Human Ecology
https://doi.org/10.1007/s10745-019-00098-4

Different but Similar? Exploring Vulnerability to Climate Change in Brazilian and South African Small-Scale Fishing Communities

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Abstract
Small-scale fisheries face similar challenges and constraints, including marginalization, spatial competition, unequal power relations, limited participation in decision-making processes, and climate stressors. We compare the vulnerability of small-scale fishing communities under pressure from climate change in the southern Cape in South Africa and the South Brazil Bight in Brazil using a standardized vulnerability framework to identify the differences and/or similarities between the fishing communities in both countries. In Brazil, high dependence on fishing and attachment to place increased the vulnerability of the fishers; in contrast, in South Africa strong dependence on markets to buy food threatened food security of the fishers. These findings provide noteworthy insights into the regional vulnerability of fishing communities in both countries; additionally, the results support the development of local climate change mitigation plans and provide examples for similar communities that are likely to experience climate stressors in other regional locations.

Keywords Small-scale · Fisheries · Climate change · Vulnerability · Management · Southern cape, South Africa, South Brazil bight, Brazil

Introduction

Fisheries in developing countries, including South Africa and Brazil, are subjected to strong and increasing anthropogenic pressures that affect social-ecological systems (SESs) (Béné *et al.* 2016). Specifically, negatively impacted small-scale fisheries play crucial roles as sources of livelihoods, food security, and income for millions of people in developing countries (Garcia *et al.* 2003). While target species, vessel types, fishing methods, and management approaches vary widely around the world and within regions it is generally thought that resource use, community impact, and policy issues are alike (FAO 2016).

In recent decades, the global development of both small- and large-scale fishery sectors has in many cases led to the overexploitation of resources and threatened habitats and ecosystems (Pauly and Zeller 2016). The traditional management practices of natural resources in small-scale fisheries that may have been in place for generations have changed because of non-participatory and increasingly centralized fisheries management systems, rapid technological developments, and demographic changes (Berkes *et al.* 2001). In many places, ongoing conflicts with large-scale fishing operations are problematic, expressing themselves in increasing interdependence or competition between small-scale fisheries and other sectors - which may include tourism,

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10745-019-00098-4) contains supplementary material, which is available to authorized users.

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Published online: 07 August 2019

aquaculture, agriculture, energy, mining, industry, and infrastructure developments (Pauly 2006) – that typically have stronger political or economic influences.

Other constraints faced by small-scale fisheries around the world include marginalization and poverty (Nayak *et al.* 2014). These are multidimensional in nature and are caused not only by low incomes but also by factors that preclude the full enjoyment of human rights, including civil, political, economic, social, and cultural rights. Small-scale fishing communities also tend to have limited or disadvantaged access to markets and poor access to health, education, and other social services (Maru *et al.* 2014). Other characteristics include low levels of formal education and inadequate organizational structures. Available opportunities are limited, with fishing communities facing a lack of alternative livelihoods, unemployed youth, and unhealthy and unsafe working conditions (Brugere *et al.* 2008). Pollution, environmental degradation, and climate change impacts can add to these threats (Allison and Ellis 2001). All these factors make it difficult for small-scale fishers to communicate their goals and/or grievances, defend their human and tenure rights, and secure the sustainable use of the fishery resources on which they depend (FAO 2015).

In the last two decades, South Africa and Brazil, together with Russia, China, and India (BRICS) have become increasingly important actors in globalized trade. Of the BRICS countries, South Africa and Brazil experienced similar low growth in the early 1990s; however, although their gross domestic product growth accelerated in the 2000s (OECD 2009), both countries have experienced low growth in recent years (OECD 2019). These positive outcomes were favored both by major macroeconomic policy reforms, started in the early 1990s in both countries; and significant productivity gains and rapid integration into the world economy (Arnal and Forster 2010). South Africa and Brazil are both experiencing a relatively recent democracy. In Brazil, the process of democratization began in 1984 after the end of the military regime when the new constitution and the emergence of a presidential republic were consolidated in 1989. In South Africa, democracy started in 1994 after the fall of the apartheid regime and subsequent general elections. What differentiates the pre-democracy period in the two countries is their fishers' access to fishing rights. During apartheid fishing rights were largely denied to any person who was not classified as "white," preventing most traditional small-scale fishers from being allocated commercial fishing rights (Kleinschmidt *et al.* 2003; van Sittert 2002). As a result, historically disadvantaged individuals who had their fishing rights denied began to work as crew on commercial small-scale fishing boats. In Brazil, although small-scale fishers had their fishing rights during the military regime, no policy was developed for the sector, which remained marginalized during this period. Despite the difference in fishing-rights access, the small-scale fishers were marginalized and forgotten in both countries and it was only after political liberalization that they were able to express themselves more freely, particularly in defending their rights and access to resources (Isaacs 2011; Diegues 2006).

Accordingly, small-scale fishing communities in both countries are characterized by elevated levels of poverty and unemployment, with few opportunities to earn an income outside of fishing; poor infrastructure; limited access to services; and a range of social problems that are associated with these conditions (Diegues 2006; Glavovic and Boonzaier 2007). The size of the fishing communities and the proportion of households from these communities that are involved in fishing activities are also similar in the two study regions (Aswani *et al.* 2018), which are also affected by similar climate stressors as both are marine hotspots where sea surface temperature is warming quickly (Hobday and Pecl 2014). These hotspots are expected to experience the effects of climate change earlier than others and it was thus suggested that they could serve as early case studies for understanding the impacts of climate change as well as for developing adaptation strategies (Hobday *et al.* 2016) One methodology for such comparisons is through vulnerability studies at different scales and between identified marine hotspots, following an approach also carried out under global assessments such as those of the Intergovernmental Panel on Climate Change (IPCC). Aswani *et al.* (2018) developed a method for a comparative vulnerability assessment between case studies in these hotspot areas and first results showed that the framework is flexible for local contexts while maintaining important information that is consistent across all sites to allow for comparisons.

