Technical report of JSPS KAKENHI project 18H03427

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Authored by:
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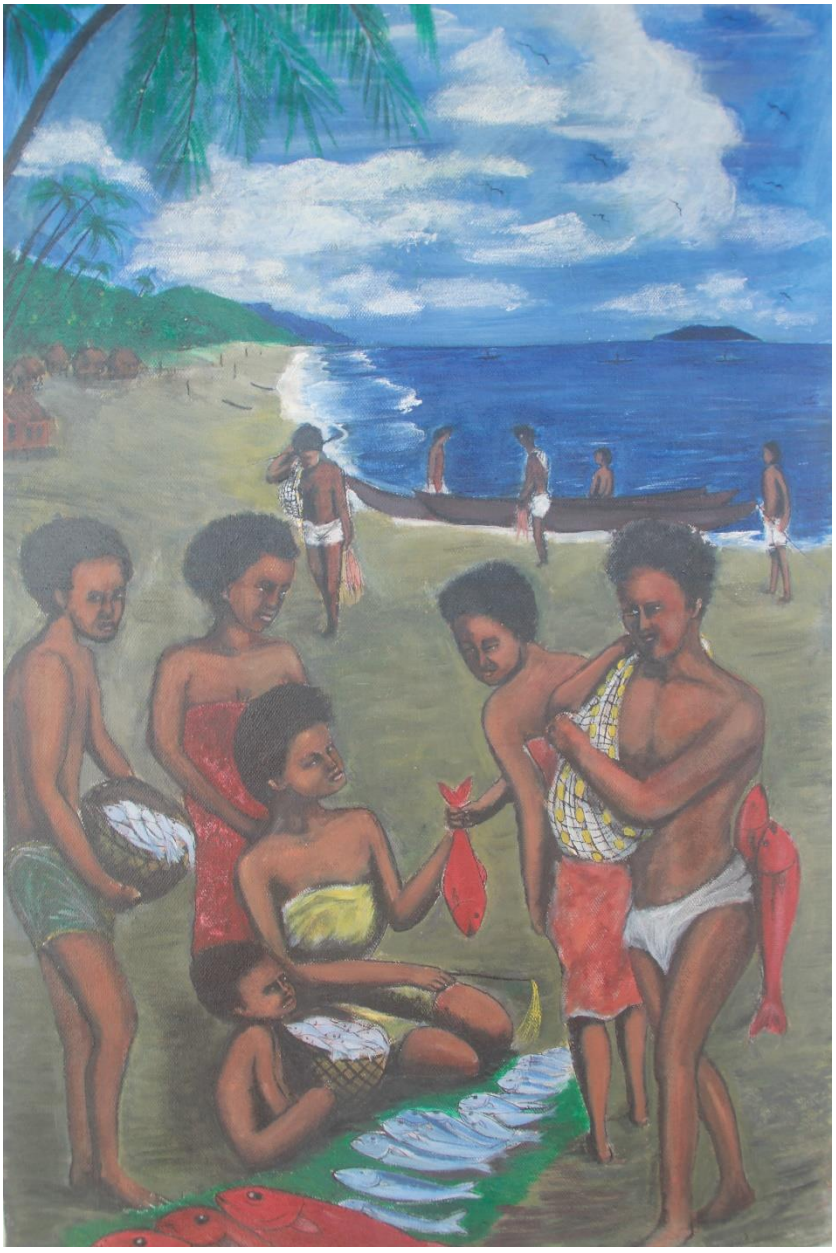
November 2021



Fising leaf blong vilage pipol

Painting: Iduramoa Junior. Fishing life of village people,
West Guadalcanal artisanal fishing communities.

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Suggested citation:
Otumawu-Apreku K., Higashida K., Yamazaki S., & Kiyama S. 2021. *Artisanal fisheries in the Solomon Islands: The Wantok paradigm in West Guadalcanal*. Technical Report of the 2018-2020 JSPS KAKENHI Project 18H03427.

Available from:
https://doi.org/10.14989/tr.afsi.2021.1

Conducted by:

Solomon Islands National University

Supported by:

Funding:

This project was supported by JSPS KAKENHI Grant Number 18H03427.

Ethical Statement:

This project involving human participants was reviewed and approved by the Ethics Board of the Graduate School of Agriculture, Kyoto University (R1-3). The project was permitted by the Ministry of Education and Human Resource Development, Solomon Islands, in accordance with the Research Act 1982 (Reference number: 14/19). The participants provided their verbal informed consent to participate in this study.

Foreword

The Solomon Islands rural communities' high dependence on fish for food and cash income calls for solutions to address inherent challenges confronting management of the country's fisheries resources. Addressing the fundamental difficulties that inhibit and threaten the sustainability of vital livelihood resources of communities requires a better understanding of the cultural, socio-economic and behavioural characteristics of these communities, the nature of extraction of the resources and the direction of possible changes that can be made to achieve desirable outcomes. Recent evidence of overexploitation and vulnerability of the resources, particularly reef fish stocks, in the Solomon Islands, and in the Pacific Island Countries and Territories in general, points to falling stock levels. The resultant risk to food security and livelihoods dictates that serious attention should be paid to finding management solutions that have the potential to address the overexploitation and vulnerability challenges of coastal fisheries resources, a resource base that is fundamental to the very existence of human life in the nation's rural communities. The Solomon Islands Government (SIG) has clearly emphasised that protecting the resource habitat and actively promoting fishing practices that safeguard the sustainability of food security, increase food production and guarantee fisheries' contribution to national economic growth and citizens' well-being for current and future generations remain important national objectives. This report clearly details that, in line with the country's objectives, identifying desirable management measures that can possibly address challenges confronting coastal fisheries will, among others, provide desired benefits. Such benefits have been identified and include the following: provision of the means to prevent conflict among users of the resources and between users and resource owners; promotion of fishing at both economically and biologically sustainable levels; conservation of the resources for future generations; provision of the means for better

resource utilisation; and ensuring a more socially desirable distribution of economic benefits from the resources.

To contribute to the search for management solutions that can conceivably help address problems in fisheries and promote sustainable use of resources, this study, covering eight small-scale fishing communities in West Guadalcanal, was conducted to analyse fisher cooperative networks in terms of resource exploitation and management, showing the general characteristics of the fishers and capturing the current picture of their lives. Specifically, the study examined fisher networks' fishing activities, including equipment use, catch sharing and information exchange in the management of the resources. Using network degree centralities, the study evaluated the systemic-wide cooperative tradition in the communities, the wantok system, to determine its role in fisher networks in the communities. Employing the indegree, outdegree and betweenness centrality technique, we examined the interaction, influence and dependency at the intra- and inter-community levels in respect to resource exploitation and management. We established that, although wantokism may not entirely explain fisher networks' role in resource utilisation in the communities, it is pervasive in fishing equipment use, catch sharing, failure to report rule-breaking (for fear of wantok sanctions) and conflict resolution in resource exploitation as well as information sharing about environmental changes in fishing grounds and education about new fishing rules in the communities. We further identify that the wantok system, though it provides social protection and support for local people, is not without negative outcomes. The system can either contribute to the establishment of effective voluntary resource management schemes or accelerate the pace of resource depletion by promoting myopic cooperation for resource harvesting, which leads to resource exhaustion in the medium- to long-term. We also establish that the role of community leaders, particularly chiefs, in resource management in the communities remains vital.

We conclude this report by discussing promising avenues for future research that will

help improve our understanding of community-based resource management systems that are likely to promote sustainable use of coastal resources as well as the development of local communities in the Solomon Islands. Our aim is to make clear what further actions must be taken to find solutions for sustainable development.

Acknowledgements

We thank the Hulavu, Kobiloko, Kotsatsai, Lambi, Mangakiki, Tasiloki, Verahue Anglican and Verahue Catholic communities and fishers who provided great help during the survey for this study in 2019. Our sincere appreciation also goes to Bernadeth Angosade Raymond, who dedicated her time to coordinating the survey activities in all the communities and gave us the necessary support that contributed significantly to the success of this study. Bernadeth did all this selflessly, always with warm smiles and kindness. The success of the survey also largely depended on the support of the community leaders: chiefs, catechists, youth leaders and other volunteers who showed great interest in the data collection process. The hospitality and kindness of these individuals, who welcomed us into their communities and helped in many ways to carry out the survey, was greatly appreciated. We thank the Solomon Islands Development Trust (SIDT) for giving us the opportunity to connect and interact with the communities and their leaders during our pre-survey meeting and interview in 2018. This initial interaction paved the way for the success of the survey. We are grateful to the following individuals for their great advice: Shigeru Toyama, Junji Yamazaki and Keigo Iwayanagi (of the Embassy of Japan in Solomon Islands); Shitau Miura, of Japan International Cooperation Agency (JICA); Azusa Kubota (UNDP Country Manager and UN Joint Presence Office Manager); Shannon Seeto (WWF Country Manager, Solomon Islands office); Delvene Boso (World Fish Country Director); and Rueben Sulu, of the Ministry of Fisheries and Marine Resources (MFMR).

We are thankful to the students and staff of the Department of Fisheries Studies (DFS), of the Solomon Islands National University (SINU), for their participation and great support in diverse ways in ensuring the success of this study. In particular, our gratitude goes to Beth Marisha Mekimo, Clarence Cheon, Henry Bala, Esther Pukariamae Keuwewe, Rita

Taro, Alfred Kejoa, Miriam Arzienta Sulu, Saresian Ivupitu, Bezo Vegah, John Lidley Donne, Daniel Pita Tutu and Prince Niubo Adino, who conducted the interviews with community fishers as enumerators, sometimes working late into the night. We are equally grateful to Jim Damusaru, Collin Gereniu and Fiona Meke (DFS academic staff), who served as survey team leaders and were responsible for ensuring accuracy and efficiency in the data collection process. We thank our drivers, George Siota and Clifford Bako, for transporting the survey team safely to and from the communities and delivering supplies to the team on a daily basis. Our appreciation also goes to Louisa Andy, who oversaw the provision of meals, accommodations, cleaning and other daily chores that kept the team healthy for the six days spent in the remote communities. We are thankful to Hyeongwoo Je, a Korea International Cooperation Agency (KOICA) volunteer deployed to DFS, who helped conduct sea water quality tests in the Verahue communities during the 2018 pre-survey visit. The test was very helpful in the design of the 2019 survey. The all out support and cooperation of SINU contributed significantly to the success of this study. We are extremely grateful for the support and cooperation received from Mr. Solomon Pita (Dean of the Faculty of Science and Technology) and Capt. Starling Daefa (Director of the School of Technology & Maritime Studies). Last, but not least, we are grateful to Iduramoa Junior, a DFS student, who kindly helped to design the cover page of this report.

Contents

1. Introduction

1.1 General overview: fisheries and the Solomon Islands

Globally, it is estimated that about a billion people depend on seafood, with 25% of the world's animal protein obtained from fish and higher percentages occurring in developing nations. At the same time, subsistence and small-scale commercial artisanal coastal fisheries employ from 10 to 20 times as many people as commercial fisheries (Food and Agriculture Organization [FAO], 2016; Gutierrez, 2011; McWhinnie & Apreku, 2013). Fish intake is estimated to provide 50% to 90% of animal protein intake in rural areas and 40% to 80% in urban communities, with most fish consumed by rural communities coming from subsistence fisheries (Aswani & Hamilton, 2003; Bell et al., 2009; Gillet et al., 2015). In the Pacific region, disparities in fish consumption among urban, coastal and inland communities stress the need to ensure the availability of fish, particularly for coastal societies for whom fish is a basic food requirement (Bell et al., 2009). The high dependency of Pacific Island countries and territories' (PICTs) rural communities on fish protein, coupled with the communities' projected inability to meet required per capita fish consumption by 2030, underscores the need to identify issues concerning management of fish resources, both at local and national levels. Furthermore, the second international conference on nutrition (ICN2) emphasised that, with the high dependency of coastal communities on fish and seafood for nutrition and health needs, greater responsibility lies on how the resources are managed to ensure sustainability for all citizens across time (FAO, 2016). Despite the need for management solutions to the falling stock levels and the resulting risk to livelihoods, the management of coastal fisheries in PICTs has received little attention, even in the face of the recent evidence of vulnerability and overexploitation of reef resources (Bell et al., 2009).

The Solomon Islands' fisheries sector is a major contributor to the state's gross domestic

product (GDP), while annually providing food and livelihood worth millions of dollars to coastal communities (Albert et al., 2015; Bell et al., 2015; Bènè, 2006). Small-scale fishing is an important and major economic endeavour of the state's coastal communities, involving nearly 84% of the nation's population (Solomon Islands Government [SIG], 2010, 2011). Coastal subsistence fisheries output (about USD 10.98 million) was more than three times that of coastal commercial fishery, and accounted for nearly 5.5% of all marine fisheries production in 2007 (Gillet, 2009). The historic dependence of the Solomon Islands on marine resources as a reliable source of protein and cash income (Schwartz, 2011) makes the recent evidence of stock depletion a serious concern for current and future generations (Brewer et al., 2009; Green et al., 2006; Gutiérréz, 2011; Hanich, 2018; Schwartz, 2011; Sulu et al., 2015). According to Brewer (2011) the lack of fisheries management regimes in rural and local areas has not helped the situation.

1.1.1 Vulnerability of rural coastal communities

Among members of the PICTs, the Solomon Islands is considered a highly vulnerable nation, with high dependency on fisheries, limited access to other options of protein, high population growth and low GDP (Albert et al., 2015; Bell et al., 2015). With increasing population size and rising demand for natural resources, coastal fisheries in the Solomon Islands are generally fully exploited and, in some cases, considered a serious factor contributing to poverty and food insecurity in rural communities (Brewer, 2011; Melanesian Spearhead Group [MSG], 2015; SIG, 2010). Albert et al. (2015) also emphasised that a decline in fish catch will adversely impact the health of coastal people, given their high dependency on fish as a major source of protein.

Overexploitation of coastal fisheries in the Pacific region, due to population pressures and undesirable human activities exacerbated by climate change, is considered serious (Cinner & McClanahan, 2006; Dalzell et al., 1996). Schwarz et al. (2007), for example, cited

destructive human practices such as fish poisoning and use of explosives, marine pollution and sedimentation through logging, free uncontrolled access to reefs and the dwindling authority of traditional local chiefs as practices exerting undue pressure on the resource. Assessment of coral reef fish and some commercially important vertebrates in the Solomon Islands has indicated that stocks are already overexploited across a number of the provinces, stressing the need to establish management systems that can ensure long-term sustainability of the resource (Green et al., 2006). Brewer et al. (2013) also underscored the importance of coral reef fisheries to the livelihoods of coastal communities and highlighted the detrimental effects of widespread degradation and unsustainable fishing, leading to severe stock depletion. Exerting pressure on fish biomass in coastal areas, due to population and economic pressures, overexploitation is expected to continue to contribute to stock declines in the Solomon Islands (Brewer et al., 2009; Hanich, 2018; Gutierrez, 2011; Schwartz, 2011; SIG, 2011, 2017). Therefore, understanding human behaviour in resource management in coastal artisanal fisheries and its contribution to overexploitation remains a vital scientific process, demanding further examination to fully establish its influence in the dynamics of the resource (Grant & Berkes, 2007; Johannes, 2002; Turner et al., 2014). In the case of the Solomon Islands, this has received minimal attention.

In addition to pre-existing and emerging anthropogenic factors, challenges encountered in the Solomon Islands include natural disasters and other climate-related issues, such as cyclones, sea-level rise, tsunamis and earthquakes (Schwartz et al., 2007). This calls for effective community management to ensure sustainable levels of the stock within the context of climate change (Hanich et al., 2018). The contention is that even though communities acknowledge the falling levels of stock in the waters around them and are conscious of the impact on their social and economic livelihoods, they do not seem to know how to address the stock depletion challenge (Green et al., 2006). This further stresses the need for effective management measures to prevent stock declines and stem the resulting loss of rural livelihood.

Additionally, limited studies in coastal fisheries in the country have made a comprehensive investigation of the subject imperative (Albert et al., 2015; Gillet & Cartwright, 2010; Secretariat of the Pacific Community [SPC], 2013).

1.1.2 National fisheries management objectives

The Solomon Islands' Fisheries Management Act (No. 2, 2015) (SIG, 2015a) of the Environmental Statute aims at a management system that promotes long-term conservation and sustainable management of the nation's fisheries resources. This objective demands that continental and marine small-scale and artisanal fishing activities, as well as offshore commercial fishing, are conducted in a manner that preserves fish habitat, protects the coastal ecosystem, prevents pollution of the coastal environment, including mangroves and swamps, and ensures maximum socio-economic benefit to the people for present and future generations (Price et al., 2015). It has been observed that the use of destructive methods, often considered by local communities as environmentally benign, is transitioning to counterproductive enterprises with significant ecological threats (Sabetian & Foale, 2006). Therefore, protecting the resource habitat and actively promoting fishing practices that seek to ensure sustainability of food security, increase food production and guarantee fisheries contribution to the national economic growth and citizens' well-being for current and future generations remain important objectives of the government of the Solomon Islands (SIG, 2010).

The Solomon Islands' national food security policy (SIG, 2010) outlines the promotion of sustainable fisheries production as a core component of the state's plans to ensure food security and economic development. This objective requires efficient management of the sub-sector in order to safeguard the sustainability of the resource and ensure food security at all times. Community participation in coastal fisheries management is widely perceived as a mechanism that promotes effective resource management at the rural level (Costanza et al.,

1998; Dietz et al., 2003; Ostrom, 1990; Ostrom et al., 2002; Pomeroy, 1995; Yew, 1996). In the case of the Solomon Islands, it is anticipated that seeking community involvement and incorporating traditional knowledge and practices into daily management of the resource will guarantee effective management (SIG, 2015a).

1.1.3 Challenges

Management issues in fisheries have been found to be diverse, competing and often conflicting, with the purpose of management considered as forms of control in a manner that ensures a fishery will continue to yield benefits to the community in accordance with overall national goals (Munro & Fakahau, 1993). Specifically, and from a socio-economic perspective, coastal small-scale fisheries are confronted with issues of cost, including gear, maintenance, fuel, labour, fluctuating market prices and marketing challenges, issues of catch-sharing and competing employment opportunities for the youth. According to Munro and Fakahau (1993), these issues affect fishing communities' response to changes in the sector and, therefore, underline that management options need to be based on a complex matrix of biological, social, economic and political considerations. As a means to address this situation, Brewer et al. (2008) proposed a multi-strategy approach to coastal resource management, indicating that conservation management efforts, among others, should involve cross-cutting collaboration. Emphasising the desirability of management regimes, Munro and Fakahau (1993) provided five important benefits:

1. Provision of means to prevent conflict among users of the resource and between users and resource owners;
2. Promotion of fishing at both economically and biologically sustainable levels;
3. Conservation of fisheries resources for future generations;
4. Provision of the means for better resource utilisation; and
5. Ensuring a more socially desirable distribution of economic benefits from the

resource.

A critical question that continues to dominate the sustainability discourse is the extent and the conditions under which coastal marine resources can continue to fulfil their food security function and, at the same time, be exploited in a manner that does not threaten their limited ecological capacity (Aswani et al., 2017; FAO, 2016; Hardy et al., 2013). Research has found that the Solomon Islands' marine system's natural productivity limits have already been stretched beyond their resilience boundaries for molluscs and pearl oysters in previous centuries (Dalzell et al., 1996; Hawes et al., 2011). Evidence has shown that there is little indication to suggest that the long-term sustainability of the Solomon Islands' fisheries is secured, and that the first fisheries crisis may happen around 2050 or 2060, in the best-case scenario (Hardy et al., 2013). This alarming picture is, unfortunately, in the not-too-distant future in terms of developing adequate policy and community responses. It is believed that the solutions may be found in community-based coastal resource management, which, besides other factors, requires cultural and behavioural changes among the fishing communities (Andrew et al., 2007; Aswani et al., 2017; Aswani & Hamilton, 2003; Govan, 2009; Hardy et al., 2013). As Hilborn (2007) succinctly put it, understanding the motivation and behaviour of fishermen is a key ingredient to successful fisheries management. This is in support of the Worm et al.'s (2006) reversibility argument. Until now, however, not much research has been conducted to investigate the cultural and behavioural characteristics of these communities and the directions of possible changes that can be made to achieve desirable management outcomes.

1.1.4 Leadership and social capital in community-based resource management

According to Pretty et al. (2003), contrary to the 'wilderness myth' (Nash, 1973), even 'empty' and idle natural environments (pristine resources for that matter) require protection

from harmful human practices. This argument reinforces the need to identify management systems that can effectively protect marine resources in order to safeguard life at all times. The literature presents sufficient evidence to support the effectiveness of community participation in sustainable management of natural resources (Aswani & Furusawa, 2007; Dryzek, 2000; Pretty et al., 2003; Uphoff, 2002). Pretty et al. (2003), for example, identified the main tenets of social capital believed to foster effective community-based resource management to include trust, reciprocity and exchanges, common rules, norms and sanctions, and connectedness. The idea that social capital, borne out of social bonds (connectedness) and norms, is critical for sustainable management of natural resources, including fisheries, is well documented in the literature (see, for example, Ostrom et al., 2002; Pretty et al., 2003; Singleton & Taylor, 1992).

Social capital has been defined as features of social organisation, including networks, norms and trust, which facilitate coordination and cooperation for mutual benefits (Chan et al., 2006; de Renzio, 2000; Jenson, 2010; Putnam, 1993). Contributing to the community-based fisheries management (CBFM) success debate, Leopold et al. (2013) pointed out that most CBFM systems are short-lived, often dependant on the trajectory or lifespan of external government or non-government agency support. This supports the argument that the apparent dynamism of community-based management, in the early 2000s, was partly exogenous and attributable to global conservation and sustainable goals (Hviding, 2003; White, 2007). Leopold et al. (2013) supported the hypothesis that strategies put in place by external interventions often differed among stakeholders, particularly traditional leaders and resource users. It has also been argued that the role of the state and its regulatory organs cannot be dispensed with, emphasising that community-based management systems require state structures to ensure their success (Hviding, 2003). For example, state support for communities through education, insulation from external pressures and constant state-community dialogue are considered vital and likely to strengthen community social

capital and reinforce resource management systems (Pretty et al., 2003).

The literature has suggested that leadership and social capital are crucial and beneficial for collective action and the maintenance of environmental conservation and management at the community level (for example, see Coleman, 1990; Fukuyama, 1995; Ostrom, 2005; Pretty & Smith, 2004). Examining the possible forces that may account for community-based management success, Pretty et al. (2003) contended that, in the presence of dense community networks and frequent and effective communication, including lack of easy exit options for group members, social capital is likely to promote functional management systems in rural communities. Bodin and Crona (2008), however, pointed out that even in the presence of high levels of strong leadership and social capital, exploiting their positive influence in resource management may not always yield the desired outcome. For example, it was observed that the 'closeness' of social networks within a community may result in unwillingness to report rule-breaking, as well as lack of combined initiative to combat overexploitation (Bodin & Crona, 2008). Opinions on the success of community-based resource management remain mixed. Although some have attributed the ability and effectiveness of a community-based management system to prevent the tragedy of the commons, to leadership and social capital (Costanza et al., 1998; Dietz et al., 2003; Ostrom, 1990), others have argued that success is primarily attributable to strong leadership (Gutierrez, 2011), combined with clear incentives through catch shares and conservation benefits (Olsson et al., 2004; Pretty, 2003; Sigmund et al., 2010). Leopold et al. (2013) have also argued that CBFM is highly sensitive to the temporal change in a number of factors, including multiple and conflicting management outcomes; lack of social cohesion, leadership and financial resources; and dynamics of socio-political relationships, as well as environmental factors. Any treatment of these, it is further contended, should be regarded as a location-specific adaptive process. The emphasis here is that the investigation into fisher and fishing communities' behaviour in the quest for management solutions should be multi-faceted and ongoing, with a critical focus on specific

community synergies, given that human behaviour is dynamic and ever-evolving.

The success of CBFM has also been attributed to small-scale fisher groups' ability to develop their own norms and rules to manage common-pool resources (Earnst et al., 2013). Such groups are contended to rely on local knowledge of the dynamics of the resource and their autonomy to design mechanisms to address the commons dilemma (Basurto, 2005; Basurto et al., 2013; Cinner et al., 2012; Cox et al., 2010; Gelcich et al., 2005, 2006; McClarahan et al., 2006). The belief is that marine customary tenure provides coastal communities with forms of tenure over reefs and habitats, which can provide a critical foundation for communities to determine and enforce management measures and avoid the commons tragedy (Hanich et al., 2018). Empirical evidence suggests that a potential approach to understanding the tenets of resource management and addressing the challenges is the interaction of leadership with specific aspects of social capital in the research design (Crona & Bodin, 2006).

1.1.5 Social cohesion

It has been argued that social cohesion and social capital are different concepts (Chan et al., 2006; Jenson, 2010; Putnam, 1993). According to Friedkin (2004), the subject of social cohesion, together with its antecedents and consequences, has become increasingly confused as the plethora of definitions increases. Among the numerous definitions, Jenson (1998) defined social cohesion as a process of developing shared values, shared challenges and equal opportunities based on a sense of trust, hope and reciprocity. Chan et al. (2006), on the other hand, defined social cohesion as a state of affairs concerning how well people in a society [group] 'cohere' or 'stick' together. They claimed that social cohesion is also seen as a reflection of individuals' state of mind, which is manifested in their behaviour and requires participation, cooperation and mutual help. Friedkin (2004) identified two main domains of the subject: 1) individual membership attitudes and behaviour; and 2) group-level

membership conditions, indicating that groups may be cohesive in different ways. Following Friedkin, Oxoby (2009) argued that social cohesion is a condition of a group that affects the [group's] decision environment.

The literature indicates that social cohesion can be used as a vital tool to strengthen management structures (see, for example, Turok, 2006), which, in the case of fisheries, can benefit current and future coastal communities. It is also believed that elements of society contribute to the collective endeavour to limit selfish practices and improve the durability of economic relations through a shared sense of purpose, mutual support, agreed norms and rules of behaviour (Turok, 2006).

In this research, we followed Friedkin (2004), Oxoby (2009) (and the literature cited in their work), and adopted the classical definition of social cohesion as the causal system that determines individual membership attitudes and behaviour as well as group conditions. We would also argue that even when social cohesion is defined as a process [not a condition or state], the underlying tenet remains positive behaviour and attitude that are expected to yield positive outcomes to benefit a group or individuals in the group. If individuals in a group are bonded by trust, hope and reciprocity, then it can be presumed that they are trusting in a collective goal that, all things being equal, will yield some future returns – the reciprocity of tomorrow's [positive] outcome – for today's sound collective decision.

1.2 The Solomon Islands

1.2.1 Geography and climate

The Solomon Islands, a tropical country, is located between latitudes 5°S and 12°S, and longitudes 152°E and 170°E, lying north of Australia and east of Papua New Guinea, in the South West Pacific region (**Fig. 1**). The country comprises over 994 islands, scattered around a double chain archipelago between Papua New Guinea and Vanuatu, consisting of a

combination of mountains and low-lying coral atolls. Falling within a tuna-rich and potentially mineral-rich maritime Economic Exclusive Zone (EEZ) of 1.34 million km^2, the country has a total landmass of 28,369 sq. km. and a 10,000 km. stretch of coastline (SIG, 2017). The EEZ borders with Australia and New Caledonia in the south, and with the open seas in the north. The six main islands, Choiseul, New Georgia, Santa Isabel, Malaita, Guadalcanal and Makira, are characterised by rugged and mountainous landscapes of volcanic origin and forested with many coastal areas surrounded by fringes of reefs and lagoons (SIG, 2011). The remaining hundreds of smaller volcanic islands and low-lying coral atolls are scattered among and beyond the bigger islands. It is reported that the country's location within the earthquake belt or 'Ring of Fire' makes earthquakes a normal occurrence and renders the country extremely vulnerable to the effects and impacts of earthquakes. Geographically, the islands are categorised into three major 'geological provinces', which comprise: 1) the Pacific Geological Province, which includes Malaita, Ulawa and the north-eastern part of Santa Isabel Island; 2) the Central Geological Province, including Makira, Guadalcanal and the Florida Islands, the southwestern part of Isabel and Choiseul; and 3) the Volcanic Geological Province of New Georgia, Russell Islands, Shortland Islands and north-western tip of Guadalcanal and Savo (SIG, 2017).

Though there are currently no data on specific climate change impacts on the Solomon Islands fisheries (Phillips & Pérez-Ramírez, 2018), Johnson et al. (2018) maintained that global warming is projected to have a profound effect on the physical environment in the tropical Pacific Ocean, in which the Solomon Islands' waters are located. Temperature rises, due to climate change, are expected to negatively affect the food web supporting tuna in the Pacific region, as well as the future distribution and abundance of the fishery. Citing the literature, Johnson et al. (2018) contended that the four main species of tuna in the region are expected to respond directly to changes in water temperature, O_2, ocean current, ocean acidification and the location of the warm pool, and this will lead directly to changes in the

food web structure. Coastal fisheries, also according to Johnson et al., are not immune to the direct effects of these changes, particularly on habitats such as coral reefs, mangrove forests, seagrass meadows and intertidal sand and mud flats, and they argued that these form a mosaic of habitats that support important coastal fisheries. For example, they posited that sea surface temperatures (SSTs), according to projections, are expected to cause mass coral bleaching at least twice as frequently by 2050 and every one to two years by 2100, while at the same time reducing live coral cover by 50% by 2050, in a best-case management scenario, and by 75% under a poor management scenario, with expected reduction in coastal fisheries production by up to 20% by 2050, under a high emission scenario. Climate change impact on coastal and ocean ecosystems in PICTs, according to Johnson et al., has been recognised as a challenge to the region's dependence on fish for state revenue as well as food and household income.

The above noted literature is supported by the SIG (2017), which has emphasised that an earlier intergovernmental panel on climate change (IPCC) assessment report indicated, with high certainty, that fisheries and other marine resources in the country are likely to be heavily affected by climate change. The expected impact, it is claimed, will result from increased SST, leading to higher risks of coral bleaching and the alteration of calcification chemistry in coralline and other calciferous exoskeleton biota, caused by CO_2-driven ocean acidification, alteration of larval dispersal pattern, impact on recruitment processes, and species reproduction as well as fish survival and growth.

