

Research

Factors Influencing Adaptive Marine Governance in a Developing Country Context: a Case Study of Southern Kenya

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ABSTRACT. Adaptive governance can be conceptualized as distinct phases of: 1) understanding environmental change; 2) using this understanding to inform decision making; and 3) acting on decisions in a manner that sustains resilience of desirable system states. Using this analytical framework, we explore governance in practice in two case studies in Kenya, that reflect the “messiness” of contemporary coastal governance in many developing country contexts. Findings suggest that adaptive marine governance is unlikely to be a smooth process of learning, knowledge sharing, and responding. There are institutional, sociocultural, and political factors, past and present, that influence each phase of both local and state decision making. New local institutions related to fisher associations and Beach Management Units influence learning and knowledge sharing in ways contrary to those expected of institutions that enable collaborative fisheries management. Similarly, state decision making is relatively uninformed by the diverse knowledge systems available in the coastal zone, despite the rhetoric of participation. Historical relations and modes of working continue to play a significant role in mediating the potential for adaptive governance in the future. The case studies are illustrative and point to a number of institutional and political issues that would need to be addressed in processes of governance reform towards more adaptive management in developing country contexts.

Key Words: coral reefs; coastal zone; fisheries; governance; inclusion; knowledge; participation

INTRODUCTION

Small-scale fisheries and the coastal social-ecological systems in which they are embedded are complex systems (Mahon et al. 2008, McClanahan et al. 2008). They are difficult to govern because they are dynamic and unpredictable (Norberg and Cumming 2008). Alternative management paradigms, including integrated, collaborative, and ecosystem-based management, address a number of the failings of conventional, hierarchical management but do not explicitly aim to manage this uncertainty. Adaptive management does. Adaptive management is unique as a framework for managing the uncertainty, nonlinearity, and emergent properties inherent in complex systems (Walters and Hilborn 1978, Holling 1979, Walters 2007).

Adaptive governance holds wide appeal conceptually, but its performance in practice has not yet been demonstrated (Plummer and Armitage 2007). Evidence for the potential of adaptive governance

comes primarily from studies of traditional management systems that have continued over time (Johannes 1981, Gadgil et al. 1993, Davidson-Hunt and Berkes 2003, Parlee et al. 2006, Aswani et al. 2007), or from case studies of governance transitions in developed country settings (e.g., Olsson et al. 2006, 2008, McCook et al. 2010). There is still relatively little insight into how adaptive governance might play out in developing country contexts. We use an analysis of governance in practice in two case studies in Kenya to examine the potential for adaptive governance. The case studies reflect the “messiness” of contemporary coastal governance in many developing countries, being a mixture of hierarchical, moderately collaborative, and somewhat integrated management. They are illustrative and point to a number of issues that need to be addressed in governance reform toward more adaptive management in such contexts.

Adaptive governance is society’s capacity to understand and respond to environmental (and

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social) feedback, in the context of change and uncertainty, to sustain and enhance resilience of desirable system configurations (Berkes and Folke 1998, Hahn et al. 2006). We focus specifically on the learning function of adaptive governance (Armitage et al. 2008a). To operationalize the concept for analysis, we break it down into distinct processes. Adaptive governance involves the capacity to: 1) understand environmental change, 2) use this understanding to inform decision making, and 3) act on decisions in a manner that sustains resilience of desirable system states. We examine these processes at two levels at which operational institutions (Ostrom 2005) are formulated: the level of resource-user decision making and the level of state management.

We begin by briefly outlining contemporary coastal governance in Kenya, focusing on two case-study sites in southern Kenya. The methods used for data collection are then described. The analysis focuses first, on processes of adaptive management at the local level, looking at the ecological knowledge systems of fishers, to what extent local knowledge and other knowledge systems inform the fishers' decision-making processes, and whether institutions and behavior have been amended as a result. It then assesses knowledge, decision making, and reform at the level of state management. The discussion explores the opportunities and challenges to reforming management systems toward more adaptive governance in developing country contexts.

CONTEMPORARY COASTAL GOVERNANCE IN KENYA

A variety of government agencies and others manage the Kenyan coast, using a range of approaches and tools, often with overlapping and evolving mandates (McClanahan et al. 2005c). Most notable from a small-scale fisheries perspective are the Kenya Wildlife Service (KWS), a parastatal agency responsible for conservation and protected areas in Kenya; the Kenya Fisheries Department (KFD), responsible for fisheries development and management; the Kenya Marine and Fisheries Research Institute (KMFRI); the Coast Development Authority (CDA); and the National Environmental Management Authority (NEMA). Other stakeholders include independent research organizations, donor agencies, and a number of international and national nongovernmental organizations. These stakeholders