Against the backdrop of prior research in the southern Cape in South Africa and the South Brazil Bight in Brazil (Gammage *et al.* 2017; Martins 2018; Gammage *et al.* 2019), which has provided crucial background insights into participating communities, we carried out a more specific comparative social vulnerability assessment between selected small-scale fishing communities. Our results, framed in the context of vulnerability to climate change and its components (sensitivity, exposure, adaptive capacity), provide a quantitative evaluation of the similarities and differences between communities. The key differences identified through the quantitative analysis allow for a deeper interpretation of some of the factors that drive vulnerability in these communities.

Materials and Methods

Study Area

In South Africa, our study focused on the Southern Cape (STC) small-scale commercial handline fishery that operates in the inshore area of the Agulhas Bank (Fig. 1). The area is part of the Benguela Current Large Marine Ecosystem, an eastern boundary current system that sustains important fisheries for Angola,

Namibia, and South Africa (see Jarre *et al.* 2015 for an overview). In South Africa's Western Cape province, the traditional line fishery is a boat-based, multiuser, multispecies, and multi-area fishery targeting 50 commercially important fish species (Griffiths 2000). A variety of anthropogenic and other stressors, including resource scarcity, poor socioeconomic conditions and policy, and regulatory challenges, affect the inshore social-ecological system of the area. The line fishery in the STC mainly harvests the silver kob (*Argyrosomus inodorus*) as their economically most viable and sustainable target species. Although other species, such as silvers/carpenters (*Argyrozona argyrozona*), red fish (such as red roman, *Chrysoblephus laticeps*), and sharks, are targeted in the absence of kob, these species are not profitable nor are they conducive to the long-term sustainability of livelihoods. Harvesting alternative species is a way to keep things 'ticking over,' as the high-value, slow-growing red fish are scarce, and fishers must travel approximately 30 km offshore to catch the relatively low-value silvers (Gammage *et al.* 2017).

The Southern Brazil Bight (SBB) is defined as the area of the Brazilian Southeastern continental shelf that extends from Cabo Frio (23°S; 42°W) to Cabo Santa Marta (28.5°S; 48.6°W) (Castro and Miranda 1998) (Fig. 1). The region has a heterogeneous coastline with a diversity of ecosystems. Oceanographic features include the occurrence of mesoscale eddies from the Brazil Current (to the east), intrusion of South Atlantic Central Water, and seasonal upwelling (Silveira *et al.* 2000). These features boost the regional primary productivity and, as a result, some fisheries (Gasalla and Rossi-Wongtschowski 2004) and consequently the SBB supports the most highly developed fishing industries in the country, contributing to about half of Brazil's commercial fishery yield and supporting important pelagic and demersal fisheries (MPA 2011). However, small-scale fishing still predominates in several traditional fishing communities along the coast where fishing is practiced daily by most fishers. These fishing communities are characterized by traditional cultures, values, and behaviors strongly associated with nature (Diegues 2006). Small-scale fisheries are multispecies and multi-gear occurring in coastal and inshore areas, with small-sized boats or canoes, and equipment using very simple technology.

Data Collection

We collected data through a household survey on the social vulnerability of marine-dependent coastal communities to climate change. This survey was carried out in countries with various levels of economic development as part of the Belmont Forum's Global Learning for Local Solutions (GULLS) project (Hobday *et al.* 2016). The overall GULLS framework, proposed by a multilateral scientific team, aimed to ultimately improve efforts in fishing community adaptation through characterizing, assessing, and predicting the future of coastal-marine resources followed by the co-development of adaptation options through the provision and sharing of knowledge across fast-warming marine hotspot regions (Hobday *et al.* 2016; Popova *et al.* 2016). Specifically, the social working group of the project developed a social vulnerability framework to assess different marine-dependent coastal communities in the southern hemisphere in an internationally comparative effort (Aswani *et al.* 2018). A key component of this social vulnerability framework is the collection of rich, local-level, data to provide a

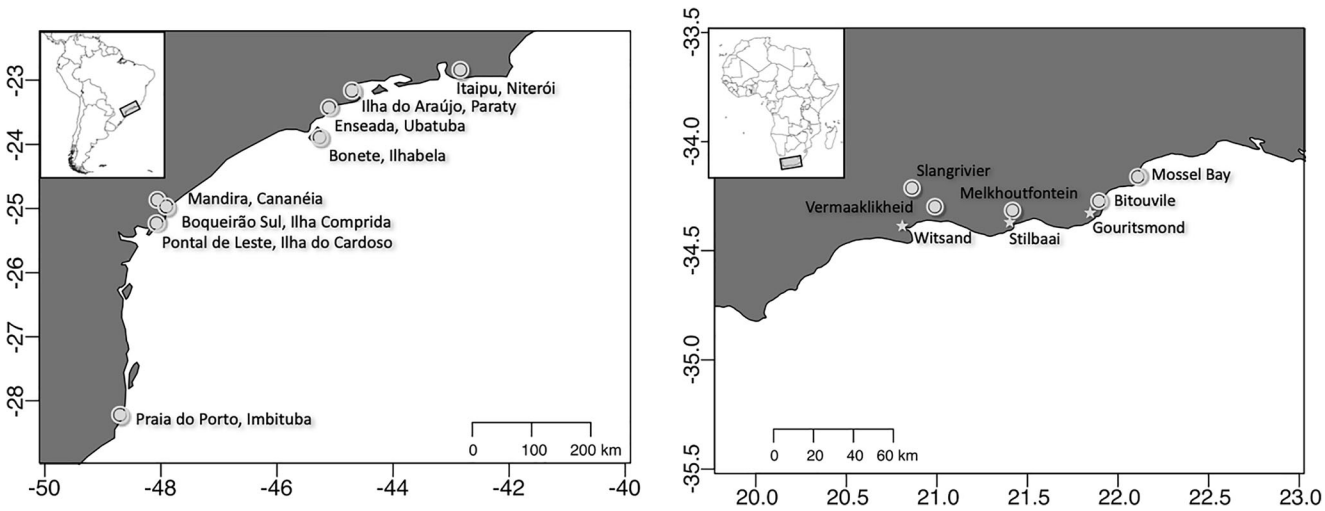

Fig. 1 The sampled regions in the South Brazil Bight (left) and the southern Cape (right). The surveyed communities are shown by black dots. In the southern Cape, the stars represent the fishery harbors of the sampled communities