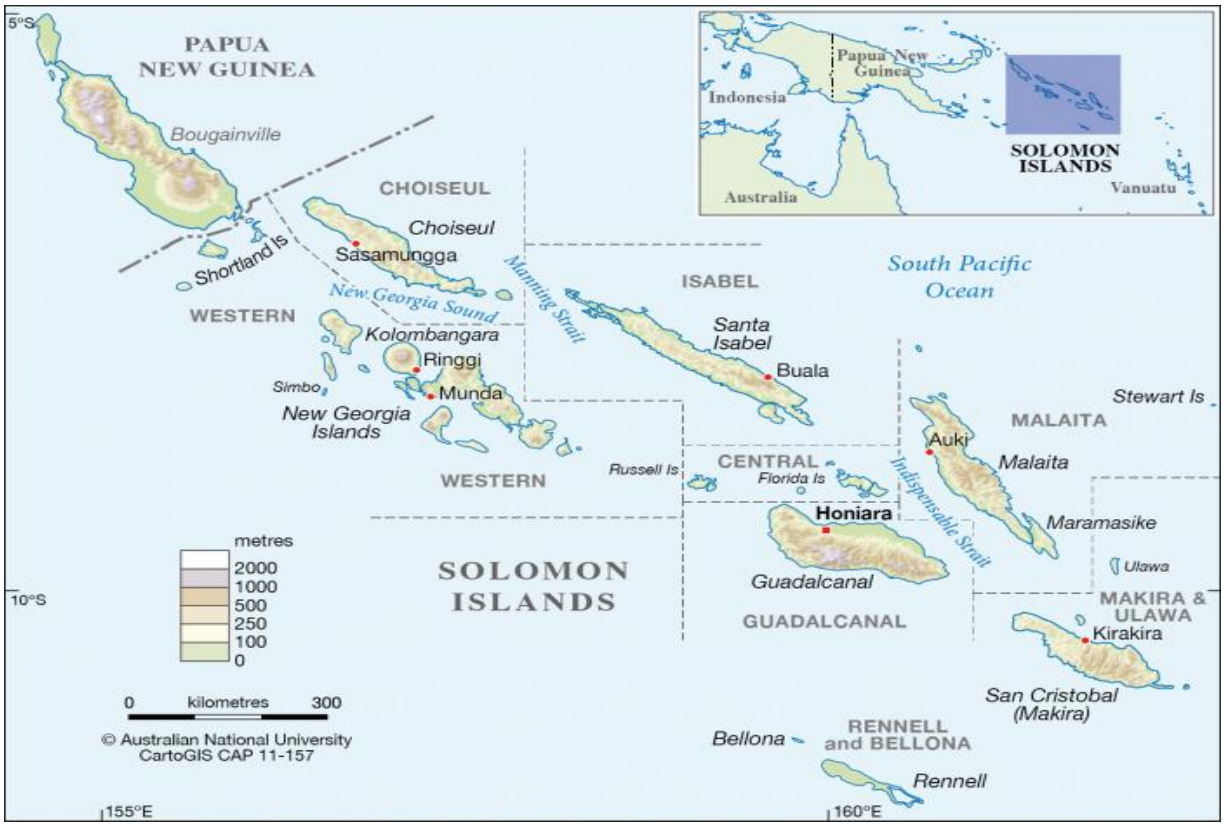


Figure 1. Solomon Islands provinces and capitals.

Source: The Australian National University, CartoGIS Services Maps Online, College of Asia and the Pacific.

1.2.2 Political setup and population

The Solomon Islands gained independence from the British in 1978 and is currently a member of the British Commonwealth of Nations (Green et al., 2006). Honiara, the state capital, is the seat of the national government. The nation is divided into nine administrative provinces: Guadalcanal; Malaita; Western; Choiseul; Isabel; Makira-Ulawa; Central; Temotu; and Rennell and Bellona. Each of these provinces is administered by provincial governments with premiers as heads. The national administration is a parliamentary system with 50 elected members from the nine provinces. At the local village and community level, chiefs, church and other elected leaders play significant leadership roles, including settlement of disputes among community members and at the household level (Green et al., 2006). Guadalcanal Province is constituted by 21 wards on one main island, with a number of associated small islands, and it is the most populated province in the Solomon Islands after Malaita Province (Govan, 2013).

The provisional count of the 2020 national population census put the country's population at approximately 721,455, with about 124,247 households; putting Guadalcanal, excluding Honiara, at 154,150 (SIG, 2020).[1] The provisional data put male/female populations for the province at 79,093 (51.3%) and 75,057 (48.7%), respectively, with a population growth rate of 3.7%, compared with 5.8% for Honiara and 2.7% for the entire nation. Malaita is reported as the most populated among the nine provinces, with a current population of 173,347 and a growth rate of 1.3%. Rennell and Bellona Province is the least populated, with an estimated population of about 4,091, growing at a rate of 3.0%. **Figure 2(a)** presents the provincial population distribution for three consecutive census periods, i.e., from 1999 to 2019.

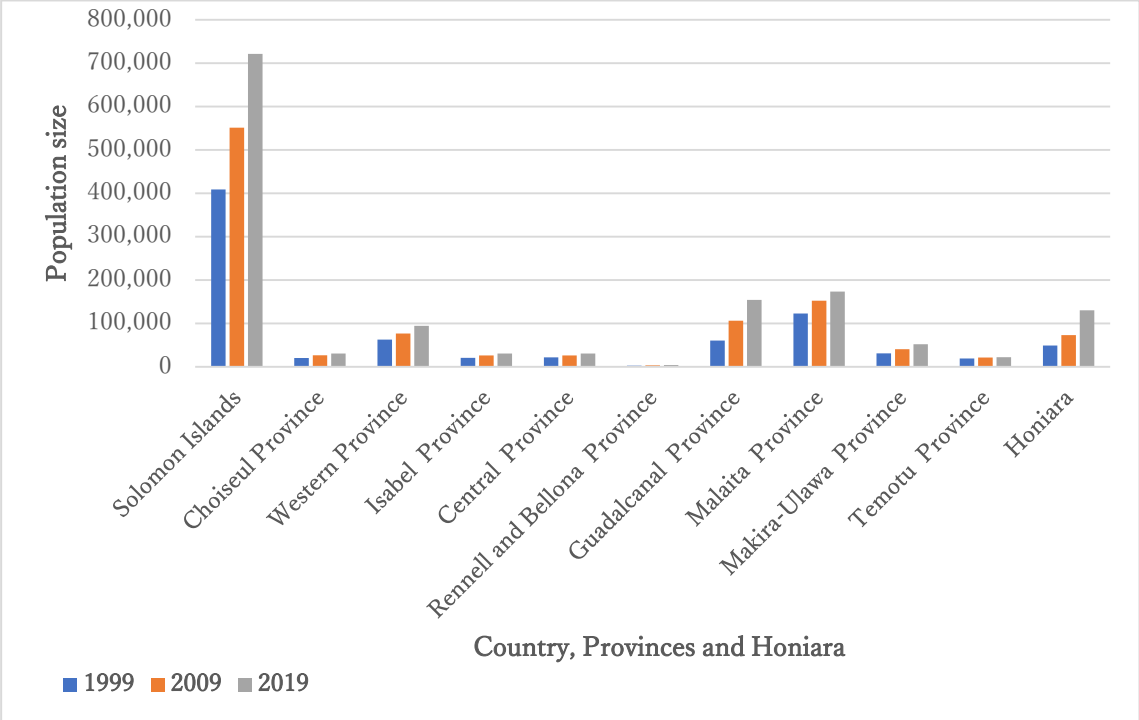


Figure 2(a). **Population distribution of the country and, across provinces and Honiara for three consecutive census periods: 1999 to 2019.**

Data source: 2020 Provisional Count and the 2009 and 2019 National Population and Housing Censuses.

[1] At the time of preparing this report, only a brief summary of the provisional census information was available. Thus, it did not provide detailed information about all the necessary population parameters needed here.

The 2012/2013 projections recorded the population distribution for Guadalcanal as 44% in the 0–14 age group, 15% in the 15–24 group, 38% in the 25–59 group and 3% in the 60 and above group (SIG, 2015b). Current census data put the nation's urban–rural population distribution at 25.6% and 74.4%, respectively. **Figure 2(b)** and **(c)** present the absolute urban–rural population distribution and percentage changes in the 1999, 2009 and 2020 population censuses. Honiara remains the largest recipient of migrant influx from the other islands and provinces.

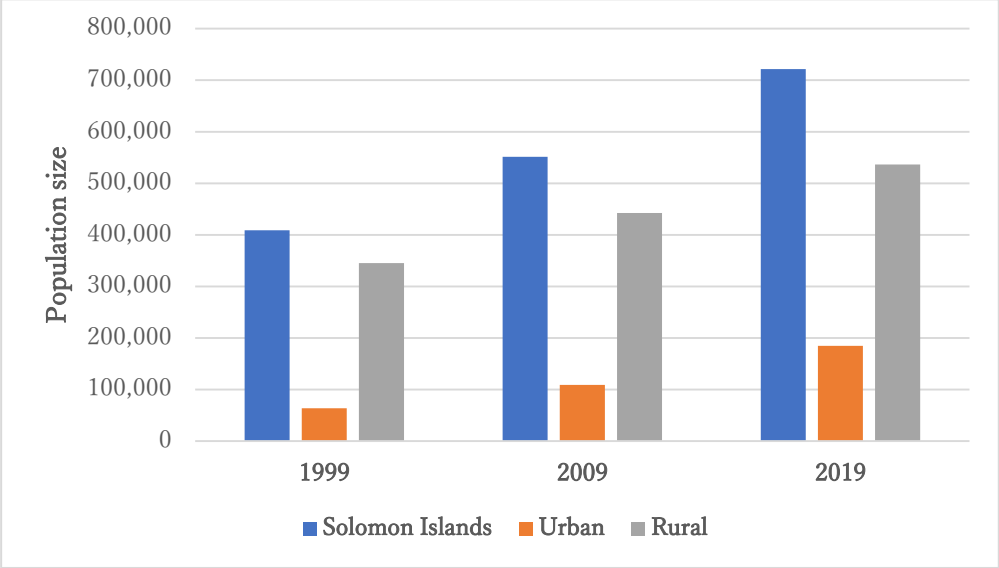


Figure 2(b). Urban–rural population distribution in 1999, 2009 and 2019 population censuses.

Data source: 2020 Provisional Count and 2009 and 2019 National Population and Housing Censuses.

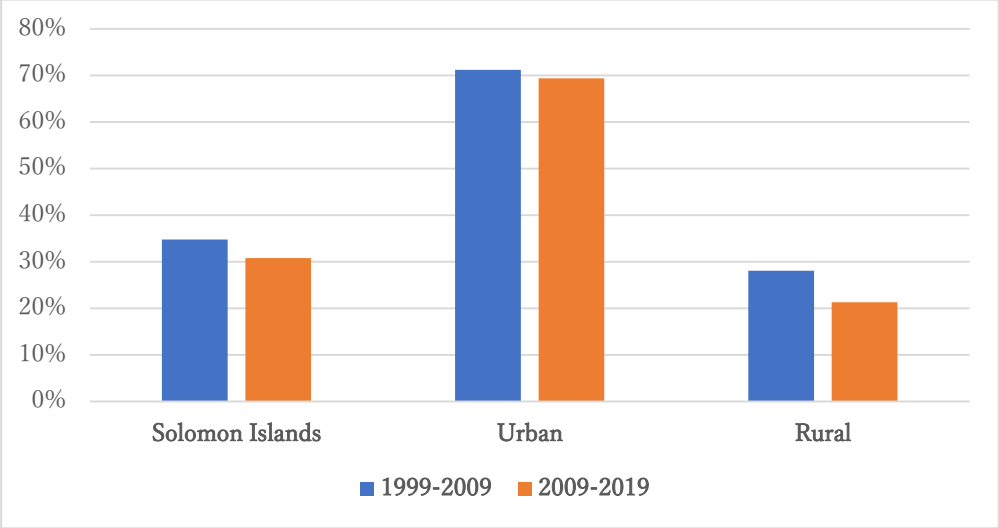


Figure 2(c). Urban–rural population change.

Data source: 2020 Provisional Count and 2009 and 2019 National Population and Housing Censuses.

1.2.3 Economic challenges

Like many developing countries, including its neighbours in the Pacific region, the Solomon Islands is not immune to the severity of a myriad of economic challenges. Major challenges include low per capita GDP ($2,340 in 2019); high annual population growth rate, estimated from 2.6% to 3% (World Population Review, 2020); heavy dependence on subsistence cash crop agriculture; dominant informal sector; overdependence on unprocessed export products, mainly raw timber (constituting about 40% of export earnings); dwindling export earnings primarily due to overexploitation of the major export earner (timber); commodity market fluctuations; poor infrastructure; and low human capital (SIG, 2017). Events of extreme weather, cyclones and earthquakes, as well as other more localised climatic events, such as flash floods and storm surges, inflict significant economic costs, cause severe environmental challenges and drive social tensions, which leave the country in a near constant state of recovery (SIG, 2014b).[2] The extreme climatic events are predicted to continue and become more pronounced as conditions of global climate change exacerbate. The Solomon Islands, as a country, remains extremely vulnerable to significant devastation and hardship, with sporadic setbacks in its development efforts (SIG, 2014b). According to the National REDD+ Readiness Roadmap 2014-2020, the nation's vulnerability and unfortunate circumstances are worsened, in many ways, by poor planning and management of development activities and the inappropriate altering of key ecosystems, in particular watersheds such as river channels, upstream river catchments and coastal mangroves (SIG, 2014b).

[2] Awareness poster in Verahue Anglican village. **Figure 3** shows the communities' awareness of weather and climate-related challenges in the Solomon Islands.

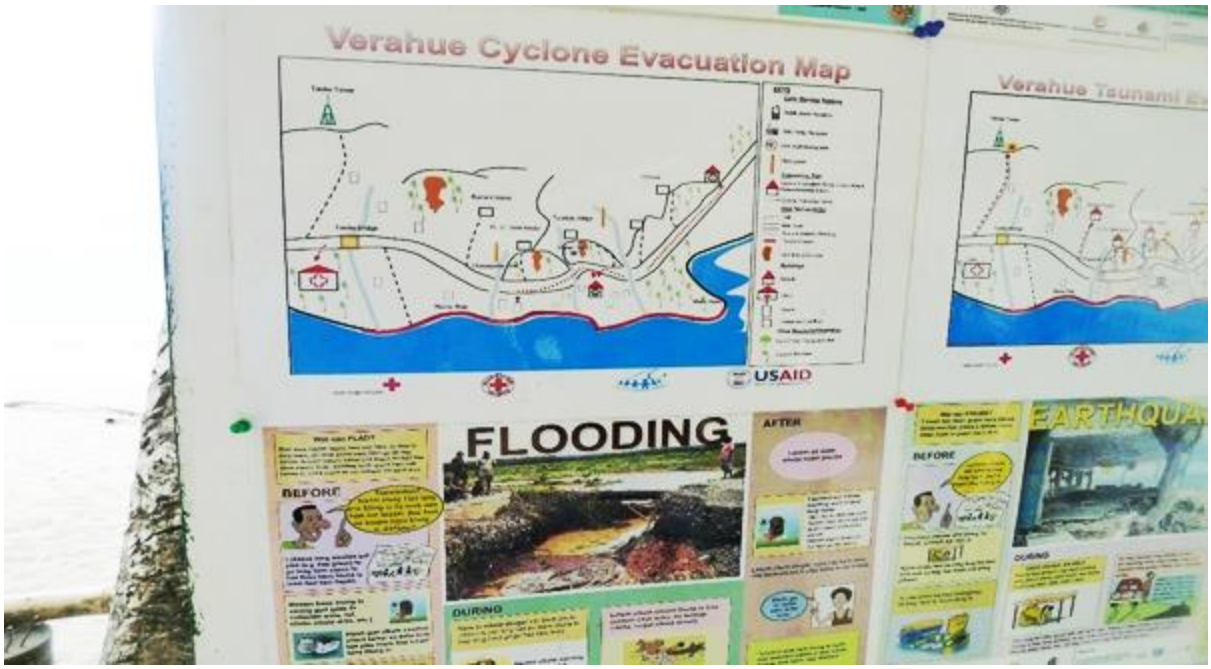


Figure 3. Community disaster awareness poster: Verahue Community Centre, Verahue, West Guadalcanal.

Source: Poster photo taken by KAKEN Project Team, November 2018.

1.2.4 Fisheries sector

The Solomon Islands is endowed with rich inshore and offshore fishery resources. The fisheries sector, a major contributor to the formal economy, generating millions of dollars annually in revenue for the national economy (SIG, 2017), is roughly structured into four fisheries: 1) offshore locally based fishery, 2) offshore foreign-based fishery, 3) coastal commercial fishery and 4) coastal subsistence and artisanal fishery (Gillett, 2011). The offshore local and foreign-based fisheries, located in Honiara, create formal jobs, including tuna cannery processing and transhipment for export, utilise large vessels to catch tuna, produce most of the tuna (96%) by volume and earn the highest percentage (93%) by value in the fisheries sector. Trolling for pelagic fish around fish aggregation devices (FADs) and diving for the sea cucumber (bêche-de-mer) are considered two of the important coastal commercial fisheries (Gillet & Tauati, 2018). Other income sources of the fishery include coral, trochus, shark fin, lobster and aquarium fish, all of which are supplied to the local urban and export markets. Vessels of this fishery fish in lagoons, on reefs and in coastal pelagic

areas by hand-lining, trolling, spearing (i.e. using both spear guns and weighted spears), netting and hand collection. In the fishery, small outboard-powered vessels are mainly used, though some commercial fishing, in particular for bêche-de-mer, is done using non-powered canoes, or without a vessel, i.e. by spear-fishing or trochus collection from shore. In addition, coastal commercial fishery landing sites are located mostly at population centres, near the main urban area of Honiara, and to a much lesser extent, around the towns of Auki (Malaita Province) and Gizo in the west (Gillet & Tauati, 2018).

Coastal subsistence and artisanal fisheries, practised by about 90% of the population living in remote rural areas, are operated in lagoons and on inshore reefs, using non-powered canoes or swimming. The fishing format diversifies by islands and communities. To some extent, however, coastal fishers in some rural areas compensate for falling catches of reef fish from shallow coral reefs by visiting fishing sites further away, diversifying fishing methods and targeting pelagic species through trolling (Gillet & Tauati, 2018). In both the coastal commercial fishery and coastal artisanal fishery, the production volume and the value of production are not formally recorded and therefore rely on guesswork estimation based on a per capita dietary fish volume and the population. The estimates of the catch by the coastal fishery vary widely (Gillet, 2011; Gillet & Tauati, 2018), thus obscuring the facts about the coastal fishery.

For the purpose of this study, it is important to point out that although specific information about West Guadalcanal fisheries, and in particular the study area, is not available, information about fisheries in the PICTs generally applies to the Solomon Islands and West Guadalcanal. The tuna industry in the PICTs, and for that matter the Solomon Islands, is patronised by large vessels owned by distant water fishing nations (DWFNs) as well as domestic and locally based fishing fleets, with much of the catch sold on international markets by multinational fish trading corporations (Johnson et al., 2018). The two main fisheries in the region, known by their fishing methods, are purse-seine and pole-and-line

fisheries and longline fisheries (Bell, 2009; Gillet, 2015). The pole-and-line fishery targets schools of skipjack tuna (*Katsuwonus pelamis*) and juvenile yellowfin tuna (*Thunnus albacares*) and supplies to canneries in the Pacific region, Asia and Europe. The longline fishery, on the other hand, concentrates on mature bigeye and yellowfin tuna for the Japanese sashimi trade and other high-value markets, and albacore for canning in the American Samoa and Fiji markets (Forum Fisheries Agency [FFA], 2018; Gillet, 2015).

The purse-seine fishery in the region's EEZ is managed under the Parties to Nauru Agreement's (PNA) Vessel Day Scheme (VDS), to which the Solomon Islands is a signatory (Gillet, 2009). The scheme, considered one of the most successful and cooperative multinational fisheries management arrangements in the world, controls the number of days vessels are allowed to fish (Aqorau, 2009; Johnson et al., 2018). Management measures in the region's waters are aimed at reducing mortality of bigeye tuna, including banning the setting of purse-seine nets near FADs for several months each year, closing high seas pockets to purse-seine fishing, prohibiting discarding small tuna at sea and imposing annual catch limits for bigeye tuna in the longline fishery (Johnson et al., 2018).

Johnson et al. (2018) categorised coastal fisheries in the region into three broad groups: 1) demersal fish, which are caught mainly for local consumption and also for export through the live reef fish and aquarium trades in limited quantities; 2) inshore pelagic species, mostly dominated by tuna; and 3) invertebrates harvested from shallow subtidal and intertidal habitats for subsistence and export. A variety of demersal inshore pelagic and invertebrate species harvested for subsistence and for sale at local and export markets are considered fairly consistent across the region (Johnson et al., 2018).[3] Also, according to Johnson et al., management of demersal coastal fisheries and their habitats involves a mixture of approaches, including community-based ecosystem approaches to fisheries management (CEAFM) practices and the establishment of locally managed marine area (LMMA) practices.

[3] For details on different coastal fisheries species in the region, please see Johnson et al. (2018), pp. 340–343.

Management of invertebrates, on the other hand, includes imposition of a moratorium on fishing to allow stock recovery as well harvest season and size limits, and in some cases, outright prohibition of harvest of egg-bearing larger crustacean species.

The Solomon Islands, like other 'ocean states' in the PICTs, largely depend on fisheries for food and economic development (Johnson et al., 2018). The country is considered a prime fishing ground, abundant in four valued tuna species: skipjack tuna (*Kastuwonus pelannis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), and South Pacifica albacore (*Thunnus alalunga*). Tuna catch in the country's EEZ from 2010 to 2014 was estimated at 132,279 tonnes, fetching the nation about USD 2.63 billion in earnings, with access and licence fees from DWFNs worth about USD 228 million, constituting 9% of GDP (Johnson et al., 2018). The FFA (2019) has indicated that in addition to direct revenue earnings from tuna catch, the tuna sector employed about 3,009 people from 2016 to 2018. It is estimated that tuna catches in the region have doubled in the last 25 years, from about 1.5 million tonnes in 1990 to 2.8 million tonnes in 2014, resulting mainly from skipjack tuna catches (Johnson et al., 2018). According to SIG (2017), tuna in the Solomon Islands currently remains the major form of industrial fishing, adding that Soltai Fishing Company, the only fish processing plant in the country, employs over 2,000 locals, the majority of whom are women.

The main goods produced for household consumption in the Solomon Islands are predominantly from subsistence household activities in agriculture, fisheries, livestock and handicraft. In Guadalcanal, for example, fish and seafood products combined constitute about 12% of household production (SIG, 2015b). Fish is an important source of food security in the Solomon Islands, with fish consumption, like elsewhere in the Pacific region, averaging from three and five times the global average, and providing from 50% to 90% of the dietary animal protein for rural communities (Bell, 2009). According to Johnson et al. (2018), coastal reef fisheries, a major source of household fish food, are currently experiencing harvest

pressure due to population increase, thereby reducing the quantity needed to provide the required food nutrition of 35 kgs. per person per annum. Subsistence income from fishing activities is about SBD 13.5 million per annum compared with the national average of about SBD 138 million. Temotu has been identified as the province with the highest subsistence income from fishing, constituting about 25% of the national average.

By species, subsistence gross income from fishing in Guadalcanal is estimated at 5.5%, of national fish income, from all fish types, including 2.9% for deep sea fish, 1.3% for tuna, 1.2% for reef fish, and 0.1% for other seafoods (SIG, 2015). Artisanal coastal fishing provides income from sales of catch surpluses, after household consumption needs are satisfied. These are mainly sales of high-value species, including sea cucumbers and trochus, for the export market (Johnson et al., 2018). Operation costs of subsistence fishing activities in Guadalcanal are mainly from fuel (SBD 10.75 million per annum), fishing equipment (SBD 1.4 million per annum) and labour (SBD 360,000), constituting a total of SBD 13.25 million per annum, compared with the national annual average of SBD 5.46 million. The Guadalcanal Fisheries Ordinance, gazetted in 2011, among other things, aims to promote the development and management of marine resources in order to improve the living standards of customary fishing rights owners, support markets and maintain sustainable use of the resource (Govan, 2013).

An assessment of Solomon Islands marine resources by Green et al. (2006) indicated that while overfishing is a concern for coral reef and marine fisheries resources in some provinces, the situation is serious for some species of commercially important invertebrates. Their report further noted that the overfishing problem is likely to be exacerbated with the rapid rise in the country's population. They further maintained that variations in food fish populations can be attributed to the impact of anthropogenic activities, mostly fishing, on reef fish populations. The assessment further showed that the healthiest populations of food fishes are observed in areas with small human populations, while those in worse conditions are found within

locations in or close to heavily populated provinces of Guadalcanal and Malaita. In addition to that, they found that the level of fishing pressure on reef and other marine fish stocks in these and nearby provinces may be too high, a situation further complicated by the use of highly efficient and destructive fishing methods, particularly blast fishing, gill netting and night spear fishing as well as targeting spawning aggregation sites.

1.3 Scope and objective of the report

Exploring the existence and, therefore, the possibility of the structures of social capital to promote strong management systems in Solomon Islands fishing communities, we believe, will promote sustainability of the resource and protect livelihoods, household income and the sector's much needed contribution to the nation's economic development. In this report, we advance research in this area further and explore the exact constituents of social cohesion and social bond (connectedness through networks) and explore how these play into effective resource management at the community level.

To what extent this is true for the Solomon Islands, a country facing coastal resource overexploitation, calls for urgent investigation, making this study's findings an important contribution to the current discourse. From this perspective, this study certainly makes a significant contribution to the provision of the much needed empirical analysis of social challenges, including leadership, social capital, social cohesion and social network analysis in community resource management, which, according to the literature, is currently lacking (for example, see Bodin & Crona, 2009; Turner, 2014). We also believe that this will help guide policy measures to stem stock depletion, ensure food security, safeguard household income and make a much needed contribution to national economic development in the medium to long term.

For our purpose, we focused on group-level membership conditions, such as sharing (i.e.

sharing catch, income, equipment, information) and reporting wrongdoing, on the basis that groups are cohesive when group-level conditions produce positive membership attitudes and behaviour that maintain such conditions (Friedkin, 2004) to promote effective resource management. Without loss of generality, we also concentrated on group cohesiveness in as far as it influences community resource management and impacts community resource outcomes. Following Friedkin's (2004) identification of individual attitudes and behaviour, and in line with our focus on group cohesiveness, we considered individuals' attraction, or incentive and willingness, to remain in a group as well as their behaviour within the group. In other words, we explored the antecedents that possibly determine the consequence of the group dynamics as it is important to ensure that factors promoting social cohesion and encouraging positive resource utilisation outcomes are maintained. Jenson (2010), for example, recognised that social cohesion is an ideal to be striven for and constantly nurtured, improved and adapted.

In the case of West Guadalcanal,[4] and to a large extent the Solomon Islands in general, what exactly defines social cohesion and how that impacts community resource management remains unexplored. Understanding the tenets of community structures, such as strong leadership, social cohesion, robust social capital, *wantokism*[5] and traditional knowledge, norms and practices, in small fishing communities, can therefore provide further insights and help identify solutions to management challenges and recommend appropriate mechanisms to address inherent problems, as empirically established elsewhere. For example, Earnst et al. (2013) used the example of a remote Chilean community to demonstrate small-scale fisheries' ability, based on customary tenure, norms, practices and traditional knowledge, to effectively manage their fishery to ensure sustained livelihood over multiple generations. To this end, we investigated the role of leadership, specifically analysing functions of community chiefs,

[4] West Guadalcanal was our research site, which is located in Guadalcanal Province. See section 2 for the details.

[5] Wantok/Wantokism is an important cultural ideological setup, endemic not only in the Solomon Islands, but also in the entire Melanesian culture. Please see section 4 for further details.

which is called ‘bigman’, and social cohesion, through social network systems, in the West Guadalcanal context. We also considered the existing wantok system, a form of social capital, in communities and its role in resource management. We want to be clear that we did not measure cohesion at this stage; rather, we investigated the influence of cohesion on resource management outcomes, a subject well in line with Oxoby’s (2009) position.

In this report, we do not prove or establish a causal relationship between the tenets of social systems and community resource management. What we do is to try to tease out the structure, if any, of these social dimensions and the directions in which they are associated with resource management in the communities. It would also be naïve to pretend that sampling fishers from one region in one province can generalise management practices across a nation. We are well aware that small-scale and artisanal fishers are heterogeneous, even in one given community, in terms of fishing practices, methods, equipment, catch-type and so on. We are, however, convinced that some characteristics are pervasive, especially in small fishing communities with common traditional knowledge and norms. Such pervading characteristics can provide some general premises that may aid the understanding of community management systems around the country and lead to the identification of some fundamental community management guidelines.

The rest of this report is structured as follows. The data collection process, including a description of the research site, data collection and data capture and cleaning, is detailed in the next section. Section 3 describes the socio-economic and demographic characteristics of the respondents, including their cultural and ethnic backgrounds. The concept of wantokism is discussed in section 4, exploring its origin and its contemporary role in leadership, group dynamics and social networking, and how these play out in resource utilisation and management. In section 5, we analyse community fishing activities, including catch and effort, fishing experience, networking in fishing equipment use, fish sharing, consumption and sales. Cooperative behaviour and conflict resolution are analysed in section 6, detailing

information sharing and networking in fishing activities, rules and non-compliance as well as cooperation among fishers. Section 7 concludes the report with a discussion and recommendations for future research.

2. Data Collection

2.1 Research site

This study targeted the population of fishers aged 18 years or older in West Guadalcanal who operate traditional artisanal fisheries under village-based voluntary participating fishery management. Guadalcanal Province, spanning about 5,348 sq. kms., is the largest of the nine provinces in the Solomon Islands, and it includes Honiara, the state capital, which lies at latitude 9°25'S and longitude 159°58'E (**Fig. 4**). The province is the largest of the bigger islands and the only one with a significant area of grassland and rich alluvium soils. A 2015 census update put the province's population at 108,663, with males and females representing 51% and 49% of the population, respectively, in a total of 20,321 households (SIG, 2015b). Socio-economic activities of the province are typical of those elsewhere in the country. It is estimated that about 7.4% of households in the province are engaged in all types of fishing activities, with household income from fish constituting about 1.2% of household employment income, compared with the national average of about 2.5%. This average constitutes about 1% of total household income in the province, compared with the national average of 1.9%. Annual household gross income from all types of fish is estimated at about 5.5%, comprising deep sea fish (2.9%), reef fish (1.2%), tuna (1.3%) and other seafood (0.1%). In terms of production, fish and other seafood contribute nearly 12% of home production (SIG, 2015b).

Figure 4. Map of Guadalcanal Province.

Source: 2000-2021 Dreamstime.com.

In West Guadalcanal, fishing villages are generally scattered along the coastline, and the fishing activities reflect typical artisanal fishing practices in the Solomon Islands. West Guadalcanal is, thus, an ideal region to elucidate how artisanal fishers use local marine resources, how fishers' social connection is generated and how community-based marine resource management is implemented. In this area, most existing villages can be identified from the paper-based map published by the SIG. However, some villages named by local fishers and those that are newly formed cannot be identified from the map. Therefore, random sampling at the level of villages is not possible. Instead, we selected all seven villages in the region, where two of the villages were further separated for religious reasons; hence, the data used in this study consisted of eight self-organised fishing villages, namely Verahue Anglican, Verahue Catholic, Mangakiki, Tasiloki, Hulavu, Kobiloko, Kotsatsai and Lambi (**Fig. 5**).

