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RESEARCH

Growing vulnerability in the small-scale fishing communities of Maio, Cape Verde

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Abstract

This study depicts the increasing vulnerability of Maio's (island of Cape Verde's archipelago) small-scale fishing communities that rely directly on rich but declining fish stocks. The concept of mobility is defined in this paper to describe inward and outward flows of resources, people, species, and governance. Mobility is a useful tool for studying small-scale fishing communities, as it enables environmental, economic, and political factors that shape vulnerability to be analyzed on the same footing. While most elements flowing outward from Maio and surrounding waters are beneficial (e.g., fish catches and local governance capacity) and most flowing inward are detrimental (e.g., foreign industrial vessels, international interference, and greenhouse gas), the overall result is increasing vulnerability for local communities. Maio is concomitantly very dependent on the unstable and intermittent inward flow of some elements, such as fuel, food, and international aid. The Actor in 4 dimensions (A4D) methodology (in-depth interviews regarding residents' and experts' perceptions of their marine environment and its governance) allows a comparison to be made between the perceptions of vulnerability and facts (provided by official documents and a scientific literature review). The A4D results namely indicate that locals hope for better fishing and marketing equipment and infrastructure that would improve their commercial mobility. Interviewees also ask for stronger local, national, and regional self-governance and law enforcement to protect their sea resources.

Introduction and background

This study stems from a large body of research on coastal communities and Small Island Developing States' (SIDS) vulnerability (Adger 2006; Smit and Wandel 2006; Turvey 2007; Allison et al. 2009; Zou and Wei 2010; Guillotreau et al. 2012; Monnereau et al. 2013; Bennett et al. 2015, 2016; IPCC 2017).

According to Adger (2006) and Bennett et al.'s (2016) definitions, vulnerability is the sum of sensitivity, exposure, and limited adaptive capacity:

$$\text{Vulnerability} = \text{Sensitivity} + \text{Exposure} - \text{Adaptive capacity},$$

where sensitivity is the susceptibility of an entity or system to the effects of an exposure (Bennett, Blythe et al. 2016); exposure is the degree to which trends and shocks are experienced by a region, resource, or group; and adaptive capacity is the ability to modify and alleviate exposures, to absorb and recover from losses stemming from hazards, and to exploit new opportunities that arise in the process of adaptation (Adger 2006; Smit and Wandel 2006; Allison et al. 2009). However, as multiple exposures may interact and overlap, such as overfishing and climate change (Bennett et al. 2015, 2016; Blythe et al. 2016), and as some factors may be considered simultaneously as exposures, sensitivity as well as adaptive capacity, this paper will not detail each factor according to these categories. It will highlight major factors of vulnerability and broader "vulnerability drivers"[1] that were reported by interviewees.

Climate change and globalization have been identified as general vulnerability drivers (Smit and Wandel 2006; Leichenko and O'Brien 2008; Allison et al. 2009; Brklacich et al. 2009; Bennett et al. 2016) and SIDS and small-scale

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[1] Vulnerability "drivers" are defined as large-scale exogenous conditions and trends that operate at different speeds and scales (Bennett et al. 2016; Armitage and Johnson 2006.

fishing communities stand out as being particularly vulnerable groups (Turvey 2007; Guillotreau et al. 2012; Monnereau et al. 2013; Schuhbauer and Sumaila 2016; IPCC 2017). Small-scale fishing communities are most vulnerable to climate change (Allison et al. 2009; Guillotreau et al. 2012), to the decline of resources (FAO 2005; Wong et al. 2005), and to political, social, and health threats (Allison and Horemans 2006).

In the community vulnerability literature, many authors have asked for various exposures to be better incorporated into vulnerability analysis and outcomes (Leichenko and O'Brien 2008; Brklacich et al. 2009; Bunce et al. 2010; Smith et al. 2013; Bennett et al. 2015, 2016) and have expressed the need for more empirical studies to link theory and local experiences of multiple exposures (Turner et al. 2003; Silva et al. 2010; Zou and Wei 2010). Authors also have asked for analysis incorporating perceptions of vulnerability based on individual values (O'Brien and Wolf 2010, Hicks and Cinner 2014, Bennett et al. 2016). Studying a variety of exposures by an analysis of local actors' perceptions of vulnerability in a new case (Maio) is the goal of our research. We use in-depth interviews of local people and experts regarding their perceptions of the marine social-ecological system and of its governance. Answers bring out vulnerability factors that are considered as most important for Maienses and actors working on their marine system. We compare perception data with a review of available official reports and scientific studies.

In a context of growing subsistence dependency on a pressured marine environment, this paper examines Maio (Cape Verde) small-scale fishing communities' vulnerability. Maio's vulnerability mainly results from a high sensitivity (namely tied to SIDS features), from various exposures related to global social-environmental changes, and from a low adaptive capacity (e.g., limited financial and human means).

Vulnerability factors are then integrated into a mobility analysis. The mobility concept is defined fully in the "Definition of mobility" section, but a mobility analysis can basically be thought of as a study of the displacements of different elements in and out of the social-ecological system. Our paper shows that most elements decreasing Maio's vulnerability (e.g., fish catches, governance capacity, educated and skilled people) are leaving the social-ecological system and that most elements increasing Maio's vulnerability (e.g., international interference, industrial vessels, greenhouse gases) enter the social-ecological system. Mobility dynamics therefore aggravate Maio's social-ecological system's vulnerability.

The remainder of this introduction describes the general setting of Cape Verde and the particular setting of Maio island within the archipelago. The introduction ends by defining the concept of mobility, which will be used throughout the article. The "Methodology" section presents an innovative method, the Actor in 4 Dimensions (A4D), which serves to gather the actors' perceptions. The "Results" section compares perceived and effective mobility issues that may impact vulnerability in Maio small-scale fishing communities.

Cape Verde setting

Cape Verde is part of the Small Island Developing States (SIDS) group (Banque africaine de développement 2014). SIDS are comprised of independent oceanic island countries of small size and population with a developing economy status (Briguglio 1995; Turvey 2007; Monnereau et al. 2013). Cape Verde was discovered by the Portuguese in 1456 and became a strategic platform for trading slaves. Cape Verdean culture and language (Creole) are thus descended from Portuguese and African influences. The volcanic archipelago lies about 570 km west of Dakar and comprises ten islands and 15 islets (Fig. 1).

Like most SIDS, Cape Verde has a small local market, few exportable resources (mainly fish), and limited agricultural and mineral production, which contribute to the country's sensitivity. It therefore relies heavily on the global and regional context (e.g., imports and transportation costs (United Nations 2010)) and the environment (Allison et al. 2009; Barnett and Campbell 2010; Lee et al. 2014).

Small size, insularity, and poor resources combined with inhospitable natural and climatic conditions prevent Cape Verde from being a major producer or exporter or from competing in global markets with bigger developing economies (Resende-Santos 2016). The country has turned to a service economy (now 75% of the country's gross domestic product or GDP), mainly from direct foreign investments, official development assistance, diaspora remittances, and tourism receipts, which are all driven by foreign countries' demand and market policies (Resende-Santos 2016). Cape Verde's GDP per capita is around US$3000.

Cape Verde also depends on the environment for the subsistence of its people (i.e., via fisheries and agriculture), for tourism development (i.e., to attract foreigners), for transporting goods and services (through the ocean), and for security (relying on stable environmental conditions). Thus, climate change, droughts, and rainfall irregularities (SLN Cabo Verde and SDTIBM 2008, Borges dos Santos 2016) combined with insecure agriculture and scarce subsistence and livelihood alternatives (SLN Cabo Verde and SDTIBM 2008, Callado et al. 2013) have forced many Cape Verdeans to migrate to cities. Approximately 60% of Cape Verde's population lives in Praia and Mindelo (Republica de Cabo Verde 2013).

