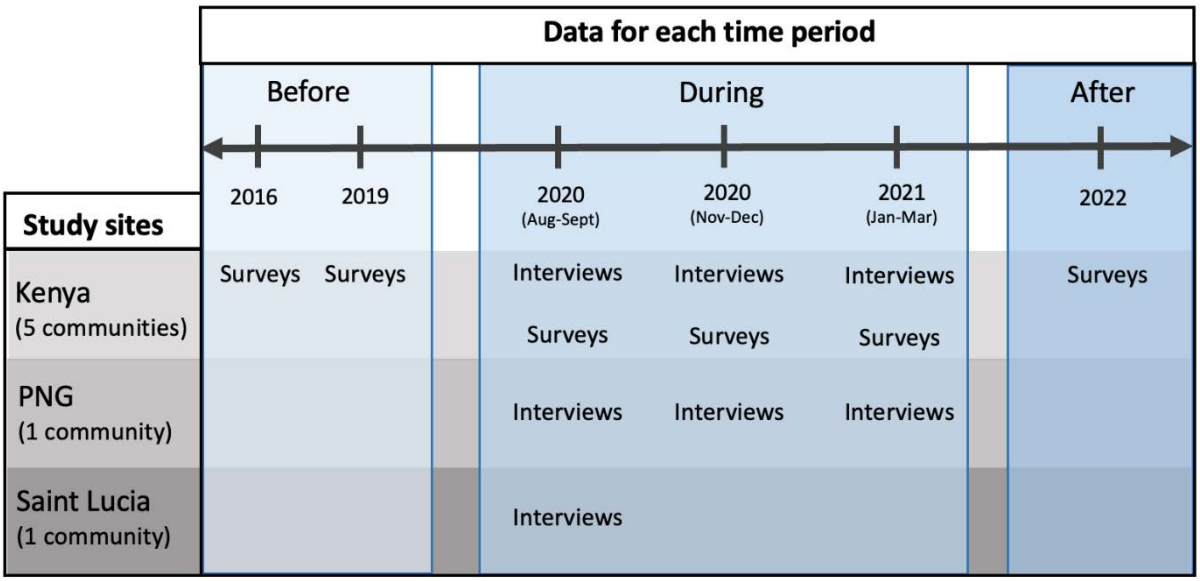

Figure 8. Data used from each site and time period

Each of the following chapters draws on a subset of this data (**Table 1**). Chapter Three, which is an overview of COVID-19 impacts in Kenya, is based on the first round of phone interviews conducted in five Kenyan communities in August-October of 2020. Chapter Four, which applies the Food Systems framework to studying the impacts of the pandemic, is based on interviews from one community each in Kenya, Papua New Guinea and Saint Lucia conducted in July-October 2020. Chapter Five applies the Six Domains of Adaptive Capacity framework to analyse the interviews from all three rounds during the first year of the pandemic in the five Kenyan communities (August- September 2020, November-December 2020 and January-March 2021). Finally, Chapter Six is based on the 3D Wellbeing framework and draws on the interviews and short surveys from all three rounds during the pandemic in the five Kenyan communities, as well as the surveys conducted before and after the pandemic.

Table 1. Data used for each chapter, including data type, location, and time periods

Chapter	Sites	Data	Time period(s)
Ch. 3	5 Kenyan communities	Interviews	First round during the pandemic
Ch. 4	1 community in Kenya, St. Lucia, and PNG	Interviews	First round during the pandemic
Ch. 5	5 Kenyan communities	Interviews	3 rounds during the pandemic
Ch. 6	5 Kenyan communities	Surveys	2 rounds before, 3 rounds during and 1 round after the pandemic
		Interviews	3 rounds during the pandemic

2.3 Site descriptions

During the first year of the pandemic, we conducted semi-structured interviews and short surveys via phone with 51 women and men living in seven coastal small-scale fishing communities in three of the major small-scale fishing regions of the world: the Western Indian Ocean (Kenya), the Pacific (PNG) and the Caribbean (St. Lucia) (**Fig. 9**). These three countries and the communities within them were selected a) because they share similar basic characteristics as small island or coastal, small-scale fisheries dependent communities, but are also geographically diverse and have various social, environmental and economic differences and levels of infrastructure, market connectivity and different governance structures, meaning they are both similar and different enough to be interesting comparative case studies; and b) because we had pre-existing research relationships with the communities. Specifically, my supervisors had been working in Ahus Island, PNG for 17 years and the five Kenyan communities for five years. Dr. Wade had five years of experience working in St Lucia, and I had visited Ahus Island twice for fieldwork and conducted a pilot study there for my research project which was prevented due to the pandemic. This meant that between us we had extensive connections with local partner organisations who could act as facilitators; relevant baseline data; experienced local research assistants; experience and familiarity with people and communities we would not be able to interact with or speak to in person during the data collection phase; and contact information for potential participants; all of which made it possible for us to conduct remote research on short notice. By working in communities where we have ongoing relationships and by partnering directly with local organisations who regularly work with the participating communities, we were able to mitigate some of the ethical issues associated with extractive "parachute science", in that regular return visits allow us to communicate findings directly with community members and we were able to ensure findings were shared with people in positions to effectively utilise it on the ground (Stefanoudis et al. 2021). I also consulted with other colleagues who were conducting research during the pandemic regarding guiding principles and practical strategies for conducting ethical and effective remote research during the planning and research design phase, in an effort to avoid harm and facilitate some benefit to the participating communities (McDougall et al. 2020).

We conducted three rounds of interviews in July-October 2020, November-December 2020 and January-March 2021 in Kenya and PNG, and one round of interviews in August-September 2020 in St. Lucia. All the communities share a high dependence on small-scale fisheries for food and income, with varying levels of engagement in other livelihood activities and different levels of connectivity to external food import and fish export markets. The three countries were all subject to a wide range of COVID-19 restrictions in the first year of the pandemic, ranging from social distancing requirements to full curfews and lockdowns (**Table 2**) (Ministry of Health 2020a, PNG National Department of Health

and World Health Organization 2020, Saint Lucia Ministry of Health 2020, Kenyan Ministry of Health 2021).

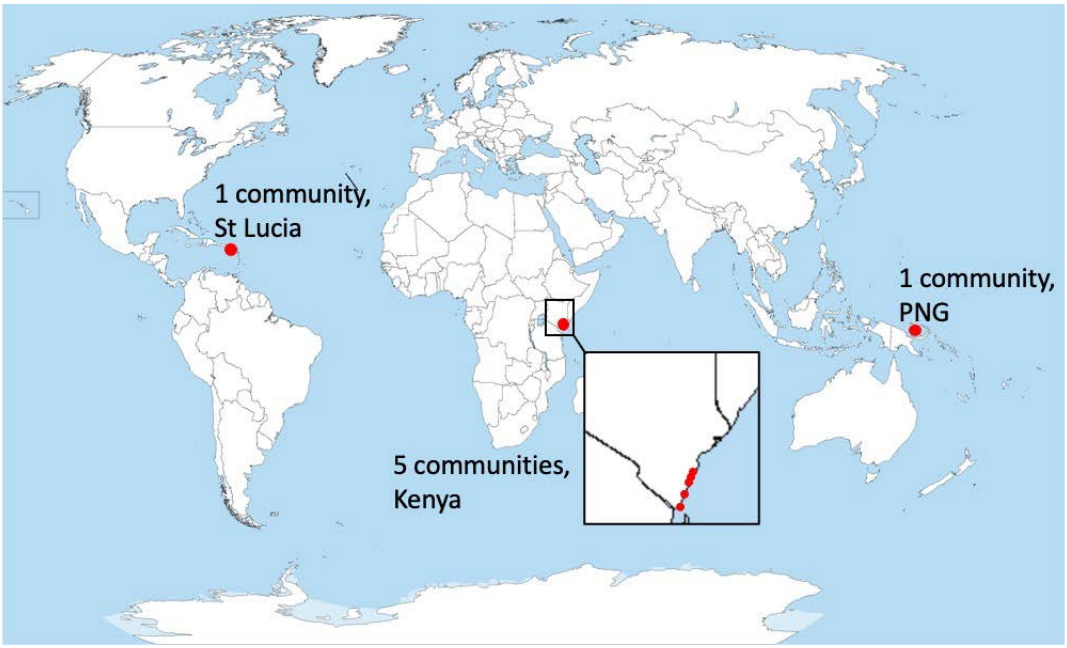

Figure 9. World map showing study sites. Insert shows the south coast of Kenya with the five study sites from A to E going from north to south.

Table 2. Summary of key COVID-19 containment policies in study countries

Containment policy	Kenya	PNG	St. Lucia
Curfews	■	■	■
Limited people in boats and vehicles	■	■	■
Social distancing in markets and food stores	■	■	
Other social distancing rules	■	■	■
Reduced market and food store opening hours/days	■	■	
Full market closures		■	
Mandatory mask wearing	■		■
Group gatherings banned	■	■	
Gleaning in groups banned	■		
Lockdowns			■
Travel restrictions (inc. to other communities or counties. All international borders closed)	■	■	
Selling betelnut banned [5]		■	
Instructed to limit market purchases		■	

[5] Important income source in PNG, particularly for women

2.3.1 Five Kenyan communities

We conducted interviews in five coastal communities in southern Kenya, defined by the boundaries of local Beach Management Units, which govern local fishing practices. Three of the communities are just north of the city of Mombasa in Kilifi County, and two are south of Mombasa in Kwale County. All five communities are highly dependent on fisheries for food and income. Fish catch is either consumed by fishers and their families, sold to female fish traders (known as Mama Karangas) for local distribution, sold to traders who take the fish to markets in Mombasa where it fetches higher city prices, or sold to hotels for tourist consumption. Each of the communities—anonymized as community A, B, C, D and E[6]— are similar, but with some differences in fishing activities and other livelihoods, connections to markets, and levels of reliance on tourism and informal work (**Table 3**). These sites were selected both to capture this diversity, and because we had existing long-term connections that enabled us to successfully undertake mobile phone data collection. In response to COVID-19, in June 2020 the Kenyan government put in place several measures to stem the spread of COVID-19, including school closures, curfews, and limits on social gatherings, transportation, movement, and permitted business activities. Restrictions were strictly enforced by police. Kilifi, Mombasa and Kwale Counties had some of the highest case rates in the country during the first wave of the pandemic, and as such were subject to more stringent restrictions than elsewhere in Kenya, including the implementation of county border closures (Ministry of Health 2020a). These restrictions effectively meant that the study communities were cut off from the closest major markets in Mombasa where a large proportion of their fish catch is sold, resulting in reduced prices and sales (Lau et al. 2021b). Coastal areas around Mombasa were greatly affected by a reduction in tourism, which lead to a loss of industry jobs and reduced demand for fish from hotels (Lau et al. 2021b). Curfew hours, social distancing requirements and movement restrictions all disrupted fishing and marketing activities. Overall economic decline in the region reduced demand and lowered prices for fish, resulting in reduced income for fishers and fish traders.

[6] The communities in Ch. 4 are named, including the Kenyan community Mkwiro. The five Kenyan communities are anonymised in the other chapters to protect participant confidentiality, as some of the responses are potentially sensitive.

Table 3. Summary description of five Kenyan communities

	Community A	Community B	Community C	Community D	Community E
Description	Rural, sparsely populated coastal area in Kilifi County with several dispersed sub-villages which use the same fishing grounds. Some fishing grounds and one of six landing sites are shared with community B.	Small, fisheries dependent coastal village in Kilifi County. Shares some fishing grounds with fishers from community A.	Fisheries-dependent coastal village in Kilifi County. Landing site on a protected lagoon with fringing reefs.	Coastal village in Kwale county. Most households are involved in fishing or post-harvest work.	Small fishing village on a coastal island in Kwale county. Close to a marine park with extensive reefs, mangrove areas and seagrass beds and high biodiversity.
Fisheries	Primarily subsistence fishing using low-capital traditional fishing practices and small boats, generally close to shore.	Primarily reef and seagrass fisheries with limited capital investment (no boats or canoes, go out on foot). Frequent use of banned spearguns.	Primarily reef and seagrass fisheries. Labour intensive fishing practices with limited, basic, family-owned equipment and boats.	Customary restrictions on the use of destructive gears. Primarily shallow inshore and reef fishing using traditional gears owned by fishers or co-workers.	Many women are octopus fishers. Higher level of capital investment (e.g., boats and canoes). Fish are sold to traders on the mainland for distribution.
Alternative livelihoods	Relatively diverse livelihood opportunities inc. tourism, construction, industry, and farming.	Fishing is supplemented by small-scale businesses and subsistence agriculture. Most women engage in post-harvest work (e.g., as Mama Karangas/ women fish traders).	Fishing is supplemented by informal economic activities (e.g., casual labour, selling snack foods on the side of the road). Some seasonal subsistence agriculture (dependent on rainfall).	Fishing is supplemented by stone mining, limited tourism, and seasonal agriculture (dependent on rainfall).	Strong tourism industry associated with marine reserve, important source of employment (esp. for youth). Little arable land to support agriculture.

2.3.2 Dennery, St. Lucia

Dennery Village is a fishing community located on the island of St. Lucia, in the Eastern Caribbean. As of the 2010 census, Dennery had an estimated population of 2700 people across 955 households (Central Statistical Office of Saint Lucia 2011). The primary livelihood activities in the community are tourism, fishing, and agriculture. Most fishers are members of the Dennery Fishing Co-operative, which acts as a central point for purchasing gear and selling fish, as well as providing services to fishers such as training and financing options. Catch landed at the Dennery Fishing Co-operative is sold locally to community members, wholesale to hotels and restaurants across the island, and to traders for export to the United States and other Caribbean Islands. St. Lucia is highly dependent on imported foods (Simoes and Hidalgo 2011). Households will often travel to two of the island's main towns once a month (Vieux Fort, 32.2 km away and Castries, 24.6 km away) to purchase a monthly supply of food supplemented by small shops located in the village. The national government closed borders, established curfews and physical distancing requirements, and restricted non-essential services, movement, and gatherings in late March of 2020 (Office of the Prime Minister of Saint Lucia). Curfew hours were reduced and limited social activities were permitted by mid-June (Saint Lucia Ministry of Health 2020a). At the time of interviews (August 2020) there were 26 cases of COVID-19 in St. Lucia (Saint Lucia Ministry of Health 2020b).

2.3.3 Ahus Island, Papua New Guinea

Ahus is a small island in Manus Province of Papua New Guinea (PNG) with a community of approximately 940 people in 160 households. The community is almost entirely dependent on marine resources for food and income. In 2018, 90% of households participated in fishing, gleaning, or marketing marine products. The island has little arable land and, therefore, limited capacity for agricultural production beyond small household vegetable gardens and fruit trees. The community is normally able to obtain "garden food" (fresh fruit, vegetables, and sago) when people from mainland Manus bring supplies to the island market (typically held three times per week prior to COVID-19). The main market for selling fish outside of the community is in Lorengau, the provincial capital of Manus Island, as well as shops selling imported "store food" (rice, flour, etc.), fuel for boats, and financial and health services. Restrictions were developed at the national and provincial government level. However, individual community leaders, in consultation with local government representatives, had significant agency in enforcing restrictions and deciding which non-mandatory recommendations they would implement and were able to undertake additional measures as they saw fit. At the time of the first round of interviews (July–August 2020), there were no cases of COVID-19 in Manus Province.

2.4 Interview data collection

We conducted interviews with five to six fishers or local fish traders and a community leader[7] in one small-scale fishing community in Papua New Guinea (PNG) (f=3, m=3+leader), five communities in Kenya (f=3, m= 3+leader/community), and one in St. Lucia (f=1, m=5)[8]. We conducted three rounds of interviews in the Kenyan and PNG communities, but only one in St. Lucia due to logistical challenges associated with the pandemic. The same participants were interviewed in each round so we were able to track changes in their experiences and responses through time. We also conducted one-off interviews with five male fish traders in Kenya who buy fish in the communities and transport them to sell in Mombasa markets. Interviews were conducted via mobile phone as in-person fieldwork was not possible during the pandemic. The interviewers in Kenya and PNG had previously worked in those communities and therefore had an established rapport with participants, which helped to facilitate the remote interviews. The first round of interviews took place in August-October of 2020[9], the second from November-December 2020, and the third from January-March 2021.

Drawing on sociodemographic information from the authors' previous research in PNG and Kenya (Barnes 2018, Barnes et al. 2020), participants were purposefully selected across a range of genders, ages, clans/ethnic groups, family sizes, and livelihood activities (see **Appendix 6** for demographic summary), as well as whether they had previously indicated willingness to participate in future research. The previous research in Kenya had primarily targeted male fishers, so in some cases we recruited female family members of previous research participants to ensure women were represented. Participants in St. Lucia were purposely recruited through a key informant at the Dennery Fishing Co-Operative. Some selected participants did not have their own mobile phone but were able to borrow one from relatives or neighbours, meaning that participation was not limited by whether they could afford a phone. In the Kenyan communities, aside from three women in Community E who were octopus fishers, all women interviewed were local female fish traders (Mama Karangas), and all men were fishers. In the PNG and St. Lucia communities both the women and men were fishers. Participants were chosen to represent different age groups (under 30, 30-45, over 45) (**Appendix 6**).

[7] All community leaders interviewed were men

[8] We aimed to achieve a gender balance in the interviews, however official community leaders in Kenya are generally men, meaning we interviewed a total of four men and three women in each community by default. Due to a lack of previous connections with women in St. Lucia we struggled to obtain their contact information and recruit them remotely and were thus unsuccessful in achieving a gender balance in that community.

[9] Interviews took place from July-August in PNG, in August in St. Lucia and in Kenya from August-October 2020

We focused on these different characteristics in order to capture diverse perspectives on the pandemic. First, age has been associated with differential ability to adapt to changes (e.g., because of differences in accumulated assets and knowledge (Lawson et al. 2020)). Older and younger fishers and traders in different locations may fish differently and hold different alternative livelihoods. Second, the experiences of female fish traders are likely very different to that of others in the community; gender has been shown to shape people's adaptive capacity to shocks (Ngigi et al. 2017, Rao et al. 2019b). Female fish traders tend to sell lower quality fish, buy directly from fishers and have specific locations that they sell from and customers they sell to, and thus be particularly vulnerable to market changes (Fröcklin et al. 2013). Interviews with fish traders enabled us to ask specifically about disruptions and disconnections to larger markets that individual fishers and female fish traders did not experience directly. Finally, interviews with community leaders allowed us to ask about changes and coping mechanisms at a community scale, which we then triangulated with findings from individual interviews.

Potential participants were initially contacted to provide them with information about the research and invite them to participate. If they consented to be interviewed, interviewers arranged to call back at a time convenient to them for the full interview. On the second call, interviewees were again given the opportunity to ask questions before verbally confirming consent to continue. Interviewees were compensated for their time at the rates established for previous in-person interviews and surveys conducted in the community (5PGK/interview in PNG, 4XCD/interview in St. Lucia, 350KES/interview in Kenya).

Interviews were arranged at a convenient time for participants and were conducted in the most commonly used local language (Swahili in Kenya, Tok Pisin in PNG, and English in St. Lucia) by trained local research assistants. Interviews lasted between 30 minutes to one-hour. The interviewers recorded, transcribed, and translated interviews to English. Translations were cross-checked by other members of the research team fluent in the relevant language.

Our qualitative questions aimed to elicit detailed descriptions of individual and household's experiences around the pre-identified themes of impacts to livelihoods (particularly fishing), markets, food security, and wellbeing, and other impacts (see **Appendices 2-4** for interview questions). Interviews with women and men from the community, both fishers and local fish traders, included questions at a household level. Interviews with community leaders focused on the same questions at a community-scale, to gain a broad sense of whether the impacts and outcomes described by individual households were observed at a broader scale. Interviews with male traders had a more explicit focus on how connections to broader markets beyond the community were disrupted. The

interview questions were piloted with four other fishers from Mkwiro, Kenya, and two people from a mainland community adjacent to Ahus Island in PNG, and then adjusted for clarity to ensure they were fit for purpose.

In the first round of interviews, we asked participants to describe their experiences since the onset of the COVID-19 pandemic; particularly how containment policies had impacted fishing, fish marketing, physical and economic access to food, food decision making and consumption patterns, and how they responded to these changes. We also asked specific questions about changes to livelihoods and wellbeing. To ensure the information provided about what restrictions were in place at different times was accurate, and that the casual links we inferred from interviews were robust, we cross-checked between interviews, key informants, local research assistants and against policy and other government documentation when able. Interviews were semi-structured: interviewers particularly prompted participants to explain how and why the changes they described occurred to elicit information about the relationships between different impacts. In subsequent rounds of interviews, participants were asked the same questions but in relation to changes since the previous interview. Interviewers reviewed previous interviews with each participant before calling and asked some specific follow-up questions based on previous responses as appropriate (for example asking about progress on changes participants previously stated they planned to make if they did not bring them up independently).

Interviews were analysed in NVivo using a combination of inductive and deductive coding based on the themes of each of the theoretical frameworks. The specifics of this analysis will be detailed in the relevant chapters. The general methodology of inference from a limited number of semi-structured qualitative interviews is particularly appropriate when looking at distinct, context specific cases, as it can facilitate the nuanced exploration of people's behaviour and motivations within their individual contexts without the constraints imposed by pre-defined survey tools, and prioritises individuals' perspectives on their own experiences (Denzin 2005, Bercht 2021). It is ideally suited for situations where there is a need to delve into complex situations in a timely manner, but where there are constraints on data collection which prevent larger-scale quantitative approaches (Cox 2019), as was the case during the pandemic.

2.5 Human ethics approval

We developed an ethical remote research protocol and trained our interviewers in sensitive elicitation techniques, with specific attention to discussing potentially distressing topics related to the pandemic, for example food insecurity and virus mortality (**Appendix 7**). Data has been anonymised and securely

stored. Research protocols for the surveys and interviews during COVID-19 were approved by the Human Ethics Committee at James Cook University (H8109) and Oregon State University (IRB-2020-0678). The research protocols for the surveys of Kenyan fishers conducted in 2016, 2019 and 2020 were approved by the James Cook University Human Ethics Committee (H8109 and H7603) (Methods described in Chapter Six).

Chapter Three: COVID-19 impacts on coastal communities in Kenya[10,11]

3.1 Abstract

Even after case numbers have dropped and restrictions have lifted, COVID-19 continues to have far-reaching impacts around the world, including on small-scale fishing communities. This study details the findings from 39 in-depth interviews with community members, community leaders, and fish traders in five communities in Kenya about their experiences since the beginning of the COVID-19 pandemic in March 2020. The interviews were conducted by mobile phone between late August and early October 2020. In each community, people were greatly impacted by curfews, rules about gathering, closed travel routes, and bans on certain activities. Fish trade and fisheries livelihoods were greatly disrupted. Respondents from all communities emphasized how COVID-19 had disrupted relationships between fishers, traders, and customers, changed market demand, and ultimately made fishing and fish trading livelihoods very difficult to sustain. While COVID-19 impacted different groups in the communities—i.e., fishers, female fish traders, and male fish traders—all experienced a loss of income and livelihoods, reduced cash flow, declining food security, and impacts on wellbeing. As such, although small-scale fisheries can act as a crucial safety net in times of stress, the extent of COVID-19 disruptions to alternative and informal livelihoods stemmed cash flow across communities and meant that fishing was unable to fulfil a safety net function as it may have done during past disruptions. In the event of future pandemics or other shocks, it is essential to ensure policies and protocols support continued fishing or diversification into other informal livelihoods, and that ongoing COVID-19 recovery support reaches the most vulnerable. This will be critical in safeguarding the wellbeing of families in these coastal communities.

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[10] Adapted from Lau, J., **Sutcliffe, S.,** Barnes, M., Mbaru, E., Muly, I., Muthiga, N., ... & Cinner, J. E.., 2021. COVID-19 impacts on coastal communities in Kenya. *Marine policy*, *134*, 104803.

[11] **Contributions** JDL was the lead author for the report (Lau et al. 2021a) and subsequent journal article (Lau et al. 2021b) this chapter is adapted from. We jointly conceptualised the report and paper, developed the interview guide, oversaw data collection, analysed the data, and developed the report which the paper and this chapter is based on. JDL wrote the initial draft of the paper adapted from the report, with significant advice on structuring from JEC, which I reviewed and edited. JEC, MB, EM, IM, SW, and NM provided advice on conceptualisation, data collection and analysis and reviewed and edited the paper. Data collection was conducted by SW and IM with logistical support from EM and NM. I use "we" throughout to reflect the collaborative nature of this chapter.

3.2 Introduction

The novel coronavirus (COVID-19) has had major impacts on society. As of July 27th 2021, there had been 195 million cases with almost 4.2 million associated deaths (Worldometer 2021). Additionally, restrictions on human movements to curb the spread of the disease (e.g., lockdowns, curfews) affected global food systems and employment (Aura et al. 2020, Okyere et al. 2020).

Fisheries are a major source of employment and food security for millions of people globally, and they were particularly at risk from the pandemic. Small-scale fisheries are often highly communal, requiring close proximity to harvest, sell, and process fish. Poor sanitation and unenforced social distancing at landing sites can make them a hotspot for contamination (Okyere et al. 2020). Fish are also one of the world's most traded commodities, which means fisheries market chains—and the livelihoods and food security they support—are highly vulnerable to the types of trade and movement restrictions that were implemented under COVID-19 (Knight et al. 2020, Bassett et al. 2021). Yet, we are only just beginning to understand how COVID-19, and the policies and measures put in place to contain the pandemic, have affected fisheries-dependent communities.

As of July 2021, a handful of studies had begun reporting on how COVID-19 reduced the food security of fisheries-dependent communities (Jomitol et al. 2020, Steenbergen et al. 2020b, Manlosa et al. 2021). For example, in parts of Vanuatu, COVID-19 restrictions reduced food availability (Steenbergen et al. 2020b). In Sabah, Malaysia, market disruptions and reduced income made food less accessible; fishers reported being unable to afford basic foods like rice (Jomitol et al. 2020). Studies are also beginning to examine how COVID-19 impacted different dimensions of wellbeing—material, subjective and relational—which form a crucial part of the broader social values of small-scale fisheries (Johnson et al. 2018). For instance, in Vanuatu, COVID-19 impacted people's relational wellbeing by affecting day-to-day relationships people value and rely upon (Steenbergen et al. 2020b). Several studies have also examined some of the mechanisms through which wellbeing and food security have been affected, primarily focused on changing livelihoods, market disruptions, and a lack of external support (Coll et al. 2021, Sunny et al. 2021, White et al. 2021). Others have charted how different actors drew on aspects of adaptive capacity to adapt or cope with shocks (Bassett et al. 2021).

Here, we contribute to this body of emerging empirical literature by examining the impacts of COVID-19 on markets and livelihoods, associated response strategies, and broader impacts on wellbeing and food security in five coastal communities in coastal Kenya, which rely on fisheries and fish trade for their livelihoods.

3.3 Background and methods[12]

As of July 27th, 2021, Kenya had 197, 959 cases of COVID-19. In June 2020, the government put in place a number of measures to stem the spread of COVID-19, including curfews and limits on social gatherings, transport, movement, and permitted business activities. Coastal areas around Mombasa were greatly affected by a drop in tourism, risking a poverty and hunger crisis among poorly paid workers (UN News 2020). To understand the impacts of these measures in our study communities, we conducted a series of in-depth interviews with 15 women (12 female fish traders, three female fishers) and 15 male fishers of various ages, four male fish traders, and five community leaders (see Chapter Two for details of how we selected participants and conducted interviews and Appendices 1-3 for interview questions). Specifically, we asked about impacts to livelihoods, markets, food security, and wellbeing (which encompassed subjective, material, and relational wellbeing). We content-organised these themes into disruptions to livelihoods and markets, associated coping strategies, and overall outcomes on food and nutrition security and wellbeing.

We focused specifically on the outcomes of COVID-19 disruptions on food and nutrition security and wellbeing, as holistic and interrelated indicators. Food and nutrition security 'exists when all people at all times have physical, social and economic access to food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life' (Committee on World Food Security 2012). The FAO predicted that in 2020, between 83 and 132 million more people were undernourished globally as a consequence of COVID-19 (FAO et al. 2020). In Kenya, a rapid assessment of the impacts of COVID-19 on rural farmers found that two-thirds had suffered losses of food security and income, and that both those who were income-poor and those more dependent on income from labour were worse off (Kansiime et al. 2021). Before the pandemic, 1.3 million people across Kenya were already facing crisis levels of food insecurity (USAID 2020). The second outcome focus was on wellbeing. Wellbeing is multidimensional, encompassing three interconnected dimensions: material, subjective and relational. Broadly, multidimensional wellbeing encompasses what a person has (material), how they are able to use what they have, including through fulfilling social relationships (relational), and the level of satisfaction or quality of life derived from what a person has and can do (subjective) (McGregor 2007, McGregor and Pouw 2017).

We note that these outcomes are not mutually exclusive. For instance, food security is directly connected to material wellbeing. Thus, we use these outcomes as a heuristic for exploring key

[12] See Chapter Two for a description of the methods we used to conduct the interviews discussed here.

patterns, rather than as completely conceptually distinct concepts. In the following sections, we therefore present all results on food and nutrition security under that heading, and not as part of material wellbeing, though the two issues are clearly interconnected.

3.4 Results

3.4.1 Measures to stem COVID-19

The first case of COVID-19 was reported in Kenya on 12th March 2020. By 15th March 2021, the total number of confirmed cases had reached 113,967+ (Kenyan Ministry of Health 2021). Throughout March and early April 2020, the Kenyan government instituted measures to reduce the spread of the virus and minimize causalities. These included cessation of movement in and out of cities**,** such as the capital city of Nairobi, and the three coastal counties of Mombasa, Kwale, and Kilifi, which had the highest case rates and where most fishing activities occur. Other key measures included dusk to dawn curfews, closure of areas of mass gathering such as schools and places of worship, social distancing, wearing of face masks, and restricting international travel. These measures—especially curfews, social distancing, and the cessation of movement to cities that act as primary fish markets—affected fishing trips and duration, disrupted the fish value chain, and affected the livelihoods of fishers.

3.4.1.1 Government and other support

To cushion vulnerable communities, such as those involved in fishing and fish processing, the government of Kenya prioritized the provision of direct financial assistance (e.g., some counties like Kilifi distributed cash stipends via mobile funds transfer), relief food, and tax relief. Respondents across the five communities we studied articulated different experiences in receiving aid and support, and also regarding communication about its distribution. Three respondents in Community E, including one trader, described receiving a small portion of aid in the form of food. A community leader in Community B was involved in organizing donations from other community organizations (e.g., Community B Beach Residents Association) to deliver a once-off food aid package to fishers that included maize flour, beans, sugar, and soap for fishers, and mentioned that fishers in Community A had received similar support from the Community A Beach Residents associations. In contrast, a small number of respondents from other communities articulated delays, confusion, or absence of support. For instance, several respondents mentioned that while they had heard talk of government or other support, they had not received aid, even after registering. One woman from Community A said, “we had been told there were donations like foods that were to be brought [here]. I think it was brought, but… but we never got relief food” (Woman, age 46). In Community C, respondents explained that there was some government support in the form of payment, but that only some in the community received it; one woman explained that her family “were registered to get aid but we have not seen

any assistance" (Woman, age 29). Others were confused about how and who to register with. Two respondents expressed concern about how aid was distributed. One community leader described how:

> "The government also selected the weak fishers and helped them, and the strong fishers were left out. They also selected one fisher in each household to get the support hence some fishers did not get the aid and that becomes a big problem" (Man, community leader, age unknown).

3.4.2 COVID-19 disruptions to livelihoods and markets

Table 4. Disruptions to livelihoods and markets. Summary of general disruptions to livelihoods and markets and disruptions and responses specific to different livelihood groups within communities.

	Disruptions	**Responses**
General	Income and cash shortages Lack and loss of jobs Lack of capital to start new livelihood activities Difficulties in communication/ organization Social distancing and movement restrictions disrupted market interactions Curfew rules disrupted trading and fishing hours	Used savings and sold assets Fishers/ traders stopped negotiating prices of fish, simply sold to avoid waste Some respondents looked for alternatives to supplement income (tailoring, general manual labour, mining etc) Supplemented purchases with food from home gardens if possible
Fishers and fishing	Unable to fish at night because of curfew Influx of fishers to cope with collapse of informal livelihoods (Communities B, C, D) Unable to travel to fish because of movement restrictions Unable to sell to traders Demand for high value species decreased because of closure of hotels	Started hawking fish directly in community Some started processing fish so they wouldn't spoil Switched to fishing for locally desirable species Some fishers changed tactics (e.g., shift to net from spear fishing, or fishing illegally at night) Accepted lower prices

Female fish traders	Ban on selling cooked food (at outset of lockdown) disrupted female fish traders' businesses Decrease in supply of fish at landing sites, Decrease in customers Curfew reduced selling hours Buying/selling less fish Decrease in profit from fish trading business (lower price)	Buying fish from shops (alongside or instead of from fishers) Hawking fish door to door Changed marketing practices from single stall, open until late at night, to selling from home or door to door Some raised prices to compensate for buying fish at higher prices Accepted lower prices
Traders	Unable to access larger markets (e.g., Mombasa) Curfew reduced selling hours Buying/selling less fish Price reductions, lack of circulating money reduced demand for fish	Fish that normally be sold at "fresh" prices in the evenings sold at reduced prices next day Sold fish locally (instead of at bigger markets) for lower prices Accepted lower prices

Lack of cash, curfews, and limits on gathering and mobility disrupted the transfer of fish through the value chain in ways that impacted fishers and fish traders (both women and men). Across all communities, almost all respondents designated loss of livelihood and income as the worst impact of COVID-19 and emphasized it as an ongoing challenge (**Table 4**), regardless of age or gender. Specifically, all respondents described how the loss of jobs and cash flow more broadly had changed demand for fish and rendered fishing and trading livelihoods very precarious. Specifically, whole industries closed, hotels had no visitors because of international and internal movement bans, and cement and industrial work could not continue because of social-distancing requirements and likely a lack of customers. These disruptions led to income and cash shortages in all five communities, and were particularly disruptive in Community A, Community B and Community C, where a large number of industries and hotels provided wage labour for workers from both within and outside the community. One trader explained:

> "Many people do casual jobs, and they are the majority who buy fish, but they were not working. You know there are women who depend on going somewhere to wash clothes and get income so that they can at least buy fish and taste it, but they didn't have money. When you got fish there were no buyers as there was no money." (Man, fish trader, age unknown).

Reduced cash in the community led to decreased demand for fish, which created feedbacks that decreased supply when fishers were unable to sell fish.

COVID-19 greatly disrupted local market dynamics at landing sites, within communities, and beyond. Specifically, limits to gathering combined with limited time to trade (because of the curfew), meant that normal face-to-face negotiations were nearly impossible and existing customer-trader and fisher-trader relationships could not be sustained. Timely and direct negotiations about the price and on-sale of fish are particularly important because if not sold quickly, or if left to sit in the heat of day, fish will spoil and lose value. One community leader explained how:

> "And social distance rules also affected us to some extent because at the landing site, when fish are coming there are normally many types of traders like Mama Karanga[13]. They come in big numbers and even other traders also come in big numbers. Now people were forced to use their network. You call someone to come and again call another one and sometimes fish go bad" (Man, community leader, age unknown).

A fish trader emphasized the importance of face-to-face social negotiations in the market:

> "Normally in our place of work, we're used to socialising and mingling with people to negotiate and agree on price as in a normal market situation, you know. So, it's not possible with the rules in place especially when they are pinning people down it becomes very hard, because when fishermen come, they have no time to negotiate. Instead, they tell you to take fish for this price and go away" (Man, fish trader, age unknown).

Alongside a lack of cash in the community, the inability of fishers, traders, and customers to conduct market negotiations explains the variety of reports about the changed dynamics of landing sites, where fishers found fish hard to sell, and traders (both women and men) found fish hard to procure.

As we describe in the following section, these disruptions to livelihoods and markets impacted fishers, female fish traders, and male fish traders differently. Different groups coped differently and were differently constrained in the ways they could cope. However, across all communities, all groups experienced the same broad outcome of decreased food and nutrition security and decline in wellbeing (discussed in section 3.4.3). We found no distinct patterns between older and younger respondents, and few between communities (noting that we were not seeking to test differences between respondent characteristics, but rather gain a broad sense of experiences across a range of

[13] Female fish traders who produce and sell cooked fish in street stalls

identities within communities). We describe the experiences of each group in turn (**Table 4**), before describing these collective outcomes.

3.4.2.1 Fishers and fishing

For fishers that fish at night, or who travel to their fishing grounds, the curfew rules left only a short window to both catch and then sell fish. In Community B, two fishers and the community leader mentioned this as a problem. Ten fishers—including at least one from each community—mentioned the curfew as a major disruption and described being cautious about going out fishing or selling fish late because of a fear of not reaching home again before the curfew came into place. Fishers who were not close to their fishing and landing sites had difficulty physically getting there to fish.

> "You know we fishers; we get more catch at night. Now if the curfew rules have come and we want to go and fish at night, it becomes a problem. Sometimes we want to go early morning when it still darkness, but it was also a problem" (Man, Community leader, age unknown).

One woman explained how her husband had been unable to fish because of the curfew:

> "He used to get his livelihood in the ocean, but he could not go because they were stopped from going to the ocean. He could only go during the day and get very little catch because he normally fishes at night with other crews, but he could not go because of curfew" (Woman, age 38).

The closure of informal industries and lack of alternative livelihoods increased fishing pressure in some communities. Community leaders in Community C and Community D, and one fisher from Community A noted an increase in the number of people fishing in the community. In Community C, a community leader described how people who had been living away and pursuing fishing livelihoods in other communities returned home and began fishing there. In Community D, a community leader explained that "the number of fishers has increased and brought negative impacts, because people who had fishing experience but stopped fishing to get employment, after losing their jobs they all came back to do fishing" (Man, community leader, age unknown). In contrast, a community leader from Community B explained that "Sometimes there were more, as those who were doing other livelihoods started fishing, but due to high fish supply the fish traders didn't buy fish, [so the number of] fishers reduced." (Man, community leader, age unknown). In sum, the number of people fishing fluctuated across communities in line with the depressed market. The closure of hotels and the coastal tourism industry also decreased market demand for higher-priced fish. Fishers turned to selling their catch within villages, but there was less demand and ability to pay fish trader prices for products that were

previously only sold to hotels (e.g., rabbit fish and lobsters). One fisher explained that "You sell at a different price as people in the village don't know types of fish and when you sell at a high price, even if the fish is big, they will refuse to buy it" (Man, age 21). The female fishers in Community E described shifting from fishing to gleaning (one) or farming seaweed (one), or fishing with a smaller crew to comply with social distancing rules.

In response to changed market conditions and inability to organize effectively, some fishers started selling their own fish and processing them to make them last longer, which decreased their value. Two fishers from Community B and one from Community C described how they had illegally and secretly continued to go fishing at night, while another fisher from Community A described breaking movement restrictions to fish in better spots; "my fellow fishers who live there used to call to inform me when police were not around to go and fish. At least I was getting something for my children to eat" (Man, age 45).

To cope with changed markets, fishers and two female fish traders described hawking fish door to door in the community (four respondents from Community A, four from Community B, two from Community C, three from Community D). Another two fishers who were able to access a freezer left large fish there until they were able to be sold. Two fishers from Community B stopped fishing for higher value species that were previously sold to hotels (such as lobster) and turned to fishing species that are more popular with local consumers.

Other fishers described being limited in their ability to cope because of immobility caused by travel restrictions, and the collapse of other possible alternative livelihoods, such as work in factories or the tourist industry. Three respondents in Community E described seeking out casual work such as manual labour or selling processed foods (when available), while two respondents from Community C noted increased competition for the casual construction work that was still available.

In addition to COVID-19 restrictions, fishers in all communities were concurrently impacted by the southeast monsoon season (*Kusi*), when sea conditions are rough, fishing is difficult, and catch is usually low. COVID-19 restrictions on mobility and time when people could be out of their homes severely limited strategies for coping with decreased fish catch during *Kusi*—such as moving to find alternative sources of livelihoods, or access fishing opportunities elsewhere—creating a double burden. As one fisher explained:

> "Corona affected us greatly. Before corona I was capable of looking for livelihood in different places. For example, I used to go to Shimoni, Lamu and many coastal landing sites to go fishing. But when corona came… it was not easy to go to the ocean and fish, therefore I used to dodge

> [police] to at least go and fish and when I came back the catch was very small, and I had to look for someone to buy my fish. When I get traders, they complain that they don't have money. They even wanted to take fish and pay later but because I used to depend on the catch I got each day, I used to plead with them to at least take fish and give me some money even if it was a little" (Man, age 25).

3.4.2.2 Female fish traders

All female fish traders noted that they were impacted by COVID-19 disruptions. The curfew greatly reduced the time female fish traders had to both procure and sell fish. One woman explained that "Back when corona started and curfew time started at 7pm, you'd be forced to remove your display box because when the police find you, they pour out your fish and you lose everything" (Woman, age 42). Another emphasized that she "was not getting customers because the curfew time was barring customers to buy fish and jobs had been lost and people had no livelihood. Most companies had closed down" (Woman, age 29).

In addition, early in the state of emergency, selling cooked food was banned for a short time. As such, female fish traders—who commonly fry and sell fish in portions—were unable to continue to sell fish and struggled to maintain their businesses. When the state of emergency passed and female fish traders were able to continue operating, all female fish traders described both being unable to buy enough fish from fishers, and also struggling to sell the fish they had procured at a profit. One woman explained the need to connect early with fishermen, as supply and demand of fish became uncertain:

> "You have to tell fishermen please assist me to get fish so that I can go try my luck [selling it]. If you don't do that and there are many traders at the landing site, they'll give someone else and you come back without fish" (Woman, age 42)

Others experienced long queues at fish shops and difficulty buying fish directly from fishers at landing sites. In all communities, female fish traders were buying and selling less fish because of a combination of changed supply and demand, and thus making far less profit than before COVID-19. In Community B, one woman estimated her sales had decreased from 10-15kg to only 3-5kg, and all respondents mentioned that profit had decreased dramatically.

Female fish traders tried to cope with these livelihood shocks by using existing savings and loans where possible, until they had exhausted their savings. Three female fish traders from three different communities referred to this as "eating capital". One woman said, "we still continue with the business but it's very hard. We have been forced to eat capital" (Woman, age 38). To cope with the restrictions imposed by the curfew, some female fish traders started selling door to door, while others simply had to limit their selling time. In Community A, for instance, female fish traders changed marketing

practices from having single stalls set up until late at night, to selling from home or door to door and ending before curfew. However, two female fish traders also explained they were hesitant to leave their usual spot in case customers thought they'd given up selling fish; they considered consistent face-to-face interactions with customers and fishers as critical to continuing to maintain a presence and healthy business. Another female fish trader explained that she felt disadvantaged by others who, having lost other incomes, had turned to fish trading but were moving about selling fish, rather than staying in one spot.

To continue their business and cope with decreased supply of fish, female fish traders started buying fish from fish stores to supplement and sometimes replace fish bought directly from fishers. Almost all female fish traders explained that they had started buying from fish shops because they did not see any alternative. One female fish trader explained that even though "fish trading has little profit, like KES 200-300, we are used to fish trading and cannot leave doing it. If we don't get fish at the landing site, we go to the fish shop" (Woman, age 38).

3.4.2.3 Male fish traders

Traders (who were all men) who previously transported fish to bigger cities (e.g., Mombasa) were unable to move across closed borders between the three coastal counties of Mombasa, Kwale, and Kilifi. One trader explained that "everybody in coast region depends on Mombasa as economic hub. But now if all boundaries are closed, where do you pass through?" (Man, fish trader, age unknown). Many traders saw drastic drops in their customer base, were unable to access bigger markets (e.g., in Mombasa).

> "The market share changed because if you were trading with 100 people a day before corona, right now you only have 5 people a day. So, some fish vendors have stopped doing their business and disconnected storage equipment like freezers because you cannot leave your freezer on with only one kilo of fish" (Man, fish trader, age unknown).

Like female fish traders, male traders faced reduced selling time because of curfews. Fish that would normally be sold at "fresh" prices in the evenings sold at reduced prices the next day. One fish trader explained how:

> "The rules have also affected me and other traders because the time you expect customers to come and buy fish in the evening from 7pm onwards, that's the very time curfew is almost starting, and you're required to close the fish shop and go home. So, it affected me so much" (Man, fish trader, age unknown).

A community leader from Community B described how the closure of the hotel and tourism industry impacted local markets: “There was difficulty in getting market as the markets here had very few consumers. Like the fish traders of [Regional hub 1] and [Regional hub 2] locally depended on consumers from [Regional Hub 2] estate, [Regional Hub 2] ridge, [Regional Hub 2] and these places were all closed” (Man, community leader, age unknown, additions included for anonymity).

To cope with these disruptions, one trader had shifted to selling vegetables alongside fish. Others had attempted to sell fish locally. One trader explained, “when you get fish and because you can’t sell it outside, the little you get you have to look for ways to sell it locally” (Man, fish trader, age unknown). Finally, traders resorted to selling fish at reduced prices the following day, and some, when lacking cash, traded store goods for fish as payment to fishers.

3.4.3 Outcomes

The disruptions to markets and livelihoods described above led to a range of outcomes (**Table 5**) that were evident across the five communities and groups there-in.

Table 5 Summary of broad outcomes across food and nutrition security and multidimensional wellbeing Respondents across all communities and different livelihood types experienced a range of these outcomes.

Food and nutrition security
Reduced variety and quantity of food, reduced number of meals per day
Primarily consuming ugali, reduction in consumption of rice, fish, meat, vegetables and chapati
Purchasing smaller portions of food (unable to afford bulk)
Wellbeing
Material
Lack of income and money, loss of jobs
Unable to afford goods and services
Unable to complete building projects, long term advancement
Forced to borrow from neighbours, buy food on credit
Profit immediately goes towards food
Drawing on existing assets and savings
Relational
Unable to meet at landing sites, difficulty communicating
Unable to sit and talk with friends and family and provide mutual support in difficult times
Pressures of being the only breadwinner
Unable to participate in church/mosque/group prayer, weddings, funerals, sport
Feeling lonely and isolated

Subjective

Frustration at sensed lack of agency and inability to progress projects to support the household

Unhappiness at failure of business and future uncertainty

Worry about children at home, not attending school

Sense of hopelessness

Fear about the virus or being punished for lack of compliance with rules

Describing situation as "suffering"

3.4.3.1 Food and nutrition security

The disruptions described above severely impacted food security across all five communities. All households reported a decrease in both the quality and quantity of food they consumed. Although foods were available in shops, all respondents mentioned that they could not afford the same quantities or variety of food because of reduced cash flow. One woman explained:

> "If you're not working, how do you eat? If you're not working, you cannot get food because it really affected us for sure. Because eating is a problem, we're not getting food properly. Where do we get food when people are not working?" (Woman, age 29)

All respondents reported that their dietary diversity decreased because they were unable to afford to eat a variety of foods: almost all were eating only corn meal (*ugali*), with some more affordable side dishes, such as sardines or amaranth leaves. For instance, one man explained that "Since corona started… there is no money you can eat *ugali* the whole month and I have even forgotten how rice tastes" (Man, age 30). A small number of respondents explicitly articulated the suffering caused by not eating a variety of foods. For instance, one man said, "But all these [foods] I am mentioning for you, I am even salivating because right now I am not getting such type of food" (Man, age 69). Several respondents emphasized how the insufficient quality and quantity of food was having health impacts. One man explained that:

> "[If] today you eat cassava, tomorrow ugali, the next day beans, and the following day rice, like that, yes, [your] stomach is used to that. But [if] today cassava, tomorrow cassava, and the following day cassava, it'll give you disease" (Man, age 69).

Finally, a small number of fishers emphasized that hunger was an ongoing problem and contributed to a lack of energy. For example, one man explained that "the most pressing [challenge] was to do with *daily bread* [said in English] because you cannot do anything if you have nothing in your stomach. That is what impacted us most" (Man, age 48). Two respondents described severe food insecurity,

whereby their household had gone for a whole day without eating anything. Some respondents tried to cope with and ameliorate food insecurity by supplementing food with household farming where possible. Almost all respondents had shifted to eating cheaper foods (such as sardines), budgeting almost all money towards food.

3.4.3.2 Wellbeing

The impacts of COVID-19 rules impacted all dimensions of the material, subjective and relational wellbeing of respondents. We describe the outcomes on wellbeing across each of the three dimensions.

3.4.3.2.1 Material Wellbeing

The direct outcome of disruptions to livelihoods and markets (section 3.4.2) was a marked decrease in material wellbeing. This decrease was described in some form by all participants, who had either a family member who had lost their job(s), or whose business has deteriorated. As one woman explained: "my husband is out of job, children are not going to school and my business is down" (Woman, age 45). Another fisher described how "Some people in my family used to do casual jobs in different places, but now all of them are at home. They were laid off because of corona." (Man, age 28), while a fish trader summarized the situation as: "The rules meant no jobs and a job is money" (Man, trader, age unknown). Respondents' attempts to cope with the disruptions to livelihoods (see section 3.4.2) meant that they used up savings (including money set aside for school fees in four cases), sold assets, and ended up spending the little money they made directly on food (or traded fish directly for food; see section 3.4.3.1). As such, across all five communities, fishers, female fish traders, and male fish traders all experienced uncertainty, precarity, and growing stress on their material wellbeing. Seven respondents described using up or "eating capital" to cope with the disruptions to their livelihoods, meaning that when restrictions do ease, they will have few reserves to draw on to invest in their businesses again.

The impact of COVID-19 on material wellbeing may be connected to the precarity of fishing-related livelihoods more broadly. For instance, one community leader emphasized that the impacts on material wellbeing were particularly acute for fishers and in fishing communities because of their direct dependence on fishing, which only provides a low income:

> "For sure corona is all over the world but there are some communities whose income has always been small for a long time. They are affected so much. Like we fishermen, we must go out [fishing] in order to eat… there are special people whose income is very small, they have been affected so much" (Man, community leader, age unknown)

2.4.3.2.2 Relational wellbeing

The disruptions to communication and connections with other fishers, traders, and customers, and to family and friends more broadly, impacted people's relational wellbeing. All respondents also expressed a decrease in relational wellbeing. While all of our respondents had access to a mobile phone, several described how communication became difficult when meeting in groups was banned: "Communication was difficult as we could not meet in groups and others have no mobile phones, so we could not talk to each other" (Man, age 24). One respondent expressed how the stress and struggle of the broader changes wrought by COVID-19 had been compounded because he was unable to talk to and find support from other friends as he normally would:

> "My life has drastically changed to the extent that I even don't know what to say. When I come back home, I feel confused in respect to how life is taking me. In short things are very tight… After fishing we used to meet with friends and talk about life issues but that has changed. When we see each other, everyone is struggling to earn something and there is no time to sit together. That has been a big change to me" (Man, age 30)

Another older fisher also described that "there are things you may want to enquire from someone, how to do them better, but you are not allowed to be in a sitting of three to four people, so you are forced to do things your way and this is difficult." (Man, age 48)

Relational wellbeing impacts extended beyond livelihood settings, as all respondents were also unable to attend churches or mosques and had shifted to praying at home. One man described these bans as "impossible and… terrible" (Man, age 45). Important social events, such as funerals and weddings, had a limit on the number of people who could attend. Respondents also described being unable to shake hands with and hug others, visit relatives, and more generally having to maintain a distance. One respondent had been forced to send his wife and children to live with relatives when he could not afford to support them, and this caused him great distress. Finally, the pressures of COVID-19 disruptions caused stress on household relationships for some families. One man explained, "because there was no food my wife was getting annoyed with me" (Man, age 45).

3.4.3.3 Subjective wellbeing

Over three quarters of respondents mentioned a sense of frustration and a sense of hopelessness at being unable to progress with projects to improve their household's lives (for example in three cases, continuing progress on building a house), grow and develop their businesses, and save money because any income went immediately to food. In particular, almost all female fish traders expressed a sense of hopelessness because they were unwilling to let their business or customer base collapse, and thus were running their business at very little or no profit, with a great deal of difficulty. One female fish

trader described how “Corona brought us down to the knees; we still don’t know what we shall do. We’re therefore praying for corona to go away” (Woman, age 46). Another emphasized that the deterioration of her fish trading business “killed [her] hope… [and she is] experiencing difficulties in life because [her] business is completely deteriorated” (Woman, age 38).

Together, this lack of agency affected respondent’s subjective wellbeing. One fisher said: “I don’t have any happiness completely in my life. I don’t know when all this will end” (Man, age 30). Indeed, at least one respondent from each community, including two community leaders, described their and their families’ situation as suffering. For instance, one man explained how, “this situation has really made me suffer. My family has really suffered as we can go so many days unable to wash clothes and even getting tea in the morning is difficult” (Man, age 30). 28 respondents mentioned that they, or someone within their household had lost some form of income, thus increasing pressure on those who were still able to bring in some form of income. More than half of our respondents in each community mentioned concern and difficulties that came from their children not being able to attend school, and nine respondents (one from Community A, two from Community E, four from Community D, and two from Community C) articulated worry about not being able to pay school fees when schools did reopen.

Finally, three respondents (from Community D and Community B) described a general fear of the virus, and also fear of being beaten or punished by police if found breaking COVID-19 rules. For instance, one fisher who fished outside curfew hours or in locations that weren’t approved to continue to have a fishing income, described how “we decided to use secret routes like caves so that we could not meet the police. When we were fishing, we ensured that when we heard a boat coming, we looked who they were, and we were fishing secretly but with fear” (Man, age 30).

3.5 Discussion

Early studies suggest that COVID-19 has been “a harbinger of massive and life altering changes” for small-scale fisheries (Bennett et al. 2020). Disruptions to the seafood system will continue to have far-reaching and direct impacts on livelihoods and food security (Knight et al. 2020). In coastal communities in Kenya, COVID-19 impacted food security and the connected dimensions of wellbeing. In particular, loss of income, lack of cash in the communities, and subsequent decline in food security combined to cause a decrease in material, subjective and relational wellbeing. Akin to inland fisheries in Kenya, continued food insecurity and lack of income may have impacted the health of fishing households, making them more vulnerable both to COVID-19 itself, and to the continued measures to contain it (Fiorella et al. 2021). Prolonged periods of subsisting on staple carbohydrates leads to

nutrient deficiencies, declines in health, work capacity and increased vulnerability to disease in short-term, and in the long-term, it can impact adult health and inhibit growth and development in children, reducing their future physical and cognitive capacity (Bloem et al. 2005a, Black et al. 2008). The impacts of COVID-19 on the subjective wellbeing of coastal communities are concerning. People were less able to access health services for other health problems aside from COVID-19 (Ahmed et al. 2020), and the mental health system is severely under resourced and unable to implement the recommended mental health guidelines (Jaguga and Kwobah 2020). Several respondents in our study spoke of confusion and lack of transparency around both government and other support. In other places a lack of support has caused some fishers to break COVID-19 rules (Manlosa et al. 2021, Sunny et al. 2021). However, many respondents in Kenya expressed that there was nothing that could be done except to wait for the pandemic to be over. Several emphasized the need to have faith.

We found that coastal communities in Kenya experienced livelihood losses and disruptions similar to those reported in inland fisheries in Kenya (Aura et al. 2020, Fiorella et al. 2021). In Kenya's inland fisheries, curfews and lockdowns influenced fishing and fish trade (Aura et al. 2020). In addition, restrictions on movement, and fear of contracting COVID-19 meant that small-scale fishing families had less access to fishing grounds and fished less (Fiorella et al. 2021). Similarly, in Bangladesh, lockdown restrictions meant that small-scale inland fishers and fish farmers were prohibited from working on their ponds and wetlands (Sunny et al. 2021).