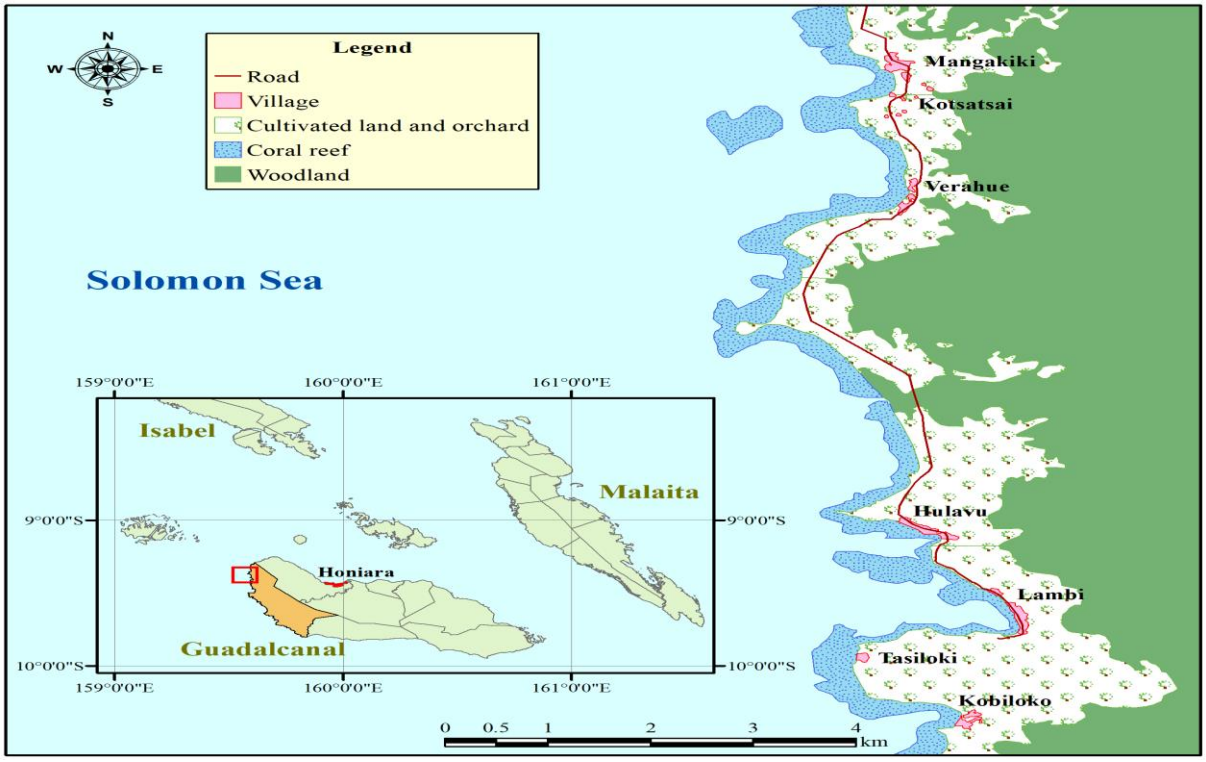


Figure 5. Map showing communities where the research took place (West Guadalcanal).

Source: Solomon Islands land use 1:50000 map (major hydro, road and vegetation data for 2003).

The selection of the study area in West Guadalcanal was primarily based on prior knowledge that these villages, in the context of the Solomon Islands, have developed traditional customary systems and organised communities.[6] In addition, a number of criteria were considered in the selection, including the implementation of various types of resource management; the presence of differences in landings, as well as differences in fishing methods and, or target fish species; and varying degrees of dependency on fishing activity (i.e. different effort share of natural fishing versus aquaculture and non-fishing activities such as agriculture). **Figure 6** shows a small settlement in Verahue Anglican village, one of the villages selected for the study.

[6] Background information about the Solomon Islands and Guadalcanal was obtained during a series of consultative discussions with the Director of the Solomon Islands Development Trust (SIDT) in Honiara. SIDT engages in series of baseline data collection and project activities with various communities in the country, and it is also a collaborative partner in this project.

Figure 6. A coastal settlement in Verahue community, West Guadalcanal.

Source: KAKEN Project, November 2018.

2.2 Environmental characteristics

The selected villages lie at latitude 9°S and longitude 159°E. The fisheries environment across the country is confronted by threats of unsustainability due to poor management of the resource, use of inappropriate and destructive fishing methods that are depleting valuable and fragile coastal marine resources, including coral reefs and mangroves, and the lack of public awareness and information flow. In addition, direct dumping of domestic and industrial waste into water bodies, including the use of shorelines as toilet facilities, is reported as a major contributor to coastal environmental problems (Berdach & Llegu, 2011; ABM & CSIRO, 2014).

Other environmental challenges confronting the Solomon Islands, including West Guadalcanal, are identified as the impact of widespread unsustainable logging practices, such as soil erosion, poor water quality, loss of habitat and biodiversity, loss of future opportunities for alternative sustainable livelihoods and increased risk from extreme weather events due to climate change. An assessment of species diversity on coral reef habitat about 10–20 kms.

north of our survey sites clearly supports this observation. The assessment found a growing number of crown-of-thorns starfishes (COTS) in one-third of 72 survey sites due to damage to coral reef habitat (Turak, 2006). In particular, of the coral-damaged sites, Mary Shoal in north-western Guadalcanal, offshore of Tambea village, was found to be severely damaged by the COTS outbreak. The report further mentioned the negative impact of human habitation on coral reefs, such as rubbish pollution, high sediment levels and dive sites. Subsequent studies of the relationship between coral species diversity of the sites and socio-economic factors have further suggested that market proximity to coral reef fishery resources has a negative impact on the diversity of coral fish species, with the sea area of north-western Guadalcanal being identified to be under high threat (i.e. low biomass) (Brewer et al., 2012; Brewer et al., 2009).

The general environmental characteristics of the communities are not different from those in other coastal areas of the Solomon Islands, and specifically those in West Guadalcanal. As detailed in subsection 1.2, the villages are prone to events of extreme weather, cyclones and earthquakes as well as other more localised climatic events, such as flash floods and storm surges, resulting in severe environmental challenges and often inflicting significant economic losses on the inhabitants. Tropical cyclones, resulting in flooding and wind damage in the Solomon Islands, with attendant severe flooding and landslides in Guadalcanal, Malaita, Makira and Santa Isabel, have become frequent (ABM & CSIRO, 2014). However, projections indicate the likelihood of reduction in the occurrence of tropical cyclones by the end of the twentieth-first century, and the possibility of an increase in the average maximum wind speed of cyclones from 2% to 11% and a rise in rainfall intensity of about 20% within 100 kms. of the cyclone centre are expected to occur. This will affect the Solomon Islands with an increase in the proportion of more intense storms (ABM & CSIRO, 2014).

The wet season is normally November to April, with the dry season occurring from May

to October (SIG, 2014a). Heavy rainfall and high winds are considered some of the most serious environmental vulnerability challenges across the country (Berdach & Llegu, 2011; ABM & CSIRO, 2014). The SIG (2017) reported that the highest rainfall of 8,304 mm, at 430 m above sea level, in Guadalcanal, was recorded in 1970, adding that 250 mm daily rainfall is normal. The mean annual rainfall of 3,000 to 5,500 mm is reported to vary with topography, as well as latitude and island orientation towards prevailing winds. Rainfall distribution, in terms of intensity and location in the country, can generally be described as uneven. **Figure 7** shows the ten-year daily rainfall distribution from 2011 to 2020. According to the Ministry of Environment, Climate Change, and Disaster Management (MECDM) (SIG, 2014a), Honiara and all of Guadalcanal were worse affected by the April 2014 tropical cyclone, Ita, which recorded a rainfall of 715 mm in a 4-day period, about three times the normal rainfall for the month. The resultant severe flooding, causing rivers to overflow their banks, washing away farm crops, livestock, homes, and leading to loss of life, necessitated the preparation of a humanitarian action plan to address the immediate humanitarian needs and put recovery measures in place. For example, World Vision (2015) reported four days of continuous rainfall of about 100 mm in Honiara and the Guadalcanal plains, which resulted in a loss of human life and over 9,000 people rendered homeless. West Guadalcanal, especially the Aruligo flood areas, continues to experience a series of natural disasters caused by extreme and intense rainfall, resulting in disastrous flash floods that lead to loss of lives and property. In particular, loss of fishing equipment, including fishing boats in the affected communities, mostly in West Guadalcanal, is reported to have seriously affected artisanal fishing (SIG, 2017). On average, it is estimated that the country experiences one to two tropical cyclones per annum.

According to a climate change adaptation report (ABM & CSIRO, 2014), temperatures across the Solomon Islands are tied to changes in surrounding ocean temperatures. Given the influence of weather and ocean temperatures on fishing efforts, fish behaviour and fish

migration, drastic climate changes pose serious threats, not only to commercial fisheries, but also to small-scale coastal fisheries and their livelihoods (Berdach & Llegu, 2011). Daily temperatures of the Solomon Islands, in general, are said to fluctuate from 22°C to 32°C throughout the year. Annual minimum and maximum temperatures have increased in Guadalcanal since 1951 at a rate of 0.15°C/decade, with substantial variation in rainfall from year to year. Temperature rise is projected to continue across the country, ranging from 0.4 and 1.0°C, under a high emission scenario through 2030. Rising temperatures, as earlier observed, lead to increased CO_2 absorption and sea water acidification with a potentially disastrous impact on reefs and marine organisms, including coral bleaching. Under all emission scenarios (i.e. low, medium and high), the acidity level in Solomon Islands waters is expected to continue on the ascendancy over this century. The impact of this on coral reefs and other ecosystems, according to the climate adaptation report, is likely to be compounded by other stressors, such as coral bleaching, storm damage and fishing pressure (ABM & CSIRO, 2014).

As explained earlier, another environmental challenge confronting West Guadalcanal is sea-level rise. Sea-level rise with the attendant saline intrusion in ground water, coastal bleaching, exposure to strong tidal waves, shoreline erosion and other factors continue to pose a serious challenge to coastal communities in West Guadalcanal. The sea level near the Solomon Islands is reported to have risen by about 8 mm/year since 1993, a rise much higher than the global average of 2.8–3.6 mm/year, with severe environmental and livelihood consequences. Under a high emission scenario, the rise for the Solomon Islands is projected in the range of 4–15 cm and expected to increase storm surges and coastal flooding (ABM & CSIRO, 2014). The artisanal fishery, in addition to other livelihood and economic activities in West Guadalcanal, unfortunately is not immune to these environmental threats and hazards. It is important to observe that severe flooding and sea-level rise affect human activities and human life in diverse and serious ways. Gornitz (1999), for example, pointed out that rising

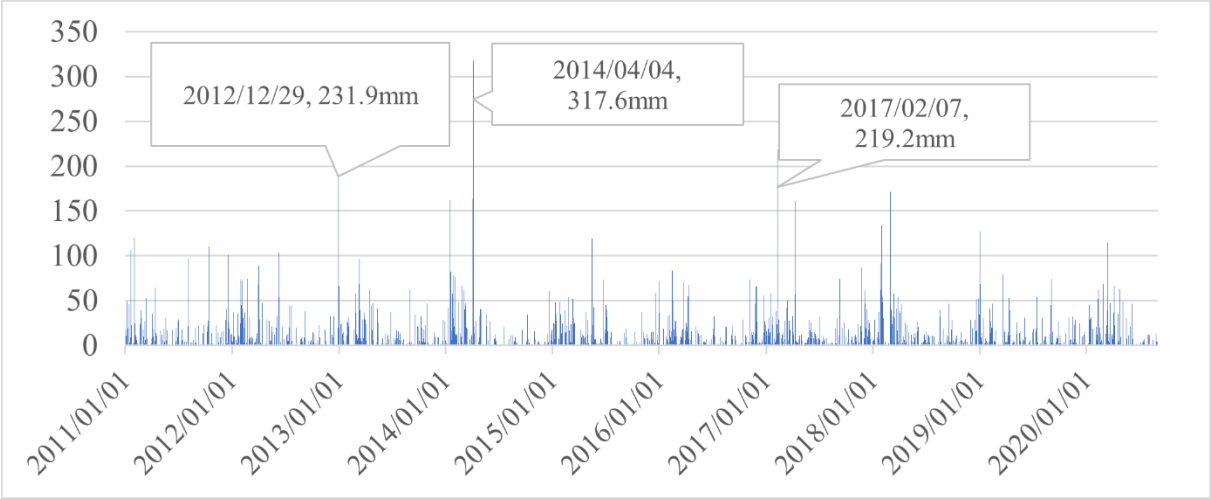


Figure 7. Daily rainfall (mm) at the Honiara observation station from January 2011 to August 2020.

Source: The data were personally collected from official sources at the MECDM, Honiara, Solomon Islands.

sea water levels increase the threat of episodic flooding by storm waves, thus eroding beaches. The resultant intrusion of saltwater in coastal aquifers, it has been emphasised, could contaminate urban water supplies and affect agricultural production. Supporting this position, FAO (2015) suggested that sea-level rise will affect the salinity of surface and groundwater in coastal areas.

2.3 Survey design and data collection

Data used in this study were primary data, collected from the 10th to the 16th of July 2019. The survey was conducted using structured questionnaires in English (see Appendix B) and administered by trained enumerators/field assistants from the Department of Fisheries Studies of the Solomon Islands National University. Prior to the survey, in November 2018 and July 2019, the project team, together with the director of the SIDT and a local lead person, visited Verahue Anglican, one of the communities, for a pre-survey meeting with some members and leaders from the eight selected communities (**Fig. 8**: a post-meeting group photo). The survey design was informed by these pre-survey meetings, pretesting of the questionnaire at the

Figure 8. Project team and community members.

Source: KAKEN Project, November 2018.

study site and consultation with other stakeholders, including the SIDT, Ministry of Fisheries and Marine Resources, WorldFish and the WWF.

The administration of the questionnaires took a face-to-face interview format, where the enumerators carefully read out each question to respondents and recorded their answers. The enumerators who were Solomon Islanders wrote and spoke English fluently and could explain the questions to respondents in *pijin* (pidgin), a local version of the English language, which the respondents generally understood well. This approach was adopted because most respondents either did not speak English fluently or write well. All enumerators attended training and information sessions to obtain background information about the study and to ensure that they had a common understanding of the survey questions and interview process. To ensure consistency and accuracy, the survey was conducted on a village-by-village basis, i.e. one village at a time, by all enumerators. Respondents were not allowed to communicate with each other during the interview. In addition, each completed questionnaire was vetted by field supervisors, with errors and/or unclear responses verified with respondents and corrected immediately. The questionnaires were administered to a total of 253 respondents.

Figure 9(a). Enumerators administering the questionnaire in Mangakiki village.

Figure 9(b). Enumerators administering the questionnaire at a fisher's house in Kobiloko village.

Figure 9(a) and **(b)** show enumerators administering questionnaires to respondents in two villages.

Major variables captured in the survey included: (1) socio-demographics (e.g. age, gender, education attainment, household composition, income, geographical origin and

relationships with wantoks); (2) fishing production (e.g. catch, effort and vessel characteristics); (3) social networks in terms of workplace collaboration, sharing in catch, income and gear, resource management and knowledge exchange).[7] In particular, to capture in situ social connection over fishing life, respondents were asked the following nine questions (Q1–Q9) that captured relevant situations about their cooperation and social interactions.

Q1. When you notice a change in the natural environment in your fishing grounds, such as the amount of fish or the condition of the mangrove forest and coral reef, is there anyone you discuss the issue with? (Information network)

Q2. If you observe someone breaking fishing rules or restrictions, do you report that to anyone? (Reporting non-compliance network)

Q3. When there are new fishing restrictions to protect important fish stock in your villages, is there anyone who will talk with other village members to follow the new restriction? (Leadership in resource management)

Q4. When you encounter a conflict over fishing activities (e.g., territory, catch, gear) with other fishermen, is there any person you first ask for help to settle the conflict? (Territorial conflict resolution)

Q5. In your village, is there anyone outside your family that gives you fish for free? (Fish-receiving)

Q6. In your village, is there anyone outside your family that you gives fish for free? (Fish-giving)

Q7. Over the last one week, who were the fishermen you most often went fishing with? (Fishing companionship and cooperation)

[7] Unfortunately, we could not conduct the lab-in-the-field experiment this time. Thus, we did not obtain villagers' preferences, such as risk and time preferences, altruism and inequality aversion.

Q8. Did you use someone else's boat, gear, nets etc. to carry out your fishing activities? (Gear borrowing)

Q9. Did anyone else use your boat, gear, nets etc. to carry out his/her fishing? (Gear renting)

2.4 Data capture and cleaning

The field data were subsequently captured electronically using Epi Info software (version 7), retrieved from https://www.cdc.gov/Epi Info/support/downloads.html. The electronic data were cross-checked to make sure there was perfect matching with responses in the paper questionnaires. The captured data were cleaned manually and electronically (using the R software). Errors and inconsistencies identified and cleaned included misspelling or differences in names, inconsistent responses and disparities in quantity values. Misspelt or different names for variables suspected to be identical included respondent and other subject names, village, tribe, clan, language and dialect names. These were manually cross-checked from the source through native community resource persons engaged to assist in the data cleaning process. Corrected names were then used to correct the corresponding electronic versions. Inconsistent responses and quantity values included disparities in quantities and numerical entries, such as a respondent's fishing income exceeding his/her total income, zero entries for non-zero responses etc. These were cleaned during preliminary analysis before a final master file in an Excel format was created for further analysis. Outliers were left to be handled at various stages of different analyses. The final raw data consisted of 189 variables and 253 respondents.

3. Socio-economic and Demographic Characteristics

3.1 Socio-demographics of respondents

We will now discuss the demographics and some of the socio-economic variables of respondents who participated in this survey. The demographic variables we analysed included age, gender, religious affiliation, household size, dependants in households, number of fishers in households, years respondents have lived in a village, clan membership, ethnicity and languages spoken. The socio-economic variables included years of schooling, vocational training acquired, household income, including income for fishing activities, other income sources, and household expenditure as well as external sources of assistance to communities that benefit households. **Table 1** presents the summary statistics of these variables. The average age of respondents was about 36 years, ranging from 18 to 80.

Table 1. Summary statistics: socio-demographics of respondents

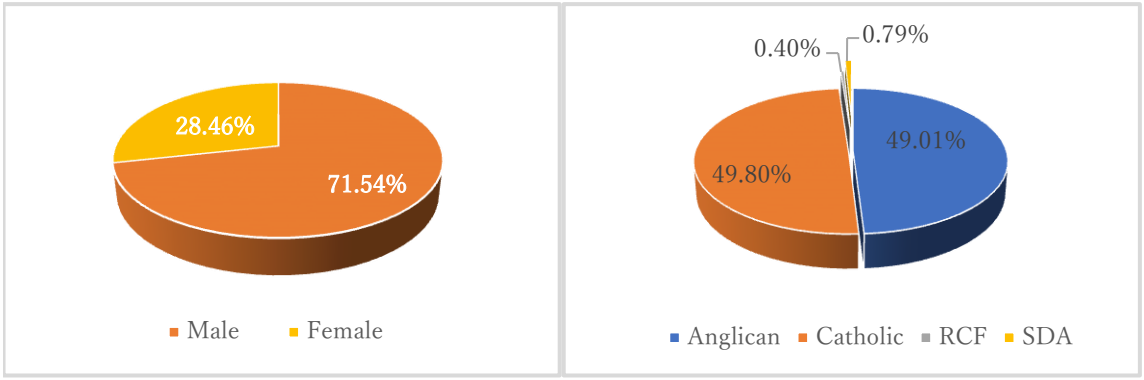
Variable	Mean	Min	SD	Max
Age (years)	35.98	18	11.90	80
Years lived in village	25.97	1	14.07	66
Years of schooling	8.51	0	3.68	30
External assistance received (No.)*	1.86	0	1.13	5
Household size	6.44	1	3.34	28
Dependants in household	3.44	0	2.71	16
Fishers in household	2.86	1	1.75	10
Weekly household income (SBD)	1125.68	0	2720.53	36700
Weekly household income from fish (SBD)	250.46	0	435.88	4000
Non-fishing income sources (No.)**	2.20	0	1.19	6
Weekly household expenditure (SBD)	381.03	0	683.95	6000
Weekly household food expenditure (SBD)	75.41	0	134.44	1500
No. of obs.	253			

Notes: (No.)* refers to the number of assistance sources from organisations and public institutions,

including NGOs (local and foreign), churches etc. (No.)** refers to number of non-fishing income sources, including farming, livestock, logging, private business enterprise, formal employment (public/private), casual labour and remittances. SD, is standard deviation.

It is important to note that our sample represents the population of fishers but not the general population of community members in the study area. This is reflected in the skewed gender distribution in the sample, in the proportions of about 72% and 28% for males and females, respectively (**Fig. 10(a)**), suggesting that generally both males and females in the communities are engaged in fishing, in one form or another, with females essentially fishing for home consumption as and when needed, while their male counterparts mostly engage in fishing for income and recreation.

It was observed that all respondents are affiliated to one kind of religious body or organisation, with the majority belonging to the Catholic or Anglican denominations in almost equal numbers, i.e., nearly 50% Catholic and about 49% Anglican (see **Fig. 10(b)**). Other religious affiliations are comparatively insignificant in numbers, and these include the Seventh Day Adventist (SDA) and Revival Christian Fellowship (RCF) denominations. How this affects fishing activities in the communities is not entirely clear. It must, however, be noted that the SDA communities, though in relatively small numbers, are strict adherents of non-active work on Saturdays and would, thus, not go fishing on the Sabbath, which is observed from sunrise to sundown.



(a) Gender distribution (b) Religious affiliation

Figure 10. Distribution of respondent demographics and religious affiliation.

Examining household characteristics of the respondents, such as household size, number of dependants as well as fishers in households, provided some insight into fishing activities in the villages. We observed that household size among respondents ranged from one to 28 persons, with an average of about seven persons per household. The number of dependants, on the other hand, ranged from 0 to 16, with an average of three persons. On average, three persons per household were found to be fishers, with the numbers ranging from 1 to 10 persons (**Table 1**). We found that, on average, fishers in households constituted about 43% of the average household size, the same proportion as dependants in respondents' households. Nearly 76% of respondents indicated that they have other household members who are also engaged in fishing (**Fig. 11(a)**). Overall, we found that respondents have lived in these communities for an average of about 26 years, ranging from one to 66 years. We assumed that these respondents had a rich history in their environment, including the fish and fishing environment, and thus could be relied on to provide reliable information on the prime subject of this survey.

3.2 Socio-economic characteristics

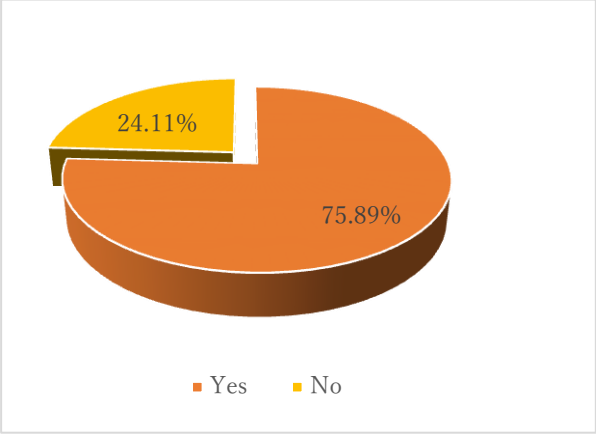
As mentioned above, the survey included questions that sought to elicit information about respondents' socio-economic activities. Summary statistics of this information are provided in **Table 1**. The results show that, on average, respondents had approximately nine years of schooling, with no formal education in some cases. Given the wide range of years in school, a minimum of 0 and a maximum of 30, it was difficult to rely on the average to draw any meaningful conclusions. However, this average might be a signal of some degree of reasonable education, at least well beyond primary education. We felt that this would be useful in information gathering, sharing and policy interpretation and implementation in resource management at village and community levels. It must also be noted that primary

education in the Solomon Islands is six years, and so an average of nine years of schooling indicates that many respondents have completed a three-year secondary, or high school, education. **Figure 11(b)** details the educational attainment distribution, with primary and secondary education registering the highest percentages of 43.48 and 46.64, respectively. Tertiary education forms less than 9%, with just under 2% having no education at all. We also established that vocational training was minimal among the respondents, with only about 23% having acquired some form of vocational education (**Fig. 11(c)**).

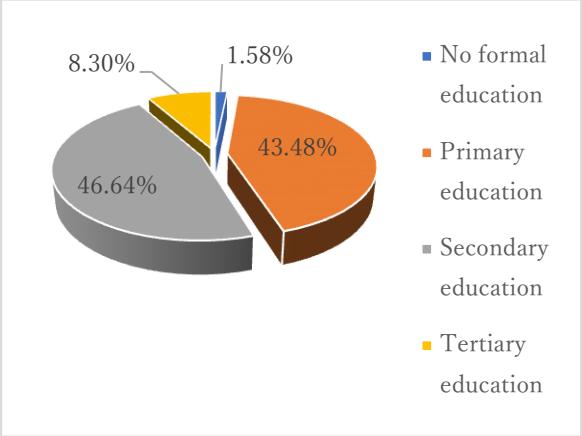
Household income can be considered a measure of household economic well-being, so the question of household weekly income and the portion that comes from fishing activities was examined. Results show that, on average, household weekly income was about SBD 1,126 (**Table 1**). These incomes, compared with provincial income levels, are quite high. A probable reason can be attributed to the outliers, some of which are extremely high (e.g. a maximum of SBD 36,700 as shown in **Table 1**). As detailed below, another reason may be offered by households' engagement in a number of income-generating activities. The median income of SBD 500, however, may well reflect the reality. According to the 2009 National Census report, only 5% of the province's population fell within the SBD 500 to SBD 999 range, with 1% in the SBD 1,000 to 1,499 monthly income bracket, and the same percentage earning over SBD 1,500 per month (SIG, 2009). We found the average household weekly income to be SBD 250 from fishing activities. The 2009 Provincial Census report indicates that 45% of household income in Guadalcanal was from fish, crop and handicraft sales. The Census report also shows that about 3% of the province's residents had no income, justifying the no income and other income levels recorded in this survey. In fact, the maximum SBD 36,700 weekly income was recorded from a particular household that was engaged in multiple economic activities, including commercial fishing. This household was an outlier, not representing the typical rural household in the villages surveyed. On household expenditure, we found that, on average, household weekly expenditure was about SBD 381,

with a median of SBD 200 and a maximum of SBD 6,000. This is quite within the provincial average (SIG, 2009). Household weekly expenditure on food, on the other hand, registered an average of SBD 75 and a maximum of SBD 1,500.

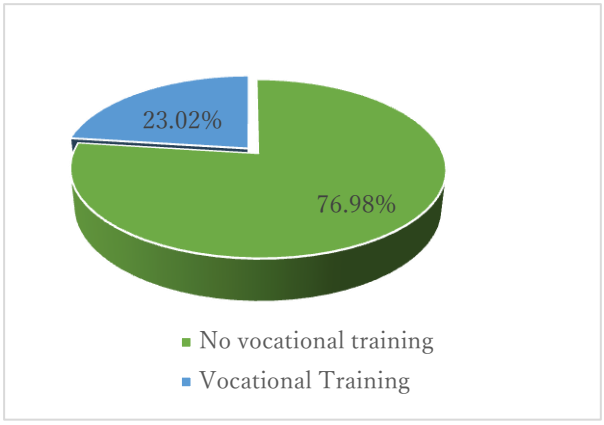
Besides fishing, respondents mentioned up to six other sources of income. These sources include farming, livestock, logging, private business enterprises, formal employment (wages and salaries), casual labour and remittances. These were also identified in the 2009 Census report mentioned above. On average, respondents mentioned two of such income sources, though some respondents did not have any other income sources besides fishing. A discussion with village and community leaders revealed that a number of organisations and public institutions, including NGOs (local and foreign), churches etc., from time to time, bring various projects to the communities. Respondents were, therefore, asked if their households benefited directly from such activities. We found that households, on average, benefited from about two of such external assistance sources, with five being the maximum. About 87% of respondents stated that they had benefited from one form of external assistance or another (**Fig. 11(d)**).



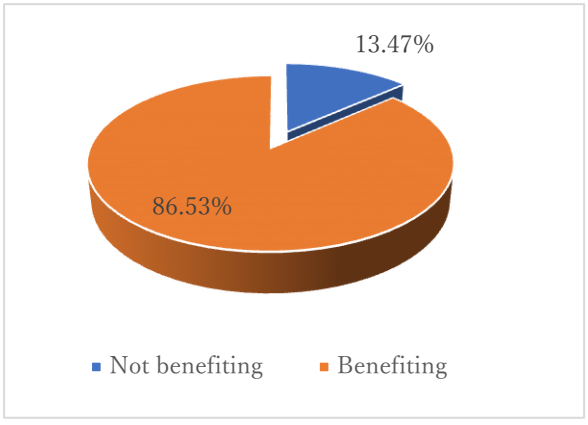
(a) Other household members engaged in fishing



(b) Respondents' educational attainment



(c) Vocational training among respondents

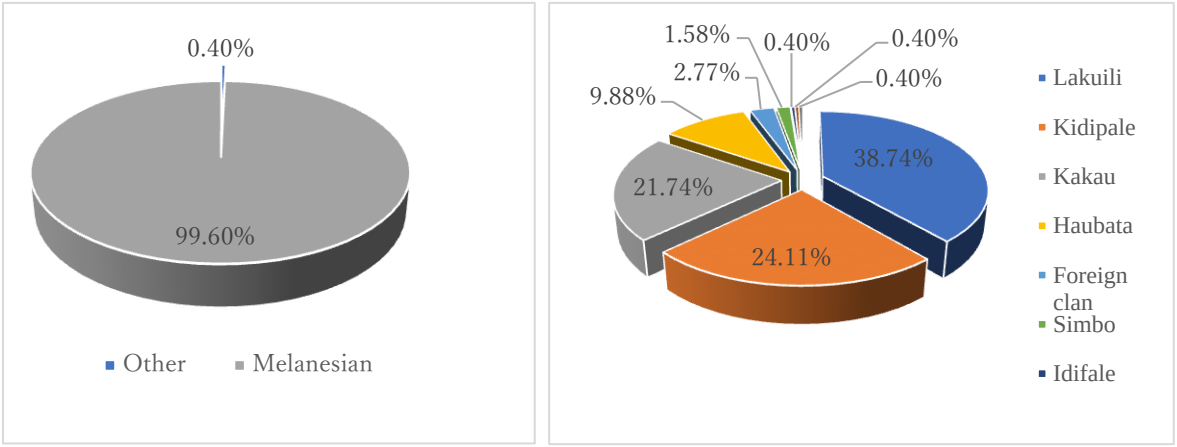


(d) Households benefiting from external Assistance

Figure 11. Distribution of respondent socio-economic and other characteristics.

3.3 Cultural and ethnic diversity

To understand the cultural diversity of the villages and how it may have impacted social cohesion, networking and resource management, we asked respondents about their ethnic, clan and language backgrounds; results are presented in **Figure 12(a)**. We determined that though the respondents are homogenous in terms of ethnic grouping (about 99% are Melanesian), they are largely heterogeneous in clan composition. We found that the majority of respondents, about 39%, are from the Lakuili clan, with the Kidipale and Kakau clans following at proportions of about 24% and 22%, respectively (**Fig. 12(b)**). It is perhaps important to note that even though respondents are heterogeneous by clan composition, they are largely homogeneous in language and ethnicity; about 94% of respondents speak the Ghari language (**Table 2**). We observed that all other languages are proportionally very small. These, according to the village and community leaders, are 'foreign' languages spoken by residents from other tribes, islands and provinces in the Solomon Islands. The leaders also explained that within these major language groups there are dialects, which include Geri, Di, Qae (all of the Ghari language group), Kwaio, Fataleka, Gegua and Hograno, which are of the 'foreign' language groups.



(a) Ethnic distribution (b) Distribution of clan membership

Figure 12. Ethnic and clan distributions.

Table 2. Distribution of languages spoken in the villages

Language	Freq.	%
Ghari*	238	94.07
Doku of Lengo	4	1.58
Savosavo	4	1.58
Bilua	1	0.40
Gela	1	0.40
Kirugala	1	0.40
Maringe	1	0.40
Poleo	1	0.40
Sa'a of Malango	1	0.40
Other 'foreign' languages	1	0.40
No. of obs.	253	

Note: *The Ghari language is inclusive of the associated dialects: Di, Geri and Vaturanga.