detailed understanding of processes which influence community vulnerability, while allowing for the data to be scaled up to regional, country, and global levels. We used this framework in our regional comparison of the SBB and STC fishing communities that formed part of GULLS project. The same database has been used for an even more detailed, local analysis of community-level vulnerability drivers in the SBB (Martins 2018) and STC (Gammage *et al.* 2019).

The Brazilian survey comprised 250 questions and the South African survey comprised 253 questions. Data were collected by the research team members of each country through face-to-face interviews at the household level. For this research, we selected a subset of similar questions (n = 135) that had been used in both countries. Of the 19 examined components, questions were divided into 57 subcomponents and then separated into the three vulnerability categories: sensitivity, exposure, and adaptive capacity (Fig. 2, Supplementary Table 1). As the survey consisted of diverse types of questions, we measured the indicators on different scales and normalized them to a value between 1 and 4 to allow for a consistent interpretation. Due to the non-normality of the data, we calculated the scores of each component, subcomponent, and categories using the median, with no weight being attributed to the indicators. We then derived the final vulnerability score from the three categories using the equation: [Vulnerability = (Exposure + Sensitivity) – Adaptive capacity].

The vulnerability analysis shows what subcomponents contribute to similarities or differences between communities. We then use the key differences indicated by the analysis to comparatively explore drivers of vulnerability, building on understanding stemming from i) the GULLS survey information, ii) the additional complementary qualitative information collected in both countries, and iii) the available secondary data and literature.

The statistical comparison consisted of a test to identify the differences and similarities in aspects of vulnerability for the SBB and STC fishing communities. To determine significant differences between countries, we first tested the normality of the data using the Shapiro-Wilk test (Royston 1982). The data that were normally distributed were tested using a two-sample Student's t Test (McDonald 2008). Data with non-normal distribution were tested using a nonparametric Wilcoxon test (Bauer 1972). These tests were applied to the subcomponents, components, categories, and vulnerability scores (Supplementary Table 1). The analysis was performed using the *devtools* (Wickham and Chang 2016) package for the R software.

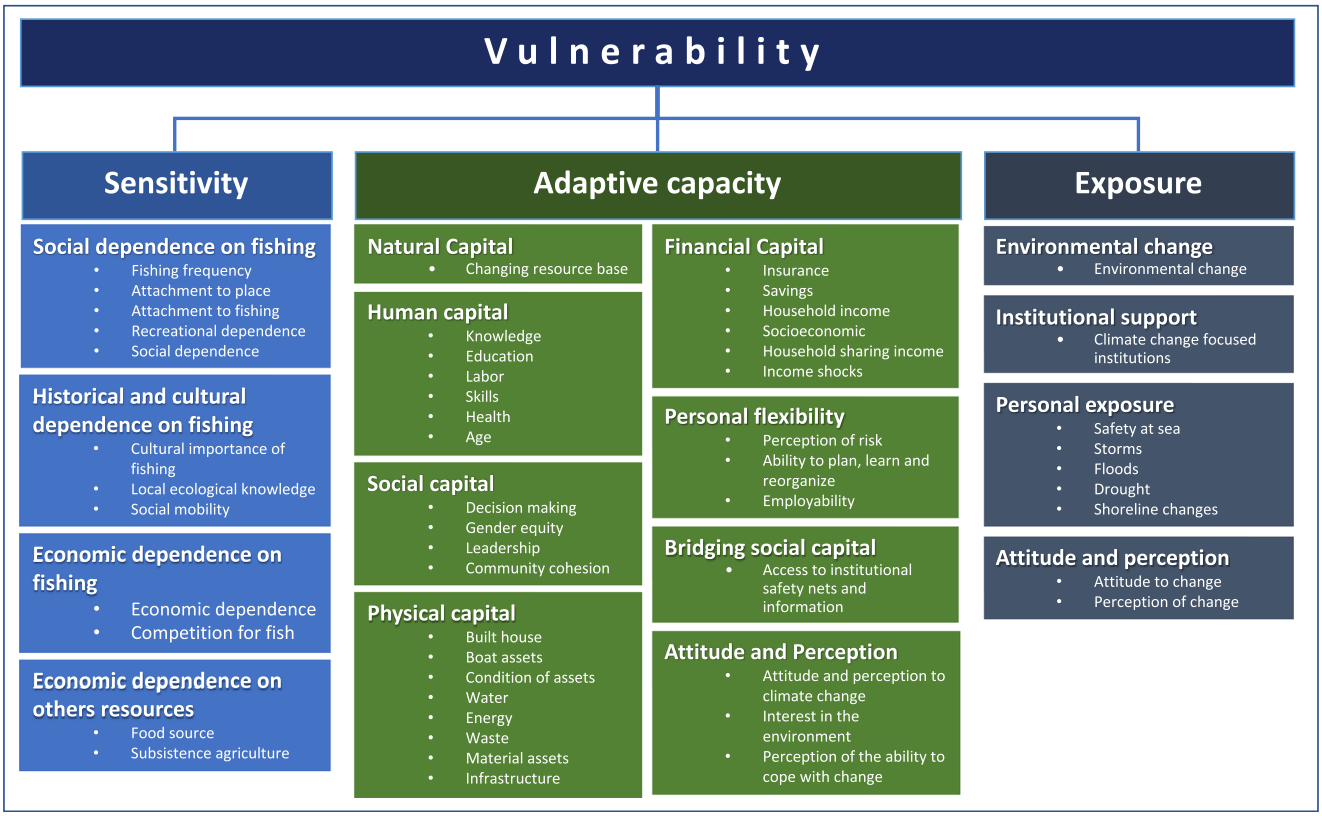

Fig. 2 The vulnerability components and subcomponents used in the comparison of South Brazil Bight and southern Cape fishing communities. Adapted from Aswani *et al.* 2018