Many of the key impacts to fisheries in Kenya and other places have been caused by disruptions to markets (e.g., insufficient gear supply, low demand resulting in unsold fish, increased commodity prices) (Bhat et al. 2020, Sunny et al. 2021). The fish traders we interviewed expressed concerns that the pandemic had disrupted their trade networks, which might have longer-term consequences, especially for more marginalised female fish traders. In other parts of Kenya, Aura et al. (2020) found inconsistent changes in price for key species in inland lake fisheries, with some locations reporting higher prices during COVID-19, and others (notably those with prolific aquaculture, which may glut the market) reporting lower prices. We did not estimate the price reduction at our sites, but in Malaysia fish sold to middlemen for 50-70% lower than before movement restrictions were implemented (Jomitol et al. 2020). In other fisheries, several studies reported dramatic declines in sales due to global market demand, as China banned many imports at the start of the pandemic (Knight et al. 2020, Smith et al. 2020, Sunny et al. 2021). For example, prawn prices in the Philippines dropped by as much as 50% due to a lack of exports (Manlosa et al. 2021). However, in our study, international demand is not a strong component of many reef fisheries (except for the export octopus fishery (Wamukota and McClanahan 2017) and reduced sales to hotels for international tourists). Similar to our findings in

Kenya, there were also reduced local demands reported in Bangladesh (Sunny et al. 2021) and in the Philippines (Manlosa et al. 2021) due to job and associated income losses. Consistent with our results, there were fewer middlemen operating and higher transportation costs and risks for fishers in Malaysia (Jomitol et al. 2020).

Rapid-onset crises like wars and pandemics can severely disrupt linked social-ecological systems (Stokes et al. 2020). In some instances, these disruptions may lead to increased pressure on natural resources, as people migrate to secure alternative food sources, shift labour to natural resource-based livelihoods due to unemployment, or lead to overexploitation due to limitations in management capacity (Stokes et al. 2020). In other instances, these may lead to an 'anthropause' where pressure on natural resources are reduced (Stokes et al. 2020). For example, in the Spanish Mediterranean, fishing effort, landings, and revenues were down by 34%, 49%, and 39% respectively during the COVID-19 pandemic (Coll et al. 2021). Likewise, in the United States, landings declined by ~40% during the COVID-19 pandemic (White et al. 2021), though this was not the case for all species (Smith et al. 2020). Our interviews revealed some increased fishing pressure on inshore fishing grounds in three communities, likely due to labour from the informal economy being attracted to the fishery as a result of COVID restrictions. However, this increased effort did not reportedly result in increased yield, probably because the Kenya fishery is already heavily overexploited (McClanahan 2019). Indeed, in line with our findings, preliminary evidence suggests conflicting reports on whether the COVID-19 pandemic has increased or decreased pressure on inland lake fisheries in East Africa (Aura et al. 2020, Stokes et al. 2020). For example, Aura et al. (2020) report that fish stocks in inland capture fisheries in Kenya benefited from reduced fishing pressure. However, our results are similar to those reported in Vanuatu, where two thirds of surveyed villages reported an increase in fishing effort, mostly inshore canoe fishing, diving, and gleaning (Steenbergen et al. 2020b). As with our sites in Kenya, this increase in effort in Vanuatu did not result in higher yields because most activity was from already overexploited reefs and was conducted by inexperienced fishers (including returned students and children, (Steenbergen et al. 2020b)). Our study relied on reported increases in effort; future studies could use remote sensing and fisheries yield data to triangulate these observations. Using remote sensing data to investigate changes in the area covered by fishing boats in harbor (instead of out to sea), Avtar et al. (2021) estimated that a quarter of the annual fish production was lost due to COVID-19 across three key harbors in India.

Fishers, fish traders, and coastal communities are facing severe livelihood and food security challenges in the face of COVID-19. In line with findings on food insecurity in other fishery-systems, our findings suggest that when public health rules—such as curfews and social distancing—disrupt fisheries

livelihoods, there is need to institute measures to support individuals and communities. Social capital and face-to-face interactions are critical for fish markets and fish value chains to function, especially for female fish traders who have smaller businesses, and a regular customer base. Fish spoils easily, and face-to-face transactions and quick sales help ensure that fish sold is fresh and thus less likely to be wasted. Thus, those who depend on fisheries livelihoods are particularly impacted when fish value chains are disrupted in places where digital or mobile communication and access to freezers or other means of storing and preserving fish are lacking, as in all the communities we interviewed and most coastal fishing communities in Kenya. Enhancing access to alternative ways of selling and storing fish when markets are disrupted may help buffer the impacts of shocks such as COVID-19.

More immediately, there is need to ensure that support reaches communities in a timely manner and that community members are well informed about how to access it, especially during extreme shocks like the state of emergency. Several interviewees mentioned confusion about forms of support and how to access them. In addition, treating small-scale fisheries as essential services (e.g., by permitting people to be exempt from curfew), and or facilitating ways of communicating and trading that do not involve large gatherings will help ameliorate some of the disruptions to fisheries livelihoods in the event of future pandemics (Bennett et al. 2020). Female fish traders—who are likely already more vulnerable within fish value chains (Fröcklin et al. 2013)—may need targeted support to access resources, such as financial loans (Pomeroy et al. 2020), to regenerate their fish trading businesses or to be able to explore and innovate in other sectors (Cohen et al. 2016). A number of female fish traders from all of our study sites explained that they had continued buying and selling fish, often at a loss, or barely breaking-even, because they did not want to lose customers, and had no other business to turn to.

More broadly, a critical focus needs to be placed on making small-scale fisheries more resilient (Cinner et al. 2018b). Financial institutions such as the World Bank have begun to develop insurance schemes for small-scale fisheries that protect them from future disruptions (Knight et al. 2020). For female fish traders specifically, and traders more broadly, access to short term business loans (Pomeroy et al. 2020) to restart and build their businesses will be critical to re-building household assets and overall wellbeing once COVID-19 restrictions and impacts start to dissipate. For many fisheries, market diversification may be key to buffering against border closures and other market shocks (Knight et al. 2020). In some cases, technology could help some fishers diversify into more affluent local markets through online purchasing (Manlosa et al. 2021). For example, in more affluent areas of Manila, Philippines, market demand for fish products remained strong and was aided by online purchase and delivery systems and weekly mobile markets (Manlosa et al. 2021). That said, the far-reaching impacts

of the COVID-19 pandemic in the coastal communities we studied effectively closed off many existing avenues, such as alternative livelihoods, that may have buffered livelihoods in the past, and access to mobile phones and online distribution systems is limited.

3.6 Conclusion

In the coming months and years, the COVID-19 pandemic will continue to reverberate across aspects of livelihoods, food and nutrition security, and ultimately human wellbeing, probably in unforeseen ways. COVID-19 will not be the last pandemic, or the only major disruption communities are likely to face in the near future. As the long-term effects of the pandemic continue to unfold and we look to an uncertain future under climate change, there is need to ensure that policies and protocols support or at least seek to accommodate continued fishing, trading businesses and diversification into other informal livelihoods. In addition, ensuring that schemes such as small loans and financial aid reach the most vulnerable will be critical in ensuring that coastal communities and households are able to safeguard and rebuild their wellbeing and adaptive capacity now, and in the face of future shocks.

Chapter Four: COVID-19 impacts on food systems in fisheries-dependent island communities[14,15]

4.1 Abstract

Policies designed to contain the COVID-19 pandemic have impacted food systems worldwide. How impacts played out in local food systems, and how these affected the lived experiences of different people is only just coming to light. I conducted a structured analysis of the impacts of COVID-19 containment policies on the food systems of small-scale fishing communities in Kenya, Papua New Guinea, and Saint Lucia, based on interviews with men and women fishers, fish traders, and community leaders. Participants reported that containment policies led indirectly to reduced volumes of food, lower dietary diversity, increased consumption of traditional foods, and reduced access to fish for food and income. Although the initiating COVID-19 containment policies and food and nutrition security outcomes often appeared similar, I found that the underlying pathways and feedbacks causing these impacts were different based on local context. Incorporating knowledge of how context-specific factors shape food system outcomes may be key to tailoring strategies to mitigate the ongoing impacts of COVID-19 and designing timely, strategic interventions for future systemic shocks.

4.2 Introduction

4.2.1 COVID-19 impacts on food and nutrition security

As the COVID-19 pandemic unfolded, governments implemented policies to stop its spread, including restricting movement, enforcing physical distancing, and closing markets and meeting places (Hale and Webster 2020). These policies impacted all aspects of food systems at different scales, and some of these impacts have had ongoing consequences even as case numbers have dropped, and

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[14] Adapted from **Sutcliffe, S.,** Lau, J.D., Barnes, M., Mbaru, E., Wade, E., Hungito, W., Muly, I., Wanyonyi, S., Muthiga, N., Cohen, P. J., Cinner, J. (2023) COVID-19 impacts on food systems in fisheries-dependent island communities. *Ecology and Society* 28(1).

[15] **Contributions:** I developed the research question for this chapter, conducted data analysis and wrote the chapter. The Interview protocol was jointly developed with JDL, JEC, MB, EM, EW and PJC. Data collection was conducted by EW, WH, IM and SW with logistical support from EM and NW and oversight from JDL and me. JEC, JDL and MB provided advice on the research question design, data analysis and paper structure. JDL, MB, EM, EW, WH, MI, SW, NM, PJC and JEC provided feedback and editing.

restrictions have eased. National and global-scale value-chain analyses have shown significant changes to food production, trade and distribution, retailing, and consumption patterns (Erokhin and Gao 2020). The collapse of the tourism and restaurant sectors saw a drop in demand for high-value food commodities, including imports from low and middle-income countries (Love et al. 2021). International food trade was disrupted by movement restrictions, quarantine procedures and trade bans (Schmidhuber 2020, Love et al. 2021) and many small-scale producers were forced to transition to more localized food distribution methods (Bassett et al. 2021). Market closures and movement restrictions also reduced food access (Stephens et al. 2020). In many low and middle-income countries, declining incomes and price volatility led people to consume fewer nutrient-dense foods (Harris et al. 2020, Kundu et al. 2021), increasing the risk of micronutrient deficiencies, and associated risks including birth complications, inhibited development for infants and young children, and ultimately stunted growth (FAO et al. 2020).

While at times severe, the scale, scope and nature of impacts were not straightforward; they varied between different contexts, and among different food system actors and consumers. Emerging evidence shows that the costs of COVID-19 containment policies were most extreme for populations and parts of society already vulnerable to poverty, food insecurity, and marginalization (FAO et al. 2020, Laborde et al. 2020, UN Women 2020), particularly in low and middle-income countries with limited institutional capacity to cope with social, economic and physical shocks (Phillips et al. 2020, Carducci et al. 2021). Yet, there is limited analysis of the linkages and feedback loops between different impacts within any context, and how these interacting impacts were experienced by different people. Whilst it is largely too late to alter the strategies implemented to contain COVID-19, we can take lessons from the last few years to inform ongoing impact support policies and responses to future systemic shocks. Without a clear picture of the mechanisms through which policies can potentially impact food and nutrition security in different contexts, it will remain difficult to design strategic policy adaptations and interventions that can help balance the trade-offs between managing future social, economic or environmental shocks and ensuring food and nutrition security for all (Food Security Information Network 2020, IMF 2020, Laborde et al. 2020).

4.2.2 Food systems approach

In this chapter, I explore the suitability of a structured food systems approach for understanding the different pathways through which COVID-19 containment policies impacted food and nutrition security. Food and nutrition security is defined as “a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 2001). Food systems are

comprised of all the actors and activities relating to food, from production through processing, distribution, preparation to consumption; as well as the nutrition, socio-economic and environmental outcomes of these processes, and the external factors which influence them (HLPE 2020). Food systems analysis can be applied at multiple scales, from examining actors and processes within local communities to mapping out connections across global markets.

The Sustainable Food Systems Framework developed by the High-Level Panel of Experts on Food and Nutrition (HLPE) (**Fig. 10**) is arguably the most comprehensive and widely acknowledged framework developed to encapsulate these components and the relationships between them. The framework outlines five key components of food systems: 1) *systems supporting food production,* which provide inputs into the food system; 2) *food supply chains,* which include all the processes and actors involved in food production, processing, distribution, marketing, consumption and waste disposal; 3) *consumer behaviour,* or individual consumer awareness and decision making around food acquisition, preparation and consumption; 4) *food environments,* which consist of the physical, economic, social and political contexts which determine food accessibility, affordability, safety and consumer preferences; and 5) *diets*, including the quality, quantity, diversity, safety and adequacy of consumed food. The system components are tightly linked. For example, the food environment shapes food supply chains, consumer behaviour and diets. These system components also determine both *nutrition and health outcomes* and broader *economic, social equity and environmental impacts* of food systems. Each of these components interact with complex *drivers of change* at various scales. *Policy and governance systems,* comprising both formal and informal rules and norms, both directly influence food system processes and actors, and shape environmental, social and economic drivers of change (HLPE 2020).

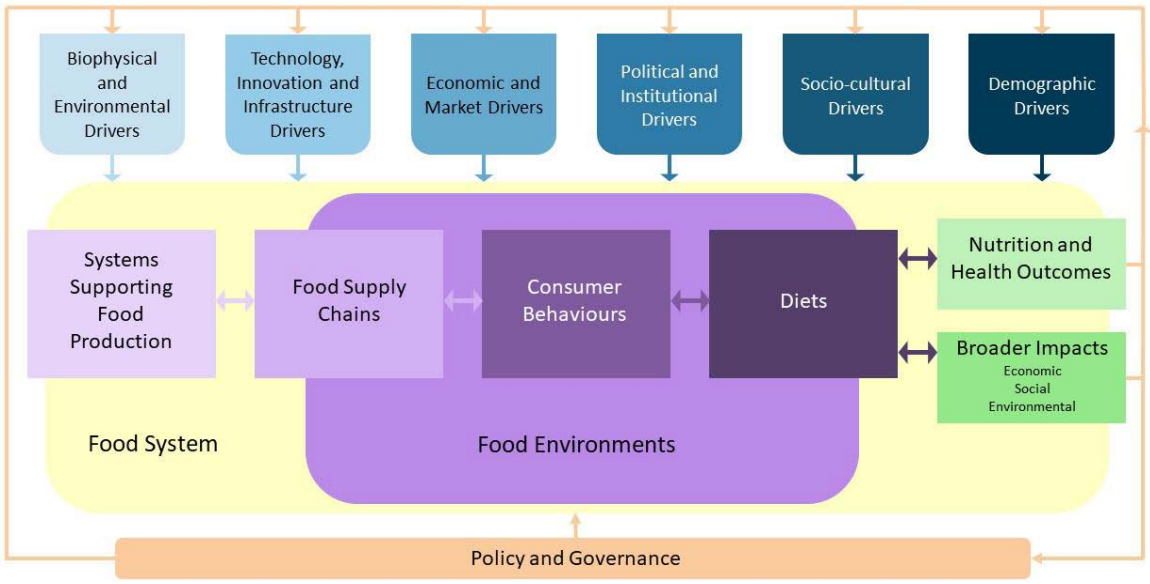

Figure 10. Sustainable Food Systems Framework. Source: Food and Agriculture Organisation of the United Nations. Adapted with permission.

Food systems analysis is grounded in the understanding of the interdependencies and feedbacks between system actors, processes and drivers (Harris et al. 2020, HLPE 2020), and requires both examination of changes across different drivers and components in the system, but also how those changes then affect actors and processes (Devereux et al. 2020). Structured analysis based on the food system framework can help identify where nutrition potential is lost from the system (or could be gained) by accounting for interdependencies, trade-offs and feedbacks induced by shocks (Béné 2020, Devereux et al. 2020, Steenbergen et al. 2020a); and can help identify potential strategic intervention points specific to local systems (Ingram 2011). I examine the impact pathways of COVID-19 containment policies through multiple, interconnected components of the whole food system, which shaped food and nutrition security outcomes in small-scale fishing communities.

4.2.3 COVID-19 in small-scale fisheries

Small-scale fisheries are an essential source of income and livelihoods, and provide protein and micronutrients for the estimated 108 million people involved in small-scale fisheries value chains worldwide (World Bank 2012). However, fishers and the aquatic foods they produce and distribute are often overlooked in food systems literature (Olson et al. 2014, Tezzo et al. 2021, Simmance et al. 2022) despite their prevalence and significance for food and nutrition security worldwide (Beveridge et al. 2013, Béné et al. 2015). Small-scale fisheries can broadly be defined as the processes and actors (both women and men) involved in harvesting fish or other aquatic foods (hereafter collectively termed “fish”) from small boats or the shore (including on foot) in coastal or inland waters, as well as

post-harvest processing and distribution of these products (Allison and Ellis 2001, Smith and Basurto 2019). There is significant variation in the production and distribution strategies, and in the social, economic, and geographic contexts of fishing operations which fit this definition (FAO 2015), and therefore the ways they are affected by and can respond to shocks like COVID-19 (Bassett et al. 2021, Love et al. 2021). Here, I focus on marine small-scale fisheries in low-income communities in the global south. In this context, small-scale fisheries are critical for poor and marginalized groups with limited resources and alternate livelihood opportunities; indeed they can provide a safety net where other livelihoods fail in the face of shocks (Béné et al. 2010).

However, small-scale fishing communities, particularly those in the global south, may be particularly vulnerable to COVID-19 and other shocks because of economic, political, and geographic isolation. Communities where small-scale fisheries are a common livelihood frequently also experience low incomes, limited livelihood choices, and poor infrastructure; face climate and non-climate related environmental degradation; and receive limited government support (Bennett et al. 2016, Bennett et al. 2020). Small-scale fishers generally do not have access to reserve capital or insurance to see them through shocks, and are dependent on being able to go fishing for food, and for income through regular sale of catch (FAO 2020b). Communities living on small islands were particularly vulnerable to the deliberate isolation required to keep COVID-19 at bay. With relatively little arable land for agricultural production, people living on small islands may have relatively few options for livelihoods and can be particularly dependent on fisheries, tourism, remittances, and food imports (Farrell et al. 2020b, Hickey and Unwin 2020). Early reports of the impacts of COVID-19 containment policies in small-scale fishing communities indicate disruptions to fish value chains, resulting in loss of income and reduced availability and accessibility of food, especially in countries heavily dependent on fish for livelihoods, animal proteins and micronutrients (Eriksson et al. 2020, FAO 2020b, Jomitol et al. 2020, Rosen 2020, Steenbergen et al. 2020a, Lau and Sutcliffe 2021, Lau et al. 2021b, Monirul Alam et al. 2022, Nyiawung et al. 2022b, Western Central Atlantic Fisheries Commission 2022).

Here, I examine how COVID-19 containment policies interacted with food systems in three small-scale fishing communities in three distinct geographic regions. The three communities have varying levels of connectivity with regional and global trade networks, supply chains and social, economic, and political influences. I primarily focus on actors and processes within or directly connected to the specific communities, which I refer to as the "local food system". I sought to identify 1) what the food and nutrition security outcomes are associated with COVID-19 containment policies in small-scale fishing communities; 2) which specific components of local food systems have been impacted by COVID-19 containment policies, and how; and 3) how impacts on specific system components have

flowed through food systems and interacted with other food system drivers. To answer these questions, I undertook a series of qualitative interviews with women and men living in small-island small-scale fishing communities in three regions (see Ch. 2). I analysed these interviews using a food systems framework (**Fig. 10**) to identify the impacts of containment policies during the initial months of the pandemic, and to identify the impact pathways and feedback mechanisms that women and men experienced as being particularly acute in their local food systems. First, I briefly describe my methodological approach to analysing the interviews for this chapter. I then highlight the main dietary changes participants experienced during the early stages of the pandemic. Next, I describe the primary overarching process through which COVID-19 containment policies inhibited diets. I then provide a broad overview of how impacts flowed through connected components of the food system framework, before providing specific examples of direct and indirect impact pathways and feedback processes in the local food system of each site.

4.3 Methods

This chapter draws on the interviews from PNG, St. Lucia and one community in Kenya (community E) from the first round of data collection conducted between July and October 2020, as described in Chapter Two. I specifically drew on the questions in which I asked participants to describe their experiences of how containment policies had impacted fishing, fish marketing, physical and economic access to food, food decision making and consumption patterns, and how they responded to these changes (See **Appendices 2-4** for interview templates). I also draw on specific questions about changes to livelihoods and wellbeing, which are directly related to food and nutrition security, either as food system drivers or outcomes. Information about the role of other food system drivers (e.g., biophysical and environmental drivers, technology and infrastructure drivers etc.) was derived from participants' explanations of the causes of different impacts. To ensure the casual links I inferred from interviews were robust, I cross-checked between interviews, key informants, local research assistants and against policy and other government documentation when able. I did not directly ask participants to identify or project the health and nutrition outcomes of these changes. Most of these outcomes will not be immediately apparent and would generally require anthropomorphic measurements to accurately detect (though likely outcomes can be inferred from the reported dietary changes). Furthermore, the intention of my interviews was to identify participants' perceptions of changes to the food system as they happened, rather than their projections of medium to long-term outcomes.

Following common practice in qualitative research (Newing et al. 2011, Linneberg and Korsgaard 2019), I analysed the interviews in NVivo using a combination of deductive and inductive coding. I identified the perceived impacts of the pandemic and polices to contain it on the local food system

and then deductively coded them to one or more of the components in the food system framework (**Fig. 10**) (HLPE 2020). I then used inductive coding to classify and synthesize impacts within each component (**Table S3**). Where participants made explicit causal connections between different impacts and processes, these were coded as relationships or links between the relevant system components. For example, where one participant stated:

> "Getting money during the pandemic was a bit hard. So, we go for the cheapest. If we have money, we buy rice. If not, one 10 kina is enough. You can't buy 10kg of rice, but with 10 kina you can buy a bag of sago that will sustain you for two weeks. So, if I can buy rice, no, I'll say, let's get sago, because sago, you can get one bag for 10 kina, and that will keep us for two weeks,"

this was coded to "economic and market drivers" (lack of income), "food environments" (affordability) and "consumer behaviour" (choosing to buy sago instead of rice), and as links between these system components. I looked for dominant themes and outliers, both in the coding and through broader analysis of the interviews. Participants' descriptions of specific containment policies and processes were cross-checked against government and development agency communications, supplemented with insights from in-country partners, where additional context was required for interpretation. The food system impacts and interactions with various system drivers described below are derived directly from interviews. An initial sample of five interviews were cross-checked by Dr. Lau and the coding structure was refined accordingly. The final coding and synthesis were reviewed again by Dr. Lau to rest for coding rigour. I consulted extensively with the interviewers and other in-country partners to review the coding, to resolve any disagreements and clarify interpretation.

4.4 Results

4.4.1 Material impact: changes to diets

All participants reported some changes to their diets due to policies implemented to contain COVID-19; though the nature, scope and severity of impacts varied between sites and participants. These impacts included reduced quantity, quality, diversity, and adequacy of diets (**Table S3**). In all three sites, most participants reported eating less than they normally would because they either reduced meal sizes or skipped meals altogether. To manage for food scarcity, households carefully rationed food to make it last.

> "So, we'd serve, little, little for each child and each adult. It doesn't matter if you're full up or only just full, that was your share" (Man, 44, PNG).

> "We have to watch our income we spend these days because of COVID. If you have to eat less or something, that is what we do now" (Man, age unknown, St. Lucia).

In both Kenya and PNG, participants stated they were eating simpler meals with fewer different types of food, and the same meals each day (**Table S3).** In Kenya, participants reported consuming less meat and vegetables, instead primarily consuming staple carbohydrates such as *ugali* (maize meal porridge) and sometimes rice. One woman in PNG said, "Before, we'd all eat rice often. Not now. I've cooked sago over and over, and everyone complains…but there's nothing else" (Woman, 32, PNG).

Participants in all three sites reported improvements in hygiene practices such as regular handwashing. In addition, primarily in PNG but also in Kenya, some participants reported increased consumption of traditional foods, including local fruits and vegetables, due to reduced access to processed, store-bought foods. COVID-19 containment policies also resulted in additional economic, social, and environmental outcomes (discussed further below).

4.4.2 Primary processes driving dietary changes

I identified an underlying process, common across all three sites, through which COVID-19 containment policies led to dietary changes (**Fig. 11)**. The various COVID-19 containment policies disrupted fishing activities, as well as post-harvest trading, transportation, processing, and marketing. These disruptions both reduced the physical availability of food and reduced fishers' income because they were less able to sell their fish, which in turn reduced their ability to buy other food and goods. In response to loss of purchasing power due to loss of income, people were forced to reduce food expenditure, resulting in a decline in the quantity, quality, and diversity of their diets. This pattern was articulated by one fisher from PNG:

> "There's one way of getting money, and money is food. If you have money, you get food. If you don't have money, you can't get food. And the way we get money is from the sea alone. And if we're affected in how we sell it, and there's no fish, then there's no money to get food from the store" (Man, 40, PNG).

While this was the primary process responsible for reduced food and nutrition outcomes in all three sites, the mechanisms triggering the process varied and were influenced by underlying social, economic, and environmental conditions, and the resulting outcomes and system feedbacks (both direct, and more in-direct and complex). In the following sections, I provide an overview of the flow of impacts across the whole food system, and then provide illustrative examples of direct and indirect pathways, and more complex system feedbacks.

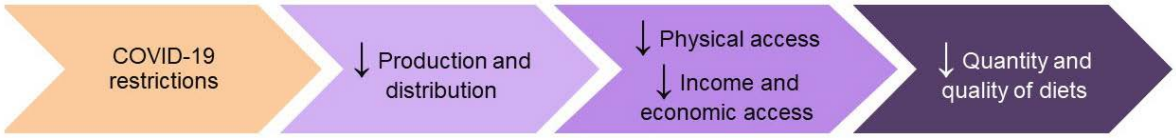

Figure 11. Primary process. General pattern of how COVID-19 containment policies impacted food and nutrition security.

4.4.3 Flow of impacts across the food system

Participants from all three sites identified changes arising from COVID-19 containment policies that corresponded to each of the components and drivers in the food system (see **Table S3** for a full list of impacts). They described a wide range of interconnections between impacts on processes in each component (**Fig. 12**). In sum participants shared 260 instances across 49 directional pairs where system components or drivers influenced another (e.g., 11 instances where a change in the food environment influenced an aspect of consumer behaviour, and three where consumer behaviour influenced food environments). In most cases, participants described situations where an impact of COVID-19 containment policies on one system driver or component caused ripple effects through other linked components in a chain (i.e., policy *X* influenced component *Y*, which then influenced component *Z*). COVID-19 containment policies primarily directly influenced food supply chains, food environments and economic and market drivers (**Fig. 12**, orange arrows). The consequences of these direct impacts then flowed through the rest of the system, with successive links between supply chains, food environments, consumer behaviour, and diets (**Fig. 12**, purple arrows).

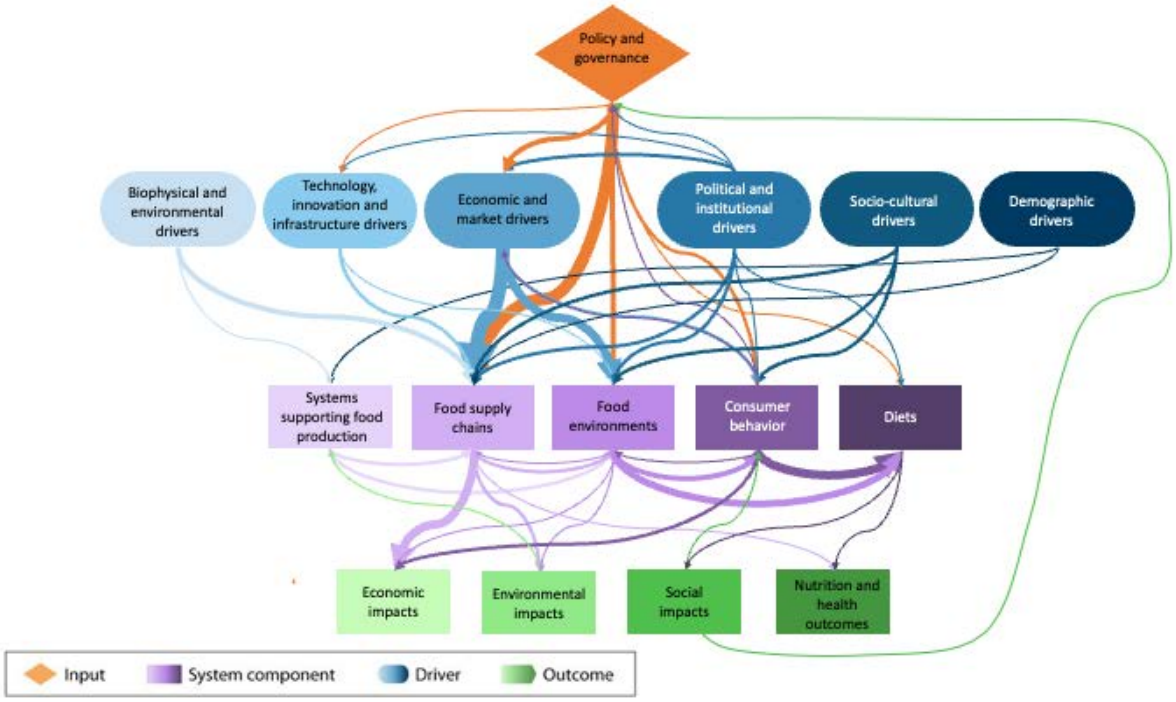

Figure 12. Flow of impacts through the food system. Flow chart showing links between impacts on connected system components from the Food System Framework. The colour of each arrow indicates the origin component, corresponding to the colours used in Fig. 10. The width of the arrow represents the coding frequency of the link. Note that each driver and food system component in the model is essentially a conceptual organizational unit which contains multiple processes, for example food supply chains include both production and distribution, so any given coded link from policy and governance to supply chains could refer to containment policies impacting either one of those things. In some cases, the links between impacts on the same specific elements within two system components were made by multiple participants, so the frequency of coding represented by the thickness of each arrow is a function of both the number of links between different elements in each component, and how often each link was described.

In other cases, the impact of a policy on a particular food system component was either exacerbated or mitigated by pre-existing drivers or system structures (i.e., policy *X* and driver/component *Y* together influenced component *Z*). Many of these drivers were not themselves directly impacted by COVID-19 containment policies (as shown by the limited orange arrows connecting to blue ovals in **Fig. 12**) but worked in combination with COVID-19 containment policies to impact system processes, actors, and outcomes (**Fig. 12**, blue arrows). For example, the onset of COVID-19 containment policies in Kenya coincided with the windy season (known as *Kusi*), when catch rates are at their lowest because fishers are often unable to go out due to bad weather conditions. Physical distancing rules limited the number of fishers allowed on boats, which reduced catch efficiency, and meant some fishers were not able to go out every day if they would normally work on someone else's boat. While fishers may have been able to cope with one or the other, the combined effects of *Kusi* and COVID-19 containment policies meant that fishers were unable to catch enough fish to meet their food and income needs. As one fisher said: "One side we suffer from corona and on the other side we suffer

from *Kusi*" (Man, 49, Kenya). In each site, the differences in underlying drivers of change and food system structures meant that similar containment policies created different impact pathways and outcomes, including variation in the nature and severity of impacts on different vulnerable groups within each community.

4.4.4 Direct value-chain impacts

In St. Lucia, multiple participants reported that curfews were restricting the amount of time they could spend on fishing and agriculture (**Fig. 13**). Being unable to fish at peak times in the early mornings, evenings, or at night represented a direct impact on food production (i.e., a negative impact on food supply chains). This impact then reduced income for both fishers and other participants in the fishery value chain (i.e., an economic and market driver), the availability of fish for food, and the financial accessibility of other foods (i.e., a negative impact on food environments), which then in turn influenced diets. Several other containment policies directly impacted food supply chains (**Table S3**). For example, in Kenya and PNG, physical distancing rules meant fewer people than normal were allowed on fishing boats (from four or more to only two people under the new rules), reducing catch efficiency. There were also direct impacts on other system components, including food environments, e.g., where physical distancing rules and mandatory reduced market and shop operating hours reduced the physical accessibility of food.

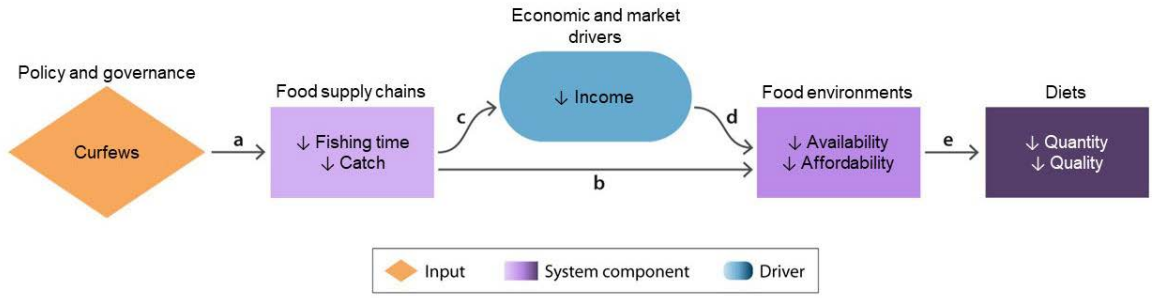

Figure 13. Curfews and reduced production capacity in St. Lucia. The implementation of curfews in St. Lucia meant that people were unable to go out fishing during key times in the early morning and evenings, reducing overall fish catch, and limiting time spent on small-scale farming and other productive activities (a). Reduced fish and agricultural production meant that less fish and produce was available to local consumers (b), and fishers' income was reduced (c), limiting their ability to purchase other foods (d), resulting in an overall reduction in diet quality and quantity (e).

4.4.5 Interactions with socio-economic and environmental drivers

COVID-19 containment policies also influenced food systems indirectly through system drivers. For example, in Kenya, county border closures resulted in disruptions to national transport infrastructure systems, which temporarily broke food supply chains that relied on border crossings (**Fig. 14**). This disrupted formal food distribution systems, and some stores struggled to get stock in the early stages of the pandemic, temporarily reducing food availability before containment policies were refined to restore formal supply chains. (Commercial food transporters were categorized as essential services and allowed to cross national and country borders, but vehicles and drivers were required to obtain specific documentation from a formal employer, comply with curfew hours, and undergo testing when crossing borders, which resulted in significant delays (Famine Early Warning Systems Network 2020, Ministry of Health 2020b, a). Moreover, fish traders in Kenya often rely on public transport or carpooling to transfer relatively small amounts of fish from coastal villages, such as Mkwiro, into larger markets in cities like Mombasa. These informal food distribution methods were completely shut down while the border closures were in place, as they were not included in the measures to preserve formal distribution chains servicing stores. Traders were forced to try to sell fish in smaller towns within their county, where demand and selling prices were lower. As a result, fish traders bought less fish from fishers, and at lower prices, which reduced income and financial accessibility of other foods for fishers.

> "What can we do? The fish dealers set the price. If only they reached Mombasa the price could be higher, but they sell in local markets like Ukunda. They don't reach town (Mombasa) where they have the market they depend on" (Man, 61, Kenya).

Several of the participants described having to make conscious trade-offs between economic and nutritional outcomes. For example, they described having to reduce their food intake and dietary diversity or use up limited savings, sell assets, not buy other supplies, or take out store credit.

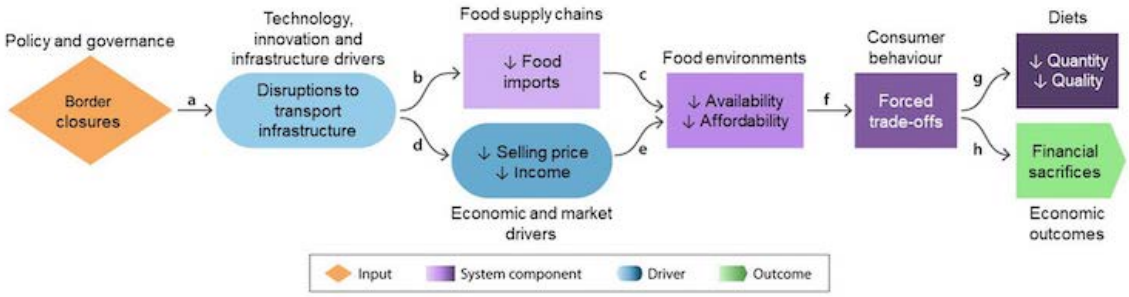

Figure 14. County border closures and value chain breakdown in Kenya.Food is often transported in and out of rural Kenyan communities informally, with people carrying fish and other supplies with them on buses and cars. When travel between counties in Kenya was banned, formal goods transport infrastructure was partially disrupted, and public transport systems largely shut down (a). This caused disruptions to supply chains bringing food into the community (b), reducing the availability of some foods in stores (c). In addition, fish traders were unable to take fish from the community to cities to sell at higher city market prices, and therefore reduced the price they were willing to pay fishers for their fish, thereby reducing fishers' incomes (d). As such, fishers' purchasing power was reduced and food became less affordable (e). Limited availability and financial accessibility of food in stores influenced fishers purchasing decisions (f), causing them to reduce the quantity, quality and/or diversity of food they purchased and consumed (g) or resort to using limited savings or making other financial sacrifices to maintain their diets (h) or a combination of both.

COVID-19 containment policies also caused indirect impacts across the food system through other drivers. For example, gender norms (a socio-cultural driver) around childcare in Kenya meant that due to school closures, many women (in particular) were forced to stay home to look after their children during the day. Children were not able to be cared for by family and friends due to the restrictions placed on visiting other households. As such, women were unable to undertake their normal food production, processing, and marketing, or other economic activities, which reduced household income and disrupted normal household food acquisition, preparation, and consumption. Similarly, in PNG specific economic activities generally undertaken by women were temporarily banned by the government, such as selling betelnut (a palm seed containing stimulants, commonly chewed as a social and cultural practice throughout Asia and the Pacific), removing one of the few sources of income available to women (Robins et al. 2020). Reduced social interaction also disrupted traditional food sharing practices (also a socio-cultural driver). One woman in PNG perceived the lack of food sharing to be a deliberate choice arising from food scarcity, fear, and uncertainty, and viewed the behaviour as immoral: "There was greedy behaviour when this situation happened, and I see, all our good ways from before are going finished now, and the bad is starting" (Woman, 32, PNG).

Economic and market drivers, particularly loss of income, also indirectly influenced food systems. In St. Lucia, fishers normally sell large proportions of their catch to hotels and restaurants. When the

local tourism industry collapsed due to border closures, fishers lost a significant income stream, which reduced their food purchasing power.

In PNG, physical distancing rules limited the number of people allowed in boats. To comply with physical distancing rules, only four people could take a motorboat to the mainland market to sell fish and buy food, compared to up to 12 prior to the pandemic. Fewer people meant the ticket cost—to cover the cost of fuel—was higher for each passenger. Fuel was also harder to obtain (a technology, innovation, and infrastructure driver). In response, boat drivers decreased the number of trips—meaning fewer places available each day—and used smaller engines to reduce fuel consumption—meaning that what had been a 30-minute trip took over two hours. Alongside less demand for fish and reduced prices in the markets, the financial and time costs of accessing the market outweighed the profit made from selling fish. In addition, the increased transport costs of travelling into town made purchasing store food more expensive and inconvenient. Some participants reported a resurgence in traditional fish-for-produce exchanges with nearby villages instead of cash purchases in the later stages of the study period, partly due to the reduced accessibility of mainland shops, and partly due to overall reduced cash flow in the community.

> "The market was bad because there was no money…We used only fish, and we exchanged it. Some people (from the mainland) came, and we exchanged just some fish for sago, we exchanged fish for bananas, so we could get food to help us, and the mainlanders could get fish" (Woman, 54, PNG).

4.4.6 System feedbacks

COVID-19 containment policies led to a range of adaptive responses at multiple scales, social feedbacks, and system changes, which, in some cases, in turn led to changes to the original containment policies and system drivers. In Mkwiro, Kenya, the breakdown in fish distribution chains (i.e., a negative impact on food supply chains) resulted in reduced income for fishers and therefore reduced the financial accessibility of fresh produce and grain (i.e., a negative impact on food environments), which fishers would normally purchase from small stores on the island or markets in Shimoni (the closest mainland town). In response to the lost income and threat of food insecurity (i.e. a negative impact on diets), some fishers (those with sufficient adaptive capacity to do so) invested in small-scale farming projects (i.e. a feedback altering food supply chains), with plans to sell a proportion of the yield in the community, which would increase the physical availability of fresh produce on the island overall (i.e. food environments) and replace some of the lost income from fishing (i.e. a feedback to economic drivers).

In a more complex example, Ahus Island has limited agricultural capacity. The community is largely dependent on external markets and outsiders bringing (non-fish) food to the local market. Local leaders decided to close the local market in the early stages of the pandemic for fear of transmissions and banned interaction between communities to prevent gatherings and maintain isolation. Participants explained that their community was unlike "mainland communities" because on the small island most people were unable to fall back on local small-scale agriculture as a safety net. As one man said, "If you're in a city, in a town or an urban area, you're ok compared to us on islands and in villages. And the mainland is alright as well because they have gardens...For us on this island, it is hard" (Man, 44, PNG). The effects of these containment policies on food availability and accessibility were severe and led to additional social consequences such as exacerbating ongoing tensions between leaders and young men in the community. This then created a negative feedback loop where already disadvantaged groups within the community were disproportionately affected, increasing social inequity (**Fig. 15)**. To obtain food, people broke rules banning travel between communities, thereby undermining the original intention of closing the market to minimize inter-community contact. In response to these negative social and food and nutrition security outcomes, leaders revised the rule and re-opened the markets with physical distancing measures in place to minimize risk.

> "The leaders all sat down, they saw that, they set rules, they told us, but people didn't follow them. So, they said, ok, these things will stay, but we have to follow government's rules about physical distancing between us in all social activities" (Man, 32, PNG).

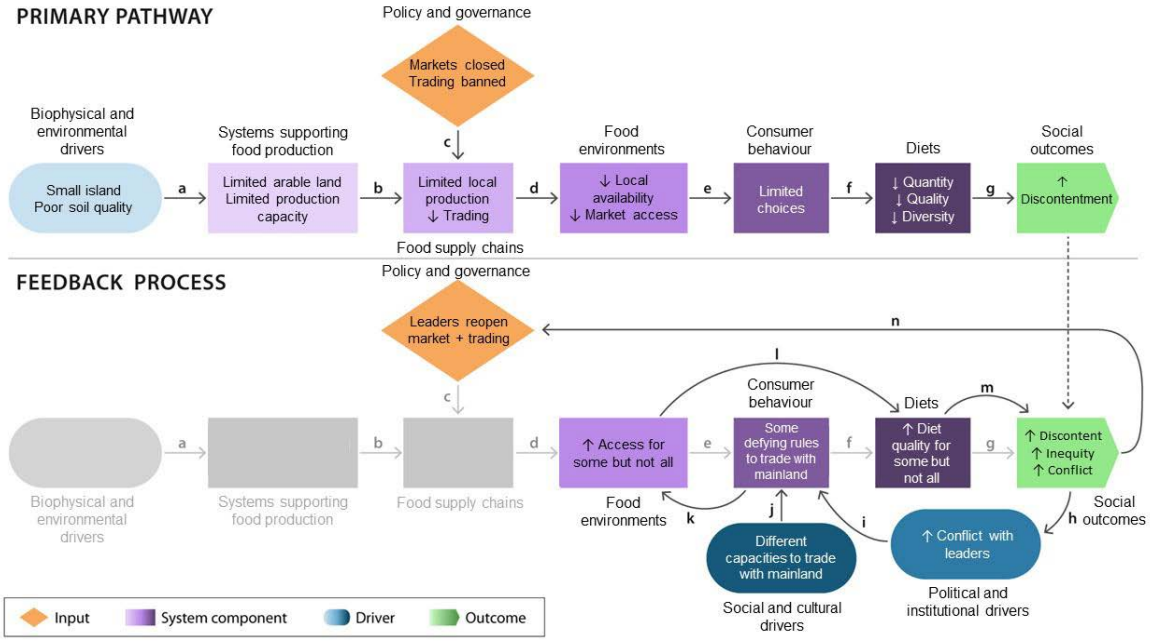

Figure 15. Market closures and social feedback mechanisms in PNG. Ahus is a small island relative to its population size, with poor soil quality, making it an unfavourable environment for growing food crops (a). As such, on-island food production is limited to small household gardens and fruit trees, and people are largely dependent on food brought to the local market from the mainland (b). In the early stages of the pandemic, community leaders decided to close the markets to prevent too many people aggregating and stop mainlanders coming to the island; and banned direct trading with mainland communities (c). Availability of fruit and vegetables on the island became limited, and mainland markets were inaccessible (d). People were only able to obtain food from fishing and what they could grow in small gardens, if they had them (e), resulting in severe restrictions in diet quantity, quality, and diversity (f). This caused increasing discontent in the community (g) and escalated existing conflict between leaders and young men (h). Some people (primarily young men) chose to defy the rules established by the community leaders and paddled across to the mainland at night in canoes to trade fish for vegetables directly with relatives (i), but only those who had access to canoes, had relatives on the mainland willing to trade with them, were physically able to make the journey and were willing to break rules were able to trade (j). As such, some households in the community got access to fruits and vegetables from the mainland, but most still had restricted access (k), meaning that diet quality improved for some but not all (l), increasing social inequity, discontent, and conflict in the community (m). In response, leaders decided to re-open the market with physical distancing measures in place (n).

4.5 Discussion

The consequences of COVID-19 containment policies reverberated throughout the fisheries-dependent food systems I studied. In sum, I found households experienced reduced volumes of food and lower dietary diversity, increased consumption of traditional foods, and improved hygiene practices. Fishers experienced reduced access to fishing grounds and markets which led to reduced availability of fish and a decline in income. The hardships that people faced due to COVID-19 containment policies are concerning and in some instances alarming. If diet quality and quantity remain lowered for protracted periods while economies remain repressed, this could lead to severe health outcomes, particularly for women of reproductive age and children aged under five (Pérez-

Escamilla et al. 2020). Insufficient macro and micro-nutrient intake can inhibit growth and development in children and are associated with a range of long-term health issues (Bloem et al. 2005b, Black et al. 2013). There were some shifts in behaviour that could be considered as positive outcomes, particularly if they are maintained long-term, for example, improved hygiene practices could lead to improved food safety and nutritional outcomes (Schmidt 2014). Moreover, increased consumption of fresh local produce (i.e., a more traditional diet) could help combat the rapid nutrition transition towards an industrialized diet characterized by high consumption of processed, imported foods high in added fats and sugars, associated with high rates of nutrition-related chronic conditions such as overweight and obesity, type 2 diabetes, and cardiovascular disease (Popkin 2003, Savage et al. 2020).

4.5.1 Primary process driving dietary changes

The pattern I identified of reduced availability and accessibility of food and lower diet quality and quantity in these three communities is consistent with reports of food and nutrition security impacts in rural agricultural or fishing communities, during COVID-19 (Harris et al. 2020, Jomitol et al. 2020, Blazy et al. 2021) and previous social, environmental and economic shocks (Béné 2020). Similar impact pathways of shocks through food systems have been reported during and after conflicts and following natural disasters (Cohen and Pinstrup-Andersen 1999, Israel and Briones 2012).

4.5.2 Compounding impacts and compromised safety nets

In each community, there were multiple factors compounding reduced food availability and access, sometimes with interacting ripple effects, which curtailed people's capacity to cope and adapt to the situation. Adaption to food system shocks may lie in alternative food sources, engaging in alternate livelihood activities, or relying on assistance from less-affected people in their social networks (Ziervogel and Ericksen 2010, Tam et al. 2014). In fact, during economic shocks, fisheries have historically functioned as a livelihood safety net when salaried employment opportunities or capital-intensive production activities have been compromised (Béné et al. 2010, Belton et al. 2021). However, my findings and those of others suggest that normal adaptive strategies were undermined by the compounding impacts of COVID-19 (Fiorella et al. 2020, Kruczkiewicz et al. 2021). Almost every aspect of daily life was impacted in some way for all community members. Thus, people were unable to draw on the back-up livelihood activities, resources, and social support systems they would normally use to cope with smaller, isolated shocks, such as remittances or food sharing networks (Wossen et al. 2016). For example, Pacific Island communities have historically relied on food sharing and exchange networks, both within and between communities, as a food and nutrition security safety

net during crises, particularly for the most vulnerable (Campbell 2015). Traditional food sharing also plays an important role in broader community cohesion and relational wellbeing. My results suggest that food sharing networks were unable to compensate for reduced physical and economic accessibility of store-bought and garden foods, because of the breakdown in both traditional inter- and intra-community exchange and forced isolation. Across all three sites, the barriers to catching and selling fish experienced by people already dependent on fisheries also undermined fisheries' potential function as a safety net for people who lost salaried employment. Future investigations into if and how communities were able to cope with and adapt to the multiple simultaneous effects of COVID-19 may provide insights into their ability to adapt to future complex and compounding effects of simultaneous climate change impacts and other social and environmental shocks.

4.5.3 Implications for the design of strategic interventions

Many studies have found that COVID-19 containment policies resulted in restricted food availability, accessibility, and diet quality (Erokhin and Gao 2020, Stephens et al. 2020, Carducci et al. 2021). By using a structured comparison, I was able to discern that the same outcome was driven by different, context-specific mechanisms. As such, policy and interventions require design and adjustment according to specific food system characteristics. For example, the three communities in this study were connected to external food supply chains to different extents. As such, each would require different types of interventions to restore or replace supplies. With limited agricultural capacity (limited land), island supply chains rely on the mainland and are extremely vulnerable to the loss of this connection (Charlton et al. 2016). Unlike the community in St. Lucia, and other coastal regions of PNG and the Pacific, small and isolated islands like the PNG community are unable to fall back on small-scale agriculture to mitigate some of the impacts of reduced access to external markets (LMMA Network et al. 2020, Steenbergen et al. 2020a). In this case, small policy adjustments were able to restore connectivity and resume relatively normal food trade. In PNG, provincial borders were closed in a similar way to county borders in Kenya, but this policy appears not to have significantly impacted the community once access to the mainland market was restored. While the community on the island itself is not self-sufficient, its food system is relatively geographically constrained, and both the physical and economic food access issues could have been (and in some ways were) substantially alleviated by local leaders facilitating increased (COVID-safe) provincial-scale market connectivity. In this instance, it was key that local leaders had the ability to self-organize to decide how best to balance the specific needs of the community within the scope of national requirements and recommendations.

In contrast to the relatively locally bounded local food system in PNG, the community in Kenya was primarily impacted through disrupted connections with external markets due to the provincial border

closures. Throughout Africa, national COVID-19 containment policies underestimated rural-urban food market integration when imposing movement restrictions, failing to preserve domestic food supply chains to, and income streams for rural producers (Liverpool-Tasie et al. 2021). As such, the value chain disruptions in Kenya would likely have required national-level policy changes to support the longer, often informal value chains that are critical to both rural and urban food and nutrition security (Zimmerer and de Haan 2020), whilst minimizing potential virus transmission. At a larger scale, St. Lucia fishers were significantly impacted by international movement restrictions, because their main income stream is from selling high-value fish to wholesalers for overseas exports and to hotels and restaurants servicing international tourists on the island. In this case, and perhaps also in Kenya, a significant transition to more local fish distribution channels was likely necessary. To varying extents, all three communities still shared the common characteristic of being highly dependent on fishing for food and income and to trade for non-fish foodstuffs. Communities which still have a strong cultural and economic link to fishing but also have more potential for livelihood diversification and nutritional self-sufficiency, for example coastal and inland fisheries with higher agricultural potential, may have been more resilient to the breakdowns in fish trade experienced in these communities (Allison and Ellis 2001, Marschke and Berkes 2006, Allison 2011, LMMA Network et al. 2020).

Understanding how communities are vulnerable to changes at different scales is one of many contextual factors critical for designing effective policy responses to shocks. It is also critical to ensure that any future pandemic containment or impact mitigation policies, or indeed responses to any systemic shocks, address not only differences between, but also within communities. Different food system actors are vulnerable to different impacts and have different capacities to adapt to meet food system changes arising from shocks (Smith and Frankenberger 2018). Shocks, particularly those related to climate change, are projected to increase in frequency and severity (Barnett 2011). COVID-19 may provide an opportunity to identify target areas and strategies for building food systems that are more resilient against complex, intersecting and protracted shocks (Klassen and Murphy 2020, Phillips et al. 2020).

The instances in which multiple impact pathways converge or diverge around a single point, or bottleneck in the food system, may represent a point for strategic intervention. For example, in the PNG site, access to the mainland market was a major food access bottleneck. COVID-19 containment policies reduced connectivity between the island and the mainland through infrastructure closures, transport restrictions and social gathering limits, and led to reduced incomes, limited access to diverse foods, and essential services. Supporting connectivity while minimizing transmission risk may have been a single-entry point to resolving multiple barriers to food access. For instance, women drew on

social and communication networks by asking friends to buy and sell on their behalf when they could not travel into town. Similar adaptations have been noted in other instances of reduced physical connectivity; some small-scale food producers and distributers have successfully utilized digital technologies to restructure local food distribution channels to facilitate the movement of foods in more controlled and predictable ways with minimal physical contact (Mittal and Grimm 2020, Bassett et al. 2021).

Given that the majority of negative impacts experienced by the communities were directly related to stringent containment policies, the obvious question to ask is what would have happened if such containment policies were not put into place or if they were less stringent. Firstly, there is substantial evidence that the rapid implementation of restrictions curbed the spread of the disease and reduced mortality rates, though the degree of effectiveness does seem to be higher in high-income than low-income countries (Carraro et al. 2020, De Brouwer et al. 2020, Deb et al. 2020, Pincombe et al. 2021). However, the conclusions of global reviews comparing the effectiveness of different containment measures during COVID-19 and previous epidemics and pandemics, and the relative human and economic costs of adopting strong measures vs. experiencing much higher case rates remain mixed. While some have concluded that the rapid implementation and enforcement of stringent policies led to overall better outcomes in terms of reduced mortality, lower economic decline, and faster recovery rates, particularly in low-income countries, it is hard to generalise as much depends on the specific nature of the policies, prior conditions in different countries, and the implementation of corresponding support programs (Carraro et al. 2020, Picchioni et al. 2022). Dietrich et al. (2022) found that more stringent restrictions resulted in increased food prices in countries which had regionally integrated markets, but not in places with segmented markets, and Picchioni et al. (2022) found that places with shorter value chains were better able to mitigate the food security impacts of stringent restrictions A study comparing the strictness of containment policies vs food security and livelihood concerns and impacts in five African countries, including Kenya, did find that countries with more stringent restrictions appeared to experience more food insecurity and livelihood disruptions, but those countries which implemented more social support alongside restrictions were able to mitigate many of the negative effects (Birner et al. 2021). This is supported by several other studies which have reinforced the importance of buffering the negative food security impacts of restrictions with corresponding social support mechanisms (Ceballos et al. 2020, Nechifor et al. 2020, Picchioni et al. 2022, Abay et al. 2023).. However, others concluded that the benefits of flattening the curve and slowing transmission rates so that healthcare systems would not be overwhelmed in countries which already lacked functioning healthcare systems would be minimal, and that the likely increase in mortality from food insecurity and disruptions to vital ongoing health interventions such as child

immunisations due to lockdowns outweighed the prevented COVID-19 mortalities in countries with high rates of extreme poverty (Abbas et al. 2020, Husain et al. 2020).

4.5.4 Limitations and applications

My qualitative study focused on gaining a deeper understanding of people's lived experience with the food security impacts of COVID-19 in fishing communities. I attempted to interview people from a range of backgrounds within each community, including both men and women, to capture variation in the experiences of actors who connect to the food system in different ways and are influenced by different drivers. However, I was limited in the number of interviews I could include in the study, which affects the generalizability of the experiences I captured. My methodology could be applied more extensively within a community to build a more comprehensive understanding of the local food system, or in multiple communities for further contextual comparisons. Additionally, my interviews were conducted approximately five months into the pandemic, and interviewees were asked to reflect on changes since the onset of the pandemic. Recall bias may have impacted the results, particularly participants' reflections of the initial months of the study period, as the accuracy of individuals' recollections of their own experiences can decline rapidly over time.