4. Wantokism

It is impossible to examine the crux of fisher behaviour and culture in the Solomon Islands without considering an important cultural ideological setup, endemic not only in the Solomon Islands but also in the entire Melanesian culture, which is generally known as wantokism (the wantok system). To understand and appreciate the cultural dimensions of the findings presented in this report, we will provide some insights into the wantok system.

4.1 Wantokism: concept and origin

Wantok, literally stands for 'one talk', referring to people who speak the same language, originate from the same geographical background or share a similar ethnic identity (McLeod 2008; Murray, 2016). De Renzio (2000) extended this definition to include common social associations, such as religious groups. It is contended that the wantok system may create a sense of belonging and concern for community well-being, as people share limited resources and vital information (Murray, 2016). From another perspective, the wantok system is described as a distinct ideological setup in the Melanesian culture, which controls resources and connects the pre- and post-colonial contact periods (Nanau, 2011). Based on this background, we have identified two main types of the wantok system: a more traditional setup, preceding colonial contact, and a contemporary structure, which originated in the post-European colonial contact era. The post-colonial wantok system traces its roots to the European coconut plantation establishment period, where labourers from distinct language [*langus*, in the Solomon Islands pidgin parlance] groups lived and worked together (Nanau, 2011, p. 34). The wantok system, both the traditional and contemporary, is also considered a network, built on distinct family, clan, tribal, linguistic, specific island and other geopolitical

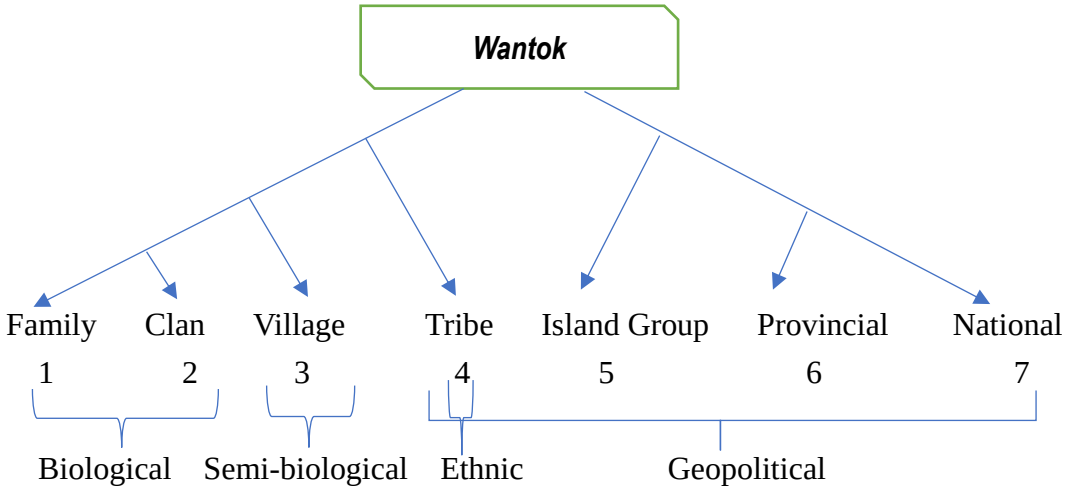


Figure 13. A schematic identification of wantok levels in the Solomon Islands.
Source: KAKEN Project, November 2019.

Note: Each of these levels has leaders with their functional roles and levels of authority. As identified in the above review, the strength of the leadership authority, powers and influence on wantok behaviour, including resource utilisation and sharing, cooperation and social cohesion, are essentially determined by distance (how far the individual is removed from the biological level of wantok, being stronger at the biological level). In this schematic presentation, we ascribe components 1 to 4 to the more traditional, pre-colonial contact system, and 5 to 7 to the more contemporary, post-European contact wantok arrangement.

groupings and identities (Nanau, 2011; Tanda, 2011). Murray (2016) proposed the extension of the pre-political wantok communities of families, villages and clans to include relations that unite the entire nation. In **Figure 13**, we present a schematic identification of wantok levels in the Solomon Islands, as we see it today.

4.2 Sharing in the wantok system: group cohesion and reciprocity

Tanda (2011) extended the wantok description, in both systems, to include a relationship of sharing, aimed at meeting various socio-cultural and economic needs of individuals and groups, in a narrow sense. This system of sharing is embodied in both material (natural and otherwise) and emotional support exchange among wantoks, a system that is reciprocal and mutually beneficial. By definition, the concept of sharing in the wantok system is a social requirement, built on unwritten social contract, a social capital whose violation is gravely frowned upon (Nanau, 2011; Tanda, 2011). Positioning wantok as a source of social capital,

de Renzio (2000), for example, explains that wantok is embedded in social relations and provides opportunities for trust, cooperation and mutual benefits. In a wider context, wantok is an essential network, depicting inter- and intra-group [community] relationships, supporting Murray's (2016) proposition that wantokism is a system that can be extended to promote national unity. Extension of the contemporary wantok self-interest [singularity], as Murray (2016) put it, to a 'commonality' that promotes positive network and social cohesion, creates strong social bonds and can be employed to better manage community fisheries resources. This is what our study explored. The importance and feasibility of this is supported by the wantok literature.

From the above discussion, two major wantok patterns emerge: micro and macro patterns. In the micro framework, the wantok system is a biological and semi-biological relational concept (a family, clan and village – a closer kinship socio-cultural/*kastom* (traditional culture) system), while the macro construct, on the other hand, describes the wider geopolitical system of association at the tribal, island, provincial, national and regional levels. The tribal structure, though of a wider geopolitical arrangement, is more of an ethnic construct, a collection of village structures bonded by culture/kastom or language, or both. This has been explained by Nanau (2011) and Tanda (2011), who pointed out that the wantok system can be identified at many levels: the family, the village (i.e., relationship of closer proximity) and the geopolitical boundary (i.e., tribal, close island groups, provinces, national and regional) levels. Underlying these is also the kastom system of practices (indigenous kastom practices at the micro level) and adopted socio-cultural norms, including Christian church norms, at the macro level (Tanda, 2011).

4.3 The wantok paradigm: the role of social network, the 'bigman', enforcement, and the resource

The social network concept in the wantok system, as mentioned elsewhere in this report, is strongly evident in resource use and control. Nanau (2011) argued that group cooperation and social networking and cohesion in the wantok system are better enforced and cemented by reciprocity at the micro (biological or kinship) level, adding that the strength of the contractual social obligation of reciprocity is reduced the farther away one moves from the micro to the macro level. This strongly supports the strength of sharing in resource (fishing equipment and gears) use, as well as catch and income sharing among individuals at the intra-community level, compared with that observed between inter-communities, reported in this study. It is also argued that claims or rights to natural resources over land and fishing grounds are essentially determined at the micro wantok level: the 'biological' kinship and village levels. The group with ownership rights, in the Melanesian context, is usually at the micro level (Nanau, 2011, pp. 34, 37).

The bigman of the group at the micro level is naturally the family head or his appointee, often appointed on the basis of inheritance (i.e., depending on the system of inheritance, that is, matrilineal or patrilineal), seniority (age) or social standing in the family, such as one's education, material wealth etc. At the village level, the village chief is the bigman. Anecdotal accounts by indigenes in the Solomon Islands suggested that the strength of decision-making in the wantok system weakens the farther one moves away from the micro-biological/family context of the village, tribe, etc., to the national and regional contexts. This is particularly so when it comes to resource extraction and sharing, individual personal decision-making and punishing unethical behaviours. In terms of the role of the bigman in regulatory enforcement and compliance, we observed that even though reporting rule-breaking was low among respondents, a habit partly attributed to wantokism, those reporting rule-breaking would

report to the village chief, the bigman. This is an obvious indication of the role of the bigman in regulatory enforcement and resource management.

It is, perhaps, appropriate to add that at the micro level, the family head (the family bigman) is a pivotal determining factor in a number of ways. Anecdotal evidence suggested that whereas the village bigman can and does have control in matters of peace and harmony at the village or community level, the family head is the deciding factor when it comes to family resource ownership and sharing. In the Solomon Islands, over 87% of natural resources (land) (Price et al., 2015) are customary- (family and communal) owned. Though there is currently no legal consensus on the ownership of fishing grounds, according to Price et al. (2015, p. 31), the seabed, by *The Lands and Titles Act*, falls within the definition of land, with customary ownership. This suggests that harmonious use and control of natural resources, including fishing grounds, is, first and foremost, very much dependant on the family bigman, the village chief and their heirs, appointees, designated or accepted bigmen. This may help explain the greater influence of village chiefs in resource management and conflict resolution, compared with the influence of church leaders and other levels of leadership in the communities, as observed in this report. While the former, the chief, is of micro nature (i.e., of biological kinship), the latter, church and other leaderships, are of macro context, delineated from the natural kinship and resource ownership setup.

The terms bigman and chief have been used interchangeably in the discussion above; thus, it is important to provide some explanation. McLeod (2008) posited that in the Melanesian system, the concept of bigman and chief cannot be distinctly dichotomised, arguing that in the ethnographic realities of Melanesia, the two are oftentimes used interchangeably, with the term chief employed more frequently. However, it is indicated that chiefs are influential village leaders whose level of power is determined by inheritance, or in some cases appointment, based on the issue at hand (Murray, 2016; Nanau, 2011). Whereas appointed community chiefs may not have power over land issues, they may have greater

influence over other community issues. De Renzio (2000), on the other hand, has contended that bigmen are individuals who possess exclusive knowledge, impose discipline, uphold traditional values and give executive direction. What is clear from these descriptions is that both bigman and chief are leaders at the village or community level, entrusted with the power to lead, control and manage day-to-day affairs under their authority, be it ensuring village or communal well-being and peaceful coexistence, taking good care of the common good or ensuring equitable resource allocation.

4.4 Contemporary wantokism

In this study, we also looked at resource sharing, compliance and rule-breaking. It was thus necessary to see how these fit into the contemporary wantok paradigm. Analysing the relevance of wantokism in Melanesian culture, McLeod (2008) pointed out the importance of kinship and the inherent notion of reciprocity, alongside the existence of sanctions for failure to honour social obligations. Murray (2016) posited that in the face of enormous change in modern societies, the wantok system can be anachronistic and amendable to corruption, nepotism and other abuses in everyday social interactions, a view earlier expressed by de Renzio (2000). De Renzio also suggested that some characteristics of wantokism, a complex web of reciprocity obligation based mostly on ethnic identity, can have both negative and positive overall impacts on group functioning. In the framework of non-compliance or rule-breaking and accountability, for example, the negative impact of wantokism can be observed. In relation to wantokism, de Renzio submitted that the process of modern urbanisation and nation building notwithstanding, there is no doubt that geographic, ethnic and linguistic affiliations exert an important influence on group behaviour, as portrayed in the wantok system in Papua New Guinea, for example. In this regard, de Renzio explained, individuals may act to cooperate with group objectives as they recognise that it is in their

long-term interest because of the expectations of reciprocity, or simply because they have developed attributes and motives to limit their pursuit of self-interest.

McLeod (2008) suggested that while strengthening the internal accountability system and mechanisms of public scrutiny may assist in enforcement, it does not mitigate the negative sanctions village or community members face when they 'fail' their wantoks. This can be a source of disincentive in community resource management, as it encourages rule-breaking (de Renzio, 2000). By implication, this explains why rule-breaking may not be reported, for fear of sanctions by the wantok system. Another negative dimension of the contemporary wantok phenomenon is its counterproductiveness in promoting inter-community cooperation. De Renzio further argued that wantokism is not likely to promote widespread efficiency, equity and well-being outside of the immediate members of the group, explaining that strong intra-community ties prevail at the expense of weak inter-community bonds.

The contemporary wantok is, thus, considered a negative deviation from the 'traditional' wantok framework, the former being a system built on socio-economic manipulation, exploitation and corruption (de Renzio, 2000; McLeod, 2008; Nanau, 2011; Tanada, 2011). Arguably, such a system is not likely to promote cooperation and social cohesion, particularly when it comes to resource sharing. Tanda (2011, p. 15) asserted that the contemporary system is perverted, unethical and used solely for personal gain and fame. Nanau (2011, p. 50) added that the farther one moves away from the smaller (micro biological and village) system, towards the wider (macro) context, the more wantokism degenerates into a system of corruption, political expediency and exploitation. Nanau's (2011) conclusion, however, was that the wantok system in the Melanesian socio-economic and political setting will persist across time. These observations on the contemporary wantok system suggest that to promote, preserve and ensure sustainable cooperation and social cohesion in resource sharing and use, emphasis should be placed on fostering the micro-biological and village-level wantok structures as well as strengthening the role of the 'bigman' or the village and community

chiefs. Religion, particularly the post-colonial Christian religious structures, has also been found to promote wantokism, but the outcome has received mixed reactions, even among the clergies (Tanda, 2011). Nanau (2011, p. 41) cited Ross (1978) to suggest that kinship, and for that matter wantokism, transcends Christian and pagan boundaries. In other words, even though religious affiliation may foster wantokism and contribute to social cohesion, its remoteness from the micro (biological kinship) wantok structure renders its influence less potent, more so when it comes to resource sharing.

It must be noted that a certain trend, 'closedness', as far as wrongdoing in communities is concerned, has been observed and captured in recent works by Bodin and Crona (2008) as a negative phenomenon. In their words, 'closedness' of community social networks, such as wantokism, may result in negative behaviour, such as unwillingness to report wrongdoing (or rule-breaking). Such an observation is consistent with what we observed at the current study site, where rule-breaking reporting among the communities is low.

5. Fishing Activities and Networks

We collected data on a number of variables with the objective of understanding the general characteristics of fishing operations in the communities. These included fishing experience, respondents/fishers' own assessment of stock status in their fishing grounds, observed changes in the fishing environment, fishing rules and restrictions in the communities, compliance and rule-breaking and channels for resolving conflicts arising in the fishing environment. A related issue also examined here, in this and the next sections, includes networking in relation to information sharing within the communities. In this section, we outline these and other factors in detail.

5.1 General characteristics of fishers and fishing activities

5.1.1 Fishing experience

It is expected that a fisher's ability to understand the fishing operation and the environment in which he or she operates will largely depend on years spent fishing and the fishing experience. To determine the respondents' experience, we asked them about the years of their fishing experience. Responses ranged from 1 to 50 years, with an average experience of about 18 years (**Table 3**).

5.1.2 Fishing grounds

We established that nearly 65% of respondents fish within their village or community territory, with 35% fishing outside of their territory (**Fig. 14**). Fishing within one's village waters in the Solomon Islands, and in Guadalcanal, is not surprising or uncommon. The assumption is that, apart from high sea waters, fishers will not ordinarily venture into waters belonging to other villages without invitation or consent. As we stated earlier, land ownership

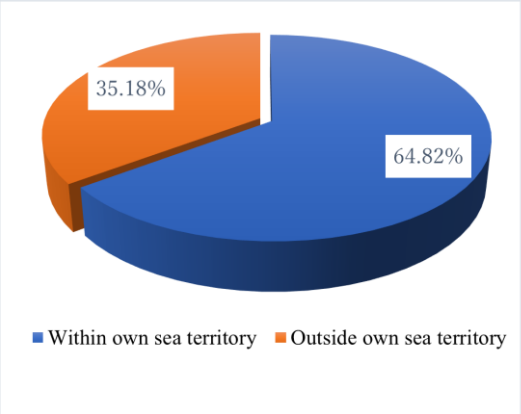


Figure 14: Respondents' main fishing area.

in these environments is largely communal, with communities believing that land below the high-water mark and areas offshore, including the seabed, is customary land (see Price et al., 2015).

Nevertheless, small-scale fishers also fish different areas in their waters for varying reasons, which include abundance of preferred species, and often consider such grounds as their own fishing grounds, concealing or protecting these from other fishers. For example, conversations with some of the fishers during this survey showed that some fishers in the villages, particularly those fishing for commercial purposes, conceal their fishing grounds from others, other than relatives, fishing companions or close wantoks. Under no circumstance will they allow 'intruders' (i.e., outsiders/non-village members) into their fishing grounds, for fear of losing out on catch. This means that how far fishers travel and the time it takes to arrive at respective fishing grounds will differ. As part of fisher experience in relation to fishing grounds, we tried to establish when fishers observed changes in stock status in their fishing grounds, and so the question of when changes were noticed was asked. Some respondents, presumably those with longer fishing experience and those who may have been fishing in the same grounds, indicated that they had observed changes as far back as

Figure 15. **Island mackerel sale along the West Guadalcanal-Honiara City highway.**

Source: KAKEN Project, November 2018.

Table 3: Summary statistics: time variables

Statistics	Fishing experience (yrs.)	Travel time to fishing grounds (hrs.)	Time change in stock noticed (yrs.)
Mean	18.26	1.14	4.86
Min.	1.00	0.02	0.04
SD	11.92	1.24	5.47
Max.	50	8	20
No. of obs.	253	253	186

some 20 years ago. Our results show that, on average, respondents have noticed changes, at least, in the last 5 years (**Table 3**). Further discussion on reasons for stock changes is detailed in section 6. **Figure 15** shows a fishmonger selling island mackerel (*Rastrelliger faughni*) by the roadside in one of the communities, along the West Guadalcanal-Honiara highway.

5.1.3 Travel time to fishing grounds

To understand how far fishers normally travel to fish, respondents were asked to indicate the

time taken to travel to their respective fishing grounds. Travel time to fishing grounds was found to differ widely, ranging from a few minutes to a maximum of eight hours, with an average of one hour (**Table 3**). This was supported by explanations given by respondents. Households living close to the shores will take a few minutes to reach the waters to cast their fishing nets or drop their poles and lines. These are mostly women and the elderly, essentially people fishing for immediate home consumption. There are, however, other fishers who would travel longer distances, farther out to sea in bigger outboard motor boats, purposely to catch fish for sale.

5.2 Catches and effort

The respondents in the survey conduct their fishing activities in a number of ways, which define their fishing effort, catch, social networking around these activities and other factors. To appreciate these activities, as well as the networking structures in place, we collected a number of variables, including number of days fishers go to sea (fishing days), time of fishing (day/night), fishing trips per fishing day, time spent fishing on each trip, types of species caught, use of fish caught (i.e. household consumption, cash sales, sharing), average sales price per individual species. We also tried to determine the types of fish caught by these respondents and how the fish caught are used or distributed between consumption and sales. To understand the social networking system in the villages and communities further, we collected data on variables about fish sharing practices. The data collected included quantities of fish given out to, or received from, other village or community members for free. In this section, we detail the description of these variables.

5.2.1 Fishing effort

In the literature, studies on fishing pressure largely focus on the level of catch and effort (for

an example, see Kleiber et al., 2014), raising concerns about the effects of pressure and the sustainable removal of both target and non-target catch, as well as the ecosystem effects, from widespread fishing activities (for examples, see McCluskey & Lewison, 2008; Pauly et al., 2005). The argument is that obtaining the necessary and accurate information on fishery catch and effort is a necessary component to facilitating sustainable fisheries management (McCluskey & Lewison, 2008). Earlier discussions in this report echoed similar concerns and their impact on rural community livelihood in the Solomon Islands, as well as the need to address the challenges (for examples, see Schwartz et al., 2011; SIG, 2010). Assessing the fishing effort level in rural communities is, therefore, necessary not only to obtain the right data, but also to assess the situation and suggest possible management strategies to ensure sustainable fishing in rural communities. This section focuses on fishing effort in terms of fishing days, trips per day, fishing time per trip and fishing times (day/night). Later in subsection 5.3, we look at fishing capital and equipment as another aspect of effort.

The effort data showed that, on average, respondents go fishing for about three out of every seven days, with seven days being the maximum fishing days (**Table 4**). Non-active fishers (i.e. respondents who indicated they were not actively involved in fishing), on the other hand, may not go fishing at all in a particular week. These are essentially subsistence fishers who go fishing for food, or other needs, as and when required. On average, respondents take one trip per fishing day, spending an average of about four hours at sea for each trip. Regarding the question of fishing times, our analysis revealed that fishing times differ among respondents. Whereas about half of the respondents go fishing in the daytime, a good proportion (about 45%) do so at night, with a relatively small percentage (about 4%) fishing day and night (see **Fig. 16)**.

Table 4. Summary statistics of fishing effort: days, trips and time

Variable	Statistics			
	Min.	Max.	Mean	SD
Fishing days	0	7	2.75	1.60
Fishing trips (units)	0	7	1.39	0.64
Fishing hours	0	24	4.16	3.46
No. of obs.	253			

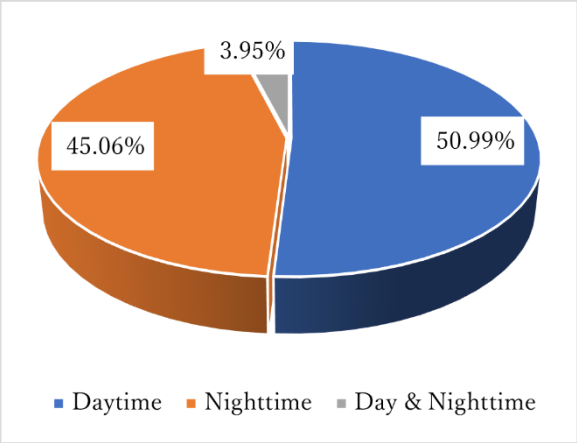


Figure 16. Distribution of fishing times.

5.2.2 Fish type caught

Six fish types (species groups) were identified in this study as the main species caught, which included coral fish, tuna, kingfish, shellfish, shark and squid. Other minor species, mostly molluscs, were grouped together as 'other' types. **Tables 5** and **6** detail the distribution and summary statistics. Of all the fish types, coral fish is the most commonly caught; about 97% of the 253 respondents had caught this species over the seven days prior to the survey. The next major fish type caught during the period was tuna (about 32%), with all other fish types being well below 10%.

Table 5. Distribution of fish types (species groups) caught

Variable	Freq.	%
Coral fish	246	97.30
Tuna	82	32.41
Kingfish	20	7.91
Shellfish	5	1.98
Shark	6	2.37
Squid	16	6.32
Other fish type	18	7.11

Note: All 253 respondents answered *Yes* or *No* for each fish type.

Only *Yes* responses for each fish type are reported here.

Table 6. Summary statistics of daily catch per type (species groups) of fish (in kgs.)

	Fish type						
Statistics	Coral	Tuna	Kingfish	Shellfish	Shark	Squid	Other
Mean	9.87	18.60	10.20	9.82	15.67	6.81	9.98
Min.	0.5	1	0.5	0.5	1	0.5	1.5
Max.	90	270	50	30	70	30	40
SD	13.07	32.86	12.33	12.74	26.87	8.64	10.47
No. of obs.	246	82	20	5	6	16	18

To gain further insight into the catch variable, summary statistics of average daily catch over the previous seven days were calculated. **Table 6** shows that with the exception of shellfish, the average daily catch per species group, in terms of weight, was roughly estimated to be from 10 to 19 kgs. The maximum weight caught, however, was tuna at 270 kgs. Given that the survey focused mainly on artisanal fishers, with a substantial level of subsistence, it is not surprising that the minimum weight of fish caught of all fish types ranged from 0.5 to 1.5 kgs.

5.2.3 Consumption and cash sales

We now turn to fish consumption and sales among respondents. First, we examined consumption. The survey was used to determine how the communities distributed their fish harvest by establishing how much of the fish caught went into household consumption, how much went into sales for cash income and how much was given for free. Since it was difficult to get respondents to give the exact quantity of fish they allocated for different purposes, we asked, if they had a given quantity of fish, say 10 fish, how much of it was kept for household consumption, sold for cash income and given to others for free. The results showed that the average amount of coral fish kept for household consumption was the highest among all the species categorisations (see **Table 7)**. The extreme cases of either none (i.e., minimum) or all (i.e. maximum) being kept for household consumption were also observed for all species caught. **Figure 17** shows kingfish (*Scomberomorus cavalla*) bough for SBD 150 in Lambi village by the research team for a meal.

Figure 17. Kingfish sold for SBD 150 in Lambi village.

Table 7. Summary statistics of fish use (by fish type caught): household consumption, sold for cash income or given to others for free

Statistics	Catch use								
	Household consumption			Sold for cash income			Given for free		
	Coral	Tuna	Other	Coral	Tuna	Other	Coral	Tuna	Other
Mean	4.06	2.62	3.10	2.33	5.49	4.57	3.61	1.89	2.33
Min.	0	0	0	0	0	0	0	0	0
Max.	10	7	10	8	8	9	10	10	10
SD	1.93	1.84	2.75	2.73	2.70	3.49	1.78	1.84	2.22
No. of obs.	246	82	63	246	82	63	246	82	63

Note: 'Other' denotes fishes other than coral reef fish and tuna, i.e., aggregation of kingfish, shell, shark, squid and other fishes. The aggregation was necessary in order to account for fish types that could not be estimated separately.

Results of the survey revealed that in addition to consumption, fishers had other ways of using their fish catch, which included cash sales and gifts to other community or village members. First, we investigated catch sales for cash income. Again, we asked a similar hypothetical question and found that, on average, coral fish was the most sold, in terms of quantities, with the extreme case of either none (i.e., minimum) or all (i.e., maximum) sold. We observed this among respondents for all species categories (see **Table 7).** For those respondents who sold part of their catch, it was important to establish the prices at which they sold for each species. Details of our findings are summarised in **Table 8.** We observed that the average price of kingfish was highest at SBD 19.12/kg., followed by squid, tuna and coral fish, in that order. The maximum price, however, was noted for tuna at SBD 70/kg., followed by coral fish, kingfish, and squid in that order. Average and maximum prices for 'other' species were higher than those of shark. Interestingly, however, shark had the highest minimum price compared with all other types.

Table 8. Average price of fish sold: by fish type (SBD/kg.)

Statistics	Fish type					
	Coral	Tuna	Kingfish	Shark	Squid	Other
Mean	16.27	16.83	19.12	12.5	17.70	14.25
Min.	3	3	9	10	7.26	6.8
Max.	50	70	40	15	30	22.2
SD	5.27	9.48	8.08	3.54	6.83	5.39
No. of obs.	178	75	17	2	15	15

Note: Fishers who did not sell any catch were excluded from this summary. Shellfish was not sold.
SBD: Solomon Islands Dollar, the national currency.

5.2.4 Fish sharing

The act of reciprocity and mutual support within the communities, in terms of fish sharing, was elicited by asking respondents if they shared their catch with others. It was not surprising to find that over 96% of respondents shared their catch in this respect. In addition, nearly 64% of respondents shared their income from fishing with others (see **Table 9)**. We have to be explicit here to indicate that this analysis refers specifically to sharing with others, meaning relatives (i.e., non-immediate family members), wantoks, friends etc. We went further to find out if this sharing was for free or otherwise. To do this, we first tried to get an idea about actual quantities of fish given out for free, by asking similar hypothetical questions as we had in the case of consumption and cash sales. The results showed that respondents, on average, gave about two pieces of tuna (out of a total catch of 10), about 4 pieces for coral fish and about 2 pieces for 'other' fish types to friends and wantoks, for free (see **Table 7**).

To clearly establish the level of reciprocity, i.e., giving and receiving of free fish outside of immediate family members, respondents were asked to indicate if they gave out or received fish for free from non-family community members. We found that the majority, about 94% of respondents, gave fish for free to non-family community members, while nearly 81% of respondents received free fish gifts from non-family community members (**Fig. 18 (a)** and **(b)).**

Table 9. Distribution of catch and fish income sharing with non-family members

Category	Frequency	%
Catch share		
Yes	244	96.44
No	9	3.56
Total	253	100
Fishing income share		
Yes	161	63.64
No	92	36.36
Total	253	100

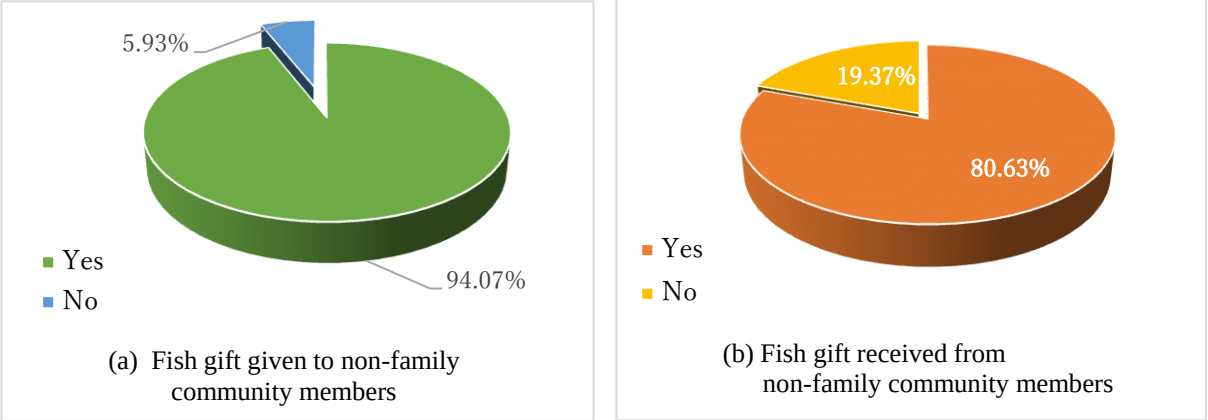


Figure 18. Fish gift: giving and receiving.

In a wantok society, this level of sharing is expected and may be considered as one of the indicators of the strength of the wantok system, the social networking, in the villages and communities. We discussed the subject of wantok earlier in section 4. Before we discuss the social networking aspect of free fish-giving, we will look at the frequency of giving and receiving. We observed that on average, respondents offered fish as a free gift to non-family community members twice in a week to an average of about two people (2.01). The statistics are not much different the other way round; i.e., respondents on average received free fish gifts about twice (1.89 times) in a week from about two people (1.68) on average (see **Table 10**).

We explored the social networking aspect of fish sharing in two ways, statistically and

graphically, using social network measures. Like other network measures discussed earlier, we categorised fish sharing networks into four different degrees of centricity: degree, indegree, outdegree and betweenness, at the village level, at the individual [respondent] level and at the village cluster level. Summary statistics of these are detailed in **Table 11.** In both fish-giving and fish-receiving networks, the means of indegree and outdegree measures were close in absolute terms, suggesting that the same level of fish sharing events happened. However, we observed that the average indegree measure of fish-givers was less than that of fish-receivers, indicating dependence of receivers on givers.

The opposite was the case for outdegree, where the average outdegree of givers exceeded that of receivers, signifying the influence of fish-givers over fish-receivers. On average, the betweenness centrality network measure for fish-giving was also observed to be much higher (a mean of 12.95) than that for receiving (a mean of 4.32). This can be understood as the result of there being more bridges between fish-givers than between fish-receivers, on average. The mean of the degree network measure was equally higher for fish-giving (a mean of 2.78), compared with a mean of 2.58 for receiving, though the medians were the same. The mean in this case can be interpreted as fish-givers being more central and, therefore, wielding more influence than fish-receivers. This, in a sense, can be seen as a natural consequence of a giver having dominance over a receiver. In effect, 550 and 405 fishers were observed in

Table 10. Summary statistics of fish gifts in a week: to and from community members

Statistics	Frequency of fish given	Fish gift recipients	Frequency of fish received	Fish gift givers
	(Fish gift)	(No. of persons receiving)	(Fish receipt)	(No. of persons giving)
Mean	2.00	2.01	1.89	1.68
Min.	0	0	0	0
Max.	10	3	10	3
SD	1.31	0.96	1.32	1.14
No. of obs.	238	253	204	253

Table 11. Summary statistics of fish sharing network: giving and receiving fish gift

Network Measure	Fish Sharing							
	Fish gift (giving)				Fish gift (receiving)			
	Mean	Median	Min	Max	Mean	Median	Min	Max
Degree	2.78	3	0	7	2.58	3	0	18
Indegree	0.71	0	0	5	0.91	0	0	18
Outdegree	2.07	2	0	3	1.67	2	0	3
Betweenness	12.95	0	0	192	4.32	0	0	148.5

fish-giving and fish-receiving networks, respectively. Of these, 13 and 12 mutual connections were also observed in fish-giving and fish-receiving networks, respectively, suggesting some level of reciprocity between fish-givers and fish-receivers.