At a wider level, Cape Verde's history, culture, economy, and identity have been shaped by emigration. Cape Verdeans started to leave for the USA in the mid-eighteenth century and later for Europe (Resende-Santos 2016). The main reason for

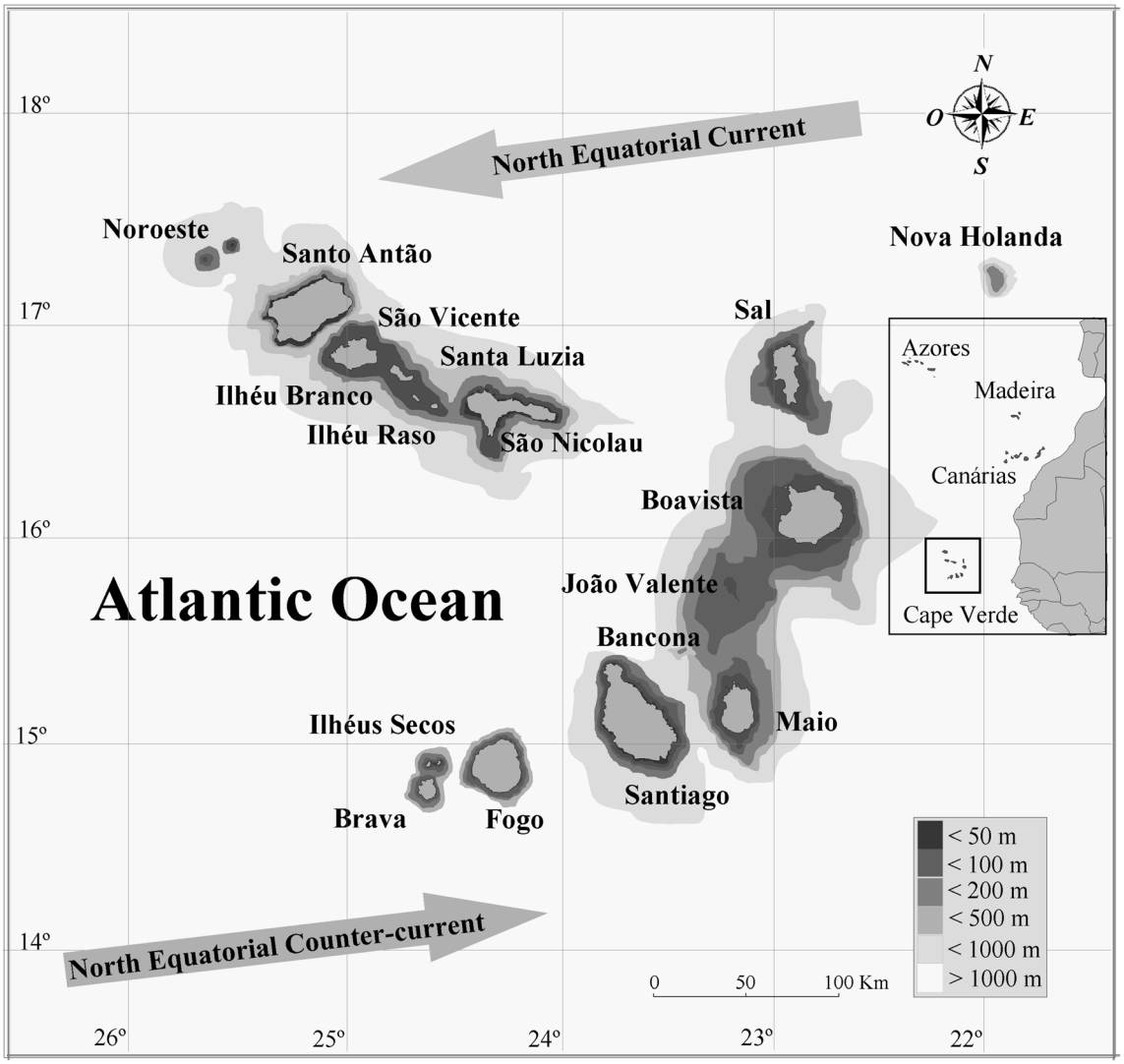

Fig. 1 A bathymetric map of the Cape Verde archipelago (fig. taken from (Medina 2008))

emigration has been a lack of food (often caused by droughts) and inadequate economic opportunities. Even if emigration has decreased since the 1970s, the country's main "export" may be its own people, with one of the largest diasporas in the world relative to its resident population. Cape Verde's diaspora supports the country through remittances (about 9% of GDP) and also through tourism demand and knowledge transfer. Therefore, the diaspora has a great influence on Cape Verde's economy and development.

With a mere 261 mm of annual rainfall, Cape Verde is considered a semi-desert territory. Irregular rainfall, low water retention, insufficient freshwater sources (SLN Cabo Verde and SDTIBM 2008), and a proportion of only 18.6% arable land (Sociedade de avaliaçao estratégica e risco SaeR 2015) limit Cape Verdean agriculture. This harsh insular environment and the country's economic and political dependence resulting from its colonization history make Cape Verde especially sensitive to various exposures (Bennett et al. 2016).

With no significant mineral resources other than salt and sand, the ocean (for transportation, trade, tourism, desalinized water) and its fish stocks (for local use, market, and exports) thus constitute Cape Verde's principal resources (Sociedade de avaliaçao estratégica e risco SaeR 2015). Fish (mainly yellowfin, bigeye, and skipjack tunas, as well as swordfish and blue shark) constitute 85% of Cape Verde's exports. These exports have increased exponentially since 2004 (Banco de Cabo Verde 2012). Direct exports and fisheries partnership agreements with foreign industrial fleets draw foreign currencies into Cape Verde (European Union 2014; Câmara de Comércio Industria e Turismo Portugal Cabo Verde 2015; Instituto Nacional de Estatistica Cabo Verde 2015). Fishing activities presently employ 10% of all employed Cape Verdeans (Diop 2012) and that number continues to grow (Baptista 2005; ESR 2011). Most importantly, fisheries support the livelihoods of one-fifth of Cape Verde's population directly or indirectly (FAO 2008; Sociedade de

avaliaçao estratégica e risco SaeR 2015). Cape Verde's fishing-dependent population grew by 20% from 2005 to 2011 (Sociedade de avaliaçao estratégica e risco SaeR 2015), following the general West African tendency (Belhabib et al. 2015b).

However, the living conditions of the small-scale fishing population are deteriorating. Fishers' incomes are decreasing while their costs (fuel, material) are increasing (Belhabib et al. 2015b). For many, if not most, fishing is no longer a sufficient source of income. Instead, fishing has become a safety valve (Béné 2003), a last resort subsistence solution (Oceanic Développement and Lda 2010) for populations with limited adaptive capacity (Allison et al. 2009) or those facing poverty (Baptista and Lopes 2009) or unemployment in more lucrative sectors such as tourism.

Although fisheries represent a critical activity for Cape Verde's subsistence and livelihoods, they only account for 10% of Cape Verde's primary economic sector (Câmara de Comércio Industria e Turismo Portugal Cabo Verde 2015, Instituto Nacional de Estatistica Cabo Verde 2015), which itself only constitutes 8.3% of the country's GDP (Ministère de l'économie et des finances de la République française 2018). The fisheries' low share of Cape Verde's GDP can be explained by many factors, including partnership agreements' massive underestimation of fish value (see the "An outward flow of resources" section) and the under-recording of a significant part of fisheries' economic activity.

Faced with environmental and anthropogenic changes, Cape Verde also has scarce resources; transportation limitations; and high financial, energy, and material dependency (Cesarini 2013) that narrow its adaptive capacity. Adding to these pressures, the "fishing activity" safety valve is becoming unreliable. Poor fishing-dependent populations are directly affected by more frequent and extreme climatic events (Teixeira Santos 2010; United Nations Environment Programme 2011; Niang et al. 2014) and overfishing, which explains why Cape Verde's small-scale fishing communities' population decreased by 8% between 2005 and 2011 (Monteiro 2011), despite the growth in fishing activity and the fishing-dependent population. Effectively, we observe a general growing dependence on fish, but a decline in communities that are organized around fishing activities.

Cape Verde's vulnerability thus comes from its intrinsic sensitivity (SIDS situation, aridity, and lack of non-ocean resources), its extrinsic exposures (climate change and overfishing, among others), and low adaptive capacity reflected by low technical, human, and financial means to cope with sensitivity and exposure factors.

Cape Verde's constitution (1992) acknowledges its cultural and economic dependence on nature and on the vulnerability associated with that dependence. This concern is also reflected in its national development plans, projects, and strategies (Direcçao Geral do Planeamento 2002; Ministério do Ambiente Agricultura e Pescas 2004; DGASP et al. 2007; MAHOT-DGA and PCSAPCV 2012; Republica de Cabo Verde 2012; Cesarini 2013; Republica de Cabo Verde 2013; Bonnin et al. 2016; Republica de Cabo Verde 2016a). More recently, two integrated economic and governance strategies have specifically been aimed at making better use of the oceans' goods and services: the "Sea Cluster" and the "Blue Economy Plan" (Republica de Cabo Verde 2015; Sociedade de avaliaçao estratégica e risco SaeR 2015). However, these documents tend to downplay or neglect the vulnerability of a large part of the population, like the Maienses, who depend on sea services and goods for their very subsistence.

Maio island

Situated only 23 km from Santiago Island, Maio is one of Cape Verde's poorest islands. Its 275 km^2 area represents 6.8% of the country's territory. Its population is about 7000 people.

Maio's precipitation (less than 150 mm annually) and vegetation cover are some of the lowest in Cape Verde (Direçao Geral dos Recursos Marinhos and PRAO-CV 2016). This acute dryness exacerbates other environmental problems like erosion, low water retention, and food crops. Furthermore, Maio has no groundwater. This island thus relies entirely on desalinized ocean water for its drinking water, made via a process requiring electricity produced with foreign fuel, which is also vital for fishing boat motors. Maio's history and development have been marked by droughts and crises linked to these arid conditions (Cesarini 2013). These factors contribute to a more severe sensitivity of Maio island, even compared with Cape Verde's average.