Beyond tracing linear value chains and direct impacts, taking a food systems approach allowed us to identify feedback loops, interacting drivers and more convoluted impact pathways. I found that even where mechanisms and food and nutrition security outcomes at first seem similar, the underlying pathways and feedbacks causing these impacts may be very different. The ability to identify these processes and contextual influences is the key strength of the food system approach. However, it is also a weakness in that it requires significant time and resources to identify and apply locally tailored responses when shocks are occurring at large scales. There are some inevitable trade-offs between timeliness and nuance when it comes to evaluating and meeting diverse needs. These trade-offs are amplified during protracted shocks, as repeatedly conducting analysis at this level of detail is costly for public agencies, but it is critical to ensure that any negative feedbacks and unintended consequences of policy interventions are being addressed.

4.6 Conclusion

The context-specific understandings of processes and drivers which can be gained through systems analysis are key to designing appropriate policy responses or additional interventions in local food systems which address the specific needs of communities. Whilst in-depth mapping across multiple local food systems can be time and resource consuming (Delaney et al. 2018), my analysis shows that the substantially different specific needs across different contexts call for more nuanced policy

approaches which account for this degree of variation. In general, supplementing high level, quantitative analysis of food supply chains and diets with qualitative explorations of experiences at smaller scales can provide a more comprehensive picture to inform effective policy responses to COVID-19 and future shocks.

Chapter Five: Harnessing multiple domains of adaptive capacity: Insights from the COVID-19 pandemic[16]

5.1 Abstract:

The global community has been faced with multiple shocks in recent years, including the COVID-19 pandemic and increasing climate-driven environmental changes. Whether and how people can respond to such shocks depends on multiple factors, collectively referred to as adaptive capacity. Here, I empirically examine the role of the multiple domains of adaptive capacity in shaping responses to shocks. Specifically, I explore how people in five coastal Kenyan communities drew on their adaptive capacity to respond to shocks to food security, livelihoods, and wellbeing. I undertook qualitative interviews across three time periods through the first year of the COVID-19 pandemic. I analysed them using a combined deductive and inductive coding strategy based on a recently developed theoretical framework outlining six "domains" of adaptive capacity: assets, flexibility, social organisation, socio-cognitive constructs, learning and agency. I found that people responded to the impact of COVID-19 across a continuum from temporary coping strategies to more substantial adaptations and transformations. I not only found that people drew from all six domains of adaptive capacity but identified multiple interdependencies between these domains which shaped how they influenced responses. For example, people's social networks (part of the organisation domain) played an important role in facilitating their access to assets and learning opportunities, and influenced their socio-cognitive constructs, which in turn influenced the adaptive actions they could take. My findings suggest that policies and interventions to build adaptive capacity and resilience would benefit from a multidimensional approach that accounts for interactions between domains of adaptive capacity.

5.2 Introduction:

In the last three years, the global community has experienced multiple, unprecedented social and economic crises arising from climate-driven natural disasters, international conflicts, and of course, the COVID-19 pandemic. These events have led to food system breakdowns, rising inequality, and an additional ~150 million people entering extreme poverty (Laborde et al. 2021, Swinnen and Vos 2021,

[16] **Contributions:** I developed the research question for this chapter, conducted data analysis and wrote the chapter. The survey and interview protocol for the data collected during the pandemic was jointly developed with JDL, JEC, MB, EM, EW and PJC. Data collection was conducted by IM and SW with logistical support from EM and NW with oversight from JDL and me. MB, JEC, JDL and MB provided advice on the research question design, data analysis and paper structure. JDL, MB, and JEC provided feedback and editing.

Mottaleb et al. 2022, Vos et al. 2022). In the face of these kinds of shocks, people are forced to adapt in order to maintain their livelihoods, food security and wellbeing (Adger et al. 2003). However, different people can respond to similar impacts in diverse ways, from implementing short term strategies to ride out the shock, to adjusting existing practices to fit their new circumstances, or even completely changing key aspects of their way of life (Béné and Doyen 2018).

Whether, and how, people respond to shocks is shaped by their adaptive capacity, that is, their ability to minimise, cope with, take advantage of, and recover from the changes they experience (Adger and Vincent 2005, Gallopín 2006). Adaptive capacity is not a one-dimensional characteristic; rather, multiple interconnected factors such as people's access to financial and material resources, knowledge, and social capital are all theorised to facilitate different aspects of adaptation (and thereby comprise different aspects of adaptive capacity (Yohe and Tol 2002, Mortreux and Barnett 2017, Cinner et al. 2018a)). However, most adaptive capacity literature remains theoretical; takes a limited definition of adaptive capacity; measures adaptive capacity without directly linking it to responses; or is based on analyses of hypothetical scenarios and proactive actions (Mortreux and Barnett 2017, Cinner et al. 2018a, Berrang-Ford et al. 2021). Little research to date has empirically examined how different aspects of adaptive capacity are associated with different types of adaptive responses, (Barnes et al. 2020, Salgueiro Otero et al. 2022, Salgueiro-Otero et al. 2022). Additionally, while there has been research on interactions between some of the factors associated with adaptive capacity (for example there is extensive evidence linking social networks and access to resources both within and beyond the adaptive capacity literature (Lin 1999, Adger 2003a, Dapilah et al. 2020)), there has been little systematic consideration of these interactions within the empirical research on the multiple factors associated with different adaptations (Cinner et al. 2018a). A better understanding of the multiple dimensions and functional mechanisms of adaptive capacity is critical for proactively preparing to deal with future shocks arising from the climate crisis and other inevitable social and ecological changes.

5.2.1 The spectrum of adaptive responses

Responses to shocks can vary in scale from strategies to minimise impacts whilst avoiding significant long term changes, to complete reorganisation of social-ecological system structures (Béné and Doyen 2018). There is a wide range of terms used to categorise different types and levels of adaptive behaviours within and across disciplines and scales, which can lead to confusion unless terms and their intended meaning within a given context are clearly defined (Gallopín 2006, Smit and Wandel 2006, Jakku and Lynam 2010, Béné and Doyen 2018, Zanotti et al. 2020) (e.g., see Berman et al. (2012) for a summary of various definitions of coping, coping capacity, adaptation and adaptive capacity). In this

chapter, I use *responses* as a general term to refer to any kind of changes made in response to an experienced or anticipated shock. I then break these responses down into three different categories or levels: coping strategies, incremental adaptations, and transformations (**Fig. 16**). I define *coping strategies* as short-term responses aimed at buffering, absorbing or "riding out" the immediate effects of shocks, with the intention of returning to the previous status-quo (Corbett 1988, Lemos et al. 2013). *Incremental adaptations* refers to adjustments to existing practices and system structures in response to changes in external drivers, which still maintain the general system functions and characteristics (Nelson et al. 2007, Béné et al. 2014). *Transformations* are more fundamental changes, generally implemented when shocks make existing practices untenable, including novel, large scale adaptations, relocations, or alterations to dominant system structures, and are associated with major, sustained changes in social-ecological relationships and outcomes (Walker et al. 2004, Kates et al. 2012, Béné et al. 2014, Filho et al. 2022). It is important to note that degree to which a given adaptation is incremental vs transformative is best represented by a spectrum, rather than discrete categories, and can vary between individuals and contexts (Manyena 2006, Kates et al. 2012, Lemos et al. 2013, Béné et al. 2014, Barnes et al. 2017) (**Fig. 16**). However, these kinds of discrete categories do draw out some key distinctions and can be helpful for unpacking complex concepts (Béné et al. 2018), which is why I have chosen to use them.

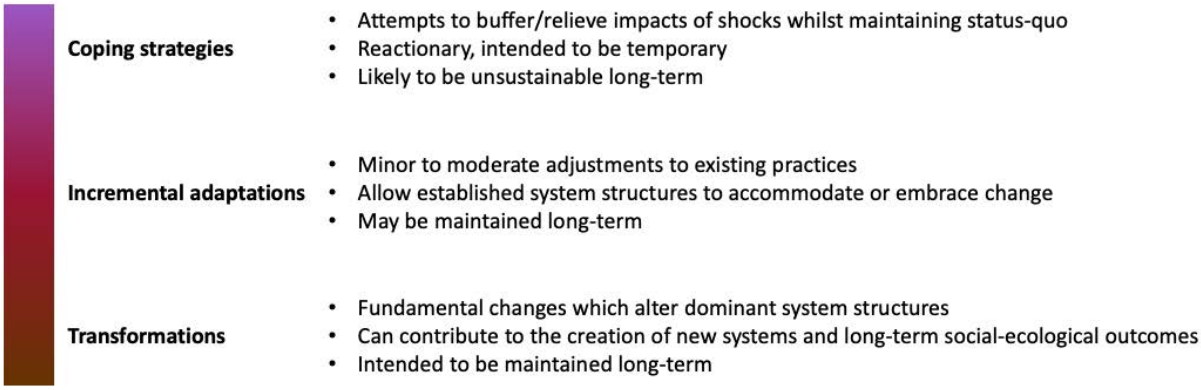

Figure 16: Spectrum of levels of adaptive responses from coping strategies to transformations

Responses at all three levels can lead to neutral, positive, or negative outcomes (or a combination thereof) for different actors and the broader social-ecological system they are embedded in (Turner et al. 2010, Adger et al. 2011). Responses that result in primarily negative outcomes are termed *maladaptive* (Scheraga and Grambsch 1998, Juhola et al. 2016, Magnan et al. 2016, Schipper 2020). Coping strategies frequently become maladaptive if maintained long term, particularly in the context of individual or household food and income insecurity, as they are intended to be temporary stop-gap measures and are often unsustainable (Maxwell 1996, Lemos et al. 2013). For example, during shocks

like famines, natural disasters, recessions, conflicts, and other events which disrupt food affordability, people often increase their proportional intake of cheap, filling, but generally low-nutrient staple carbohydrates like rice and maize and reduce the proportion of animal-sourced proteins and vegetables (Compton et al. 2010, Hoang 2018). This allows them to consume the same quantity of food at a lower cost, but can lead to micronutrient deficiencies and associated long-term health issues in the medium-to-long term, particularly for children and women of reproductive age (Torlesse et al. 2003, Bloem et al. 2005b, Amuna and Zotor 2008). Coping strategies are also often associated with eroding long-term adaptive capacity, for example expending assets or undermining overall health (Corbett 1988, Lemos et al. 2013). On the other hand, shocks have the potential to be tipping points which prompt paradigm-shifting transformational responses and can lead to more sustainable and beneficial futures (Herrfahrdt-Pähle et al. 2020, Markard and Rosenbloom 2020, Brulé 2023, Csutora and Zsóka 2023). For example, in small-scale fisheries, COVID-19 saw much-needed general worker health and safety protocols instigated and new local food supply chains and distribution methods established (Bassett et al. 2021). The factors which lead to coping strategies vs. incremental adaptations vs. transformations are likely to be different, stemming from different levels and forms of adaptive capacity (Wilson et al. 2013, Béné and Doyen 2018).

5.2.2 Adaptive capacity

There are multiple conceptualizations of adaptive capacity which emphasize different (though often overlapping) critical components at different scales and in different contexts. For example, the seminal Third IPCC report proposed six key elements which determine the ability to respond to climate change at the community or region level (economic wealth, technology, information and skills, infrastructure, institutions, and equity) (IPCC 2001). Ivey et al. (2004) and Adger (2003b) emphasise the importance of effective institutions and social capital. Adger and Agnew (2004) and Grothmann and Patt (2005) highlight the importance of less tangible factors such as whether there is recognition of the need to adapt, the desire to adapt, and belief in the ability to do so; and Vincent (2007) concludes that institutional responses, and the availability and accessibility of resources are common core components, but are operationalised in different ways across scales. Recently, Cinner and Barnes (2019) integrated diverse research across the social sciences to bring these insights together into a cohesive framework for understanding adaptive capacity (**Fig. 17**). The framework outlines six interconnected domains of adaptive capacity, which can facilitate or act as barriers to responses: assets, flexibility, organisation, agency, learning and socio-cognitive constructs. *Assets* consist of the finances, technology and services which people have access to, both individually and collectively (Cinner et al. 2009a, McClanahan and Cinner 2011). *Flexibility* refers to the ability to choose from a

diverse range of strategies (Cinner et al. 2018a). *Social organisation* refers to the formal and informal relationships between individuals, communities, institutions and governance structures at multiple scales which enable or inhibit people's responses (Adger 2003a, Cinner et al. 2018a). *Learning* is about people's capacity to not only access information, but process it to identify change, make causal attributions, evaluate potential responses and manage uncertainty (Fazey et al. 2007, Cinner and Barnes 2019). *Socio-cognitive constructs* are the mental frameworks such as risk attitudes and cognitive biases which shape people's perceptions of shocks, the necessity and possible benefits of potential responses, and ultimately decisions about whether and how they should act (Mortreux and Barnett 2017). In the context of adaptation, *Agency* is the power to make free choices about whether or not to utilise the other domains of adaptive capacity to make changes, and if so, how (Brown and Westaway 2011, Cinner et al. 2018a).

Figure 17: Framework outlining six interconnected domains of adaptive capacity: Flexibility- the ability to choose from a diverse range of strategies; Organisation- the formal and informal relationships between individuals, communities, institutions and governance structures; Learning- the ability to access and process information to identify change, make causal attributions, evaluate responses and manage uncertainty; Socio-cognitive constructs- mental frameworks such as risk attitudes, cognitive biases and social norms which shape perceptions of shocks and potential responses; and Agency- the ability to make free choices about whether and how to change (Cinner and Barnes 2019). Used with permission.

Importantly, high levels of adaptive capacity in any of the six domains do not automatically lead to responses and may lead to both positive and negative outcomes. For example, increased access to more efficient fishing gears (assets) may result in temporary benefits in the form of higher catches, but in the long-term cause an ecological collapse (Cinner and Barnes 2019), and highly connected, cohesive groups (social organisational structures) can become rigid and reject new ideas and opportunities to adapt (Bodin and Crona 2009, Barnes et al. 2022). Additionally, these domains are interlinked; for example, social networks can facilitate access to assets and learning opportunities (Barnes et al. 2017).

5.2.3 Adaptation to COVID-19

The COVID-19 pandemic provides an opportunity to examine how people respond to multi-dimensional shocks, what factors influence their ability to make different kinds of adaptations, and how those factors interact with each other. Both the outbreak of the disease and the subsequent policies across the world to slow its spread have had wide-ranging impacts on human wellbeing, food and nutrition security, and livelihoods. These outcomes are the result of disruptions to food production and value chains, increased food prices, unemployment, infrastructure breakdowns, a reduction in social support systems and overall economic decline (Béné 2020, Erokhin and Gao 2020, Harris et al. 2020, Schmidhuber 2020, Kundu et al. 2021, Love et al. 2021, Sutcliffe et al. 2023). These kinds of disruptions are likely to reoccur with increasingly frequent and severe natural disasters and resource conflicts under climate change. As such, some of the lessons from experiences and responses to COVID-19 may be applicable to future shocks (Manzanedo and Manning 2020, Cooper and Nagel 2021, Negev et al. 2021, Pelling et al. 2021). Much of the research on the social and economic effects of the COVID-19 pandemic to date has focused on documenting impacts and identifying adaptations (Stephens et al. 2020, Belton et al. 2021, Love et al. 2021, Tripathi et al. 2021, Alam et al. 2022, Schreiber et al. 2022, Khan et al. 2023, Marsden et al. 2023). There is still a need to understand the different types of adaptive responses people made or did not make, and more importantly, why. This information can help inform policies and programs that will build adaptive capacity and help communities to navigate future shocks more effectively.

In this chapter, I empirically examine the role of the multiple domains of adaptive capacity in shaping various responses to the COVID-19 pandemic, using the five small-scale fishing communities on the south coast of Kenya described in Chapter Two as a case study. I first explore the types of responses community members made across the first year of the pandemic. I then examine how each of the six domains of adaptive capacity facilitated or acted as a barrier to responses or where a lack of adaptive capacity forced people into making changes they did not want. I explore some of the

interdependencies between the six domains, and then conclude with some reflections on the applicability of this research to responses to other shocks, such as extreme climate events.

5.4 Methods

This chapter is based on interview data from the five coastal communities in southern Kenya described in Chapter 2.2.1. The interviews were conducted following the methods described in Chapter 2.3.

For this chapter, I analysed the interviews in NVivo using a combination of deductive and inductive coding, following standard qualitative research principles (Newing et al. 2011, Linneberg and Korsgaard 2019). I first open-coded the interviews to identify specific coping strategies, incremental adaptations and transformations participants either made or wanted to make (but were unable to do so) in response to the impacts of COVID-19. Similar responses were grouped to facilitate interpretation (see **Table S4** for full list of codes). Importantly, while there is a focus on temporary vs. long term changes in the definitions of coping strategies, incremental adaptations, and transformations, in this instance I based my categorisations on actor intention when the change was first made rather than the actual long-term outcomes. For example, a coping strategy (such as a reduction in household food expenditure) may have been maintained for a long time, even if that lead to negative outcomes, and an incremental or transformative action with the potential to lead to substantial long-term change (such as switching livelihood activities) may have been reversed relatively quickly. Additionally, the timelines for determining whether a particular adaptive response was ultimately successful or not varies based on what the adaptation is, for example it is likely to be evident fairly quickly whether changing the location where someone sells fish results in more sales and/or better prices fairly quickly. On the other hand, it is likely to take at minimum a full harvest cycle, and more realistically several, to determine whether investing in agriculture was a good long-term food and income strategy. As such, I did not make conclusions about the success or failure of particular adaptations beyond identifying coping strategies which are well-established in the literature to be unsustainable in the long-term.

I then deductively coded each adaptation to one or more of the six domains of adaptive capacity which either facilitated the adaptation, acted as a barrier to the adaptation, or where a lack of capacity forced people into making an undesirable (mal)adaptation. While in some cases participants explicitly identified things that facilitated, prevented, or forced adaptations, in other cases I had to infer the relevant domain(s) from context. For example, when people talked about using ice to preserve fish overnight because they could not sell it when they returned from sea in the evenings due to the curfew, I inferred that they were drawing on assets (i.e., buying ice or owning a freezer, which is rare). This method of inference from qualitative interviews is particularly appropriate for researching

complex behaviour and motivations in highly context-specific situations where pre-defined survey tools may not be sufficiently nuanced, and/or where there are constraints on data collection which make large-scale quantitative approaches impractical (Denzin 2005, Cox 2019, Bercht 2021).

Participants' descriptions of specific containment policies and processes were cross-checked against the interviews with community leaders and fish traders, with government and development agency communications, and with insights from in-country partners where additional context was required for interpretation. I consulted extensively with co-authors and in-country partners to review the coding, resolve uncertainties, and clarify interpretations.

The majority of the results presented are purely qualitative, though in some instances I have reported basic quantitative data about the frequency of different responses. I could not statistically test for differences in responses between communities due to the small sample size, which would make any such tests underpowered. However, despite the moderate differences between the communities described above, general exploratory analysis indicated a high degree of heterogeneity in the responses of different individuals within communities, with no clear evidence of community clustering (**Fig. S2**). As such, I have combined results across all the communities where I have presented quantified results.

5.5 Results

5.5.1 Responses to the shock

Based on my interviews, I identified 206 instances where individual participants (not including leaders and traders) made a change in response to the impacts of COVID-19 in the first year of the pandemic (**Fig. 18**). These included 64 unique responses which I subsequently grouped into 17 broad categories, nine of which I classified as types of coping strategies, six as types of incremental adaptations and two as types of transformations (**Fig. 18, Table 6, Appendix 9, Table S1**).

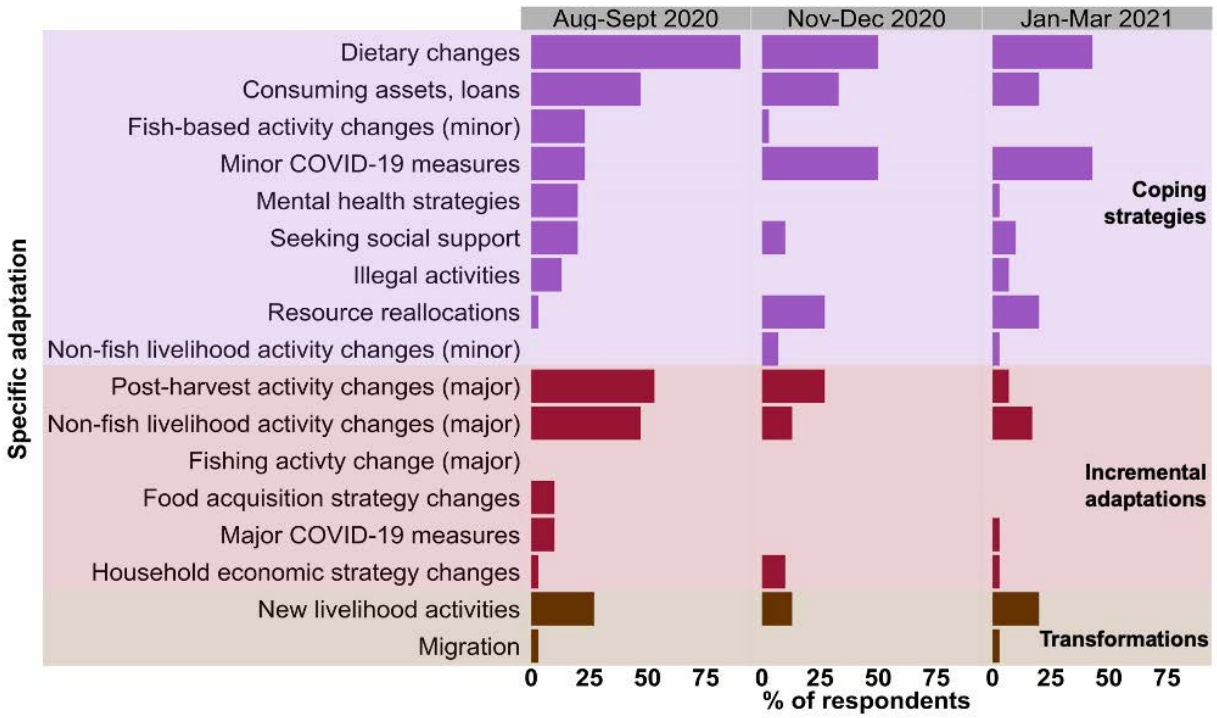

Figure 18: Percentage of individual respondents who engaged in each category of response in each of the three time periods (not including leaders and traders) (n=36). Colours indicate the level of response (coping strategy, incremental adaptation, or transformation). See Appendix 9, Table S4 for additional explanation and examples of specific responses in each category.

Table 6. Examples of coping strategies, incremental adaptations, and transformations undertaken in coastal Kenya as a result of COVID-19 and its containment policies.

	Example 1	**Example 2**
Coping strategies	Consuming less food: "We were forced to change because when you get fish and don't sell them, if you used to cook 2kg of ugali you'll be forced to reduce and only cook 1/2kg for children to eat and drink water and call it a day. That's how it was, when you became lucky to get breakfast, you skip lunch and eat supper." (F, 46, community B)	Selling productive assets at low prices: "When corona started, we had goats and chickens and we sold them one by one to get money for food…When corona started the only source of income was the animals and there was no money, so you are forced to sell very cheap compared to what you really expect." (M, 21, community A)
Incremental adaptations	Changing proportional effort invested in different livelihood activities:	Selling fish to consumers directly instead of through traders:

	"We used to juggle between casual construction works and fishing but now I spend most time fishing." (M, 24, community B)	"When I came with fish there were no fish traders to sell the fish to, so I was forced to walk from house to house to sell them"
Transformations	Migrating:	New livelihoods:
	"In towns the population has decreased, and many people have gone back to their rural homes. They moved from towns where they were used to living and where they were supposed to get jobs, but they are not there now." (Leader, community B)	"I am doing farming. I got a plot and did a tomato nursery with 900 seedlings. So, I sell one bucket at KES500 (~4USD) and at least get some profit. I saw that it is better to have a tomato nursery." (M, 48, community B)

While I did not aim to rigorously quantify and statistically evaluate the extent to which people adapted given the small sample size and variable scales of different response strategies, I did note that each respondent adopted multiple different strategies at some point in the first year, and the diversity of strategies individuals were engaging in decreased through time. Most responses were made in the first six months, when the most stringent restrictions were in place (n=130, ~ 3.6/participant). Most responses were either maintained throughout the study period, or early strategies were dropped in later periods as restrictions eased (including adaptations and transformations which had the potential to be new long-term strategies, such as engaging in a new livelihood activity) (n=74 (~2/person) in time 2; n=64 (~1.7/person) in time 3), with few examples of people switching from one strategy to the next through time. The two main exceptions where particular responses were increasingly used in later rounds were an increase in strategies to mitigate the risk of COVID-19, and changes in household resource allocation and economic strategy (e.g., changing which expenses were prioritised in household budgets and decisions around making major new investments).

5.5.1.1 Coping strategies

All participants reported implementing coping strategies to relieve the immediate impacts, particularly income loss, and many maintained these strategies throughout the study period. 93% of households reported making at least one dietary change in the first round of interviews in July-October 2020, with 43% maintaining at least some dietary changes through to early 2021. These changes generally involved a combination of reducing dietary diversity, reducing total food intake (both smaller and less frequent meals), eating less preferred but cheaper foods, and increasing the consumption of household fish catch and home-grown or foraged foods instead of purchasing food.

Some participants were able to seek out social support (e.g., cash, food supplies), either from friends and family or from institutions, particularly in the initial months. Several participants took out cash loans or store credit to cover immediate needs. Some found repaying these loans difficult because income remained low for some time. By October 2020 several participants had used savings or sold or consumed household assets (e.g., livestock), often at reduced prices, to make up for lost income. This strategy became less common in subsequent interview rounds, either because financial pressure was reduced, or assets had been exhausted.

Some participants reported engaging in illegal activities, particularly breaking curfews and other COVID-19 restrictions, because they felt that the consequences for not complying with restrictions were less severe than the threat of food insecurity, even though many participants described strict and at times violent enforcement of rules. Multiple participants and community leaders also mentioned an increase in crime in their communities as people became desperate. Participants also implemented a range of minor adjustments to their daily lives to limit their exposure to COVID-19 (e.g., avoiding public spaces and setting up hand washing stations), and these increased throughout the study period as people became more aware of both risks and containment strategies.

5.5.1.2 Incremental adaptations

Participants made a range of incremental adaptations to their livelihoods and home lives, particularly during the first six months of the pandemic. Some of these were maintained through subsequent rounds of interviews, and some new incremental adaptations were adopted in subsequent rounds, but most people returned to previous practices once things returned to "normal" towards the end of 2020. Incremental adaptations included selling fish in communities within their counties instead of to traders for export to Mombasa; fishing during the day instead of at night to comply with curfews; and introducing post-harvest processing activities such as freezing, drying, or cooking catch instead of selling it fresh. However, many returned to selling fresh catch to traders for export when restrictions were lifted. In addition, many participants shifted the proportional effort they were putting into different livelihood activities they were already engaged in—though what this adaptation looked like varied significantly by community, sometimes in directly contrasting ways. For example, in some of the communities, prior to COVID-19, a much higher proportion of people had paid work in factories, tourism, or construction etc., and only fished occasionally to supplement their income or for direct consumption. When many of these industries all but shut down, those people turned to fishing as their primary livelihood. In contrast, in the communities which were more heavily reliant on fisheries for income, particularly fishing for high-value fish to sell in Mombasa markets and to tourist hotels, people who would normally only occasionally take on casual construction jobs or informal economic activities like selling snack foods or doing laundry increasingly relied on that work to supplement lost

income from fisheries when fish value chains broke down. Similarly, some participants increased their investment in farming at various scales, either planting a larger area in agricultural communities, or expanding household gardens to grow at least a few additional vegetables to consume or sell. However, this strategy again varied by community, primarily based on availability of arable land.

5.5.1.3 Transformations

Relatively few participants made major transformations, as defined here. Some participants migrated out of their communities in the hope of being able to find work elsewhere. Community leaders also mentioned migration from communities, particularly in the communities with initially higher rates of formal employment. Some participants took up completely new livelihood activities, for example switching from fishing to farming. However, these switches likely had mixed results. For instance, one leader stated that these were not always beneficial changes, as people were switching to low-income livelihoods, and often lacked the knowledge and experience to make them successful. In addition, the pandemic coincided with a severe drought, which severely undermined the potential benefits of investing in agriculture as a transformative strategy.

5.5.2 Role of the six domains of adaptive capacity

I identified three mechanisms through which adaptive capacity influenced responses to the impacts of COVID-19. 1) High capacity in a particular domain enabled people to take a specific action; 2) low capacity in a particular domain forced people to take a specific undesirable action; and 3) low capacity in a particular domain prevented people from taking a desired action. I classed adopting a particular strategy as using adaptive capacity to facilitate an action when people were consciously choosing to take a particular action, even knowing it may have negative outcomes. In turn, I identified a lack of capacity forcing an undesirable action, when people were forced to take that action due to a lack of other viable alternatives. Almost all of the responses people felt forced into due to a lack of adaptive capacity (particularly a lack of assets) were coping strategies with a high potential to become maladaptive when sustained too long, such as reducing dietary diversity (**Fig. 19**). A relatively high proportion of the responses that people were prevented from making due to a lack of adaptive capacity were the more substantial, transformative responses. Each of the six domains of adaptive capacity were important for facilitating or preventing various responses, though to varying extents, and a lack of assets, agency, social organisation, and flexibility all forced people into taking undesirable actions (**Fig. 19, Table 7**).

Table 7: Examples of how each of the domains of adaptive capacity influenced responses through each of the three mechanisms: 1) Facilitated- high capacity in a particular domain enabled people to take a specific action; 2) Lack forced- low capacity in a particular domain forced people to take a specific undesirable action; and 3) Barrier- low capacity in a particular domain prevented people from taking a desired action.

AC domain	Facilitated	Lack forced	Barrier
	**A)** Flexibility to switch between locations and strategies for selling fish, for example going door to door allowed people to maintain income when markets closed. "We used to get challenges to sell. Sometimes we used to fry them and put in a basin and go around door to door to show people that we have fish." (M, 45, community B)	**B)** Forced to increase fishing effort and fish illegally at night due to lack of alternative income sources: "The fishing duration was short, and you were forced to secretly fish more hours. I was forced to go fishing at night although it was dangerous as I could be arrested." (anonymised)	**C)** Unwillingness or inability (whether perceived or objective) to do anything other than fishing/fish trading prevented income diversification: "We are used to fish trading and cannot leave doing it." (F, 38, community A)
	**D)** Social capital allowed people to obtain food on credit: "I was going to the shop and taking my bundle of maize flour, take baking flour, like 10kg, then I write in an agreement that when I get money, I will pay…And at the time like that I was trusted so much because I was taking food from other shops on credit and was paying in bits until I was clear." (M, 27, community E).	**E)** Lack of trust that other people would obey rules led to people not going to church and other social activities: "The church is attended by different people, and you cannot easily know who is good and who is bad. People are also disobeying rules and so I reduced going there." (M, 21, community A)	**F)** A lack of connections prevented access to financial support: "I have not seen any support. I am just seeing things happen and yet I have a family just like that. I don't know which door the support is passing through. Even I don't know who ate the money…Every Monday people are getting KSH2000, but myself I am not self-dependant, and I am getting nothing and have children." (F, 46, community C)
	**G)** Perceived risk and strong sense of social obligation to protect others led to the adoption of COVID-19 mitigation strategies: "I observed how everyone behaves and realised everyone believes in themselves, washes hands, wears face masks and when leaving the house wears gloves so that we protect ourselves well. When one gets dirty, they wash hands, as I tell everyone to be cautious because we are one family and should avoid touching each other as we are close to each other so that we are safe. (F, 42, community D)	(Not applicable, as you cannot have a "lack" of socio-cognitive constructs, as they are a way of thinking rather than something that can be quantified.)	**H)** Social norms around self-sufficiency lead to a lack of support from leaders: "That's an individual case whereby you try to see what your family will eat. As a community, it's just to give each one a hand of advice but not a handout in order to support each other, and that is why the Swahili came up with a saying that 'Everyone is to carry his cross,' okay?" (Leader, community E)

I) High self-efficacy facilitated strategic planning and proactive livelihood diversification:
"I had thought to sit down with my husband to talk about how life is and see how we can improve on our wellbeing…The biggest business I have seen here that can help me in my life is to build a rental house…therefore I have a piece of land to build." (F, 38, community C)

J) Forced to sell fish to traders on credit and wait for them to pay when they receive income due to lack of power:
"You are forced to sell fish on credit, and you may be given KES200 (1.6USD) and told you will be given the balance later but every day you just wait and be told the same thing." (M, 30, community D)

K) Perceived lack of alternative options and family obligations prevented migrating to find work:
"No, I have not done anything for now. I don't know what to do or where to go. What will I leave my family with before I go anywhere? If I had something to leave behind, I would go look for income somewhere else because I will be going to start a new life while leaving a burden at home." (M, 30, community A)

L) Ability to interpret and respond to other people's fishing practices and market supply and demand trends lead to switching gears to target potentially less exploited species and/or fill a market gap.
"We stopped using spearguns as many were using them and we looked for nets." (M, 21, community B)

(No examples identified)

M) Lack of knowledge and experience, and an inability to learn quickly and effectively limited the success of new livelihood activities:
"Remember, you have been forced to change to a place where you don't have any skills to utilise to get your daily needs. Therefore, you are just going there to try to do something but in the real sense you're not doing it. So, the income they are getting from what they are doing cannot sustain the demand they have" (Leader, community B)

N) Assets like electricity connections and farmland allowed livelihood diversification:
"The change that we made is that I looked for small hustles at home. For example, we have electricity that I used to sell water to the villagers and planted some vegetables which I used to sell to people." (M, 25, community C)

O) Selling productive assets at low prices due to lack of cash income:
"People have been forced to slaughter many animals before they reach maturity to meet their needs because they have nothing… again when you look at the environment you find that whatever you have, you're forced to sell at throwaway prices so that you get money to use. Therefore, we have been losing our assets cheaply like that" (Leader, community B)

P) A lack of start-up capital prevented livelihood diversification:
"I don't have an alternative livelihood apart from mining business. I used to play merry-go-round but when corona came and made me lose my fish business, it became very hard for me to be a member of merry-go-round. That could have been the only means to get capital to restart my fish business." (F, 29, community D)

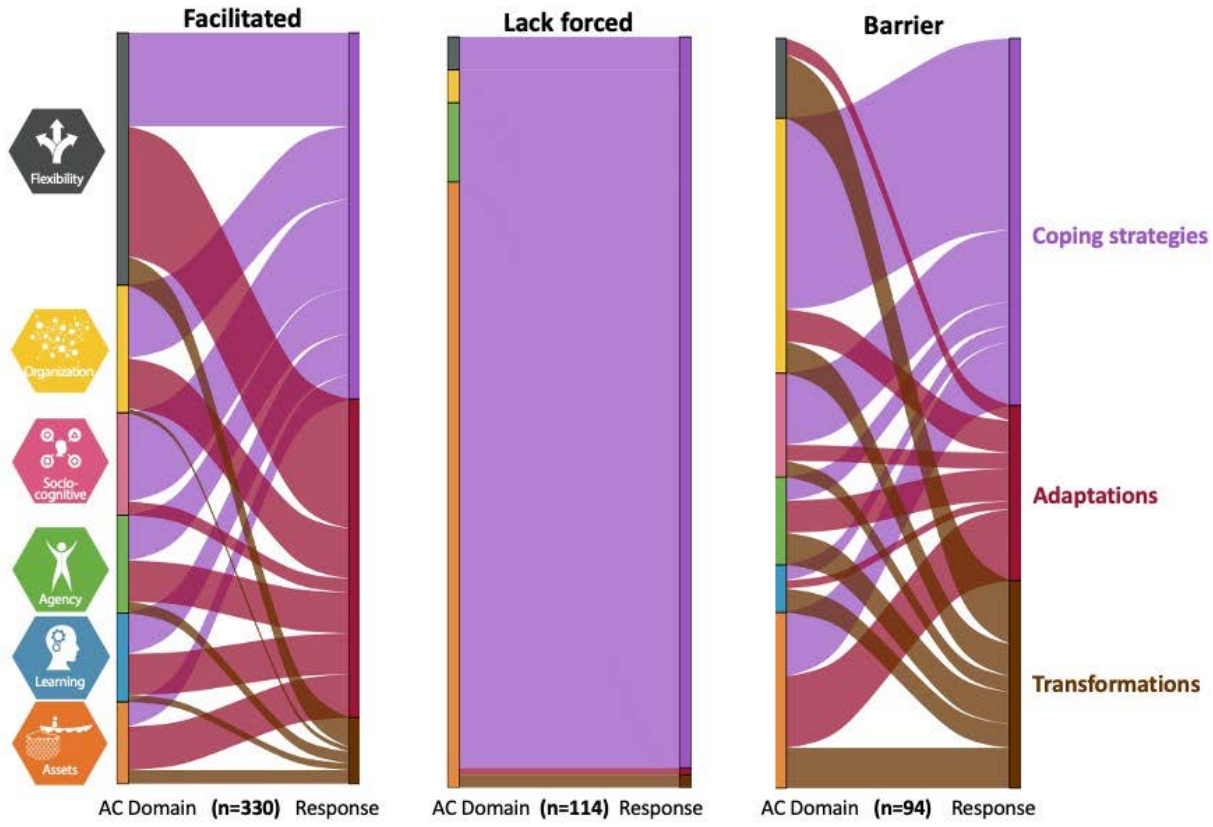

Figure 19: Relationship between responses and adaptive capacity domains. Alluvial plots showing A) which domains of adaptive capacity facilitated specific responses, B) where a lack of a specific domain forced people into taking an undesirable action; and C) where a lack of a specific domain was a barrier to a planned response, aggregated across all three time periods. The thickness of segments on the axis and the bands indicate frequency. The colours on the left axis correspond to the Adaptive Capacity Framework (Fig. 17). The colours of the bands and right axis indicate the level of response (Fig. 16).

5.5.2.1 Flexibility

Flexibility was critical to facilitating responses at all levels, but particularly incremental adaptations to livelihoods and diets. That is, people who already had multiple options available to them, and/or who were already engaged in a diverse range of activities were able to shift strategies and transition effort more easily to less-effected food and income sources. For example, people who had other jobs, but occasionally fished, were able to increase their engagement in fishing when they lost other work without needing to obtain additional skills or equipment. As restrictions and behaviour patterns fluctuated, some Mama Karangas (female fish traders) exercised flexibility to deal with extreme shifts in fish supply, demand, and pricing. To maintain a business presence and attempt to maximise their profits as circumstances changed throughout the course of the pandemic, they switched between buying fish at landing sites and fish shops; and selling fish from stalls at the side of the road, from their homes or going door to door, and changed the species of fish they bought and sold depending on who

was buying and at what prices. In contrast, other women and men either could not or would not alter, diversify, or switch livelihood strategies. They were unable to identify potential adaptations to existing livelihood activities and said that there were no alternative livelihoods available.

5.5.2.2 Social organisation

Social organisation (connections to other people and to institutions) was key for obtaining loans and social support, getting access to cold storage when fish could not be sold right away, and finding alternative markets when normal value chains broke down (**Fig. 19, Table 7D**). Some fishers and fish traders decided to share resources and distribute catch amongst themselves to minimise overheads and make up for reduced efficiency, particularly within groups that would normally work together every day but no longer could. Community A particularly benefited from strong, supportive social networks and effective, pro-active leadership. They were able to organise food donations for those most effected, create youth support programs, and distribute facemasks and information about COVID-19. In contrast, people without strong, established ties to shopkeepers were less likely to be able to get food on credit, and people with less friends and family struggled to find help. As one person put it "You will find that in the community if you don't have food you may ask from your friends and neighbours and they will give you, but if you are not used to people you may fail to get help." (Leader, community B). Arguably even more crippling was either a lack of ties to leaders and others with power and influence over resources, or when people in those positions were ineffective or corrupt (**Table 7F**). Many participants felt that there was significant bias in who was given aid and felt frustrated, angry, and let down when they did not receive private or government support when others did.

5.5.2.3 Socio-cognitive constructs

Risk perceptions and social norms influenced whether participants felt the need to adapt and change their livelihoods, implement COVID-19 mitigation strategies, and comply with restrictions (**Fig. 19, Table 7G**). In some cases, these perceived risks led to people pro-actively implementing mitigation strategies while still trying to maintain income and lifestyle. Other participants' perceptions of potential risks prevented action. They were concerned about the risks of contracting COVID-19, or about police shutting down small businesses, likely with extreme force, and felt it was safest to stay at home rather than attempting to find alternative ways to maintain their business or start new ones. Others felt there was no or minimal risk, and accordingly did not try to adapt to mitigate it. Others said that they were concerned about both the risk of contracting COVID-19 and of facing police enforcement but felt that the risk of food insecurity was more pressing and so continued fishing and other livelihood activities as normal. One participant said that if the government did not provide aid to compensate for lost income as promised, he was not going to comply with regulations and change

his behaviour. Social norms around self-sufficiency shaped whether people were willing to give or receive support to other community members (**Table 7H**).

5.5.2.4 Agency

Self-efficacy and perceived power were a key factor in whether people even tried to change their behaviours and mitigate the impacts of COVID-19. Some people actively evaluated their options and made strategic plans about how to maximise their income given the constraints they were under and then best budget and utilise the food and income they did get (**Fig. 19, Table 7I**). In contrast, multiple people said that if they could not buy and sell fish as normal, there was nothing else that they could do, even as others in similar situations around them were adapting. “There is nothing to do but just sell there and take whatever little you will get.” (M, 27, community E). They continued fishing or fish trading, even when they were not making a profit, or even actively losing money and not getting paid for their fish (**Table 7J**).

5.5.2.5 Learning

People’s ability to iteratively access and interpret information about the pandemic and associated rules and recommendations was a major driver of decisions about whether to proactively implement mitigation strategies and whether to comply with rules or continue in previous behaviours to maintain food and income security (**Fig. 19, Table 7L**). There was significant inconsistency in people’s understanding of what was happening and what the restrictions were, particularly in the first round of interviews. As information became more available, people were better able to make informed choices about whether and how to respond. Fishers and fish traders who were able to consistently identify market trends and adjust which species they targeted and sold, where and to whom, were better able to maintain their income. People’s level of success in adjusting or taking up new livelihoods was influenced by their previous knowledge and experience, and whether they were able to quickly learn and adapt if they tried something new (**Table 7M**). Multiple people commented that it was difficult for them to get information about the pandemic, fisheries, and other important topics, and to discuss and collectively develop ideas about possible adaptations due to social distancing requirements. For example, one community had recently started a seaweed farming project for women, and they were expecting to have people visit to help them learn how to do it more effectively, but that was no longer possible.

5.5.2.6 Assets

Almost all participants reported being “forced” into making trade-offs between multiple negative outcomes by adopting undesirable and even maladaptive coping strategies due to a lack of assets (**Fig. 19**). For example, most participants were forced to choose between reducing the quality, quantity, or diversity of their diets, or often a combination of them all, due to a lack of income. Some households

prioritised quantity, and others quality. In some cases, participants described situations where taking a particular maladaptive response created a negative feedback loop which continued to undermine their resilience and adaptive capacity. This pattern was particularly common when people sold or consumed assets or took out loans due to a lack of liquid capital and were then unable to recover as their economic circumstances worsened (**Table 7O**). One woman described how, when demand for fish dropped, she was unable to sell all the fish she was buying, meaning she did not earn enough money to cover costs to purchase more fish to sell on subsequent days. Without income to buy other food and to avoid waste, she and her family were forced to consume her fish supplies directly. (Mama Karangas (female fish traders) describe this as "eating capital"). She started collecting gravel as an alternative livelihood activity because it did not require start-up capital, but it is a labour intensive, low profit activity. As a result, she struggled to earn enough to make ends meet, was not able to save enough to continue participating in the women's rotational savings groups and was too tired to do other income-earning activities. She was unable to save up enough capital to re-enter the fish trade and was still collecting gravel in the final round of interviews after many other participants had returned to pre-pandemic livelihood activities and income levels.

5.5.3 Interactions between domains of adaptive capacity in influencing responses

I identified pairwise interactions between all the domains of adaptive capacity (**Table 8**). The clearest and most frequent examples of interactions between pairs of domains were between social organisation (ties to both peers and leaders) and the other domains. Organisation played a key role in facilitating access to aid and credit (assets) (**Table 8D)** and information and learning opportunities (**Table 8L**). Access to and understanding of information about COVID-19 and strategies for prevention was key to people's willingness and capacity to adapt their daily routines (**Table 8H**). Flexibility was often directly dependent on whether people had the necessary social ties, assets, learning ability, socio-cognitive constructs, and agency to switch strategies.

Table 8: Examples of pairwise interactions between domains of adaptive capacity

					
	**A)** Access to capital and supplies determined if strategies were possible (i.e., enabled flexibility) e.g., new livelihood opportunities which required inputs.	**B)** Access to phones determined whether people could participate in and influence community decision making when in-person meetings were cancelled and moved to online/calls and texts.	**C)** Access to technology largely determined access to information and learning opportunities when social distancing prevented personal interactions.	**D)** Social ties to leaders and other community members influenced access to credit, aid, and other assets.	**E)** Access to asset bases influenced people's perceptions of their ability to ride out the events of the pandemic vs. the need to adapt.
	**F)** Socio-cognitive constructs influenced which strategies people considered and whether they thought they were viable options, for example people who felt their identity was tied to fishing often said they felt they could not do anything else.	**G)** People's perceived ability to manage and control the events of the pandemic and their capacity to respond shaped decisions about whether and how to adapt.	**H)** Access to information and perceived reliability of information sources shaped risk perceptions and stimulated/prevented action.	**I)** Leaders' socio-cognitive constructs influenced whether they facilitated aid distribution and leveraged their own social connections to benefit the community.	
	**J)** Connections to/ collaborations with peers created new opportunities through resource sharing.	**K)** The inability to meet in person limited people's ability to participate in collective decision making about community fisheries management	**L)** Social distancing rules limited social interaction and therefore opportunities to learn from each other and develop ideas.		
	**M)** Access to information and the capacity for creative problem solving and sharing ideas shaped awareness of possible options and knowledge of how to implement them.	**N)** Increased understanding of the pandemic in later months allowed people to make informed, independent choices about how to balance mitigating COVID-19 risks and meeting other needs.			
	**O)** Agency (particularly self-efficacy) shaped perceptions of what options were available and viable.				

I also identified multiple more complex interactions between domains (**Fig. 20**). For example, interactions with experts coming into the community (facilitated by community leaders) to communicate with them about COVID-19 directly were particularly important for causing shifts in risk perceptions, thereby motivating, and directing prevention behaviours in a way that hearing news and recommendations from external media sources did not (**Fig. 20A**). This example demonstrates the complex interactions between social organisation, learning and socio-cognitive constructs. Relationships between peers within the community facilitated knowledge and resource exchanges which were critical for allowing people to start engaging in and succeeding in new livelihood activities or strategies, for example sharing equipment or providing advice on farming or different fishing techniques. In other words, social organisation facilitated learning and access to assets leading to increased flexibility (**Fig. 20B**). Additionally, agency and socio-cognitive constructs both shaped and were shaped by relationships between community members and leaders, and in turn influenced access to assets. In communities where leaders perceived that the pandemic posed minimal risk to their communities and believed that individuals had a responsibility to meet their own needs without external support, people within those communities did not receive timely aid and assistance (**Fig. 20C**). In comparison, in communities where leaders perceived the risk of COVID-19 and associated impacts on their community to be high, and felt they had the responsibility to support community members in meeting basic needs, they used their own influence to ensure resources were distributed to people most in need (**Table 8D, Fig. 20C**). On the other hand, expectation of aid and assistance from the government, combined with low-self efficacy, did mean that some people did not pro-actively adapt, and subsequently struggled when the promised aid was not delivered.

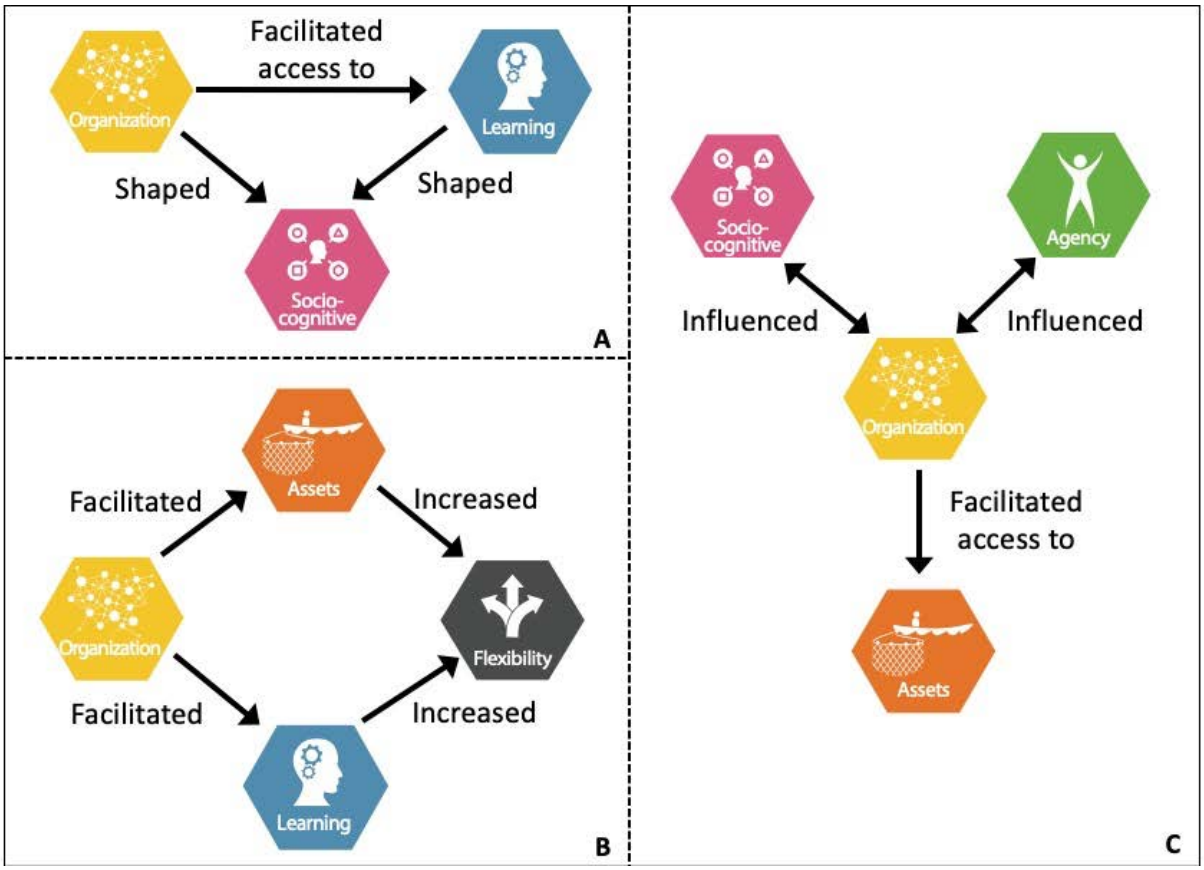

Figure 20: Examples of complex interactions between domains of adaptive capacity. (A) Interactions with experts coming into the community, facilitated by community leaders (organisation) to communicate with people about COVID-19 were particularly important for informing people about implications of the pandemic for their community and preventative actions they could take (learning). This more effective learning mechanism caused shifts in risk perceptions (socio-cognitive constructs), thereby motivating, and directing prevention behaviours in a way that hearing news and recommendations from external media sources did not. (B) Connections and collaborations with peers (organisation) meant that people were able to share knowledge and experience (learning) and resources like equipment (assets) which were essential to being able to participate in and succeed at new livelihood strategies and activities (flexibility). (C) Leaders' socio-cognitive constructs and sense of personal responsibility and agency determined whether or not they used their influence to support others in their community (organisation). In communities where leaders perceived that the pandemic posed minimal risk to their communities and believed that individuals had a responsibility to meet their own needs without external support, people within those communities did not receive timely aid and assistance. In comparison, in communities where leaders perceived the risk of COVID-19 and associated impacts on their community to be high, and felt they had the responsibility and capacity to support community members in meeting basic needs, they used their own influence to ensure resources were distributed to people most in need.

5.5.4 Long term implications of responses to the shock

Finally, my results suggest that how people drew on their adaptive capacity during the pandemic may have exhausted avenues for adapting to change in the future, especially projects that would have supported general resilience in the longer term. Specifically, many participants expressed concern that their experiences during the pandemic had undermined their long-term resilience and adaptive

capacity in the face of future stocks. Long-term projects and plans to develop new livelihoods and investments had been undermined. As one woman said, “I lack any business to improve on my life.” (F, 40, community E). People suffered from malnutrition as well as physical and mental health impacts, some of which lingered even as restrictions eased, and incomes improved. There was particular concern that children were missing school and that families did not have money for school fees when they reopened because they were struggling just to bring in enough money for food. They worried that their children’s futures had been harmed by increased crime, more frequent youth pregnancies, and a lack of education.

> “I really wished to get a chance to see at least my child going far with education. It would have been good. But right now, my life is not so good. Children are not going to school and my business is not stable. I am not so much educated but through my personal jobs I used to get my daily bread and push on like that with life. Before corona, my priority was about education for my children.” (F, 42, community D)

While the second and third round of interviews suggest that most people were able to resume their previous livelihood activities, improve their diets and resume their social lives once restrictions eased; there was ongoing concern about the long-term implications of these disruptions and associated maladaptations going forward due to lost momentum, reduced resource bases and missed opportunities.

5.6 Discussion

Throughout the first year of the COVID-19 pandemic, participants engaged in a range of adaptative actions; from coping strategies to incremental adaptations and even some transformations. Respondents described how all six domains of adaptive capacity helped them to respond to shocks, but also described how a lack of adaptive capacity forced them into taking undesirable actions and prevented planned responses. The six domains of adaptive capacity did not influence actions independently of each other, but interacted in complex ways to shape which responses people could, and did, engage in.

5.6.1 The spectrum of adaptive actions

Participants primarily engaged in coping strategies and incremental adaptations, with relatively few transformations. These strategies were broadly similar to the kinds of responses that other low-income rural households engaged in during the pandemic. For example, Belton et al. (2021) also identified that people involved in aquatic food value chains across Asia and Africa similarly responded to COVID-19 by altering fishing and fish processing activities, diversifying their livelihoods, drawing on

social networks and reducing food consumption. This is also consistent with response patterns during previous social, economic, and environmental shocks which have disrupted food and income security. In a metanalysis of household data from responses to diverse shocks in 35 countries from 2014-2020, d'Errico et al. (2023) found that while there were some patterns of difference in the kind of responses people took to different types of shocks, changing consumption patterns, livelihood diversifications, selling assets, taking out credit and drawing on social support networks are consistently the most common responses. The strong dependence on coping strategies relative to adaptive and transformative strategies is also consistent with what has been observed in other rural food-producing communities during COVID-19 (Meuwissen et al. 2021).

