



Local perceptions of environmental changes in fishing communities of southwest Madagascar

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ABSTRACT

Southwest Madagascar is a region that is significantly impacted upon by climate change. As in a lot of developing countries, the livelihoods of many communities in this region are dependent on fishing. This makes these communities particularly vulnerable to climate-related changes. We conducted a survey in two coastal fishing communities in the Toliara Province, Ambola and Ambotsibotsike. Using a free listing exercise, semi-structured interviews and focus group methods, we documented local perceptions of environmental changes and responses to changes. Results were compared, taking into account the differences in the degree of remoteness, market exposure and religiosity. Time periods that respondents reported as having had a high degree of change were compared to time periods of historical records of cyclones occurring in Toliara Province. Mostly, changes in the environment were said to have started 21–40 years ago. An overlap was observed between time periods when respondents observed changes in their environment and time periods of high magnitude cyclones. Answers relating to the local environment show that both villages identify with a sea culture, but the local ecological knowledge is arguably more accurate in the remote village of Ambola. In Ambotsibotsike God's intervention was predominantly identified as the source/cause of changes in the natural environment. Ambola also displayed a higher proportion of household members who participate in fishing from pirogues (at least one person per household). In both villages, the most reported change was a reduction of sea resources (64.2% of the answers in Ambola and 69.5% in Ambotsibotsike). Villagers' adaptation responses reflected the presence of NGOs in both villages. This influence was particularly strong in Ambola, where the establishment of reserves was found to be a predominant strategy to cope with change (54.8% of the answers). Our study provides additional insights that can be used in relation to the discussion of the role of the market, of religion, and the influence of NGOs on local knowledge. It seeks to contribute to the need to implement sustainable conservation strategies and successful community-based management plans.

1. Introduction

Coastal ecosystems play a fundamental role in maintaining coastal livelihoods in developing countries (Barbier et al., 2011; Costanza, 1999; Godfray et al., 2010). However, these ecosystems are endangered by ongoing climate and human-driven changes. Millions of people rely on coral reefs for their survival, but 19% of the world's coral reefs were lost in 2008 (Wilkinson, 2008). Under IPCC emission scenarios the global coral cover could decrease by 92% by 2100 (Speers et al., 2016). Increasing sea temperatures and negative impacts associated with the encroachment of human activities are threatening coral reefs globally

(Hughes et al., 2003). This is likely to cause serious difficulties for social and ecological systems trying to adapt to these rapidly occurring changes (Berkes et al., 2008; Cinner et al., 2012; Fernández-Llamazares et al., 2015). The South-West Indian Ocean is warming relatively faster than others (Hobday and Pecl, 2014). This phenomenon is having an influence on the distribution and abundance of marine species (Cochrane et al., 2009). Increased ocean temperatures have both terrestrial and coastal implications. For instance, decreasing rainfall phenomena occur in some areas affecting culture-based livelihoods (Funk et al., 2008). High rainfall episodes can also be triggered by the ENSO phenomenon. For instance the 1998 ENSO induced a massive coral

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bleaching in the Western Indian Ocean (McClanahan, 2008). This episode resulted in 30% coral mortality regionally (Wilkinson, 2008). These regional phenomena could well be causing a decline in fish production and consequently increasing the vulnerability of millions of people (Cinner et al., 2012).

Madagascar is one of 110 countries worldwide that are particularly vulnerable to coral reefs disappearing, as it relies heavily upon reefs both economically and socially (Burke et al., 2011). The country has recently been named a dark spot in a review of global reef health (Cinner et al., 2016). The socio-economic conditions of traditional coastal fishing communities in Madagascar are characteristic of tropical coastal poverty: a high birth rate, child labour, poor access to health services and potable water, isolation from markets and schooling, fisheries-dependant livelihoods, and the vulnerability of ecosystems that communities rely on (Billé and Mermet, 2002; Cripps, 2009). In 2003, over half of the Malagasy population was living within 100 km of the coast, and 10% within 30 km of reefs (Burke et al., 2011). In this context, marine resources are of critical importance for many coastal communities (Le Manach et al., 2012) ensuring food security for many of them. With 4.7 million tons of fish caught during the 1950–2008 period (Le Manach et al., 2012), Madagascar's food security is widely reliant on fisheries, especially small scale fisheries. Climate change is likely to increase human vulnerability in this region, especially as Madagascar is located in a very active cyclonic area and the increased sea surface temperature has amplified the frequency and intensity of these meteorological events over the past 50 years (Emanuel, 2005; Webster et al., 2005). In South-West Madagascar, the social and economic vulnerability is even higher as the region's ocean is warming even faster than other areas of the country (Hobday and Pecl, 2014). Further, fisheries are the primary source of sustenance as well as being the primary source of income for people in that region (Laroche et al., 1997). Livelihood diversification remains limited and most coastal communities are likely to over-exploit their resources as a poverty coping strategy (Harris, 2011). This diminishes ecosystem and livelihood resilience and increases vulnerability to ongoing global changes (Cinner et al., 2012).