In contrast with its terrestrial aridity (ECOS 2012), Maio's marine environment is rich and diverse. Maio's insular shelf extends about 3560 km^2 (Bravo de Laguna 1985). It forms Cape Verde's most important insular platform, presenting great potential for marine resources and unique marine biodiversity (ECOS and DECM 2009) that includes many coral species, sponges, algae, lobsters, cone snails, cetaceans, sharks, turtles, etc. It is home to approximately 75% of the Cape Verdean archipelago's groundfish and pelagic fish (Stromme et al. 1982). Mauritania's upwelling, the Canary Current, depth currents, and the more local "island effect" also enhance Maio's phytoplankton and marine biodiversity (Almada 1993; Medina et al. 2007; Benchimol 2008; Benchimol 2012). Still, some 30 marine species of Maio are threatened (IUCN 2013), justifying protection recommendations by scientists and the government (Almeida 2013).

Maio island's population's subsistence and economy rely on small-scale fisheries. Fisheries' contribution to food security is explained by affordable prices and resource abundance. Fisheries directly contribute to maintaining 160 families on the island (8.5% of the families) and indirectly maintain the

whole Maiense community. In 2015, Maio's artisanal fisheries (generally 3–8-m boats with outboard motors) employed 113 fishermen, 24 divers, 89 fish sellers, 14 ship owners, and 1 sport fisher (Direçao Geral dos Recursos Marinhos and PRAO-CV 2016). On average, there are two fishermen per boat. Most fishermen use handlines to catch demersal and pelagic species (Direçao Geral dos Recursos Marinhos and PRAO-CV 2016). Maienses annually consume about 67 kg of fish per capita, more than three times the national average (Tvedten and Hersoug 1992; Santos et al. 2013). While Cape Verde's economy is mainly urbanized and oriented towards the third sector (especially tourism), Maio's economy and Maienses' subsistence depend directly on natural resources (fish, corns and beans, goats and cows, coal, and salt) and its population is mainly rural (57%) (Ministério do Ambiente Agricultura e Pescas 2004; Cesarini 2013).

Maio hosts numerous small-scale fishing communities. The biggest of these communities is Vila do Porto Inglès, with 3055 people (Fig. 2). It is the island's main urban settlement and the seat for city hall and a few governmental organizations' offices. Vila do Porto Inglès's large beach is a fish-landing site for almost a third of the island's boats (Direçao Geral dos Recursos Marinhos and PRAO-CV 2016). It hosts the island's fishermen association's office and the only fishing monitoring station. Calheta (Fig. 2) is the most important fish-landing site of the island with almost half of all Maio's boats (Direçao Geral dos Recursos Marinhos and PRAO-CV 2016) and hosts key fishing actors (including divers who catch fish and lobsters). It is also where buzio (local marine cone snails) catches are increasingly disembarked. The Barreiro settlement (Fig. 2) is home to a strong and united group of fishermen who seek more decision-making power and promote environmentally friendly practices.

Maio's considerable fishing banks and marine resources attract fishermen from other islands (Cesarini 2013).[2] These fish constitute most of the products found in Praia's fish market. Maio's marine resources also attract international fishing vessels, which are often observed on its insular platform (Merino 2006; Cesarini 2013). In addition to the pressure from industrial fisheries, tourism and conservation projects are expected to affect Maienses' vulnerability by changing their livelihood in the coming years.

The following analysis deals with multiple, intersecting factors that influence the vulnerability of the Maio community. It also provides insights into those factors contributing to long-term sustainability in Maio. Since the concept of mobility has emerged as useful for studying Maio's vulnerability and especially to predict vulnerability's evolution over time, it will be defined before going any further.

[2] Marine resources' exploration access is free between the islands.

Definition of mobility

The concept of mobility has recently been gaining in popularity, but is used in a variety of contexts (as attested by the MARE 2017 conference[3]), often without a specified definition. In this paper, mobility refers to the tendency or capacity of an element (e.g., resources, people, species, governance) to move in a given space (e.g., physical, political, economic). When considering a given subspace, each element can have an inward or outward flow with respect to that subspace. For example, tunas (resource) being caught in Maio's waters (subspace) by a foreign fleet is an outward flow of resources (Fig. 3).

Similarly, a political decision on Cape Verde's fisheries (governance) made by an international agency instead of the national parliament (subspace) is an outward flow of governance. The mobility concept thus allows environmental, economic, and political factors to be studied in the same framework. Moreover, an element's flow direction with regard to a given subspace can tell us if the vulnerability will increase or decrease over time in the subspace.

The various relationships between mobility and vulnerability, especially critical in SIDS, will be explored in this article. In addition to the mobility concept, which helps visualize and analyze vulnerability in a given space, the comparative analysis of perceptions that was conducted and data concerning some vulnerability elements will be used. The Actor in 4 Dimensions (A4D) is an innovative methodology that allowed Maienses' and marine experts' visions on Maio island's vulnerability to be gathered, while other official data sources allowed data on fishing activities and regulations to be obtained. These methods are detailed in the following section.

Methodology

Analysis of actors' perceptions

We followed the Actor in 4 Dimensions (A4D) theoretical and methodological model (Sébastien 2006; Sébastien and Paran 2006). This methodology allows analysis and modeling of an actor's relationship with other actors (the social profile) and that actor's relationship with nature (the environmental profile) (Sebastien 2010) by conducting semi-structured interviews lasting 2 h on average. The A4D original methodology also allows studying local environmental governance. It defines the territory as a socio-environmental system, that is to say, as the interrelations between social and environmental issues. Therefore, the A4D model aims to qualify the relations

[3] MARE Conference 2017: "People and the Sea IX: Dealing with Maritime Mobilities", (http://www.marecentre.nl/2017-conference/)

Fig. 2 Arrows pointing towards Vila do Porto Inglès, Barreiro, and Calheta (fig. taken from (Google, 2019)

between individuals, whether they are strong (powerful) or weak actors, and the relations between humans and non-humans, whether they are future generations or other species (Sebastien 2010). It aims to examine actors' perceptions of environmental and social issues for a given space. It was designed to provide an understanding of the overall stakeholder dynamics for a territory, based on the analysis of different practices, representations, and knowledge about the environment and the actor system.

Our interviews were conducted as part of our ongoing study producing and analyzing territorial footprints based on small-scale fishing actors' perceptions of their marine environment and governance. More specifically, we probed how actors defined and perceived the following: (1) services from

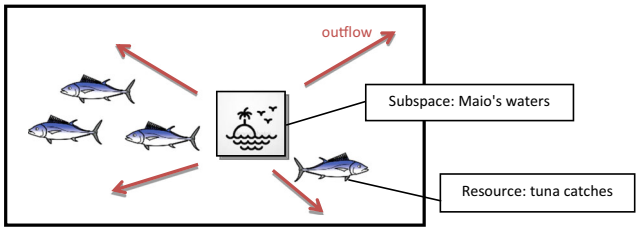

Fig. 3 Tunas' outflow from Maio's waters

and threats related to their marine environment, (2) people and projects affecting their social and environmental relationships, and (3) observed and anticipated changes. Though not directly addressing the concepts of vulnerability or mobility nor prompting specific issues, these interviews allowed us to extract the main components that constitute vulnerability from the actors' points of view. Interviewees were mainly selected from the three principal coastal communities of Maio (Vila do Porto Inglès, Calheta, and Barreiro). Some stakeholders also come from other cities but were chosen because of their work on Maio's marine environment and governance. The main selection criterion was diversity (of background, age, gender, sector), with snowball references to other actors to interview, which allowed targeting all relevant stakeholders and collecting a diversity of actors' perceptions.

Vila do Porto Inglès, Calheta and Barreiro small-scale fishing communities are relatively homogeneous in their lifestyles and livelihoods and share the fishing territory of the small island. Hence, their interviews were pooled together to sketch a general portrait of Maio's small-scale-fishing communities' perception of vulnerability.

Fieldwork was completed in two on-site visits: one in the summer of 2013 (May–August) and the other in late 2015 (November–December). Locals helped with Creole translation, social facilitation, and identifying significant interviewees. In total, 32 members of Maio's small-scale fishing community were interviewed, i.e., 24 from Vila do Porto Inglès (half fishermen and fish saleswomen, another half working in restaurants, municipal, or national agencies and tourism associations), 3 from Barreiro (2 fishermen and 1 student), and 5 from Calheta (fishermen, community facilitators and 1 boat carpenter). Outside Maio's community, 2 members of a local NGO, 7 managers or decision-makers (national or regional level), and 2 scientific researchers working on Maio's marine environment completed the A4D interviews. Other conversations with officials and community members provided a broader perspective on how people view small-scale fishing communities in Cape Verde.

Apart from the interview data, very few data are available on Maio's biophysical environment or its socio-economical profile due to onerous study fees and low local academic funding. Subjective data were thus essential to our analysis. Their recurrence and corroboration with external sources guided our work.