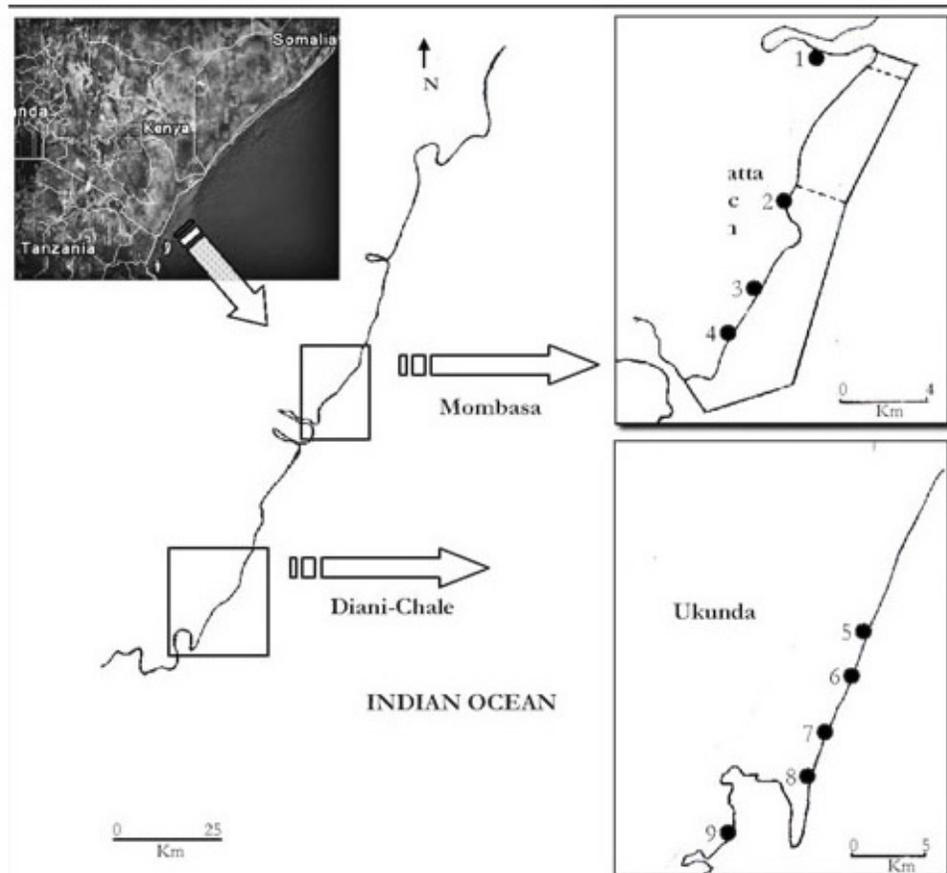
constitute a layer of management on top of customary local management, which varies in strength across areas and is, itself, changing. Consequently, governance of Kenya's coastal zone is a patchwork of approaches including customary management, hierarchical governance, and integrated coastal area management; management tools including marine protected areas, customary gear restrictions, fisheries regulations, licensing, and environmental impact assessment; and initiatives including infrastructure development, investment in fishing technologies, ecotourism ventures, and others. The case-study sites reflect this "messiness," being designated as protected areas of high tourist interest, supporting multispecies small-scale fisheries governed to differing extents by customary authority.

The Mombasa Marine Park and Reserve and Diani–Chale Marine Reserve are adjacent marine protected areas (MPAs) (Fig. 1). The Mombasa Marine Park (no-take) and Reserve (traditional use only) were established in 1986 and are managed by the KWS. The Diani–Chale Marine Reserve was legally designated in 1995, but active management of the MPA failed because of intense conflict between the KWS and local communities over benefit sharing (International Union for the Conservation of Nature 2003). The Diani–Chale Management Area is the terminology used by the different stakeholders of the area, as reference to its reserve status is controversial and contested (hence the reserve is not shown in Fig. 1).

Small-scale fisheries are organized around landing sites. The nine sites included in this research are highlighted in Fig. 1. Marina, Kenyatta, Msanakani, and Nyali landing sites are adjacent to the Mombasa Marine Reserve. Kenyatta is the only one of these that does not use illegal beach seine nets, that is, weighted nets typically with small mesh size, which are dragged along the seabed in inshore areas (Fig. 2). This site is supported by the Integrated Coastal Area Management initiative led by the CDA and funded by USAID. The remaining three landing sites are, by comparison, generally excluded from management processes and social development projects (Glaesel 1997, *personal observation*). None of them have received development aid.

The five landing sites in Diani–Chale included in this study are Mwaepe, Mvuleni, Mwanyaza, Chale, and Gazi. The fisher population in Diani–Chale is considered relatively more homogenous than in

Fig. 1. Mombasa Marine Park is 10 km² (represented by the dotted line) and the Reserve is 200 km² (represented by the solid line).