The network centrality (**Fig. 19(a)**)[8] well supports the sharing analysis discussed earlier in this section. In this case, the outdegree centrality (depicted by the directional arrows) for fish-giving is clearly evident, particularly from respondents (the fishers) to dependants (receivers). The directional flow of arrows from fishers (the givers) to the receivers (see **Fig. 19(a)**) clearly supports the giver dominance discussed above. The role of a leader (position) does not seem to override the giving and receiving social practice within villages; circle sizes denoting degree centrality appear to be the same for all categories of village members. At the village cluster level (see **Fig. 19(b**)), the social networking in fish-giving depicts intra- and inter-village giving. The arrows portraying the interactions show two interactive processes. The first, the intra-village fish-giving, largely shows fish-giving among village members, i.e., strictly within the villages. The second, inter-village giving, is localised among some of the villages. The most pronounced inter-village fish-giving is that of Village G and Village H; this is shown as two-directional (reciprocal), Village G gives to Village H, and vice versa. These are neighbouring villages, siting side by side and, therefore, this is not surprising. The

[8] See Appendix A for the theory and application of the social network analysis. Network diagrams were created by Gephi 0.9.2 (https://gephi.org/users/download/).

fish-giving interaction between Village E and Village D, on one hand, and Village E and Village G, on the other, is less pronounced and one directional. These are also neighbouring villages within close proximity, less than two kilometres away from each other, at most. An inter-village giving interaction that is a little puzzling is that of Village G and Village B. Village B is farther away from Village G, in fact, on two separate peninsulas, more or less, and with considerable travel distance between them. In **Figure 19(b)**, we do not observe any fish-giving interaction between the remaining villages, including Village B and villages close to it, such Villages A and F.

The fish-receiving centrality picture (**Fig. 19(c)**) at the individual level within villages follows quite a similar description as that of fish-giving. The directional arrows, generally, show a flow of fish-gifts from respondents (fishers) to receivers, indicating a strong dependency of receivers on givers. Here, too, node sizes (circles) of fish-givers, be they chiefs, chairmen or leaders, are similar. This also signifies that position does not matter in the villages as far as fish-sharing is concerned. The fish-receiving network for village clusters (**Fig. 19(d)**) is no different from that described under fish-giving in **Fig. 19(b)**; it has the same directions and clustering of intra-and inter-village receiving, with position remaining irrelevant in fish-sharing. Some interesting networking can, however, be observed. There is intense and reciprocal interaction between Villages D and B, villages far apart from each other, and Villages G and H, very close neighbours. The interaction between Villages G and B, on one hand, and Villages H and B, on the other, are, however, less intense, but reciprocal. The relationship between Villages A and B appears very limited, and one directional, with Village B on the receiving end. An interesting observation in terms of the fish-giving networking of Villages G and H is the concentration of receiving by a few individuals in Village G, i.e., nodes 215, 223 and 220 (**Fig. 19d**). We found that of these, only one (node 220) was a chairman and catechist in Village G's church, while the remaining two were ordinary village members. Though this may not provide much insight as to the category of

people receiving fish gifts, it does emphasise the earlier observation that fish-sharing is not necessarily dependant on individuals' position within the village or community.

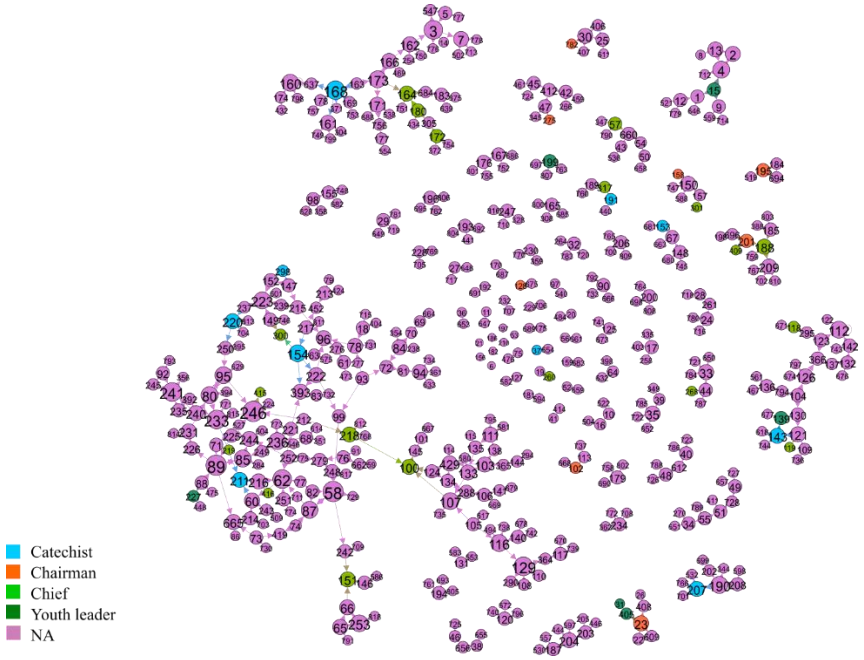


Figure 19(a). Degree centrality of fish-giving network by position.

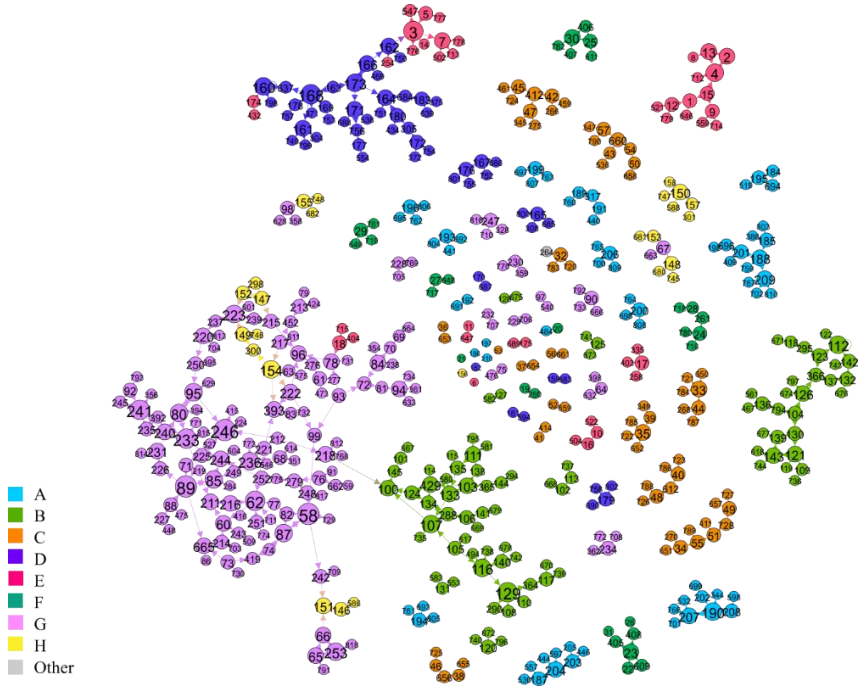


Figure 19(b). Degree centrality of fish-giving network by village.

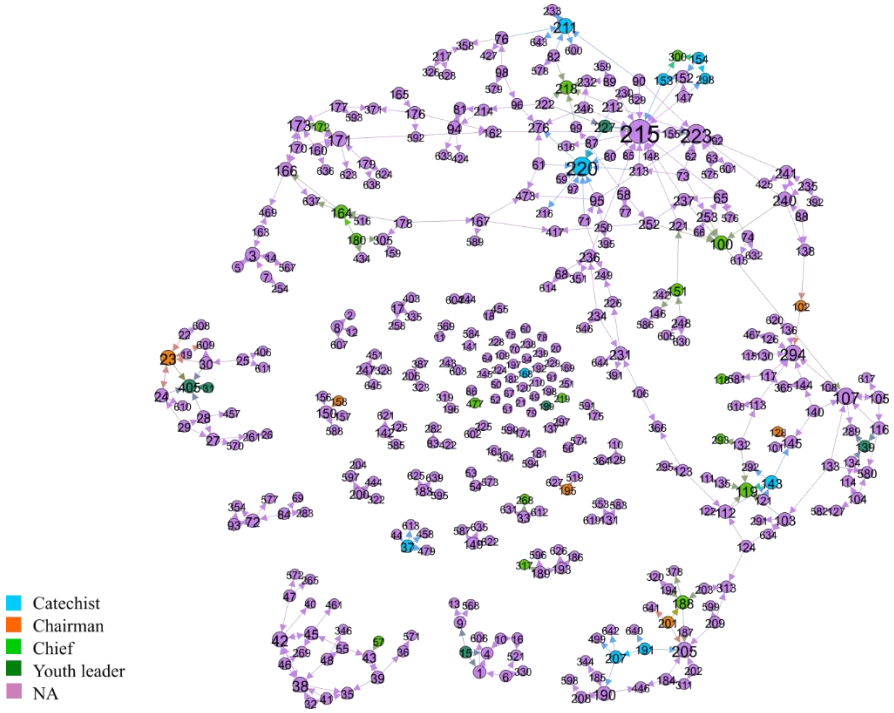


Figure 19(c). Degree centrality of fish-receiving network by position.

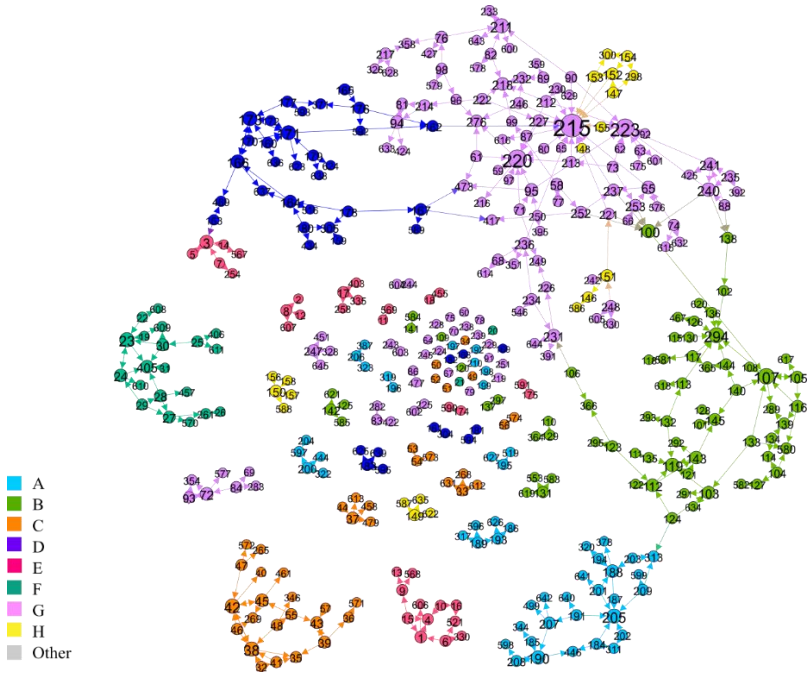


Figure 19(d). Degree centrality of fish-receiving network by village.

Figure 19. Degree centrality of fish gift: giving and receiving network.

Node size denotes the degree of centrality.

5.3 Fishing capital and equipment

Access to fishing gear in small-scale inshore fishing communities, where poverty levels are high, is of utmost importance, not only in the extraction of the fish resource itself, but also in the generation of household income (Crona & Bodin, 2010). It has also been suggested that gear ownership implies a source of power over those who depend on its use and, thus, likely affects the ability of dependant individuals to change their extractive behaviour (Crona & Bodin, 2010). Béné (2006) contended that low capital input, capital/labour ratio and investments, or low technology are usually recognised as the cause of low productivity (i.e. catch per unit of fishing effort [CPUE]) and yield. The argument is that whereas low CPUE may be a good thing for resource conservation, it obviously does impact the socio-economic outcomes of small-scale fishers who, in the case of the villages in this study, as discussed earlier, generally fish at subsistence levels.

The inherent social factors in the villages, including kinship and other interpersonal relations, make it compelling to explore fishing capital and equipment ownership structures as well as sharing arrangements in the villages. In this study, fishing capital in the villages was assessed with the primary objective of evaluating capital sharing among fishers and how that could help explain the social cohesion and resource management systems in place. Further to that, assessing fishing equipment type, ownership and sharing arrangements in the villages was also meant to help identify, albeit indirectly, the capital intensity and the possible effect on the stock and household income.

Shester and Micheli (2011) observed that although the ecological impact of specific fishing equipment is widely investigated in offshore commercial fisheries in industrialised nations, the literature remains sparse on the habitat impact of small-scale fishing gear. While the relatively low technology and the limited aerial coverage of small-scale fisheries are expected to lead to low ecological impact, some gear in small-scale fisheries has been found

to be capable of removing or damaging benthic structures that support marine life (Shester & Micheli, 2011). This equipment may interact with the fish habitat, or ecosystem in general, in different ways, with severe impacts, comparable to those of commercial fisheries, on a per unit of catch basis (Morgan & Chuenpagdee, 2003; Shester & Micheli, 2011). Benthic structures, including algae, sea grass, corals and sponges, are, in this sense, considered the most sensitive habitats to fishing gear impact. The emphasis is that studies on habitat effects of small-scale fishing gear, particularly traps and gillnets, have been sparse and with mixed results.

While the assessment of the ecological impact of fishing equipment and practices in fishing communities was not the focus of the current study, we considered it important to identify gear types used by fishers in these villages in order to establish informed management strategies that may help address the challenges local fishing gear and practices pose to the ecology and fish habitat. We thus analysed equipment (i.e. boat and gear) type, ownership and sharing systems in these communities. Fishers in this study also use a variety of gear types, including hook-and-line, spear, bow and arrow, trap, net, FADs, bait, diving gear and poison.

5.3.1 Fishing equipment: operated, owned and shared

This section examines equipment operated (used), owned and shared in regard to engine boats (also referred to as motorboats) and canoes, specifically, engine boat and canoe use in relation to fishing activities among respondents. All respondents were asked to answer three questions about fishing equipment (canoes and engine-propelled boats) separately: Canoes (whether they operate/use canoes or not; whether or not they own the canoe and whether or not they share in the use of canoe); and engine-propelled boats (whether they operate/use engine boats or not); whether or not they own the engine boat, and whether or not they share in the use of engine boats. In other words, all 253 respondents answered each of the two

Figure 20(a). A wooden canoe in Tasiloki Village.

Figure 20(b). Engine-propelled wooden boat with the owner, Kobiloko Village.

questions as separate questions, not jointly. The results (see **Table 12**) showed that respondents operated or used two main types of fishing equipment or fishing vessels, which were canoes and engine/motor-propelled boats, also referred to as outboard motorboats, in the villages. **Figure 20(a)** and **(b)** show the two main equipment types operated by fishers in the villages.

We determined that of the number responding to the canoe question, a majority, over 79%, operated/used canoes, while about 20% did not. We observed that some fishers used a combination of equipment as and when available, given that there was equipment sharing. Ownership (and non-ownership) among those who used canoes was in almost equal proportion with non-ownership (i.e., 50.20% and 49.80%, respectively). On the other hand, a good proportion (a little over 69%) of respondents using this equipment did share, with nearly 31% not sharing in the use of this equipment. Engine-propelled boat operation, ownership and sharing are quite different from that of canoes. Whereas only a little over 19% of those who answered this question operated engine boats, nearly 81% did not operate engine boats. Over 88% of fishers who used engine boats did not own them, and only about 17% shared in the use of engine boats. Intuitively, it appeared that the majority of engine-propelled boat owners did not share their equipment with other fishers in the villages,

Table 12. Equipment: operated (used), owned and shared

Equipment use	Equipment			
	Canoe		Engine-propelled Boat	
	Yes (%)	No (%)	Yes (%)	No (%)
Operated (used)	79.45	20.55	19.37	80.63
Owned/Not-Owned*	50.20	49.80	11.86	88.14
Shared[9]	69.17	30.83	17.39	82.61
No. of obs.	253		253	

Note: Yes and no for ownership means owned and not-owned, respectively.

with a possible reason being that the capital investment involved in the acquisition of engine propelled boats was high and therefore owners wanted to be careful in their use, or because of the high operational cost (high fuel cost) or both.

5.3.2 Fishing gear use and ownership structure

To understand the composition of gear type used in the villages, we asked respondents to identify the gear used in their fishing operations. In all, ten gear types were identified. We found that respondents who answered 'yes' to the use of hook-and-line were in the majority (about 95%). The most significant types of gear used, besides hook-and-line, in terms of proportion of respondents using them, were bait, lure, spear and net, respectively, in that order (see **Table 13**). Poisonous substances for fishing, though found to be of minimal use among respondents, have been shown to be a concern in other parts of the country, as explained earlier in this report and can, therefore, not be ignored. It must also be emphasised, as discussed earlier in this section that a good number of these types of gear may interact with the fish habitat or the ecosystem in general, in different ways, with severe impacts. **Figure 21** shows a man fishing with hook-and-line in a community where this study took place.

We attempted to determine the ownership structure of the fishing gear used, and

[9] 'Shared' here refers to sharing in the use (operation) of fishing equipment, between the owner and other family members, relatives or friends, or sharing equipment between a borrower and others (e.g. friends, relatives etc.).

Figure 21. A community member fishing with hook and line.

consequently the borrowing and lending arrangements in place in the villages.

Table 14 details the structure of fishing gear ownership.[10] We observed that apart from hook-and-line, bait and, to some extent, lure and spear, all of which were largely privately owned, perhaps due to their low capital structure, all other gear types were not privately owned. We also noted that joint ownership of gear was minimal, the highest being fishing nets (about 9.5%). This helped to explain the high level of gear borrowing observed in the study (**Table 14).**

[10] Private ownership here refers to personal acquisition of fishing equipment. Joint ownership, on the other hand, refers to ownership by two or more fishers (i.e., joint acquisition). Equipment **jointly owned** is acquired by two or more fishers. This is opposed to **sharing** in the use of equipment.

Table 13. Fishing gear use

Response	Gear type used									
	Hook & line (%)	Spear (%)	Bow & arrow (%)	Trap (%)	Net (%)	FAD (%)	Lure (%)	Bait (%)	Diving gear (%)	Poison (%)
Yes	94.86	31.62	4.74	3.56	23.72	7.11	45.85	79.45	2.77	1.19
No	5.14	68.38	95.26	96.44	76.28	92.89	54.15	20.55	97.23	98.81
No. of obs.	253	253	253	253	253	253	253	253	253	253

Table 14. Fishing gear ownership structure

Gear type	Gear ownership type			
	Private ownership		Joint ownership	
	Privately owned (%)	Not privately owned (%)	Jointly owned (%)	Not jointly owned (%)
Hook & line	90.91	9.09	5.14	94.86
Spear	30.04	69.96	1.98	98.02
Bow & Arrow	3.56	96.44	0.79	99.21
Trap	1.58	98.42	1.58	98.42
Net	5.93	94.07	9.49	90.51
FAD	1.19	98.81	1.19	98.81
Lure	42.29	57.71	1.98	98.02
Bait	76.28	23.72	2.37	97.63
Diving gear	2.77	97.23	0.00	100
Poison	0.40	99.60	0.79	99.21
No. of obs.	253		253	

5.3.3 Equipment borrowing and renting

It is believed that when inequality in asset ownership is reflected in a manner that places poor owners in debt to fish merchants to whom they have committed their catch, while more well-to-do owners avoid such indebtedness, it is bound to hamper collective action (see Crona & Bodin, 2010; Gaspart & Platteau, 2001). This can be a serious setback to community resource management efforts. Fortunately, the level of fishing asset ownership and dependency described in the above literature did not entirely apply to the villages under

discussion in this study, though some aspects of dependency did exist. In this examination, we looked at equipment ownership and dependency under communal compatriotship. In other words, borrowers and lenders are compatriots whose main interactions (**Table 15**) are not based on pure market arrangements, with capital gains as the central motive. However, to what extent this seemingly insignificant level of dependency in these villages impeded their collective action in the management of the resource was beyond the scope of the current study.

In this study, we also examined the forms of obligation binding in respect to borrowers and asset-dependency (i.e., borrowing and renting). Forms of honouring borrowing or rental obligations in the villages included payment by cash and in kind (i.e., goods and labour). Under borrowing, three levels of fishing compatriotship were identified: i.e., borrowing from one, two or three compatriots, as the number of compatriots a fisher can deal with in any given time period. In other words, a fisher borrowing equipment can do so from up to three lenders (who we here refer to as compatriots) in a given time period. This usually happens because a fisher wanting to borrow or rent equipment may not be able to do so from the same equipment owner (i.e. compatriot) at all times, for one reason or the other. One possible reason could be that the compatriot is using the equipment for some other purpose (e.g. own use, or lent out/rented to another fisher), or the fisher has a pending payment obligation to a previous compatriot, and so decides to look for another borrowing or renting source, while trying to settle previous obligations. We assumed, for fear of social sanctions in a wantok system, there would be no debt repudiation. In reality, fishers may borrow from any number of compatriots, but for analytical purposes, we limited the number to a maximum of three.

For clarity, we examined borrowing and renting separately, starting with borrowing. The results in **Table 15** show that the proportion of borrowers, in this case fishers, making payments increases as the number of compatriots from whom they borrow increases, increasing marginally from a minimum of about 30%, when fishers are borrowing from only

one compatriot, to a maximum of about 35%, when they borrow from three compatriots. This is logical because if borrowing arrangements involve payment, then the higher the number of compatriots from whom fishers borrow (i.e., from multiple compatriots), the higher the number of fishers obligated to make payments, i.e., the higher the proportion of payment obligation to compatriots. The proportion of fishers paying cash follows a similar pattern, increasing marginally from about 7%, with borrowing from one compatriot, to a maximum of about 12% when borrowing from three compatriots. We found that payment in goods is more pronounced among fishers, in the proportions of about 61%, 68% and nearly 54%, respectively, when one, two and three compatriots are involved. Notice that the proportion of fishers making payment in labour is comparatively almost negligible and, in fact, non-existent when only two compatriots are involved. A possible explanation here is that in a relatively 'income poor' fishing environment, it may be preferable for debt to be settled in kind, specifically in goods, and not in services (labour). This could be different in typically poor farming communities where farmhand labour as payment may be preferable.

Under equipment renting, we looked at payments from a maximum of three fishers. In other words, for ease of analysis, we restricted this to compatriots' ability to rent out equipment to three fishers at any point in time. Here, we addressed the question of compatriots receiving payments from one, two or three fishers to whom they rent out fishing equipment. Rent payments showed similar patterns to those observed under borrowing. For

Table 15. Forms of payment made when borrowing or renting fishing equipment

Variable	Borrowing						Renting					
	Compatriots						Fishers					
	The first compatriot named		The second compatriot named		The third compatriot named		One fisher		Two fishers		Three fishers	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Payment	30.07	69.93	32.35	67.65	34.88	65.12	36.51	63.49	37.84	62.16	46.27	53.73
Cash	7.19	92.81	7.35	92.65	11.63	88.37	7.41	92.59	5.41	94.59	2.99	97.01
Goods	61.44	38.56	68.24	36.76	53.49	46.51	56.61	43.39	57.66	42.34	50.75	49.25
Labour	0.65	99.35	0.00	100	2.33	97.67	2.12	97.88	0.00	100	0.00	100
No. of obs.	153		68		43		189		111		67	

example, the percentage of compatriots receiving payment increased with an increase in the number of fishers to whom they rented equipment, i.e. increasing from about 37%, when rented to only one fisher, to about 46%, when rented to three fishers. Again, the proportion of compatriots receiving cash payment from renting was quite minimal, ranging from about 7% to about 5% and just under 3%, when equipment was rented to one, two or three fishers, respectively. Here again, the proportion of compatriots receiving payment in goods was much higher than those receiving payment in cash, with payment receipts in labour (service) being about 2%, when rented to one fisher, and non-existent with the involvement of two or three fishers. A similar argument made in the borrowing case holds here as well: money is largely hard to come by in poor fishing communities, and so equipment renters may be more willing to accept payment in goods, presumably for household consumption, and not labour.

5.3.4 Fisher networking: equipment use

In the preceding sections, we discussed equipment ownership and use under communal compatriotship and examined asset dependency and the forms of obligation to equipment lenders. We will now discuss the nature of networking among fishers in the villages in relation to equipment use. Specifically, we examined the degrees of networking in gear

borrowing and renting among fishers. We observed that in the case of gear borrowing, the mean (1.62) of the degree centrality measure was largely explained by the outdegree mean (**Table 16**). Recall that the degree measure is a sum of indegree and outdegree measures. The relatively low mean of the indegree measure, compared with that of outdegree, suggests that gear lenders are influencers. The results further suggest that as far as gear borrowing is concerned, interpersonal relationships are important in the villages; fishers must relate well to be able to borrow from gear owners, especially given that from 65% to nearly 70% of those who borrow fishing equipment do not make payment of any kind (**Table 15**). Furthermore, the mean and median of the degree is relatively smaller than that of the degree observed in the food sharing network (**Table 11**), suggesting that gear sharing may be a more limited option than food sharing. The mean of the betweenness centrality (1.30), showing the average number of times one acts as a bridge between two people (see Appendix A), suggests that, on average, borrowers may not have to go through more than two people, as bridges, to be able to borrow fishing gear.

The situation is not much different when it comes to gear renting networking. The mean degree centrality of 2.14 was largely explained by outdegree centrality (1.47), again suggesting that gear renters are influencers. The comparison of indegree and outdegree means here also points out the importance of interpersonal relationship in the villages as far as gear renting is concerned, especially when from about 54% to 63% of compatriots renting out gear

Table 16. Summary statistics of fisher networking: gear use (borrowing and renting)

Network measure	Fisher networking: borrowing and renting							
	Gear borrowing				Gear renting			
	Min.	Median	Mean	Max.	Min.	Med.*	Mean	Max.
Degree	0	1	1.62	14	0	2	2.14	9
Indegree	0	0	0.57	14	0	0	0.67	8
Outdegree	0	1	1.05	3	0	1	1.47	3
Betweenness	0	0	1.30	48	0	0	3.88	135

did not receive payment of any kind (**Table 15**).

We examined the gear borrowing and renting networking at intra- and inter-village levels as shown in **Figure 22(a, b, c and d)**. At the intra-village level (**Fig. 22(a)**), we determined the nature of gear borrowing between lenders (compatriots) and borrowers (fishers) within the same village. The majority of the intra-village flows were outbound (outdegree) with small inbound flow concentrations, particularly towards nodes 95, 107, 220 and 248 (indegree). This suggests a higher level of dependency compared with a much lower degree of influence. Here too, position did not play a major role, as chiefs and other leaders were either borrowing or serving only as bridges between borrowers and lenders (see, for example, nodes 119 and 218 (chiefs), and 168 and 207 (church leaders)). Borrowing and lending networking at the inter-village level, depicted in **Figure 22(b)**, suggests that not many inter-village gear borrowing and lending interactions occur. However, we can see a few bridges (betweenness) among a few neighbouring villages.

Figure 22(c and d) describe gear renting between renters (fishers) and lessors/rentees (compatriots). From the data in **Figure 22(c)**, we can see that there is a high level of outbound (outdegree) flows from renters to rentees, with relatively few nodes with concentrated inbound (indegree) flows serving as major rentees, implying a relatively high level of dependency on gear renting. We also can see a high concentration of inbound flows to nodes 100 (solely inbound) and 57, 188 (a bridge between renters and rentees), who all happened to be chiefs. A couple of non-community leaders (nodes 58, 107, 167 and 205) can also be observed to be rentees (indegree influencers). Inter-village renting (**Fig. 22(d)**), unlike inter-community borrowing (**Fig. 22 (b)**), is particularly strong among neighbouring communities.

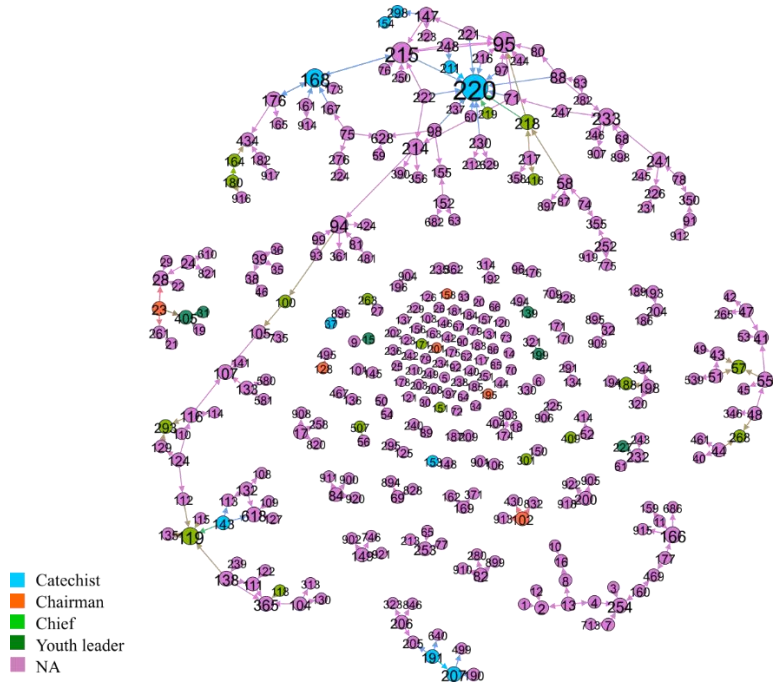


Figure 22(a). Degree centrality of gear borrowing network by position.

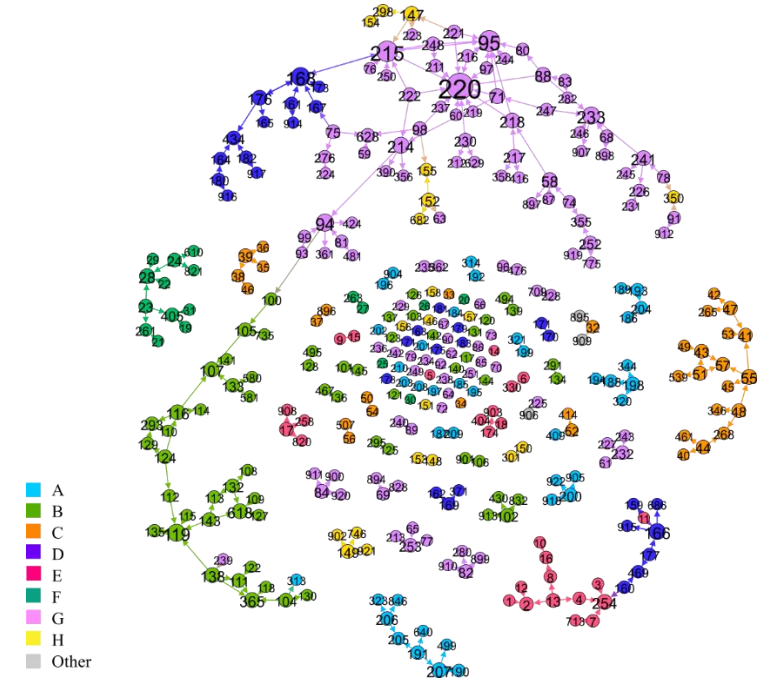


Figure 22(b). Degree centrality of gear borrowing network by village.