Results

Vulnerability

The STC fishing communities are more vulnerable to change in the marine environment than the SBB fishing communities (t-test, $p = 0.0412$, Fig. 3a). The low adaptive capacity and high exposure scores of STC fishing communities were not compensated for by the relative low sensitivity. In the SBB communities, the high adaptive capacity and low exposure were enough to compensate for the high sensitivity associated with the strong dependence on fishing, which resulted in a lower vulnerability score.

Sensitivity

There is no difference between the SSB and STC fishing communities in terms of overall sensitivity (Wilcoxon test, $p = 0.05877$, Fig. 3b). However, differences emerge when scaling down to the component and subcomponent levels. In the component level, differences were found only in the historical and cultural dependence on fishing components, with the STC fishing communities displaying higher sensitivity (t-test, p = <0.001). However, in the subcomponents fishing frequency (Wilcoxon test, $p = 3.856e-09$) and attachment to place (Wilcoxon test, $p = 0.0002689$), cultural importance of fishing (Wilcoxon test, p = <0.001), and competition for fish

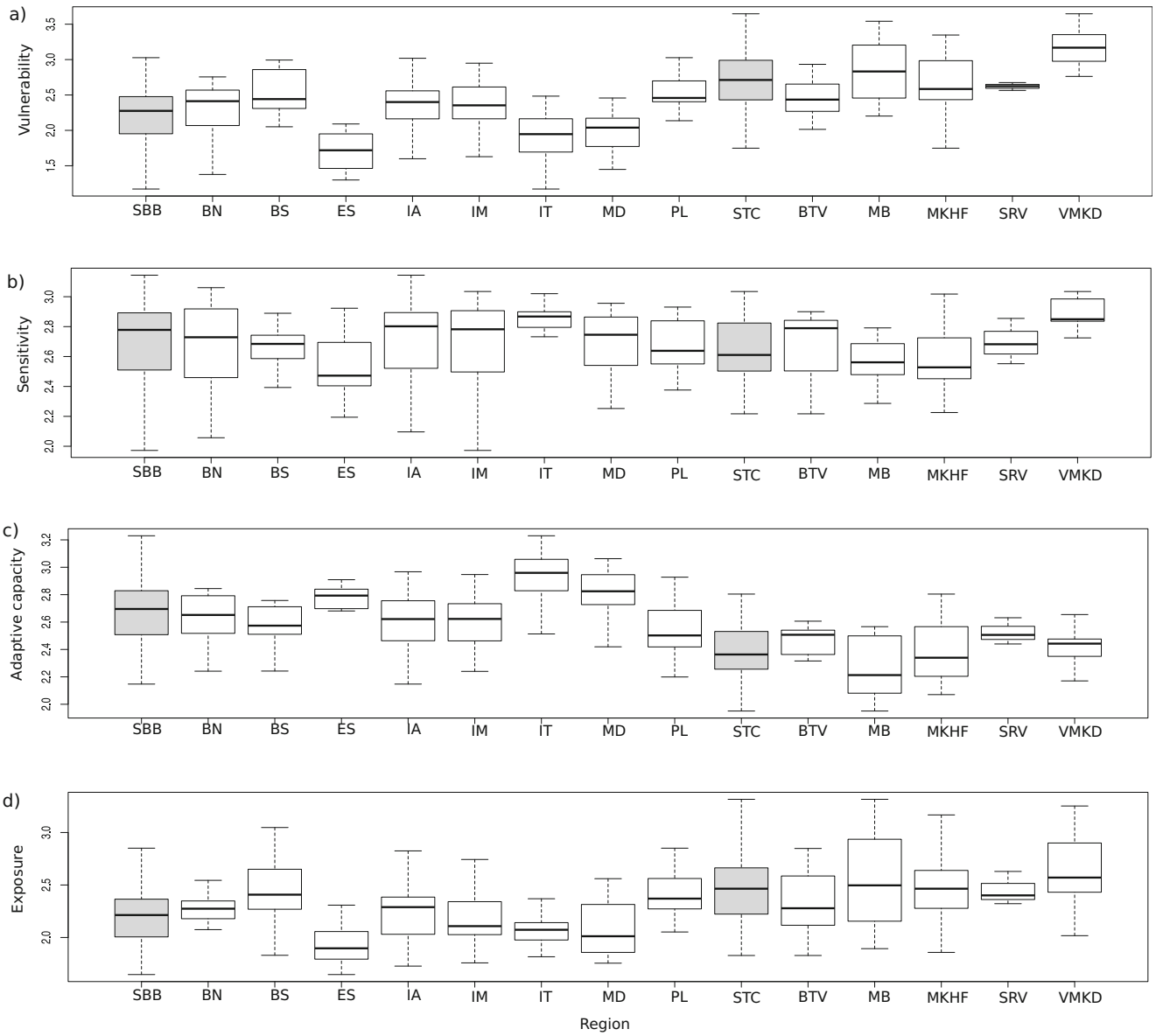

Fig. 3 Scores of vulnerability (**a**), sensitivity (**b**), adaptive capacity (**c**) and exposure (**d**) for the South Brazil Bight and southern Cape fishing communities. The solid black lines represent medians; open boxes are 25% and 75% of the observations; bars indicate the range of durations; and dots represent the outliers

(Wilcoxon test, $p = 1.633e-10$) the SBB fishing communities had higher sensitivity scores. In the subcomponent referring to social dependence the STC fishing components scored higher (Wilcoxon test, $p = 3.815e-06$), specifically through higher social mobility (Wilcoxon test, p = <0.001) and a higher dependence on (market/shop-bought) food source (Wilcoxon test, $p = 1.439e-10$).