Data sources for fishing activities and regulations

Fisheries data were obtained via the Sea Around Us (SAU) database (Sea Around Us - Fisheries 2017). SAU reconstructs catch data using additional available fisheries, socio-

Table 1 A4D results concerning vulnerability (results for 43 interviewees)

Vulnerability issues mentioned by interviewees	Interviewees mentioning the issue (%)
Fish decline (tunas, sharks)	95
Overfishing and fishing competition	98
Industrial and semi-industrial illegal fishing in 3-nmi zone	88
Industrial boats unequal technological competition	81
Need for local boats to be better equipped (adaptation)	67
Need for refrigeration, transportation and storage facilities	51
Need for better fishing control and monitoring	98
Subsistence directly depends on the ocean	98
Ocean dependence creates poverty and insecurity	84
Competition between local fishermen/loss of solidarity	60
Hope rising from conservation initiatives	72
Need for marine conservation	98
Transportation insufficiencies	58
Hope for sustainable tourism	70
Erosion and floods	51
Better environmental and political education/knowledge	98
Communication between local communities and decision-makers and participation in decision-making	53

economic, and population data sources combined with the Food and Agricultural Organization's (FAO) original data based on national reports (Santos et al. 2013). Reconstructed catches include reported and unreported activities. West Africa's surrounding water (Fishing Area 34: Eastern Central Atlantic) is the region where fishing catches are the most underestimated (by four times) in the world (Pauly and Zeller 2016). Research on the SAU database was done by country, sector (artisanal, subsistence, or industrial), and commercial group.

Legislative texts were collected via a legislative database (FAO 2017b) during the summer of 2016. Jurisdictional data were categorized by type of legislative text, type of activity, and by purpose (zone delimitation, activity restriction, management plan approval, etc.). This work was mapped in the "Atlas cartographique de droit de l'Environnement marin au Cap-Vert" (Bonnin et al. 2016).

Results

Table 1 shows the results, concerning vulnerability, taken from the A4D interviews.

Considering the importance of fisheries through interviewees' answers, we decided to divide our results into two main sections: issues associated with a growing fishing crisis and issues not directly related to fishing activities and dependence.

Main findings from the A4D: a fishing crisis

Interviewees' answers concerning fisheries are categorized into four sub-sections: an outward flow of resources, unfair fishing competition due to a technological gap, deficient control over fishing activities, and their own ocean dependence. All of these factors are leading to a growing fishing crisis.

An outward flow of resources

Almost all actors (95%) perceived a fish decline (especially in tunas and sharks) in Maio's waters (Table 1). This was corroborated by Cesarini (Cesarini 2013) and by recent anecdotal information and pictures (Underwood Hewitt 2017) showing artisanal boats regularly returning empty from their fishing expeditions. Nearly all the actors (98%) also mentioned overfishing and fishing competition as important vulnerability concerns, which they mostly attribute to industrial and semi-industrial boats (88%) entering the fishing zone reserved for locals (Table 1) (3 nautical miles according to law) (Bonnin et al. 2016). In truth, semi-industrial boats from Santiago and Sao Nicolau increasingly come to fish in Maio's 3-mile-zone waters as a knock-on effect from the pressure of foreign vessels fishing illegally in the 12-nautical-mile zone reserved for Cape Verdean vessels (Cesarini 2013).

According to SAU's data, global industrial catches have tended to increase in Cape Verde's waters (Fig. 4). This corresponds with local perceptions and official statistics showing an increase in national industrial catches since 2008, going from about 4000 tons to almost 6000 tons in 2012 (Fig. 5) (Sociedade de avaliaçao estratégica e risco SaeR 2015). Both graphs (Figs. 4 and 5) also show a slight decrease in artisanal

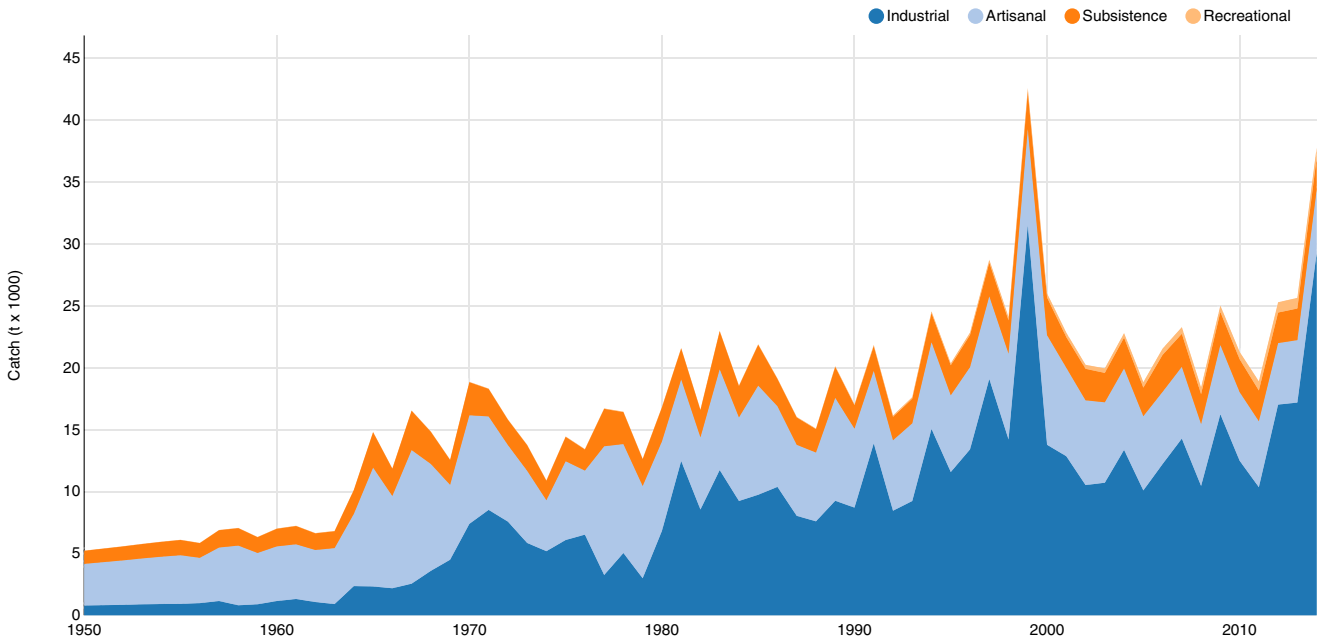

Fig. 4 Reconstructed catches by fishing sector in the waters of Cape Verde (Sea Around Us - Fisheries 2017) (fig. taken from (Pauly and Zeller 2016))

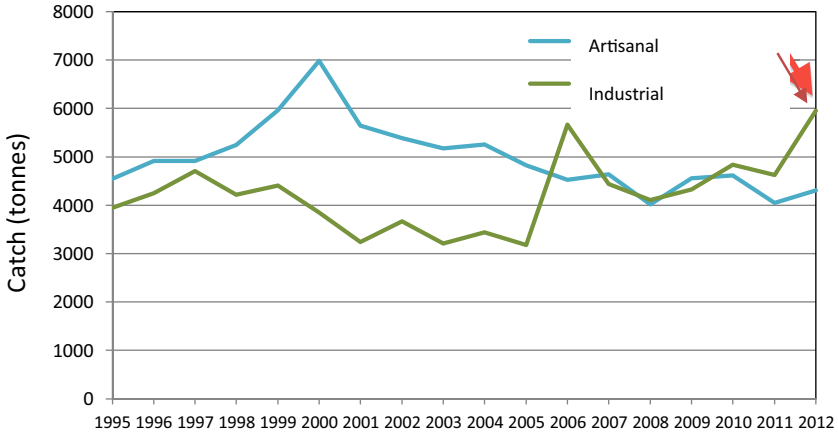

Fig. 5 Catch trend from artisanal and industrial fleets of Cape Verde (fig. taken from (Sociedade de avaliaçao estratégica e risco SaeR 2015))

and subsistence[4] catches over time. Maio fishers' annual artisanal catches are estimated at 496 tons (Cesarini 2013), slightly more than 1/10 of the country's registered artisanal catches.

Cape Verde's industrial fishing catches (about 6000 tons in 2012) are only part of the catches included in SAU industrial catch data (15,000–20,000 tons in 2012). Foreign vessels also fish in Cape Verde's Exclusive Economic Zone (EEZ). Under the tuna fishing agreement (2014–2018), European vessels (from Spain, France and Portugal) are allowed to fish 5000 tons of tuna, swordfish, and blue sharks each year (European Union 2014). China has also signed a private "second generation agreement," or joint venture agreement. In fact, Belhabib and colleagues (Belhabib et al. 2015a) showed that the average annual European fleet's reconstructed catches (2000–2010) are more than three times higher than those reported in Cape Verde's EEZ (19.1 tons × 10^3 reconstructed vs. 6.2 tons × 10^3 reported) and four times allowed catches (5 × 10^3 tons) (European Union 2014). The average annual Chinese fleet catches are almost ten times higher than officially reported (13.9 tons × 10^3 reconstructed vs. 1.4 tons × 10^3 reported) for the same period (Belhabib et al. 2015a).

