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Collapse and recovery in a remote small island—A tale of adaptive cycles or downward spirals?

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ABSTRACT

Few studies consider how social-ecological systems recover from disturbance. We consider the small semi-autonomous island of Rodrigues (Indian Ocean). Based on semi-structured interviews ($n = 70$), a fisher survey ($n = 73$), weather data and official records we build a timeline of key events. We tabulate local perceptions (5+ mentions) of changes (social, economic and natural capital) and look for signs of adaptive cycles in the island's social-ecological past. Rising human pressure and extreme weather event impacts are reported since first settlement. We propose a recent "collapse" phase catalysed in the 1970s by severe drought, based on respondents' perceptions of still-ongoing changes in farming and fishing, water, external dependence, migration and inter-island political change. Connectivity (flows of people, goods, information, money, power) appear to have strengthed local island recovery, but degradation continued, not least due to water scarcity and a lack of shared political vision as Rodrigues became more tied into the wider world.

Overall, our findings suggest social-ecological systems may get stuck in a post-collapse recovery without any new structure emerging, presuming adaptive cycles can even be detected. Data gaps and global change redefining spatial and temporal scales could mean the adaptive cycle's usefulness is limited in development policy-making contexts.

1. Introduction

Issues of how people respond to change catalysed by external stress, and how society reorganizes afterwards, may determine if societies survive or collapse (Gunderson and Holling, 2002; Diamond, 2005). Coastal ecosystems with rising populations are highly subject to feedback effects between social and ecological elements as they face increasingly intense environmental change (Turner, 2000; Adger et al., 2005b). Small islands are often most exposed to such risks and impacts (Pelling and Uitto, 2001; Tompkins and Adger, 2004; Meheux et al., 2006; Cherian, 2007). Small and marginal "sister" islands within island states may be particularly at risk as they are often seen as a burden (van Beukering et al., 2007) and receive fewer financial resources. For example, coral reefs at the core of small island social–ecological systems are globally threatened and face collapse, with consequent loss of livelihoods (Scheffer et al., 2003; Carpenter, 2008). This can be linked to multiple stressors including human activity and external factors such as climate change and risks of ocean acidification (Hughes et al., 2003). Island vulnerability needs to be better understood (Pelling and Uitto, 2001; Gowrie, 2003; SOPAC, 2003) for how it relates to sustainable development (McMichael and Butler, 2003; Kerr, 2005; Adger, 2006; Young et al., 2006a,b). Studies of natural hazard impacts in small islands often focus on the short-term rather than long-term, and economic more than social and ecological aspects (Meheux et al., 2006).

2. Resilience

Resilience concepts focusing on dynamic change and adaptation – or potential for recovery from damage – are proposed as a replacement for sustainable development paradigms focused on "lifestyle and production" (e.g. in Holling and Gunderson, 2002; Abel et al., 2006). As a property of social–ecological systems resilience may be seen as the amount of change a system can take while keeping the same function/structure; the extent of a system's ability to self-organise; and an ability to build and increase the capacity for learning and adaptation (Walker et al., 2002; Folke, 2006; Brand and Jax, 2007). Policy may aim to prevent a system from moving to an undesired configuration in the face of external stress or disturbance whilst nurturing elements that

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enable the system to renew and reorganise. Recent reviews highlight the policy relevance to adaptively managing vulnerable social–ecological systems of understanding two critical stages of Holling's Adaptive Cycle – collapse and reorganisation – to forestall and overcome crises (Abel et al., 2006).

2.1. Aims and objectives

Few field studies focus on collapse and reorganisation (Folke, 2006), and we are unaware of any for small islands. We aim to identify historical and recent social and ecological change in a sub-national small island where development is focused a common pattern of fishing, farming and tourism. We look for factors which may have influenced collapse and recovery from disturbances such as natural hazards. We discuss the relevance of Holling's conceptual Adaptive Cycle in line with our findings.

2.2. Research site

Small island studies relate mostly to state rather than non-state islands and regions, although climate change risks to both are recognised (Brown et al., 2001; Abel, 2003; Kerr, 2005; Tompkins, 2005). Remote Rodrigues island (18.3 km long by 6.5 km wide) lies at 19′4″S, 63′25″E in the inter-tropical zone of the south-western Indian Ocean (Fig. 1) 600 km east of its central government in the main island of the Republic of Mauritius (henceforth MIOM) (McDougall and Upton, 1965). Rodrigues (104 km^2) steep volcanic flanks and deep narrow valleys rise to 398 m (McDougall and Upton, 1965). The island has one of the Indian Ocean's largest reef lagoons (approximately 200 m^2). With exceptions (Gade, 1985), Rodrigues is barely researched beyond natural sciences. Semi-autonomy (2001) raises its relevance to how islands respond to disturbance (Bhikajee, 2001; Rees et al., 2005; Payet and Agricole, 2006).