Note: The four fish landing sites included in the research are shown: 1=Marina, 2=Kenyatta, 3=Msanakani, and 4=Nyali. The Diani-Chale Management Area is 250 km² and lies 26 km south of Mombasa. The five fish landing sites are: 5=Mwaepi, 6=Mvuleni, 7=Mwanyaza, 8=Chale, and 9=Gazi (Weru et al. 2000).

other areas in that most fishers identify themselves as of the same tribe, Digo. There is also more documented evidence for the persistence of some traditional authority in these areas (Glaesel 1997, 2000, McClanahan et al. 1997), which has been successful in prohibiting the use of beach seine nets by migrating fishers. The exception is Gazi, which supports a larger population of migratory fishers using more diverse gears than elsewhere and where beach seine nets are used in inshore areas in the off-

season (Kiswahili: *kaskasi*). With the exception of Mwanyaza, all of these sites have received development aid.

METHODS

Data on ecological knowledge, decision-making processes, and institutional and behavioral change were collected over a 12-month period between

Fig. 2. Two fisher crews dragging beach seine nets in inshore areas in Mombasa. Photo by Louisa Evans.



2005 and 2006 through document analysis, questionnaire surveys of resource users at fish landing sites ($n=172$), key informant interviews with personnel from government agencies, nongovernmental and research organizations, and resource-user representatives ($n=49$), in-depth interviews (2–3 hrs) with resource users at fish landing sites ($n=58$), month-long resource-user diaries and follow-up interviews ($n=9$), and participant observation. At the fish landing sites, ~10% of the population was sampled through a purposive sampling technique used to elicit responses from different groups by age, gender, occupation, and gear.

Interviews were transcribed and coded. Ranked questionnaire responses were converted into a priority index using a risk-mapping technique adapted from Smith et al. (2000) and Quinn et al. (2003). Respondents were asked to rank the options given for each question in order of importance or relevance, from 1–5 (1=most important; 5=fifth-most important). The frequency of respondents that ranked a particular issue as relevant is calculated into an incidence index (I) ranging from 0–1 (0=not ranked by anyone; 1=ranked by all). The ranked order is computed into a severity index (S) on a scale of 1–2 (1=most important; 2=least important) using:

$S=1+(r-1)/(n-1)$ where r is the ranked order and n is the total number of issues or options identified or available in that particular question. The priority index is then calculated from $P=I/Av(S)$ and ranges from 0–1 (0=no relevance; 1=most relevant). The priority score allows us to compare responses from different groups of resource users.

Follow-up dissemination processes have updated information on current issues up to 2008.

ADAPTIVE MANAGEMENT AT THE LOCAL LEVEL

Here, we query the potential for adaptive management at the level of resource-user decision making. First, we look at whether local ecological knowledge confers an understanding of complex system change. Then, we examine whether external knowledge systems help inform local-level decision making. We finish by exploring to what extent local-level institutions or resource-user behaviors are subsequently adjusted.

Understanding Environmental Change: the Role of Traditional Knowledge

The literature on the potential governance function of local ecological knowledge is divided. On one hand, authors question the ability (and motivation) of resource users to appropriately conceptualize ecosystem-based processes (Christie 2005) and the utility of some local knowledge for management (Foale 2006). On the other hand, traditional or local ecological knowledge is heralded as a fundamental basis of adaptive customary management regimes that persist over time (Davidson-Hunt and Berkes 2003, Parlee et al. 2006, Aswani et al. 2007). As we will illustrate, our analysis finds that the breadth and depth of local ecological knowledge is a factor of the degree of interaction among resource users and their environment as well as the level of engagement with local knowledge networks, but that these learning mechanisms are dynamic and are influenced by evolving institutions and sociocultural change. Note that although it is not addressed here, local or traditional ecological knowledge is also endowed with political and cultural meaning and function and has inherent value separate from its potential utility in local and state governance of the environment.

The close and constant interaction between local resource users, in particular fishers, and their environment, can act as a monitoring system. In Kenya, the nature of tropical artisanal fisheries means that fishers use a variety of resources, habitats, and methods and, so, as a collective, they gain a widespread understanding of ecosystem dynamics, even if motivated primarily by resource extraction. There is considerable cohesion of views on environmental change among fisher groups. Of fishers surveyed, 70% perceive environmental decline, and 13% see improvement. Interview data show that many fishers register changes in habitat quality and quantity, change in catch, and changes in abundance of key fish families over time, and can relate these to various disturbances, including destructive gear and too many fishers in too small an area. In particular, the reduction in abundance and availability of key commercial species, such as rabbit fish (*Siganidae*) (Kiswahili: *tafi*), kingfish (*Scombridae*) (Kiswahili: *kolekole*), and sardines (*Clupeidae*) (Kiswahili: *simsim*), and the loss of seagrass habitat associated with increased populations of sea urchin (*Tripneustes gratilla*) (Kiswahili: *mafume*, *mapoe*) are lamented by many fishers.