Indeed, the data are more difficult to find and analyze for China due to opaque fishing agreement terms and conditions (Standing 2008; Belhabib et al. 2015a). These types of agreements result in reflagging China's vessels as Cape Verdean vessels. As observed in Mauritania and Senegal, Cape Verde's industrial fleet is probably mainly constituted of reflagged foreign vessels (Obaidullah and Osinga 2010; PRODOC 2010; Belhabib et al. 2012; Cesarini 2013; Santos et al. 2013; Belhabib et al. 2015a). In truth, only a few genuine Cape Verdean vessels are able to go offshore (> 12 nautical miles from baseline) (Santos et al. 2013).

The European Union (EU) pays on average 525,000 euros per year to fish in Cape Verde's EEZ (European Union 2014). For its part, China compensates Cape Verde in confidential and indirect ways (Belhabib et al. 2015a) such as by participating in building a dam, a stadium, and a hospital (Escobar and Kimbamba Simoes 2012; Belhabib et al. 2015a). However, analysts wonder if these payments are truly related to fisheries. In fact, financial compensations offered by the EU and China (average values between 2000 and 2010) for fishing in Cape Verde's EEZ are extremely low. Officially, their compensation should be 0.3% and 9%, respectively, but the actual compensations are in fact 0.1% and 1%, respectively (Belhabib et al. 2015a). Such low levels of compensation for fishing cannot help local communities adapt to hugely increased overfishing by foreign vessels.

The aforementioned opaque and inequitable fishing practices are nonetheless compatible with the United Nations' Convention for the Law of the Sea UNCLOS (FAO 2017a). The UNCLOS states that a coastal state must determine its EEZ's allowable catch and must give other states access to the part of the allowable catch that it will not harvest itself (Ndiaye 2011). However, like other developing countries, Cape Verde does not have the technical or financial means to evaluate its fishing stocks. Therefore, it relies on foreign evaluations of its resources (COFREPECHE et al. 2013) that may be biased. Although UNCLOS specifies that fishing agreements should not jeopardize local development and livelihoods, the burden of proof rests on the coastal state's shoulders. Partnership countries are also likely to put economic and governance pressure on Cape Verde, as they are also the ones providing "international development aid."

Cape Verde's industrial fishers proportionally target small pelagic (54%) and large pelagic fish (40%), while artisanal fishers prefer large (41%) and small (33%) pelagic fish (Almeida 2016). According to the few (about 9.4%) foreign fleets' reported catches, foreign vessels target and catch mainly migratory (mobile) species such as tunas, swordfish, and sharks as bycatch (Fonseca 2000; Ministério do Ambiente Agricultura e Pescas 2004). Foreign fleets are thus in greater competition with artisanal fleets, even if also competing with Cape Verdean industrial fleets. Also, some species included in the agreements are fragile: bigeye tunas are considered overfished while

[4] Artisanal and subsistence fisheries are included in the "small-scale fisheries" category together with recreational fisheries.

skipjack tuna is barely above sustainable exploitation levels (ICCAT 2017). Competition for declining stocks thus occurs around Cape Verde's archipelago, without noticeable measures to reduce the pressure on fish populations.

In Maio, artisanal fishers find that tuna has become rarer over at least the last 10 years. For that reason, they turn to small pelagic fish, namely the vulnerable and declining Atlantic horse mackerel (IUCN 2013) from the commercial perch-like group (SAU categories) and other low-value species traditionally used for subsistence (Ministério do Ambiente Agricultura e Pescas 2004; Cesarini 2013; Belhabib et al. 2015b; Direçao Geral dos Recursos Marinhos and PRAO-CV 2016). Figures 6 and 7 show that industrial fishing vessels have increased their pressure both on tuna populations and perch-like fish populations, at the expense of artisanal and subsistence fishers. Effectively, artisanal fishers constitute 100% of Cape Verde's small-scale tuna fishers while they constitute two-thirds of small-scale fishers of perch-like fish; the remaining third is comprised of subsistence fishers.

In addition to being associated with foreign industrial overfishing, this fishing crisis results from a lack of local technological means, from inefficient control and monitoring, and from a great dependence of local communities on the ocean.

Unfair fishing competition due to a technological gap

Of the interviewees, 81% mentioned industrial boats poaching in the 3-nautical-mile zone reserved for local artisanal fishing as a critical threat because industrial boats outcompete local small boats (Table 1). Industrial vessels and fishers also threaten Maio fishers' security when the latter try to defend their fishing rights (e.g., through voluntary or involuntary collisions). Such unequal fishing competition between national (smaller and low equipped) and foreign (with high fishing capacity) vessels also concerns scientists (Cesarini 2013; Almeida 2016). On the other hand, 67% of the interviewees could see bigger boats and technology like GPS and fish aggregating devices (FADs) as adaptation capacity factors if used by locals to enable them to fish more efficiently and safely (Table 1), even if they are aware that this could increase overfishing. Faced with declining fishing stocks, fishers do not see how they could survive without motors and diving gear for profitable species such as lobsters and buzios (*Strombus latus*, gastropod). Thus, technological inputs appear helpful in assuring day-to-day food security in Maio as long as industrial fishing occurs in the island's local zone, and overfishing of migration species like tunas continues offshore. Moreover, tracking fish may be complicated in the near future, due to climate change, rising ocean temperatures and fish migrating in search of their ecological niches (Sumaila et al. 2011; Boyd et al. 2014). Technological adaptation (bigger, more robust, and better-equipped vessels) may thus become unavoidable for small-scale fishers in our globally changing social-ecological context. Increased fishing effort is therefore predicted (Belhabib et al. 2016).

Many Maienses interviewed for this study (51%) also expressed the need for sustainable fish storage installations and tools (cannery, ice machines, distribution trucks, etc.) on their island (Table 1). Better refrigeration and transportation conditions would allow small-scale fishers to adapt to the longer boat trips now necessary to catch scarcer fish and to overcome fuel cost increases by going out to the sea less often.

Lack of control over fishing activities

Almost all interviewees (98%) asked for better control and monitoring of fish size, fishing season, gear, and zones

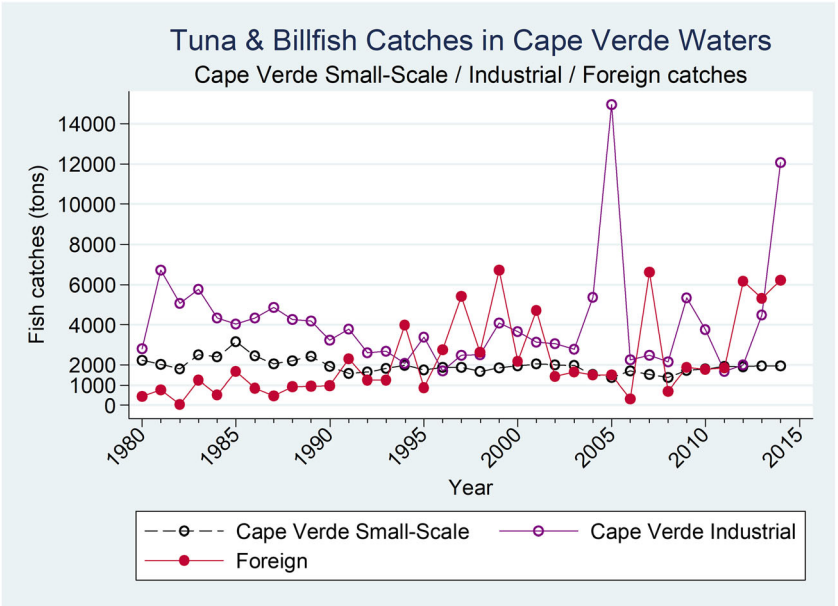

Fig. 6 Tuna and billfish commercial group catches in Cape Verde's water by country and sector. Data was taken from (Pauly and Zeller 2016; Sea Around Us - Fisheries 2017)

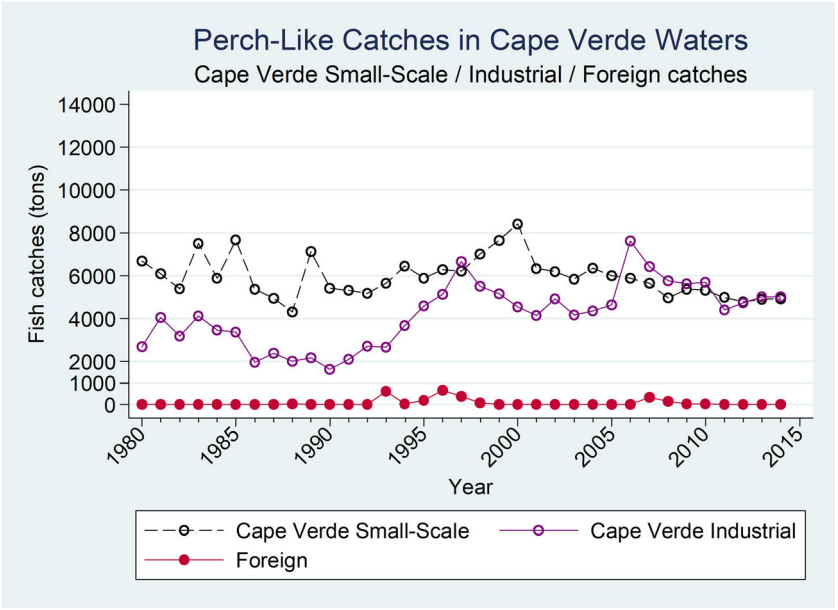

Fig. 7 Perch-like commercial group catches in Cape Verde's water by country and sector. Data was taken from (Pauly and Zeller 2016, Sea Around Us - Fisheries 2017)

(Table 1). Foreign fishing fleets excessively and illegally pressuring Maio's declining fish stocks are the main concern for local fishing communities. This vulnerability factor has been corroborated by other data sources and reports (DGT and WWF 2010; ARSF 2011; Cesarini 2012; Almeida 2016), which further underline the need to protect artisanal fisheries from industrial fisheries and illegal practices.