There are several likely explanations for why relatively few people undertook potentially transformative responses (for example engaging in new livelihood activities), and even fewer maintained them once restrictions eased and they could return to previous ways of life. Implementing radical transformations is harder and more confronting than implementing coping strategies and incremental adaptations. This is particularly the case in situations with a high degree of uncertainty, high perceived costs of transformative action, and institutional and behavioural barriers which reinforce the status quo (Kates et al. 2012), all of which occurred during COVID-19. Indeed, transformations involving substantial livelihood changes or relocations are often perceived as actively undesirable in contexts where people have a strong sense of occupational and place attachment (Marshall et al. 2012), as is the case for many small-scale fishers (Urquhart and Acott 2013, Johnson 2018). With some exceptions, the interviews indicated that most participants did not take transformative actions because they felt that transformations were not necessary, rather than because they were prevented from making desired changes due to a lack of practical capacity (it should be noted that the perceived necessity and desirability of change is a psychosocial component of adaptive capacity). There was a common perception that the pandemic was likely to be over quickly, and people needed to just "make do" until restrictions lifted, meaning that permanent transformations were not considered necessary and desirable. In general, the way people frame problems, particularly relating to scale, can place limits on the potential solution space they consider and whether they prioritise immediate needs or long-term resilience in their decision making (Adger et al. 2011). This framing of the pandemic as a sudden but temporary hindrance to get through rather than a long-term shift to adapt to is a major point of divergence between perceptions of and potential responses to the pandemic and climate change, which is a protracted, escalating crisis (Pahl et al. 2014). As such, it limits the extent to which we can draw direct comparisons between people's responses to COVID-19 and their ability to make transformative changes in response to recuring and

protracted climate impacts. This is an ongoing issue within resilience and adaptation research, which is dominated by studies of relatively acute shocks (Sabates-Wheeler et al. 2022).

The relative lack of long-lasting substantial adaptations and transformations identified in this study does not necessarily indicate that fishers in these communities fundamentally lack the ability to transform, should they see it as necessary in response to future shocks with more permanent ramifications. Even though relatively few participants appear to have maintained substantial changes after restrictions eased, their experience responding to the pandemic, and observing the responses of others, even ones which were subsequently abandoned, may have been a learning opportunity which increased their awareness and understanding of adaptive and transformative options available to them in the face of future shocks, as well as their sense of self-efficacy. Indeed, the ability to use experiences to inform future planning and proactive adaptation is itself part of adaptive capacity (Engle 2011). It should be noted that much of the research around how learning from previous exposure to shocks can increase adaptive capacity has focused on repeated experiences of specific environmental shocks which are anticipated to occur with increasing frequency and severity under climate change, for example exposure to floods or wildfires, and not on the transferability of lessons across different kinds of shocks (Lebel 2013, Kroepsch et al. 2018, Aryal et al. 2020). However, while the specific causal factors behind the pandemic vs. a particular climate-driven environmental crisis may be different, the immediate affects which people need to respond to, such as disruptions to disruptions to food production and supply chains, income insecurity, and breakdowns in infrastructure and support systems are likely to be similar (Manzanedo and Manning 2020, Cooper and Nagel 2021, Negev et al. 2021, Pelling et al. 2021). As such, observations of what strategies people used to deal with these secondary impacts during the pandemic, whether or not they were successful, and their long- and short-term consequences, may be directly transferable.

5.6.2 Leveraging the six domains of adaptive capacity

I found that all six domains of adaptive capacity played a role in shaping responses. I did find that people drew on some domains more often than others, though this was likely both a function of how helpful that domain can be, but also the level it was present in the communities. For example, I found that flexibility was the most utilised domain, and assets the least. This finding does not mean that assets are not helpful and capacity building efforts should focus primarily on flexibility as the most useful domain. Instead, it likely reflects the overall low-asset base in the communities to begin with. There is significant evidence from both this research and the long history of capacity building research and interventions that a lack of assets is strongly associated with the adoption of maladaptive coping strategies, which create a negative feedback loop of diminishing asset bases and reinforcement of

poverty traps (Dercon 1998, Siegel and Alwang 1999, Lemos et al. 2013), and having assets increases the likelihood of engaging in more long-term adaptive and transformative strategies vs. short-term coping strategies (Sen et al. 2023).

I also found that the different domains were associated with different kinds of adaptive action. For example, flexibility, agency, and assets in particular were associated with transformative action, and flexibility, organisation and socio-cognitive constructs with facilitating or preventing coping strategies. These findings concur with previous research tying different domains with different types and levels responses (Barnes et al. 2017, Barnes et al. 2020, Green et al. 2021, Salgueiro Otero et al. 2022). Overall, these findings further support the increasing calls for more multidimensional approaches to efforts to build adaptive capacity (Mortreux and Barnett 2017, Barnes et al. 2020, Green et al. 2021, Elrick-Barr et al. 2023).

5.6.3 Interactions

One of the key findings of this research was the inherent interactions and interdependencies between the six domains. These interactions are important for understanding both the function of each domain separately, as well as people's overall adaptive capacity. In many cases, a lack of capacity in one domain significantly undermined the others, for example a lack of assets reduced flexibility where potential adaptations were contingent on inputs or capital; reduced learning capacity by restricting information access, and reduced agency by limiting people's ability to participate in collective decision making about marine resources which they depend on. In other cases, high capacity in a particular domain enhanced other domains. For example, social organisational networks increased access to assets, learning opportunities, and new livelihood options (flexibility). Both these processes demonstrate the importance of building adaptive capacity in multiple domains. Attempts to increase one domain while neglecting the others is likely to limit or even undermine its effectiveness, and conversely, investing in multiple domains may synergistically benefit the others (Thapa et al. 2016).

Interactions between some of the domains of adaptive capacity have previously been studied on an ad-hoc basis. For example, Babcicky and Seebauer (2017) explored how social capital (organisation) interacted with risk perception and self-efficacy (socio-cognitive constructs and agency) to influence the ability of households to adapt to flooding; and there is an extensive history of research linking access to assets with livelihood diversity and other indicators of flexibility (Kassa 2019, Nnaeme et al. 2021, Bartelet et al. 2022). However, adaptive capacity research remains somewhat fragmented and theoretical (Siders 2019), and the kind of integrated, trans-disciplinary conceptualisation of adaptive capacity used here is relatively new (Cinner and Barnes 2019). As such, more complex interactions,

particularly between domains which have previously been the focus of largely separate fields, are yet to be systematically explored and empirically tested. My findings here are an early step towards exploring the interdependencies between domains; but more detailed and systematic explorations of the mechanisms through which the domains interact in different contexts is a clear area for future research.

5.6.4 Applications for climate change and other shocks

The specific conditions of the COVID-19 pandemic shaped how participants drew on different domains of adaptive capacity. For example, the social distancing requirements meant that people could not socialise with peers or participate in community decision making processes and had limited access to people outside their community who may have assisted, especially in communities with a lack of digital communication technology. In other words, during the pandemic social organisation was directly undermined, which in turn reduced opportunities for collaborative learning and the flow of innovation within the community. In crises without these direct constraints on interaction, there would be a much higher capacity for collaborative learning, idea generation, and collective action, meaning social organisation amongst peers and external actors, as well as ongoing learning processes could play a much more active role in facilitating adaptation (e.g. see Barnes et al. (2020)). In addition, community members felt they had very little agency over the broader drivers of change within the community (both the pandemic itself and largely high-level policy responses). Many participants reported feeling like there was nothing they could do other than try to cope with the immediate impacts of the pandemic. This is in direct contrast to previous research undertaken in the same five communities where most participants easily identified potential actions which could be implemented at the individual and/or community level (with sufficient resources and support) to mitigate climate impacts, for example community-based fisheries management strategies (Barnes et al., in prep). This is by no means a universal experience: a lack of self-efficacy has frequently been cited as a barrier to climate action, even where other adaptive capacity domains were relatively high (Ung et al. 2015, Eakin et al. 2016, Burnham and Ma 2017). Additionally, public messaging campaigns during the pandemic about actions individuals could take to prevent the spread of COVID-19 have been linked to increased self-efficacy, and in turn, succeeded in increasing individual behavioural change in ways (often less-coherent) climate-based behaviour change campaigns have not (Bouman et al. 2021). This only further demonstrates that an individuals' adaptive capacity, particularly in regards to the more subjective domains, can be shock-specific (Brown and Westaway 2011). There are some events, such as climate-driven natural disasters which we know are likely to occur with increasing frequency and severity. As such, it is possible to predict some likely outcomes from those events and how they might

interact with different domains of adaptive capacity (Wheeler and Von Braun 2013). It is therefore important to not only build "general adaptive capacity" by continuing to work towards core human development goals like increasing access to education and healthcare and reducing poverty, which can reduce vulnerability and increase resilience against change in general, including future unexpected shocks. We also need to strategically develop "specific capacities" and ensure that people have the specific tools and skills they are likely to need in the face of projected climate impacts in their region (Eakin et al. 2014).

5.6.5 Limitations

There were some limitations to my approach. First, using interviews which focused on broad discussions of adaptation to infer the influence of different domains of adaptive capacity may have disproportionally highlighted some domains over others. Participants frequently explicitly identified links between responses and their relationships with their community and institutions, their assets, and the choices available to them, but were, for example, less likely to reflect on their own mental frameworks and sense of agency independently and directly. This tendency does not necessarily mean the less-mentioned domains are unimportant, however. The challenges of analysing the psychosocial elements of adaptive capacity (i.e. agency and socio-cognitive constructs) relative to more tangible aspects like assets and social networks has been noted previously, and is likely why much of the adaptive capacity literature, particularly large-sample quantitative research, tends to overlook them (Grothmann and Patt 2005, Brown and Westaway 2011, Mortreux and Barnett 2017, Cinner et al. 2018a). A more direct approach where participants are explicitly asked about each domain could elicit additional insight into the role of the more subjective domains. However, my approach did provide insight into how risk perceptions, norms around individual vs collective responsibility and participants' sense of agency influenced adaptive behaviour. Additionally, it shows which factors participants consider to be important for their own adaptive capacity, and therefore what they would likely want from future capacity-building initiatives.

Secondly, although frameworks are useful for analysis and identifying specific targets for interventions, it can be difficult, and perhaps artificial, to assign specific actions to distinct categorical levels and adaptive capacity domains. For example, engaging in informal economic activities like casual labour work and making and selling snack foods are extremely common sources of supplementary income for people engaged in fisheries, but can also be a primary livelihood activity. If two people pre-COVID-9 received 90% of their income from fisheries and 10% from the occasional "odd job", and both increase their effort in informal economic activities but to different extents, with one switching to 20% informal economic activities and 80% fishing, and the other increases to 80%

informal economic activities and 20% fishing, is it accurate and meaningful to assign the same category of incremental adaptation to those changes, since both have definitionally only changed the proportional effort of their existing livelihood activities? Similarly, as my findings on interactions show, the six domains of adaptive capacity are highly interdependent, and it can be difficult to determine what factors were primarily driving particular behaviours, especially regarding the less tangible psychosocial domains (Brown and Westaway 2011, Cinner and Barnes 2019). This makes it harder to draw conclusions about which domains need to be strengthened, and therefore to make decisions about where to invest limited resources. While a challenge for research, these fundamental linkages reinforce the concept that in practice, interventions which target one domain while ignoring or undermining the others are unlikely to be successful, but conversely, improvements in one area may also lead to improvements in others (Cinner et al. 2018a). Further research on the interactions between domains is needed so we can avoid potential failures whilst leveraging potential synergies.

5.7 Conclusion

I empirically examined how people in coastal communities in Kenya drew on adaptive capacity during the COVID-19 pandemic. I found that people primarily engaged in coping strategies, with some incremental adaptations and few transformations. Whether and how people were able to make various responses was contingent on a variety of factors associated with each of the six domains of adaptive capacity and the interactions between them.

My findings empirically demonstrate the importance of all six domains of adaptive capacity during crises and reinforce the notion that pro-active resilience building activities and future crisis responses need to take an integrated, multidimensional approach. What this will need to look like in practice will depend on context. In general, however, this would mean moving beyond ensuring that people have access to physical resources. Individuals, communities, and practitioners also need to look towards the development of strong, supportive social networks; facilitating deep learning through the provision of information; and creating forums for critical thinking and idea sharing. They also need to develop diverse and sustainable livelihood opportunities, so people have the flexibility to make optimal choices; increase absolute and perceived agency; and shape cultural norms and risk perceptions to promote equitable, sustainable, informed decision making. As global shocks increase, lessons from how people adapted during COVID-19, what aspects of adaptive capacity facilitated or prevented beneficial adaptations and how the different elements of adaptive capacity interact with each other are ever more critical.

Chapter Six: Bouncing back: Recovery from the impacts of COVID-19 on human wellbeing[17]

6.1 Abstract

The COVID-19 pandemic altered almost every aspect of people's lives around the world, ultimately undermining human wellbeing. Now that most restrictions have lifted and day to day life has resumed, there is a need to identify the lingering effects of the pandemic on multiple dimensions of human wellbeing to strategically direct the ongoing recovery process. I conducted a mixed-methods longitudinal analysis of material, relational and subjective wellbeing in five fishing communities along the Kenyan coast before, during and after the peak of the COVID-19 pandemic and the implementation of COVID-19 containment policies. Specifically, I drew on qualitative analysis of interviews and quantitative analysis of surveys conducted with 34 fishers at three time points to explore how the pandemic affected multiple dimensions of wellbeing through the course of the first year of the pandemic. I then used socio-economic surveys conducted with the majority of fishers in each community in 2016, 2019 and 2022 to determine the scale of the impact of the pandemic proportionate to the impacts of ongoing changes the community. I identified a diverse range of wellbeing impacts during the pandemic, but also found that communities appear to be recovering rapidly. Although there were meaningful differences between our indicators of wellbeing immediately prior to (2019) and after (2022) the pandemic, my analysis leveraging data from several years before the onset of the pandemic (2016) suggests that these differences align with a longer-term trend likely associated with ongoing social-ecological change. In all but one indicator (work enjoyment), I found that there was either no significant difference in the level of change, more of an improvement, or less of a decline from 2019-2022 than from 2016-2019. In other words, I was unable to identify any significant long-term impacts of the pandemic on any of our indicators of human well-being. My research provides compelling evidence of the capacity of coastal fishing communities to "bounce

[17] I developed the research question for this chapter, conducted data analysis and wrote the chapter. The survey and interview protocol for the data collected during the pandemic was jointly developed with JDL, JEC, MB, EM, EW and PJC. The surveys conducted before and after the pandemic were developed by MB (Barnes et. al. 2019). Data collection for all surveys and interviews was conducted by EM, IM, and SW with logistical support from EM and NW. MB oversaw data collection for the surveys during and after the pandemic, and JDL and I oversaw data collection during the pandemic. MB, JEC, JDL and MB provided advice on the research question design, data analysis and paper structure. JDL, MB, and JEC provided feedback and editing.

back" from the impacts of COVID-19, which likely has relevance for other types of exogenous, episodic shocks.

6.2 Introduction

The COVID-19 pandemic is one of the most significant social crises in modern history. Since the onset of the pandemic, a large and growing body of literature has documented the immediate impacts of the COVID-19 pandemic on diverse aspects of human wellbeing whilst stringent restrictions were in place. In addition to the direct loss of life from the virus, we have seen significant increases in poverty, inequality and food insecurity (Laborde et al. 2021, Swinnen and Vos 2021, Mottaleb et al. 2022, Vos et al. 2022) and breakdowns in social relationships (Karantzas and Simpson 2022, Manda 2022, Kelley et al. 2023), all of which have had major psychological impacts (Chen et al. 2021, Hossain et al. 2021, Necho et al. 2021, Arora et al. 2022, Bello et al. 2022). The pandemic has been particularly catastrophic for already vulnerable populations, including people living in small-scale fishing communities. These communities often have poor infrastructure, low incomes, limited livelihood diversity, little to no access to credit and social support, and are facing ongoing declines in the ecosystems which they are dependent on (Bennett et al. 2016, Bennett et al. 2020, FAO 2020a). When faced with the COVID-19 pandemic, they experienced disruptions to food production and distribution chains, unemployment, increased food prices as incomes declined, and increased social anxiety (Lau et al. 2021b, Love et al. 2021, Nyiawung et al. 2022a, Sutcliffe et al. 2023). In short, we know that the pandemic impacted almost every aspect of people's lives around the globe, including in small-scale fishing communities, and ultimately undermined human wellbeing in the days and months after case numbers started rising and restrictions were implemented. However, as restrictions are lifted and society returns to normal, or establishes a "new normal", we also need to examine the medium-to-long term wellbeing impacts of the pandemic in diverse contexts over the next few years to guide the ongoing recovery process.

What does it actually mean for people's wellbeing to be impacted? In their seminal work on multidimensional aspects of human wellbeing, McGregor (2007) defines wellbeing as "a state of being with others, where human needs are met, where one can act meaningfully to pursue one's goals, and where one enjoys a satisfactory quality of life". There are three core dimensions of wellbeing, all of which are interconnected: material, relational and subjective (McGregor 2007, White 2008, McGregor and Sumner 2010) (**Fig. 21**). *Material wellbeing* incorporates the physical resources people can draw on, including assets, welfare, and standard of living (White 2010). A lack of material wellbeing leads to poverty and an inability to obtain basic human needs, prioritise sustainability, or adapt to change (Kofinas and Chapin 2009). *Relational wellbeing* focuses on the social relationships that people engage in which facilitate the pursuit of material and subjective wellbeing (Charles et al. 2012). It includes

both relationships with family and immediate community, but also with institutions and wider society, including the ability to access public goods and services (Coleman 1988, White 2010). It is closely linked to social capital, and incorporates supportive relationships, trust, belonging, and the capacity for collective action (Michaelson et al. 2009). *Subjective wellbeing* relates to how people think and feel about what resources and relationships they have and what they do with them (White 2010). It incorporates people's sense of identity, agency, and purpose; cultural values, ideologies, and beliefs; and their satisfaction and contentment (Aked et al. 2008, McGregor and Sumner 2010, White 2010). This third domain and its positioning at the apex of the framework is particularly important, as it-recenters wellbeing on the individual and their personal experiences, which are often generalised or completely overlooked in development literature and initiatives which focus on delivering the "objective" conditions of welfare, i.e., the availability of material goods and services (McGregor and Sumner 2010, White 2010).

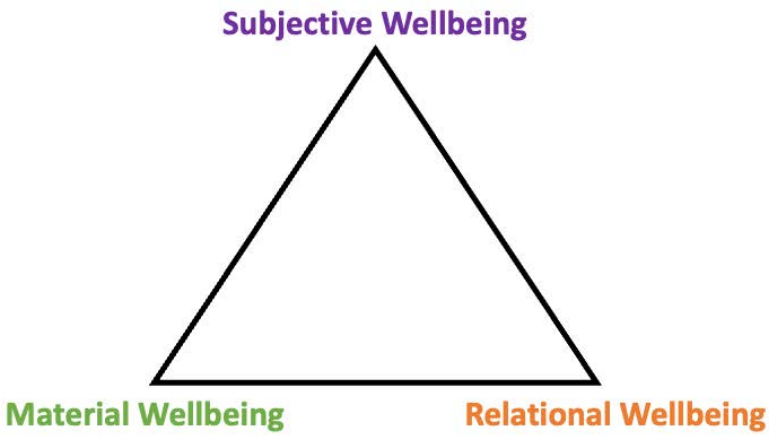

Figure 21: The three connected dimensions of 3D wellbeing. Adapted from (White 2010)

All three dimensions are critical and must be considered when evaluating or seeking to improve people's wellbeing. For example, small scale fisheries are not only a key source of food and income for millions of people, and therefore closely tied to their material wellbeing (World Bank 2012, Béné et al. 2016b), small-scale fisheries are the foundation of complex social networks which facilitate knowledge sharing and reciprocal support systems and build social cohesion, i.e., relational wellbeing (Alexander et al. 2018, Gillam and Charles 2018, Baker et al. 2021). Fishing is also strongly associated with the culture and sense of identity of fishers and their communities, and is a significant source of happiness i.e., it is key to their subjective wellbeing (Pollnac and Poggie 2008, Weeratunge et al. 2014, Holland et al. 2020). As such, anything which disrupts fishing activities could affect all three dimensions of wellbeing, and merely addressing one, for example providing alternative food and income sources

to meet material wellbeing needs, would not necessarily fulfill the other roles of fishing and restore people's overall wellbeing.

Wellbeing is closely linked to resilience and adaptive capacity, that is, people's ability to cope with and respond to change (Kofinas and Chapin 2009, Gillam and Charles 2018, Chaigneau et al. 2022). Resilience can be thought of as the ability to maintain or increase wellbeing in the face of ongoing or future change, but in turn many of the attributes associated with wellbeing are also sources of resilience (Armitage et al. 2012, Chaigneau et al. 2022). Low wellbeing can be self-reinforcing; for example multidimensional poverty can lead to social-ecological traps where people increasingly exploit and degrade the natural resources they are dependent on to meet immediate needs, thereby continually undermining their long-term resource base (Cinner 2011). Conversely, things like wealth, relationships and agency, (respectively associated with material, relational and subjective wellbeing), are key to resilience and adaptive capacity as they provide access to key assets, facilitate knowledge sharing, social support and collective action, and motivate action through the belief it can produce desired outcomes, all of which are central to people's ability to respond to change (Cinner and Barnes 2019, Chaigneau et al. 2022). As such, examining the medium-to-long term impacts of COVID-19 on all three dimensions of human wellbeing is not only important for identifying immediate needs to inform the ongoing pandemic recovery process, but also for strategically directing efforts to build resilience and adaptive capacity in the face of future shocks such as ongoing climate change. Additionally, understanding the wellbeing impacts of COVID-19, and if and how people have been able to recover from the impacts, may provide key lessons and insights for preparing for and responding to future similar shocks.

In this chapter I sought to address three research questions: 1) what were the impacts of COVID-19 on material, relational and subjective wellbeing in coastal fishing communities over the course of the first year of the pandemic? 2) Have people begun to recover from the subjective wellbeing impacts of the pandemic now restrictions have lifted? 3) How does the scale of the change in wellbeing over the three-year period from immediately before the onset of the pandemic to shortly after restrictions eased compared to changes in wellbeing in the three years prior? To address these questions, I draw on a unique longitudinal dataset. Specifically, I utilise qualitative interviews conducted in 2020 and 2021 to identify key impacts of the pandemic and pandemic mitigation strategies on material, relational and subjective wellbeing. I also utilise short surveys conducted alongside the interviews during the pandemic to quantitatively evaluate changes in subjective wellbeing over this time period to identify whether people began to recover as restrictions eased. I then use socio-economic surveys conducted in 2016, 2019 and 2022 to compare changes in wellbeing in the three-year period from

shortly before the onset of the pandemic through to after restrictions lifted to the changes in the three years prior due to ongoing social, economic, and environmental processes.

6.3 Methods

6.3.1 Study design and data collection

I conducted a longitudinal panel study in five coastal communities in southern Kenya before, during and after the peak of the COVID-19 pandemic and associated containment policies[18]. This consisted of: 1) three rounds of a standardised survey covering the majority of fishers in each community, two before the pandemic in 2016 and 2019 (Barnes et al. 2019a, Barnes et al. 2019b), and one after COVID-19 restrictions were lifted in 2022; and 2) three rounds of semi-structured interviews and short surveys with a sample population during the peak of the pandemic (2020-2021) **(Fig. 22, Table 9**).

[18] Note that throughout this chapter I refer to the surveys conducted in 2022 as conducted "after" the pandemic. It is true that the World Health Organisation did not officially downgrade the pandemic until May 2023 (World Health Organization 2023), and at time of the final submission of this thesis in 2024 there were still new cases being recorded worldwide. However, in the communities included in this study, the majority of negative impacts people experienced were related to containment policies and restrictions, as there were very few cases within the communities. By 2022, the stringent restrictions in Kenya had been lifted and participants self-identified that the worst of the pandemic and its immediate effects were over, and life had returned to more or less normal, so that is the language I have used here.

Table 9. Data source and timeline, indicators and analysis used to address research questions

Research question	What were the impacts of COVID-19 on material, relational and subjective wellbeing in coastal fishing?	Have people begun to recover from the subjective wellbeing impacts of the pandemic now restrictions have lifted?	How does the scale of the change in wellbeing over the three-year period from immediately before the onset of the pandemic to shortly after restrictions eased compare to changes in wellbeing in the three years prior?
Data source	Semi-structured interviews with a sample population (n=35). Socio-economic surveys with ~75% of fishers in each community	Surveys with a sample population (n=34).	Socio-economic surveys with ~75% of fishers in each community
Time period	*Interviews*: 3 rounds during the pandemic (August-October 2020, November-December 2020, January-March 2021) *Surveys*: before (2019) and after (2022)	- 2 rounds before the pandemic (2016, 2019) - 3 rounds during the pandemic (August-October 2020, November-December 2020, January-March 2021) - 1 round after the pandemic (2022)	2 rounds before the pandemic (2016 and 2019), and 1 round after COVID-19 restrictions were lifted (2022)
Indicators	*Interviews*: Content-organised responses based on material, relational and subjective wellbeing dimensions *Surveys/quantitative indicators*: *Material wellbeing*: - Material Style of Life (MSL) - Value of livestock owned by the respondent's household *Relational wellbeing*: - Social connectivity - Frequency of social interaction - Trust in peers - Trust in institutions *Subjective wellbeing*: - Livelihood satisfaction - Social cohesion - Work enjoyment	Subjective wellbeing - Livelihood satisfaction - Social cohesion - Work enjoyment	*Material wellbeing*: - Material Style of Life (MSL) - Value of livestock owned by the respondent's household *Relational wellbeing*: - Social connectivity - Frequency of social interaction - Trust in peers - Trust in institutions *Subjective wellbeing* - Livelihood satisfaction - Social cohesion - Work enjoyment *Control variables*: - Community - Age - Household size - Education level - Occupational diversity - Temporal change in occupational diversity - Held a community leadership position
Analysis	Non-parametric Friedman tests and post-hoc pairwise comparison Wilcoxin rank sum tests	Non-parametric Friedman tests and post-hoc pairwise comparison Wilcoxin rank sum tests	General linear mixed models

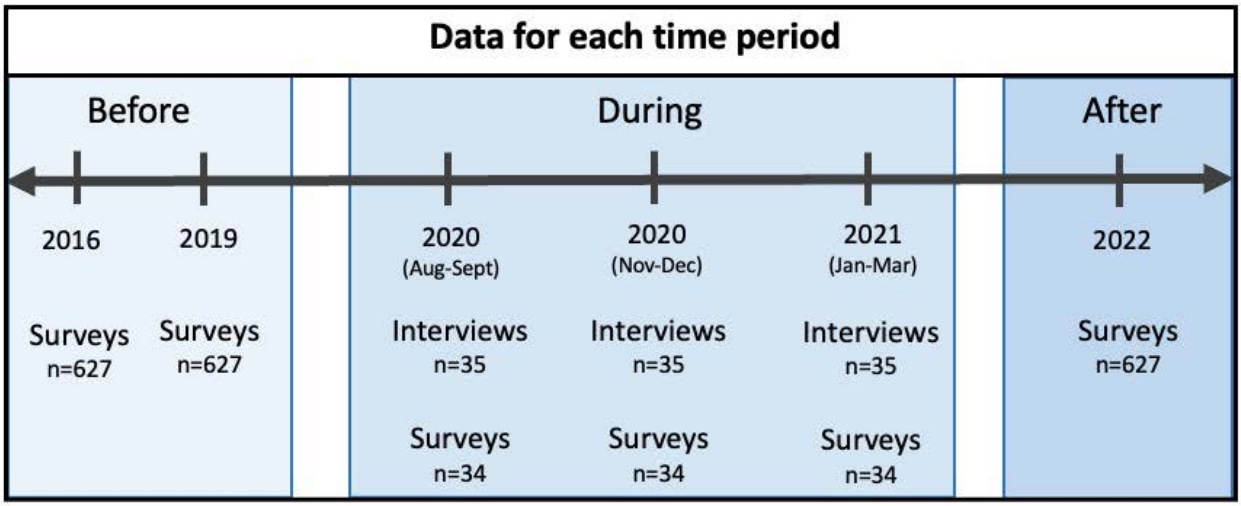

Figure 22. Timeline of data used in Chapter Six

I drew on surveys conducted by Barnes et. al. in 2016 and 2019, which we then repeated in 2022 following the same protocols (Barnes et al. 2019a, Barnes et al. 2019b)[19, 20]. We surveyed approximately 75% of the fishers in each community every three years (2016, 2019, and 2022) (**Table S5**), assessing changes in multiple socio-demographic variables through time, including wealth indicators and three indicators of subjective wellbeing (**Appendix 10**). We also collected extensive social network data from each respondent, including who they spoke to about fishing and fisheries-related topics. In the 2022 surveys, in addition to the standard questions which were repeated from the 2016 and 2019 surveys, we explicitly asked fishers to identify whether the overall effect of COVID-19 on their lives was positive, negative, or they had not been affected. If they said they had been affected by the pandemic, they were asked to summarise in what ways.

The surveys were conducted in-person in Swahili by trained local field researchers with significant previous experience working in communities along the Kenyan coast (including in our study communities). Respondents were primarily approached at fish landing sites. Some surveys were subsequently conducted in more convenient places at later times at the respondents' request. Barnes et. al. (2019) aimed to survey at least 75% of the total estimated fisher population of each community in 2016 and targeted those same respondents to participate in subsequent survey rounds. 710 fishers

[19] See Barnes et al. 2019a and Barnes et al 2019b for further methodological details of how these surveys were developed, the sampling strategy, and how they were conducted

[20] I will use "we" in the methods section when referring to the surveys lead by Barnes et. al. as part of a separate ongoing project which dovetailed with this COVID-19 research. I was not involved in the project in 2016 or 2019 but did help to develop the 2022 survey, train the field researchers, and oversee the data collection.

were surveyed in 2016, 664 in 2019 and 661 in 2022. Attrition was primarily due to fishers leaving the communities either permanently or temporarily during the survey periods, or due to mortality. Only respondents who participated in all three survey rounds were included in this analysis. The final sample consists of 627 fishers, which is approximately 68% of the estimated total fisher population of the five communities (**Table S5**).

I also drew on the key informant interviews described in Chapter Two. The same 35 participants were interviewed in each of the three rounds of data collection during the pandemic. At the end of each interview, we also asked the interviewees who had previously participated in the pre-COVID-19 surveys (i.e., the fishers but not female fish traders or community leaders) several short survey questions (**Appendix 5**). We also surveyed additional fishers as substitutes for interview participants who we did not have pre-COVID-19 survey data for so as to be able to conduct a quantitative before-during-after analysis. Survey responses were directly inputted by the interviewers into an online database during the call. The final sample for these surveys was 34 fishers, though not all fishers participated in all three survey rounds due to availability and access to phones throughout the pandemic. The survey included the same three indicators of subjective wellbeing from the previous survey rounds, as well as additional questions about fishing practices, catch, income from fishing, and food and nutrition security. Human ethics approval for this research was obtained from the James Cook University Human Ethics Panel (approval numbers H8109 and H7603).

6.3.1.1 Description of quantitative wellbeing indicators

For my quantitative longitudinal analysis of changes in wellbeing before, during and after the pandemic, I examined two indicators of material wellbeing, four indicators of relational wellbeing, and three indicators of subjective wellbeing from the three rounds of surveys in 2016, 2019 and 2022. (The number of variables used for each dimension was based on the availability of appropriate indicators in the pre-existing data set) (**Table 10**). The two indicators of material wellbeing were Material Style of Life (MSL) and the value of livestock owned by the respondent's household. MSL is a wealth indicator based on an assessment of locally relevant assets owned by households, including household appliances, transportation, fishing equipment, land, livestock and the structural composition of their house (Cinner et al. 2009b). I used a factor analysis of the assets owned by participants in 2019 to create a wealth metric based on the first axis of a principal component analysis following the methods described in Cinner et al. (2009b). The least explanatory assets were iteratively excluded until the wealth metric included 10 key assets which explained 43.4% of variance between participants. I then used the factor loadings for the 10 key assets in 2019 to calculate directly comparable wealth scores for all three years. Because I had observations from each respondent at three different time points, and because the assets they owned and the relative importance of different assets within the

community may have changed during the study period, I used the 2019 factor scores as the baseline rather than conducting a factor analysis each year separately to insure comparability. The second indicator of material wellbeing was the value of livestock (chickens, cows, sheep, goats, and donkeys) owned by the respondents' household (in USD). During the interviews we conducted during 2020 and 2021, many participants reported having to either consume or quickly sell livestock, which did temporarily provide them with food and income, but meant that they could no longer benefit from them (e.g., providing eggs, milk, or labour), and they were often sold at lower-than-expected prices due to overall economic decline. As such, I included the value of livestock as both an indicator of overall wealth as they are an important asset for rural households in the region (Ngigi et al. 2021), and because a reduction in livestock owned may be due to experiencing financial hardship and being forced to sell productive assets. The value of livestock was calculated based on the selling price in community 'E' at time of writing (personal communication, January 2023). I acknowledge these prices are likely to have fluctuated over the six-year study period, however historical records of local prices for the different livestock were not available.

I modelled four indicators of relational wellbeing. The first two indicators are based on knowledge-exchange social network data. Respondents were asked to list with whom they shared information and advice about fishing, fish marketing and fisheries management, which I refer to as "fishery-related social ties". They were also asked to identify how often they spoke to them (Barnes et al. 2019a, Barnes et al. 2019b). The two indicators included in this analysis were 1) social connectivity, captured here as normalised out-degree centrality which calculates how many fishery-related social ties they have, scaled by the size of the full network; and 2) frequency of social interaction, calculated as normalised out-degree centrality weighted by the frequency of communication with each fishery-related social tie. The size of people's support networks and frequency of social interactions have been linked to higher life satisfaction, mental health status, and the provision of instrumental and emotional support (Seeman and Berkman 1988, Pinquart and Sörensen 2000, Chan and Lee 2006, Van der Horst and Coffé 2012, Fuller-Iglesias 2015). The isolation imposed by lockdowns, border closures and social distancing requirements are likely to have disrupted these relationships, particularly for those without access to phones or other remote communication technology, and these disruptions may or may not have carried over after restrictions lifted. The second two indicators measure levels of trust in peers (bonding social capital) and in institutions. Trust in peers is the average of two 5-point Likert scale questions: how much they trust other fishers, and how much they trust people in their village. Trust in institutions is the average of their level of trust in local leaders, government, the fisheries department, and police. Both interpersonal and institutional trust are associated with psychological health and consequently physical health and overall wellbeing (Hudson 2006, Schneider et al. 2011),

and are likely to have been affected by the social isolation and substantial government interventions during the pandemic .

Subjective wellbeing was captured using three indicators of people's perceptions of different aspects of their lives: satisfaction with their food and income situation (i.e., "livelihood satisfaction"), satisfaction with their social relationships (i.e., "social cohesion"), and job satisfaction, or how much they enjoy their job and consider it important to their identity (i.e., "work enjoyment". Note that while satisfaction with food and income, jobs and relationships may seem similar to material and relational wellbeing, these are measures of people's subjective perceptions of those aspects of their lives rather than the objective measures. These three indicators were selected based on the three most important indicators of subjective wellbeing identified in a previous in-depth wellbeing assessment in Kenyan coastal fishing communities (Abunge et al. 2013). Each of these indicators was measured on a five-point Likert scale. Note that while satisfaction with food and income, jobs and relationships may seem similar to material and relational wellbeing, these are measures of people's subjective perceptions of those aspects of their lives rather than the objective measures.

Table 10. Indicators of material, relational and subjective wellbeing used to assess changes in human wellbeing through time

Wellbeing dimension	Dimension description	Indicator name	Indicator description
Material wellbeing	What you have, whether you can meet basic needs	MSL	Wealth proxy based on possession of locally relevant key assets and house construction materials (continuous factor score).
		Value of livestock	Estimated value of livestock inc. chickens, cows, sheep, goats, and donkeys in USD based on Jan 2023 selling price
Relational wellbeing	Social relationships/ connections	Social connectivity	Number of self-reported fishery-related social ties, (i.e., outdegree centrality)
		Frequency of social interactions	Frequency of social interactions (# fishery-related social ties weighted by

			frequency of communication with each tie)
		Trust in peers	Average level of trust in other fishers and community members (Likert scale from 1-5)
		Trust in institutions	Average level of trust in community leaders, government, the fisheries dept., and police (Likert scale from 1-5)
Subjective wellbeing	How you feel about what you have and your social connections; experienced quality of life	Livelihood satisfaction	Quantified satisfaction level regarding food and income (Likert scale from 1-5)
		Social cohesion	Quantified satisfaction level regarding social relationships (Likert scale from 1-5)
		Work Enjoyment	Quantified satisfaction level regarding work enjoyment and identity (Likert scale from 1-5)

6.3.3 Analysis

6.3.3.1 Overview analysis of immediate wellbeing impacts

To get a basic overview of people's experiences during the pandemic, I first evaluated the proportion of respondents in the 2022 survey who stated they were positively, negatively, or not affected by the pandemic, and what they said the most significant impacts were. I then conducted a thematic analysis of the 34 key informant interviews from during the first year of the pandemic to develop a more detailed understanding of the immediate, short term wellbeing impacts associated with changes in assets, welfare, and standard of living (material wellbeing); social relationships with peers and institutions (relational wellbeing); and overall happiness and quality of life (subjective wellbeing).

6.3.3.2 Analysis of changes in subjective wellbeing before, during and after the pandemic

I then used non-parametric Friedman tests and post-hoc pairwise comparison Wilcoxin rank sum tests to identify statistically significant changes in the three subjective wellbeing indicators for the 34 survey participants before (2016 and 2019), during (2020 and 2021) and after (2022) COVID-19 restrictions were in place. Note that I could not assess the material and relational wellbeing indicators at all six time points as it was logistically unfeasible to collect the full socio-economic surveys which we conducted in person in 2016, 2019 and 2022 over the phone during the pandemic. In particular, the MSL and social network elements of the survey are quite complex and dependent on having a much larger sample size to generate the scores used in my models than we were able to collect remotely (e.g., the MSL variable is based on a factor analysis of the assets of all the households in the community, see section 6.3.2 above). Where possible I used survey data from the same people at all six time periods. However, the research project from which the 2016, 2019 and 2022 survey data is drawn exclusively targeted fishers, most of whom were male; but the sampling strategy for our data collection during the pandemic involved targeting both men and women. Women were recruited through contacting men from the "before" surveys and asking to be put in touch with a woman in their family. As such, I did not have survey data for those women from "before" and "after". Instead, I used the survey data from the man in their household who participated in the 2016, 2019 and 2022 surveys.

6.3.3.3 Quantitative analysis of material, relational and subjective wellbeing before and after the pandemic

We then compared differences in all nine wellbeing indicators from before and after the peak of the pandemic (2016, 2019 and 2022) for all 627 survey respondents. I again used Friedman tests and post-hoc pairwise comparison Wilcoxin rank sum tests to identify statistically significant changes between the three time periods, this time for all 627 fishers who were surveyed in all three years.

6.3.3.4 Comparison of scale of wellbeing impacts due to COVID-19 with the impacts of ongoing social-ecological processes

Many indicators associated with wellbeing have been shown to vary through time due to other ongoing process of social-ecological change; both in general and in this region and context (Cinner et al. 2015, Waters and Adger 2017, Cheng et al. 2022). As such, in addition to identifying if there was any change between years, I sought to determine if the change in wellbeing across the three-year period before and after the peak of the pandemic was disproportionate to the change in the proceeding three-year period. In other words, I attempted to account for the "noise" of other ongoing processes to better understand the specific impact of the pandemic (Borkowska and Laurence 2021). I used general linear mixed models to compare the relative change in each of the nine indicators in the three years prior to the onset of the pandemic (T1: 2016-2019) to the change from immediately

before to shortly after the pandemic (T2: 2019-2016). To further aid in isolating the potential effects of the pandemic, I controlled for several co-variates which are known to influence wellbeing (Mbaru et al. 2021). These variables may have changed due to the pandemic or mediated the effects of the pandemic for different people. Specifically, I accounted for respondents' age, household size, education level, occupational diversity, temporal change in occupational diversity, and whether they held a community leadership position (Cinner et al. 2009b, Kristoffersen 2018, Kimbu et al. 2022). Most of these variables used the values from the 2019 surveys, except for household size (which was only available for 2022), and the change in occupational diversity (a composite variable measuring the level of change in occupational diversity between 2019 and 2022 relative to the level of change between 2016 and 2019, again designed to eliminate baseline noise). Individual IDs and community were included as random effects to account for the hierarchical nature of the data and the effect of using repeated measures. However, community was excluded from the models for trust in peers and trust in institutions, as model validation checks indicated overparameterization of random effects when community was included (i.e., the model was too complex for the available data). Analysis was conducted using R (R Core Team 2022), RStudio (RStudio Team 2022) and the glmmTMB package (Brooks et al. 2017). Model diagnostics were performed using the DHARMa package (Hartig 2022). An examination of Variance Inflation Factors showed no signs of multicollinearity.

6.4 Results

6.4.1 Short-term impacts on material, relational and subjective wellbeing during COVID-19

In the 2022 "after" survey, 545 (87%) of respondents said that overall, the impacts of COVID-19 on their lives were negative, with 1 person reporting an overall positive impact (the remaining 82 (13%) reported no impact). When asked in a short answer question about the primary ways they had been impacted, 532 (85%) reported disruptions to fishing and fish trading, which reduced their income, and 75 (12%) stated that their social relationships had been negatively affected.

In interviews conducted during the peak of the pandemic, when stringent restrictions were in place, respondents described multiple ways in which their material wellbeing was negatively affected. Many people lost their jobs, meaning less money was circulating in the community, which reduced demand for fish. With the international borders closed there were no tourists to buy high-value seafood in hotels, and county border closures prevented people from taking fish to major city markets. The combination of these factors significantly reduced income for fishers and fish traders.

> "Business has gone down because the buyers have no money, and many have no jobs. Before corona there were many and people used to go and find jobs, but since corona started it has really affected things completely" (F, 29, community B).

Consequently, fishers and fish traders were unable to meet many of their material needs, including buying sufficient healthy food, investing in supplementary livelihoods, home-building, and school fees once schools re-opened. As one respondent said, "The most pressing thing was to do with daily bread because you cannot do anything if you have nothing in your stomach. That is what impacted us the most." (M, 48, community B). Respondents reported having to use savings, consume assets like livestock or sell them at low-cost, get loans, and cut non-essential expenditure. Some female fish traders reported having to consume their stock because no one was buying, and they had no other food. Without sales they did not have the capital to buy additional fish later and their businesses collapsed. Others could not afford to buy inputs for farming, reducing the harvest and further undermining their income.

> "Right now, even farming has deteriorated this year because the pesticides I use for farming, I could not get because my income has gone down because of corona. I did farming but didn't get so much, now it's a problem for me. There is hunger with children and also looking for money for children to go to school" (Female, 38, community C).

Respondents also described how social distancing requirements impacted their relational wellbeing by preventing regular organised social activities (including religious practices), informal interactions, information sharing, mutual support, and working collectively. As one person said, "People were not allowed to go to churches, mosques or participate in sports. It was impossible and it was terrible," (M, 45, community B). Some people were completely separated from their families as they sent them to stay with others because they could not afford to support them in the community without normal income: "As we talk, my wife and children are not here as I sent them to stay with my mother due to the situation of life now," (M, 30, community D). The inability to gather together was particularly challenging in the context of the livelihood disruptions, as people were unable to support and learn from each other while trying to adapt to the changes to their livelihoods.

> "There are things you may want to enquire from someone, how to do them better, but you are not allowed to be in a sitting of 3-4 people, so you are forced to do things your way and this is difficult" (M, 48, community B).

Respondents repeatedly stated that the impacts of the pandemic undermined their perceived quality of life (i.e., subjective wellbeing). They reported general feelings of uncertainty and disempowerment; stress and anxiety about their financial situation, particularly their ability to provide for their family;

concern about contracting COVID-19; isolation from their support networks; and dissatisfaction with how their regular way of life had been disrupted. One woman said, "I lack any business to improve on my life." (F, 40, community E). People felt that COVID-19 was preventing them from progressing and achieving their personal goals. Respondents talked about loneliness and frustration due to forced isolation and being stuck at home: "I was not happy because we could not visit each other" (F, 45, community A); "How can you be happy when you don't even have space for breathing?" (F, 29, community C). One of the people who was separated from their family said "If my wife is not around, what will I do? I don't have any happiness completely in my life. I don't know when all this will end," (M, 30, community D). One participant talked about the guilt and distress that came from not being able to help others in the community.

> "Right now, when someone comes and kneels down and tells you that 'brother or grandpa, I have a problem to solve. Please help me with 500 or 1000KSH', will he not be like playing the guitar for a goat? Can the goat really dance? It cannot dance. So, you remain there with your heart suffering because you want to help but you cannot…he came to you to help but you have nothing to help with. Even when you look at your own family you want to cry because you can't sustain yourself" (M, 69, community D).

The impacts of the pandemic on people's wellbeing varied based on their personal circumstances. People's level of wellbeing before COVID-19 restrictions were put in place influenced how resilient they were when restrictions were implemented. For example, those who, prior to the pandemic, had a larger asset base (i.e., higher level of material wellbeing) were less vulnerable to food insecurity; and those with more social capital (relational wellbeing) had more access to support to help them get through the pandemic. For example, single mothers found it particularly difficult to support their families, especially when they did not receive aid or remittances:

> "I don't have a husband and am suffering with children. When schools open it is on me to go around so that my children can go to school. Now, when support like that has come but we're not seeing any benefits, we're just hearing that it came, and some people are already getting it every week…maybe some people are more concerned with the support than others? Or other people are so important that they need to eat, but not us?" (F, 46, community C).

6.4.2 Temporal analysis of subjective wellbeing

Our analysis comparing the three indicators of subjective wellbeing for the 34 respondents who participated in surveys before, during and after the pandemic showed that COVID-19 had a significant impact on livelihood satisfaction (Friedman test, X^2 (5) =16.21, p=0.006) and work enjoyment (Friedman test, X^2 (5) =11.53, p=0.042) **(Fig. 23, Table 11, S8)**. Specifically, post-hoc analysis with

Wilcoxin rank sum tests **(Table 12)** indicate livelihood satisfaction and work enjoyment were both stable from 2016 to 2019 (p=1 and p=0.790 respectively), but both declined significantly from 2019 levels during 2020 (p=0.001 and 0.018 respectively in Aug-Oct 2020; p=0.011 and p=0.003 respectively in Nov-Dec 2020). However, both livelihood satisfaction and work enjoyment largely "bounced back" to pre-COVID levels once the most stringent restrictions were lifted. That is, there was no significant difference between 2019 and 2022 for either livelihood satisfaction (p=1) or work enjoyment (p=0.377). A similar pattern was observed in social cohesion, but it was not statistically significant (Friedman test, X^2 (5) = 9.40, p=0.094). Together, my results suggest that while there was a short-term impact of COVID-19 on subjective wellbeing, people recovered relatively quickly and there does not appear to be a medium-term effect on the dimensions I measured.

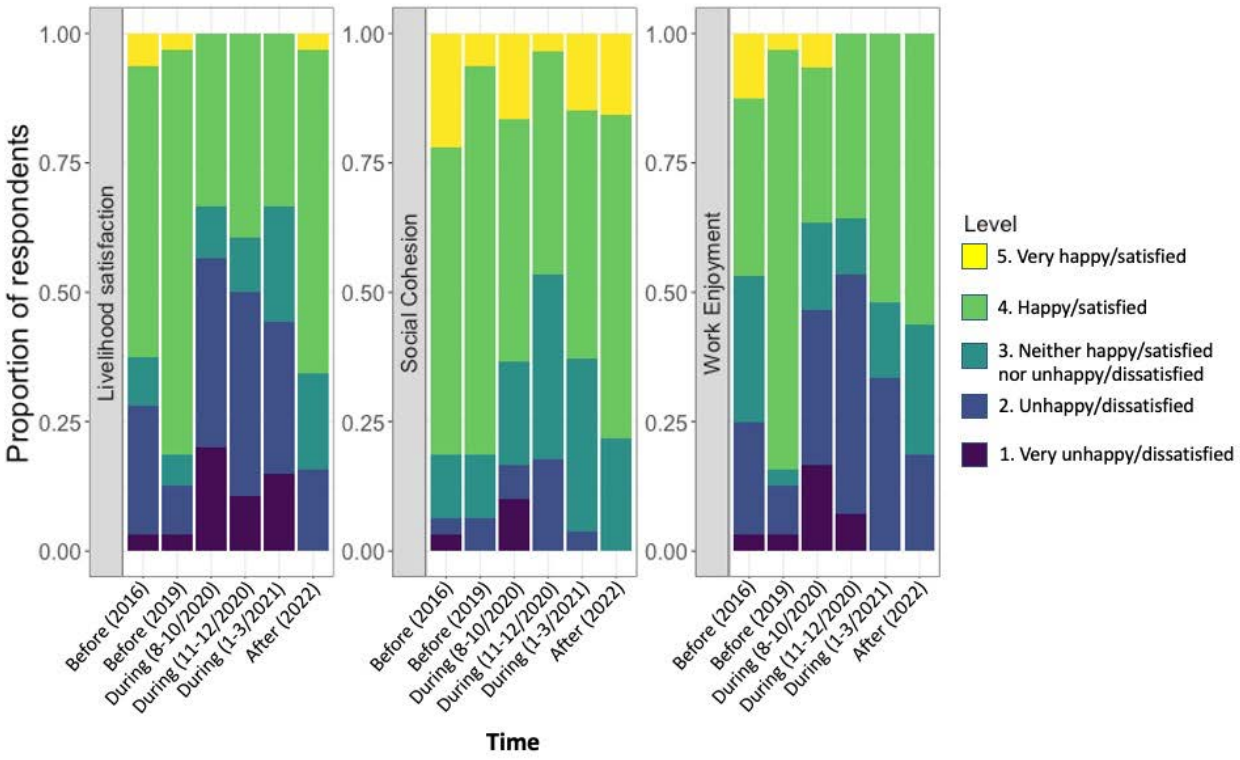

Figure 23: Changes in subjective wellbeing before, during and after the COVID-19 pandemic, based on level of livelihood satisfaction, social cohesion and work enjoyment as measured on a 5-point Likert scale from very unhappy/dissatisfied to very happy/satisfied. The mean level of livelihood satisfaction and work enjoyment was significantly lower during 2020 than during 2016, 2019 and 2022. N=34.

Table 11: Summary results of Friedman tests for significant differences in subjective wellbeing indicators (livelihood satisfaction, social cohesion, and work enjoyment) before, during and after the COVID-19 pandemic, measured on a 5-point Likert scale from very unhappy/dissatisfied to very happy/satisfied. * Indicates p<0.05. N=34.

Indicator	X^2	d.f.	p
Livelihood satisfaction	16.21	5	0.006 *
Social cohesion	9.40	5	0.094
Work enjoyment	11.53	5	0.042 *

Table 12: Results of post-hoc pairwise comparisons using Wilcoxon rank sum tests comparing livelihood satisfaction and work enjoyment before, during and after COVID-19, as measured on a 5-point Likert scale from very unhappy/dissatisfied to very happy/satisfied. Post-hoc analysis of social cohesion is not included as the base Friedman test indicated no statistically significant differences. * Indicates p<0.005. N=34.

Livelihood Satisfaction

	2016	2019	Aug-Oct 2020	Nov-Dec 2020	Jan-Mar 2021
2019	1.000				
Aug-Oct 2020	0.102	0.001 *			
Nov-Dec 2020	0.591	0.011 *	1.000		
Jan-Mar 2021	0.387	0.004 *	1.000	1.000	
2022	1.000	1.000	0.015 *	0.115	0.064

Work Enjoyment

	2016	2019	Aug-Oct 2020	Nov-Dec 2020	Jan-Mar 2021
2019	0.790				
Aug-Oct 2020	1.000	0.018 *			
Nov-Dec 2020	0.772	0.003 *	1.000		
Jan-Mar 2021	1.000	0.155	1.000	1.000	
2022	1.000	0.377	0.7511	0.2655	1.000

6.4.3 Comparison of material, relational and subjective wellbeing in 2016, 2019 and 2022

I found statistically significant differences in all indicators of wellbeing across 2016, 2019 and 2022, except for the value of livestock and livelihood satisfaction (Friedman tests, **Fig. 24, Table 13, S8).** However, in multiple indicators, wellbeing in 2019 and 2022 was more similar than in 2016 and 2019 (Wilcoxin Rank Sum Tests, **Fig. 23, Table 12**). Only two indicators of wellbeing in 2022 were

significantly different to both 2016 and 2019: the frequency of social interactions significantly increased after COVID-19 (p=<0.001), and work enjoyment decreased (p=0046 for 2016-2022, p=<0.001 for 2019-2022).

I did not find a clear pattern in material wellbeing. In contrast, according to our analysis it appears that relational wellbeing in 2022 after the pandemic was lower than in 2016, but higher than in 2019 immediately before the pandemic, whereas subjective wellbeing was slightly lower in 2022 than in both 2016 and 2019 (**Fig. 24, Table 13, S8).**

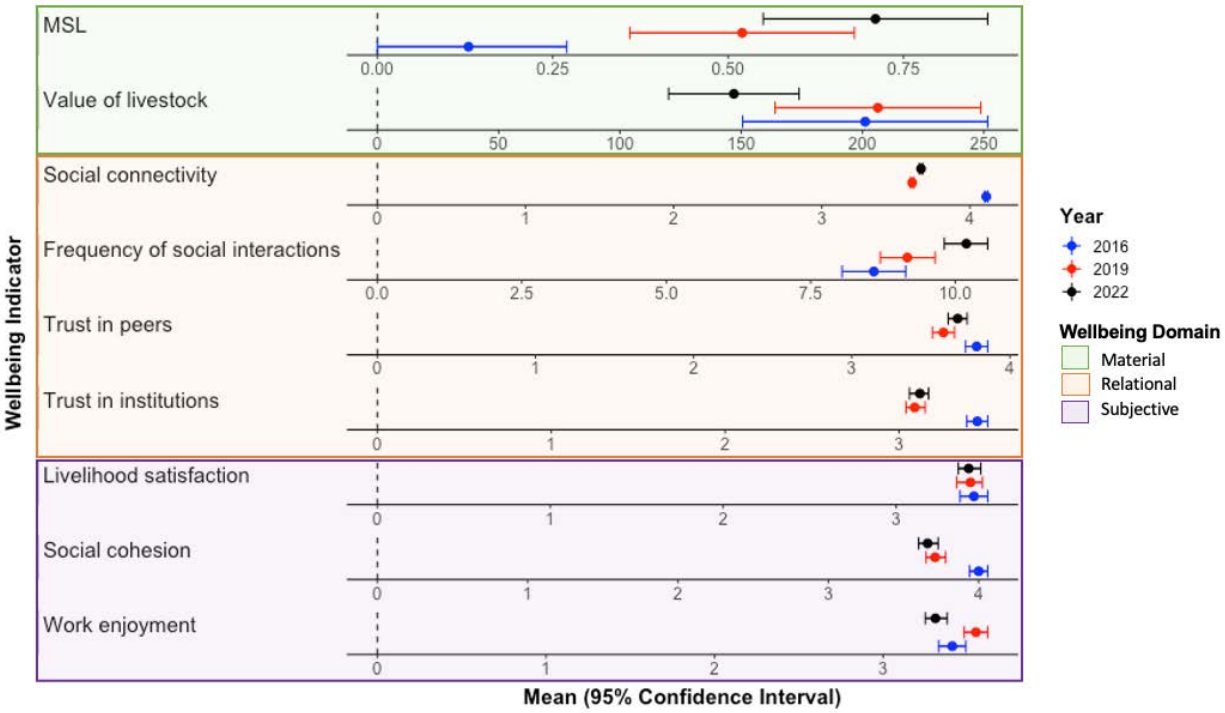

Figure 24. Mean levels of wellbeing indicators in each year. See Table S7 for summary statistics. Error bars represent 95% confidence intervals. [21]

[21] Note that the social connectivity points do include confidence intervals but are difficult to see as they are very narrow

Table 13. Results of post-hoc pairwise comparisons using Wilcoxon rank sum tests comparing material, relational and subjective wellbeing indicators before and after COVID-19. Note that post-hoc tests were only performed for indicators where initial Friedman tests indicated significant differences between years, i.e., the tests were not run for the value of livestock or livelihood satisfaction. N=627, * indicates p<0.05

Indicator	2016/2019	2016/2022	2019/2022
Material wellbeing			
MSL	0.006*	<0.001*	0.203
Relational wellbeing			
Social connectivity	0.005*	<0.001*	0.85
Frequency of social interactions	0.014*	<0.001*	<0.001*
Trust in peers	<0.001*	0.09	0.013*
Trust in institutions	<0.001*	<0.001*	0.44
Subjective wellbeing			
Social cohesion	<0.001*	<0.001*	0.45
Work enjoyment	0.069	0.046*	<0.001*

6.4.4 Change in wellbeing in the three years prior to COVID-19 vs three years after the onset of COVID-19.

We then compared the degree to which each indicator of wellbeing changed in the three years prior to COVID-19 (2016-2019) compared to the three years from immediately before to after the peak of the pandemic (2019-2022) to see if the magnitude of the net wellbeing change from before to after the pandemic was more or less than the baseline wellbeing impacts of ongoing social and ecological processes seen in the three years prior. There was a general pattern of non-significant decline in material wellbeing, an increase in relational wellbeing (significant in three out of four indicators) and a mixed pattern in the three indicators of subjective wellbeing, demonstrating that people felt differently about how COVID-19 impacted different aspects of their lives. In all but one indicator (work enjoyment), I found that there was either no significant difference in the level of change, more of an improvement (or less of a decline) from 2019-2022 than from 2016-2019 (**Fig. 25, Table 14, S9, S10**). That is to say, in general there was little evidence that there was more of a net decline in wellbeing from shortly before to shortly after the peak of the pandemic than the communities experienced in the three years prior due to other ongoing social and ecological changes.