Adaptive Capacity

The adaptive capacity of the SBB fishing communities was significantly higher than that of the STC communities (t-test, $p = 4.983e-14$, Fig. 3c). When scaling down, it becomes apparent that the SBB communities did not have the highest scores for all components and subcomponents. SBB fishing communities had higher scores in the natural capital component (Wilcoxon test, $p = 1.107e-07$), human capital (Wilcoxon test, $p = 1.067e-05$), social capital (Wilcoxon test, $p = 1.573e-11$), physical capital (t-test, $p = 1.687e-15$), and attitude and perception (Wilcoxon test, $p = 0.001126$) components. In terms of the occupational flexibility (Wilcoxon test, $p = 1.875e-05$), institutional support (Wilcoxon test, $p = 1.81e-12$), and institutional flexibility (Wilcoxon test, $p = 0.001095$) components, the STC communities had a higher score. When scaling down, the SBB communities had higher scores in the subcomponents changing resource base subcomponent (Wilcoxon test, p = 1.107e-07), knowledge (Wilcoxon test, $p < 2.2e-16$) and labor (Wilcoxon test, $p = 3.576e-08$), decision-making (Wilcoxon test, $p = 4.781e-09$), leadership (Wilcoxon test, $p = 0.001293$), community cohesion (Wilcoxon test, p < 2.2e-16), boat assets, energy, material assets and infrastructure. By contrast, the STC communities had higher adaptive capacity scores in the subcomponents relating to education (Wilcoxon test, $p = 5.128e-13$), waste (Wilcoxon test, $p = 3.173e-07$), occupational mobility (Wilcoxon test, p = 1.875e-05), resource management institutions (Wilcoxon test, p = 1.81e-12), and fishing compliance and conflict (Wilcoxon test, $p = 0.001095$).

Exposure

Overall, the STC fishing communities reported significantly higher exposure than those of the SBB communities (t-test, $p = 4.968e-07$, Fig. 3d) and perceived greater environmental change (Wilcoxon test, $p = 3.798e-10$). However, institutional support, personal exposure, and attitude and perception showed no differences between the STC and SBB scores (Wilcoxon tests, $p > 0.05$).

Discussion

Through comparing the vulnerability, sensitivity, adaptive capacity, and exposure scores at the sub-component level, key differences and similarities between the SSB and STC fishing communities have been identified (Fig. 4). The similarities between the countries were numerous and included various social, economic, and institutional themes. Considering the similarities that exist between the two countries, most of these were expected. Our analysis has, however, highlighted some key differences between the two regions that are reflected through statistical significance as reported in Results above, including participation in decision-making processes and fishing activity structure in the SBB, and mobility and temporal migration, food security, and institutional support in the STC (Fig. 4). Broadly, vulnerability in the SBB was decreased through participation of fishers in decision-making processes and the fishing assets they hold. Conversely, in the STC communities, vulnerability was decreased by the fishers' mobility and temporal working migration as well as institutional support received. Fishing activity structure increased vulnerability in the SSB communities while a lack of food security increased vulnerability in the STC communities.

We focus in the ensuing discussion on these key differences – using the results of the vulnerability analysis we make use of previous research to reflect on the drivers behind these key differences exposed by the vulnerability analysis. Through highlighting these drivers, it becomes possible to gain new insight into the vulnerability both at the local and regional (country level). The comparison exercise allowed mutual learning of the aspects that guide vulnerability in both countries and how each region has been working to mitigate the impacts of climate change on fishing communities.

Fishing Activity Structure

The factor that appears to be crucial in reducing the sensitivity of the STC fishing communities is the way the fishing activity is organized in the South African region. The sampled STC fishers were mostly crew who all participated in the small-scale commercial line fishery of the southern Cape (Gammage *et al.* 2019). In this fishing sector, the skipper typically holds the fishing rights, addresses the supply chain, and decides when to fish (Visser 2015). The crew-skipper organization of the small-scale fisheries in the STC results in the marginalization of the crew in the sector (Gammage *et al.* 2017). Consequently, the STC communities were socially and historically less dependent on fishing activities than the SBB communities and thus appeared to be less sensitive. In terms of vulnerability to the climate change framework, lower sensitivity is positive because it results in a lower vulnerability score. However, the low adaptive capacity of the STC fishers and the limited opportunities to create alternative strategies to