Interviewees were also concerned with poaching and illegal fishing by their peers. They wished for measures to improve locals' well-being to prevent them from poaching and engaging in illegal fishing out of necessity. Thus, although lobster fishing is mostly associated with industrial fishing for exportation, some artisanal fishers also fish for pink and green lobsters (Cabo Verde Natura 2000 2001) by illegally diving with scuba tanks (ARSF 2011; Republica de Cabo Verde 2011; Cesarini 2013) and then sell them to local restaurants (Ministério do Ambiente Agricultura e Pescas 2004; Monteiro 2011). As a result, the stocks of pink lobsters (ARSF 2011) and buzios (also caught by diving) have dropped markedly and are now mainly disembarked in Calheta to avoid the monitors in Vila do Porto Inglès.

Maio's territorial control is theoretical: neither the national police nor the maritime and harbor institute (IMP) delegation possesses even a boat. This is also true at the national level as Cape Verde's marine protection relies on insufficient agreement fees, paid by those most likely to overfish (PRODOC 2010).

Ocean dependence and communities' subsistence

As mentioned by 98% of the interviewees, Maienses subsist directly on the ocean for fishing, food transportation, and drinkable water via desalination, as well as for the jobs it provides (Table 1). Given fish depletion and uncertain ocean services due to climate and global changes, 84% of the interviewees mentioned that this dependency creates poverty and prevents fishers from properly feeding themselves and caring for their families' health and education (Table 1). General poverty also worsens other vulnerability exposures and hinders adaptive capacity. For instance, changing jobs, moving, or overcoming problems such as repairing a damaged boat become more difficult without money. As fuel and fishing materials are increasingly expensive, nationally fixed fish prices do not provide sufficient benefits for fishers (Rodrigues and Villasante 2016). Concomitantly, basic products (fruits, vegetables, meat) become unaffordable for the whole community with revenue so low. Furthermore, fishermen tend to direct their children towards other jobs due to artisanal fisheries' precariousness, causing a loss for Cape Verde and Maio culture to which, paradoxically, they are deeply attached.

This general precariousness due to fish decline, fishing competition, and poor livelihood conditions induces suspicion and competition between fishers resulting in a detrimental reduction of cooperation within the community (less fish sharing with those in need) and between fishers (e.g., secrecy regarding fishing sites, decreased sharing of tools) according to 60% of the actors interviewed (Table 1). To counter this erosion of trust and social cohesion, many actors mentioned feeling hopeful about conservation initiatives such as turtle protection community patrols (72%) (Table 1). However, many feel doubt and fatigue about bigger projects (e.g., PRAO fisheries' co-management program, projects of marine protected areas), which mobilize them but never seem to come to fruition.

This relationship with the ocean (subsistence possible as long as there are fish) keeps Maienses on their island, in

comparison with the rest of Cape Verde. However, the retention of people in Maio may not be entirely deliberate, but rather a consequence of Maienses' financial inability to leave their island (involuntary immobility). Maio's outflow of people is therefore lower than the country's average, but as a consequence, the inflow of diasporic remittances is also lower.

Other findings concerning non-fishing issues

Interviewees mentioned other non-fishing issues that may affect Maio's vulnerability, which we divided into four sub-sections: insufficient conservation, projected tourism developments, climate change, and improper governance at different levels.

Marine conservation prospects

Marine conservation can also be considered a mobility issue, since the government and communities try to protect their (more or less) mobile marine biodiversity and resources as much as possible by implementing marine protected areas (MPAs). Species (mostly benthic, groundfish, reef, and coastal species, but even tunas and sharks) and habitats are thus not only protected for their intrinsic and esthetic values but also for local fishermen. By regulating fishing methods, seasons, and sizes, MPAs ensure sustainability and even the growth of marine populations. MPAs also are a way to attract species, which will come to sheltered areas to breed and feed. Therefore, it could be argued that marine conservation aims to limit and even (when efficient) reverse a certain outward flow of marine catches.

Most interviewees (98%) considered that there is a real need for marine conservation measures (Table 1) in Maio that could reduce their sensitivity to offshore overfishing (albeit with little impact on the highly mobile tuna population). Although many considered that more MPAs should be created, most interviewees considered the absence of monitoring, control, and patrolling as a central issue undermining any conservation project's success.

The Cape Verde National Network of Protected Areas (RNAP) was decreed in 2003 (Bonnin et al. 2016) despite no MPAs existed in 2012. In 2014, however, 5.47% of Cape Verde's marine territory was protected (MAHOT-DGA and PCSAPCV 2012; Republica de Cabo Verde 2016a). The approval of MPA management plans started in 2015 (Bonnin et al. 2016). Given these recent changes, developments in marine protection are expected soon.

In 2014, Maio's MPAs were structured into a comprehensive network, the Maio Island Protected Areas' Network (RAPIM), covering 36,009.74 ha of which 28,418.76 are marine (Cesarini 2013). This equals about 25% of the RNAP's marine surface, greatly surpassing Maio's proportional surface of Cape Verde (7%) (Cesarini 2013). In accordance with the National Protected Areas' Strategy, the RAPIM aims to thoroughly conserve cultural and natural values for society and environmental health (MAHOT-DGA and PCSAPCV 2012; Cesarini 2013). It also promotes co-management practices for the benefit of all stakeholders (Cesarini 2013). However, even if a thorough management plan was created for the RAPIM, it can still be considered a "paper park," since it has not yet been approved by governmental authorities and no infrastructure, operationalization equipment, nor financial means (Cesarini 2013) have been put in place to make the protected areas' management effective.

Transportation and infrastructure as a trade-off for more tourism

Of the interviewees, 58% expressed their vulnerability to transportation insufficiencies (Table 1). While limited transportation to and from the island helps preserve the island and the population's lifestyle (less infrastructure, noise, and traffic), local people need better mobility to bring food, fuel, people, and services to the island. They must travel and distribute goods and services on and off the island. For now, the lack of transportation seriously hinders travel to Cape Verde's capital, Praia (even if it is only 15 min by plane and 3 h by boat), resulting in inadequate access to medical services, jobs, markets, and governmental agencies and, as a result, increases Maio's great dependency on its own declining and scarce resources and services. Difficult navigation conditions can effectively halt food and fuel delivery for 2 to 3 weeks during the winter (due to greater currents and bigger waves), creating an even more precarious situation for those living in Maio.

Likewise, 70% of interviewees would like to see some tourism development on a small, sustainable scale (Table 1). They hope that this would bring some money, transportation facilities, infrastructure, and water and sewage treatment plants to Maio. Effectively, at present, no sewage treatment is available and garbage is burnt in Maio, creating marine and air pollution. The tourism agency (SDTIBM) development plans include such facilities and infrastructure, but also expect Maio's population to increase from 7000 to 53,000 people in 30 years (SLN Cabo Verde and SDTIBM 2008, Republica de Cabo Verde 2013). This would be combined with massive changes (golf course, spa, etc.) and the construction of roads, harbors, and a new international airport (SLN Cabo Verde and SDTIBM 2008, Republica de Cabo Verde 2013).

Maio island's specific values of quietness, security, pleasantness, and nature are thus threatened by the tourism plan, even though those values are supposed to be at the plan's core (ECOS 2012; Republica de Cabo Verde 2013; Republica de Cabo Verde 2016b) and despite the fact that Maio's high vulnerability and need for protection were acknowledged by the SDTIBM (SLN Cabo Verde and SDTIBM 2008). Alternative solar and wind sources of energy, garbage collection, recycling, and

treatment are also incorporated in the plan (Republica de Cabo Verde 2013, Republica de Cabo Verde 2016b).

A brief look at recent tourism developments on Maio's neighboring islands, Boa Vista and Sal, shows that a tourism surge can increase poverty and inequities (Cesarini 2013) as well as local population emigration (Sanchez-Canizares and Castillo-Canalejo 2014). Limited mobility of tourists (clients kept at the resort) (Cabo Verde Natura 2000 2001) and a high rate of import of products from elsewhere (even fish, although it is the most important resource on the island) and staff immigration (Sanchez-Canizares and Castillo-Canalejo 2014) result in locals' loss of identity, social cohesion, and in urban elements overtaking natural landscapes (Cesarini 2013). Consequently, studies warn that badly planned tourism can create economic, social, and environmental upheaval (Sillitoe 2009; Cesarini 2013). The country's real capacity to implement a balanced, sustainable territorial plan including fisheries, conservation, and tourism thus represents a great challenge (Cesarini 2012).