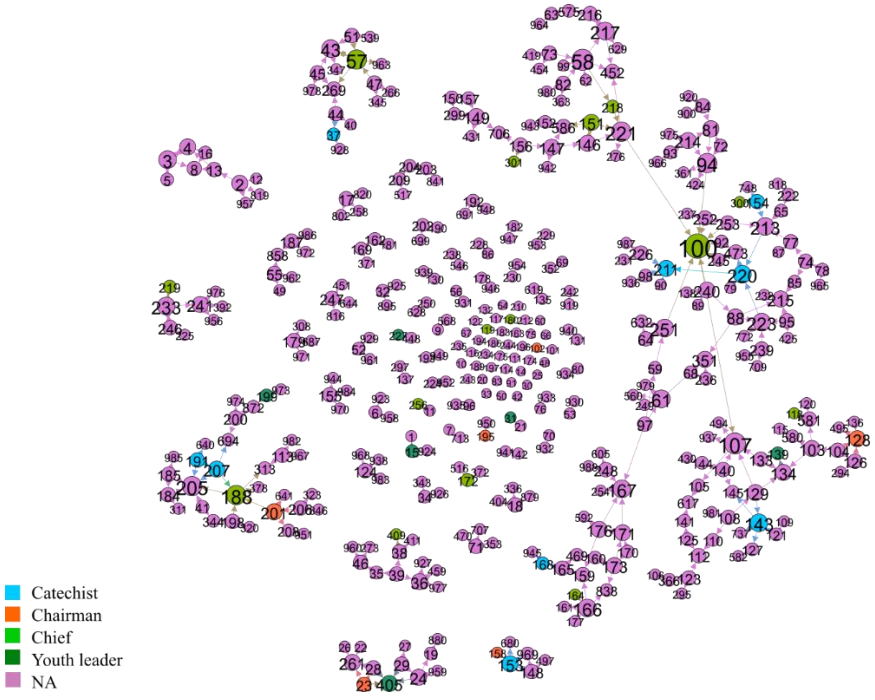


Figure 22(c). Degree centrality of gear renting network by position.

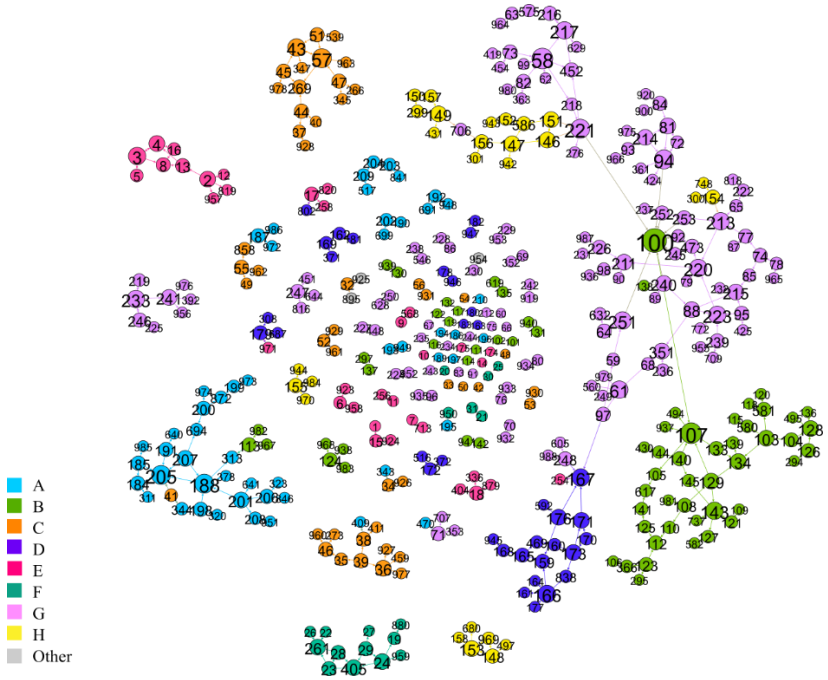


Figure 22(d). Degree centrality of gear renting network by village.

Figure 22. Gear borrowing and renting network.

6. Cooperative Behaviour and Conflict Resolution

Bodin and Crona (2008) posited that even though conflict resolution mechanisms are often considered essential prerequisites for common property resource management (Ostrom, 1990), they are rarely included in empirical studies of social capital. Contributing to the argument, Gurneya et al. (2016) contended that even though the participation of local people is critical to the success of devolved commons management, few studies have empirically investigated how individuals' participation is related to factors that operate at multiple scales. In this section, we will describe our analysis of individual and community-wide cooperative behaviour in relation to participation and interaction in community resource management. Specifically, we evaluated communities' perceived changes in stock levels, reasons for the changes, information networks in the observed environmental changes in the fisheries, relationship and companionship among fishers and how the inherent social capital mechanisms were employed to monitor rule-breaking (non-compliance) to ensure successful management and conservation of the resource.

6.1 Fishers' assessment of stock status

As noted earlier, fish stocks in the Solomon Islands are on the decline for various reasons. It was, therefore, important to get the communities' own perception of the subject of changes in stock status as well as their understanding of the possible reasons. For this purpose, we asked a number of questions to elicit information on the status of target species, when changes were observed, reasons accounting for the changes and other perceived reasons for the changes. Findings on these are presented in **Figure 23** and **Table 17** and discussed below.

6.1.1 Observed changes

To gauge the villages' perception of stock status, respondents were asked whether they thought the number of target fish species in their fishing grounds was increasing, decreasing or remaining unchanged. Nearly 66% of respondents believed that the number of fish species was decreasing, and about 23% indicated there had been no changes. Whereas about 2% of respondents could not express any opinion about the stock status in their fishing grounds, nearly 9% noted that their target species were increasing (**Fig. 23)**. Some of the communities surveyed currently practice some forms of conservation, so it was not entirely surprising that some target species were in fact increasing. For example, during the survey, a leader from one village mentioned that the village had instituted seasonal closure as a conservation method in their fishing bay, and when opened, nearby villages were allowed access. They boasted of a good harvest of shell clams, other molluscs and reef fish when the season was opened. This may offer some explanation for the belief among some village members that target species were increasing.

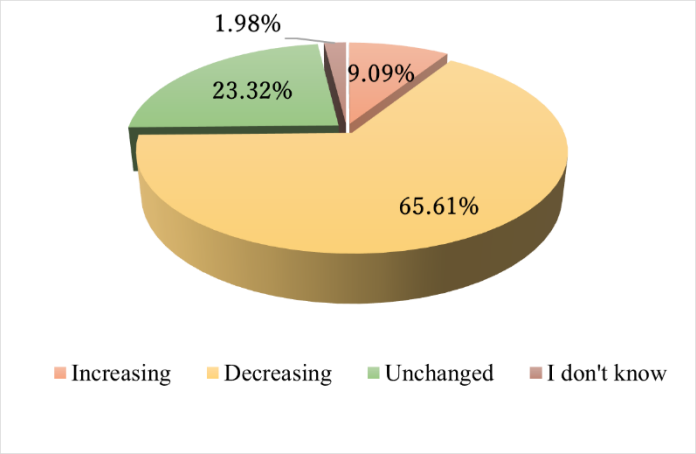


Figure 23. Perceptions about stock status in fishing grounds.

6.1.2 Reasons for the change

Explaining possible reasons accounting for the observed changes, respondents provided a

number of reasons, ranging from overfishing to natural disasters. Details of responses are provided in **Table 17**. Respondents addressed the issue of overfishing as a possible reason for the changes, by indicating that about 78% of overfishing results from own-village/community fishers, while only 37% believed that fishers from other villages were the cause. Further queries on external influences on overfishing showed that only 12% of respondents attributed overfishing in their village waters to foreign fishers. This was not surprising because the majority of small-scale fishers, with the exception of the few engaged in commercial fishing, fish close to their shores. Foreign fishers, however, are generally high seas commercial fishers, and are not likely to have a significant presence in coastal waters. Other possible reasons accounting for the changes in stock status were considered. These included loss of habitat, population growth, deforestation through commercial logging activities, climate change, inappropriate and unauthorised fishing methods, such as use of explosives and poisonous substances, natural disasters, the creation of marine protected areas (MPAs) and others. About 31% of respondents attributed the decline in stock status to loss of fish habitat, such as mangroves. On the other hand, 72% of those responding to the population factor attributed the decline to population growth. Deforestation, through logging, was considered by about 45% of respondents as the main reason accounting for stock decline. This may not seem high, compared with the situation elsewhere in the Solomon Islands, as mentioned earlier (see for example, Schwartz et al., 2007; SIG, 2011; 2017). Unlike other heavily logged regions of the country, these villages may not be experiencing heavy commercial logging activities, in comparative terms. On the subject of climate change, over 51% of respondents stated that they believe climate change is a major reason for the negative change in stock status in their fishing grounds. This generally confirms the position widely held among researchers and those documented about the Solomon Islands, as earlier highlighted in this report.

Table 17: Distribution of reasons accounting for changes in stock status

Reasons	Main reason		Not main reason	
	Freq.	%	Freq.	%
Overfishing by own village fishers	148	78.31	41	21.69
Overfishing by other village fishers	70	37.04	119	62.96
Overfishing by foreign fishers	22	11.64	167	88.36
Habitat loss	58	30.69	131	69.31
Population increase	137	72.49	52	27.51
Logging	85	44.97	104	55.03
Climate change	97	51.32	92	48.68
Use of explosives/poison	31	16.40	158	83.60
MPAs	17	8.99	172	91.01
Disasters	73	38.62	116	61.38

Note: All 189 respondents gave dichotomous views on each reason.

As indicated earlier, the villages in this survey are prone to climate-related disasters, and so we used the survey to determine if disaster is considered a major factor accounting for the observed changes in stock status. The results showed that just a little under 39% considered disaster as a major factor. Contrary to findings earlier cited in this report that unsustainable fishing methods are a major problem in the Solomon Islands, only about 16% of respondents considered this to be a major problem in these villages. MPAs are generally considered a positive conservation method in community-based fisheries management, albeit their failures and challenges have been widely documented in the literature. In the case of the villages considered in this survey, only 9% acknowledged it as a main reason for positive change in stock status in fishing grounds. This did not come as a surprise, given the case of the village mentioned earlier. In that case, the village leader lamented that management of the seasonal closure practice had not been very successful. This was attributed to the challenge of fishers

from neighbouring villages trespassing and breaking the rules, coupled with the villages' failure to report rule-breaking, mainly because those not complying were friends and relatives – the wantok syndrome. We will visit the question of rule-breaking (non-compliance) again in subsection 6.3.2.

6.2 Information networks regarding changes in the natural environment of fishing grounds

After obtaining the respondents' assessment of stock status, we tried to understand the management structures in place to address issues related to observed changes in stock status in the villages. We did this by asking about reporting and discussion channels, including information networks, available to them. In this and the next sections, we will discuss the issues related to networking in the communities. The distributions and network measures are presented in **Tables 18, 19** and **20,** and **Figures 24** and **25**.

6.2.1 Reporting and discussion of change

Respondents were asked whether they discussed noticeable changes in the natural environment of their fishing grounds, such as the amount of fish and the conditions of mangrove forests and coral reefs. About 84% of respondents indicated that they had discussed such issues, with only about 16% responding that they did not discuss the issues with anyone (**Fig. 24)**. On average, respondents discussed issues of noticeable changes in their fishing grounds with about two other community members (and up to a maximum of four) (**Table 18)**.

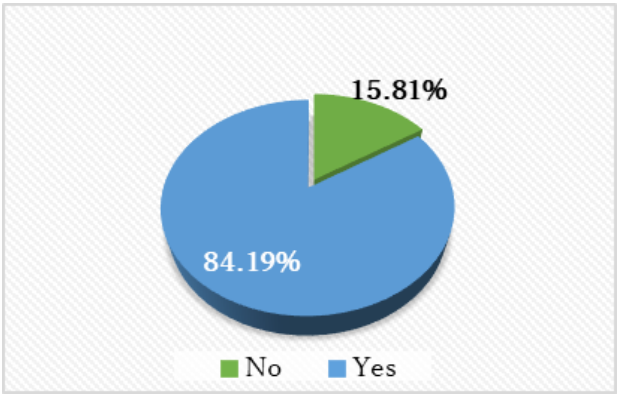


Figure 24. Respondents who discussed changes in fishing environment with community members.

Table 18. Summary statistics: fishing-related issues in communities

Statistics	Issues		
	Changes in fishing grounds (No. of persons issues are discussed with)	New fishing rules and restrictions (No. of persons communicating to the community)	Conflict resolution (No. of persons asked for help in the community)
Mean	2.39	2.09	1.82
Min.	0.00	0.00	0.00
Max.	4.00	4.00	4.00
SD	1.43	1.44	1.49
No. of obs.	253	253	253

Though this differed among villages, noticeable differences, in terms of numbers, were registered in Villages G and H. From the information supplied in **Table 19**, we can observe that in Village G, the proportion of respondents who discussed change issues with two, three or four village and community members were about 38%, 42% and 40%, respectively. Village H, a close neighbouring village, on the other hand, recorded only about 3%, for discussion with two, three or four members. Overall, among all eight villages in the survey, Village G recorded the highest number of respondents discussing changes with other village and community members (see **Table 19**).

Table 19. Distribution of number of persons with whom observed changes were discussed by village

Villages	Number of persons			
	1	2	3	4
Village A	27	24	14	7
Village B	36	29	20	16
Village C	21	18	13	11
Village D	13	11	6	1
Village E	17	15	12	4
Village F	11	10	9	4
Village G	75	68	56	30
Village H	12	6	4	2
Total	212	181	134	75

Table 20. Information and compliance networks

Network Measure	Information exchange				Non-compliance			
	Change in natural environmental				Reporting non-compliance (rule-breaking)			
	Mean	Median	Min.	Max.	Mean	Median	Min.	Max.
Degree	3.61	3	0	20	0.90	1	0	33
Indegree	1.22	0	0	16	0.27	0	0	33
Outdegree	2.39	3	0	4	0.63	1	0	1
Betweenness	14.08	0	0	253.3	0.12	0	0	11

As part of the information sharing about stock status and other fishing issues in the villages, the fishing grounds natural environmental change information sharing network was categorised into four different degrees of centricity: degree, indegree, outdegree and betweenness. In **Table 20**, we can see that outdegree centrality is, on average, twice as high as indegree, suggesting that there is more information outflow than inflow. In other words, village members are twice as likely to share information than receive it. Betweenness, which essentially depicts the number of times individuals act as bridges in the village, has the highest mean degree centricity of 14.08. This suggests a high level of information sharing about stock status and other fishing issues, though the number of such fishers is limited. It

can also be observed that degree centrality in information is more explained by outdegree centrality than indegree centrality.

Data on network information sharing at both individual and inter-village levels is presented in **Figures 25(a)** and **(b),** respectively. Graphically, **Figure 25** shows degree centrality networking in information exchange on observed changes in the natural environment of fishing grounds. While a comparatively high degree of information exchange between chiefs and respondents (fishers) can be observed (**Fig. 25(a)**), suggesting the central role of chiefs in the villages, a comparable level of degree centrality of networking among respondents is also observable. At the village level, degree centrality of information exchange on the subject is more pronounced in Village G, followed by Villages A, B, C and F, in that order, supporting earlier discussion on information sharing about observed environmental changes in fishing grounds. Villages D, E and H, on the other hand, do not exhibit a high level of degree centrality of information exchange on observed changes.

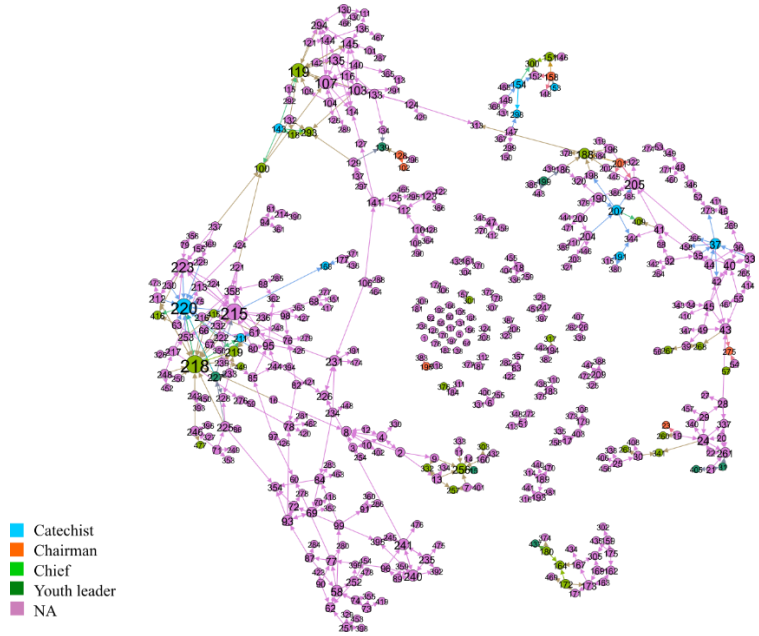


Figure 25(a). Degree centrality of information exchange network by position.

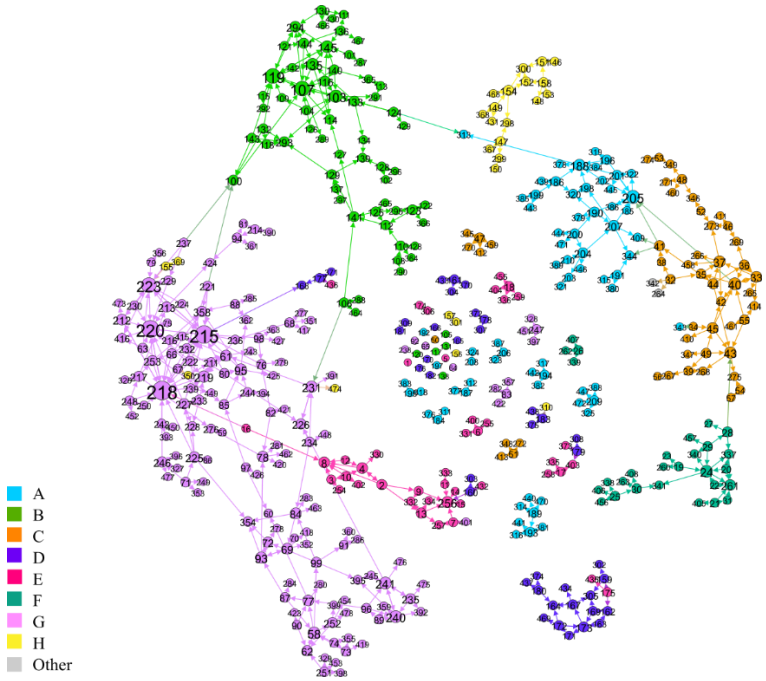


Figure 25(b). Degree centrality of information exchange network by village.

Figure 25. Degree of centrality of information exchange network.

Networking bridges are also observable among community clusters, i.e. inter-village networks (**Fig. 25(b)**), with the exception of Village D. In terms of location, Village D's community is far removed from all other communities, and though residents can be connected by boat travel, there is no road network between this village and other villages. It is, however, not clear if such isolation explains the visible lack of networking in fishing grounds information exchange with other communities.

6.3 Community fishing rules and restrictions

Management challenges in resource exploitation continue to engage the attention of researchers, particularly in respect to fisheries. Community resources also remain open to access, at least to community members, and with this comes the problem of the commons. As outlined in the introduction of this report, Ostrom (1990) and others have long argued that

communities are able to put in place measures to ensure efficient utilisation of community resources and promote sustainable use of the resources. It was, therefore, important to find out if there are any measures in place in the eight villages that seek to safeguard the sustainability of the fisheries in their fishing grounds. **Figures 26, 27, 28, 29** and **30**, and **Tables 18** and **21**, detail the results discussed in this section.

6.3.1 Rules, restrictions and compliance

On the question of management measures in place in the villages, the survey sought to find out respondents' awareness of fishery rules and applied restrictions. Only 53% of the respondents indicated they were aware that there are fishing rules and restrictions in the villages (**Fig. 26(a)**). Of these, the distribution of knowledge of various types of restrictions included the following: knowledge of restrictions on use of explosives and poisonous substances in fishing (about 45%); fishing season restrictions (about 28%); fishing location restrictions (about 16%); restrictions on use of types of gear (about 7%); fish size restrictions (about 2%); and less than 1% each for restrictions on allowable species, amount of fish and specific fishing time in a day (**Fig. 26(b)**). Overall, only 53% of those aware of the existence of fishing rules believed fishers complied with restrictions at one level or another.

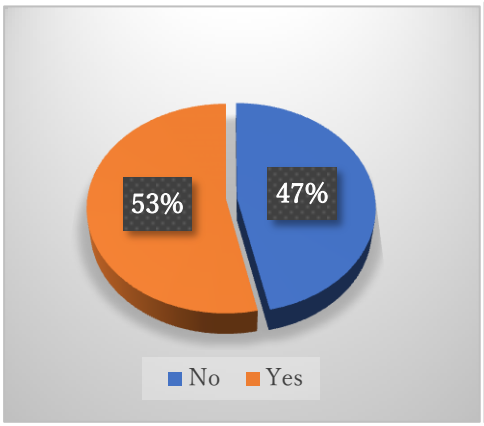


Figure 26(a). Awareness of fishing restrictions in communities.

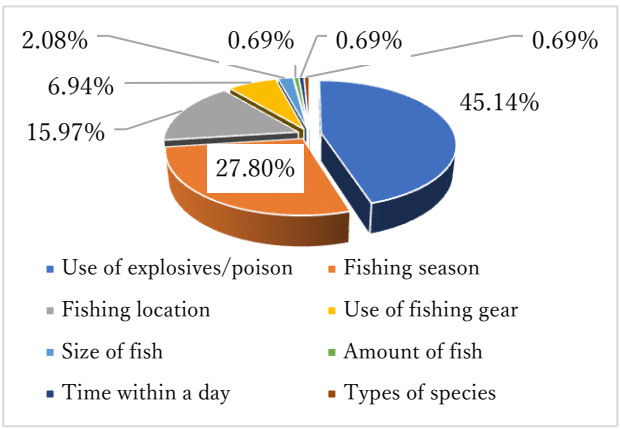


Figure 26(b). Knowledge of existing fishing restrictions in communities.

Figure 26. Knowledge and awareness of fishing restrictions.

6.3.2 Reporting non-compliance, education and territorial conflict resolution

A major criticism of Becker's (1968) crime and punishment model, which explains non-compliance behaviour, according to Karper and Lopes (2014), is its lack of social dimension. Karper and Lopes argued that the likelihood of regulatory compliance in fisheries depends not on the level of enforcement alone, but also on individual fisher behaviour and motivation, including peer and social pressure. The contention is that to foster a more comprehensive understanding of fisher compliance behaviour in order to promote fisheries management success, examination of the social and economic aspects of the fisher is vital. We push this discussion further by emphasising that understanding the compliance question through a social dimension makes the subject of social cohesion even more vital in the quest to promote fisheries management success. Thus, it was necessary to determine if: 1) there are people in the villages who would usually communicate and discuss with and educate community members when new fishing rules and restrictions are introduced; 2) non-compliance (or rule-breaking) is reported; 3) there are systems in place to receive complaints; and 4) there are avenues to resolve fishing territorial conflicts and provide help.

As shown in **Table 18**, when new fishing rules and restrictions are introduced to protect stocks, on average, there are two (and a maximum of four) community members who will usually talk to and educate the communities on the new measures. On non-compliance reporting, we found that about 62% of respondents reported non-compliance (rule-breaking) when noticed **(Fig. 27**).

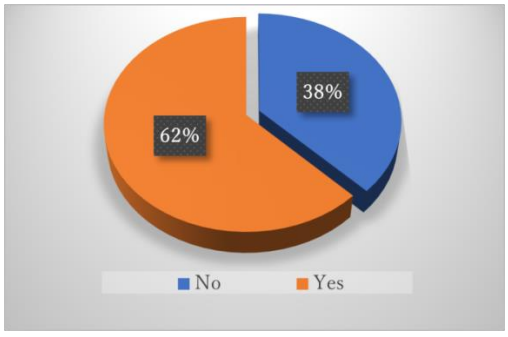


Figure 27. Reporting non-compliance (rule-breaking).

Reporting non-compliance (rule-breaking) varied from village to village, ranging from about 6% to nearly 31% (**Fig. 28**). Besides the wide range, reporting rule-breaking can generally be considered low among the villages. **Figure 28** indicates that in half of the villages, less than 10% of the people will report rule-breaking. The stark differences even between villages sitting side-by-side on the same landmass are unclear. A possible explanation can be inferred from the wantok phenomenon, where, for fear of social sanctions, people would ordinarily not want to be seen to be giving up (betraying) one of their own. The villages appear to have established channels for receiving non-compliance reports from community members. Responses indicated that those reporting rule-breaking will generally first report to certain individuals within the villages and communities. We found that persons receiving firsthand reports of non-compliance in the villages were mostly village chiefs (a little over 85%) and, to a very small extent, church leaders, such as catechists (about 6%) (**Fig. 29**).

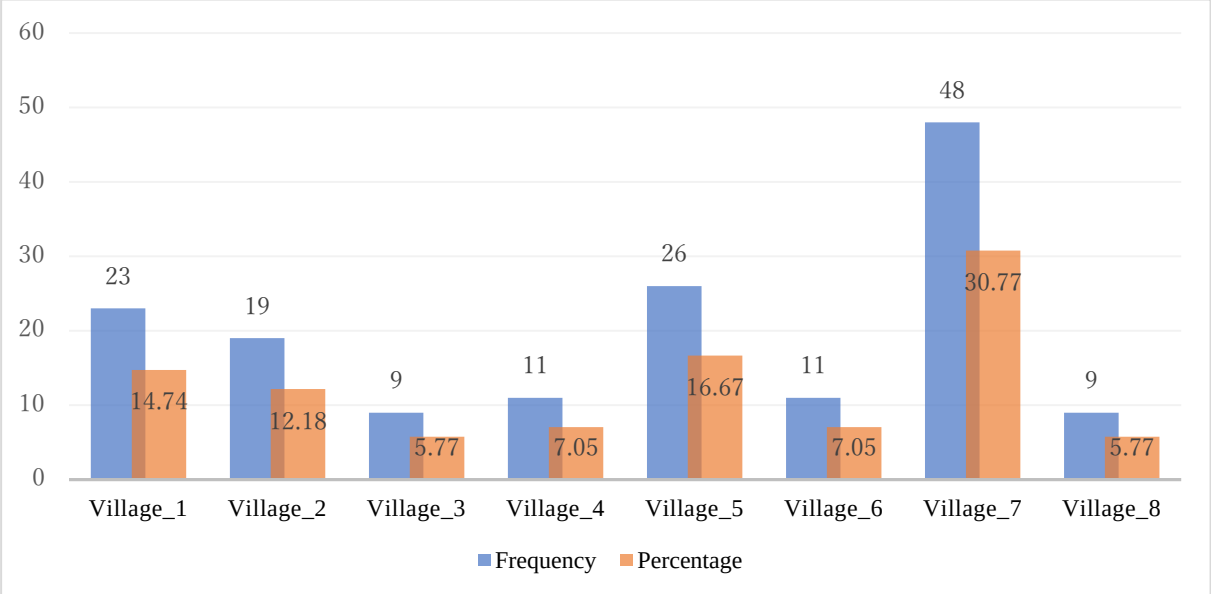


Figure 28.[11] Level of non-compliance reporting in villages: frequency (number of respondents) and percentage (proportions).

[11] Due to the sensitivity of the results here, we prefer to use numbers for the villages to ensure anonymity. The numbers are not in any order of importance.

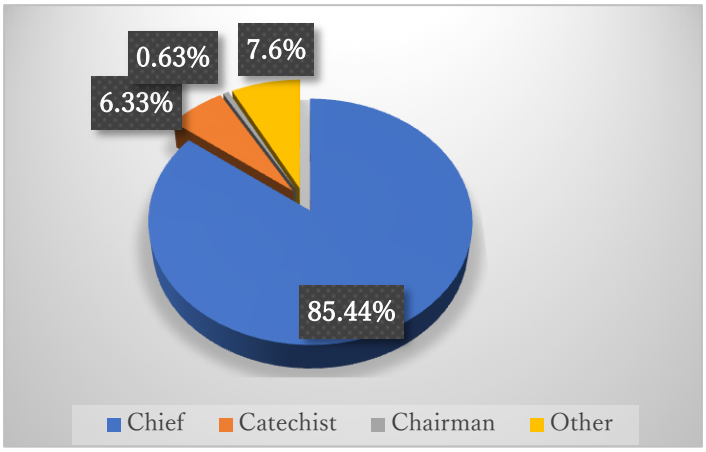


Figure 29. Persons first receiving non-compliance reports.

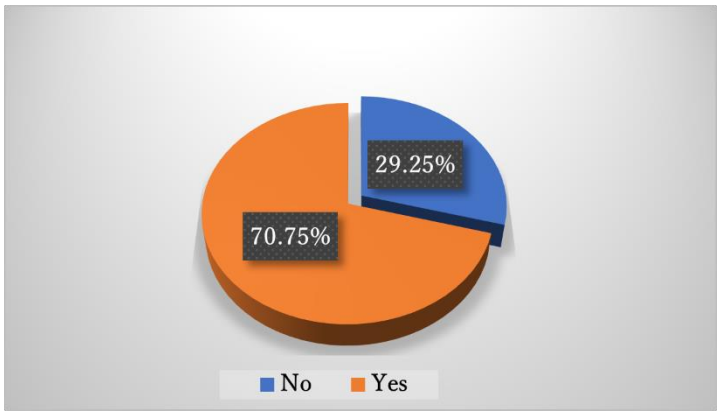


Figure 30. Reporting and requesting for assistance in times of conflict.

On territorial conflicts, a good proportion of respondents (about 71%) pointed out that when they encounter conflicts over fishing activities, such as conflicts over fishing grounds, catch or gear, there are individuals in the communities they will first report to and seek help from to resolve the conflict (**Fig. 30**). As shown in **Table 18,** people reporting and seeking help to resolve conflicts will, on average, identify two people (and up to a maximum of four), who they will approach.

In the previous discussion, we addressed rule-breaking and reporting channels. It is also important to consider the issue of fishing regulation information dissemination, education and implementation. In **Table 21**, we present the networking measures for fishing regulation information dissemination, education and implementation and conflict resolution assistance.

For clarity, recall that in the previous discussion, we referred to the number of people whom villages and community members will approach to seek help in resolving conflicts. Here, we are looking at networking in conflict resolution; it must be made clear that the two are different. **Table 21** shows that outdegree centrality of information dissemination, education and implementation is almost twice that of indegree. This can be interpreted as village and community members depending, or relying, on influential persons in the villages, such chiefs, for dissemination, education and implementation of fishing regulatory rules. Regulation education and implementation, explained by degree centrality, is largely accounted for by outdegree centrality. These findings generally support the positive aspects of the social capital theory, which has been well articulated in the fisheries literature. Kosamu (2015), for example, emphasised that robust collective social capital and strong community leadership are the most important attributes for fisheries management. It can also be inferred from the betweenness centrality measure in regulation education and implementation of fishing rules that, on average, there are about three bridges in the rule implementation network in the villages. Conflict resolution assistance network centrality measures follow similar patterns as those of the rule implementation networks. Degree centrality here is also largely accounted for by the outdegree centrality measure, with about two people serving as bridges in conflict resolution assistance (**Table 21**).