Despite substantial epistemological and contextual differences between indigenous and scientific knowledge (Agrawal, 1995), they can be complementary. Indeed, the contribution of local people's knowledge to successful development (e.g. Berkes et al., 2000; Brokensha et al., 1980; Gadgil et al., 1993) and climate change adaptation plans (e.g., Grothmann and Patt, 2005) has been shown. In the absence of scientific studies, local knowledge can contribute to building a knowledge baseline, being more likely to capture environmental signals, extreme events, compared to scientific knowledge which is synchronic (Moller et al., 2004). In some instances, local knowledge allows to better identify the characteristic of ongoing changes because local people can observe changes longitudinally and in some instances at very fine scales (Aswani et al., 2015; McCarter and Gavin, 2014). Documenting local knowledge to hybridize with existing scientific knowledge is a good start to formulate locally contextualized plans to cope and/or adapt to change (Carpenter and Gunderson, 2001). Local and indigenous traditional knowledge are also of significant importance in the planning and the management of conservation areas. Local knowledge integration in local planning, through the promotion of participative approaches or the implementation of locally-managed systems, has proven to be effective (Berkes et al., 2000; DeWalt, 1994; Gadgil et al., 1993). It follows that documenting local perceptions is important for identifying local adaptation strategies, and for designing anticipatory adaptive response plans. This process also provides the opportunity to compare local knowledge to scientific data (Aswani et al., 2015; Chaudhary and Bawa, 2011) in order to test and validate scientific hypotheses (Chaudhary and Bawa, 2011).

In Madagascar, where dependence on marine resources is high and scientific research is incomplete or patchy, it is crucial to document indigenous traditional knowledge in order to build a knowledge

baseline. Within south-west Malagasy fishing communities, the potential is important in terms of ecological knowledge as those areas have remained relatively undisturbed by the influence of markets and mass tourism. While the fishing effort of artisanal fisheries has reportedly increased over the last decade (Le Manach et al., 2012), the region has at the same time been influenced by many extreme meteorological events (i.e. cyclones, floods, droughts, etc). In this study, we document indigenous perceptions of environmental change and the drivers to which they are related in two communities of the Toliara province in South-West Madagascar. The aim of this study is to assess the local perceptions of environmental feedback loops, the way people discriminate natural from anthropogenic causes in the processes they observe, and to gauge their responses to the described changes in the environment, i.e. their adaptation mechanisms. More generally, we wanted to evaluate how local perceptions of environmental and climatic change could be integrated into regional and national climate change adaptation plans for coping with the effects of ongoing profuse environmental and climatic transformation in this large island nation.

2. Methods

2.1. Study sites

The SW coastal region of Madagascar is mainly populated by the Vezo ethnic group (“people of the sea”). They inhabit the coastal belt from Androka, in the south, to Morondava in the north of southwest Madagascar. In 2009, 35% of the coastal population was distributed along 350 km of coastline and was primarily engaged in artisanal fisheries (Bemiasa, 2009). The region has been characterized by migration flows from inland people who are locally considered as “hunter-gatherer” and “pastoralist” ethnicities searching for other sources of income. This is believed to have contributed to the reduction of stocks in the case of sea cucumber fisheries (McVean et al., 2005). In the region, authors highlight that reef species are dominant in local catches (Laroche and Ramananarivo, 1995). It follows that human pressure on reefs is likely to have dramatic consequences for peoples' livelihoods in this region.

Numerous NGOs are active in the region, contributing to local development and sustainable use of resources by implementing new MPAs and other resource management initiatives. For instance, in Ambola, the WWF has been active since 2008, developing community tourism and encouraging sustainable foraging techniques. Octopus fisheries (*Octopus cyanea*) are the most prevalent form of fishery along the southeast coast and the region also supports Madagascar's largest traditional fishery (Laroche and Ramananarivo, 1995; Laroche et al., 1997). Octopus fisheries are critical for many coastal communities, and the WWF and Blue Ventures have been taking action in the region for more than a decade to initiate locally-managed octopus reserves based on sustainable fishing strategies. This has resulted in an increase in the number of octopuses caught between 1996 and 2004 (L'haridon, 2006).

Two study sites were chosen in the area of interest (South-West Madagascar) in association with the Fisheries and Marine Sciences Institute (IH.SM), Madagascar, and WWF Madagascar. The selection was made based on our IH.SM counterparts having contacts in both villages to facilitate participation. And on villagers' livelihoods mainly relying on natural resources. We considered two communities of similar size, with a subsistence economy relying on artisanal fish catches, but with different levels of economic diversification and market integration. Ambola, located 80 km south of Toliara is made up of about a hundred households, relying mainly on fisheries. The village is accessible within 3.5 h drive from Toliara through taking a ferry in Saint-Augustin to cross the Onilahy River. The NGO WWF has been working in the village for the past 10 years teaching sustainable fishing techniques for octopus fisheries and trying to implement an eco-tourism economy. Ambotsibotsike is located 12 km North of Toliara, is made up of about 120 households, and relies on mangrove and marine fisheries.

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