Findings related to global environmental issues: climate and ocean changes

Climate and ocean changes aggravate the Maiense community's vulnerability. Effectively, greenhouse gases from foreign emitters influence Maio's environmental chemical and physical conditions. For instance, temperature and ocean levels rise, sea currents change, and the island erodes. From the mobility perspective, these issues constitute an inflow of changes caused by global transformations. During interviews, Maienses mentioned the growing unpredictability of seasons and ocean conditions. Erosion and floods are Maienses' most important physical condition concerns (mentioned by 51% of the interviewees) (Table 1). Sand extraction and coastal construction also constitute exposures that increase Maio's sensitivity to these hazards, while insularity, small surface area and poverty prevent islanders from escaping or seeking refuge, hindering their adaptive capacity when faced with climate change and associated conditions.

Studies predict a global temperature rise of at least 3 °C by the end of this century, with specific dramatic impacts on West African arid zones and Cape Verde (Niang et al. 2014). A UNESCO report records that Cidade Velha, Cape Verde's historic center on Santiago island, could be flooded if average global Earth temperatures rise by even as little as 1.3 (±0.8) °C (Marzeion and Levermann 2014), a scenario well below the 3 °C increase expected before 2100 (GIEC 2014). However, Vila do Porto Inglès (Maio island's capital) only sits 4 m above sea level, lower than Cidade Velha. The whole town as well as many populated areas bordering Maio island could be flooded sooner. In a more immediate future, an important part of Maio island, found directly at sea level, will need to be moved, namely fishing boat landings and boat parking sites, the fish market, and fishing association as well as tourism infrastructures. Areas that manage to avoid permanent submersion will increasingly endure frequent flooding with considerable damage (Vitousek et al. 2017).

The impacts of sea-level rise on local populations' vulnerability will be aggravated by intensified extreme events, modified coastal circulation and erosion, saline infiltration, and increases in the ocean's temperature and acidity (UEMOA 2010; ARSF 2011; Niang et al. 2014). As 80% of Cape Verde's population lives in the coastal zone, in houses made of non-resistant materials, the population is very sensitive to exposures such as coastal hazards and sea-level rise. Concerning Maio's adaptive capacity, interviews showed that local people do not know how to adapt or react to floods and erosion hazards, except by enforcing laws prohibiting sand extraction (Bonnin et al. 2016).

Findings related to governance: locals' concerns neglected

The country's official development assistance from the OECD Development Assistance Committee and from international organizations such as the European Commission, the World Bank and the African Development Bank totaled US$1900 million between 2000 and 2012. Cape Verde's important dependency on the eurozone, which imports 79% of the country's products (Republica de Cabo Verde 2013) and especially fish, makes it particularly vulnerable to foreign market variations, as was proven during the 2008 economic crisis, which greatly affected Cape Verde. Cape Verde also imports 80% to 85% of its first-necessity goods and 100% of its oil and derivatives (Republica de Cabo Verde 2013). Electricity used for desalination is produced at thermal power stations that use diesel and fuel oil, meaning that a shortage of fuel could have tragic consequences (Cesarini 2013).

As for money inflow, regional and international aid and economical agreements usually come with an engagement of the beneficiary to implement "good governance measures" (Oceanic Développement and Lda 2010; Banque africaine de développement 2014; European Union 2014; Commission sous-régionale des pêches 2017). This translates into developed countries inspecting and influencing Cape Verde's fishing and other marine regulations and policies, which represent a loss of governance powers for Cape Verde. While local small-scale fishing communities can hardly influence their national government's decision-making process due to their physical, socio-economic, and educational isolation and their lack of financial and organizational means, foreign aid donors and commercial partners ultimately have greater access to Cape Verde's governmental decisions via official boards and informal meetings. This outward flow of governance capacity results in distant governance not reflecting local communities' main issues, such as decreasing fish stocks, illegal fishing, and impoverishment.

Finally, although development assistance and international aid seem impressive in small dependent countries like Cape Verde, it has been estimated that the net value of landed fish catches (landed value + processing + marketing) extracted from West African waters by the EU and China alone probably equals the average net total development assistance and development aid received by West Africa between 2000 and 2010 (Belhabib et al. 2015a). Accordingly, developing Cape Verde's secondary economic sector (transformation) combined with a re-appropriation of its marine resources would generate economic benefits comparable to current foreign financial assistance. However, most developed countries crucially need West African fish stocks. For example, European catches in West African waters contribute to about 25% of Europe's total fish catches (Alder and Sumaila 2004). With such an interest in fishing in West Africa, international regulatory and economic pressures for fishing "rights" from developed countries will not end soon. This international pressure to access Cape Verde's waters is somewhat exemplified by the posture adopted by its main foreign fishing countries (Europe, China, and Japan) in international trade meetings. The latter effectively push to minimize the regulation of fishing subsidies, even if these are proven to be detrimental to the countries and the resources where they occur (United Nations Conference on trade and development UNCTAD 2016, Campling and Havice 2016).

At the national level, ministries' and agencies' responsibilities and mandates overlap while voids remain (Benchimol et al. 2003) with respect to the protection and surveillance of local fishing zones. However, 98% of the interviewees think that better environmental and political knowledge could reduce small-scale fishing communities' sensitivity and improve their adaptive capacity by giving them tools to better understand their community's situation and react effectively (Table 1). Half of the interviewees (53%) expressed the need for better communication and information sharing between local communities and decision-makers (Table 1). This should make higher-level decision-makers more aware of local realities and hopefully enable Maienses to be included in the process of marine policymaking. For instance, informed and organized Maienses could participate in decisions taken at the national level on topics that affect them (e.g., fishing and conservation). But for that, they need to be informed about decision processes, and national decision-makers should also be informed of decision terms (transparent and independent data on stocks, activities, and markets) when negotiating with other countries.

Conclusion and possible solution outlines

This study provided information on Maio's small-scale fishing communities, about which little was previously known. Our A4D method revealed actors' perceptions regarding their vulnerability and we compared these results with other available data. Most vulnerability factors can be classified into sensitivity, exposures, or adaptive capacity factors (Fig. 8) even if they may overlap or play different roles depending on the issue that is studied. For instance, reliance on local fish could be a sensitivity factor while analyzing exposure to overfishing, but it could also be an adaptive capacity factor while analyzing exposure to other market-driven changes in protein availability (e.g., Chinese chicken).

We also proposed a clear definition of the mobility concept, which provides a general theoretical framework suited to analyze environmental, economic, political, and sociological issues on the same footing. Mobility analysis allows for hypotheses about the direction of change in vulnerability factors over time.

In some ways, the mobility analysis converges with political economy theories (Prebisch 1988) as the study showed that *center countries* such as the European Union dominate *peripheral countries* such as Cape Verde through their economic, financial, and technological superiority and through the periphery's fragmentation and unequal markets. In general, Cape Verde's dependence can be characterized as an outflow of sovereignty, capital (due to debt[5] repayment), and resources. This dependence, coupled with forced neoliberal policies such as privatization, impairs Cape Verde's development and may be incompatible with poverty reduction, especially if wealth is not shared equitably (Andrade, Elisa, 2017).

Since around 2000, Maio's artisanal fishers have witnessed an outflow of their most profitable fish stocks from their reserved fishing zone, due to industrial (over) fishing. This outward flow of a critical livelihood resource increases the vulnerability of Maio's fishing-dependent communities, threatening their subsistence. Ultimately, Cape Verde's growingly fishing-dependent population will also be affected. The remaining most profitable fish stocks could still be reached by local artisanal fishers provided greater mobility and technology means, but they plead instead for a more sustainable solution: restraining overfishing and poaching. They call for reducing the inward flow of industrial fishing boats, particularly those from foreign (subsidized) fisheries, which, however, requires governmental authorities to act decisively. Structural factors obstruct this process: distance and poor transportation separating Maio island inhabitants and governmental decision-makers, political inefficiencies, and the need to "merit" international aid. All these factors indirectly feed into neglecting the needs of locals and instead emphasize foreign entities' economic fishing interests in the decision-making process.

Just like in many other SIDS, the development of tourism has been proposed by government authorities to strengthen the economy of Maio and to limit its vulnerability. However, mass tourism would create unprecedented imbalances and still would not address the most pressing livelihood issue of offshore

[5] Cape Verde's debt equals 133% of its GDP.