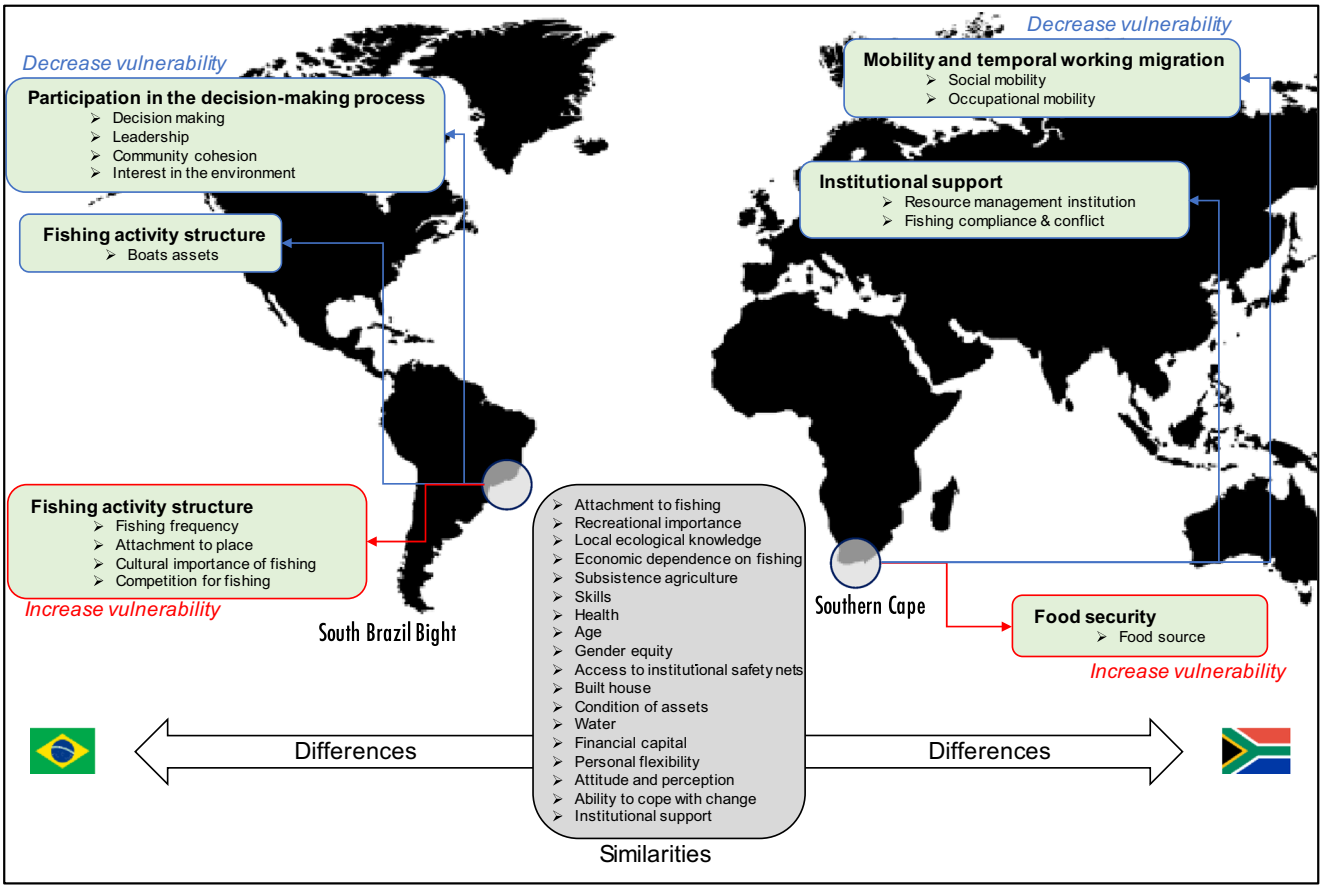

Fig. 4 Factors influencing the differences and similarities between the South Brazil Bight and southern Cape fishing communities in the vulnerability to various aspects of climate change. All differences are statistically significant

face the effects of climate change has a substantial negative impact on the final vulnerability score.

In Brazil, the SSB fishers are the owners of their boats and hold fishing rights, which gives them greater flexibility and power over fishing activities, resulting in a higher adaptive capacity. However, their relatively high dependence on fishing activities makes them more sensitive to changes in the marine environment.

Mobility and Temporal Working Migration

The STC fishers have less attachment to place and greater social mobility through their willingness to take up alternative employment to fishing; additionally, they expressed a willingness to relocate to larger towns for work if necessary. Although the STC fishers would be willing to move to another activity or town, the literature indicates a strong connection to place, which makes this migration likely to be temporary (Gammage *et al.* 2017). The handline crew regulations allow the STC fishers to have greater mobility than the rights holders and skippers, and they can move between areas to serve as crew on different boats. However, most of the crews indicated an unwillingness to pursue this strategy because it is not necessarily financially viable (Gammage *et al.* 2017). This is largely due to the additional costs incurred, as the household and family at home need to be maintained. Thus, the STC fishers display virtual mobility, although this is not necessarily used to their favor in practice.

On the other hand, Brazilian fishers display a strong connection with place, and their strong attachments to fishing and place make SSB fishers more sensitive not only compared to STC fishers, but also to those who were part of the GULLS case studies in other countries, India, Madagascar, the Solomon Islands, and Australia (Aswani *et al.* 2018). However, a considerable proportion of Brazilian fishers are involved with some alternative livelihood activities to supplement their income, albeit most of these activities are informal. Parallel activity is complementary and often contributes to higher earnings. Despite this, they consider themselves first and foremost as fishers and are unwilling to abandon their fishing activities (Hanazaki *et al.* 2013). Trimble and Johnson (2013) also found that small-scale fishers from Paraty (Brazil) and Piriápolis (Uruguay) considered fishing as a way of life rather than just a job. The freedom of fishing and the inherent occupational satisfaction features prominently in the Brazilian fishers' attachment to fishing.

Further, the SBB fishers diversify their livelihoods into other fishery-related activities, such as mussel or seaweed farming, mangrove oyster and crab extraction, or just by widening the range of catch species and diversifying the fishing gears used (Martins 2018). Other studies of Brazilian, Uruguayan, and Cambodian fishing communities also found the same capacity of households to diversify their livelihoods into fishing or non-fishing activities (Marschke and Berkes 2007; Trimble and Johnson 2013). Flexibility of livelihood strategies plays a vital role in allowing fishers to address changes and challenges. Diverse (and often multiple) livelihood strategies result in greater adaptive capacity, thereby reducing vulnerability.