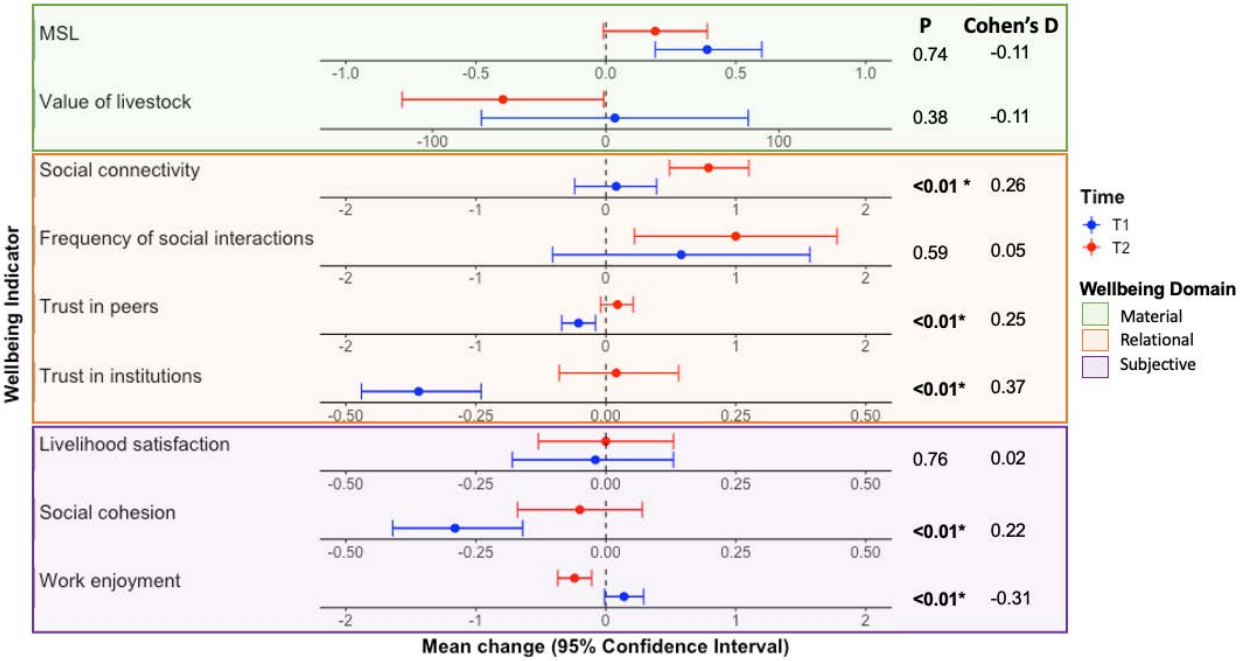

Figure 25: Change in wellbeing in Time 1 (2016-2019) vs Time 2 (2019-2022). Points represent the mean change in each 3-year time period. Error bars represent 95% confidence intervals. See Table S10.

Table 14: GLMM results comparing changes in material, relational and subjective wellbeing between T1 (2016-2019) and T2 (2019-2022). Note that only the effect of time and significant co-variates are included here; see Table S11 for full model results). N=627, * indicates p<0.05

	Estimate (S.E.)	z	p
Material wellbeing			
MSL			
Time period	0.03	0.33	0.74
Value of Livestock (USD)			
Time period	2.05	0.87	0.38
Age	-2.87	-2.07	0.04 *
Education	-0.93	-2.25	0.02 *
Relational wellbeing			
Social connectivity			
Time period	0.53	4.01	<0.01 *
Frequency of social interactions			
Time period	0.22	0.56	0.59
Leader	0.87	1.99	0.05*
Trust in peers			
Time period	0.29	4.52	<0.01 *

Trust in institutions			
Time period	0.38	6.65	<0.01 *
Subjective Wellbeing			
Livelihood satisfaction			
Time period	0.23	3.88	0.76
Social cohesion			
Time period	0.23	3.88	<0.01 *
Leader	0.23	3.88	<0.01 *
Work enjoyment			
Time period	0.38	-5.51	<0.01 *

Specifically, the degree of change in social connectivity, trust in peers, trust in institutions, social cohesion and work enjoyment were statistically significantly different in the three years prior to the three years during and after COVID-19 (**Fig. 25, Table 14, S9, S10**). There was a significantly larger increase in social connectivity from 2019 to 2022 than in the three years prior (p=<0.01). Trust in peers and trust in institutions increased in the three years during and after COVID-19, where prior to the pandemic they had a decreased (p=<0.01 for both). Only work enjoyment decreased significantly in 2019 to 2022, reversing a previous increase (p=<0.01).

Few socio-demographic factors were associated with differences in the level of change in the two time periods (**Table 10, S10**). Changes in the value of livestock was negatively associated with both age and education; and a larger increase in the frequency of social interactions and smaller decline in social cohesion were associated with holding a community leadership position.

6.5 Discussion

My analysis of surveys and interviews conducted during the pandemic in 2020 and 2021 demonstrate multiple negative impacts on material, relational and subjective wellbeing. However, my analysis comparing multiple indicators of wellbeing before and after restrictions were implemented and then lifted several years later showed minimal evidence of ongoing negative impacts on the aspects of human wellbeing I measured. In fact, my results suggest that people experienced an increase in the relational wellbeing domain, and in eight out of nine indicators the overall change in wellbeing between 2019 and 2022 was either not significantly different to, or an improvement on, the change in the three years before the pandemic. This demonstrates the capacity for people to "bounce back"

or rapidly recover from the impacts of COVID-19 on their wellbeing, and potentially also future exogenous, episodic shocks.

6.5.1 Material wellbeing

The initial disruptions to material wellbeing which I identified— primarily reduced income and consequently food insecurity — are broadly consistent with patterns that occurred in the wake of the pandemic across other small-scale fishing communities and rural communities in Kenya and around the world However, here, I provide qualitative evidence that many respondents' food and nutrition security improved as restrictions eased. Moreover, our quantitative analysis showed an overall increase in Material Style of Life from 2019-2022, which seems to indicate that on average, people were able to recover from short term declines in material wellbeing. This pattern of a strong initial impact followed by recovery is generally consistent with research from other fishing communities in Kenya and rural communities in Africa more broadly. For example, Upton et al. (2021) also identified a process of relatively quick return to (still quite high) pre-pandemic food insecurity levels after an initial increase in fresh-water small fishing communities around Lake Victoria, Kenya once restrictions eased. In contrast, Okronipa et al. (2023)'s analysis of the impacts of the pandemic on small-scale fishers around Lake Victoria found little evidence of food security impacts of the pandemic to begin with, though almost all households were already food insecure and simply remained at a stable low level. Sharp increases and then declines in food insecurity were also observed in Burkina Faso, Ethiopia, Malawi, and Nigeria, with rural communities experiencing a larger increase in food insecurity than urban populations (Rudin-Rush et al. 2022).

6.5.2 Relational wellbeing

We found that while relational wellbeing was negatively impacted by the social distancing, movement restrictions, and reduced ability to provide mutual support during the peak of the pandemic, it appears people were largely able to recover to or build on their 2019 levels of relational wellbeing by 2022. Some early research from the pandemic matches our findings and suggests that experiencing strong government interventions in the face of the pandemic, for example lockdowns, resulted in increased trust in institutions and community cohesion (Sibley et al. 2020). However, most literature to date has focused on the role of social networks and trust in stopping the spread and mitigating the impacts of COVID-19, rather than how COVID-19 has impacted relational wellbeing in turn (e.g. (Borgonovi and Andrieu 2020, Elgar et al. 2020, Lofredo 2020, Varshney and Socher 2020, Bartscher et al. 2021, Bhowmik et al. 2021, Negură et al. 2021, Wu 2021). The broader literature on the effects of shocks on relational wellbeing is mixed; with some research showing that the stress of shocks can undermine

interpersonal relationships and sense of community, and other research suggesting that crises can bring people together and increase trust and cohesion, though often only temporarily in the immediate aftermath during a "honeymoon" period before disillusionment and long-term negative relational wellbeing effects set in (Kutak 1938, Bonanno et al. 2010, Townshend et al. 2015, Prayag et al. 2021). It may therefore be that the high level of relational wellbeing I recorded shortly after the restrictions were lifted in 2022 will only be temporary. Further longitudinal analysis is needed to explore the long-term feedbacks between relational wellbeing impacts and the recovery process.

6.5.3 Subjective wellbeing

Work enjoyment and identity was one of only two indicators which was significantly lower in 2022 than in 2019 and 2016, and where there was a significantly more negative net change from before to after the pandemic compared to the three years prior. Our before-during-after analysis also showed that the level of work enjoyment in 2022 was still an improvement on what it had been during the peak of the pandemic. In short, it is the indicator which appears to have been most significantly impacted by the pandemic. Other than changes to diets, changes in livelihood activities, and particularly fishing and fish trading, were the most common impacts and responses participants described in the interviews we conducted. Many respondents described having to fish less; fish at different times using different methods; fishing alone instead of in groups; and struggling to sell the fish they caught. The satisfaction, enjoyment and sense of identity that they get from fishing has been self-identified as one of the most important aspects of wellbeing for fishers in the region (Abunge et al. 2013). Beyond meeting material needs, fishing is a way of life and a core part of the cultural, relational and personal identity of small-scale fishers, meaning it cannot simply be replaced by alternative livelihood activities which merely replicate the supply of food and income (Pollnac et al. 2001, Oleson et al. 2015, Gillam and Charles 2018, Johnson 2018, Holland et al. 2020). As such, it is somewhat unsurprising that once respondents were able to ensure their material needs were met through modified fishing practices or alternative food and income sources, ongoing disruptions to fishing as their core livelihood activity would continue to be a source of discontentment.

All three analyses show that livelihood satisfaction and social cohesion do not seem to have been significantly negatively impacted in the medium term, and there is evidence that work enjoyment is also on a recovery trajectory. This rapid recovery pattern in subjective wellbeing aligns with an extensive (though somewhat contested) body of literature around the homeostatic tendency of subjective wellbeing, known as *set point theory, hedonic adaptation,* or the *hedonic treadmill,* among other terms (Brickman 1971, Diener et al. 2006, Luhmann and Intelisano 2018). This literature suggests that people have a baseline level of subjective wellbeing, particularly happiness and life satisfaction

(Brickman 1971). Significant life events (including experiencing disasters) can temporarily increase or decrease happiness and satisfaction levels, but people tend to return to their personal "set point" as they adapt to their new circumstances (Brickman 1971). However, there is significant variation in the literature regarding how long it takes to recover from negative subjective wellbeing impacts following major disasters like earthquakes or floods, on a scale of a few months to several years (Bonanno et al. 2010, Prayag et al. 2021). Additionally, many scholars claim that sufficiently significant changes can result in long-term shifts in subjective wellbeing, and different aspects of subjective wellbeing can vary in their level of stability, and change in different ways in the long term (Diener et al. 2006, Lucas 2007). The recovery pattern I identified seems to be an example of rapid return to a subjective well-being set point. To date there is very limited longitudinal data available showing potential medium-term recovery trends in diverse indicators of subjective wellbeing following the pandemic, so we do not yet know if my findings were exceptional or the norm in this context. There have been some related-but-not-synonymous psychological mental health assessments, primarily in developed country contexts, which have detected similar patterns of increases in multiple mental health and psychological wellbeing issues in the initial period of the pandemic, which reduced over the following months (O'Connor et al. 2021, Pierce et al. 2021, Murphy and Elliot 2022). It is important to note, however, that while most people in a community may exhibit a high level of psychological resilience and only experience transient subjective wellbeing impacts following a natural disaster, or in this case, the pandemic, a statistical minority of people may still experience severe and lasting subjective wellbeing impacts (Bonanno et al. 2010). A limitation of my analysis is that I was not able to disaggregate the data to see if there were different impacts for potentially more vulnerable or marginalised groups due to the sample size, meaning there may have been people who were disproportionately impacted (statistical outliers) whose experiences are not well reflected by the findings I have presented here. Further research is needed to explore both longitudinal trends in diverse subjective wellbeing indicators in different contexts, and to examine the effects of key socio-economic factors in more detail.

The lack of significant covariates in the relative change in wellbeing models across all three domains is unexpected, as it has been well-documented, even in early COVID-19 research, that crises often differentially affect different demographic groups, often disproportionately effecting already marginalised groups (Bottan et al. 2020, Patel et al. 2020, Gupta et al. 2021). For example, Borkowska and Laurence (2021) found significant effects of age, education, wealth and ethnicity on social cohesion during 2020. Muir et al. (2023) and Geng et al. (2022) found negative associations between household size and food security during the pandemic. This is additionally supported by our interview analysis, which did indicate substantial variation in people's experiences. This highlights the value of

supplementing the analysis of large-sample quantitative wellbeing indicators with qualitative data (White 2015), or with more detailed models and outlier analysis in addition to evaluating mean effect levels. It is possible, even likely, that other socio-demographic variables that were not accounted for in the models would explain some of the observed variance. For example, since material wellbeing was an outcome variable, I did not explicitly include any wealth indicators as model covariates. However, the three domains are interdependent and can create internal feedback loops: material wellbeing is associated with both relational and subjective wellbeing (McGregor 2008), and a strong pre-existing asset base is an important buffer against shocks (Mortreux and Barnett 2017). It is possible that there was a significant negative wellbeing effect for some groups which was lost in the aggregated quantitative analysis. Future research utilising larger sample sizes should include disaggregated data analysis and more complex models which can account for variation in baseline wellbeing levels between groups.

It is important to note that the baseline level of wellbeing, particularly material wellbeing, against which I compared 2022 levels was already fairly low; and many indicators were already declining in the three years prior. The landscape of ongoing social and ecological processes influencing wellbeing in the region which I was attempting to account for includes high levels of poverty (Degen et al. 2010, Kabubo-Mariara et al. 2011), corruption (Sulemana et al. 2017), political violence (Bennett et al. 2015, Klaus 2020), terrorism events (Masinde and Buigut 2018, Kamau 2021), lack of access to water and sanitation (UNICEF 2017), environmental degradation (Abunge et al. 2013), development (Abunge et al. 2013), and significant changes to marine resource management practices (Harker et al. 2022), among others. As such, it is not that COVID-19 had negligible impacts on an otherwise high quality of life, but rather that in the medium term the effects were not disproportionate to the ongoing processes which were already affecting people's wellbeing in the region. These processes are context specific, and as such the relative scale of the effects of COVID-19 and how well people can recover from it may be comparable in areas facing similar issues but not generalisable across all contexts.

6.6 Conclusion

Our research shows that people in coastal Kenyan fishing communities experienced a diverse range of negative impacts on all three domains of human wellbeing during the peak of the pandemic. I provide compelling evidence that communities are already beginning to recover and "bounce back" from the multidimensional wellbeing impacts of the pandemic. This is clearly good news, but what does it mean for the future? From the onset of the pandemic, many people hypothesised that studying COVID-19 could provide insights into current levels of resilience, and therefore how well individuals, local communities and the global community might respond to future shocks, particularly climate change

(Klenert et al. 2020, Manzanedo and Manning 2020). Like COVID-19, climate change will impact almost every aspect of people's lives, and addressing it will require both individual, collective and institutional action (Jordan and Palmer 2020, Klenert et al. 2020). The ability of fishing communities to maintain wellbeing in the face of shocks like COVID-19 suggests that they are relatively resilient and may be similarly able to withstand future climate shocks.

However, a key difference between COVID-19 and climate change is that COVID-19, while an extreme shock, was relatively acute and immediately evident, but the ongoing effects of climate change and the fight against it will be protracted and it is somewhat intangible in its early phases (Fuentes et al. 2020). This has shaped how people perceived and responded to the pandemic vs. climate change (Fuentes et al. 2020, Jordan and Palmer 2020). Additionally, the kind of easily-quantified wellbeing and resilience indicators which are used to study the immediate impacts of acute shocks like COVID-19 (including in this study) can overlook more nuanced factors like inequalities, power dynamics, cultural processes and relationships which influence the long term outcomes of slow-onset crises such as climate change (Chaigneau et al. 2022). While similar recovery patterns to what I have observed here may be repeated following individual climate-driven natural disasters, climate change will result in both progressive and recurrent shocks which may be harder to recover from (Guillaumont and Simonet 2011). Repeated exposure to escalating climate effects can lead to negative feedback spirals and reinforce poverty traps where the most vulnerable do not have the opportunity to recover and rebuild physical and social capital before being exposed to the next shock (Carter and Barrett 2006, Barrett et al. 2007, Berhanu 2011). Similarly, later developments in set point theory suggest that while people can recover from the subjective wellbeing impacts of isolated shocks, long-term changes in circumstances can lead to long-term changes in subjective wellbeing (Diener et al. 2006, Lucas 2007, Luhmann and Intelisano 2018). As such, while my findings are encouraging in that they indicate that people have been able to recover relatively quickly from the multi-dimensional wellbeing impacts of COVID-19, this should not mean that we become complacent to the long-term risks of climate change.

Chapter Seven: General discussion and conclusions

7.1 Introduction

As a worldwide event which affected almost every aspect of people's lives, the COVID-19 pandemic offered an opportunity to apply and further develop several emerging theories around how people are impacted by and respond to shocks (Klenert et al. 2020, Manzanedo and Manning 2020). Different theories conceptualise how shocks lead to various outcomes (and therefore what needs to be done to mitigate negative outcomes) differently, depending on the scale by which they measure shocks and responses, and what outcomes they consider important (Adger et al. 2005a, Brown and Westaway 2011). As yet, there is not a single, integrated framework which draws together these different conceptualisations. Using case studies of seven coastal small-scale fishing communities in three geographic regions, I applied three different theoretical frameworks to examine the impacts of and responses to the pandemic and the restrictions put in place to contain it. I sought to address four research questions: 1) What can we learn about how people were impacted by and responded to COVID-19 by using three different theoretical framings? 2) What are the strengths and weaknesses of these theoretical framings, and how does that influence research findings and recommendations? 3) What are the benefits and/or drawbacks from utilizing or combining multiple frameworks to study the same shock? and 4) How can we apply the lessons of COVID-19 to strengthen proactive and reactive policies and interventions for future shocks, particularly climate change? Here I will summaries my findings in regard to these questions; outline how each chapter and this body of work overall has contributed to the development of theory in my field; discuss a few critiques and caveats; and suggest potential applications and future directions for this research.

7.2 Summary of findings

7.2.1 What can we learn about how people were impacted by and responded to COVID-19 through three different theoretical framings?

Throughout this thesis, and particularly in Chapter Three, I explored the immediate impacts of the pandemic in coastal fishing communities. I found that people experienced a diverse range of negative impacts on livelihoods, food security, and wellbeing. In some cases, these disruptions exacerbated existing inequalities. Many of these initial impacts were similar to those reported in other small-scale fishing communities around the world (Jomitol et al. 2020, Manlosa et al. 2021, Sunny et al. 2021, Okronipa et al. 2023), other low and middle-income countries more generally (Erokhin and Gao 2020, Harris et al. 2020, Picchioni et al. 2022), and to impacts seen in historical shocks (Cohen and Pinstrup-Andersen 1999, Israel and Briones 2012, Béné 2020). However, beyond these immediate impacts I

was able to develop a more nuanced understanding of the impacts of and responses to the pandemic by using three structured theoretical frameworks as detailed in Chapters Four, Five and Six. As the three theories focus on different processes and outcomes at different scales, in combination they lead to a more comprehensive conceptualization of the relationship between shocks and outcomes.

7.2.1.1 Food systems framework

In Chapter Four, I took a food systems approach to analyze the initial impacts of the pandemic in Kenya, Papua New Guinea, and St. Lucia. I identified impacts of the pandemic on every component classified in the HLPE food systems framework (HLPE 2020), primarily as a series of interconnected side effects of the COVID-19 containment policies put in place by the government. The primary impact pathway I identified was a reduction in physical and economic access to food, which resulted in significant reductions in food and nutrition security. This matches findings about COVID-19 impacts on food and economic security in other places (Picchioni et al. 2022), and experiences of previous socio-economic shocks (Cohen and Pinstrup-Andersen 1999, Israel and Briones 2012, Béné 2020). However, my detailed analysis using the framework revealed that these common, anticipated outcomes were the result of multiple, context-specific impact pathways and feedback mechanisms. The context-specificity of these mechanisms suggests that the most appropriate policy responses to shocks to food systems are also likely context specific. This conclusion is supported by a growing body of research from across the globe revealing the different context-specific strengths, weaknesses and adaptations required from different types of food systems during the pandemic, from more isolated rural and remote regions (O'Kane 2020, Paganini et al. 2020, Dixon et al. 2021, Ferguson et al. 2022) to the complex and increasingly digitized food distribution systems of major high-income countries (Bakalis et al. 2020, Leone et al. 2020, Thilmany et al. 2021), and the informal supply chains of urban regions in low and middle-income countries (Wegerif 2020, Zimmerer and de Haan 2020, Rwafa-Ponela et al. 2022).

7.2.1.2 Six domains of adaptive capacity framework

In Chapter Five, I applied the six domains of adaptive capacity framework (Cinner and Barnes 2019) to examine which factors shaped how individuals responded to the food security, livelihood, and wellbeing impacts of the pandemic. I found that women and men in coastal Kenyan fishing communities utilised a range of coping strategies, incremental adaptations, and transformations, many of which had the potential to be maladaptive. I found that all six domains (assets, flexibility, learning, social organisation, socio-cognitive constructs, and agency) influenced which response strategies people adopted. High levels of adaptive capacity across each of the six domains facilitated particular desirable responses (e.g., allowing them to diversify their livelihood strategy), but low

capacity either acted as a barrier preventing people from responding how they wanted to (e.g., not being able to undertake a particular activity); or forced them to respond in an undesirable way (e.g., by reducing dietary diversity). This work built on previous findings about the role each of the six domains can play in facilitating adaptation to climate-driven shocks (Barnes et al. 2017, Barnes et al. 2020, Green et al. 2021, Salgueiro Otero et al. 2022). The key, novel finding of this chapter was the complex ways the six domains interacted with each other to influence people's responses. In particular, some domains were important for facilitating the other domains (e.g., social ties influenced access to assets, increased learning opportunities and shaped socio-cognitive constructs). I concluded that efforts to build adaptive capacity against future shocks need to be multidimensional, and that they should aim to account for potential interactions between domains, and particularly aim to identify opportunities to build up those domains which may synergistically support the others.

7.2.1.3 3D Wellbeing framework

In Chapter Six, I applied the 3D wellbeing framework (White 2010) to evaluate the wellbeing outcomes of the pandemic and people's responses to it, using a mixed-methods approach. I first identified multiple negative impacts on material, relational and subjective wellbeing during the peak of the pandemic restrictions in Kenya. I then conducted a quantitative analysis of several subjective wellbeing indicators from before, during and after the peak of the pandemic. I found that while there was a statistically significant decline in subjective wellbeing during 2020, there was relatively rapid recovery back to pre-pandemic levels by 2022. I found no evidence of a larger decline in wellbeing over the three years during and after the pandemic than occurred in the three years prior due to other processes. I reflected on some potential parallels with the long term wellbeing impacts of climate-related shocks, and suggested that while my findings provide encouraging evidence for people's capacity to recover from the negative wellbeing impacts of COVID-19 in line with set point theory (Brickman 1971), this does not mean that they will be able to withstand the projected repeated, escalating wellbeing impacts of climate change.

My findings from the combination of these frameworks demonstrate that how people are initially impacted, respond to, and are affected by shocks is highly personalised and determined by both the characteristics of the systems in which they are embedded and their individual capacities. Efforts to respond to shocks need to consider how individual-level factors such as gender, age, education, location, and occupation can influence how people are differentially affected by shocks (Ch. 3) and efforts to build adaptive capacity should aim to enhance individuals' adaptive capacity across all six domains and harness potential synergies between interacting domains (Ch. 5). On the other hand, efforts also need to address system level structures and functions, for example, by increasing recognition of and support for informal rural-urban food value chains (Ch. 4.5.3) and supporting

transparent and equitable local governance and social support structures (Ch. 5.5.2.2). However, applying the three frameworks in exacting detail was extremely time consuming, and the focus on contextual nuances limits the broader applicability of my more specific findings.

7.2.2 What are the strengths and weaknesses of these theoretical framings, and how does that influence research findings and recommendations?

Beyond the important, but narrow task of identifying the impacts of COVID-19 and its containment policies in these specific communities, the key contribution of this research is evaluating the application of the three different theoretical frameworks more broadly. Specifically, I sought to explore the strengths and weaknesses of each and the potential benefits of using a combined approach to understanding shocks. Here I will outline some general reflections of each of the frameworks based on how I applied them in Chapters Four, Five and Six, and how they collectively shaped my findings.

7.2.2.1 Food systems framework

The HLPE food systems framework facilitates the identification of the impact pathways of shocks: it fundamentally incorporates the interactions between connected people and processes which lead to specific nutritional outcomes for different actors and can lead to feedback loops within the system (Ericksen 2008, HLPE 2017, Van Berkum et al. 2018, Devereux et al. 2020). Like any systems analysis, the HLPE framework is very helpful for understanding the "big picture" and the contextual factors which are driving particular outcomes, and also for identifying contextually specific failure points and corresponding solutions (Ingram 2011, Reynolds and Holwell 2020). The framework's focus on the role of external drivers, including high-level social, economic and environmental processes and political and institutional processes means that it is more likely to identify and focus interventions on the root causes of issues, which are potentially outside the scope of influence of individual local actors who are experiencing food insecurity (Van Berkum et al. 2018, Reynolds and Holwell 2020).

The framework (and food systems thinking more broadly) does explicitly acknowledge the influence of socio-economic drivers and system structures that can lead to inequitable outcomes for different individuals (HLPE 2017, 2020). However, in trying to capture the "big picture" and understand high level structural processes, it is easy to overlook individual differences in outcomes. Systems approaches are particularly susceptible to the fundamental trade-offs of scope and precision which plague social-ecological research. That is, the more locally specific and nuanced the analysis, the more difficult and complex to analyse, and the more focused on understanding individual differences, the less generalisable the findings will be. However, the less granular the analysis, the less effective it is in identifying key locally relevant weaknesses and intervention points (Ericksen 2008, Schader et al.

2014, Van Berkum et al. 2018). Food systems are themselves inherently cross-scalar; and food systems analysis requires linking factors spanning multiple spatial, temporal, jurisdictional and institutional scales, meaning that food systems "maps" can very quickly become unwieldy unless intentionally bounded (Cash et al. 2006, Ericksen 2008, Ericksen et al. 2009, Ericksen et al. 2010). As a consequence of managing these challenges of scale and complexity, detailed food systems analysis can be extremely time and resource intensive, which may be viable for long term strategic planning but is not ideal in an immediate, large-scale crisis. Researchers and policymakers seeking to use food systems approaches based on the HLPE framework or similar conceptualisations to understand the impact pathways of shocks on food and nutrition security outcomes need to make conscious trade-offs between timeliness, detail, and generalisability. In this case, I focused on a very narrow context, but attempted to identify as many system components and relationships as possible. Others choose to have a larger geographic scope, and either take longer or capture less detail, (Moseley and Battersby 2020, Béné et al. 2021, Carducci et al. 2021, Noort et al. 2022) or focus in on one element of the food system, such as food environments and only discuss the broader system for context (Cable et al. 2021, O'Meara et al. 2022)**.**

One way to mitigate this trade-off to some extent is investing in food systems research before shocks happen. Having a detailed prior understanding of different local food system dynamics could facilitate faster analysis and interventions if researchers do not have to start from scratch when mapping out the impact pathways of shocks. For example, both my findings here and other research coming out of similar contexts have identified that a lack of awareness and support for informal rural-urban food value chains was a major issue for both urban food security and rural livelihoods during the pandemic, which could have been avoided if they were better recognised and understood (Zimmerer and de Haan 2020, Liverpool-Tasie et al. 2021). Many systems analysts advocate for the development of typologies which can be used to break down food system complexity and allow policymakers to rapidly identify the likely consequences of particular shocks or interventions in a particular context based on key system attributes such as the level of household engagement and the use of technology and extension services in food production processes (Ericksen et al. 2010, Marshall et al. 2021).

It is also worth reemphasizing the HLPE food systems framework's explicit focus on food. This makes it particularly appropriate for understanding both food and nutrition security and broader social, economic, and environmental outcomes of shocks in poorer, subsistence communities where food and nutrition insecurity is one of the biggest threats from a range of different shocks, and the majority of people's livelihoods are directly connected to food value chains, as in my study communities. It would be less appropriate tool for gaining a comprehensive picture of the impact pathways and

broader outcomes of shocks in communities with more diverse livelihood portfolios and is never going to capture the full range of impacts on different aspects of people's livelihoods, health, and wellbeing. However, the HLPE food systems framework is just one specific example of the application of broader systems thinking to the problem of shocks to food and nutrition security. Different frameworks underpinned by the same conceptual principles could be applied to understand the relationship between a given shock and any set of relevant social, economic and environmental outcomes, with similar focuses, strengths and weaknesses (Reynolds and Holwell 2020).

7.2.2.2 Six Domains of Adaptive Capacity framework

The adaptive capacity framework facilitates the analysis of key factors that influence how well people are able to respond to shocks to maintain their wellbeing (Cinner and Barnes 2019). As the framework is focused on the particular capacity of individuals or groups, it can help to identify differences in the resources and needs of different groups of people and can highlight vulnerabilities and the potential for shocks to perpetuate or exacerbate inequalities. For example, in my analysis I noted some demographics of people who were less likely to have sufficient social capital with leaders and shop owners to access credit and aid (i.e., an instance where a lack of social organization could lead to a negative feedback loop of reduced access to assets for those individuals). Conceptualizations of adaptation and adaptive capacity that focus on individuals or smaller groups of people, rather than high level structures and processes, may mean that these differences are less likely to be overlooked or exacerbated, and promote agency (Eriksen et al. 2021, Singh et al. 2022). However, while this framework does place people within their wider context to some extent through capturing social organization, it does not really help explain or address high level processes outside of their immediate sphere of influence. Primarily focusing on people's adaptive capacity and the ability to minimize the negative effects of shocks at smaller scales can potentially draw focus and accountability away from addressing the root causes of vulnerability to shocks. It thus risks placing the burden of responsibility for the outcomes of shocks on individuals or marginalised groups, even when both the shocks themselves and the limitations on people's adaptive capacity are often primarily due to systemic and/or institutional factors outside of their control, and which would more effectively and more justly be addressed at that higher level (Moser and Ekstrom 2010, Islam et al. 2014, Amo-Agyemang 2021, Maltby et al. 2023a, Maltby et al. 2023b). While understanding and building individual adaptive capacity is critical, it does not replace the need for high-level institutional responses outside the scope of influence of those individuals (Adger et al. 2005a).

The key strength of this particular framework is that it outlines a diverse range of both physical resources and individual attributes that collectively shape how people can respond to shocks. It is a more holistic approach than has historically been taken by aid and development organisations which

focused primarily on material factors, such as assets and institutions, to the exclusion of less tangible, personal attributes such as agency and socio-cognitive constructs (Mortreux and Barnett 2017). The framework can be used both as a general guide for proactively building capacity in all the domains in the face of anticipated shocks, and also as a tool for retroactively examining what people lacked and what helped people to respond to specific shocks to strategically rebuild capacity for the future. However, it is difficult to analyse how all of these different domains of adaptive capacity are operating and, more importantly, effectively increase most of them in the midst of a crisis. For example, while governments or aid organisations may be able to provide physical supplies, emergency funds, and information and training as part of emergency responses, it is much harder to analyse and influence social organisational structures, individual agency, or socio-cognitive constructs as a rapid response strategy. As such, the adaptive capacity framework is not as well suited as the food systems framework or 3D wellbeing framework for identifying immediate needs and informing short term policy responses to crises but is a helpful tool during the iterative cycle of strategically preparing for and recovering from shocks.

Finally, while all six domains of adaptive capacity are important (Barnes et al. 2017, Barnes et al. 2020, Green et al. 2021, Salgueiro Otero et al. 2022) as demonstrated by my findings in Chapter Five, agency, learning, and socio-cognitive constructs are much more nebulous concepts than assets, social organisation, and flexibility. As such, they were much harder to get people to self-reflect on in interviews, which can lead to unbalanced representation of the function and relative importance of the different domains. They are also harder to intentionally influence with an intervention. Indeed, this issue is a key reason why those domains have historically been overlooked in both research and interventions (Grothmann and Patt 2005, Brown and Westaway 2011, Mortreux and Barnett 2017, Cinner et al. 2018a). This is not a flaw in the framework itself but does represent a significant challenge when operationalising it as an analytical or policy tool, though one which can be overcome with sufficient planning and care.

7.2.2.3 3D Wellbeing framework

The 3D wellbeing framework is a useful tool for developing a more holistic understanding of the impacts of shocks, beyond the dominant-but-narrow focus on access to material goods and services (Dercon and Hoddinott 2004, Gaiha and Imai 2004, Baulch 2011, Akter and Basher 2014). While in isolation, the framework does not help to identify the causal pathways which lead to particular wellbeing outcomes, or strategies to mitigate them, it can help ensure that research or interventions are focusing on the full range of wellbeing outcomes.

The individual focus of the framework could help identify different people's experiences of shocks, particularly vulnerable groups, depending on the methodology used. Specifically, calculating and comparing means of quantitative indicators of wellbeing may obscure nuance and important information about particularly vulnerable or exceptionally resilient people. This is clearly demonstrated in Chapter Six, where the quantitative analysis of survey data did not identify the differences in the experiences and outcomes for different individuals and demographic groups revealed by my qualitative analysis. More complex questionnaires and further disaggregating and breaking down the quantitative data may ameliorate this lack of clarity; but increasingly complex statistical analysis requires increasingly large sample sizes, which is not always viable with limited time and resources during crises. As such, I suggest that a mixed methods or qualitative approach is needed to maximize the potential strengths of the 3D wellbeing framework in many crisis contexts.

7.2.2.4 Summary of strengths and weaknesses

In general terms, the strengths and weaknesses I have identified are, unsurprisingly, directly related to what each framework prioritizes, and consequently what is minimized. None of the frameworks explicitly dismiss any key concepts, but because they are not a primary feature they risk being overlooked or oversimplified. For example while the HLPE Food Systems Framework does include an "other social, economic and environmental outcomes" box where human wellbeing outcomes other than the material aspect of food security could be considered, it does not provide much structure for exploring those outcomes, and the broader outcomes of food systems are generally evaluated at larger scales rather than looking at multifaceted impacts on individuals (HLPE 2017). Similarly, while the adaptive capacity framework recognizes the importance of nesting people within their larger context through the organization domain; it again does not provide a structure for capturing the full complexity of this wider context (Cinner and Barnes 2019).

It is important to note that I have specifically identified strengths and weaknesses in reference to applying the frameworks individually and collectively for the purpose of building a comprehensive understanding of how shocks lead to diverse social outcomes. While the frameworks can all clearly be useful in this context, they were not specifically designed as interchangeable methods to individually assess that entire process. Gaps in the overall picture left by each framework do not necessarily mean that the frameworks are not fit for the purpose they were originally designed for. For example, the wellbeing framework alone is not particularly helpful for identifying structural weaknesses or strategic intervention points because it was not designed as a system level mapping tool. In summary, there is not yet a general theory which on its own adequately captures how shocks lead to diverse outcomes across scales, which is why I chose to draw on insights from multiple frameworks.

7.2.3 Towards an integrated framework for studying shocks

Each of the frameworks is helpful for understanding different aspects of the shock/outcome relationship, and together build a more comprehensive picture (**Fig. 26**). The food systems framework prioritizes looking at impact pathways, and fundamentally incorporates interactions between connected people and processes which lead to feedback loops (HLPE 2020), but has a very high-level focus, prioritizes food security over any other outcomes, particularly non-material ones, and can overgeneralize the experiences of different people within communities (**Fig. 26B**). The adaptive capacity framework looks at the outcomes as a function of how well individuals or groups of people can respond to shocks, as determined by their latent adaptive capacity (Cinner and Barnes 2019), but focusing on the capacities and actions of specific individuals or communities to respond to a shock can bypass the systemic root causes of issues and corresponding potential responses which fall outside of their spheres of influence (**Fig. 26C**) (Maltby et al. 2023a). The wellbeing framework is less about understanding the processes which lead to outcomes; rather it is about exploring a diverse range of outcomes on different aspects of people's lives, particularly the non-material outcomes that are often overlooked (White 2010), and as such it does not provide insight into what needs to change to resolve identified issues (**Fig. 26D**).

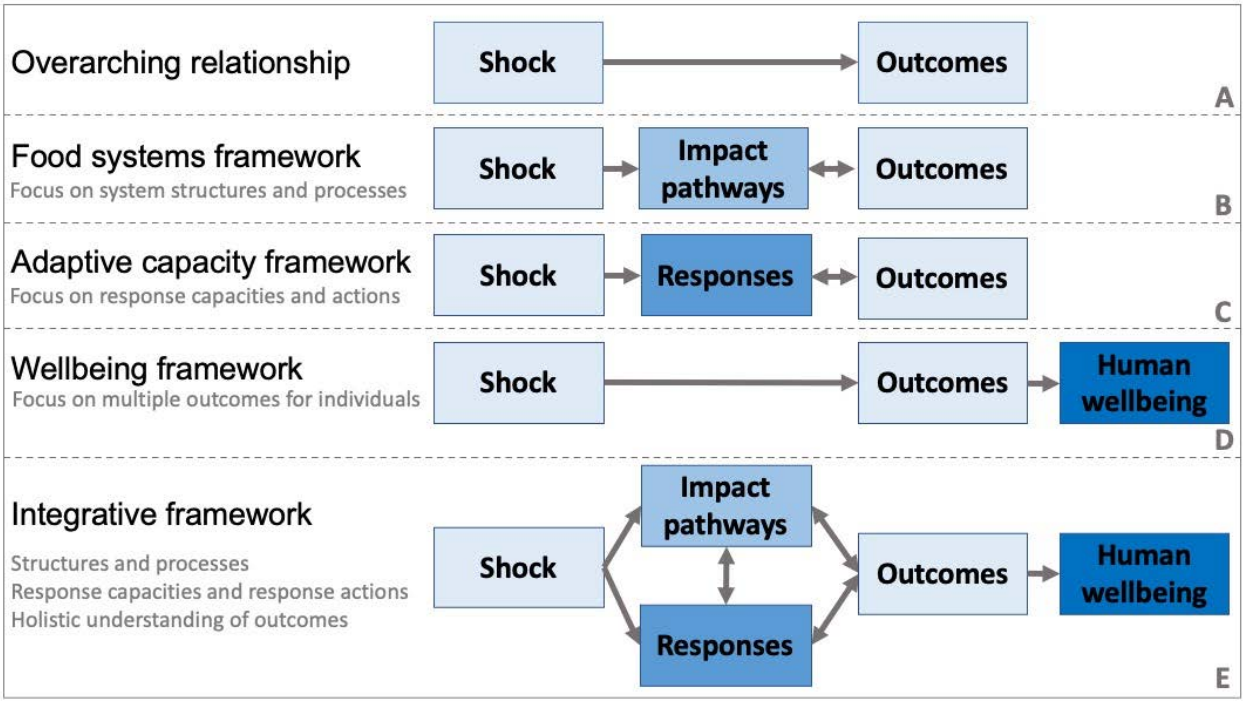

Figure 26: Contributions of the three frameworks to an integrated understanding of the relationship between shocks and outcomes based on the key focus of each framework

Here, I propose moving towards an integrative framework which draws together the key concepts from each of the three frameworks (**Fig. 26**). This generates a multi-scalar perspective which captures

both the high-level processes and drivers which are behind the impacts of shocks, as well as individual actions and a more holistic conceptualization of what outcomes are important to consider (**Fig. 26E**). Simultaneously considering both the impact pathways of shocks through higher-level system structures and processes and individual responses and how they interact is a key element of this framework, as it reinforces the importance of the sometimes-underrepresented social element of social-ecological systems-based conceptualizations of the factors contributing to resilience to shocks (Armitage et al. 2012, Brown 2014). It highlights both the importance of human agency and the role that individuals' actions play in shaping the wider system, as well as the influence of social, environmental, and economic context on the capacities and actions of individuals within the system (Adger et al. 2005a, Brown and Westaway 2011). For example, in my research I found that the characteristics of the local food systems in each community influenced the range of responses which were even theoretically available to people within those communities, such as whether there was sufficient arable land, access to inputs and market integration to transition into agriculture or buying and selling non-fish products; i.e., understanding the food system was critical for understanding the kinds of adaptations people might be able to make. However, the presence of arable land, agricultural inputs and market integration alone did not mean every individual within those communities was able to take up agriculture, which is why I also needed to examine individual-scale adaptive capacity to fully understand what factors were facilitating and limiting different responses. The inverse is also true: the actions of individuals feed back into the wider system. For example, the people who did engage in growing or trading agricultural products as well as or instead of fishing not only improved their own income and food security, but also increased the availability of those products for others in the community to consume or trade. Clearly, examining both the food system as a whole and individual scale capacities and actions and how they interact was essential for developing a full picture of the outcomes of COVID-19 for different people and communities. In turn, deciding if and how to intervene to mitigate negative impacts would require considering whether existing system structures would undermine the effects of increasing individual-level adaptive capacity or vice versa.

Finally, the addition of the human wellbeing component acts as a reminder to broaden the scope of the outcomes considered in evaluating the impact pathways of, and individual responses to shocks. For example, in my research multiple interviewees talked about the significant impact that food insecurity during the pandemic had on their own mental health, self-efficacy, and their relationship with their families; the wellbeing impacts extended beyond their material health status to their relational and subjective wellbeing. In the context of designing and evaluating policy interventions in the face of shocks, basing definitions of success solely on whether people consumed sufficient calories and nutrients to maintain their physical health risks overlooking the important social and psychological

outcomes associated with consuming preferred, culturally-significant foods in a social context (Block et al. 2011).

In short, each of the frameworks goes a long way to filling the gaps in the other frameworks, resulting in a more comprehensive understanding of what the outcomes of shocks are and how they occur. Because each framework has a specific focus, individually they may overlook potential solutions to negative outcomes from shocks but using them collectively may reveal a wider range of options. For example, applying systems thinking to shock response policies might lead to a focus on identifying bottlenecks preventing people from accessing the goods and services they need which can be resolved upstream, but analyses based on the adaptive capacity framework might lead to finding other ways for individual people affected by the bottleneck to utilize the resources which they still have available to them to meet their needs. Both strategies are valid and might be more appropriate in one instance or another, but having the option to do both, by for example facilitating a temporary coping strategy or incremental adaptation until the underlying systematic issue is identified and resolved, increases the overall solution space.

The specific combination of the three frameworks I have used here does not capture every conceivably important element, nor does every aspect of each framework need to be fully considered in the analysis of every shock. There is a lot of overlap in the elements captured by each framework, which means it is somewhat inefficient to use them sequentially as I have here. There is also still ongoing debate within the literature about the definitions and functional relationships between adaptive capacity, resilience, and wellbeing (Gallopín 2006, Brown and Westaway 2011, Lei et al. 2014, Maltby et al. 2023a), which can make trying to cobble together frameworks which conceptualise these ideas in different ways confusing, and possibly unhelpful for practitioners. Additionally, no one framework will capture every element of a complex social system or phenomena in exhaustive detail (Anfara Jr and Mertz 2014). Indeed, any framework that did incorporate everything would likely be too complex, time consuming, and resource intensive to be useful. There is an inherent trade-off in any research between efficiency and comprehensiveness. Particularly in the context of evaluating the impacts of shocks for the purposes of designing support interventions, researchers and practitioners need to be able to act quickly when livelihoods and food security have been compromised, often in many different communities simultaneously. As such, researchers and practitioners need to make strategic choices about what information is likely to be most useful for their particular goal and choose an approach that best fits their needs with the time and resources allowed. However, speed must be balanced with ensuring that research and interventions actually address the key issues people are facing, leverage potentially limited resources for maximum impact, and do not overlook marginalised

groups or exacerbate inequalities (McDougall et al. 2020). When researchers and practitioners are choosing which theories to ground their approach in, they should be aware of which concepts are foregrounded and which marginalised in ways which could compromise the conclusions of their research or the effectiveness of their intervention, overlook potentially important information and helpful solutions, or worse, undermine the wellbeing of marginalised groups (Maltby et al. 2023a). Researchers and practitioners may benefit from drawing on the key principles of different frameworks or theories to fill in gaps in a particular primary approach, without fully investing in every element of every framework which could be applied to a topic (Roe 2012, Foran et al. 2014).

My integrative framework can be used as a guide for situating a detailed analysis of a particular aspect of a shock within a broader understanding of how individual responses to shocks interact with wider food system (or broader social-ecological system) structures and processes, and the potential for impacts on different aspects of human wellbeing. For example, an agency tasked with improving food security following an armed conflict could primarily draw on systems thinking to identify breakdowns in the system and potential strategic intervention points; but then zoom out and use the integrated framework to remain mindful of how the different processes and outcomes related to the food system will interact with individuals' capacities to respond to the shock and to potential interventions, and impact different aspects of human wellbeing, rather than exclusively focusing on the material wellbeing outcome of sufficient nutrient intake.

7.2.4 How can we apply the lessons of COVID-19 to strengthen proactive and reactive policies and interventions for future shocks, particularly climate change?

Since the onset of the pandemic, researchers have suggested that we might also be able to learn from what happened during the pandemic to better inform preparations for and responses to climate change (Klenert et al. 2020, Manzanedo and Manning 2020, Pelling et al. 2021). There are some key differences between the two which may limit the direct cross-applicability of the experiences of the pandemic, but there are some distinct parallels (Fuentes et al. 2020, Cooper and Nagel 2021). Some of the indirect consequences of the pandemic are likely to occur again during extreme climate events. For example, breakdowns in food production and value chains, increased food prices, unemployment, infrastructure breakdowns, a reduction in social support systems and overall economic decline are all likely outcomes of increasingly frequent and severe natural disasters, rising sea levels and changing seasonal weather patterns (Manzanedo and Manning 2020, Cooper and Nagel 2021, Negev et al. 2021, Pelling et al. 2021). Without making changes in response to our experiences during COVID-19, these disruptions are likely to lead to similar failure points, with a similar range of possible responses and outcomes. As such, to avoid or at least minimise the negative outcomes of those disruptions during

future shocks, we can potentially look at experiences during COVID-19 and identify structural weak points using a food systems approach; identify what adaptations were helpful vs maladaptive and what areas of adaptive capacity need strengthening based on the adaptive capacity framework; and examine the effects of these impacts on a more diverse range of social outcomes using the wellbeing framework.

However, the pandemic and climate change operate at very different temporal scales. Consequently, the impacts for food systems which are subject to long term seasonal cycles are very different for relatively short-term shocks (e.g., a cyclone), medium-length disruptions (e.g., lockdowns lasting weeks or months) and protracted crises (e.g., droughts or extended conflicts). As such, they require different scales of responses to maintain food and nutrition security ranging from the provision of temporary aid through to large scale development interventions and system transformations (Russo et al. 2008). Adaptive capacity and resilience theory suggest that the way people think about shocks, including past experience, influences how they respond, meaning that people's reactions to COVID-19 vs. climate change are likely to be different (Mortreux and Barnett 2017, Fuentes et al. 2020, Botzen et al. 2021, Cooper and Nagel 2021). For example, from my interviews it seems that some people felt that they did not need to proactively adapt or transform in response to COVID because they assumed that it would be over quickly, but that is not an option with climate change. Additionally, while people may be able to learn from past experiences and improve their responses in the future (Engle 2011), repeated exposure to shocks can also dramatically undermine their ongoing resilience and adaptive capacity by trapping people in a negative feedback cycle where they have insufficient time to recover between shocks (Sacco 2004). People with low base levels of adaptive capacity are more likely to be forced into adopting maladaptive coping strategies which further exacerbate those inequalities, for example eroding their health, social capital, and asset base (Carter and Barrett 2006, Barrett et al. 2007, Berhanu 2011). Similarly, people with a higher baseline level of wellbeing are less likely to experience negative wellbeing impacts, but people with low base levels of wellbeing can become trapped in negative feedback cycles (Kofinas and Chapin 2009, Hallegatte et al. 2016, Keating et al. 2017, Gillam and Charles 2018, Prayag et al. 2021). Additionally, while people can often bounce back from isolated events and return to a stable level of subjective wellbeing, ongoing declines in circumstances are likely to erode wellbeing in the long term (Diener et al. 2006, Lucas 2007, Guillaumont and Simonet 2011, Luhmann and Intelisano 2018). In summary, the degree to which it seems people have been able to adapt to and recover from COVID-19 may give a false sense of security, as we may not be able to respond as effectively if climate disasters occur with increasing frequency and severity.

7.3 Key Contributions

It is my hope that this research has and will continue to directly inform practitioners working to address the severe, ongoing impacts of the COVID-19 pandemic in coastal fishing communities in Kenya and more broadly, and in addressing future shocks. The preliminary findings of this research in the form of public-audience summaries, policy briefs, and reports, as well as academic publications, were shared with our research partners in our study communities as well as our wider networks (Lau and Sutcliffe 2020a, Lau and Sutcliffe 2021, Lau et al. 2021a, Lau et al. 2021b, Mbaru 2021, Sutcliffe et al. 2023). The reports included specific policy recommendations, though these were particularly relevant during the peak of the pandemic when the reports were published, rather than in the current recovery phase. These included the need for rapid interventions to preserve food value chains, increased clarity of communication regarding restrictions, and transparency and equity in the provision of aid. Our direct research partners included WCS Kenya and the Kenyan Marine and Fisheries Research Institute, both of whom have active ongoing partnerships with our study communities and in Kenya more broadly and have been involved in supporting COVID-19 responses and recovery, as well long-term programs around increasing food and nutrition security, sustainable livelihoods, resilience and adaptive capacity to diverse shocks, including climate change, and multi-dimensional wellbeing which can be directly informed by my findings and recommendations from my thesis as a whole. We also directly shared our findings with WIOMSA, the PNG Local Marine Management Association (LMMA) Network and WorldFish, who are actively engaged with coastal fishing communities primarily in the Western Indian Ocean and Pacific Ocean. We also communicated early research findings directly with communities and specific research participants in Kenya during our fieldwork in 2022. We also shared our findings more broadly with the general public through articles in *The Conversation* (Lau and Sutcliffe 2020b, Mbaru et al. 2022). To date I have been unable to extensively debrief with either these partners or the communities to evaluate if and how they practically applied our findings, but both myself and my supervisors plan to maintain and develop our personal and professional relationships with these communities, and particularly discuss with them how we can work together to better understand and make use of this research.

Beyond this immediate practical application, my work led to four key contributions to theory in my field corresponding to the overarching aims of my research. **Aim 1** was to examine the relationship between shocks and social outcomes. In addressing this aim, I produced empirical evidence for the key mechanisms through which COVID-19 lead to diverse social outcomes in three major small-scale fishing regions of the world. **Aim 2** was to explore the application of different theoretical frameworks to studying shocks. I evaluated the applicability of three different prominent theoretical frameworks to studying the relationship between shocks and outcomes; evaluated the strengths and weaknesses

of the frameworks for that purpose; and explored the benefits and drawbacks of combining them. **Aim 3** was to explore the interactions between different domains of adaptive capacity. I advanced understanding of the relationships between the six domains by identifying multiple examples of complex linkages and instances where some domains played a key role in facilitating the others. Finally, in addressing **Aim 4:** evaluate the relevance of studying COVID-19 to future shocks, I identified multiple ways that the experiences during the pandemic could inform efforts to strategically build adaptive capacity and more effectively respond to similar disruptions in the future, particularly under climate change. In addressing these four aims together, I was able to develop an integrative framework for evaluating the outcomes of future shocks, which draws together the key elements of systems thinking, adaptive capacity theory, and multi-dimensional conceptualizations of human wellbeing.

7.4 Critiques and Caveats

As with any research, there are a number of critiques and caveats to this body of work. Firstly, the extent to which I was able rigorously explore the differences in how different groups of people within each community were affected by and responded to the pandemic was limited by my sample size. This was particularly the case for the quantitative analysis in Chapter Six, where I simply did not have enough survey data to fully explore the influence of different demographic variables. I was able to explore some of these differences through the interviews, but a larger sample size would be required to be able to draw firm conclusions.

Secondly, it is important to acknowledge that any cross-cultural/cross-language qualitative research is subject to researcher bias, loss of meaning through translation, and cultural misinterpretation (Squires 2009, Shimpuku and Norr 2012, Pelzang and Hutchinson 2017). Whilst I made extensive effort to consult with local research partners throughout the research, analysis and writing process, particularly my colleagues Stephen Wanyonyi, Innocent Muly and Wilda Hungito, who conducted, transcribed, and translated the interviews, there is still a significant loss of context and nuance when working with qualitative data which is so removed from the original interviewees. Though I have spent several weeks with the community in Papua New Guinea prior to the pandemic, and in one of the communities in Kenya after this data was collected but before it was fully analysed, this is relatively little time in terms of understanding a different community and culture, and there will certainly be nuances which I have overlooked or misinterpreted.

Finally, the research project was developed and initiated on extremely short notice in reaction to the pandemic, which influenced the study design, data analysis and project outputs. For example, while

the study sites do represent interesting case studies in key small-scale fishing regions of the world, their selection and the recruitment of individual participants was somewhat opportunistic, based on where my advisory team and I had existing connections and baseline data. The interviews were conducted remotely by phone, which was a significant issue for participant recruitment and retention, as a lack of access to phones and reliable signal prevented us from expanding to another study site in Papua New Guinea as originally planned and led to several participants dropping out after one or two rounds of interviews. These factors combined led to the somewhat unbalanced study design of six communities in Kenya and one each in Papua New Guinea and St. Lucia, and only being able to collect one round of data in St. Lucia instead of three.