3. Methodology

3.1. Conceptual framework

Specific methodologies for research on social–ecological systems (Folke, 2006) remain in explorative stages (Walker et al., 2002), including for reefs (Anon., 2007). The Adaptive Cycle is a recognised concept for analysing social–ecological systems, for example in Africa (Abel et al., 2006). In Australia, Walker et al. (2002) use the Adaptive Cycle (Fig. 2) to analyse historical events and show how external disturbance can change the capacity of a social–ecological system to support livelihoods—e.g. a rural water catchment district hit by drought.

In marine contexts common to islands such a natural system may pass into an irreversible ecological state, for example through over-fishing (and/or climate change) leading to loss of live coral cover in a reef (Hughes et al., 2005). Such a shift in natural "state", representing loss of ecological resilience to disturbance, may then translate into a long-term collapse—of a fishery, livelihoods and capacity to cope with future disturbance in the social system. Seixas and Berkes (2003) use the Adaptive Cycle in a South American lagoon context relevant to tropical fisheries. Target species' population lifecycles and fluctuations were linked to the natural opening and closing of a gap through a sand bar separating brackish and sea water. Policy (e.g. enforcement or gear) impacts are analysed over decades. Other authors describe windows of opportunity for policy to nudge systems into recovery (Cocks, 2003). The Adaptive Cycle has more recently been used to plot future scenarios (Evans, 2008).

3.2. Research methods

We take Rodrigues Island as our sub-national scale of study due to its small size within wider Mauritius (henceforth). MIOM is considered to be the next social–ecological scale up due to national social, economic and political links and bio-geographical connection.

Mixed methods are recommended for social research in Africa (Bulmer and Warwick, 1993; Bunce et al., 2000). We develop timelines used by Walker et al. (2002) to identify possible phases of the adaptive cycle. To do this we referred firstly to the limited secondary data and literature on Rodrigues history, e.g. colonial administrative records (North-Coombes, 1971), government reports (CSO, 2000, 2005), development plans (e.g. KPMG, 2006; UNDP, 2006) and the limited scientific journal literature (Oliver and Holmes, 2004). To cover recent years and overcome a paucity of secondary data, we completed 70 semi-structured interviews (SSI) with Rodriguan island elders, officials, resource users and others with direct or indirect influence over policy formation (Seixas and

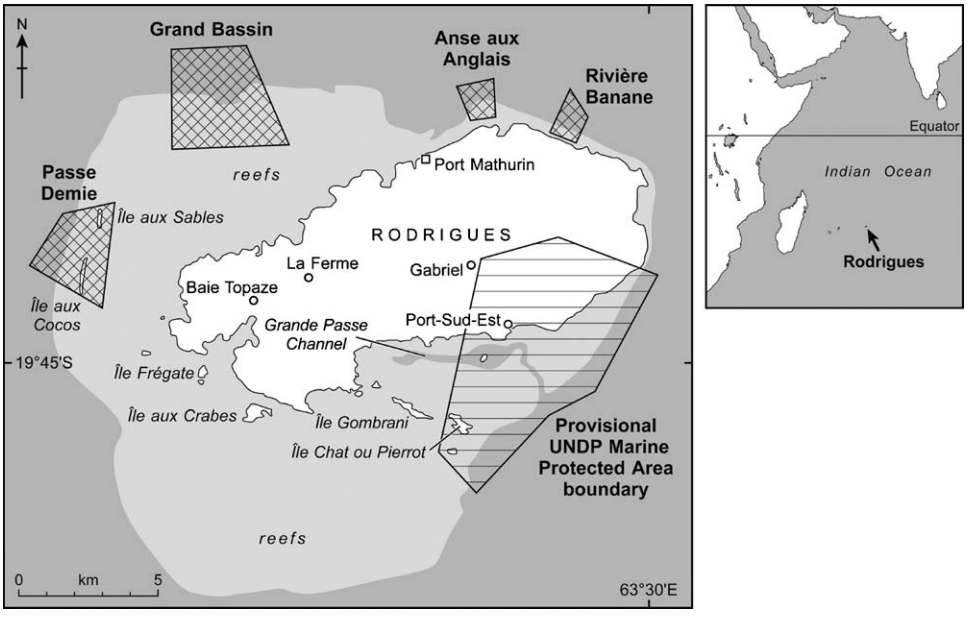

Fig. 1. Map of Rodrigues, showing actual and proposed locations (boxes) of new marine reserves and a Marine and Coastal Protected Area. (Lagoon reef flat in light grey.)