Food Security

Small-scale fisheries and aquaculture have been recognized as important opportunities to enhance household food security in developing countries, as the protein intake from fish can form an important contribution to human nutrition (Kent 1997). Kawarazuka and Bene's (2010) review went further and showed that, in addition to the provision of protein, fish contribute to the nutritional security of poor households in developing countries in many ways. The first benefit of fish consumption is its direct nutritional contribution, as the fishers' households are, in theory, able to improve their own nutritional intakes by consuming some of the fish they catch. The second benefit is increased purchasing power through the sale of fish. Finally, because the degree of control exercised by women over family income directly impacts household food security and nutritional outcomes, enhancing the economic status of women through their involvement in fishery-related activities is another important pathway to improving household nutritional security. This pattern is observed in the fishing communities of SBB but not in STC.

The STC fishers are more dependent on markets and shops in obtaining food security, as they have no control of the sale of their catch and very few have access to subsistence gardens or domestic livestock. The low access to fish for consumption together with the lack of involvement with fish processing and trading limits food sources available to STC fishers (Gammage 2015; Duggan 2018). The limitation of accessing diverse sources of food and protein, combined with the associated uncertainties related to climate change, expose the fragility of poor communities in terms of food security in this South African region.

In contrast, the small-scale fishers of the SBB communities have historically practiced, alongside their fishing activities, small-scale farming, hunting, and extracting plant resources in the Atlantic Forest (Diegues 2006). However, in recent decades, the SBB coastline has undergone an intense process of urbanization and an intensification of tourism. Together, these factors have led local people to increase their participation in commerce-related activities and have even increased the rate of migration to urban centers (Adams 2000). These changes are also reflected in new relationships between the fishers and natural resources involving changes in food acquisition and eating habits (Begossi *et al.* 2012; Hanazaki *et al.* 2013; Castro *et al.* 2016). Nevertheless, the practice of subsistence agriculture or vegetable gardening is still central to many of the fishers' households along the SBB coast (Giraldi and Hanazaki 2014). However, the ongoing transformations in the livelihoods of the SBB fishers have affected local food security, and households are increasingly dependent on fresh produce markets and/or shops to buy food. This situation is more apparent for remote communities, as distance and difficulty of accessing the market are among the main drivers of vulnerability in the SBB fishing communities (Martins 2018).

Participation in the Decision-Making Process

STC fishers have lower participation in local and regional decision-making processes; additionally, they hold the perception that their knowledge is not included in local natural resource management plans, which contrasts with the perception of the SBB fishers. The Marine Resources Act No 18 of 1998 (MLRA), a post-apartheid fisheries law according to which all South African fisheries are governed, strives to encompass the ideas of an ecosystem approach to fisheries management. Although stakeholder engagement in management decisions is encouraged, management decisions are often not participatory and are implemented in a top-down manner. There is also low confidence in and access to local leadership, whether the local fishers' representatives or the local municipal and political leadership (Gammage 2015). Finally, the biggest difference observed between the two countries is lower household participation in community organizations in STC communities, owing to a history of extreme mistrust fueled by apartheid (e.g., van Sittert 2002; Duggan 2018). The majority of the STC line fishers feel that they have long been, and continue to be, excluded from discussions surrounding policy, regulations, and management strategies, all of which directly and pervasively affect their lives (Gammage 2015; Visser 2015). Delays in the allocation of fishing rights and repeated court challenges to the allocations that have been made has resulted in the loss of confidence by the fishing industry in the ability of the government to implement the MLRA policy objectives or to bring stability back to the small-scale fishing sector in South Africa (Sowman *et al.* 2014).

Since 2012, the new Small-Scale Fisheries Policy (No 474 of 2012) (SSFP), currently under implementation, attempts to include fishers in the decision-making process and address the equal distribution of fishing rights. It is based on the establishment of community cooperatives, which will be managed by the local community associations; additionally, fishing rights

will be allocated to the co-operatives of which fishers will be members. The successful implementation of the new policy will depend on strong community cohesion, which is generally lacking (Norton 2014). Furthermore, joint efforts by government and fisheries organizations will be needed to ensure that the participating communities have the necessary infrastructure and capacity to harvest, process, and market marine resources for the local, regional and, where possible, international markets (Isaacs 2011). Successful policy implementation may however be compromised should sufficient support to the creation of conditions enabling co-operatives to effectively work together (whilst managing a business) not be forthcoming.

Although the SBB communities scored better with respect to participation in fisheries management, it is important to note that this does not necessarily imply that Brazilian fishers are fully involved and included in the decision-making processes. There is a lengthy list of studies and local initiatives that strive for the inclusion of fishers in decision-making processes, and for equal access to resources in Brazil (e.g., Moura *et al.* 2009; Seixas *et al.* 2011; Martins *et al.* 2014). The positive results we found here can be associated with the implementation of a national conservation unit system (SNUC) policy in Brazil. The SNUC assures the rights of local and traditional communities living in or nearby coastal zones to active participation in the management of the areas. Public participation is a legal requirement for studies and consultations prior to the creation of marine protected areas (MPAs), as well as after the establishment of an MPA through the consulting and decision-making boards, with the goal of ensuring resource user participation in area management. Even though participation by local communities in local MPAs have increased, the SNUC policy is still flawed in terms of ensuring the rights of communities in decision-making processes, as well as in ensuring the proper management of the marine resources (Silva *et al.* 2015). However, one specific type of MPA, the marine extractive reserve (MER), as defined in the SNUC policy, addresses the issue of including fishers in the decision-making processes. MERs encourage participation in decision making by stimulating effective social organization by including representatives from local communities on management councils and giving local people the power to approve or reject management norms (Moura *et al.* 2009). Two of eight SBB fishing communities surveyed in this study are MERs and this process has resulted in greater involvement by SBB fishers in decision-making processes, although there is still a long way to go for this participation to become effective.

Institutional Support

In terms of vulnerability, our results show that the STC fishing communities report better institutional support and flexibility, and consequently have a lower vulnerability score. This result may seem contradictory to what is reflected in the qualitative data and in other studies.