As detailed in the preface, this project was not my originally planned PhD research, and was not itself designed with a PhD thesis in mind. I commenced my PhD in 2018 and had already conducted a pilot study for my original research project but needed to complete extensive overseas fieldwork in 2020 which was obviously prevented by the outbreak of COVID-19. As such, I was forced to adopt a new, more opportunistic research project for my PhD. In the initial months of the pandemic, the research project this thesis now draws on was developed as a rapid effort to document an emerging crisis which would inform policy responses and aid interventions as well as develop theory. I only later adopted it as my thesis project several months in when it became clear that I would not be able to re-commence my original plans in a reasonable timeframe. The original goals for this project of quickly producing policy-relevant summaries particularly influenced the early data analysis strategy and outputs, which are presented in Chapter Three and Appendix One. They were intentionally less theory-heavy than the analysis and findings presented in Chapters Four, Five and Six as they were intended to be general summaries and easily interpreted and applied by non-academic audiences responding to the pandemic.

As a consequence of the limited geographic scope, reactive nature, and structure of the study, there are limits to the causal attributions I can make and the generalisability of my findings. However, while perhaps unconventional for a PhD thesis, which can normally be approached more strategically and planned in more detail, it is a representation of the kind of research which can realistically be done in response to a sudden crisis. People designing policies and interventions to mitigate the impacts of shocks quickly and at scale rarely have the luxury of prior planning, relevant baseline data, and the resources and opportunities to employ the ideal study design to inform their decision-making. Rather, they have to quickly decide what information needs to be collected and the best way to analyse it given limited time, resources, and logistical constraints. This work is an empirical example of how the three theoretical frameworks can be applied in real time with a realistically constrained dataset, which

allowed me to fully explore their functional strengths and weaknesses as practical tools for exploring how shocks lead to diverse social outcomes.

7.5 Future directions

The research I have presented here both provides detailed insights into the impacts of COVID-19 in small-scale fishing communities and further advances our understanding of how the three frameworks can individually be practically applied to the analysis of shocks, both collectively and individually. However, there are clear opportunities for continued research in each of these areas. Firstly, while I did find evidence that the study communities had begun the path to recovering from COVID-19, in that most people had been able to resume their normal livelihood activities, social interactions and diets by the final round of interviews, and surveys indicated that their subjective wellbeing had largely "bounced back", ongoing research is needed to identify any negative long-term impacts of the pandemic which will need to be addressed, especially for vulnerable groups. It will particularly be important to assess whether the impacts of and responses to COVID-19 have undermined people's general adaptive capacity and resilience to future anticipated shocks. It is well established within development and disaster literature that disasters (i.e. shocks) can lead to an iterative cycle of the negative wellbeing outcomes one shock leading to lower adaptive capacity, increased vulnerability and worse outcomes in future shocks (Hallegatte et al. 2016, Keating et al. 2017, Prayag et al. 2021).

Additionally, as mentioned in my critiques and caveats section, I was unable to quantitatively evaluate whether there were differences in wellbeing outcomes and recovery patterns between groups. Given that poverty is such a strong indicator of whether or not someone is likely to be negatively impacted by disasters and then how well they are likely to be able to recover (Hallegatte et al. 2016), this kind of disaggregated analysis will be critical in the coming years to ensure marginalised groups are not overlooked. Finally, while Chapter Five is an important first step in empirically examining the interdependencies between the six domains of adaptive capacity, these relationships require more systematic evaluation in more diverse contexts. I identified some instances where it seemed that some domains were playing key roles in facilitating the others, and where multiple domains were required to facilitate a single response. These findings suggest that there is potential for capacity-building interventions to strategically increase overall adaptive capacity by building up key domains. However, additional research is required to move these observations beyond anecdotal evidence and to determine whether this is actually a viable strategy.

7.6 Concluding remarks

The COVID-19 pandemic had profound impacts across every aspect of society, which we are still trying to understand let alone recover from. In my thesis, I sought to explore the applicability, strengths, weaknesses, and potential complementarities of three different contemporary frameworks to the analysis of the impacts of the COVID-19 pandemic, to further develop our theoretical understanding of the relationship between shocks and diverse social outcomes. I determined that the livelihood, wellbeing and food and nutrition security outcomes of the pandemic for different people were shaped by complex, context specific impact pathways. I found that actions people could take in response to the immediate impacts of the pandemic were determined by multiple domains of adaptive capacity, which interacted with each other in complex ways. While there were significant initial impacts on material, subjective and relational wellbeing during the peak of the pandemic, it does appear that the communities I studied are well on their way to "bouncing back". Based on my findings, I argue that research designed to inform proactive and reactive policy responses to shocks can significantly benefit from taking a more diverse, multi-scalar approach to understanding the relationship between shocks and their outcomes. As such, I proposed an integrative framework which incorporates simultaneous evaluation of both high-level system processes and drivers and individual capacities to respond, as well as a more holistic consideration of outcomes which incorporates relational and subjective in addition to material aspects of human wellbeing.

Even as many people's daily routines have settled into the post-COVID "new normal", and people's subjective wellbeing has restabilised, we are faced with new global conflicts, economic insecurity, social inequalities, and the growing threat of climate change. This uncertain future will require us to rapidly respond to shocks in ways that challenge rather than perpetuate inequalities and unsustainable practices and address the root causes of issues as well as providing immediate relief. While there are still many questions about how to achieve those goals, there is some guidance to be found in the failures and successes of 2020.

References

Abay, K. A., G. Berhane, J. Hoddinott, and K. Tafere. 2023. COVID-19 and food security in Ethiopia: Do social protection programs protect? Economic Development and Cultural Change **71**:373-402.

Abbas, K., S. R. Procter, K. Van Zandvoort, A. Clark, S. Funk, T. Mengistu, D. Hogan, E. Dansereau, M. Jit, and S. Flasche. 2020. Routine childhood immunisation during the COVID-19 pandemic in Africa: A benefit–risk analysis of health benefits versus excess risk of SARS-CoV-2 infection. The Lancet Global Health **8**:e1264-e1272.

Abunge, C., S. Coulthard, and T. M. Daw. 2013. Connecting marine ecosystem services to human well-being: Insights from participatory well-being assessment in Kenya. AMBIO **42**:1010-1021.

Addison, T., C. Arndt, and F. Tarp. 2011. The triple crisis and the global aid architecture. African Development Review **23**:461-478.

Adger, W. 2003a. Social capital, collective action and adaptation to climate change. Economic Geography **79**:387-404.

Adger, W. N. 2003b. Social aspects of adaptive capacity. Pages 29-49 Climate change, adaptive capacity and development. World Scientific.

Adger, W. N., and M. Agnew. 2004. New indicators of vulnerability and adaptive capacity. Tyndall Centre for Climate Change Research Norwich.

Adger, W. N., N. W. Arnell, and E. L. Tompkins. 2005a. Successful adaptation to climate change across scales. Global Environmental Change **15**:77-86.

Adger, W. N., K. Brown, D. R. Nelson, F. Berkes, H. Eakin, C. Folke, K. Galvin, L. Gunderson, M. Goulden, and K. O'Brien. 2011. Resilience implications of policy responses to climate change. Wiley Interdisciplinary Reviews: Climate Change **2**:757-766.

Adger, W. N., T. P. Hughes, C. Folke, S. R. Carpenter, and J. Rockstrom. 2005b. Social-ecological resilience to coastal disasters. Science **309**:1036-1039.

Adger, W. N., S. Huq, K. Brown, D. Conway, and M. Hulme. 2003. Adaptation to climate change in the developing world. Progress in Development Studies **3**:179-195.

Adger, W. N., and K. Vincent. 2005. Uncertainty in adaptive capacity. Comptes Rendus Geoscience **337**:399-410.

Ahmed, S. A. S., M. Ajisola, K. Azeem, P. Bakibinga, Y.-F. Chen, N. N. Choudhury, O. Fayehun, F. Griffiths, B. Harris, and P. Kibe. 2020. Impact of the societal response to COVID-19 on access to healthcare for non-COVID-19 health issues in slum communities of Bangladesh, Kenya, Nigeria and Pakistan: Results of pre-COVID and COVID-19 lockdown stakeholder engagements. BMJ Global Health **5**:e003042.

Aked, J., N. Marks, C. Cordon, and S. Thompson. 2008. Five ways to wellbeing: A report presented to the Foresight Project on communicating the evidence base for improving people's well-being. London: New Economics Foundation.

Akter, S., and S. A. Basher. 2014. The impacts of food price and income shocks on household food security and economic well-being: Evidence from rural Bangladesh. Global Environmental Change **25**:150-162.

Alam, G. M., M. N. I. Sarker, M. Gatto, H. Bhandari, and D. Naziri. 2022. Impacts of COVID-19 on the fisheries and aquaculture sector in developing countries and ways forward. Sustainability **14**:1071.

Alexander, D. 2018. Natural disasters. Routledge, New York, NY.

Alexander, S., Ö. Bodin, and M. Barnes. 2018. Untangling the drivers of community cohesion in small-scale fisheries. International Journal of the Commons **12**.

Allison, E. H. 2011. Aquaculture, fisheries, poverty and food security. Working Paper 2011-65, The WorldFish Center, Bayan Lepas, Penang, Malaysia.

Allison, E. H., and F. Ellis. 2001. The livelihoods approach and management of small-scale fisheries. Marine Policy **25**:377-388.

Almond, D., and J. Currie. 2011. Killing me softly: The fetal origins hypothesis. Journal of economic perspectives **25**:153-172.

Amo-Agyemang, C. 2021. Decolonising the discourse on resilience. International Journal of African Renaissance Studies-Multi-, Inter-and Transdisciplinarity **16**:4-30.

Amuna, P., and F. B. Zotor. 2008. Epidemiological and nutrition transition in developing countries: Impact on human health and development. proceedings of the Nutrition Society **67**:82-90.

Anfara Jr, V. A., and N. T. Mertz. 2014. Theoretical frameworks in qualitative research. Second edition. Sage publications.

Armitage, D., C. Béné, A. T. Charles, D. Johnson, and E. H. Allison. 2012. The interplay of well-being and resilience in applying a social-ecological perspective. Ecology and Society **17**.

Arora, T., I. Grey, L. Östlundh, K. B. H. Lam, O. M. Omar, and D. Arnone. 2022. The prevalence of psychological consequences of COVID-19: A systematic review and meta-analysis of observational studies. Journal of health psychology **27**:805-824.

Aryal, J. P., M. L. Jat, T. B. Sapkota, D. B. Rahut, M. Rai, H. S. Jat, P. C. Sharma, and C. Stirling. 2020. Learning adaptation to climate change from past climate extremes: Evidence from recent climate extremes in Haryana, India. International Journal of Climate Change Strategies and Management **12**:128-146.

Aura, C. M., C. S. Nyamweya, C. O. Odoli, H. Owiti, J. M. Njiru, P. W. Otuo, E. Waithaka, and J. Malala. 2020. Consequences of calamities and their management: The case of COVID-19 pandemic and flooding on inland capture fisheries in Kenya. Journal of Great Lakes Research **46**:1767-1775.

Avtar, R., D. Singh, D. A. Umarhadi, A. P. Yunus, P. Misra, P. N. Desai, A. Kouser, T. A. Kurniawan, and K. Phanindra. 2021. Impact of COVID-19 lockdown on the fisheries sector: A case study from three harbors in Western India. Remote Sensing **13**:183.

Babcicky, P., and S. Seebauer. 2017. The two faces of social capital in private flood mitigation: Opposing effects on risk perception, self-efficacy and coping capacity. Journal of Risk Research **20**:1017-1037.

Bakalis, S., V. P. Valdramidis, D. Argyropoulos, L. Ahrne, J. Chen, P. J. Cullen, E. Cummins, A. K. Datta, C. Emmanouilidis, and T. Foster. 2020. Perspectives from CO+ RE: How COVID-19 changed our food systems and food security paradigms. Current Research in Food Science **3**:166.

Baker, D., G. Murray, J. Kaijage, A. Levine, D. Gill, and E. Makupa. 2021. Relationships matter: Assessing the impacts of a marine protected area on human wellbeing and relational values in southern Tanzania. Frontiers in Marine Science **8**:673045.

Barnes, M. L. 2018. Unpublished data.

Barnes, M. L., Ö. Bodin, A. M. Guerrero, R. R. McAllister, S. M. Alexander, and G. Robins. 2017. The social structural foundations of adaptation and transformation in social–ecological systems. Ecology and Society **22**.

Barnes, M. L., Ö. Bodin, T. R. McClanahan, J. N. Kittinger, A. S. Hoey, O. G. Gaoue, and N. A. Graham. 2019a. Social-ecological alignment and ecological conditions in coral reefs. Nature communications **10**:2039.

Barnes, M. L., L. Jasny, A. Bauman, J. Ben, R. Berardo, Ö. Bodin, J. Cinner, D. A. Feary, A. M. Guerrero, and F. A. Januchowski-Hartley. 2022. 'Bunkering down': How one community is tightening social-ecological network structures in the face of global change. People and Nature **4**:1032-1048.

Barnes, M. L., E. Mbaru, and N. Muthiga. 2019b. Information access and knowledge exchange in co-managed coral reef fisheries. Biological Conservation **238**:108198.

Barnes, M. L., P. Wang, J. E. Cinner, N. A. Graham, A. M. Guerrero, L. Jasny, J. Lau, S. R. Sutcliffe, and J. Zamborain-Mason. 2020. Social determinants of adaptive and transformative responses to climate change. Nature Climate Change:1-6.

Barnett, J. 2011. Dangerous climate change in the Pacific Islands: Food production and food security. Regional Environmental Change **11**:229-237.

Barrett, C. B., B. J. Barnett, M. R. Carter, S. Chantarat, J. W. Hansen, A. G. Mude, D. Osgood, J. R. Skees, C. G. Turvey, and M. N. Ward. 2007. Poverty traps and climate risk: Limitations and opportunities of index-based risk financing. SSRN Electronic Journal.

Barrett, C. B., M. R. Carter, J.-P. Chavas, and M. R. Carter. 2019. The economics of poverty traps. University of Chicago Press Chicago.

Bartelet, H. A., M. L. Barnes, and G. S. Cumming. 2022. Determinants, outcomes, and feedbacks associated with microeconomic adaptation to climate change. Regional Environmental Change **22**:59.

Bartscher, A. K., S. Seitz, S. Siegloch, M. Slotwinski, and N. Wehrhöfer. 2021. Social capital and the spread of COVID-19: Insights from European countries. Journal of Health Economics **80**:102531.

Bassett, H. R., J. Lau, C. Giordano, S. K. Suri, S. Advani, and S. Sharan. 2021. Preliminary lessons from COVID-19 disruptions of small-scale fishery supply chains. World Development **143**:105473.

Baulch, B. 2011. Why poverty persists: Poverty dynamics in Asia and Africa. Edward Elgar Publishing.

Behnassi, M., and M. El Haiba. 2022. Implications of the Russia–Ukraine war for global food security. Nature Human Behaviour **6**:754-755.

Bello, U. M., P. Kannan, M. Chutiyami, D. Salihu, A. M. Cheong, T. Miller, J. W. Pun, A. S. Muhammad, F. A. Mahmud, and H. A. Jalo. 2022. Prevalence of anxiety and depression among the general population in Africa during the COVID-19 pandemic: A systematic review and meta-analysis. Frontiers in Public Health **10**.

Belton, B., L. Rosen, L. Middleton, S. Ghazali, A.-A. Mamun, J. Shieh, H. S. Noronha, G. Dhar, M. Ilyas, and C. Price. 2021. COVID-19 impacts and adaptations in Asia and Africa's aquatic food value chains. Marine Policy **129**:104523.

Ben Hassen, T., and H. El Bilali. 2022. Impacts of the Russia-Ukraine war on global food security: Towards more sustainable and resilient food systems? Foods **11**:2301.

Ben-Arieh, A. 2007. Measuring and monitoring the well-being of young children around the world. paper commissioned for the EFA Global Monitoring Report:9-22.

Béné, C. 2020. Resilience of local food systems and links to food security- A review of some important concepts in the context of COVID-19 and other shocks. Food Security:1-18.

Béné, C., R. M. Al-Hassan, O. Amarasinghe, P. Fong, J. Ocran, E. Onumah, R. Ratuniata, T. Van Tuyen, J. A. McGregor, and D. J. Mills. 2016a. Is resilience socially constructed? Empirical evidence from Fiji, Ghana, Sri Lanka, and Vietnam. Global Environmental Change **38**:153-170.

Béné, C., R. Arthur, H. Norbury, E. H. Allison, M. Beveridge, S. Bush, L. Campling, W. Leschen, D. Little, and D. Squires. 2016b. Contribution of fisheries and aquaculture to food security and poverty reduction: Assessing the current evidence. World Development **79**:177-196.

Béné, C., D. Bakker, M. J. Chavarro, B. Even, J. Melo, and A. Sonneveld. 2021. Global assessment of the impacts of COVID-19 on food security. Global Food Security **31**:100575.

Béné, C., M. Barange, R. Subasinghe, P. Pinstrup-Andersen, G. Merino, G.-I. Hemre, and M. Williams. 2015. Feeding 9 billion by 2050 – Putting fish back on the menu. Food Security **7**:261-274.

Béné, C., A. Cornelius, and F. Howland. 2018. Bridging humanitarian responses and long-term development through transformative changes—Some initial reflections from the World Bank's adaptive social protection program in the Sahel. Sustainability **10**:1697.

Béné, C., and L. Doyen. 2018. From resistance to transformation: A generic metric of resilience through viability. Earth's Future **6**:979-996.

Béné, C., B. Hersoug, and E. H. Allison. 2010. Not by rent alone: Analysing the pro-poor functions of small-scale fisheries in developing countries. Development Policy Review **28**:325-358.

Béné, C., A. Newsham, M. Davies, M. Ulrichs, and R. Godfrey-Wood. 2014. Resilience, poverty and development. Journal of International Development **26**:598-623.

Béné, C., P. Oosterveer, L. Lamotte, I. D. Brouwer, S. de Haan, S. D. Prager, E. F. Talsma, and C. K. Khoury. 2019. When food systems meet sustainability–Current narratives and implications for actions. World Development **113**:116-130.

Bennett, N. J., J. Blythe, S. Tyler, and N. C. Ban. 2016. Communities and change in the anthropocene: Understanding social-ecological vulnerability and planning adaptations to multiple interacting exposures. Regional Environmental Change **16**:907-926.

Bennett, N. J., E. M. Finkbeiner, N. C. Ban, D. Belhabib, S. D. Jupiter, J. N. Kittinger, S. Mangubhai, J. Scholtens, D. Gill, and P. Christie. 2020. The COVID-19 pandemic, small-scale fisheries and coastal fishing communities. COASTAL MANAGEMENT **48**:336-347.

Bennett, R., G. Chepngeno-Langat, M. Evandrou, and J. Falkingham. 2015. Resilience in the face of post-election violence in Kenya: The mediating role of social networks on wellbeing among older people in the Korogocho informal settlement, Nairobi. Social Science & Medicine **128**:159-167.

Bercht, A. L. 2021. How qualitative approaches matter in climate and ocean change research: Uncovering contradictions about climate concern. Global Environmental Change **70**:102326.

Bergman-Rosamond, A., T. Gammeltoft-Hansen, M. Hamza, J. Hearn, V. Ramasar, and H. Rydstrom. 2022. The case for interdisciplinary crisis studies. Global Discourse **12**:465-486.

Berhanu, W. 2011. Recurrent shocks, poverty traps and the degradation of pastoralists' social capital in southern Ethiopia. African Journal of Agricultural and Resource Economics **6**:1-15.

Berkes, F., C. Folke, and J. Colding. 2000. Linking social and ecological systems: Management practices and social mechanisms for building resilience. Cambridge University Press.

Berkhout, E., N. Galasso, M. Lawson, P. A. Rivero Morales, A. Taneja, and D. A. Vázquez Pimentel. 2021. The Inequality Virus: Bringing together a world torn apart by coronavirus through a fair, just and sustainable economy. 1787486400.

Berman, R., C. Quinn, and J. Paavola. 2012. The role of institutions in the transformation of coping capacity to sustainable adaptive capacity. Environmental Development **2**:86-100.

Berrang-Ford, L., A. Siders, A. Lesnikowski, A. P. Fischer, M. W. Callaghan, N. R. Haddaway, K. J. Mach, M. Araos, M. A. R. Shah, and M. Wannewitz. 2021. A systematic global stocktake of evidence on human adaptation to climate change. Nature Climate Change **11**:989-1000.

Beveridge, M. C., S. Thilsted, M. Phillips, M. Metian, M. Troell, and S. Hall. 2013. Meeting the food and nutrition needs of the poor: The role of fish and the opportunities and challenges emerging from the rise of aquaculture. Journal of Fish Biology **83**:1067-1084.

Bhat, B. A., S. Gull, and G. Jeelani. 2020. A study on COVID-19 lockdown impact on food, agriculture, fisheries and precautionary measures to avoid COVID-19 contamination. Galore International Journal of Applied Sciences and Humanities **4**:8-18.

Bhattacharya, R., and D. Bose. 2023. A Review of the Sustainable Development Goals to make Headways through the COVID-19 Pandemic Era. Environmental Progress & Sustainable Energy **42**:e14093.

Bhowmik, J., S. A. Selim, H. M. Irfanullah, J. S. Shuchi, R. Sultana, and S. G. Ahmed. 2021. Resilience of small-scale marine fishers of Bangladesh against the COVID-19 pandemic and the 65-day fishing ban. Marine Policy **134**:104794.

Birner, R., N. Blaschke, C. Bosch, T. Daum, S. Graf, D. Güttler, J. Heni, J. Kariuki, R. Katusiime, and A. Seidel. 2021. 'We would rather die from Covid-19 than from hunger'-Exploring lockdown stringencies in five African countries. Global Food Security **31**:100571.

Black, R. E., L. H. Allen, Z. A. Bhutta, L. E. Caulfield, M. De Onis, M. Ezzati, C. Mathers, and J. Rivera. 2008. Maternal and child undernutrition: Global and regional exposures and health consequences. The Lancet **371**:243-260.

Black, R. E., C. G. Victora, S. P. Walker, Z. A. Bhutta, P. Christian, M. De Onis, M. Ezzati, S. Grantham-McGregor, J. Katz, and R. Martorell. 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet **382**:427-451.

Blazy, J., F. Causeret, and S. Guyader. 2021. Immediate impacts of COVID-19 crisis on agricultural and food systems in the Caribbean. Agricultural Systems **190**:103106.

Block, L. G., S. A. Grier, T. L. Childers, B. Davis, J. E. Ebert, S. Kumanyika, R. N. Laczniak, J. E. Machin, C. M. Motley, and L. Peracchio. 2011. From nutrients to nurturance: A conceptual introduction to food well-being. Journal of Public Policy & Marketing **30**:5-13.

Bloem, M. W., S. De Pee, and I. Darnton-Hill. 2005a. Micronutrient deficiencies and maternal thinness: First chain in the sequence of nutritional and health events in economic crises. Preventive nutrition: The comprehensive guide for health professionals:689-710.

Bloem, M. W., S. De Pee, and I. Darnton-Hill. 2005b. Micronutrient deficiencies and maternal thinness: First chain in the sequence of nutritional and health events in economic crises. Pages 689-710 Preventive Nutrition. Springer.

Bodin, Ö., and B. I. Crona. 2009. The role of social networks in natural resource governance: What relational patterns make a difference? Global Environmental Change **19**:366-374.

Bonanno, G. A., C. R. Brewin, K. Kaniasty, and A. M. L. Greca. 2010. Weighing the costs of disaster: Consequences, risks, and resilience in individuals, families, and communities. Psychological science in the public interest **11**:1-49.

Borgonovi, F., and E. Andrieu. 2020. Bowling together by bowling alone: Social capital and COVID-19. Social Science & Medicine **265**:113501.

Borkowska, M., and J. Laurence. 2021. Coming together or coming apart? Changes in social cohesion during the COVID-19 pandemic in England. European Societies **23**:S618-S636.

Bottan, N., B. Hoffmann, and D. Vera-Cossio. 2020. The unequal impact of the coronavirus pandemic: Evidence from seventeen developing countries. PLOS ONE **15**:e0239797.

Botzen, W., S. Duijndam, and P. van Beukering. 2021. Lessons for climate policy from behavioral biases towards COVID-19 and climate change risks. World Development **137**:105214.

Bouman, T., L. Steg, and T. Dietz. 2021. Insights from early COVID-19 responses about promoting sustainable action. Nature sustainability **4**:194-200.

Brickman, P. 1971. Hedonic relativism and planning the good society. Adaptation level theory:287-301.

Brooks, M. E., K. Kristensen, K. J. van Benthem, A. Magnusson, C. W. Berg, A. Nielsen, H. J. Skaug, M. Maechler, and B. M. Bolker. 2017. glmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modeling. The R Journal **9 (2)**:378-400.

Brown, K. 2014. Global environmental change I: A social turn for resilience? Progress in Human Geography **38**:107-117.

Brown, K., W. N. Adger, and J. E. Cinner. 2018. Moving climate change beyond the tragedy of the commons. Global Environmental Change **54**:61-63.

Brown, K., and E. Westaway. 2011. Agency, capacity, and resilience to environmental change: Lessons from human development, well-being, and disasters. Annual review of environment and resources **36**:321-342.

Brulé, R. 2023. Climate shocks and gendered political transformation: How crises alter women's political representation. Politics & Gender **19**:928 - 934.

Burnham, M., and Z. Ma. 2017. Climate change adaptation: Factors influencing Chinese smallholder farmers' perceived self-efficacy and adaptation intent. Regional Environmental Change **17**:171-186.

Bush, S. R., and M. J. Marschke. 2014. Making social sense of aquaculture transitions. Ecology and Society **19**.

Cable, J., L. A. Jaykus, K. Hoelzer, J. Newton, and M. Torero. 2021. The impact of COVID-19 on food systems, safety, and security—A symposium report. Annals of the New York Academy of Sciences **1484**:3-8.

Camfield, L., G. Crivello, and M. Woodhead. 2009. Wellbeing research in developing countries: Reviewing the role of qualitative methods. Social Indicators Research **90**:5-31.

Camfield, L., and A. McGregor. 2005. Resilience and wellbeing in developing countries. Pages 189-209 *in* M. Ungar, editor. Handbook for working with children and youth: Pathways to resilience across cultures and contexts. SAGE Publications.

Campbell, J. R. 2015. Development, global change and traditional food security in Pacific Island countries. Regional Environmental Change **15**:1313-1324.

Carducci, B., E. Keats, M. Ruel, L. Haddad, S. Osendarp, and Z. Bhutta. 2021. Food systems, diets and nutrition in the wake of COVID-19. Nature Food **2**:68-70.

Carlsson, L., E. Callaghan, A. Morley, and G. Broman. 2017. Food system sustainability across scales: A proposed local-to-global approach to community planning and assessment. Sustainability **9**:1061.

Carraro, A., L. Ferrone, and M. Squarcina. 2020. Are COVID-19 containment measures equally effective in different world regions? DISEI, Università degli Studi di Firenze.

Carter, M. R., and C. B. Barrett. 2006. The economics of poverty traps and persistent poverty: An asset-based approach. The Journal of Development Studies **42**:178-199.

Cash, D. W., W. N. Adger, F. Berkes, P. Garden, L. Lebel, P. Olsson, L. Pritchard, and O. Young. 2006. Scale and cross-scale dynamics: Governance and information in a multilevel world. Ecology and Society **11**.

Ceballos, F., S. Kannan, and B. Kramer. 2020. Impacts of a national lockdown on smallholder farmers' income and food security: Empirical evidence from two states in India. World Development **136**:105069.

Chaigneau, T., S. Coulthard, T. M. Daw, L. Szaboova, L. Camfield, F. S. Chapin III, D. Gasper, G. G. Gurney, C. C. Hicks, and M. Ibrahim. 2022. Reconciling well-being and resilience for sustainable development. Nature sustainability **5**:287-293.

Chan, Y. K., and R. P. L. Lee. 2006. Network Size, Social Support and Happiness in Later Life: A Comparative Study of Beijing and Hong Kong. Journal of Happiness Studies **7**:87–112

Charles, A., E. H. Allison, R. Chuenpagdee, and P. Mbatha. 2012. Well-being and fishery governance.*in* Visible possibilities: The economics of sustainable fisheries, aquaculture and seafood trade: Proceedings of the sixteenth biennial conference of the International Institute of Fisheries Economics and Trade. International Institute of Fisheries Economics and Trade (IIFET), Corvallis, Dar es Salaam, Tanzania.

Charlton, K. E., J. Russell, E. Gorman, Q. Hanich, A. Delisle, B. Campbell, and J. Bell. 2016. Fish, food security and health in Pacific Island countries and territories: a systematic literature review. BMC PUBLIC HEALTH **16**:285.

Chen, J., N. Farah, R. K. Dong, R. Z. Chen, W. Xu, J. Yin, B. Z. Chen, A. Y. Delios, S. Miller, and X. Wan. 2021. Mental health during the COVID-19 crisis in Africa: A systematic review and meta-analysis. International Journal of Environmental Research and Public Health **18**:10604.

Cheng, S., Y. Yu, W. Fan, and C. Zhu. 2022. Spatio-temporal variation and decomposition analysis of livelihood resilience of rural residents in China. International Journal of Environmental Research and Public Health **19**:10612.

Chuenpagdee, C., P. McConney, G. Munro, B. Ferreira, E. Marschoff, J. Rice, and A. Rosenberg. 2016. Social and economic aspects of sea-based food and fisheries.*in* L. Inniss and A. Simcock, editors. The First Global Integrated Marine Assessment. Cambridge University Press.

Cinner, J., M. M. Fuentes, and H. Randriamahazo. 2009a. Exploring social resilience in Madagascar's marine protected areas. Ecology and Society **14**.

Cinner, J. E. 2011. Social-ecological traps in reef fisheries. Global Environmental Change **21**:835-839.

Cinner, J. E., N. W. Adger, E. H. Allison, M. L. Barnes, K. Brown, P. J. Cohen, S. Gelcich, C. C. Hicks, T. P. Hughes, J. Lau, N. A. Marshall, and T. H. Morrison. 2018a. Building adaptive capacity to climate change in tropical coastal communities. Nature Climate Change **8**:117-123.

Cinner, J. E., W. N. Adger, E. H. Allison, M. L. Barnes, K. Brown, P. J. Cohen, S. Gelcich, C. C. Hicks, T. P. Hughes, J. Lau, N. A. Marshall, and T. H. Morrison. 2018b. Building adaptive capacity to climate change in tropical coastal communities. Nature Climate Change **8**:117-123.

Cinner, J. E., and M. L. Barnes. 2019. Social dimensions of resilience in social-ecological systems. One Earth **1**:51-56.

Cinner, J. E., T. Daw, and T. R. McClanahan. 2009b. Socioeconomic factors that affect artisanal fishers' readiness to exit a declining fishery. Conservation Biology **23**:124-130.

Cinner, J. E., C. Huchery, C. C. Hicks, T. M. Daw, N. Marshall, A. Wamukota, and E. H. Allison. 2015. Changes in adaptive capacity of Kenyan fishing communities. Nature Climate Change **5**:872.

Clemente-Suárez, V. J., S. Rodriguez-Besteiro, J. J. Cabello-Eras, A. Bustamante-Sanchez, E. Navarro-Jiménez, M. Donoso-Gonzalez, A. I. Beltrán-Velasco, and J. F. Tornero-Aguilera. 2022. Sustainable development goals in the COVID-19 pandemic: A narrative review. Sustainability **14**:7726.

Cohen, M. J., and P. Pinstrup-Andersen. 1999. Food security and conflict. Social Research **66**:375-416.

Cohen, P. J., S. Lawless, M. Dyer, M. Morgan, E. Saeni, H. Teioli, and P. Kantor. 2016. Understanding adaptive capacity and capacity to innovate in social–ecological systems: Applying a gender lens. AMBIO **45**:309-321.

Coleman, J. S. 1988. Social capital in the creation of human capital. American journal of sociology **94**:S95-S120.

Coll, M., M. Ortega-Cerdà, and Y. Mascarell-Rocher. 2021. Ecological and economic effects of COVID-19 in marine fisheries from the Northwestern Mediterranean Sea. Biological Conservation **255**:108997.

Committee on World Food Security, t. 2012. Coming to terms with terminology: Food security, nutrition security, food security and nutrition, food and nutrition security. thirty-ninth session of the Committee on World Food Security. FAO, Rome.

Compton, J., S. Wiggins, and S. Keats. 2010. Impact of the global food crisis on the poor: What is the evidence. London, UK.

Connell, J., and K. Lowitt. 2020. Food security in small island states. Springer, Singapore.

Cooper, D. H., and J. Nagel. 2021. Lessons from the pandemic: Climate change and COVID-19. International Journal of Sociology and Social Policy **42**.

Corbett, J. 1988. Famine and household coping strategies. World Development **16**:1099-1112.

Cote, M., and A. J. Nightingale. 2012. Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. Progress in Human Geography **36**:475-489.

Coulthard, S., D. Johnson, and J. A. McGregor. 2011. Poverty, sustainability and human wellbeing: A social wellbeing approach to the global fisheries crisis. Global Environmental Change **21**:453-463.

Cox, S. 2019. Qualitative Analysis to Support Long-term Strategies. World Resources Institute (WRI) and United Nations Development Programme (UNDP): Climate action with tomorrow in mind. Expert Perspectives on Long-term Climate and Development Strategies. WRI and UNDP, Washington.

Csutora, M., and Á. Zsóka. 2023. Crises as incubators of sustainable mobility patterns? Evidence from two shock events. Sustainable Development.

d'Errico, M., J. Pinay, E. Jumbe, and A. H. Luu. 2023. Drivers and stressors of resilience to food insecurity: Evidence from 35 countries. Food Security **15**:1161–1183.

Dapilah, F., J. Ø. Nielsen, and C. Friis. 2020. The role of social networks in building adaptive capacity and resilience to climate change: A case study from northern Ghana. Climate and Development **12**:42-56.

De Brouwer, E., D. Raimondi, and Y. Moreau. 2020. Modeling the COVID-19 outbreaks and the effectiveness of the containment measures adopted across countries. medRxiv:2020.2004. 2002.20046375.

Deaton, A. 1997. The analysis of household surveys: A microeconometric approach to development policy. World Bank Publications.

Deb, P., D. Furceri, J. D. Ostry, and N. Tawk. 2020. The effect of containment measures on the COVID-19 pandemic.

Degen, A. A., J. Hoorweg, and B. C. Wangila. 2010. Fish traders in artisanal fisheries on the Kenyan coast. Journal of Enterprising Communities: People and places in the global economy **4**:296-311.

Del Rio, C., L. F. Collins, and P. Malani. 2020. Long-term health consequences of COVID-19. Jama **324**:1723-1724.

Delaney, A., T. Evans, J. McGreevy, J. Blekking, T. Schlachter, K. Korhonen-Kurki, P. A. Tamás, T. A. Crane, H. Eakin, W. Förch, L. Jones, D. R. Nelson, C. Oberlack, M. Purdon, and S. Rist. 2018. Governance of food systems across scales in times of social-ecological change: a review of indicators. Food Security **10**:287-310.

Dempsey, L., M. Dowling, P. Larkin, and K. Murphy. 2016. Sensitive interviewing in qualitative research. Research in nursing & health **39**:480-490.

Denzin, N. K. 2005. The Discipline and Practice of Qualitative Research. IN: Denzin, NK, and Lincoln, YS. The sage handbook of qualitative research. Sage: Thousand Oaks CA. pp (1-33).

Denzin, N. K. 2017. The research act: A theoretical introduction to sociological methods. Transaction publishers.

Dercon, S. 1998. Wealth, risk and activity choice: Cattle in Western Tanzania. Journal of Development Economics **55**:1-42.

Dercon, S., and J. Hoddinott. 2004. Health, shocks and poverty persistence. Pages 123-136 *in* S. Dercon, editor. Insurance against poverty. Oxford University Press, Oxford.

Devereux, S. 2007. The impact of droughts and floods on food security and policy options to alleviate negative effects. Agricultural Economics **37**:47-58.

Devereux, S., C. Béné, and J. Hoddinott. 2020. Conceptualising COVID-19's impacts on household food security. Food Security **12**:769-772.

Diener, E., R. E. Lucas, and C. N. Scollon. 2006. Beyond the hedonic treadmill: Revising the adaptation theory of well-being. American Psychologist **61**:305–314.

Dietrich, S., V. Giuffrida, B. Martorano, and G. Schmerzeck. 2022. COVID-19 policy responses, mobility, and food prices. American Journal of Agricultural Economics **104**:569-588.

Dixon, J. M., J. Weerahewa, J. Hellin, M. F. Rola-Rubzen, J. Huang, S. Kumar, A. Das, M. E. Qureshi, T. J. Krupnik, and K. Shideed. 2021. Response and resilience of Asian agrifood systems to COVID-19: An assessment across twenty-five countries and four regional farming and food systems. Agricultural Systems **193**:103168.

Draucker, C. B., D. S. Martsolf, and C. Poole. 2009. Developing distress protocols for research on sensitive topics. Archives of psychiatric nursing **23**:343-350.

Eakin, H., A. York, R. Aggarwal, S. Waters, J. Welch, C. Rubiños, S. Smith-Heisters, C. Bausch, and J. M. Anderies. 2016. Cognitive and institutional influences on farmers' adaptive capacity: Insights into barriers and opportunities for transformative change in central Arizona. Regional Environmental Change **16**:801-814.

Eakin, H. C., M. C. Lemos, and D. R. Nelson. 2014. Differentiating capacities as a means to sustainable climate change adaptation. Global Environmental Change **27**:1-8.

Edwards, R. B. 2020. Bubble in, bubble out: Lessons for the COVID-19 recovery and future crises from the Pacific. World Development **135**:105072.

Elgar, F. J., A. Stefaniak, and M. J. Wohl. 2020. The trouble with trust: Time-series analysis of social capital, income inequality, and COVID-19 deaths in 84 countries. Social Science & Medicine **263**:113365.

Elrick-Barr, C. E., R. Plummer, and T. F. Smith. 2023. Third-generation adaptive capacity assessment for climate-resilient development. Climate and Development **15**:518-521.

Engle, N. L. 2011. Adaptive capacity and its assessment. Global Environmental Change **21**:647-656.

Ericksen, P., B. Stewart, J. Dixon, D. Barling, P. Loring, M. Anderson, and J. Ingram. 2010. The value of a food system approach. Pages 24-25 *in* John Ingram, Polly Ericksen, and D. Liverman, editors. Food security and global environmental change. Routledge.

Ericksen, P. J. 2008. Conceptualizing food systems for global environmental change research. Global Environmental Change **18**:234-245.

Ericksen, P. J., J. S. Ingram, and D. M. Liverman. 2009. Food security and global environmental change: Emerging challenges. **12**:373-377.

Eriksen, S., E. L. F. Schipper, M. Scoville-Simonds, K. Vincent, H. N. Adam, N. Brooks, B. Harding, L. Lenaerts, D. Liverman, and M. Mills-Novoa. 2021. Adaptation interventions and their effect on vulnerability in developing countries: Help, hindrance or irrelevance? World Development **141**:105383.

Eriksson, H., A. Ride, D. Notere Boso, M. Sukulu, M. Batalofo, F. Siota, and C. Gomese. 2020. Changes and adaptations in village food systems in Solomon Islands: A rapid appraisal during the early stages of the COVID-19 pandemic. WorldFish, Penang, Malaysia.

Erokhin, V., and T. Gao. 2020. Impacts of COVID-19 on trade and economic aspects of food security: Evidence from 45 developing countries. International Journal of Environmental Research and Public Health **17**:5775.

Famine Early Warning Systems Network. 2020. Kenya Food Security Outlook Update: Planned cash transfers likely to alleviate impacts of COVID-19 and floods on urban and rural households.

FAO. 1996. Rome Declaration on world food security and World Food Summit plan of action. Food and Agriculture Organisation of the United Nations, Rome.

FAO. 2001. The state of food insecurity in the world 2001. Food and Agriculture Organisation of the United Nations.

FAO. 2015. Voluntary guidelines for securing sustainable small scale fisheries in the context of food security and poverty eradication. Food and Agriculture Organisation of the United Nations, Rome.

FAO. 2020a. The state of world fisheries and aquaculture 2020: Sustainability in action, Rome.

FAO. 2020b. Summary of the impacts of the COVID-19 pandemic on the fisheries and aquaculture sector: Addendum to the state of world fisheries and aquaculture 2020. Rome.

FAO, IFAD, UNICEF, WFP, and WHO. 2020. The state of food security and nutrition in the world 2020: Transforming food systems for affordable healthy diets.

FAO, D. University, and WorldFish. 2023. Illuminating hidden harvests – The contributions of small-scale fisheries to sustainable development. Rome.

Farrell, P., A. M. Thow, J. T. Wate, N. Nonga, P. Vatucawaqa, T. Brewer, M. K. Sharp, A. Farmery, H. Trevena, and E. Reeve. 2020a. COVID-19 and Pacific food system resilience: Opportunities to build a robust response. Food Security **12**:783-791.

Farrell, P., A. M. Thow, J. T. Wate, N. Nonga, P. Vatucawaqa, T. Brewer, M. K. Sharp, A. Farmery, H. Trevena, and E. Reeve. 2020b. COVID-19 and Pacific food system resilience: opportunities to build a robust response. Food Security **12**:783-791.

Fazey, I., J. A. Fazey, J. Fischer, K. Sherren, J. Warren, R. F. Noss, and S. R. Dovers. 2007. Adaptive capacity and learning to learn as leverage for social–ecological resilience. Frontiers in Ecology and the Environment **5**:375-380.

Ferguson, C. E., T. Tuxson, S. Mangubhai, S. Jupiter, H. Govan, V. Bonito, S. Alefaio, M. Anjiga, J. Booth, and T. Boslogo. 2022. Local practices and production confer resilience to rural Pacific food systems during the COVID-19 pandemic. Marine Policy **137**:104954.

Field, C. B., V. Barros, T. F. Stocker, and Q. Dahe. 2012. Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change. Cambridge University Press.

Filho, W. L., F. Wolf, S. Moncada, A. L. Salvia, A.-L. B. Balogun, C. Skanavis, A. Kounani, and P. D. Nunn. 2022. Transformative adaptation as a sustainable response to climate change: Insights from large-scale case studies. Mitigation and Adaptation Strategies for Global Change **27**:20.

Fiorella, K. J., E. R. Bageant, L. Mojica, J. A. Obuya, J. Ochieng, P. Olela, P. W. Otuo, H. O. Onyango, C. M. Aura, and H. Okronipa. 2021. Small-scale fishing households facing COVID-19: The case of Lake Victoria, Kenya. Fisheries Research **237**:105856.

Fiorella, K. J., J. Coffin-Schmitt, K. M. Gaynor, G. H. Gregory, R. Rasolofoson, and K. L. Seto. 2020. Feedbacks from human health to household reliance on natural resources during the COVID-19 pandemic. The Lancet Planetary Health **4**:e441-e442.

Food Security Information Network. 2020. Global report on food crises: Joint analysis for better decisions. International Food Policy Research Institute, Washington DC.

Foran, T., J. R. Butler, L. J. Williams, W. J. Wanjura, A. Hall, L. Carter, and P. S. Carberry. 2014. Taking complexity in food systems seriously: An interdisciplinary analysis. World Development **61**:85-101.

Fraser, E. D., W. Mabee, and F. Figge. 2005. A framework for assessing the vulnerability of food systems to future shocks. Futures **37**:465-479.
Fröcklin, S., M. de la Torre-Castro, L. Lindström, and N. S. Jiddawi. 2013. Fish traders as key actors in fisheries: Gender and adaptive management. AMBIO **42**:951-962.
Fuentes, R., M. Galeotti, A. Lanza, and B. Manzano. 2020. COVID-19 and climate change: A tale of two global problems. Sustainability **12**:8560.
Fuller-Iglesias, H. R. 2015. Social ties and psychological well-being in late life: The mediating role of relationship satisfaction. Aging & Mental Health **19**:1103-1112.
Gaiha, R., and K. Imai. 2004. Vulnerability, shocks and persistence of poverty: Estimates for semi-arid rural South India. Oxford Development Studies **32**:261-281.
Gallopín, G. C. 2006. Linkages between vulnerability, resilience, and adaptive capacity. Global Environmental Change **16**:293-303.
Ganesan, B., A. Al-Jumaily, K. N. Fong, P. Prasad, S. K. Meena, and R. K.-Y. Tong. 2021. Impact of coronavirus disease 2019 (COVID-19) outbreak quarantine, isolation, and lockdown policies on mental health and suicide. Frontiers in psychiatry **12**:565190.
Gatti, R., D. Lederman, A. M. Islam, F. R. Bennett, B. P. J. Andree, H. Assem, R. Lotfi, and M. E. Mousa. 2023. Altered destinies: The long-term effects of rising prices and food insecurity in the Middle East and North Africa.
Geels, F. W. 2009. Foundational ontologies and multi-paradigm analysis, applied to the socio-technical transition from mixed farming to intensive pig husbandry (1930–1980). Technology Analysis & Strategic Management **21**:805-832.
Geels, F. W. 2010. Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research policy **39**:495-510.
Geng, J., S. U. Haq, J. Abbas, H. Ye, P. Shahbaz, A. Abbas, and Y. Cai. 2022. Survival in pandemic times: Managing energy efficiency, food diversity, and sustainable practices of nutrient intake amid COVID-19 crisis. Frontiers in Environmental Science **10**.
Gillam, C., and A. Charles. 2018. Fishers in a Brazilian shantytown: Relational wellbeing supports recovery from environmental disaster. Marine Policy **89**:77-84.
Global Panel on Agriculture and Food Systems for Nutrition. 2016. Food systems and diets: Facing the challenges of the 21st century. Global Panel on Agriculture and Food Systems for Nutrition., London, UK.
Gough, I., and J. A. McGregor. 2007. Wellbeing in developing countries: From theory to research. Cambridge University Press.
Gough, I., J. A. McGregor, and L. Camfield. 2006. WeD working paper 19: Wellbeing in developing countries: Conceptual foundations of the WeD programme.
Graham, C. 2005. Insights on development from the economics of happiness. The World Bank Research Observer **20**:201-231.
Green, K. M., J. C. Selgrath, T. H. Frawley, W. K. Oestreich, E. J. Mansfield, J. Urteaga, S. S. Swanson, F. N. Santana, S. J. Green, and J. Naggea. 2021. How adaptive capacity shapes the Adapt, React, Cope response to climate impacts: Insights from small-scale fisheries. Climatic Change **164**:1-22.
Grothmann, T., and A. Patt. 2005. Adaptive capacity and human cognition: The process of individual adaptation to climate change. Global Environmental Change **15**:199-213.
Guillaumont, P., and C. Simonet. 2011. To what extent are African countries vulnerable to climate change? Lessons from a new indicator of physical vulnerability to climate change, FERDI Working Paper, No. I08,. Fondation pour les études et recherches sur le développement international (FERDI), Clermont-Ferrand.
Gupta, J., M. Bavinck, M. Ros-Tonen, K. Asubonteng, H. Bosch, E. van Ewijk, M. Hordijk, Y. Van Leynseele, M. L. Cardozo, and E. Miedema. 2021. COVID-19, poverty and inclusive development. World Development **145**:105527.
Hale, T., and S. Webster. 2020. Oxford COVID-19 government response tracker.

Hallegatte, S., A. Vogt-Schilb, M. Bangalore, and J. Rozenberg. 2016. Unbreakable: Building the resilience of the poor in the face of natural disasters. World Bank Publications.

Harker, A. L., T. Stojanovic, A. Majalia, C. Jackson, S. Baya, and K. D. Tsiganyiu. 2022. Relationships between livelihoods, well-being, and marine protected areas: Evidence from a community survey, Watamu Marine National Park and Reserve, Kenya. Coastal Management **50**:490-513.

Harris, J., L. Depenbusch, A. A. Pal, R. M. Nair, and S. Ramasamy. 2020. Food system disruption: Initial livelihood and dietary effects of COVID-19 on vegetable producers in India. Food Security **12**:841-851.

Hartig, F. 2022. DHARMa: Residual Diagnostics for Hierarchical (Multi-Level/ Mixed) Regression Models.

Herrfahrdt-Pähle, E., M. Schlüter, P. Olsson, C. Folke, S. Gelcich, and C. Pahl-Wostl. 2020. Sustainability transformations: Socio-political shocks as opportunities for governance transitions. Global Environmental Change **63**:102097.

Hickey, G. M., and N. Unwin. 2020. Addressing the triple burden of malnutrition in the time of COVID-19 and climate change in Small Island Developing States: What role for improved local food production? Food Security **12**:831-835.

HLPE. 2017. Nutrition and food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. FAO, Rome.

HLPE. 2020. Food security and nutrition: Building a global narrative towards 2030. High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

Hoang, H. K. 2018. Analysis of food demand in Vietnam and short-term impacts of market shocks on quantity and calorie consumption. Agricultural Economics **49**:83-95.

Holland, D. S., J. K. Abbott, and K. E. Norman. 2020. Fishing to live or living to fish: Job satisfaction and identity of west coast fishermen. AMBIO **49**:628-639.

Hossain, M. M., M. Rahman, N. F. Trisha, S. Tasnim, T. Nuzhath, N. T. Hasan, H. Clark, A. Das, E. L. J. McKyer, and H. U. Ahmed. 2021. Prevalence of anxiety and depression in South Asia during COVID-19: A systematic review and meta-analysis. Heliyon **7**:e06677.

Hudson, J. 2006. Institutional trust and subjective well-being across the EU. Kyklos **59**:43-62.

Husain, A., S. Sandström, F. Greb, J. Groder, C. Pallanch, and P. Agamile. 2020. Economic and food security implications of the COVID-19 outbreak. Wood Food Programme.

IMF. 2020. World economic outlook, April 2020: The great lockdown. IMF online.

Ingram, J. 2011. A food systems approach to researching food security and its interactions with global environmental change. Food Security **3**:417-431.

IPCC. 2001. Climate change 2001: Impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

IPCC, editor. 2022a. Climate Change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, UK and New York, NY, USA.

IPCC. 2022b. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty 1009157949, Cambridge University Press, Cambridge, UK and New York, NY, USA.

Islam, M. M., S. Sallu, K. Hubacek, and J. Paavola. 2014. Limits and barriers to adaptation to climate variability and change in Bangladeshi coastal fishing communities. Marine Policy **43**:208-216.

Israel, D. C., and R. M. Briones. 2012. Impacts of natural disasters on agriculture, food security, and natural resources and environment in the Philippines, PIDS Discussion Paper Series, No. 2012-36,. Philippine Institute for Development Studies (PIDS), Makati City.

Ivey, J. L., J. Smithers, R. C. De Loë, and R. D. Kreutzwiser. 2004. Community capacity for adaptation to climate-induced water shortages: Linking institutional complexity and local actors. Environmental Management **33**:36-47.

Jaguga, F., and E. Kwobah. 2020. Mental health response to the COVID-19 pandemic in Kenya: A review. International journal of mental health systems **14**:1-6.

Jakku, E., and T. Lynam. 2010. What is adaptive capacity? Report for the South East Queensland Climate Adaptation Research Initiative. CSIRO Climate Adaptation National Research Flagship.

Johnson, D. S. 2018. The values of small-scale fisheries. Pages 1-21 *in* D. Johnson, T. Acott, N. Stacey, and J. Urquhart, editors. Social wellbeing and the values of small-scale fisheries. Springer, Cham.

Johnson, D. S., T. G. Acott, N. Stacey, and J. Urquhart. 2018. Social wellbeing and the values of small-scale fisheries. Springer Cham.

Jomitol, J., A. J. Payne, S. Sakirun, and M. O. Bural. 2020. The impacts of COVID-19 to small scale fisheries in Tun Mustapha Park, Sabah, Malaysia: What do we know so far? Preprints.

Jordan, C. J., and A. A. Palmer. 2020. Virtual meetings: A critical step to address climate change. **6**:eabe5810.

Juhola, S., E. Glaas, B.-O. Linnér, and T.-S. Neset. 2016. Redefining maladaptation. Environmental Science & Policy **55**:135-140.

Kabeer, N. 2015. Gender, poverty, and inequality: A brief history of feminist contributions in the field of international development. Gender & Development **23**:189-205.

Kabubo-Mariara, J., A. Wambugu, and S. Musau. 2011. Multdimensional poverty in Kenya: Analysis of maternal and child wellbeing. PEP PMMA **12**.

Kamau, J. W. 2021. Is counter-terrorism counterproductive? A case study of Kenya's response to terrorism, 1998-2020. South African Journal of International Affairs **28**:203-231.

Kansiime, M. K., J. A. Tambo, I. Mugambi, M. Bundi, A. Kara, and C. Owuor. 2021. COVID-19 implications on household income and food security in Kenya and Uganda: Findings from a rapid assessment. World Development **137**:105199.

Karantzas, G. C., and J. A. Simpson. 2022. Separation, social isolation, and loss in the context of COVID-19 and beyond. Current Opinion in Psychology **47**:101400.

Kassa, W. A. 2019. Determinants and challenges of rural livelihood diversification in Ethiopia: Qualitative review. Journal of Agricultural Extension and Rural Development **11**:17-24.

Kates, R. W., W. R. Travis, and T. J. Wilbanks. 2012. Transformational adaptation when incremental adaptations to climate change are insufficient. Proceedings of the National Academy of Sciences **109**:7156-7161.

Keating, A., K. Campbell, R. Mechler, P. Magnuszewski, J. Mochizuki, W. Liu, M. Szoenyi, and C. McQuistan. 2017. Disaster resilience: What it is and how it can engender a meaningful change in development policy. Development Policy Review **35**:65-91.

Kelley, H. H., Y. Lee, A. LeBaron-Black, D. C. Dollahite, S. James, L. D. Marks, and T. Hall. 2023. Change in financial stress and relational wellbeing during COVID-19: Exacerbating and alleviating influences. Journal of Family and Economic Issues **44**:34-52.

Kenyan Ministry of Health. 2021. Health Ministry announce 731 new cases of COVID-19. MoH News, Nairobi.

Khan, M. A., M. E. Hossain, M. T. Rahman, and M. M. Dey. 2023. COVID-19's effects and adaptation strategies in fisheries and aquaculture sector: An empirical evidence from Bangladesh. Aquaculture **562**:738822.

Kimbu, A. N., I. Booyens, and A. Winchenbach. 2022. Livelihood diversification through tourism: Identity, well-being, and potential in rural coastal communities. Tourism review international **26**:25-40.

Klassen, S., and S. Murphy. 2020. Equity as both a means and an end: Lessons for resilient food systems from COVID-19. World Development **136**:105104.

Klaus, K. 2020. Political violence in Kenya: Land, elections, and claim-making. Cambridge University Press.

Klenert, D., F. Funke, L. Mattauch, and B. O'Callaghan. 2020. Five lessons from COVID-19 for advancing climate change mitigation. Environmental and Resource Economics **76**:751-778.

Knight, C. J., T. L. Burnham, E. J. Mansfield, L. B. Crowder, and F. Micheli. 2020. COVID-19 reveals vulnerability of small-scale fisheries to global market systems. The Lancet Planetary Health **4**:e219.

Kobayashi, Y., T. Heinrich, and K. A. Bryant. 2021. Public support for development aid during the COVID-19 pandemic. World Development **138**:105248.

Kofinas, G. P., and F. S. Chapin. 2009. Sustaining livelihoods and human well-being during social-ecological change. Pages 55-75 *in* C. Folke, G. Kofinas, and F. Chapin, editors. Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world. Springer, New York, NY.

Kreps, G. A. 1984. Sociological inquiry and disaster research. Annual review of sociology **10**:309-330.

Kristoffersen, I. 2018. Great expectations: Education and subjective wellbeing. Journal of Economic Psychology **66**:64-78.