Table 21. Regulatory information dissemination, education and implementation and conflict resolution networks

Network Measure	Regulation information				Conflict resolution			
	Dissemination, education and implementation				Conflict resolution assistance			
	Mean	Median	Min.	Max.	Mean	Median	Min.	Max.
Degree	3.08	2	0	51	2.58	2	0	44
Indegree	1.02	0	0	48	0.78	0	0	42
Outdegree	2.06	2	0	4	1.80	2	0	4
Betweenness	2.54	0	0	133.5	2.16	0	0	94.5

We now present a graphical description (**Fig. 31**) of non-compliance and fishing regulation information dissemination, education and implementation networks, at both intra and inter-village levels, as done in the previous cases. Starting with the non-compliance network at intra-village level, we observed that in all the villages, chiefs are the key individuals receiving non-compliance reports from fishers, with very minimal involvement (a few instances) of other village and community leaders, such as church leaders, serving as bridges (betweenness) (**Fig. 31(a)**). This may well suggest the important role leaders, especially chiefs, play in resource management in the villages and communities. At the inter-village level, there was a similar phenomenon of village leaders being the main recipients of non-compliance reports. Inter-village network bridges in non-compliance reporting were observed only in one instance between two neighbouring villages (see **Fig. 31(b)**). A possible explanation is that these villages generally restrict fishing activities to their own-village/community waters (see section 5.1.2 and **Table 3**) and are, therefore, more likely to report non-compliance to own-village/community leaders.

Regarding regulation information dissemination and education, we observed that chiefs and fishers (respondents) are the main/influential or key persons disseminating information and educating community members about the implementation of new fishing regulations and restrictions in the villages (**Fig. 31(c)**). This clearly explains the importance of leadership in resource management at the village level, as indicated earlier. Network bridges in information dissemination, education and implementation of new regulations and restrictions at the inter-village level (see clusters in **Fig. 31(d)**), though highly concentrated and mainly involving leaders, do exist between neighbouring villages, suggesting social networking in regulation implementation and restrictions in information sharing or collaboration of some sort (i.e., a good degree of betweenness centrality) among the villages (see **Fig. 31(d)**).

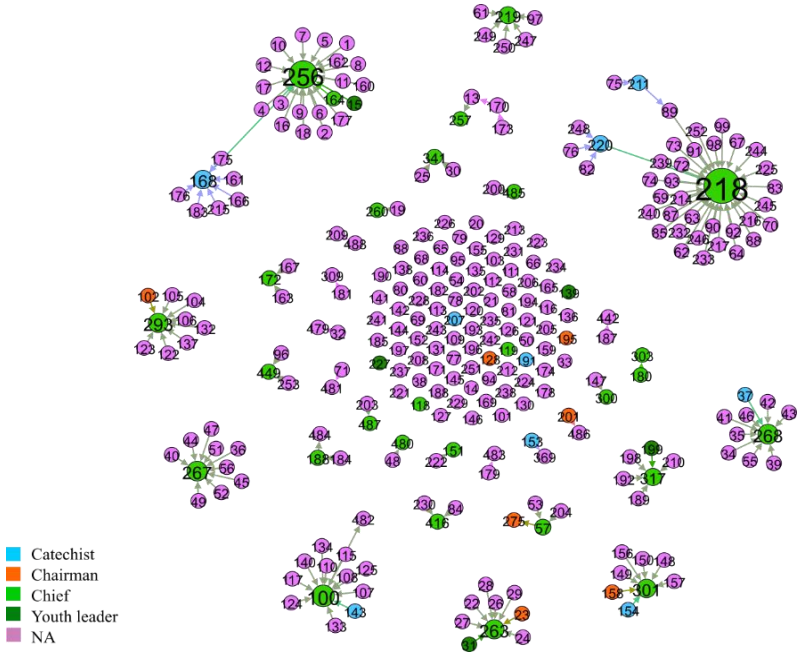


Figure 31(a). Degree centrality of non-compliance network by position.

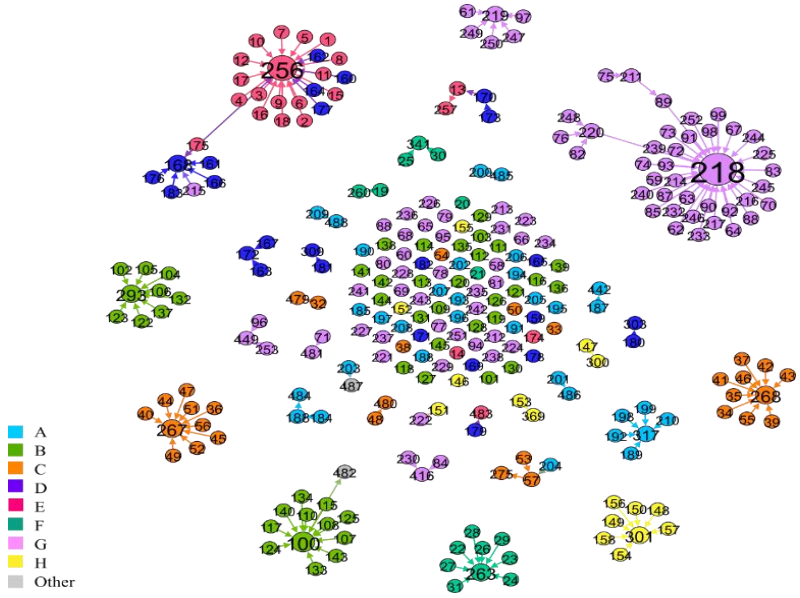


Figure 31(b). Degree centrality of non-compliance network by village.

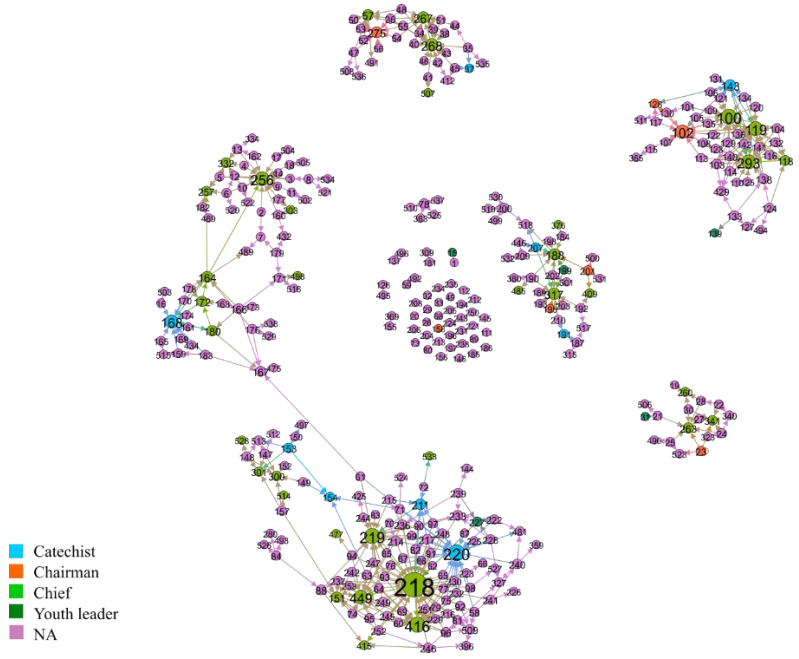


Figure 31(c). Degree centrality of information dissemination, education and implementation network by position.

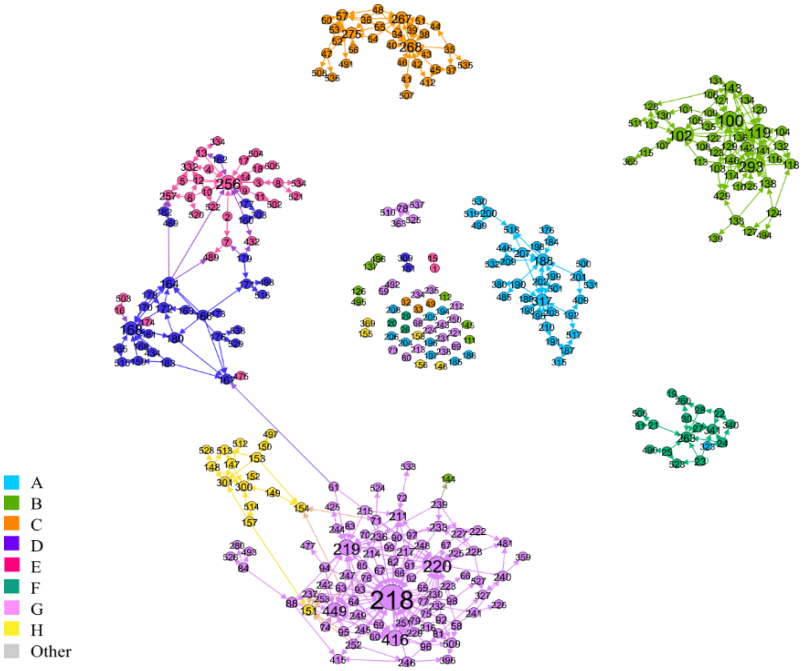


Figure 31(d). Degree centrality of information dissemination, education and implementation network by village.

Figure 31. Degree centrality of non-compliance, regulation information and conflict resolution network.

Finally, we want to address the issue of conflict resolution assistance networks at both intra- and inter-village levels. Supporting our earlier discussion on seeking assistance in conflict resolution, **Figure 32(a)** shows that at the intra-village level, fishers (respondents) will essentially seek help from the chiefs to redress conflicts they encounter in their fishing activities. To a lesser degree, catechists and chairmen, in that order, are also seen as persons of authority that respondents will use to help resolve conflicts; this supports findings observed about the centrality measures discussed earlier. At the inter-village (cluster) level (**Fig. 32(b)**), a high level of betweenness centrality (i.e. bridges) between neighbouring villages was observed, suggesting collaboration in conflict resolution across villages. It can be argued that the wantok paradigm transcends village boundaries, indicating that bonds between people in the area are not restricted within villages but permeate villages, signalling inter-village support and willingness to safeguard peace and ensure harmony in resource exploitation and utilisation.

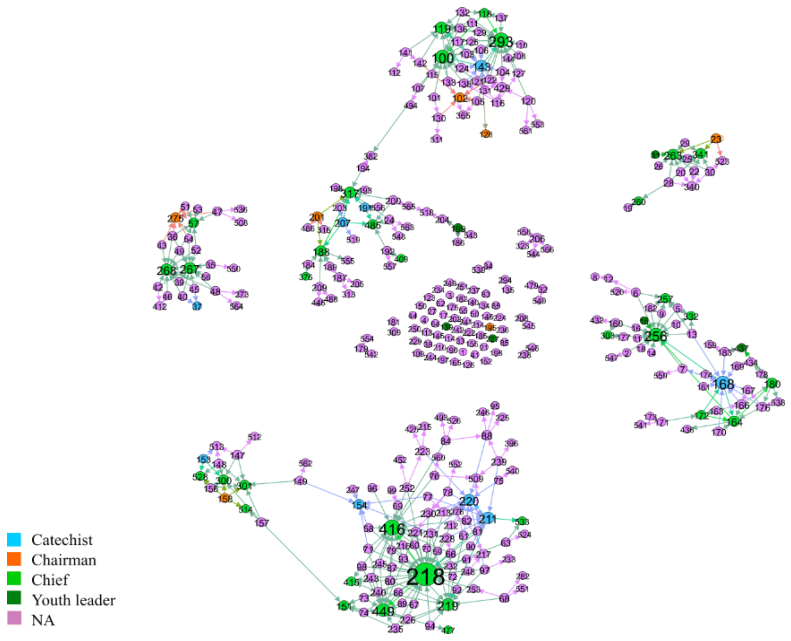


Figure 32(a). Degree centrality of conflict resolution network by position.

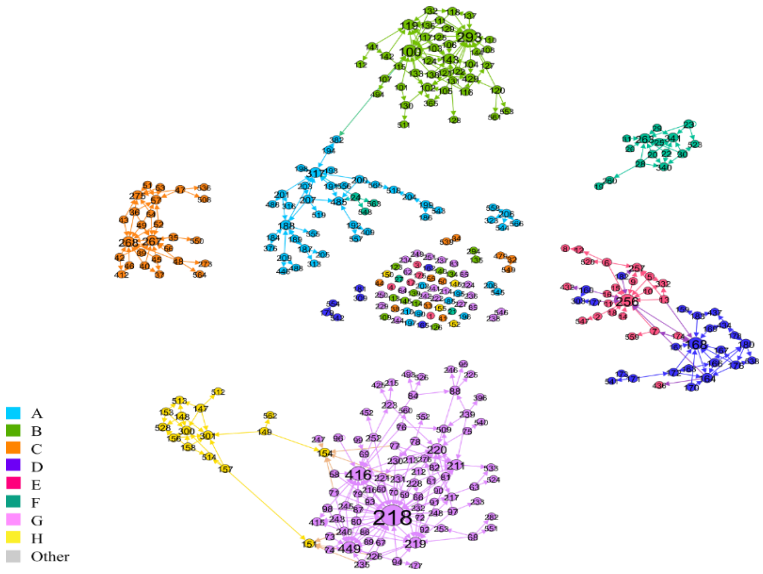


Figure 32(b). Degree centrality of conflict resolution network. by village.

Figure 32. Degree centrality of conflict resolution network.

6.4 Relationship with other fishers

The presence of dense village networks is considered a possible force that may account for community management success (for example, see Pretty et al., 2003). Even though the 'closeness' of a community social network may result in negative behaviour such as unwillingness to report wrongdoing or rule-breaking, including the lack of combined initiative to combat overexploitation (for example, see Bodin & Crona, 2008), social capital, including networks, norms and trust, does facilitate coordination and cooperation for mutual benefits (Chan et al., 2006; Jenson, 2010; Putnam, 1993). To determine the possible positive outcome of social capital, social cohesion and networking, we investigated fisher cooperation and networking behaviour by exploring relationships among fishers to tease out the influence, if any, of these social dimensions and the directions in which they impact resource management in the villages. This was also intended to help us understand how such relationships among individuals in the villages and communities can foster sustainable utilisation and management of fishery resources. **Figure 33** shows a family fishing activity near one of the villages where this study took place.

Figure 33. A family from one of the villages fishing with nets.

6.4.1 Fishing companionship and cooperation

We sought to explore fisher relationships through respondents' cooperation in their fishing activities. In **Table 22**, we report a number of variables assumed to portray cooperation among fishers. These include the number of days respondents fish together with their companions, the number of fishing companions and the number of fishers (respondents) they mostly fished with. The results show that, on average, respondents go fishing with companions for about two days in the week, reaching a maximum of seven days. Fishing with an average of about four fishers on each occasion, up to a maximum of 20, was also observed. On the question of the number of companions respondents go fishing with most of the time, we found that respondents go fishing with two fishers on average, and up to a maximum of three, on a weekly basis.

Table 22. Summary statistics: cooperative activities among respondents

	Cooperative activities in a week		
Statistics	No. of days fished with others	No. of fishers fished with	No. of fishers most fished with
Mean	2.10	3.53	2.08
Min.	0	0	0
Max.	7	20	3
SD	1.66	3.16	1.15
No. of obs.	253	253	253

To further understand the nature of cooperation among fishers in the villages, we analysed centrality measures, as shown in **Table 23**. Summary statistics of the network measures revealed a mean degree centrality, which, like others discussed earlier, is largely accounted for by the outdegree centrality mean measure. The high betweenness mean degree centrality here suggests cooperation through interconnected groups (fisher clusters) with bridges, signalling a reasonably high degree of interdependence among fishers between villages.

To establish the level of cooperation with other fishers, besides family members, we asked respondents if they go fishing with other fishers most of the time. We used the responses to construct a cooperation network. In **Figure 34(a)** and **(b)**, we present the pictorial characteristics of intra- and inter-village fishing cooperation. We found that with the exception of some isolated cases where fishers fish alone, there is a high network of cooperation within the villages (see **Fig. 34(a)**). The level of cooperation in this case is not necessarily by position, i.e., between fishers and village and community leaders, but village-wide cooperation among individuals. This is also a demonstration that fishers in the villages cooperate with one another in a reciprocal manner, which is typical of the wantok system, as discussed earlier. At the inter-village level (**Fig. 34(b)**), we observed widespread bridges, through bonding, between villages in cooperative networking fishing activities.

Table 23. Summary statistics of fisher networking: cooperation

Network measure	Networking: cooperation			
	Min.	Median	Mean	Max.
Degree	0	3	3.15	16
Indegree	0	0	1.06	13
Outdegree	0	3	2.09	3
Betweenness	0	0	7.80	189

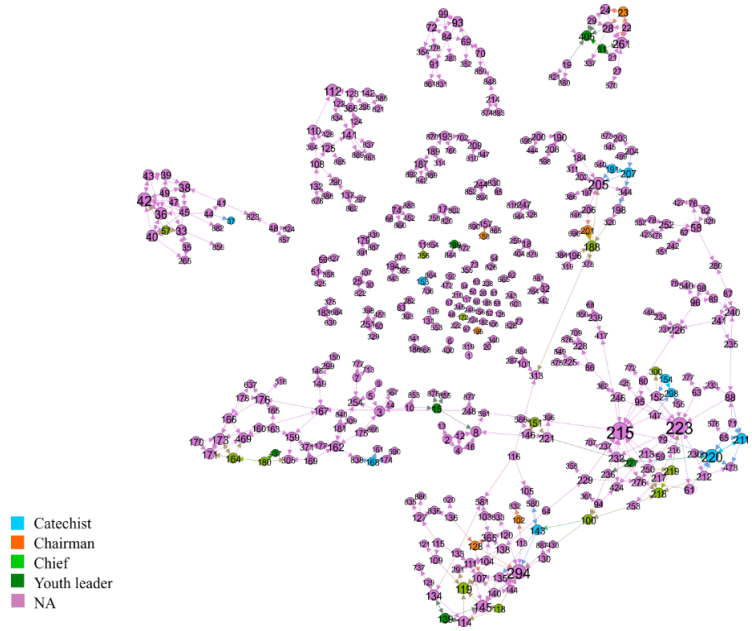


Figure 34(a). Degree centrality of fishing-cooperation network by position.

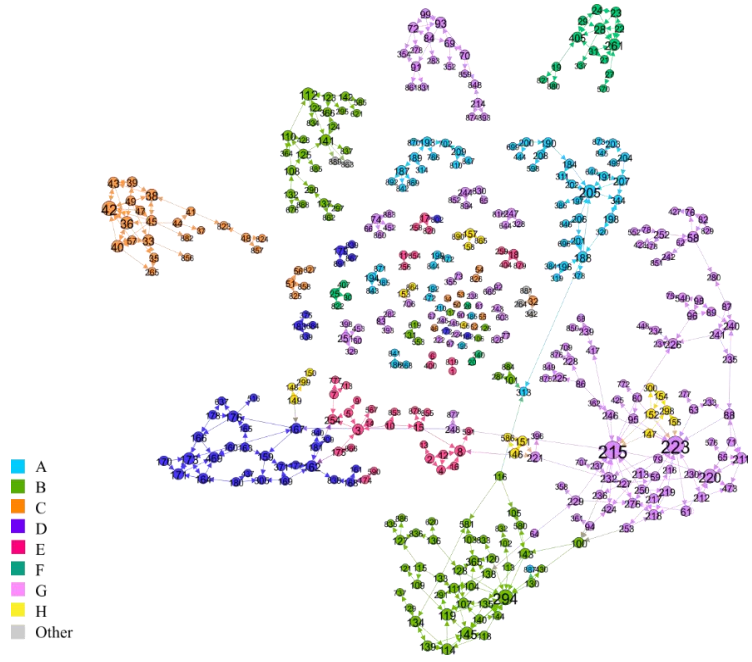


Figure 34(b). Degree centrality of fishing cooperation by village.

Figure 34. Degree centrality of fishing cooperation.

However, a high level of networking through cooperation in fishing activities may not necessarily be a sign of cooperation in resource exploitation, nor be interpreted as an indication of cooperation in resource management. Thus, the possibility of it playing a positive role in village resource management, as pointed out in the literature, for example, by Pretty et al. (2003), cannot be entirely ignored.

7. Discussion and Future Tasks

Our survey thoroughly collected data on fishing activities in eight small-scale fishing villages in West Guadalcanal. In particular, we investigated a variety of networks among fishers, such as the networks on fishing activities, equipment borrowing and information exchange. In this section, based on the literature and our survey results, we will discuss promising avenues for future research to improve our understanding of community-based resource management systems and to promote the sustainable use of coastal resources as well as the development of local communities in the Solomon Islands. Our aim is to make it clear what has yet to be done to find solutions for sustainable development.

7.1 Relationship between the wantok system and fishers' behaviour

7.1.1 Networks

In the beginning of Section 4, we noted that the wantok system plays a key role in determining fishers' behaviour in the Solomon Islands. For the purposes of this report, however, we could not fully identify the structure and cooperation mechanism of the wantok system. For example, according to **Figure 18 (a)** and **(b)**, the majority, about 94%, of respondents gave fish for free to non-family community members, while nearly 81% of respondents received free fish gifts from non-family community members. We also found that the network structure of wantoks, in terms of the free exchange of fish, does not completely correspond to that of villages. Moreover, the wantok system is often characterised as a social security system based on reciprocity. Our social network analysis has elucidated the detailed

characteristics of the fishers' networks on giving and receiving fish for free within their communities. In particular, the survey data enabled us to distinguish the degree, indegree, outdegree and betweenness centralities and, accordingly, made it possible to examine the relationship between the characteristics of fishers and giving/receiving behaviour. However, we did not delve into the reciprocal mechanism of fishers in terms of both their preferences and actual behaviour. For example, we have not yet clarified whether the pure altruism or trust relationship is the main source of the actual reciprocal behaviour. If pure altruism is the main source, fishers may give fish to both core and peripheral members of the wantok in the same way. They may give fish for free even to outsiders of their own wantok. However, if trust in the wantok is the main source, fishers may clearly separate core and peripheral members as well as insiders and outsiders. Moreover, time preferences may influence the strength of the bond among the wantok members. One of the important future tasks is to clarify the cooperation mechanism of fishers under the wantok system in more detail.

When it comes to borrowing or lending fishing equipment, our survey demonstrated that borrowers and lenders are compatriots whose main interactions are not based on pure market structures or financial incentives, indicating the existence of borrowing and lending networks based on traditional compatriotism. We also found that gear borrowing networks do not centre around the bigman, but rather among the fishers and their compatriots. This may indicate that these networks are not based entirely on the wantok system. Our result is supported by similar findings from a small-scale fisheries study conducted in a rural East African fishing community, where equipment exchange, i.e., capital borrowing and lending, was found to exist among the fishers themselves (Crona & Bodin, 2010). This is contrary to other investigations where a patron–client (bigman (benefactor)–client) type of relationship was found to be a common feature in capital lending in many rural societies (see Crona & Bodin, 2010). In this respect, the relationship between the wantok system and network formation of borrowing and lending remains to be further investigated.

Given that the wantok system plays a key role in the society of the Solomon Islands, the social norm based on this system influences fishers' behaviour and the informal rules of their communities. When considering the support and measures for sustainable development of rural communities, the authorities and international organisations consider the structure of the society (the relationship between the modern governance structure and the wantok system). Thus, it is important for researchers to disentangle the complicated structure of society.

7.1.2 Effective (voluntary) resource management

It is not clear if the existence of traditional social norms (such as wantok) gives rise to effective voluntary resource management. Similar to other traditional social norms,[12] the wantok system is likely to have both positive and negative effects on the efficiency and effectiveness of voluntary resource management and how the objectives of resource management are perceived and shared by the local resource user groups.

Regarding the positive effects, for example, Ha'apio et al. (2019) conducted a field survey in two villages of the Solomon Islands and found that aid and support from family and community based on the wantok system is crucial for local people to recover from disasters. Because the government's assistance, such as monetary aid and information provision, is often insufficient, cooperation within communities plays a role in social security and income distribution. Thompson and Wadley (2018) demonstrated that traditional culture, such as the wantok system, can contribute to child protection in the Solomon Islands because not only families but also communities have responsibility for child protection.

However, there are negative effects of the wantok system. For example, Walton (2020) described the wantok system as an impediment to establishing an effective anti-corruption agency in the Solomon Islands. As noted above, the wantok system provides social protection

[12] Alló and Loureiro (2017) examined the positive effect of social norms on the effectiveness of a Marine Protection Area for shellfish in Garcia, Spain.

and support for local people. At the same time, however, this role causes corruption because the wantok leaders or public officials have incentives to take a large part of state resources for their own communities.

The findings described in the literature indicate that the wantok system can either accelerate the pace of resource depletion by promoting myopic cooperation for resource harvesting, which leads to resource exhaustion in the medium run, or contribute to the establishment of effective voluntary resource management schemes. For example, in this survey, we observed that the fear of sanctions, a wantok phenomenon discussed in the report, generally causes community members to not report rule-breaking. This is obviously a serious setback to resource management and sustainability. Thus, it is essential to clarify the factors that positively (or negatively) affect the success (or failure) of resource management and, accordingly, sustainable use of fish resources.

Fortunately, our survey provided several insights that will be of value for future surveys and analyses. First, most fishers in the targeted communities perceived that the main causes of stock depletion are anthropogenic and include overfishing and population increase. At the same time, however, only 9% of respondents believed that MPAs are a main driver of improving stock status in their fishing grounds. These responses indicate that the resource management scheme works as intended if the scheme is appropriate for the targeted areas and species and if fishers perceive that such a scheme is effective. In addition, when new fishing rules and restrictions to protect stocks are introduced into a community, there seem to be persons who will usually talk to and educate the community about them. Thus, it would be important (i) to clarify the relationship between the wantok system and these persons, and (ii) to elaborate the role of these persons in effectively promoting the resource management scheme.

Second, similar to the networks regarding fish giving/receiving and equipment borrowing/lending, there are information exchange networks (**Table 20**). There are also

cooperative mechanisms for fishing activities (**Table 22**). Thus, the mechanism of the existing cooperative systems may be used to encourage cooperation that results in more sustainable and efficient use of natural resources. However, it is noteworthy, as can be construed from the evidence shown in **Table 22,** that cooperative behaviour in fishing activities may cause short-run overharvesting with the diffusion of efficient techniques. Thus, a mechanism to discourage this type of cooperation is required, particularly when fishing pressure needs to be reduced under a voluntary resource management scheme. At the same time, in respect to the question of compatriotism's relationship to fishing and gear and fish food sharing as well as other resource management scenes, we also found that a number of fishers do not have any relation with other fishers. The reason for this is not yet clear, so determining this represents a future task.

Third, our survey data demonstrated village-level differences in the effectiveness of monitoring and reporting of non-compliance (i.e., rule-breaking). For example, reporting non-compliance varied from village to village, ranging from about 6% to nearly 31% (**Fig. 28**), and generally, we found it to be low across all the villages, with reporting being well below 10% in half of the villages. This clear difference may be a key to finding the factors that influence the success or failure of voluntary monitoring, such as the characteristics of leaders, the function of the wantok system, socio-economic factors, stock status and experience of disasters.

Moreover, **Table 17** indicates the possibility that cross-border fishing activities cause resource depletion. Also, our network analysis has provided evidence of the existence of a higher level of social networking among villages through bridges (Fig. 22). Monitoring within communities/groups may not work well because fishers do not want to report the rule-breaking of friends and relatives. In such cases, resource management institutions with more than one fishing community may work effectively.

Fourth, we found that persons receiving reports of rule-breaking in the communities are

mostly community chiefs (87%) and, to a very small extent, church leaders, such as catechists (4%). This possibly indicates that the wantok system may work for resource management in the present situation. Due to the great complexity of the wantok hierarchical structure, this report was not able to go into depth on how traditional wantok norms regulate/permit fisher's behaviour: that is, the relationship between fishery governance and wantok. A more systemised survey will clarify this issue. Hence, it is important to elucidate who makes rules/norms and who operates the management schemes on a practical level. For example, Jeffery et al. (2017) examined transitional justice in the Solomon Islands and referred to the importance of church and the wantok system in society. Considering the structure of the society, it is important to clarify who is in fact making rules regarding resource management. As one of the measures of our study, we pursued the visualisation of social cohesion which is built into the general fishing life.

Although we have so far considered voluntary resource management, similar points can be applied for adaptation to climate change. Recently, climate change has been acknowledged by local fishers in the Solomon Islands (see Ha'apio et al., 2019). However, fishers may just accept climate change and consider that nothing can be done to cope with global-scale environmental disasters without appropriate support and information. Thus, it is also an important avenue for future research to consider (i) how fishers in local communities in the Solomon Islands adapt to climate change and (ii) what kinds of factors and support can improve their adaptability.[13] We also surveyed the state of assistance from the government and any third-party organisations. We found that 87% of fishers receive some assistance from them (**Fig. 11(d)**). At this stage, we cannot yet capture how the assistance network works for the local community-based fishery in place. Although we are not sure whether the assistance is due to wantok, this assistance format, like an inter-governance nexus with

[13] See Hanich et al. (2018) for a review of research methods for adaptation of small-scale fisheries to climate change in the Pacific Islands region.

multi-stakeholders, is thought to be important to enforce adaptive fishing community management (Crona et al., 2017). This clarification should be one of the future tasks.

7.1.3 Market mechanisms and distribution channels: monetary incentive and social norms

When examining the resilience, adaptability and sustainability of fishers and their communities in the Solomon Islands, the degree of permeation of market economies should be considered. Although local people maintain the wantok system and the custom of giving and receiving daily necessities for daily lives without pecuniary transactions, they also purchase food and other goods at the market. For example, Bottcher et al. (2019) investigated the food purchasing behaviour of adults in Malaita. Moreover, according to Ha'apio et al. (2019), households in peri-urban areas are more monetarised than those in rural villages. These facts indicate that (i) the market mechanism has been permeating the villages in the Solomon Islands, and (ii) the degree of permeation may depend on the location and other characteristics of villages/communities. We need to establish whether monetary incentives work to influence the appropriate measures and support for sustainable development and resource use. Thus, we should examine the degree of permeation of the market mechanism for each village and how monetary incentives work for them.

7.2 Technical aspects for obtaining robust causality

There are four important aspects (which represent future tasks) that must be considered in order to obtain robust causalities in terms of the aims of our research.

First, it is critical to determine whether we can effectively collect data from respondents by random sampling. For conducting our sampling method, we obtained lists of villages and households. Ha'apio et al. (2019) referred to the bureaucratic barriers for the survey with neutral sampling methods. However, they finally established their own criteria for choosing

the sample households. Thus, random sampling should be conducted to uncover the facts pertaining to the behaviour of fishers.

Second, we need scientific data regarding resources and climate. It might be difficult to collect the resource stock data because a formal stock assessment requires the capacity of physical infrastructure and scientific research. It is also costly even for the authorities of developed countries where the vessels and monitoring systems are equipped with cutting-edge devices. However, it may be possible to collect climate data, such as temperature and precipitation, and oceanographic data, such as nutrients, sea water temperature, and tides. We also need objective data regarding the behaviour of fishers. For example, we can capture the fishing grounds precisely by equipping canoes and engine boats/motorboats with GPS loggers. Although questionnaires make it possible to obtain information about the perception or subjective evaluation of fishers regarding climate change and their fishing behaviour, their descriptions may be different from the true environmental conditions or realised behaviours. Thus, by obtaining objective data, we can estimate the effects of natural and socio-economic factors on fishers' behaviour and productivity more precisely.[14] It would also be valuable to analyse the deviation of fishers' perception of the facts and the actual facts themselves: the causes of the deviation, the effect of the deviation, the relationship between the size of the deviation and collective actions etc.