In South Africa the SSFP seeks to address many drivers of vulnerability of the STC fishing communities. Institutional involvement is expected to reduce fishers' vulnerability to global change once the policy has been successfully implemented However, the long implementation process has generated a great deal of uncertainty and mistrust within fishing communities and many wonder whether it will achieve its proposed goals. At this point, it is difficult to speculate on the positive and/or negative impacts on STC fishers' vulnerability. Importantly, the existence of a small-scale fishing policy that is actively being implemented is a major difference between South Africa and Brazil, and this was reflected in the responses of the STC fishers.

In Brazil, there is a need to improve institutional support, and its lack was the main negative aspect in our analysis. There is no longer any collection of catch statistics on behalf of the Brazilian management authority (Freire *et al.* 2015). The most current information available on Brazilian catch landings is based solely on estimation models for the period between 2008 and 2011, yet no detail is provided about catches and species (MPA 2011). In the state of São Paulo, catches are being monitored despite the interruption at the national level, but similar efforts do not occur in all states. It is crucial for Brazil to resume its data collection system for all Brazilian fisheries. Catch landing data are essential for the proper implementation of fisheries policy and management, and the lack of data compromises the effectiveness or improvement of management. The qualitative data suggest that some level of informal monitoring is taking place, with fishers being fully aware of the fish stock situation (e.g., Martins *et al.* 2018). However, the data do not provide insight into informal monitoring practices as such. Important in this context is that government is failing to monitor, compromising a scientifically sound basis for fisheries management.

Poor enforcement of legislation is another example of the lack of institutional support, and it constitutes one of the main complaints of fishers in Brazil. The SSB fishers noted that, in addition to inefficient enforcement, in most cases, enforcement is also inconsistent and not equally applied to all groups and sectors (Seixas *et al.* 2011). This situation also highlights the government's lack of support for the fishing sector, as enforcement is a government imperative and one of the causes of conflict and mistrust in the role and ability of the Brazilian fisheries authority in managing the sector.

There is no specific policy for the small-scale fisheries sector in Brazil. The SNUC policy, which was implemented in the 2000s, provided new perspectives of resource management and witnessed unprecedented growth in the implementation of co-managed reserves, where local people play an increasingly vital role in decision-making processes (Lopes *et al.* 2011). A specific policy for the small-scale fisheries

sector, as it is being implemented in South Africa, still needs to be developed in Brazil. The recent international guidelines for small-scale fisheries highlight the need to incorporate such policies for small-scale fisheries into the legislation of regional and international instruments that govern small-scale fisheries (FAO 2015); however, Brazil has not yet started to move in this direction.

Beyond the Indicators

As demonstrated in our assessment of a set of internationally agreed vulnerability indicators, there are specific fishery and local coastal community traits that drive the vulnerability of small-scale fishing communities at the local level, and which are unique to the specific contexts within South Africa and Brazil.

During our fieldwork with the STC and SBB fishing communities, despite the differences in the quantitative estimates of the vulnerability scores, both groups of fishers raised similar issues during the survey, predominately centered on the lack of clarity and understanding of the actions taken at government level. Highlighted issues raised included ineffective management, poor or ineffective policies, unclear understanding of how policy will be implemented, and a general mistrust in the government actions. Previous work carried out in Brazil and South Africa also found similar constraints that have proven to be barriers in the management of coastal fisheries in these regions (e.g., Sowman *et al.* 2013; Trimble *et al.* 2014), underlining the value of a comparative approach.

Regardless of organizational differences and the degree of involvement in decision-making, both the STC and SBB fishing communities urgently demand clarity from the government in terms of actions and strategies for the fishing sector. The uncertainties generated by the lack of understanding of management actions create conflicts between different fishing sectors, general detachment from management processes, and non-compliance with proposed rules. The objectives, processes, procedures, and intended outcomes need to be transparent and clearly defined and need to include the meaningful participation of all fishers.

South Africa's SSFP has attempted to respond to and correct the problem over access to coastal resources and many of the points discussed in this paper; however, the outcome will only become clear in the medium-term future. In Brazil, the fishing sector has faced an institutional crisis with the recent cessation of collection of relevant statistics by the Ministry of Fisheries. Despite this crisis and the lack of governmental support, the small-scale fisheries in Brazil continue to supply local and regional markets, even under the large range of pressures that the small-scale fishing communities have been suffering, owing to the expansion of the real estate and tourism sectors, conservation policies, and environmental degradation (Diegues 2006). Further actions are required to ensure the viability of small-scale fishing activities and livelihoods for future generations in Brazil and South Africa alike.

Our findings provide a basis for strategic options for enhancing community adaptation pathways developed or pursued by the small-scale fisheries in two recent democracies and emerging economies, Brazil and South Africa. They also provide new insights into the vulnerability of coastal communities in both regions decreasing through livelihood alternatives and participation in the resource management in SBB and anticipated institutional support and fishers' short-term mobility in STC. Our insights provide a model evaluation of dimensions of vulnerability through the combination of globally comparative, quantitative research and locally specific, in depth qualitative research. It is our hope that the approach and results of this study will be taken up in the assessment of other communities experiencing similar stressors, and most importantly serve as a basis for adaptation programmes reducing their vulnerability to global change.

Acknowledgements We thank CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) for the scholarship for the first author (IMM) and FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) for the research grant to MAG and IMM. The support of the South African Research Chair in Marine Ecology and Fisheries, funded by the South African Department of Science and Technology and administered by the South African National Research Foundation, to LCG and AJ is gratefully acknowledged. All authors thank the GULLS project (Belmont Forum research initiative) for the opportunity to interact, and for collating part of the data underlying this study. We express our sincere gratitude to all fishers who kindly collaborated with the study.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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