Kroepsch, A., E. A. Koebele, D. A. Crow, J. Berggren, J. Huda, and L. A. Lawhon. 2018. Remembering the past, anticipating the future: Community learning and adaptation discourse in media commemorations of catastrophic wildfires in Colorado. Environmental Communication **12**:132-147.

Kruczkiewicz, A., J. Klopp, J. Fisher, S. Mason, S. McClain, N. Sheekh, R. Moss, R. Parks, and C. Braneon. 2021. Opinion: Compound risks and complex emergencies require new approaches to preparedness. Proceedings of the National Academy of Sciences **118**.

Kundu, S., M. H. Al Banna, A. Sayeed, M. S. Sultana, K. Brazendale, J. Harris, M. Mandal, I. Jahan, M. T. Abid, and M. S. I. Khan. 2021. Determinants of household food security and dietary diversity during the COVID-19 pandemic in Bangladesh. Public Health Nutrition **24**:1079-1087.

Kutak, R. I. 1938. The sociology of crises: The Louisville flood of 1937. Social Forces **17**:66-72.

Laborde, D., W. Martin, J. Swinnen, and R. Vos. 2020. COVID-19 risks to global food security. Science **369**:500-502.

Laborde, D., W. Martin, and R. Vos. 2021. Impacts of COVID-19 on global poverty, food security, and diets: Insights from global model scenario analysis. Agricultural Economics **52**:375-390.

Lau, J., and S. Sutcliffe. 2020a. We didn't have money or enough food': how COVID-19 affected Papua New Guinean fishing families.

Lau, J., and S. Sutcliffe. 2020b. We didn't have money or enough food': how COVID-19 affected Papua New Guinean fishing families. The Conversation.

Lau, J., and S. Sutcliffe. 2021. Of Isolation and Atolls: Coping with Covid-19 in Manus, Papua New Guinea. Pages 385-401 COVID in the Islands: A comparative perspective on the Caribbean and the Pacific. Springer.

Lau, J., S. Sutcliffe, M. Barnes, E. Mbaru, I. Muly, N. Muthiga, S. Wanyonyi, and J. Cinner. 2021a. COVID-19 impacts on coastal communities in Kenya. James Cook University.

Lau, J., S. Sutcliffe, M. Barnes, E. Mbaru, I. Muly, N. Muthiga, S. Wanyonyi, and J. E. Cinner. 2021b. COVID-19 impacts on coastal communities in Kenya. Marine Policy **134**:104803.

Lau, J. D., J. E. Cinner, M. Fabinyi, G. G. Gurney, and C. C. Hicks. 2020. Access to marine ecosystem services: Examining entanglement and legitimacy in customary institutions. World Development **126**:104730.

Lawson, E. T., R. S. Alare, A. R. Z. Salifu, and M. Thompson-Hall. 2020. Dealing with climate change in semi-arid Ghana: Understanding intersectional perceptions and adaptation strategies of women farmers. GeoJournal **85**:439-452.

Lebel, L. 2013. Local knowledge and adaptation to climate change in natural resource-based societies of the Asia-Pacific. Mitigation and Adaptation Strategies for Global Change **18**:1057-1076.

Lei, Y., J. a. Wang, Y. Yue, H. Zhou, and W. Yin. 2014. Rethinking the relationships of vulnerability, resilience, and adaptation from a disaster risk perspective. Natural Hazards **70**:609-627.

Lemos, M. C., A. Agrawal, H. Eakin, D. R. Nelson, N. L. Engle, and O. Johns. 2013. Building adaptive capacity to climate change in less developed countries. Pages 437-457 *in* G. Asrar and J. Hurrell, editors. Climate science for serving society. Springer, Dordrecht.

Leone, L. A., S. Fleischhacker, B. Anderson-Steeves, K. Harper, M. Winkler, E. Racine, B. Baquero, and J. Gittelsohn. 2020. Healthy food retail during the COVID-19 pandemic: Challenges and future directions. International Journal of Environmental Research and Public Health **17**:7397.

Lichter, K. E., T. Drew, S. Demeulenaere, E. Wong, O. Mohamad, S. S. Yom, and H. P. Bagshaw. 2022. Environmental outcomes associated with transition from in-person to a virtual oncology conference during the COVID-19 pandemic. JAMA oncology **8**:1351-1352.

Lin, N. 1999. Building a network theory of social capital. Connections **22**:28-51.

Linneberg, M. S., and S. Korsgaard. 2019. Coding qualitative data: A synthesis guiding the novice. Qualitative research journal.

Liverpool-Tasie, L. S. O., T. Reardon, and B. Belton. 2021. "Essential non-essentials": COVID-19 policy missteps in Nigeria rooted in persistent myths about African food supply chains. Applied Economic Perspectives and Policy **43**:205-224.

LMMA Network, PNGCLMA, and WCS-PNG. 2020. COVID19 Update #4: PNG. 16 July 2020.

Lofredo, M. P. P. 2020. Social cohesion, trust, and government action against pandemics. Eubios Journal of Asian and International Bioethics **30**:182-188.

Love, D. C., E. H. Allison, F. Asche, B. Belton, R. S. Cottrell, H. E. Froehlich, J. A. Gephart, C. C. Hicks, D. C. Little, and E. M. Nussbaumer. 2021. Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system. Global Food Security:100494.

Lucas, R. E. 2007. Adaptation and the set-point model of subjective well-being: Does happiness change after major life events? Current directions in psychological science **16**:75-79.

Luhmann, M., and S. Intelisano. 2018. Hedonic adaptation and the set point for subjective well-being.*in* E. Diener, S. Oishi, and L. Tay, editors. Handbook of well-being. DEF Publishers, Salt Lake City, UT.

Magnan, A. K., E. L. F. Schipper, M. Burkett, S. Bharwani, I. Burton, S. Eriksen, F. Gemenne, J. Schaar, and G. Ziervogel. 2016. Addressing the risk of maladaptation to climate change. Wiley Interdisciplinary Reviews: Climate Change **7**:646-665.

Mahler, D. G., N. Yonzan, and C. Lakner. 2022. The impact of COVID-19 on global inequality and poverty. The World Bank.

Mahoney, J. 2004. Revisiting general theory in historical sociology. Social Forces **83**:459-489.

Maltby, K., J. Mason, H. Cheng, G. Fay, R. Selden, L. Williams, and C. Alves. 2023a. Navigating concepts of social-ecological resilience in marine fisheries under climate change: Shared challenges and recommendations from the northeast United States. ICES Journal of Marine Science:fsad151.

Maltby, K. M., S. Kerin, and K. E. Mills. 2023b. Barriers and enablers of climate adaptation in fisheries: Insights from Northeast US fishing communities. Marine Policy **147**:105331.

Manda, S. 2022. Impact of COVID-19 pandemic on rural livelihoods in Zambia: A gender and wellbeing perspective. Working Paper IDRC-OXFAM-006. African Economic Research Consortium.

Manlosa, A. O., A.-K. Hornidge, and A. Schlüter. 2021. Aquaculture-capture fisheries nexus under COVID-19: Impacts, diversity, and social-ecological resilience. Maritime Studies **20**:75-85.

Manyena, S. B. 2006. The concept of resilience revisited. Disasters **30**:434-450.

Manzanedo, R. D., and P. Manning. 2020. COVID-19: Lessons for the climate change emergency. Science of The Total Environment **742**:140563.

Markard, J., and D. Rosenbloom. 2020. A tale of two crises: COVID-19 and climate. Sustainability: Science, Practice and Policy **16**:53-60.

Markhvida, M., B. Walsh, S. Hallegatte, and J. Baker. 2020. Quantification of disaster impacts through household well-being losses. Nature sustainability **3**:538-547.

Marschke, M. J., and F. Berkes. 2006. Exploring strategies that build livelihood resilience: a case from Cambodia. Ecology and Society **11**.

Marsden, A. R., K. K. Zander, and J. A. Lassa. 2023. Smallholder farming during COVID-19: A systematic review concerning impacts, adaptations, barriers, policy, and planning for future pandemics. Land **12**:404.

Marshall, N., P. Marshall, J. Tamelander, D. Obura, D. Malleret-King, and J. Cinner. 2010. A framework for social adaptation to climate change: Sustaining tropical coastal communitites and industries. IUCN, Gland, Switzerland.

Marshall, N. A., S. E. Park, W. N. Adger, K. Brown, and S. M. Howden. 2012. Transformational capacity and the influence of place and identity. Environmental Research Letters **7**:034022.

Marshall, Q., J. Fanzo, C. B. Barrett, A. D. Jones, A. Herforth, and R. McLaren. 2021. Building a global food systems typology: A new tool for reducing complexity in food systems analysis. Frontiers in Sustainable Food Systems **5**:432.

Masinde, B., and S. Buigut. 2018. Effect of terrorism and travel warning on Kenyan tourism demand. Tourism Analysis **23**:283-288.

Maxwell, D., L. Russo, and L. Alinovi. 2012. Constraints to addressing food insecurity in protracted crises. Proceedings of the National Academy of Sciences **109**:12321-12325.

Maxwell, D. G. 1996. Measuring food insecurity: The frequency and severity of "coping strategies". Food Policy **21**:291-303.

Mbaru, E. 2021. Impacts of COVID-19 on markets, livelihoods, and well-being in fisheries in coastal Kenya. WIOMSA News Brief. Western Indian Ocean Marine Science Association, Zanzibar, Tanzania.

Mbaru, E., J. Lau, and S. Sutcliffe. 2022. How COVID affected markets and livelihoods in Kenya's fisheries sector. The Conversation.

Mbaru, E. K., C. C. Hicks, G. G. Gurney, and J. E. Cinner. 2021. Evaluating outcomes of conservation with multidimensional indicators of well-being. Conservation Biology **35**:1417-1425.

McClanahan, T. R. 2019. Coral reef fish communities, diversity, and their fisheries and biodiversity status in East Africa. Marine Ecology Progress Series **632**:175-191.

McClanahan, T. R., and J. Cinner. 2011. Adapting to a changing environment: Confronting the consequences of climate change. Oxford University Press.

McDougall, C., M. J. Akester, D. Notere Boso, A. Choudhury, Z. Hasiba, H. C. Karisa, M. Pereira, C. R. Price, A. Ride, J. Scott, D. Shearer, S. Sutcliffe, and S. H. Thilsted. 2020. Ten strategies for research quality in distance research during COVID-19 and future food system shocks. CGIAR Research Program on Fish Agri-Food Systems Program Brief: FISH-2020-11, Penang, Malaysia.

McGregor, A., and A. Sumner. 2010. Beyond business as usual: What might 3-D wellbeing contribute to MDG momentum? IDS bulletin **41**:104-112.

McGregor, J. A. 2007. Researching wellbeing: From concepts to methodology.*in* I. Gough and J. A. McGregor, editors. Wellbeing in Developing Countries. Cambridge University Press, Cambridge.

McGregor, J. A. 2008. Wellbeing, poverty and conflict. Briefing paper **1**.

McGregor, J. A., and N. Pouw. 2017. Towards an economics of well-being. Cambridge Journal of Economics **41**:1123-1142.

Mendoza, R. U. 2011. Crises and inequality: Lessons from the global food, fuel, financial and economic crises of 2008–10. Global Policy **2**:259-271.

Meuwissen, M. P., P. H. Feindt, T. Slijper, A. Spiegel, R. Finger, Y. de Mey, W. Paas, K. J. Termeer, P. M. Poortvliet, and M. Peneva. 2021. Impact of COVID-19 on farming systems in Europe through the lens of resilience thinking. Agricultural Systems **191**:103152.

Michaelson, J., S. Abdallah, N. Steuer, S. Thompson, N. Marks, J. Aked, C. Cordon, and R. Potts. 2009. National accounts of well-being: Bringing real wealth onto the balance sheet. New Economics Foundation, London New Economics Foundation.

Miller, F., H. Osbahr, E. Boyd, F. Thomalla, S. Bharwani, G. Ziervogel, B. Walker, J. Birkmann, S. Van der Leeuw, and J. Rockström. 2010. Resilience and vulnerability: Complementary or conflicting concepts? Ecology and Society **15**.

Ministry of Health, K. 2020a. Public Health (COVID-19 Restriction of Movement of Persons and Related Measures) (Mombasa County) Order, 2020.
Ministry of Health, K. 2020b. The public health (COVID-19 restriction of movement of persons and related measures) rules, 2020.
Mittal, A., and J. Grimm. 2020. ICT solutions to support local food supply chains during the COVID-19 pandemic. Journal of Agriculture, Food Systems, and Community Development **10**.
Monirul Alam, G. M., M. N. I. Sarker, M. Gatto, H. Bhandari, and D. Naziri. 2022. Impacts of COVID-19 on the Fisheries and Aquaculture Sector in Developing Countries and Ways Forward. Sustainability (Switzerland) **14**.
Mortreux, C., and J. Barnett. 2017. Adaptive capacity: Exploring the research frontier. Wiley Interdisciplinary Reviews: Climate Change **8**:e467.
Moseley, W. G., and J. Battersby. 2020. The vulnerability and resilience of African food systems, food security, and nutrition in the context of the COVID-19 pandemic. African Studies Review **63**:449-461.
Moser, S. C., and J. A. Ekstrom. 2010. A framework to diagnose barriers to climate change adaptation. Proceedings of the National Academy of Sciences **107**:22026-22031.
Mottaleb, K. A., G. Kruseman, and S. Snapp. 2022. Potential impacts of Ukraine-Russia armed conflict on global wheat food security: A quantitative exploration. Global Food Security **35**:100659.
Muir, J. A., M. Dheresa, Z. J. Madewell, T. Getachew, G. Mengesha, C. G. Whitney, N. Assefa, and S. A. Cunningham. 2023. Food insecurity amid COVID-19 lockdowns: Assessing sociodemographic indicators of vulnerability in Harar and Kersa, Ethiopia. medRxiv:2023.2001. 2031.23284545.
Murphy, J., and M. Elliot. 2022. An analysis of changes in wellbeing during the COVID-19 pandemic in the UK. Discover Social Science and Health **2**:6.
Mutunga, N. M. 2012. Can livelihood approaches adequately evaluate the determinants of food insecurity to inform interventions in Kenya?
Narayan, D., R. Chambers, M. K. Shah, and P. Petesch. 2000. Voices of the poor: Crying out for change. New York: Oxford University Press for the World Bank.
Nechifor, V., O. Boysen, E. Ferrari, K. B. Hailu, and M. Beshir. 2020. COVID-19: Socioeconomic impacts and recovery in Ethiopia. Publications Office of the European Union.
Necho, M., M. Tsehay, M. Birkie, G. Biset, and E. Tadesse. 2021. Prevalence of anxiety, depression, and psychological distress among the general population during the COVID-19 pandemic: A systematic review and meta-analysis. International Journal of Social Psychiatry **67**:892-906.
Negev, M., Y. Dahdal, H. Khreis, A. Hochman, M. Shaheen, M. T. Jaghbir, P. Alpert, H. Levine, and N. Davidovitch. 2021. Regional lessons from the COVID-19 outbreak in the Middle East: From infectious diseases to climate change adaptation. Science of The Total Environment **768**:144434.
Negură, P., L. Gașper, and M. Potoroacă. 2021. Trust in institutions, social solidarity, and the perception of social cohesion in the Republic of Moldova in the early phase of the COVID-19 pandemic. Comparative Southeast European Studies **69**:453-481.
Nelson, D. R., W. N. Adger, and K. Brown. 2007. Adaptation to environmental change: Contributions of a resilience framework. Annu. Rev. Environ. Resour. **32**:395-419.
Newing, H., C. Eagle, R. Puri, and C. Watson. 2011. Conducting research in conservation. Routledge Oxfordshire.
Ngigi, M. W., U. Mueller, and R. Birner. 2017. Gender differences in climate change adaptation strategies and participation in group-based approaches: An intra-household analysis from rural Kenya. Ecological Economics **138**:99-108.
Ngigi, M. W., U. Mueller, and R. Birner. 2021. Livestock diversification for improved resilience and welfare outcomes under climate risks in Kenya. The European Journal of Development Research **33**:1625-1648.
Nnaeme, C., L. Patel, and S. Plagerson. 2021. Assets, cash transfers and urban livelihoods in South Africa. Journal of International Development **33**:382-395.

Noort, M. W., S. Renzetti, V. Linderhof, G. E. du Rand, N. J. Marx-Pienaar, H. L. de Kock, N. Magano, and J. R. Taylor. 2022. Towards sustainable shifts to healthy diets and food security in sub-saharan Africa with climate-resilient crops in bread-type products: A food system analysis. Foods **11**:135.

Novak Colwell, J. M., M. Axelrod, S. S. Salim, and S. Velvizhi. 2017. A gendered analysis of fisherfolk's livelihood adaptation and coping responses in the face of a seasonal fishing ban in Tamil Nadu & Puducherry, India. World Development **98**:325-337.

Nyiawung, R. A., R. K. Ayilu, N. N. Suh, N. N. Ngwang, F. Varnie, and P. A. Loring. 2022a. COVID-19 and small-scale fisheries in Africa: Impacts on livelihoods and the fish value chain in Cameroon and Liberia. Marine Policy **141**:105104.

Nyiawung, R. A., R. K. Ayilu, N. N. Suh, N. N. Ngwang, F. Varnie, and P. A. Loring. 2022b. COVID-19 and small-scale fisheries in Africa: Impacts on livelihoods and the fish value chain in Cameroon and Liberia. Marine Policy **141**.

O'Connor, R. C., K. Wetherall, S. Cleare, H. McClelland, A. J. Melson, C. L. Niedzwiedz, R. E. O'Carroll, D. B. O'Connor, S. Platt, and E. Scowcroft. 2021. Mental health and well-being during the COVID-19 pandemic: Longitudinal analyses of adults in the UK COVID-19 Mental Health & Wellbeing study. The British journal of psychiatry **218**:326-333.

O'Kane, G. 2020. COVID-19 puts the spotlight on food insecurity in rural and remote Australia. The Australian Journal of Rural Health **28**:319.

O'Meara, L., C. Turner, D. C. Coitinho, and S. Oenema. 2022. Consumer experiences of food environments during the COVID-19 pandemic: Global insights from a rapid online survey of individuals from 119 countries. Global Food Security **32**:100594.

Okronipa, H., E. R. Bageant, J. Baez, H. O. Onyango, C. M. Aura, and K. J. Fiorella. 2023. COVID-19 experiences of small-scale fishing households: The case of Lake Victoria, Kenya. Frontiers in Sustainable Food Systems **6**:680.

Okyere, I., E. O. Chuku, B. Ekumah, D. B. Angnuureng, J. K. Boakye-Appiah, D. J. Mills, R. Babanawo, N. K. Asare, D. W. Aheto, and B. Crawford. 2020. Physical distancing and risk of COVID-19 in small-scale fisheries: A remote sensing assessment in coastal Ghana. Scientific Reports **10**:1-13.

Oleson, K. L., M. Barnes, L. M. Brander, T. A. Oliver, I. van Beek, B. Zafindrasilivonona, and P. van Beukering. 2015. Cultural bequest values for ecosystem service flows among indigenous fishers: A discrete choice experiment validated with mixed methods. Ecological Economics **114**:104-116.

Olson, J., P. M. Clay, and P. P. da Silva. 2014. Putting the seafood in sustainable food systems. Marine Policy **43**:104-111.

Paganini, N., K. Adinata, N. Buthelezi, D. Harris, S. Lemke, A. Luis, J. Koppelin, A. Karriem, F. Ncube, and E. Nervi Aguirre. 2020. Growing and eating food during the COVID-19 pandemic: Farmers' perspectives on local food system resilience to shocks in Southern Africa and Indonesia. Sustainability **12**:8556.

Pahl, S., S. Sheppard, C. Boomsma, and C. Groves. 2014. Perceptions of time in relation to climate change. Wiley Interdisciplinary Reviews: Climate Change **5**:375-388.

Paras, A., C. Johnson, S. Henson, A. Coleman, and J. Otto. 2020. The impact of the Covid-19 pandemic on Canada's foreign aid sector. Guelph Institute of Development Studies.

Patel, J. A., F. Nielsen, A. A. Badiani, S. Assi, V. Unadkat, B. Patel, R. Ravindrane, and H. Wardle. 2020. Poverty, inequality and COVID-19: The forgotten vulnerable. Public health **183**:110.

Pelling, M., W. T. Chow, E. Chu, R. Dawson, D. Dodman, A. Fraser, B. Hayward, L. Khirfan, T. McPhearson, and A. Prakash. 2021. A climate resilience research renewal agenda: Learning lessons from the COVID-19 pandemic for urban climate resilience. Climate and Development:1-8.

Pelzang, R., and A. M. Hutchinson. 2017. Establishing cultural integrity in qualitative research: Reflections from a cross-cultural study. International Journal of Qualitative Methods **17**:1609406917749702.

Pérez-Escamilla, R., K. Cunningham, and V. H. Moran. 2020. COVID-19 and maternal and child food and nutrition insecurity: a complex syndemic. Maternal & child nutrition.

Phillips, C. A., A. Caldas, R. Cleetus, K. A. Dahl, J. Declet-Barreto, R. Licker, L. D. Merner, J. P. Ortiz-Partida, A. L. Phelan, and E. Spanger-Siegfried. 2020. Compound climate risks in the COVID-19 pandemic. Nature Climate Change:1-3.

Picchioni, F., L. F. Goulao, and D. Roberfroid. 2022. The impact of COVID-19 on diet quality, food security and nutrition in low and middle income countries: A systematic review of the evidence. Clinical Nutrition **41**:2955-2964.

Pierce, M., S. McManus, H. Hope, M. Hotopf, T. Ford, S. L. Hatch, A. John, E. Kontopantelis, R. T. Webb, and S. Wessely. 2021. Mental health responses to the COVID-19 pandemic: A latent class trajectory analysis using longitudinal UK data. The Lancet Psychiatry **8**:610-619.

Pincombe, M., V. Reese, and C. B. Dolan. 2021. The effectiveness of national-level containment and closure policies across income levels during the COVID-19 pandemic: An analysis of 113 countries. Health policy and planning **36**:1152-1162.

Pingali, P., L. Alinovi, and J. Sutton. 2005. Food security in complex emergencies: enhancing food system resilience. Disasters **29**:S5-S24.

Pinquart, M., and S. Sörensen. 2000. Influences of socioeconomic status, social network, and competence on subjective well-being in later life: a meta-analysis. Psychology and Aging **15**:187–224.

PNG National Department of Health, and World Health Organization. 2020. Papua New Guinea coronavirus disease 2019 (COVID-19) health situation report #41.

Pollnac, R. B., and J. J. Poggie. 2008. Happiness, well-being and psychocultural adaptation to the stresses associated with marine fishing. Human Ecology Review:194-200.

Pollnac, R. B., R. S. Pomeroy, and I. H. Harkes. 2001. Fishery policy and job satisfaction in three southeast Asian fisheries. Ocean & Coastal Management **44**:531-544.

Pomeroy, R., C. Arango, C. G. Lomboy, and S. Box. 2020. Financial inclusion to build economic resilience in small-scale fisheries. Marine Policy **118**:103982.

Popkin, B. M. 2003. The nutrition transition in the developing world. Development Policy Review **21**:581-597.

Popkin, B. M., L. S. Adair, and S. W. Ng. 2012. Global nutrition transition and the pandemic of obesity in developing countries. Nutrition reviews **70**:3-21.

Prayag, G., L. K. Ozanne, and S. Spector. 2021. A psychological wellbeing perspective of long-term disaster recovery following the Canterbury earthquakes. International Journal of Disaster Risk Reduction **63**:102438.

Quak, E.-j. 2018. Food systems in protracted crises: Strengthening resilience against shocks and conflicts.

R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Ramay, S. A. 2020. 21st century global order: Factors behind change. Sustainable Development Policy Institute.

Rao, N., E. T. Lawson, W. N. Raditloaneng, D. Solomon, and M. N. Angula. 2019a. Gendered vulnerabilities to climate change: Insights from the semi-arid regions of Africa and Asia. Climate and Development **11**:14-26.

Rao, N., A. Mishra, A. Prakash, C. Singh, A. Qaisrani, P. Poonacha, K. Vincent, and C. Bedelian. 2019b. A qualitative comparative analysis of women's agency and adaptive capacity in climate change hotspots in Asia and Africa. Nature Climate Change **9**:964-971.

Reva, A. 2012. Living through crises: How the food, fuel, and financial shocks affect the poor. World Bank Publications.

Reynolds, M., and S. Holwell. 2020. Introducing systems approaches. Systems approaches to making change: A practical guide:1-24.

Richter, L. M., B. Daelmans, J. Lombardi, J. Heymann, F. L. Boo, J. R. Behrman, C. Lu, J. E. Lucas, R. Perez-Escamilla, and T. Dua. 2017. Investing in the foundation of sustainable development: Pathways to scale up for early childhood development. The Lancet **389**:103-118.

Roberts, A. 2020. The third and fatal shock: How pandemic killed the millennial paradigm. Public Administration Review **80**:603-609.

Robins, L., A. Lal, J. McCarthy, A. McWilliam, A. Palo, N. Thomson, P. Warr, and M. Webb. 2020. COVID-19 and food systems in the Indo-Pacific: An assessment of vulnerabilities, impacts and opportunities for action. Canberra.

Roe, E. 2012. Taking complexity seriously: Policy analysis, triangulation and sustainable development. Springer Science & Business Media.

Rose, A. 2007. Economic resilience to natural and man-made disasters: Multidisciplinary origins and contextual dimensions. Environmental Hazards **7**:383-398.

Rose, A. 2021. COVID-19 economic impacts in perspective: A comparison to recent US disasters. International Journal of Disaster Risk Reduction **60**:102317.

Rosen, L. 2020. Impacts of COVID-19 on aquatic food supply chains in Bangladesh, Egypt, India, Myanmar, Nigeria and Timor-Leste, February-April 2020. CGIAR Research Program on Fish Agri-Food

Systems, Penang, Malaysia.

RStudio Team. 2022. RStudio: Integrated development environment for R. RStudio, PBC, Boston, MA.

Rudin-Rush, L., J. D. Michler, A. Josephson, and J. R. Bloem. 2022. Food insecurity during the first year of the COVID-19 pandemic in four African countries. Food Policy **111**:102306.

Russo, L., G. Hemrich, L. Alinovi, and D. Melvin. 2008. Food security in protracted crisis situations: Issues and challenges. elief:1.

Rwafa-Ponela, T., S. Goldstein, P. Kruger, A. Erzse, S. Abdool Karim, and K. Hofman. 2022. Urban informal food traders: A rapid qualitative study of COVID-19 lockdown measures in South Africa. Sustainability **14**:2294.

Sabates-Wheeler, R., J. Lind, P. Harvey, and R. Slater. 2022. Strengthening responses at the nexus of social protection, humanitarian aid and climate shocks in protracted crises: BASIC Research framing paper.

Sacco, E. 2004. Shocks and response model. Page 34 *in* Towards effective and sustainable seed relief activities: Report of the workshop on effective and sustainable seed relief activities, Rome, 26-28 May 2003. Food & Agriculture Org.

Saint Lucia Ministry of Health, t. 2020. Saint Lucia records case #26 of COVID-19. Government of Saint Lucia, Saint Lucia.

Salgueiro Otero, D., E. Ojea, and M. L. Barnes. 2022. Transformation in times of climate change: What makes a fisher diversify livelihoods? Frontiers in Marine Science:1373.

Salgueiro-Otero, D., M. L. Barnes, and E. Ojea. 2022. Climate adaptation pathways and the role of social-ecological networks in small-scale fisheries. Scientific Reports **12**:1-13.

Savage, A., H. Bambrick, and D. Gallegos. 2020. From garden to store: Local perspectives of changing food and nutrition security in a Pacific Island country. Food Security **12**:1331-1348.

Schader, C., J. Grenz, M. S. Meier, and M. Stolze. 2014. Scope and precision of sustainability assessment approaches to food systems. Ecology and Society **19**.

Scheraga, J. D., and A. E. Grambsch. 1998. Risks, opportunities, and adaptation to climate change. Climate research **11**:85-95.

Schill, C., J. M. Anderies, T. Lindahl, C. Folke, S. Polasky, J. C. Cárdenas, A.-S. Crépin, M. A. Janssen, J. Norberg, and M. Schlüter. 2019. A more dynamic understanding of human behaviour for the Anthropocene. Nature sustainability **2**:1075-1082.

Schipper, E. L. F. 2020. Maladaptation: When adaptation to climate change goes very wrong. One Earth **3**:409-414.

Schmidhuber, J. 2020. COVID-19: From a global health crisis to a global food crisis. FAO Food Outlook **9**.

Schmidt, C. W. 2014. Beyond malnutrition: The role of sanitation in stunted growth. Environmental Health Perspectives **122**.

Schneider, I. K., E. A. Konijn, F. Righetti, and C. E. Rusbult. 2011. A healthy dose of trust: The relationship between interpersonal trust and health. Personal relationships **18**:668-676.

Schreiber, K., B. Soubry, C. Dove-McFalls, and G. K. MacDonald. 2022. Diverse adaptation strategies helped local food producers cope with initial challenges of the COVID-19 pandemic: Lessons from Québec, Canada. Journal of Rural Studies **90**:124-133.

Seel, M. 1997. Well-being: On a fundamental concept of practical philosophy. European Journal of Philosophy **5**:39-49.

Seeman, T. E., and L. F. Berkman. 1988. Structural characteristics of social networks and their relationship with social support in the elderly: Who provides support. Social Science & Medicine **26**:737-749.

Sen, A. 1999. Development as freedom. Oxford University Press.

Sen, S., N. C. Nayak, and W. K. Mohanty. 2023. Choices between adaptation and coping strategies as responses to cyclonic shocks and their impact on household welfare in villages on the east coast of India. International Journal of Disaster Risk Reduction **94**:103834.

Seyed Alinaghi, S. A., P. Mirzapour, O. Dadras, Z. Pashaei, A. Karimi, M. Mohsseni Pour, M. Soleymanzadeh, A. Barzegary, A. M. Afsahi, and F. Vahedi. 2021. Characterization of SARS-CoV-2 different variants and related morbidity and mortality: a systematic review. European journal of medical research **26**:1-20.

Shakil, M. H., Z. H. Munim, M. Tasnia, and S. Sarowar. 2020. COVID-19 and the environment: A critical review and research agenda. Science of The Total Environment **745**:141022.

Shimpuku, Y., and K. F. Norr. 2012. Working with interpreters in cross-cultural qualitative research in the context of a developing country: Systematic literature review. Journal of advanced nursing **68**:1692-1706.

Sibley, C. G., L. M. Greaves, N. Satherley, M. S. Wilson, N. C. Overall, C. H. Lee, P. Milojev, J. Bulbulia, D. Osborne, and T. L. Milfont. 2020. Effects of the COVID-19 pandemic and nationwide lockdown on trust, attitudes toward government, and well-being. American Psychologist **75**:618.

Siders, A. R. 2019. Adaptive capacity to climate change: A synthesis of concepts, methods, and findings in a fragmented field. Wiley Interdisciplinary Reviews: Climate Change **10**:e573.

Siegel, P. B., and J. Alwang. 1999. An asset-based approach to social risk management: A conceptual framework. Human Development Network, Social Protection Unit, The World Bank, Washington, D.C. .

Simmance, F. A., P. J. Cohen, C. Huchery, S. Sutcliffe, S. K. Suri, X. Tezzo, S. H. Thilsted, P. Oosterveer, C. McDougall, and M. Ahern. 2022. Nudging fisheries and aquaculture research towards food systems. Fish and Fisheries **23**:34-53.

Singh, C., S. Iyer, M. G. New, R. Few, B. Kuchimanchi, A. C. Segnon, and D. Morchain. 2022. Interrogating 'effectiveness' in climate change adaptation: 11 guiding principles for adaptation research and practice. Climate and Development **14**:650-664.

Skiles, M., E. Yang, O. Reshef, D. R. Muñoz, D. Cintron, M. L. Lind, A. Rush, P. P. Calleja, R. Nerenberg, and A. Armani. 2022. Conference demographics and footprint changed by virtual platforms. Nature sustainability **5**:149-156.

Smit, B., and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change **16**:282-292.

Smith, H., and X. Basurto. 2019. Defining small-scale fisheries and examining the role of science in shaping perceptions of who and what counts: A systematic review. Frontiers in Marine Science **6**.

Smith, H., A. G. Lozano, D. Baker, H. Blondin, J. Hamilton, J. Choi, X. Basurto, and B. Silliman. 2021. Ecology and the science of small-scale fisheries: A synthetic review of research effort for the Anthropocene. Biological Conservation **254**:108895.

Smith, L. C., and T. R. Frankenberger. 2018. Does resilience capacity reduce the negative impact of shocks on household food security? Evidence from the 2014 floods in Northern Bangladesh. World Development **102**:358-376.

Smith, S. L., A. S. Golden, V. Ramenzoni, D. R. Zemeckis, and O. P. Jensen. 2020. Adaptation and resilience of commercial fishers in the Northeast United States during the early stages of the COVID-19 pandemic. PLOS ONE **15**:e0243886.

Squires, A. 2009. Methodological challenges in cross-language qualitative research: A research review. International journal of nursing studies **46**:277-287.

Steenbergen, D. J., P. Neihapi, D. Koran, A. Sami, V. Malverus, R. Ephraim, and N. Andrew. 2020a. COVID-19 restrictions amidst cyclones and volcanoes: A rapid assessment of early impacts on livelihoods and food security in coastal communities in Vanuatu. Marine Policy:104199.

Steenbergen, D. J., P. Neihapi, D. Koran, A. Sami, V. Malverus, R. Ephraim, and N. Andrew. 2020b. COVID-19 restrictions amidst cyclones and volcanoes: A rapid assessment of early impacts on livelihoods and food security in coastal communities in Vanuatu. Marine Policy **121**:104199.

Stefanoudis, P. V., W. Y. Licuanan, T. H. Morrison, S. Talma, J. Veitayaki, and L. C. Woodall. 2021. Turning the tide of parachute science. Current Biology **31**:R184-R185.

Stephens, E. C., G. Martin, M. van Wijk, J. Timsina, and V. Snow. 2020. Impacts of COVID-19 on agricultural and food systems worldwide and on progress to the sustainable development goals. Agricultural Systems **183**:102873.

Stokes, G. L., A. J. Lynch, B. S. Lowe, S. Funge-Smith, J. Valbo-Jørgensen, and S. J. Smidt. 2020. COVID-19 pandemic impacts on global inland fisheries. Proceedings of the National Academy of Sciences **117**:29419-29421.

Sulemana, I., A. M. Iddrisu, and J. E. Kyoore. 2017. A micro-level study of the relationship between experienced corruption and subjective wellbeing in Africa. The Journal of Development Studies **53**:138-155.

Sunny, A. R., S. A. Sazzad, S. H. Prodhan, M. Ashrafuzzaman, G. C. Datta, A. K. Sarker, M. Rahman, and M. H. Mithun. 2021. Assessing impacts of COVID-19 on aquatic food system and small-scale fisheries in Bangladesh. Marine Policy **126**:104422.

Sutcliffe, S., J. D. Lau, M. L. Barnes, E. Mbaru, E. Wade, W. Hungito, I. M. Muly, S. Wanyonyi, N. A. Muthiga, P. J. Cohen, and J. Cinner. 2023. COVID-19 impacts on food systems in fisheries-dependent island communities. Ecology and Society **28**.

Swinnen, J., and R. Vos. 2021. COVID-19 and impacts on global food systems and household welfare: Introduction to a special issue. Agricultural Economics **52**:365-374.

Tafere, K. 2016. Inter-generational effects of early childhood shocks on human capital: Evidence from Ethiopia.

Tam, B. Y., L. Findlay, and D. Kohen. 2014. Social networks as a coping strategy for food insecurity and hunger for young Aboriginal and Canadian children. Societies **4**:463-476.

Tezzo, X., S. R. Bush, P. Oosterveer, and B. Belton. 2021. Food system perspective on fisheries and aquaculture development in Asia. Agriculture and Human Values **38**:73-90.

Thapa, B., C. Scott, P. Wester, and R. Varady. 2016. Towards characterizing the adaptive capacity of farmer-managed irrigation systems: Learnings from Nepal. Current Opinion in Environmental Sustainability **21**:37-44.

Thilmany, D., L. Brislen, H. Edmondson, M. Gill, B. B. Jablonski, J. Rossi, T. Woods, and S. Schaffstall. 2021. Novel methods for an interesting time: Exploring US local food systems' impacts and initiatives to respond to COVID. Australian Journal of Agricultural and Resource Economics **65**:848-877.

Thomas, K., R. D. Hardy, H. Lazrus, M. Mendez, B. Orlove, I. Rivera-Collazo, J. T. Roberts, M. Rockman, B. P. Warner, and R. Winthrop. 2019. Explaining differential vulnerability to climate change: A social science review. Wiley Interdisciplinary Reviews: Climate Change **10**:e565.

Thomas, S., A. Sagan, J. Larkin, J. Cylus, J. Figueras, and M. Karanikolos. 2020. Strengthening health systems resilience: key concepts and strategies.

Thu, K. M., S. Bernays, and S. Abimbola. 2022. A literature review exploring how health systems respond to acute shocks in fragile and conflict-affected countries. Conflict and health **16**:1-12.

Thurmond, V. A. 2001. The point of triangulation. Journal of nursing scholarship **33**:253-258.

Tierney, K. J. 2007. From the margins to the mainstream? Disaster research at the crossroads. Annu. Rev. Sociol. **33**:503-525.

Torlesse, H., L. Kiess, and M. W. Bloem. 2003. Association of household rice expenditure with child nutritional status indicates a role for macroeconomic food policy in combating malnutrition. The Journal of nutrition **133**:1320-1325.

Townsend, E., E. Nielsen, R. Allister, and S. A. Cassidy. 2020. Key ethical questions for research during the COVID-19 pandemic. The Lancet Psychiatry **7**:381-383.

Townshend, I., O. Awosoga, J. Kulig, and H. Fan. 2015. Social cohesion and resilience across communities that have experienced a disaster. Natural Hazards **76**:913-938.

Triggs, A., and H. Kharas. 2020. The triple economic shock of COVID-19 and priorities for an emergency G-20 leaders meeting.

Tripathi, H. G., H. E. Smith, S. M. Sait, S. M. Sallu, S. Whitfield, A. Jankielsohn, W. E. Kunin, N. Mazibuko, and B. Nyhodo. 2021. Impacts of COVID-19 on diverse farm systems in Tanzania and South Africa. Sustainability **13**:9863.

Turner, W. R., B. A. Bradley, L. D. Estes, D. G. Hole, M. Oppenheimer, and D. S. Wilcove. 2010. Climate change: Helping nature survive the human response. Conservation Letters **3**:304-312.

UN News. 2020. Kenya relief bid begins to avert 'hunger crisis' among poor workers hit by COVID. UN News.

UN Women. 2020. Think piece: Gender and climate change in the context of COVID-19.

Ung, M., I. Luginaah, R. Chuenpagdee, and G. Campbell. 2015. Perceived self-efficacy and adaptation to climate change in coastal Cambodia. Climate **4**:1.

UNICEF. 2017. Situation analysis of children and women in Kenya, 2017. UNICEF.

UNSDR. 2009. UNSDR terminology on disaster risk reduction. United Nations International Strategy for Disaster Reduction, Geneva, Switzerland.

Upton, J., E. Tennant, K. J. Florella, and C. B. Barrett. 2021. Household resilience, and rural food systems: Evidence from southern and eastern Africa.

Urquhart, J., and T. Acott. 2013. Constructing 'The Stade': Fishers' and non-fishers' identity and place attachment in Hastings, south-east England. Marine Policy **37**:45-54.

USAID. 2020. Food assistance fact sheet Kenya.*in* USAID, editor.

Van Assche, K., M. Gruezmacher, and R. Beunen. 2022. Shock and conflict in social-ecological systems: Implications for environmental governance. Sustainability **14**:610.

Van Berkum, S., J. Dengerink, and R. Ruben. 2018. The food systems approach: Sustainable solutions for a sufficient supply of healthy food. Wageningen Economic Research.

Van der Horst, M., and H. Coffé. 2012. How friendship network characteristics influence subjective well-being. Social Indicators Research **107**: 509-529.

Varshney, L. R., and R. Socher. 2020. COVID-19 growth rate decreases with social capital. medRxiv:2020.2004. 2023.20077321.

Vincent, K. 2007. Uncertainty in adaptive capacity and the importance of scale. Global Environmental Change **17**:12-24.

Vos, R., J. McDermott, and J. Swinnen. 2022. COVID-19 and global poverty and food security. Annual Review of Resource Economics **14**.

Walker, B., C. S. Holling, S. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. Ecology and Society **9**.

Waller, M. A. 2001. Resilience in ecosystemic context: Evolution of the concept. American Journal of orthopsychiatry **71**:290-297.

Wamukota, A., and T. McClanahan. 2017. Global fish trade, prices, and food security in an African coral reef fishery. COASTAL MANAGEMENT **45**:143-160.

Waters, J., and W. N. Adger. 2017. Spatial, network and temporal dimensions of the determinants of adaptive capacity in poor urban areas. Global Environmental Change **46**:42-49.

Weeratunge, N., C. Béné, R. Siriwardane, A. Charles, D. Johnson, E. H. Allison, P. K. Nayak, and M. C. Badjeck. 2014. Small-scale fisheries through the wellbeing lens. Fish and Fisheries **15**:255-279.

Wegerif, M. C. 2020. “Informal” food traders and food security: Experiences from the COVID-19 response in South Africa. Food Security **12**:797-800.
Western Central Atlantic Fisheries Commission, t. 2022. Effects of the COVID-19 pandemic on the Fisheries and Aquaculture sector in the region and responses for recovery. Food and Agriculture Organisation of the United Nations.
Wheeler, T., and J. Von Braun. 2013. Climate change impacts on global food security. Science **341**:508-513.
White, E. R., H. E. Froehlich, J. A. Gephart, R. S. Cottrell, T. A. Branch, R. Agrawal Bejarano, and J. K. Baum. 2021. Early effects of COVID-19 on US fisheries and seafood consumption. Fish and Fisheries **22**:232-239.
White, S. C. 2008. But what is wellbeing? A framework for analysis in social and development policy and practice. Paper for Regeneration and Wellbeing: Research into Practice, University of ….
White, S. C. 2010. Analysing wellbeing: A framework for development practice. Development in Practice **20**:158-172.
White, S. C. 2015. Relational wellbeing: A theoretical and operational approach. Bath Papers in International Development and Wellbeing.
Wilson, S., L. J. Pearson, Y. Kashima, D. Lusher, and C. Pearson. 2013. Separating adaptive maintenance (resilience) and transformative capacity of social-ecological systems. Ecology and Society **18**.
World Bank. 2012. Hidden harvest: The global contribution of capture fisheries. Worldbank; WorldFish, Washington, DC.
World Economic Forum. 2020. Insight Report: COVID-19 Risks Outlook A Preliminary Mapping and Its Implications.
World Health Organization. 2020. Health at a glance: Asia/Pacific 2020 measuring progress towards universal health coverage: Measuring progress towards universal health coverage. OECD Publishing.
World Health Organization. 2023. Statement on the fifteenth meeting of the IHR (2005) Emergency Committee on the COVID-19 pandemic.
Worldometer. 2021. COVID-19 coronavirus pandemic.*in* Worldometer, editor.
Wossen, T., S. Di Falco, T. Berger, and W. McClain. 2016. You are not alone: Social capital and risk exposure in rural Ethiopia. Food Security **8**:799-813.
Wu, C. 2021. Social capital and COVID-19: A multidimensional and multilevel approach. Chinese Sociological Review **53**:27-54.
Wu, J., A. Rajesh, Y.-N. Huang, K. Chhugani, R. Acharya, K. Peng, R. D. Johnson, A. Fiscutean, C. D. Robles-Espinoza, and F. M. De La Vega. 2022. Virtual meetings promise to eliminate geographical and administrative barriers and increase accessibility, diversity and inclusivity. Nature biotechnology **40**:133-137.
Yohe, G., and R. S. Tol. 2002. Indicators for social and economic coping capacity—Moving toward a working definition of adaptive capacity. Global Environmental Change **12**:25-40.
Zanotti, L., Z. Ma, J. L. Johnson, D. R. Johnson, D. J. Yu, M. Burnham, and C. Carothers. 2020. Sustainability, resilience, adaptation, and transformation: Tensions and plural approaches. Ecology and Society **25**.
Ziervogel, G., and P. J. Ericksen. 2010. Adapting to climate change to sustain food security. Wiley Interdisciplinary Reviews: Climate Change **1**:525-540.
Zimmerer, K. S., and S. de Haan. 2020. Informal food chains and agrobiodiversity need strengthening—not weakening—to address food security amidst the COVID-19 crisis in South America. Food Security **12**:891-894.

Appendices

Appendix 1: Of isolation and atolls: Coping with COVID-19 in Papua New Guinea[22, 23]

A1.1 Abstract

In early 2020, Papua New Guinea went into a state of emergency to contain the spread of COVID-19. Emergency measures prevented a direct health crisis but had consequences for the livelihoods and wellbeing of communities across the country. This chapter details findings from in-depth interviews conducted in July and August 2020 with people living on an atoll island in Manus Province. We asked people to describe how the state of emergency impacted their livelihoods, food security, and wellbeing, and whether they had done anything to cope. When the state of emergency began, leaders closed the weekly island markets to stop large gatherings of people, which quickly led to food shortages. The community's ability to access mainland markets and essential services was severely disrupted both by bans on movement and by social distancing rules that reduced boat transport. In the town market, customer numbers and demand for fish was severely reduced. Cash flow largely ceased. These changes impacted islander's income and ability to access store-bought goods and foods. When local markets re-opened, most people returned to bartering. To cope with these impacts, many families decreased the quality and quantity of food they ate. These findings suggest that atolls without agricultural safety nets are highly vulnerable to shocks that cause isolation. We discuss how the types of assets, lack of flexibility, and perceptions of risk shaped household capacities to adapt during the state of emergency. Finally, we highlight key leverage points for supporting atoll island communities through continuing disruptions from the COVID-19 pandemic and future similar shocks: recognize that isolation presents a distinct challenge for atoll islands, ensure that support reaches islands quickly, ensure clear communication about rules, and acknowledge and pursue strategies to navigate trade-offs between necessary public health rules, livelihoods, food and nutrition security and wellbeing.

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[22] Adapted from (Lau and Sutcliffe 2021)

[23] **Contributions** JDL was the lead author for the book chapter and report this appendix chapter is adapted from. We jointly conceptualised the report and book chapter, developed the interview guide, oversaw data collection, analysed the data, and developed the report which the book chapter and this chapter is based on. JDL wrote the initial draft of the report and book chapter, which I reviewed and edited. JEC, MB, and WH provided advice on conceptualisation, data collection and analysis and reviewed and edited the paper. Data collection was conducted by WH. I use "we" throughout to reflect the collaborative nature of this chapter.

A1.2 Introduction

The spread of COVID-19, and policies across the world to contain it, continue to have wide-reaching impacts on small-scale fishing communities; from the 'triple economic shock' (Triggs and Kharas 2020) of changed demand, supply, and finances, to extensive environmental, geopolitical, societal and technological consequences (World Economic Forum 2020). COVID-19 has been 'a harbinger of massive and life altering changes… in small-scale fisheries and coastal fishing communities around the world' (Bennett et al. 2020). In bringing these abrupt changes, COVID-19 has illuminated significant gaps in people's capacity to adapt to shocks—or their adaptive capacity. Six key domains support adaptive capacity; assets, flexibility, learning, organization, agency, and socio-cognitive constructs (such as previous experiences of risk) (Cinner et al. 2018b, Cinner and Barnes 2019)(Cinner et al. 2018; Cinner and Barnes 2019). The COVID-19 pandemic has highlighted whether and how households are able to draw on these domains of adaptive capacity in times of shocks, and the degree to which outside forces (such as imposed isolation) thwart coping mechanisms. Better understanding of the impacts of COVID-19 in the Pacific is highlighting how local adaptive capacities may help or be hindered by this unique and isolating shock.

In the Pacific, most countries—including Papua New Guinea—successfully implemented policies to minimise transmission in the early stages of the pandemic, including hard border closures and limitations on internal travel. Preventing a virus taking hold in the region was critical. Most Pacific Island health systems are ill-equipped to cope with an outbreak. Limited testing and contact tracing capacity, insufficient medical supplies, healthcare workers and hospital beds, and community conditions which make household protection difficult, would likely have led to rapid spread and high mortality (World Health Organization 2020). While these policies averted a direct health crisis, they continue to have severe secondary consequences for small-island states with a high dependence on international tourism, food imports and remittances (Farrell et al. 2020a, Hickey and Unwin 2020). With a lack of social protection, countries in the Pacific are ill-equipped to support their citizens to navigate the economic fallout from isolation policies (Edwards 2020). Many people across the Pacific lost incomes, and food became less accessible and less affordable—a critical shock to already food and nutrition insecure communities with pre-existing social-ecological vulnerabilities (Connell and Lowitt 2020).

As of December 13, 2020, Papua New Guinea has had 725 confirmed cases of COVID-19 (PNG National Department of Health and World Health Organization 2020) Between March 2020 and June 2020, PNG was in a state of emergency that restricted movement between provinces, closed schools and required

non-essential workers to stay home. Since then, despite a rise in cases, there has been a move to a new normal with relaxed restrictions but continuing emphasis on social distancing and other methods to stop the spread of the pandemic. As this new normal unfolds, the COVID-19 pandemic will continue to reverberate across aspects livelihoods, food and nutrition security, and ultimately human wellbeing, likely in unforeseen ways.

These early COVID-19 restrictions in Papua New Guinea had some impact on coastal fishing communities. Rapid assessment surveys about the impact of COVID-19 on fishing and coastal communities in New Ireland and Central Province in Papua New Guinea found that food security was a persistent problem (LMMA Network et al. 2020). Around two-thirds of those surveyed reported that was not enough food available in their villages. In Kavieng, New Ireland, the state of emergency coincided with less than average rainfall, which in turn exacerbated the stress of COVID-19 on food security. In these communities, restrictions did not completely disrupt access to markets. Of those surveyed, only around 25% reported that restrictions on movements during the state of emergency prevented them accessing markets to sell produce and seafood.

This chapter adds to these findings by providing an in-depth, and open-ended examination of individual and household's experiences of COVID-19 impacts in an atoll island context in Manus Province. The island is highly dependent on fisheries, has little arable land, and most services—including the main market, hospital, ATMs, supermarkets, hardware stores and petrol—are in the town of Lorengau on the mainland. Thus, the findings presented in this chapter are pertinent to small, atoll island coastal communities, who may have fewer food safety nets, and more issues of access (Connell and Lowitt 2020). Specifically, we examine how COVID-19 and rules to combat it impacted food and nutrition security, livelihoods, and wellbeing of individuals and households and whether and how households were able to cope. From these findings, we outline implications of the continuing pandemic on atoll island communities and explore what these findings suggest about the capacity for households to adapt to COVID-19.

A1.2.1 Background and study site

Ahus island is a small atoll, located North of the mainland in Manus Province, Papua New Guinea. Approximately 780 people reside on the island. Although some families receive remittances and support from family members who have migrated to work in larger cities, most families depend on reef and pelagic fisheries for their livelihoods. Ahus islanders troll for pelagic fish, and line or spearfish for reef fish in coral reefs surrounding the island and glean for molluscs and echinoderms. The island itself is has little arable land. Aside from coconut *(cocos nucifera)* and galip nut *(canarium indicum)*

trees, and some small household gardens (including bananas, capsicums, and leafy greens), almost no food is grown on the island. Instead, Ahus islanders get most of their fresh produce at regular markets both on the island itself and in close-by mainland communities, where they also sell fish. In addition, many market fish and access shops and services at Lorengau, the closest major town.

Ahus, like many communities in Papua New Guinea, is governed through a combination of customary leadership and democracy, through an elected councillor. Coral reefs resources are governed by customary institutions of sea tenure and user rights for different areas, times and gears, based on gender and clan identity (Lau et al. 2020). The legitimacy of customary rules, and customary leadership more broadly, has shifted as the island navigates social changes (ibid).

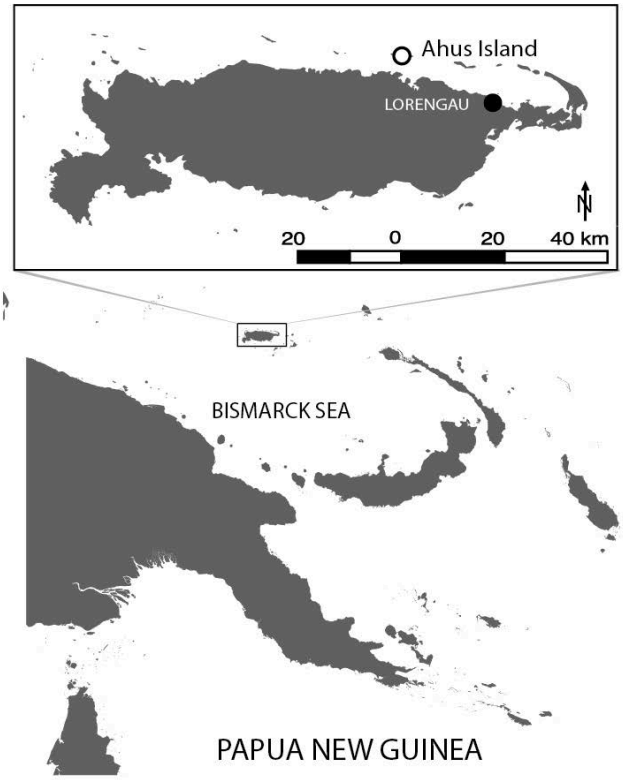

Figure S1. Location of Ahus Island, Manus Province, Papua New Guinea (adapted from Lau et al. 2020)

Ahus islanders are not unfamiliar with shocks to their community. In 2009, a king tide flooded houses and covered much of the lagoon's reef in sand. Many perceive climate change to be a growing threat. Households are already taking action to adapt climate change, for instance, by building seawalls, changing fishing practices, or diversifying livelihoods. A recent study found social connections, socio-ecological ties, and perceived power or agency over change, impacted the sorts of adaptive and transformative actions that households took (Barnes et al. 2020). However, the changes wrought by COVID-19 were unique and overlayed with these environmental shocks.

A1. 3 Methods

We conducted qualitative interviews to understand the impacts of the COVID-19 pandemic on livelihoods, food and nutrition security and wellbeing. Qualitative, short-term insights into the impacts of COVID-19 are important in guiding policy and supporting targeted larger scale, and quantitative studies (Steenbergen et al. 2020b). This research was only possible because of the long-term research partnership with the community. The findings in this chapter are based on seven in-depth interviews. which took place in July and August 2020. We interviewed three women and three men, who were purposefully chosen to represent different ages, clans, and thus perspectives and experiences of the pandemic. We also interviewed an active local leader, an older man, as a key informant to understand COVID-19 impacts at a community scale. Interviews were arranged at a convenient time for participants, conducted over mobile phones by a Papua New Guinean research assistant. She undertook comprehensive training in qualitative interviewing as part of the project and has previously worked as a research assistant in the community. Interviews lasted between 30 minutes to one-hour. The research assistant voice recorded and transcribed each interview, and both the first author and the research assistant translated interviews to English and cross-checked each translation.

Qualitative questions aimed to elicit detailed descriptions of individual and household's experiences across a range of themes including livelihoods, food and nutrition security, and wellbeing. We asked participants to recall their experiences during PNG's state of emergency. The findings presented in this chapter are based on a preliminary analysis of the first round of qualitative interviews. Specifically, we identified key impacts and coping mechanisms in relation to livelihoods, food and nutrition security and wellbeing. These interviews were followed by a second round collected in October 2020, and the third is planned for February 2021.