Third, fishers' preferences and behaviour should be quantified to obtain robust estimates of correlations. Framed field experiments might be an effective means in this respect. Many experimental studies have been conducted in developing countries to extract the preferences of local residents, among which several studies focused on the behaviour of small-scale fishers in rural fishing villages. As an example, it would be valuable to study how cooperation and trust behaviour are affected by the difference of fishing workplaces, such as

[14] In terms of the data issue, we will further need to collaborate with the government and NGOs in terms of marine science.

the sea versus lakes (Gneezy et al., 2015). In the Solomon Islands, this kind of social tie behaviour can be surveyed, focusing on factors such as target fish species, geography and climate threat. Experiments with proper incentive schemes will make it possible for us to collect data on preferences more precisely than using only a survey-based approach. Once the fisher's preference is known, we may further characterise both the network generation mechanism and the network's disjuncture mechanism as an effect of individual preference beyond the description of wantok (fisher's true nature). It would be important to elucidate whether or not both mechanisms can balance. This clarification will guide the way to fisher's behaviour management for successful fishery management.[15] Moreover, we should collect data at different points in time for creating panel data, by which robust causalities can be captured. Although it is time-consuming, the survey should be conducted continuously.

Fourth, the micro foundation for the behaviour of artisanal fishers in our research should be theoretically formulated. Several articles have provided an overview of factors that influence fishers' behaviour and analytical approaches (Andrews et al., 2020; Oyanedel et al., 2020; Weeratunge et al., 2014). However, because welfare and policy implications depend on what kinds of behavioural mechanisms are assumed, it would be important to set up rigorous theoretical models with micro foundations.

[15] Concerning the importance of the understanding of fishers' behavior for effective resource management, see Hilborn (2007) for an example.

Appendix A: Social Network Analysis

A.1 Social network

This report has estimated a basic fisher centrality measure, characterising how central a fisher is in a social network, based on fishing activities, which can be related to the number of ties held among fishers in a directed network diagram. Fishers' social networks are often discussed in respect to the status of marine resource management and the factors that affect it, such as the impact of gear use on fishers' recognition of resource status, bycatch reduction effect on homophily in fishing and social capital and leadership in right-based fishery governance (Barnes et al., 2016; Crona et al., 2017; Crona & Bodin, 2010). In this context, the questionnaire of this survey contained nine questions that identified fishers whom the respondents asked for help in different situations the respondents encountered in their fishing activities (for details, see 2.2 Data collection). The relationships between a respondent (person *i*) and those with whom the respondent has ties (person *j*) were collected in an edge list format, which is commonly used in social network analysis. In total, the names of 988 fishers, including 253 respondents, were collected for the nine questions. Every fisher was labelled with a different integer number as identification, which corresponded to an element number of a row and a column of an adjacency matrix, which was used for the estimation of the fisher's centrality.

The Fishers' social network can be drawn as a diagram with nodes and edges corresponding to the fishers and their ties, respectively. In graph theory, the network diagram can be mathematically transformed (for example, see Wasserman & Faust, 1994). Suppose we have a social network consisting of n fishers. Then, the diagram can be formulated as a directed adjacency matrix $\boldsymbol{A} = [\underline{a}_{ij}]$ ($i, j = 1\ldots, n$), where $a_{ij} = 1$ if a person i ties to a person j, otherwise = 0. Using this matrix, this report estimated four network metrics, as described in

the next section.

A.2 Degree centrality

Degree centrality is one of the simplest metrics for describing fisher centrality in a social network. In a directed social network diagram, two distinguished centrality measures are defined for a node or fisher, namely indegree and outdegree. The indegree of a fisher *i* is given as the number of inbound edges from other fishers, *j*, to the fisher *i*:

$$C_{indegree}(i) = \sum_{j=1, j\neq i}^{n} a_{ji}. \quad \text{(A.1)}$$

Outdegree of a fisher *i* is the number of outbound edges from the fisher *i* to other fishers *j*:

$$C_{outdegree}(i) = \sum_{j=1, j\neq i}^{n} a_{ij}. \quad \text{(A.2)}$$

The sum of indegree and outdegree (Eq. A.3) is then called the degree of fisher *i*, and the difference between outdegree and indegree (Eq. A.4) is defined as the flux (Bollobás, 1998):

$$C_{degree}(i) = C_{outdegree}(i) + C_{indegree}(i) \quad \text{(A.3)}$$

$$C_{flux}(i) = C_{outdegree}(i) - C_{indegree}(i). \quad \text{(A.4)}$$

This report presents three fisher centrality degree estimates: degree, outdegree and indegree. The degree illustrates the degree to which the fisher is a totally central player, the outdegree illustrates the degree to which the fisher depends on other fishers in a given fishing activity and indegree illustrates the degree to which the fisher is influential to other fishers. Take, for example, the ten-node directed network diagram in **Figure A.1**, where **node 6** bridges two clusters, **A** and **B**. Obviously, **node 1** has four inbound edges from all other nodes belonging to cluster **A** (**nodes 2–5**). In fact, the indegree and outdegree of **node 1** are 4 and 0,

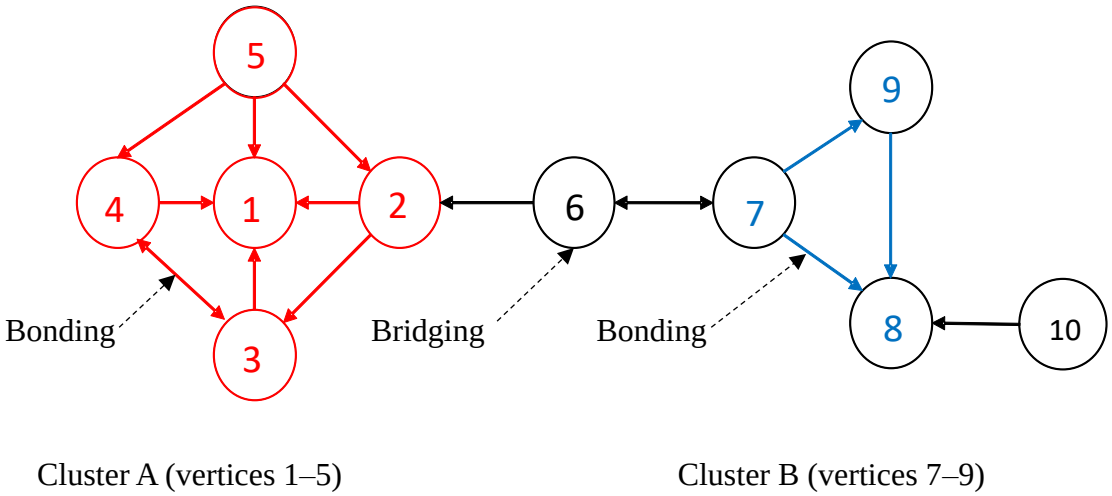


Figure A1. A 10-person schematic network diagram.

respectively. In cluster **A**, **node 1** with the biggest indegree is likely to be the most influential person in the cluster, as shown in **Figure A2(a)**. Meanwhile, the 0 outdegree of **node 1** is shown as the smallest node in **Figure A2(b)**. As a result, the degree of **node 1** becomes 4. Compared with cluster **B**, the degree of every node of cluster **A** is relatively higher, illustrating a stronger bonding between people than cluster **B** (**Fig. A1(c)**). Meanwhile, centrality of a person who only has ties with others may have a low degree, e.g., **node 10** is located at a fringe of the network graph and its degree is 1, shown as the smallest node in **Figure A.2(a)**.

A.3 Betweenness centrality

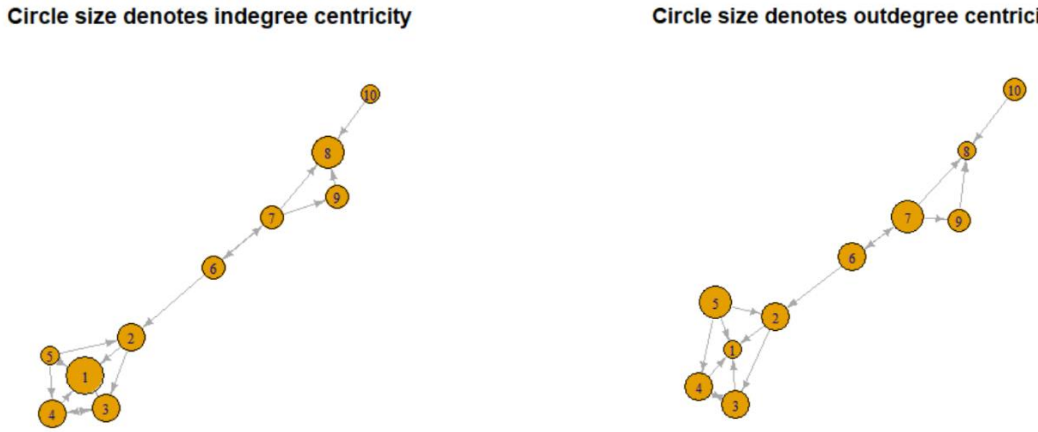
Betweenness centrality is another measure of a node's centrality, quantifying the number of times a node acts as a bridge along the shortest path between the other two nodes (Freeman, 1977), which is the fourth network metric presented in this report. Suppose there are two different persons, *j* and *k*, in a social network. We can then count the total number of shortest paths between the two nodes as $\sigma(i)_{jk}$. Also, suppose there is one other node, *i* ($\neq j$, *k*, i.e.

different from j and k). Then, we can count the number of shortest paths through the two nodes, j and k, as $\sigma(i)_{jk} \leq \sigma_{jk}$. The Betweenness centrality is then calculated as the sum of the fractions, $\sigma(i)_{jk}/\sigma_{jk}$:

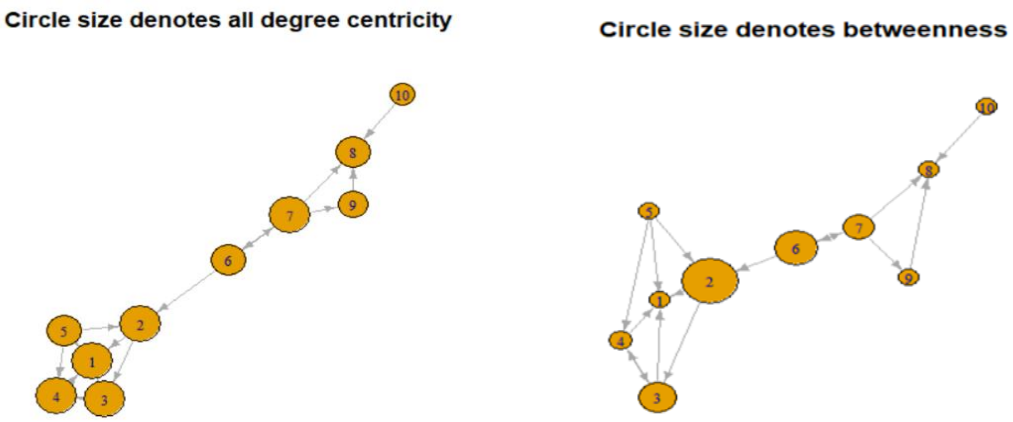
$$C_{betweenness}(i) = \sum_{i \neq j \neq k}^{n} \frac{\sigma(i)_{jk}}{\sigma_{jk}}. \quad \text{(A.5)}$$

A person, i, is then identified to be an in-between when the person has a relatively high value of betweenness centrality. Thus, betweenness centrality can be used to identify those who bridge between clusters.

We revisit the 10-node network diagram (**Fig. A1**) here. The betweenness centrality of **node 6** is estimated as 4, shown as a relatively big node (**Fig. A2(b)**), and **node 6** is likely to be a key person bridging clusters **A** and **B**.



(a) Indegree centrality in network (b) Outdegree centrality in network



(c) Degree in network (d) Betweenness centrality in network

Figure A2. Network diagram by centrality. Node size denotes each centrality.

A.4 The estimation tool

A series of degree centrality estimations use the function '**degree**' mounted in library '**igraph**', in the R software. Another function, '**Betweenness**', is used to estimate betweenness centrality. See https://igraph.org/r/doc/igraph.pdf for the function's details.

Appendix B: The Questionnaire

Solomon Islands National University

UNIVERSITY *of* TASMANIA

West Guadalcanal Fishing Communities Survey 2019

Interviewer (*full name*): _____

Date of interview (*day/month/year*): _____/_____/_____

Time of interview (*hh/mm*): _____/_____

Respondent (*full name*): _____

Village: _____

Instructions

- Thank their participation.
- Introduce yourself as an enumerator from the Solomon Island National University.
- Make sure that your respondent is 18 years old or above. If younger, stop the interview.
- Explain that:
  - You are going to ask them about their fishing activity.
  - This interview is for the academic research only (no government involvement).
  - All information will be kept confidential.
  - The survey takes about 40 minutes to complete and this is a voluntary survey.
- Guide the respondent patiently.
- For a multiple choice question, circle the "number" corresponding to the answer to each question (e.g., (1) Yes, 2. No). Where instructed, circle multiple numbers.

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Survey Coordinator Verification Check ☐

Part A: General Characteristics of Your Fishing Operation

Q1. How many years have you been fishing in your life? _____years

Q2. (a) Where is your current main fishing area? (*read all options out and circle **ONE** option*)

1. Within my own village sea territory
2. Outside my own village sea territory

(b) How many hours do you usually spend travelling to your main fishing area?
(*record in minutes or hours*)

_____ minutes ***OR*** _____ hours

Q3. (a) Do you share the fish you catch with other people outside your household?
(*circle Yes=1, No=2*)

1. Yes
2. No

(b) Do you share your fishing income with other people outside your household?
(*circle Yes=1, No=2*)

1. Yes
2. No

Q4. (a) Do you think that the amount of fish in your fishing grounds (i.e., your target species) is increasing, decreasing, or about the same over time? (*read all options out and circle **ONE** option*)

1. Increasing (*go to Q4b*)
2. Decreasing (*go to Q4b*)
3. About the same (*go to Q5*)
4. I don't know (*go to Q5*)

(b) When did you notice the change?
(*record in year or months*) _____ years ago ***OR*** _____ months ago

(c) What do you think is the main reason for the change?
(*read all options out and circle ALL applicable options*)

1. Overfishing by fishermen from my village
2. Overfishing by other Solomon fishermen
3. Overfishing by foreign fishermen
4. Fish habitat loss, such as the degradation of coral reef
5. Population growth
6. Deforestation/logging
7. Climate change
8. Fishing with bomb and poison
9. Creation of marine protected areas
10. Natural disasters, such as cyclones and earthquakes
11. Other (*specify*)_____

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Q5. (a) When you notice a change in the natural environment in your fishing grounds, such as the amount of fish or the condition of the mangrove forest and coral reef, is there anyone you discuss the issue with? (*circle Yes=1, No=2*)

1. Yes (*go to Q5b*)
2. No (*go to Q6*)

(b) Who are the persons you most often discuss the issue with?
(*maximum 4 persons; identify the names and their villages*)

	Full name	Village Name (*or other comment*)
Person 1		
Person 2		
Person 3		
Person 4		

Q6. (a) Are there any fisheries restrictions applied in your village? (*circle Yes=1, No=2*)

1. Yes (*go to Q6b*)
2. No (*go to Q7*)

(b) What restrictions are there? (*read all options out and circle ALL applicable options*)

Restricting….
1. Amount of fish I can catch
2. Types of species I can catch
3. Size of fish I can catch
4. Location I can go for fishing
5. Time within a day I can go fishing
6. Fishing season or months
7. Use of some fishing gear (other than bomb and poison)
8. Use of bomb and poison
9. Others (*specify*) _____

(c) In your opinion, what proportion of fishermen in your village follows these restrictions?
(*100% means everyone follows; 0% means nobody follows; 50% means half of the people follow*)

_____%

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Q7. (a) If you observe someone breaking fishing rules or restrictions, do you report this to anyone? (*circle Yes=1, No=2*)

1. Yes (*go to Q7b*)
2. No (*go to Q8*)

(b) To whom would you first report this? Name the person and his/her village.

	Full name	Village Name (*or other comment*)
First Person to Report		

Q8. (a) When there are new fishery restrictions to protect important fish stocks in your village, is there anyone who will talk with other village members to follow the new restrictions? (*circle Yes=1, No=2*)

1. Yes (*go to Q8b*)
2. No (*go to Q9*)

(b) Please tell me who the persons are. (*maximum 4 persons; identify the name*)

	Full name
Person 1	
Person 2	
Person 3	
Person 4	

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Q9. (a) When you encounter a conflict over fishing activities (e.g., territory, catch, gear) with other fishermen, is there any person you first ask for help to settle the conflict. (*circle Yes=1, No=2*)

1. Yes (*go to Q9b*)
2. No (*go to Part B*)

(b) Please tell me who the person is. (*maximum 4 persons; identify the name and village*)

	Full name
Person 1	
Person 2	
Person 3	
Person 4	

Team Coordinator Verification Check ☐

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Part B: Catch

*READ: Now, I am going to ask you questions about your fishing activity and the fish you caught **OVER THE LAST ONE WEEK**.*

Q1. (a) Thinking back over the last <u>one week (7 days)</u>, how many days did you go fishing?

_____ days

(b) On average, how many hours did you spend fishing each day?

_____ hours per day

(c) How many fishing trips did you make each day?

_____ trips per day

(d) Over the last one week, did you normally go fishing at daytime, nighttime or a mix of both?
(*read all options out and circle **ONE** option*)

1. Daytime (*between sunrise and sunset*)
2. Nighttime (*after sunset*)
3. A mix of both

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Survey Coordinator Verification Check ☐

***Use** Table 1 for Q2-Q4*

Q2. Over the last one week, what fish did you catch? Did you catch any coral reef fish, tuna or any other species? (*read each species and record Yes=1, No=2. record any species not on the list*)

Q3. For each species you caught, what was your average catch per day over the last one week? (*read each species and record catch in kg/day*)

Q4. What was the average price you received for each species you caught? (*record price in SBD/kg. record '0' if not sold*)

Table 1

	Caught	Catch	Fish price
	1. Yes 2. No	Average catch (**kg/day**)	Average price (**SBD/kg**)
Species	**Q2**	**Q3**	**Q4**
Coral reef fish			
Tuna			
Other (*specify*)			

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***Use** Table 2 for Q5*

Q5. (a) For each species you caught over the last one week, if you have 10 fish how many fish did you keep for your own household? (*prove the number; 10 means kept all for household*)

(b) Other than your own household, how many fish did you give <u>for free</u> to other non-household family members, relatives, *wantok* or friends? (*prove for the number*)

(c) How many fish did you sell to other people for cash income?
(***CONFIRM** that the total for each column is 10*)

Table 2

		Coral reef fish	Tuna	Others (in total)
Q5(a)	Kept for households			
Q5(b)	Kept for others			
Q5(c)	Sold for cash income			
	Total (*confirm*)	**/10 □**	**/10 □**	**/10 □**

Q6. (a) <u>In your village</u>, is there anyone outside your family that he/she gives you fish for free?
(*circle Yes=1, No=2*)
1. Yes (*go to Q6b*)
2. No (*go to Q7*)

(b) In the last one week, how often did he/she give you fish for free?
_____ times per week

(c) Who are the persons who most often gave you fish for free?
(<u>*maximum 3 persons*</u>; *identify the names*)

	Full name
Person 1	
Person 2	
Person 3	

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Team Coordinator Verification Check □

Survey Coordinator Verification Check □

Q7. (a) In your village, is there anyone outside your family that you give fish for free?
(*circle Yes=1, No=2*)
1. Yes (*go to Q7b*)
2. No (*go to Part C*)

(b) In the last one week, how often did you give fish to anyone for free?

_____ times per week

(c) Who are the persons you most often gave fish for free? (*maximum 3 persons*; *identify the names*)

	Full name
Person 1	
Person 2	
Person 3	

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Team Coordinator Verification Check ☐

Survey Coordinator Verification Check ☐

Part C: Capital and Fishing Equipment

*READ: Now, I am going to ask you questions about the fishing equipment you used **OVER THE LAST ONE WEEK**.*

***Use** Table 3 for Q1*

Q1. (a) Thinking back over the last one week, which type of fishing boat did you use?
(*read each item and record Yes=1, No=2*)

(b) Do you own these fishing boats or did you use someone else's boat?
(*read each item and record **ONE** option: Owned = 1, Not owned = 2*)

(c) Do you share these fishing boats with other family members? (*Yes = 1, No = 2*)

Table 3

	Used	Ownership	Family share
	1. Yes 2. No	1. Owned 2. Not owned	1. Yes 2. No
	Q1(a)	**Q1(b)**	**Q1(c)**
Traditional canoe with no engine			
Engine operated boat			
Other (*specify*)			

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Team Coordinator Verification Check ☐

Survey Coordinator Verification Check ☐

***Use** Table 4 for Q2*

Q2 (a) Thinking back over the last one week, what fishing gears did you use?
(read each item and record Yes = 1, No = 2. record any gears not in the list)

(b) Do you own these fishing gears, either privately or jointly?
*(read each item and record **ONE** option: Privately owned = 1, Jointly owned = 2, Not owned = 3)*

Table 4

	Used	Ownership
	1. Yes 2. No	1. Privately owned 2. Jointly owned 3. Not owned
	Q2(a)	**Q2(b)**
Line		
Spear		
Bow and arrow		
Trap		
Net		
Rafters or Fish aggregation devices (FADs)		
Fishing lures/lua		
Baits		
Other (*specify*)		

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PART D: Relationships with Other Fishermen

READ: Now I am going to ask you questions about your relationships with other fishermen.

Q1. Over the last one week, how many days did you go out fishing with other fishermen?
(*record '0' if did not go out fishing with others*)

_____ days

Q2. Over the last one week, how many fishermen **in total** did you go fishing with?
(*record '0' if did not go out fishing with others*)

_____ fishers

If the respondent did NOT go fishing with other people, go to Q4

***Use** Table 5 for Q3*

Q3. (a) Over the last one week, who are the fishermen you most often went fishing with?
(*maximum 3 persons; identify the names and their villages*)

(b) Of these fishermen, are there any of your family members or relatives? (*record Yes=1, No=2*)

(c) Did you share your catch with these fishermen? (*record Yes=1, No=2*)

(d) Did you share your fishing income with these fishermen? (*record Yes=1, No=2*)

Table 5

	Full name	Village name	Family/ Relative 1. Yes 2. No	Share catch 1. Yes 2. No	Share income 1. Yes 2. No
	Q3(a)		**Q3(b)**	**Q3(c)**	**Q3(d)**
Fisherman 1					
Fisherman 2					
Fisherman 3					

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Q4. (a) Did you use someone else's boat, gear, nets, etc., to carry out your fishing activities?

(*circle Yes=1, No=2*)

1. Yes (*go to Q4b*)
2. No (*go to Q5*)

***Use** Table 6 for Q4b and Q4c*

(b) Whose fishing equipment did you most often use?

(*maximum 3 persons; identify the names and their villages*)

(c) When you used someone else's fishing equipment, did you need to make a payment in cash, goods (e.g., fish and rice), labour services or any other form? (*read each item and circle ALL applicable options*)

1. No payment
2. Payment in cash
3. Payment in goods (e.g., fish, rice, etc)
4. Payment in labour services
5. Others (*specify*)

Table 6

	Full name	Village Name	Payment 1. No payment 4. labour 2.Cash 5. Others 3. Goods
	Q4(b)		**Q4(c)**
Person 1			
Person 2			
Person 3			

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Team Coordinator Verification Check ☐

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Q5. (a) Did anyone else use your boat, gear, nets, etc., to carry out his/her fishing?
(*circle Yes=1, No=2*)

1. Yes (*go to Q5b*)
2. No (*go to Part E*)

***Use** Table 7 for Q5b and Q5c*

(b) Who are the persons who most often used your fishing equipment?
(*maximum 3 persons; identify the names and their villages*)

(c) When they used your fishing equipment, did they need to make a payment in cash, goods (e.g., fish and rice), labour services or any other form? (*read each item and circle ALL applicable options*)

1. No payment
2. Payment in cash
3. Payment in goods (e.g., fish, rice, etc)
4. Payment in labour services
5. Others (*specify*)

Table 7

	Full name	Village Name	Payment 1. No payment 4. labour 2. Cash 5. Others 3. Goods
	Q5(b)		**Q5(c)**
Person 1			
Person 2			
Person 3			

Team Coordinator Verification Check ☐

Survey Coordinator Verification Check ☐

PART E: Fishing Game

READ: Now, I would like you to think about a situation where you catch fish and how many fish you can catch is different depending on the choice you make. I am going to ask you about your preferred choice in 8 different situations. For each situation, please tell me your preferred choice.

1. Would you prefer to catch 3kg of fish you like today or 3kg of the same fish after two weeks? (*circle A or B*)

   A. 3 kg of fish today
   B. 3 kg of fish after two weeks

2. Would you prefer to catch 3kg of fish you like today or 3.03kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 3.03 kg of fish after two weeks

3. Would you prefer to catch 3kg of fish you like today or 3.06kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 3.06 kg of fish after two weeks

4. Would you prefer to catch 3kg of fish you like today or 3.15kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 3.15 kg of fish after two weeks

5. Would you prefer to catch 3kg of fish you like today or 3.3kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 3.3 kg of fish after two weeks

6. Would you prefer to catch 3kg of fish you like today or 4.2kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 4.2 kg of fish after two weeks

7. Would you prefer to catch 3kg of fish you like today or 5.1kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 5.1 kg of fish after two weeks

8. Would you prefer to catch 3kg of fish you like today or 6kg of the same fish after two weeks?

   A. 3 kg of fish today
   B. 6 kg of fish after two weeks

Team Coordinator Verification Check ☐

Survey Coordinator Verification Check ☐

PART F: Demographic

Q1. What is your age? _____ years old

Q2. What is your gender?
1. Male
2. Female

Q3. What is your ethnic group?
1. Melanesian
2. Polynesian
3. Micronesian
4. Other (*specify*)_____

Q4. What clan do you belong to? _____

Q5. (a) What is the original language or dialect you speak in your wantok group? (*specify*)
_____

(b) Do you speak dialects other than your original dialect? (*specify*)
_____

Q6. What is the area of your geographical origin?

Province: _____

Constituency: _____

Ward: _____

Village: _____

Q7. **In total**, how many years have you lived in this village? _____years

Q8. (a) What is the highest degree you have attained?
(*read each item and circle **ONE** option*)
1. Primary education
2. Secondary education
3. Tertiary degree
4. No formal education

(b) Have you completed a vocational training? (*circle Yes=1, No=2*)
1. Yes
2. No

(c) How many years of formal school education do you have? _____ years

Q9. What is your religion?
1. Catholic
2. Anglican
3. Methodist
4. SDA
5. Other (*specify*)_____

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Team Coordinator Verification Check ☐

Survey Coordinator Verification Check ☐

Q10. (a) Does your community receive any form of assistance from any of the following organizations?
(*read each item and circle ALL applicable options*)

1. NGOs (such as SIDT)
2. CBO (Community-based organizations)
3. Ministry of Fisheries and Marine Resources
4. Ministry of Agriculture and Livestock
5. Donor and multilateral agencies (e.g., UNDP, World Fish, WWF, FFA, KOICA)
6. Other (*specify*) _____
7. No assistance (*go to Q11*)

(b) Does your household receive any benefit from the assistance? (*circle Yes=1, No=2*) 1. Yes 2. No

Q11. (a) Other than you, how many people currently live and eat in your household including adults, children and babies? (*probe for the number*)

Number of people: _____

(b) Of these, how many people are NOT working? (*probe for the number*)

Number of people: _____

(c) Of these, how many people are usually involved in fishing activities? (*probe for the number*)

Number of people: _____

(d) Are you the main fisher who is mostly involved in fishing activities in the household? (*circle Yes=1, No=2*) 1. Yes 2. No

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Survey Coordinator Verification Check ☐

PART G: Income and Expenditure

Q1. (a) Over the last one week, what was your household income? _____ SBD

(b) Over the last one week, what was the amount **or** proportion of your household income from fishing? (*record in % or SBD*)

_____SBD ***OR*** _____%

(c) Did you have any other sources of income? (*read each item and circle ALL applicable options*)

1. Farming
2. Livestock
3. Logging
4. Private business
5. Formal employment (government or private enterprises)
6. Casual labour
7. Remittance
8. Other (*specify*) _____

Q2. (a) Over the last one week, how much did you and your household spend in total?

_____ SBD

(b) Over the last one week, how much did you and your household spend **per day on food** that you use at home? (*food includes drinking water, spices, cooking oil, and other fuel for cooking*).

_____ SBD

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Survey Coordinator Verification Check ☐

PART H

***Use** the village MAP on the next page*

Q1. Where is your house? (*mark "**H**" on the map*).

Q2. (a) Do you own a land? (*circle Yes=1, No=2*)

1. Yes (*go to Q2b*)
2. No (*go to Q3*)

(b) Where is the area of land owned by you? (*mark "**L**" on the map*).

Q3. Where is the village sea territory? (*mark the territory on the map*)

INTERVIEWER THANKS AND TERMINATES

INTERVIEWER QUESTION

Q1. How confident <u>are you</u> about the accuracy of the respondent's answers?

1. Confident
2. Not confident

Interviewer's comments (*if any*) _____

_____

_____

_____

_____

_____

_____

_____

_____

Response report

Full response	1
Full refusal	2
Part refusal	3
Other (*specify*)_____	4

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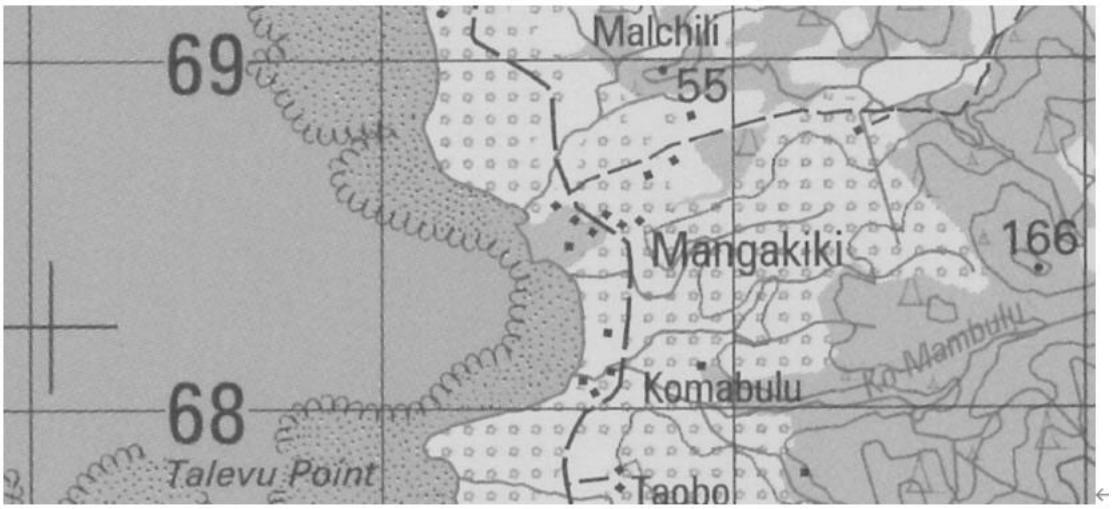
Village Map (Mangakiki)



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Team Coordinator Verification Check ☐

Survey Coordinator Verification Check ☐

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