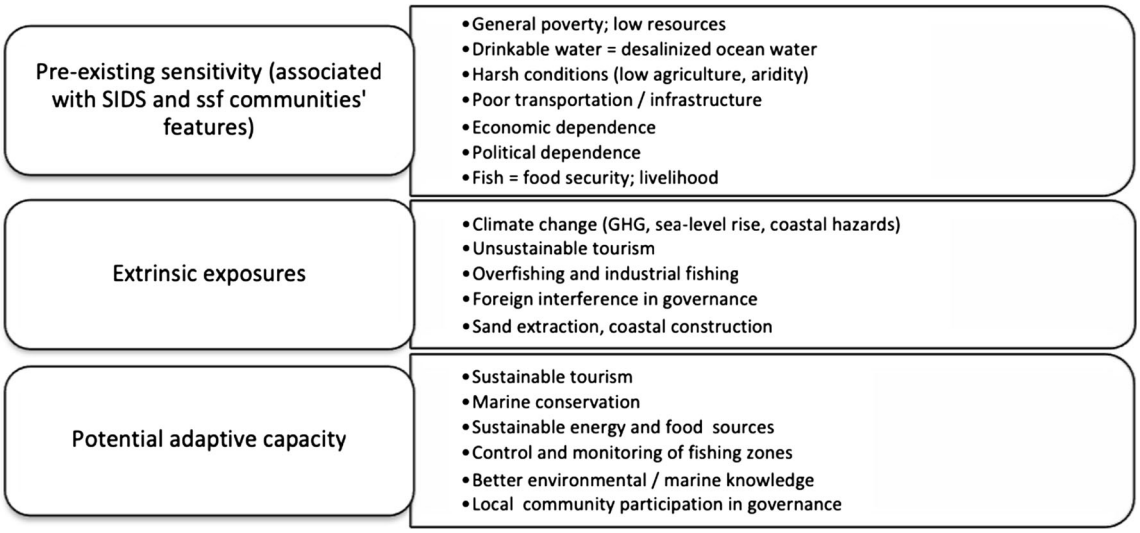

Fig. 8 Vulnerability factors of Maio (from interviews and other official data)

overfishing. Moreover, the uncontrollable but predictable catastrophic effects of climate change are on the horizon, specifically flooding. In a context of deteriorating livelihoods, the mobility of Maio's population must be increased on the island and between Maio and other Cape Verdean islands. This would improve Maienses' adaptation and alleviation capacity as they face growing threats to their safety and subsistence means.

With regard to governance, delayed implementation of fisheries, conservation, and tourism projects hinders effective action in spite of Cape Verde's progressive and forward-looking environmental laws and official documents. Cape Verde also remains financially dependent on the European Union and foreign countries and, even if its GDP and development indices increase, fishing communities are increasingly vulnerable to environmental and socio-economic threats.

A summary of the global situation is that, at every scale, elements limiting vulnerability (effective financial and human means, subsistence means, quietness, fish abundance) have tended to decrease over time (except in the case of hypothetical conservation). Elements increasing vulnerability (governance interference, subsidies to foreign fleets, greenhouse gases (GHGs), industrial fishing, lack of preparation for change, and hard fishing conditions) have tended to increase over time, except for emigration, which is limited for now, due to foreign countries' restrictive immigration policies. Tourism is an uncertain solution since it can have both positive and negative repercussions depending on its scale and degree of sustainability. For Maio, most elements are flowing in the opposite direction required to decrease its vulnerability (most beneficial elements—in green, going out and most harmful elements—in red, coming in) (Fig. 9).

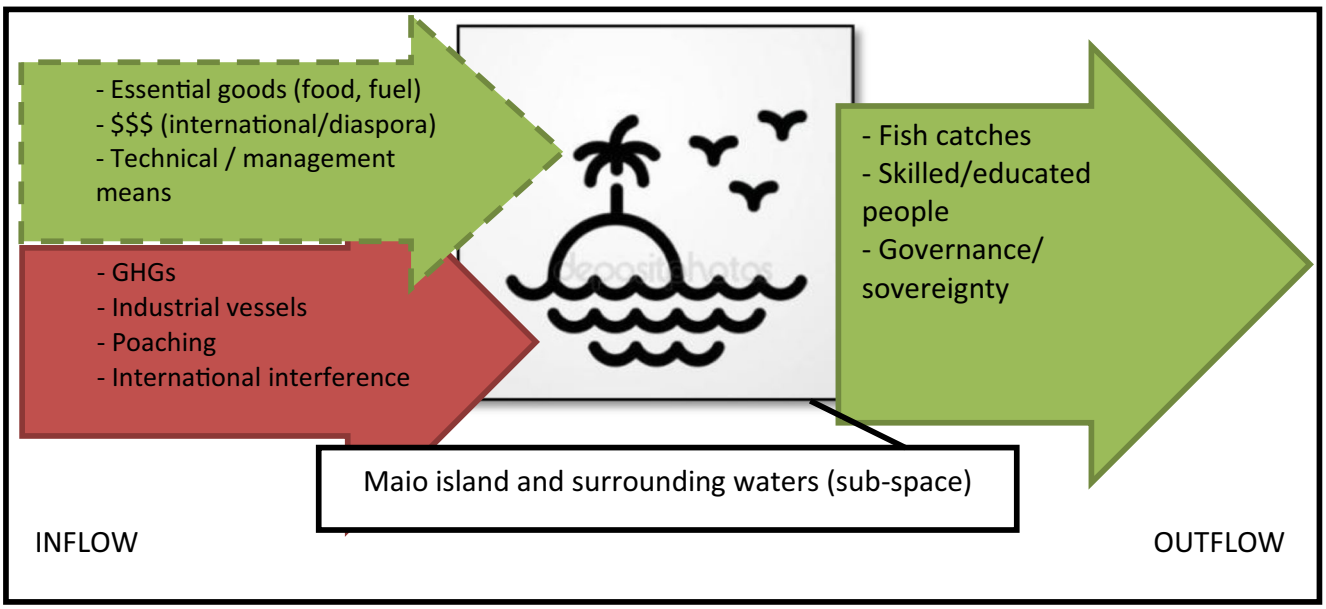

Fig. 9 Main inflows and outflows of resources, people, and governance contributing to Maio's vulnerability

Elements in the dashed green arrow are beneficial, but with limited and irregular flows.

Our analysis showed that if actual flows of resources, people, and governance are maintained, Maio's vulnerability will grow. We argue that stopping or reversing strong negative flows (the red arrow in Fig. 9) would limit Maio's vulnerability. For instance, pushing back industrial vessels from Maio's local fishing zone and increasing Maienses' participation into decision-making (instead of letting foreign countries interfere in national fisheries' decisions) would decrease the social-ecological system's vulnerability.

Our study contributed to the literature on SIDS by sharing the example of Maio island's small-scale community in Cape Verde. It answers the demand for more studies on actors' perceptions of vulnerability (O'Brien and Wolf 2010; Hicks and Cinner 2014; Bennett et al. 2016) with the results of our 43 interviews. We added data on governance and vulnerability links (Adger 2006) and outlined relations between vulnerability and mobility. As most SIDS share similar features with Maio's in terms of sensitivity, exposures, adaptive means, and mobility, we think that vulnerability issues and anticipated evolution of vulnerability may inform other SIDS cases.

Solutions to these kinds of mobility and vulnerability issues have been raised in the literature. These solutions involve cooperation within the community and with other African countries facing similar negotiating weakness with foreign countries (Kaczynski and Fluharty 2002), or with countries such as New Zealand, that have positioned themselves as opposed to toxic fishing subsidies and clamor for greater regulation (United Nations Conference on trade and development UNCTAD, McClay 2015). Knowledge of stock assessments and activities in Cape Verde's waters must be included in negotiations to ensure informed decisions are made and to avoid fish depletion (Kaczynski and Fluharty 2002; Ndiaye 2011). One of Cape Verde's governance priorities should, therefore, be to better study and monitor its marine environment, resources, and activities. Monitoring could eventually be funded by supportive countries' savings generated by diverting their subsidies (World Bank 2017). Experts also promote better local processing and marketing of Cape Verde's fish (FAO 2005). In the specific case of Maio, the island must invoke its important contribution to Praia's fish market (Cesarini 2013) and underline that its unique fishing grounds (Benchimol 2008) must be preserved in order to pursue fish exports and maintain Cape Verde's protein supply. Regionalization and self-sufficiency projects (e.g., renewable energy, garbage and water treatment plants—already included in the country's and island's development plans (Bonnin et al. 2016)) would also help with Maio's adaptive capacity. Moreover, increased autonomy brings more power in decision-making (FAO 2015). The flow of governance and resources needs to be redirected towards Maio in order to avoid dramatic consequences for local communities. Finally, as Maio relies on fishing and the ocean for its subsistence, foreign countries' help should consist of diminishing the fishing pressure applied in Cape Verde's waters and effectively assisting communities to take control of their waters. In developed countries, cutting fishing subsidies (United Nations Conference on trade and development UNCTAD, World Bank 2017) and focusing energy on helping their own fishing stocks recover would also pay in the long run and be more profitable to their people. If West African socio-ecological systems were preserved, it would *in fine* help developed countries, since population migration and social conflicts increase as subsistence and economical means decrease.

Compliance with ethical standards

Conflict of interest The author declares that she has no conflict of interest.

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