A1.4 Results

A1.4.1 Markets

COVID-19 impacted both access to and the function of markets, and thus on the community's predominately fisheries-based livelihoods. Local markets are normally held three times weekly. Mainlanders bring fresh garden produce and sago to sell, or islanders travel to sell fish in two mainland communities. In line with the directives of the state of emergency, local leaders closed the local island markets to avoid large gatherings of people.

> "…they said, there will be no market, it will stop. Because that activity gathers too many people. Too many people go and too many people hang around there. But… that's the one way for people to get food. So how can I not go to the market?" (Man, age 32).

The state of emergency also severely impacted the town market and local mainland markets—the main fish market for many fishing families from the island. Trading hours for stores and market days were reduced. Social distancing and fear of the virus meant that far fewer people attended the markets on the days they were open, resulting in fewer sales and less income for islanders who sell fish there. Decreased sales severely impacted cash flow into the community.

> "There weren't a lot of people coming to buy our produce or our fish… because of the virus, I think everyone was afraid, so not many people came to the market… Produce and food, and that sort of thing, it all moves with the people" (Man, age 47).

Thus, lack of access to markets, and lack of customers with enough cash to purchase fish meant that, even if people were able to get their fish to the markets, it was not sold at the same volume as prior to the pandemic. The closure of local markets and reduced trading hours in markets and stores in town immediately started to cause food shortages, particularly for those more vulnerable, including the elderly. Quickly, people stopped obeying the rules and the markets began again, but with social distancing rules in place. When the state of emergency lifted, the island's community leaders worked with community leaders from the mainland to increase the number of local markets and encouraged the communities to shift back to a barter system while there was little cash.

A1.4.2 Livelihoods

Alongside disruptions to markets and a subsequent lack of income, several people emphasized that movement restrictions impacted livelihoods from the sea.

> "It's true that if you're in a city, in a town or an urban area, you're more ok than us on islands and in villages. And the mainland is alright as well because they have gardens and that kind of thing. For us on this island, it is hard. Livelihoods are from the sea" (Man, age 44).

Initial movement restrictions, and some confusion about what was safe and allowed during the state of emergency, meant that people fished less than usual, or only went fishing for a short time. For many, fear and uncertainty around the virus led to them fishing less, which also coincided with the low fishing season, and bad weather:

> "For fishing, before this thing happened—yes, I am aware that the weather was not good—but our people at first were frightened and they weren't fishing enough to sustain their life during this time, when they were scared about this pandemic. But now isn't like that" (Community leader, age 67).

For those who required petrol for trolling, lack of access to petrol became a problem.

> "…when it comes to fishing, the petrol was a problem for us to get, to go out fishing far away. For the canoe, it's ok, we can paddle and go fishing. We got fish and brought them back and they weren't for selling, because how can we paddle over to the mainland and sell them? They were just for the household to eat, and when you eat, you eat fish only" (Man, age 44).

Thus, rather than generating an income, most households fished for food, or, if they were able, for trading with family on the mainland. For instance, alongside the closure of markets in the early stages of the lockdown, movement to the mainland (which is accessible by boat and canoe from the island) was also banned. Those who were able—predominantly younger fishermen—stopped complying with the bans and traded with relatives on the mainland. However, only those with family on the mainland could use this tactic, and those with enough strength to paddle across. Elderly people, and people without young men as family members were unable to access garden food in the early stages of the state of emergency, and practices of sharing food and supporting others in the community had also declined (see section on 'social relationships').

> "But, all the strong young men, the strong men, they paddle canoes. As I told you, they paddled over and exchanged to get these things. And the weak, they couldn't. The weak, like the old men, the old women, and children. When things got hard, they just crossed over to another family and ask. So, what can you say, can you just leave them hungry? We have to help them. At least they can stay with the family a bit and eat a little something, or one family doing ok can share a bit of food with them" (Man, age 44).

This quote suggests the ban on movement between the mainland and the island had a particularly big impact. Those who received remittances from family members outside the island were likely buffered from some of these impacts. The same respondent emphasized those that struggled most were "those who didn't have any children living outside the island and sending remittances]", because their only source of support was from the sea.

Finally, informal livelihoods that acted as safety nets were also affected by bans. Many women in the community supplement their family's income by marketing small goods (e.g., donuts). Selling betel nut is an informal safety net, particularly for women, for when fishing and fishing income is insufficient:

> "When they stopped betel nut in Manus, lots of the women found it hard. When the sea is ok, then it's ok, but if the sea is no good, then we can't even sell betel nut [to make up for it]. If you try and sell betel nut in town the police will get you and lock you up" (Man, age 44).

Bans on movement, and marketing activities had a far-reaching impact on people's livelihoods, and also curtailed existing alternative livelihoods that serves as safety nets.

A1.4.3 Access to services

The state of emergency also disrupted access to key services on the mainland. Aside from an Aid-post and numerous small family-run canteens, many key services, such as banks, fuel stations, stores, and the hospital, are on the mainland. When social distancing rules were in place, boat transfers to town became very difficult. Rather than 12-15 or so passengers, only 4-7 could travel on each boat, increasing the per-person transport costs. Boats ran less often, and some used smaller motors to save money, meaning that the trip took over 2 hours, compared to around 45 minutes. These changes exacerbated difficulty in accessing the town markets to sell fish, and obtain key commodities, like petrol needed for trolling.

> "Because of the space in the boat, you could only have five people. So, when it was five people to one boat, they couldn't meet the cost of petrol to get from the island to town and to come back. So, the boat owners raised the price to 50 Kina. So, at 50 Kina it will just be five people in the boat. And on the way to town there were marine police checking all the boats" (Woman, age 54).

> "Every single boat that goes to town could only take four passengers in one day, in one run. Suppose you want to go on one day, and this day, no, there are already four people so that's full, so you have to stay and wait for the next run. That's what's happening" (Man, age 32).

Lack of access to services also disrupted people's livelihoods in unforeseen ways. For instance, one respondent actively discouraged her sons from spearfishing because of the added risk of getting sick and the inability to access the mainland hospital, which had closed to all but urgent patients, in turn leading to less fish in the household.

> "So, I told our family, you can't go to the sea, because if you get sick then how can we go to the hospital? So, during that time no one went fishing, and we didn't have money or enough food" (Woman, age 54).

This quote illustrates that people made trade-offs between income and food, and the heightened risks brought by reduced access to essential service like health care.

A1.4.4 Food and nutrition security

The state of emergency immediately led to food shocks in the community. Firstly, when local markets were closed, food became hard to access. The island has little arable land, and the community predominately relies on income from fishing to purchase (or barter) food from the mainland and town. Second, lack of access to markets (described above), led to lack of cash income, which decreased people's ability to purchase store foods.

> "That's the only income we can get…from the sea. We market the fish, we sell the fish… so we can get store food from the income. It helps us to get store food" (Woman, age 25).

These impacted the diversity of people's diets, and people started eating only garden foods, including sago. People also started limiting meal sizes and eating fewer meals.

> "There was limited food … we had to… look after it well so it could last a long time, for many days more. If we'd gotten food as normal, as if the virus hadn't come, then our food would have run out quickly. So, we reduced food… We'd usually boil four cups of rice, and we reduced it, so it went down to two cups of rice. So, we'd serve, little, little for each child and each adult. It doesn't matter if you're full up or only just full, that was your share [ration]" (Man, age 44).

> "Before, we'd all eat rice often. Not now. I've cooked sago over and over, and everyone complains… but there's nothing else" (Woman, age 32).

Reducing both the quantity and diversity of food consumed to these extremes can have severe ramifications for health.

After local markets re-opened, mainland market and store access and cash flow remained limited, meaning people on Ahus were more reliant on directly trading fish for crops with nearby communities. As such, nutritious fruits and vegetables became more accessible than store bought foods with low-nutritional quality. Community leaders explicitly encouraged people to eat more traditional garden food:

> "During this time, we ate a lot of food from the village. Because we couldn't go to town a lot to find food to eat… We ate sago, we ate garden food, we ate fish, so we didn't eat tinned fish or that sort of thing" (Woman, age 54).

> "For me, lots of the time and most times for us now, we have gone back to eating village food. Because rice etc., I've talked about it, getting money during the pandemic was a bit hard" (Man, age 32).

This switch may represent a temporary transition back to traditional foods in contrast with a broad increase in the consumption of processed and imported foods. Increased consumption of fruit and vegetables could have beneficial long-term effects on health and nutrition in the community if this change carries over into life during the 'new normal'.

A1.4.5 Social relationships

Finally, social distancing measures, concern about compliance with rules, and lack of safety nets impacts people's social relationships, trust, and wellbeing in the community. Specifically, fears about the spread of the virus and distrust in neighbours' conduct impacted relationships across the community:

> "A few people went to Church, and a few people stayed at home. And this freaked us out. If we heard that, oh, people from this family, one or two had gone to town and come back to the village, now we'd be thinking "Aye, that guy went to town, and what if they got the virus there and brought it back" … So, the relationships between us, they were spoilt, really screwed" (Man, age 44).

In addition, several respondents emphasized that practices of sharing and supporting others had, because of necessity, started to decline. One respondent in particular, was very concerned about families not sharing what they had, and interpreted this as greedy or selfish behaviour:

> "When the situation happened, plenty of families were, I'd put it like, they started being selfish and greedy … food was hard a bit… if another person wants to come and ask for some sago? There was sago, but they'd say, no we don't have any. There was greedy behaviour when this situation happened" (Woman, 32).

Finally, one woman noted that during the lockdown, bans on movement within the community, and lack of cash meant that incidents related to consumption of alcohol and drunken behaviour had decreased.

> "From my viewpoint, when this happened it made lots of men stop drinking as much as before" (Women, 54).

The community leader reemphasized that this change was one good thing resulting from the pandemic.

A1.5 Discussion:

A1.5.1 Isolation and adaptive capacity

Having assets to draw on in times of need is an important part of people's adaptive capacity. However, on islands are able being able to convert assets or use assets in times of shock will depend on the type of asset itself. For instance, owning a boat and outboard motor does not greatly enhance adaptive capacity if petrol is inaccessible. Likewise, having cash does provide an important safety net, but converting cash to food is challenging in circumstances where it's difficult to access markets. Indeed, in Vanuatu, dependence on a cash economy and inter-island trade was a key vulnerability to COVID-19 restrictions, resulting in similar food insecurity issues in small, remote islands (Steenbergen et al. 2020b). The food shortages and dietary changes reported in Ahus and other communities across the Pacific during COVID-19 are compounding existing food and nutrition security challenges arising from economic and environmental changes in the region (Campbell 2015). Communities on larger islands in PNG, Solomon Islands and Vanuatu have been able to turn to household gardens and agriculture as a food and income safety net (Eriksson et al. 2020, Steenbergen et al. 2020b). However, lack of assets beyond fishing grounds meant that, unlike other coastal communities in the Pacific, Ahus islanders could not rely on 'fall back' sources of food like home gardens (Eriksson et al. 2020, Farrell et al. 2020a, Steenbergen et al. 2020b). Fishing livelihoods cannot of themselves provide a healthy diet without adding vegetables through trade. Ahus is particularly vulnerable because of its limited livelihood diversity, isolation, and small size. Other atolls with limited opportunities for agriculture will likely face similar challenges.

Lack of flexibility, in terms of dependence on cash and trade, and lack of on-island food options, make communities highly vulnerable when shocks, such as the state of emergency, create isolation. Nonetheless, when markets did reopen in Ahus, the community leaders and the community more broadly were quick to return to traditional bartering systems, and to change the frequency of local markets to make up for lack of access in town. Thus, while dependence on the cash economy can limit flexibility, flexibility can be quickly reinstated by drawing on traditional modes of exchange. The capacity for atoll communities to adapt may also be constrained by a lack of livelihood flexibility. In Ahus, there are few viable livelihoods aside from fishing. In addition, in the case of the COVID-19 state

of emergency, alternative livelihoods based on marketing small goods, were subject to the same restrictions as marketing fish.

In the context of these vulnerabilities and limits to adaptive capacity, many households limited the quality and quantity of their foods to cope with COVID-19 restrictions. This shift has troubling implications for food and nutrition insecurity. Insufficient energy and micronutrient intake can have severe health impacts, particularly for lactating women and young children with high micronutrient needs for growth and development (Black et al. 2008). If the restrictions during state of emergency had been more prolonged, then food insecurity would have become an even more critical problem. Indeed, the COVID-19 pandemic will have dire impacts on food security globally (Laborde et al. 2020). Social safety nets are critical to addressing disrupted food access, but are not well developed in the Pacific (Edwards 2020). Indeed, although Ahus Island had previously received food support during environmental disasters, there was no support during the state of emergency. Nonetheless, one positive outcome during and after the state of emergency was a shift to more nutritious garden foods, when store-bought foods became less accessible and cash harder to come by. The over-consumption of processed store foods has been a growing public health concern across the Pacific in recent years (Popkin et al. 2012).

The socio-cognitive dimensions of adaptive capacity, for example, their perceptions of risk, shaped people's responses to the state of emergency. For instance, early fears about the virus led people to fish less, and some families calculated that the inaccessibility of the hospital made certain types of more physically taxing fishing (spearfishing) too risky. Conversely, for others—such as the young men who traded with the mainland when it was banned—the choice to non-comply with rules outweighed the risks. As such, the state of emergency rules interacted with family's decision-making in different ways, for different people.

Changing social relations and distrust are particularly concerning and perhaps unique to the sort of shock caused by COVID-19. Research has found that social connections and networks are crucial in shaping how and whether people cope and adapt to climate change (Barnes et al. 2020). The nature of COVID-19 and rules around movement and distancing meant a rise in distrust and a decrease in face-to-face connections within the community, potentially with negative consequences for the social networks crucial to supporting families through future shocks and the continuing COVID-19 pandemic. In addition, on Ahus, food sharing is an important aspect of social connection. As such, stress on food and nutrition security has flow on effects to social relationships in the community by curtailing people's ability to share food and support one-another. Our findings suggest that when assets are low,

then social support through networks may also decrease, and this dynamic may create a negative feedback loop until the shock has passed.

A1.5.2 New Normal: Ways forward

The food shocks and isolation experienced during the state of emergency have subsided. Indeed, subsequent interviews suggest that access to markets, food and services has returned to a 'new normal' in the community, even as PNG is experienced an increase in cases. Nonetheless, the continuing pandemic means that future shocks and stresses are likely across the world and in Papua New Guinea. Household's experiences during the state of emergency emphasize the need to recognize distinct challenges that atoll islands face if they become isolated. In particular, atoll communities will be highly impacted by rules affecting the ease and accessibility of boat transport, especially if they have a high dependence on fisheries and fish markets for income, outside markets for food, and little food grown on-island. Rules should be coupled with measures (e.g., food support) to support communities during times when extreme measures are necessary. One option is designing ways and practices for mainland garden produce to reach islands and for fish to be bartered or sold, without overt human contact. Secondly, our findings about the food and nutrition security impacts of COVID-19 highlight the need to ensure that support reaches islands in a timely manner, especially during extreme shocks like the state of emergency. Several interviewees mentioned their confusion over whether there would be government support and talked about previous food and other relief they'd received in the aftermath of natural disasters. Finally, there is a need to ensure clear communication about future rules, and to acknowledge trade-offs between social distancing with livelihoods, food and nutrition security and wellbeing. In PNG, many government directives will be enacted through ward development councils and local forms of governance. Fear and anxiety about COVID-19 may have resulted in rules that did not account for impacts on food and nutrition security, and non-compliance with the rules may impact people's trust in the legitimacy of future directives. As PNG's new normal continues to unfold, the COVID-19 pandemic will to reverberate across aspects livelihoods, food and nutrition security, and ultimately human wellbeing, likely in unforeseen ways.

Appendix 2 Individual interview template

I'd like to hear about the changes you and your household have experienced in the past month, related to COVID-19 and government rules that have been put in place.

General

- What are the main changes you have experienced since March 2020?

Livelihoods

- Please tell me about how COVID-19 has impacted how you and your family have brought in food and income compared to how you normally would at this time of year.
    - Have you and your family made any changes to cope with these impacts? Please tell me about them.
- I am interested in understanding how COVID-19 has affected how you and your family have been fishing and gleaning.
- Has COVID-19 changed how much you've been catching compared to how you normally would at this time of year? How so?
- Has COVID-19 changed the type of catch you've been catching compared to how you normally would at this time of year? How so?
    - Have you and your family made any changes to cope with these impacts? Please tell me about them.
        - *[If they say that they're catching less fish (above), ask]* Are you selling less fish, eating less fish or a combination, or something else?

Fishing and access to markets

- Please tell me about how COVID-19 has impacted how you [buy and] sell fish (including markets)?
    - Have you and your family made any changes to cope with these impacts? Please tell me about them.
- Is it easier or harder or the same to access markets (or buyers) to buy and sell fish compared to normally at this time of year? Why?
    - Have you and your family made any changes to cope with these impacts? Please tell me about them.
- Has the price of fish changed to buy and to sell compared to this time of year normally? How?

- Have you and your family made any changes to cope with these impacts? Please tell me about them.

Food security

- Please tell me about how COVID-19 has affected the types and variety of food you and your family are eating now, compared to normally at this time of year.
- Are there foods you normally eat at this time of year that you are not eating at the moment? Why?
- Is store-bought food easier or harder to get? Why?
    - Have you and your family made any changes to cope with these impacts? Please tell me about them.

Wellbeing

- How has COVID-19 impacted other aspects other aspects of your quality of life, for example your normal routines, social interactions and level of happiness and day-to-day life compared to normal? (E.g., Church, soccer/ football).
- Have your social relations with others in the community changed? How?
    - Have you made any changes to cope with these impacts? Please tell me about them.

General

- Is there anything you'd like to add?

Appendix 3 Leader interview template

I'd like to hear about the changes the community has experienced due to the COVID-19 pandemic and the government rules that have been put in place.

General

- What are the main changes that COVID-19 has had on the community?

Institutions

- Please tell me about changes caused by COVID-19 to meetings and activities in the community compared to before? Are there regular community meetings? Has COVID-19 impacted fisheries (or reef) management? How?

Migration

- Please tell me about changes that COVID-19 is having on people coming and going in the community? Have more people come here or more people left? If so, what impact is that having?
    - Has the community made any changes to cope with these impacts? Please tell me about them.

Livelihoods

- Please tell me about impacts that COVID-19 has had on livelihoods in the community. Have the number of people fishing changed? Has the intensity of fishing changed?
    - Has the community made any changes to cope with these impacts? If so, what are these changes?

Access to markets

- Please tell me about impacts that COVID-19 has had on buying and selling fish. Are people in the community able to access markets? Why/ why not?
    - Has the community made any changes to cope with these impacts? Please tell me about them.

Food security

- Please tell me about impacts that COVID-19 has on food. How is the community making food last for everyone? Are there any projects or plans to support the community to access food? Are people in the community changing how they access food?

- Has the community made any changes to cope with these impacts? Please tell me about them.

Wellbeing

- Please tell me about impacts that COVID-19 has on the wellbeing and day to day lives of the community as a whole, for example, have church gatherings continued, are sports still played? Have social relations in the community changed? How?
    - Has the community made any changes to cope with these impacts? Please tell me about them.
- Do you think COVID-19 has impacted some people in the community more than others? How and why?

Support

- Has there been any external support? E.g., government, CBOs, NGOs? What sort?
- What further outside support is needed? (Specify that we don't provide this – we will pass this on as recommendation.

General

- Is there anything you'd like to add?

Appendix 4 Fish trader interview template

1. I'd like to understand the timeline of the coronavirus, from March until now. Can you please tell me what happened when COVID-19 started in March? For example, what rules were put in place, and also how these rules have changed since March?
2. How has the coronavirus and the government rules impacted you as a fish trader?

- In what ways has it impacted how you obtain fish from fishers?
- In what ways has it impacted how you transport and sell fish?
- How has it impacted the price of fish to buy and sell?
- How have these changes impacted you personally?
    i. Livelihood/income
        1. Has this influenced your ability to buy food for you and your family?
    ii. Lifestyle/wellbeing
- Have you made any changes to cope with these impacts?

3. Is there anything else you would like to tell us?

Appendix 5 Post-interview supplementary survey template

Livelihoods (fishing)

- How many times did you or your family go fishing in the past week?

[Number of times]

- Was that more, less, or about the same as normal for this time of year?

[a] More [b] Less [c] Same

- Did you catch more, less, or about the same fish or seafood as normal for this time of year?

[a] More [b] Less [c] Same

- Why?

[Short answer] (code to 'market over-supply', 'Covid', 'other' etc.)

- How much money did your household earn from selling fish in the past week?

[Amount]

- Was that more, less, or about the same as normal for this time of year?

[a] More [b] Less [c] Same

- Why?

[Short answer] (code to 'market over-supply', 'Covid', 'other')

Wellbeing

- How happy are you with the amount of food and money you gain from all your sources of livelihoods now?

[a] Very unsatisfied [b] Unsatisfied [c] Neither satisfied nor unsatisfied [d] Satisfied [e] Very satisfied

- Apart from income, how satisfied are you with other aspects of your livelihood, e.g., enjoyment, identity?

[a] Very unsatisfied [b] Unsatisfied [c] Neither satisfied nor unsatisfied [d] Satisfied [e] Very satisfied

- On the whole, how happy are you with your relationships with others (i.e., there are people that you trust, you can turn to in times of need, and you enjoy relaxing in their company, etc.)?

[a] Very unsatisfied [b] Unsatisfied [c] Neither satisfied nor unsatisfied [d] Satisfied [e] Very satisfied

Week 3. Food security (based on HFIAS)

- In the past 4 weeks, how many times did you worry that your household would not have enough food?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times did you or any household member have to eat a limited variety of foods due to a lack of resources?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times did you or any household member have to eat fewer meals in a day because there was not enough food?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times was there no food to eat of any kind in your household because of lack of resources to get food?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times did you or any household member go to sleep at night hungry because there was not enough food?

[a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

- In the past 4 weeks, how many times did you or any household member go a whole day and night without eating anything because there was not enough food?
  [a] none [b] 1-2 times [c] 3-10 times [d] more than 10 times

Appendix 6 Participant demographic information

Table S1 Interviewee demographics

Participant #	Gender	Age
Kenya, Community A		
A1	M	21
A2	F	29
A3	M	30
A4	F	38
A5	M	51
A6	F	45
A7_L	M	45
Kenya, Community B		
B1	M	24
B2	F	29
B3	M	45
B4	F	42
B5	M	48
B6	F	46
B7-L	M	43
Kenya, Community C		
C1	M	25
C2	F	29
C3	M	42
C4	F	38
C5	M	55
C6	F	46
C7_L	M	43
Kenya, Community D		
D1	M	28
D2	F	29
D3	M	30
D4	F	42

D5	M	69
D6	F	45
D7_L	M	50

Kenya, Community E

E1	F	29
E2	M	27
E3	M	43
E4	F	40
E5	F	58
E6	M	61
E7_L	M	NA

Papua New Guinea

ID	Gender	Age
Ahus		
AH1	M	40
AH2	M	32
AH3	M	44
AH4	W	32
AH5	W	54
AH6	W	23
AHLeader	M	65

Dennery, St. Lucia

ID	Gender	Yrs. in fishing industry
St. Lucia		
SL1	M	20
SL2	M	20
SL3	M	15
SL4	M	15
SL5	W	8
SLLeader	M	Unknown

Appendix 7 Protocol for ethical interviewing during the pandemic

Based on (Draucker et al. 2009, Dempsey et al. 2016, Townsend et al. 2020).

Discussions about COVID-19 creates a risk that interviewees may experience difficult and uncomfortable emotions. While we have previously not observed signs of distress when conducting previous surveys with similar questions about food and nutrition security, wellbeing, and livelihoods, we recognise that the current pandemic may be causing elevated anxiety or stress. There are several strategies to minimize the risk of emotional distress during sensitive research including consistent monitoring of participants' emotional reactions, providing frequent breaks during stressful data collection procedures, debriefing, and providing information on available psychological or social services (Draucker et al. 2009).

This protocol provides a framework for monitoring and responding to participant's emotional reactions during research.

Table S2 Process for responding to indications of distress during interviews

Indications of distress during interview	Actions and follow up questions
Participant indicates they are experiencing a stress or emotional distress	1. Stop the interview 2. Allow the participant time to regroup 3. Assess mood: Questions: • Tell me what you are thinking • Tell me how you are feeling right now • Do you feel you are able to go on about your day? 4. Determine if participant is experiencing acute emotional distress beyond what would normally be expected for research on food security, wellbeing, and livelihoods.

Action: Based on assessment of emotional distress:

1. If the participant is experiencing stress or emotional distress in line with what would normally be expected for research on food security, wellbeing, and livelihoods (i.e., low or minimal), then extend the offer to a) stop the interview, b) regroup, c) continue.

2. If the participant is experiencing stress or emotional distress beyond what would normally be expected for research on food security, wellbeing, and livelihoods (i.e., medium or higher levels), then stop the interview. Provide participant with the contact details of counselling service and emphasize that this is free to call 24/7. Encourage participant to contact the counselling service.

Appendix 8 Supplementary results for Ch. 4

Table S3 Impacts of COVID-19 containment policies on each component of the food systems framework. Based on final NVivo codebook. Superscripts indicate which sites each impact was reported in (P= Ahus Island, PNG; K= Mkwiro, Kenya; S= Dennery, St. Lucia).

Impacts of COVID-19 containment policies on each component of the food systems framework	
Policy and Governance	Direct COVID-19 containment policies
	Movement restrictions
	Ban on travel between counties [K]
	Recommended self-isolation and limited movement [K, P]
	Ban on leaving community and/or visiting other communities [P]
	Curfews [K, P, S]
	Lockdowns [S]
	Social distancing rules
	While fishing [K]
	At markets and stores [P, K]
	At banks, petrol stations etc. [P]
	Limits on people in boats [P, K]
	Limits on people in cars and trucks [S]
	Ban on gleaning in groups [K]
	Ban on community gatherings and meetings [K, P]
	Compulsory use of masks [K, S]
	Market closures [P]
	Reduced market and shop operating hours and days [K, P]
	Creation of a community COVID-19 taskforce [P]
	Declaration of a National State of Emergency [P]
	Promotion of good hygiene practices [P]
	Distribution of hygiene supplies [P]
	Leaders instructing community members to buy less in market [P]
	Ban on raising prices in stores and markets during pandemic [P]
	Ban on selling betelnut [P]
Systems supporting food production	Ecosystems [K, P]
Food supply chains	Production
	Foods produced
	Seafood [K, P, S]

e.g., Fish, octopus, molluscs, seaweed

Grains [K, P, S]

e.g., Maize, rice

Vegetables [K, P, S]

e.g., sweet potatoes, banana, cassava, plantains, leafy greens

Engaging in new production activities

Gleaning [K]

Fishing [K, S]

Growing crops [K, S]

Seaweed farming [K]

Changes in fishing methods

Changes in gear types [P]

e.g., from trolling to spear fishing

Changes in fishing sites [K]

e.g., only fishing close to village

Gleaning instead of fishing [K, P]

Deployment of a Fish Aggregation Device [P]

Reduction in production activities esp. fishing

Fewer people allowed on boats to fish [K]

Bad weather [K, P]

Not fishing in prime locations [K]

Fishing/farming for less time or at bad times due to curfew [S]

Not fishing for fear of getting sick [P]

Not fishing while self-isolating, staying on island [P]

Unable to get production inputs e.g., fuel for boats [P, S]

Low demand [K, P]

Low catch due to overfishing [P]

Only fishing for consumption not sale [P]

Introduction of safety measures while fishing/farming

Social distancing [K]

e.g., not gleaning in groups, limits on people in boats

Wearing masks [K, P, S]

Processing

Increase in production of prepared snack foods and meals to sell in community [K, P]

e.g., scones, cassava chips, mahamri, soup

	Processing fish, octopus etc. to sell in community (as opposed to selling fresh or to traders) [K, S]
	e.g., salting, drying, frying
	Storage, trade, and distribution
	Travel restrictions blocking imports and exports to cities [K, S]
	Shift from selling in cities to smaller close towns [K]
	Sending fish on transport trucks instead of travelling to sell in-person [K]
	Traders buying less fish, or buying at lower prices [K]
	Fishers looking for alternative markets with better prices [K]
	Disruptions in food sharing practices [P]
	Fewer traders and wholesalers to sell to [K, S]
	More traders to sell fish to [K]
	Use of fridges to store fish until it can be sold [K]
	Lack of access to cold storage [K]
	Government, NGO, and industry food aid distribution [K]
	Ban on travelling to mainland to trade [P]
	Breaking rules to trade with mainland [P]
	Retail and marketing
	Food shortages in stores and markets [K, P, S]
	Market closures and reduced hours [K, P]
Food Environments	Availability and physical access
	Unable to access fishing grounds [P]
	Less fish available [P]
	Not fishing out of fear [P]
	Unable to leave island to get food [P]
	Growing own food [K, S]
	Inability to grow own food [P]
	Food stockpiling [K, S]
	Garden foods more available and accessible than store food [P]
	Insufficient food available in stores and markets [K, P, S]
	Breaking rules to access food on mainland (dependent on having canoe and ability to paddle there) [P]
	Gifting and family support
	Community support for struggling people [P]
	Normal gifting and food sharing practices stopped [P]

Support for people with family outside community [P]

Government, NGO, and industry food aid [K]

No aid despite past instances [P]

Market and shop accessibility reduced

Transport limitations [P]

Social distancing and safety requirements [K, P, S]

Reduced opening hours/days [K, P]

Market closures [P]

New markets opened [P]

Use of intermediaries to buy food [P]

Staying home to socially distance [P]

Return to normal [P]

No differences [K]

No difference [K, P]

Affordability/economic access

Loss of income reducing economic accessibility of food [K, P]

"luxury" foods unaffordable [K, P]

Canteens in community more expensive than markets in town [P]

Only able to afford limited range of basic staples [K, P]

Only able to afford smaller quantity of food [K]

Only able to afford limited range of foods [P]

Price freezes to maintain affordability [P]

Price increases [K]

Price reductions [K, P, S]

Sellers intentionally lowering price in own community to maintain affordability [P]

Shopkeepers allowing people to get food on credit and pay later [K]

Reversion to exchange instead of cash transactions [P]

Producing own food when unable to afford to buy [P, K]

Ability to buy other foods dependent on fish sales [K, P]

Government aid increasing purchasing ability [K]

No change [K, P]

Trading and negotiating exchanges instead of cash purchases [P]

Food quality and safety

Increased food safety due to improved hygiene practices [K, P, S]

Acceptability

	Forced to make do with less preferred but more affordable and accessible foods [K, P]
	Information, guidelines, and advertising
	Encouragement from community leaders to eat garden food [P]
	Policy conditions
	Ban on raising food prices [P]
	Social distancing and other safety requirements [K, P, S]
	Promotion of hygiene practices [P]
Consumer Behaviour	Reduction in amount of food acquired, prepared, and consumed
	Buying less overall [K, P]
	Budgeting/rationing food [K, P, S]
	Preparing/eating less food at each meal [K, P, S]
	Eating fewer meals per day [K, P]
	Changes in food acquisition behaviours
	Avoidance of markets out of fear [P, S]
	Breaking rules to obtain food [P]
	Pooling resources to be able to buy food [K]
	Reliance on fishing for food [P]
	Changing types of food acquired, prepared, and consumed
	Purchasing decisions based on price [P]
	Expensive foods consumed less frequently [P]
	Preparing simpler meals with fewer ingredients [K, P]
	Buying a reduced variety of foods [K]
	Substitutions
	Vegetables instead of meat [K]
	Less preferred but more affordable/accessible foods [K, P]
	Gleaned seafood instead of fish or store food [K]
	Village food instead of store food [P]
	Proportion of catch sold vs. retained for consumption
	Both selling and eating less (reduced catch) [K]
	Eating less and selling more [K]
	Proportion sold based on availability of other food [P]

	Selling less and eating more [K]
Diets	Perceived inadequacy
	Feeling hungry [P, K]
	Feeling unsatisfied [P, K]
	Feeling unsustained [K]
	Reductions in quantity
	Not eating enough [K, P]
	Eating less than normal overall [K, P, S]
	Eating fewer meals per day [P, K]
	Reductions in quality
	Not consuming preferred foods [K, P]
	Mostly consuming nutritionally poor staple carbohydrates [K]
	Less meat and/or vegetables [K]
	Reduced dietary diversity
	Fewer different foods in each meal [K]
	Consuming same basic meal everyday [K, P]
	Only eating fish [P]
	Fewer foods affordable [K, P]
	Improved food safety due to increase in hygiene practices [K, P, S]
	Reversion to traditional instead of store-bought food [K, P]
	Reduced alcohol consumption [P]
	No changes [K, P, S]
Broader impacts	Economic impacts
	Not enough money for other things after buying food [K]
	Strict budgeting [K]
	Savings depleted or exhausted [K]
	Transition to exchange instead of cash economy [P]
	Social impacts
	Breakdown of informal social support systems like food sharing
	Results in damaged social relations and perceptions of greed and selfishness in community [P]

	Civil disobedience [P]
	Conflicts with leadership [P]
	Mental health impacts of poverty and food insecurity
	e.g., hopelessness, fear, distress at being unable to provide for family [K, P, S]
	Perceived lack of opportunity to improve quality of life [K]
	Loss of social aspects of eating food with friends and family [P]
	Reduced alcohol consumption good for the community [P]
	Environmental impacts
	Increased fishing pressure leading to overfishing [P]
	Reduced fishing pressure potentially allowing recovery [P]
Biophysical and	Bad weather conditions for fishing e.g., *strong winds, rough seas*
environmental drivers	Seasonal bad weather e.g. (Kusi, windy season) [K, P]
	Unseasonal bad weather [P]
	Seasonal produce availability [P]
	Reef health e.g., overfishing [P]
Technology,	Breakdown in food transportation and market access infrastructure
innovation, and	Fewer, slower, more expensive boats to mainland [P]
infrastructure drivers	No trucks taking fish to city markets [P]
	Lack of freezers to store fish while transport unavailable [K]
	Inability to obtain inputs
	e.g., fuel for boats [P]
	Inability to access banks [P]
	Damaged water infrastructure inhibiting hygiene practices [K]
	Deployment of FAD [P]
	Distribution of boat maintenance supplies [S]
Economic and market	Lack of money generally [K, P]
drivers	Limited cash circulation in communities [P, S]
	Family budgeting [K, S]
	Government support payments
	Helpful [K]
	Insufficient [K]
	Not frequent enough [K]

Not distributed to everyone [K]

No government support [P]

Increasing reversion to exchange instead of cash economy [P]

Remittances [P]

Depletion and exhaustion of savings [K]

Price reductions [P]

Markets

Formal market closures [P]

Reduced operating hours [K, P]

Establishment of new markets [P]

Livelihood impacts

Job loss [K, S]

Collapse of tourism [K, S]

Can't sell prepared foods [K]

Passenger boats not operating [P]

Goods trading and distribution [K]

Ban on selling betelnut P

Fishing and fish selling

Fishing as only/primary income source [K, P, S]

Uptake/increase in fishing due to job loss [K, S]

Reduced income from selling fish

Reduced prices [K, P, S]

Distribution chains blocked, traders buying for less [K]

Only selling locally at low prices [K, S]

Off-season prices [K]

Choosing to sell at lower prices so its affordable in poor economy [P, S]

Selling directly, competing with wholesalers [S]

No buyers

No tourists [K, S]

People afraid to buy [P, S]

People can't afford to buy [P, S]

Traders and wholesalers not buying and exporting [K, S]

Market access for selling

Transport restrictions [K, P]

e.g., travel bans, limits on numbers in boats, physical inability to paddle distances, increase costs of boats, reduced frequency of boats

Social distancing rules [K, P, S]

Reduced opening hours and days [K, P]

	Selling roadside instead of on dock [S]
	Traders buying less fish [K]
	Intermediaries unwilling to sell fish on behalf of others [P]
	Reduced catch or fishing effort
	Fewer people on boats [K]
	Time restrictions due to curfew [S]
	Fishing less due to reduced demand [K, P, S]
	Fishing less out of fear of virus [P]
	Bad fishing conditions [P]
	Can't get inputs *e.g., fuel,* [P, S]
	Exchanging instead of selling for cash [P]
	Focus on high-value gleaned species to sell [P]
	Insufficient to meet needs [K, P]
	Making a loss from previously profitable work
	Food production, processing and selling activities [K]
	Operating boats [P]
	Salaried income
	Those with salaried jobs increase community cash flow [P]
	Easier for people with salaried jobs than fishers/village people [P]
	Uptake or increase in alternative livelihood activities
	Cooking and selling prepared meals and snack foods [K, P]
	Casual labour work [K]
	Making and selling charcoal [K]
	Growing and selling food crops [K, S]
	Seaweed farming [K]
	Focus on high-value gleaned species to sell [P]
Political and institutional drivers	Food aid and support payments from government, industry, and NGOs [K]
	e.g., money, maize, beans, rice, sugar, cooking oil, maize, or wheat flour
	Infrequent or one-off [K]
	Regular [K]
	Irregular [K]
	Not fairly distributed [K]
	Helpful [K]
	Insufficient [K]
	Lack of institutional support and interventions [P]
	Distribution of hygiene supplies and information [P]

	Distribution of boat maintenance supplies by fisheries Co-op
	Civil strife, conflict, and disobedience [P]
	Police enforcement of COVID safety policies [K, P]
	Deployment of a FAD [P]
Socio-cultural drivers	Influence of fear on individual and community behaviour
	Not buying fish directly from fishers [S]
	Not visiting markets [P]
	Not fishing [P]
	Largely adjusted and returned to normal [P]
	Social norms and traditions
	Food sharing practices
	Social obligation to assist struggling community members [P]
	Breakdown of normal food sharing practices [P]
	Unable to move around and share meals [P]
	Loss of social aspects of food and sharing meals in community [P]
	Perception of greedy and selfish behaviour [P]
	Distribution of some fish from FAD to needy [P]
	Valuing self-sufficiency [P]
	Fishers choosing to lower prices to keep food affordable [P]
	Loss of social aspects of food and sharing meals in community [P]
	Sharing of resources and responsibilities between family members [K]
	Ability to get food on credit from stores owned by trusted friends [K]
	Not following rules that go against normal social behaviours [K, P]
	Social stratification
	Age
	Gender
	Increased care burdens for women [K]
	Lack of support for widows [P]
	Only “strong young men” able to break rules and paddle to mainland to trade for food [P]
	Women responsible for obtaining food [S]
	Family status
	People without off-island family received less support [P]
	Employment status [P, K]

Demographic drivers	Family size [P]
	Over-population [P]

Appendix 9 Supplementary results for Ch. 5

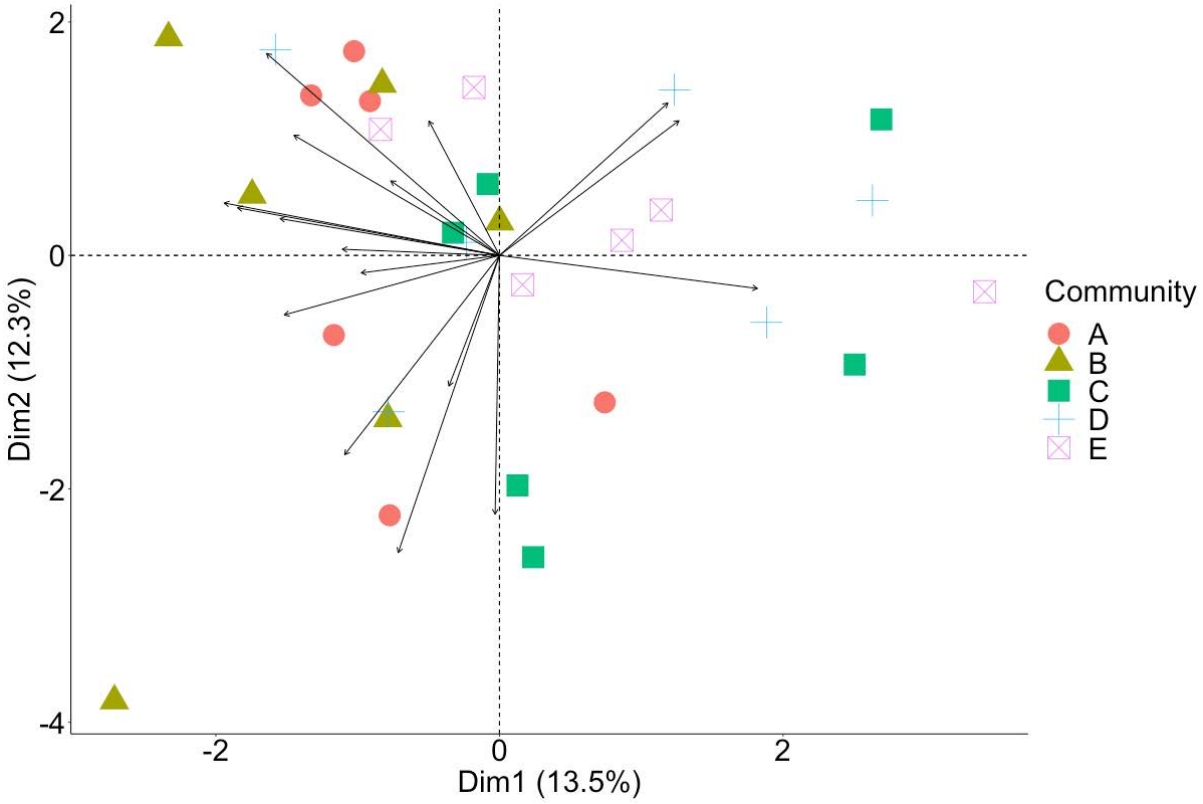

Figure S2: PCA Biplot showing variation in respondentsacross the 5 communities based on the responses they employed.

Table S4 Full list of adaptive responses. Based on final NVivo codebook.

Response category (used in primary figures in Ch. 5)	**Specific responses** (raw open coding)
Coping strategies	
Dietary changes	Buying low quality food
	Consuming different foods to normal
	Foraging for wild vegetables
	Reducing dietary diversity
	Eating less overall
	Skipping meals
Consuming assets, loans	Borrowing money or other assets
	Buying food on credit
	Loans from traders (to be paid in future fish catches)

	Selling or consuming assets (e.g., livestock)
	Using savings
Fish-based activities	Increase fish price
(minor)	Increased existing fishing activities
	Selling locally
	No longer selling fish on credit
Minor COVID-19	Diligent social distancing, masks, and caution during social
measures	interactions etc
	Distributing information by word of mouth instead of meetings
	Increased supervision and control over children
	Not participating in social activities even after restrictions eased
	Sticking to close social groups and not interacting with outsiders
Mental health strategies	Consciously altering mental frameworks/thinking positively
	Increased religious practice e.g., prayer
	Sports and other social engagements to fill time and relieve stress while not working
Social support	Food sharing
	Depending on food aid
Illegal activities	Crime
	Fishing illegally
	Secretly trading during curfew hours
Resource allocation	Planning and budgeting food expenditure
	Reducing other expenditure to afford food
	Prioritising feeding children
	Selling proportionally less, maintaining, or increasing consumption
	Consuming less catch or stock directly, selling proportionally more
	Doing tasks themselves they would normally pay someone else to do
	Cooking foods at home you would normally buy out

	Buying individual food items from stalls instead of buying in bulk and cooking Stocking up on food
Non-fish livelihoods (minor)	Casual vs. salaried employment in same industry
Incremental Adaptations	
Post-harvest activities (major)	Buying ice to preserve fish until curfew hours end Change in fish marketing strategy Change in or introduction of processing activities Collaboration between fishers to sell fish to traders Freezing fish until traders can come buy it Mama Karangas supplementing buying fish direct from fishers with buying from fish shops
Non-fish livelihoods (major)	Changing proportional effort of existing livelihood activities - Increased engagement in informal economic activities Diversifying farming Mama Karangas diversifying what they sell e.g., vegetables as well as fish
Fishing (major)	Change in fishing method Change in type of fish targeted or traded Collaborations between fishers to share effort and profit Working individually and in shifts Using personal equipment/not sharing
Food acquisition	Buying food from wholesalers and having it delivered Buying maize in bulk and milling it into flour instead of buying small flour packets Direct exchange instead of cash transactions
Major COVID-19 measures	Active widespread and substantive changes in behaviour and social practices to prevent contracting or spreading COVID-19

	Altering daily schedules and routines to fit around curfew hours and other regulations
Household economic strategy	Intentionally saving Household members combining assets (finances often kept separate) Increasing investments in livestock as future buffer Investing in new/better equipment Major construction projects for homes/businesses
Transformations	
New livelihood	Engagement in a completely new type of livelihood activity
Migration	Moving to a different community

Appendix 10 Socio-economic and social network survey questions used in Chapter Six

In Chapter Six I draw on surveys from a longitudinal study led by Associate Professor Barnes to conduct a before-during-after analysis of the wellbeing impacts of COVID-19. The following questions are the subset of survey questions used in my analysis. For further details of these surveys see Barnes et. al. 2019a and Barnes et al 2019b.

1. *Material style of life*: Interviewers asked if participants owned each of these assets and identified the materials used to build their house. The *value of livestock owned* was calculated from this list.

Power	Generator	Electricity	Solar panel	Car battery		
Appliances	TV	DVD	Satellite dish	Electric fan	Air Conditioning	
	Refrigerator	Piped water	Mobile phone	Smart phone	Radio/CD	
	Bluetooth speaker		Tablet	Laptop/computer		
Lighting	Kerosene wick	Candle	Solar light	Hurricane lamp	Light bulb	
Transport	Bicycle	Motorcycle	Vehicle	Other:		
Cooking	Firewood	Charcoal	Kerosene	Gas		
Roof	Thatch	Iron sheet	Tile	Other: _____		
Floor	Dirt/soil	Bamboo	Wood	Cement	Tiles	
Wall	Mud/thatch	Sand cement	Cement	Stone block	Plank wood	Metal
Land &	Shamba (acres)	Plot (to develop)	Business kiosk	Sheep/Goats (#)	Poultry (#)	
fishing	Cows	Donkeys	Other animals	Dugout canoe	Fish freezer	Ngalawa/ outrigger	Dhow
assets	Outboard	GPS	Surfboard	Cooler box	Fish finder	

2. *Social network indicators*: Interviewers asked participants (egos) to identify multiple individuals they communicate with about fishing (alters), and then asked a series of follow-up questions about each of those alters and their relationship with them.

    a. Who do you talk to or share information concerning fishing, for example rules, gears, fishing grounds? These could be fishermen, NGO/CBO representatives, government officials, BMU leaders, etc.
    b. How often do share information and advice about fishing with this person?

3. *Trust*: Now I want to ask you about how much you trust different types of people. Generally, how much do you trust:

    a. Other fishers
    b. People in your village
    c. Community leaders
    d. The government
    e. The fisheries department
    f. The police

4. *Subjective wellbeing*:
    a. How happy are you with the amount of food and money you gain from all your sources of livelihoods? [1] Very unhappy [2] Unhappy [3] Neither happy nor unhappy [4] Happy [5] Very happy
    b. Apart from income, how satisfied are you with other aspects of your livelihood, e.g., enjoyment, identity? [1] Very dissatisfied [2] Dissatisfied [3] Neither satisfied nor dissatisfied [4] Satisfied [5] Very satisfied
    c. On the whole, how happy are you with your relationships with others (i.e., there are people that you trust, you can turn to in times of need, and you enjoy relaxing in their company, etc.)? [1] Very unhappy [2] Unhappy [3] Neither happy nor unhappy [4] Happy [5] Very happy

5. *Control variables*:
    a. Community
    b. Age (Yrs)
    c. How many people are there in your household? This includes people staying in your house that are dependent on you.
    d. What is the highest grade of school you have completed?
    e. What jobs do you and other people in your house do that bring in food or money to your house?
        i. Fishing
        ii. Gleaning
        iii. Marketing marine products
        iv. Farming
        v. Salaried employment
        vi. Tourism
        vii. Informal economic activities
        viii. Other
    f. Are you involved in decisions about marine resource use or management? If so, how? ("hold a leadership position") was one option

Appendix 11 Supplementary results for Ch. 6

Table S5: Estimated total fisher population and number of fishers surveyed in each time period and included in this study. In 2016 we aimed to survey at least 75% of the total fisher population. In subsequent years only fishers included in the 2016 surveys were targeted. Only fishers surveyed in all three time periods were included in this analysis.

	Community A/B*	Community C	Community D	Community E	Total
Est. total fisher population 2016	380	100	290	151	921
2016	287	78	218	127	710
2019	275	73	216	100	664
2022	268	74	215	104	661
Included in analysis	262	68	211	86	627

* Communities A and B are very close together, and some fishers fish in both locations. The total fisher population estimates which were used to determine the target sample size were only available for the two communities combined.

Table S6: # respondents included in analysis of subjective wellbeing questions for each year. Due to availability and access to phones during the pandemic, not all respondents were available for every round of surveys. Due to the already small sample size, I decided to still include all available data in the analysis. I also surveyed several women during the pandemic who were not included in the 2016, 2019 and 2022 surveys.

	2016	2019	Aug-Oct 2020	Nov-Dec 2020	Jan-Mar 2021	2022
# Respondents	32	32	30	28	27	32

Table S7: Average level of subjective wellbeing before, during and after COVID-19, as indicated by livelihood satisfaction, social cohesion, and work enjoyment measured on a 5-point Likert scale from very unhappy/dissatisfied to very happy/satisfied. N=34.

Time period	Mean livelihood satisfaction (S.D)	Mean social cohesion (S.D)	Mean work enjoyment (S.D.)
2016	3.36 (1.04)	3.90 (1.00)	3.31 (1.06)
2019	3.69 (0.82)	3.81 (0.64)	3.72 (0.81)
Aug-Oct 2020	2.57 (1.17)	3.53 (1.17)	2.80 (1.24)
Nov-Dec 2020	2.79 (1.10)	3.32 (0.82)	2.75 (1.04)
Jan-Mar 2021	2.74 (1.10)	3.74 (0.76)	3.19 (0.92)
2022	3.53 (0.80)	3.94 (0.62)	3.38 (0.79)

Table S8: Summary results of Friedman tests for significant differences in material, relational and subjective wellbeing before and after COVID-19. N=627, * indicates p<0.05

Indicator	X^2	d.f.	p
Material wellbeing			
MSL	18.077	2	<0.001*
Value of livestock	0.123	2	0.94
Relational wellbeing			
Social connectivity	17.17	2	<0.001*
Frequency of social interactions	65.73	2	<0.001*
Trust in peers	21.95	2	<0.001*
Trust in institutions	66.68	2	<0.001*
Subjective wellbeing			
Livelihood satisfaction	0.80	2	0.67
Social cohesion	70.53	2	<0.001*
Work enjoyment	31.18	2	<0.001*

Table S9: Average material, relational and subjective wellbeing before and after COVID-19

Indicator	2016 Mean (S.D)	2019 Mean (S.D)	2022 Mean (S.D)
Material wellbeing			
MSL	0.13 (0.07)	0.52 (0.08)	0.71 (0.08)
Value of livestock (USD)	201.10 (25.77)	206.33 (21.63)	146.97 (13.72)
Relational wellbeing			
Social connectivity	4.11 (0.102)	3.61 (0.08)	3.67 (0.09)
Frequency of social interactions	8.59 (7.06)	9.17 (6.07)	10.18 (4.77)
Trust in peers	3.79 (0.04)	3.58 (0.03)	3.67 (0.03)
Trust in institutions	3.45 (0.03)	3.09 (0.03)	3.12 (0.03)
Subjective wellbeing			
Livelihood satisfaction	3.45 (0.04)	3.43 (0.04)	3.42 (0.04)
Social cohesion	4.00 (0.03)	3.71 (0.03)	3.66 (0.03)
Work enjoyment	3.41 (0.04)	3.55 (0.04)	3.31 (0.03)

Table S10: Mean changes in material, relational and subjective wellbeing in T1 (2016 to 2019) compared to T2 (2019-2022). N=627.

Indicator	T1 Mean (S.D)	T2 Mean (S.D)
Material wellbeing		
MSL	0.40 (1.86)	0.19 (1.78)
Value of livestock	5.23 (686.79)	-59.35 (518.61)
Relational wellbeing		
Social connectivity	0.08 (2.83)	0.79 (2.71)
Frequency of social interactions	0.58 (8.81)	1.00 (6.94)
Trust in peers	-0.21 (1.15)	0.09 (1.16)
Trust in institutions	-0.63 (1.03)	0.02 (0.99)
Subjective wellbeing		
Livelihood satisfaction	-0.02 (1.40)	0.00 (1.19)
Social cohesion	-0.29 (1.09)	-0.05 (1.05)
Work enjoyment	0.14 (1.35)	-0.24 (1.13)

Table S11: GLMM results comparing changes in material, relational and subjective wellbeing between T1 (2016-2019) and T2 (2019-2022) N=627, * indicates p<0.05

Variable	Estimate (S.E.)	z	p
Material wellbeing			
MSL			
Time period	0.03	0.33	0.74
Age	0.00	0.11	0.92
Occupational diversity	0.09	1.30	0.19
Change in occupational diversity	0.05	1.14	0.26
Education	-0.01	-0.56	0.58
Leader	-0.08	-0.88	0.38
Household size	-0.06	-0.79	0.43
Value of Livestock (USD)			
Time period	2.05	0.87	0.38
Age	-2.87	-2.07	0.04 *

Occupational diversity	2.39	1.16	0.25
Change in occupational diversity	1.02	0.75	0.46
Education	-0.93	-2.25	0.02 *
Leader	1.15	0.42	0.67
Household size	1.32	0.62	0.54
Relational wellbeing			
Social connectivity			
Time period	0.53	4.01	<0.01 *
Age	-0.00	-0.67	0.50
Occupational diversity	-0.13	-1.11	0.27
Change in occupational diversity	-0.10	-1.10	0.27
Education	0.01	0.34	0.74
Leader	0.07	0.49	0.62
Household size	0.09	-0.75	0.46
Frequency of social interactions			
Time period	0.22	0.56	0.59
Age	-0.26	-1.16	0.25
Occupational diversity	-0.35	-1.04	0.30
Change in occupational diversity	-0.41	-1.66	0.10
Education	0.02	0.35	0.73
Leader	0.87	1.99	0.05*
Household size	0.41	1.10	0.27
Trust in peers			
Time period	0.29	4.52	<0.01 *
Age	0.03	0.72	0.47
Occupational diversity	0.04	0.70	0.48
Change in occupational diversity	-0.02	-0.50	0.62
Education	0.01	1.01	0.28
Leader	0.02	0.26	0.80
Household size	-0.02	-0.32	0.75
Trust in institutions			
Time period	0.38	6.65	<0.01 *
Age	0.03	1.04	0.30
Occupational diversity	0.07	1.40	0.16

Change in occupational diversity	0.01	0.34	0.73
Education	-0.00	-0.37	0.71
Leader	0.03	0.50	0.62
Household size	0.04	0.76	0.45
Subjective Wellbeing			
Livelihood satisfaction			
Time period	0.23	3.88	0.76
Age	0.00	1.32	0.18
Occupational diversity	0.01	0.11	0.91
Change in occupational diversity	0.02	0.42	0.68
Education	-0.01	-1.01	0.31
Leader	0.06	0.79	0.43
Household size	-0.01	-0.11	0.91
Social cohesion			
Time period	0.23	3.88	<0.01 *
Age	0.00	1.10	0.27
Occupational diversity	0.00	0.16	0.87
Change in occupational diversity	-0.02	-0.52	0.61
Education	-0.01	-0.73	0.46
Leader	0.23	3.88	<0.01 *
Household size	0.00	1.10	0.27
Work enjoyment			
Time period	0.38	-5.51	<0.01 *
Age	0.00	0.11	0.91
Occupational diversity	0.02	0.35	0.72
Change in occupational diversity	0.03	0.67	0.50
Education	-0.00	-0.29	0.77
Leader	0.01	1.40	0.16
Household size	0.00	0.04	0.97