This local ecological knowledge appears suitable for informing current management challenges for several reasons. First, the majority of fishers recognize decline in environmental health. Second, fishers attribute much of this decline to human causes, which are often interlinked with natural and spiritual drivers. Third, the ecosystem attributes that fishers identify as desirable align with government and scientific priorities. For instance, the fishers sampled generally concur that fish diversity, area and health of seagrass, and water quality are the most important environmental attributes. Further, 69% of fishers sampled believe it is more important to manage for diversity rather than abundance of fish, and 75% of them perceive that society should manage the entire environment rather than focus on specific resources (see also Evans 2010).

However, this knowledge does not fully reflect a complex systems understanding. Some indicators, important from a resilience perspective, are difficult to monitor through practical interaction with the environment. Fishers in these study sites observe catch composition, and size and length of individuals caught. However, interviews with fishers suggest that they do not easily recall these details or metrics over time to infer trends. From these discussions, it is also clear that in general, local language nomenclature relates to taxonomic fish family rather than species, so species-level change over time is not tracked. Further, fishers in these areas generally prioritize seagrass habitats and are less knowledgeable about coral environments, which are, arguably, more sensitive to a range of natural and anthropogenic perturbation that manifest as bleaching, algal growth, and coral disease.

There are also two important issues that could compromise the level of fishers' understanding over time. One is the changing nature of threats, disturbance, or drivers of change. Fishers' knowledge of ecological processes in these sites is derived primarily from practical interaction with their environment. This knowledge proves relatively accurate because fishing pressure is a central driver of change in these areas and fishers can observe these causal links. As other types of ecosystem disturbance become more frequent, intense, variable, or abstract (which may be the case with climate change impacts), resource users may not be as adept at conceptualizing and understanding ecological change, although this remains to be seen.

The second issue is the shift in how fishers learn about their marine environment from each other. In the case-study areas, this is changing alongside changes in technology and local institutions. As exemplified by a gill-net fisher in Diani–Chale, many of the fishers sampled state that younger fishers do not undergo the same level of tutorage or apprenticeship from elders and relatives as they did in the past, related to reduced interest in using traditional gears:

Now it is different, because if you ask someone who taught him to fish you will never know who taught him; because most fishermen use the speargun, there is no reason for someone to teach you. If you are good at swimming you can just use it.
(Mwanyaza, March 2006)

Fisher interviews also suggest that in the past fishers learned through regular, seasonal migration to different areas, but that this has now reduced. A trap fisher in Diani–Chale explains:

The fishermen now are not shifting. They live in an area, they go and fish in an area.
(Mwanyaza, March 2006)

Fishers attribute these changes to reduced access to capital, primarily caused by an increased cost of living (see also McClanahan et al. 2005a), meaning young fishers cannot afford to buy traditional gears or to build marine vessels (wind-powered *ngalawa* or *dhow*) that are able to travel long distances. In parallel, changes to the organizational and institutional structures that govern landing sites have occurred. Newly established fisher associations require fishers to pay monthly fees, which discourages fishers from moving away from their member site. These changes to learning may in time truncate the historical contingency of some of the information exchanged between generations, and reduce the diversity of places from which information is drawn. Instead, learning is increasingly attributed to personal efforts, including observation and learning-by-doing. In these contexts, new technologies, such as goggles/masks, can enable closer observation of underwater dynamics, which may be a primary mechanism of ongoing learning (see also Gerhardinger et al. 2006, Daw 2007).

Overall, the local ecological knowledge of fishers in Mombasa and Diani–Chale shows both potential

and constraint as a mechanism of ecological feedback, and is influenced by institutional and sociocultural factors that may change the depth and breadth of understanding over time. In practice, this local ecological knowledge is also informed by external knowledge, which can also contribute to complex system understanding.

Using Knowledge to Inform Decisions

To assess the extent to which different knowledge systems inform resource-user decision making, fishers were asked to identify their most important sources of environmental knowledge. The ranked responses were calculated into a priority index ranging from 1–0, representing the most important to the least important sources (Table 1).

Fishers attribute a large proportion of environmental information to local knowledge networks, i.e., elders, other fishers, fisher associations, and independent observation. Research organizations, which are the primary source of external ecological knowledge, are ranked relatively low. Our analysis reveals that in practice, the integration of research-based knowledge and local ecological knowledge is influenced by a medley of factors related to the motivations of the research organizations and those of the fishers. Many of these factors appear to block the exchange of information at the local level, explaining the low recognition of research organizations as sources of environmental information.

There are two internationally renowned research organizations conducting long-term monitoring in coastal Kenya. At the time of fieldwork, one organization conducted participatory ecological, fish catch, and socioeconomic monitoring in Diani–Chale. The other organization conducts more classical scientific ecological and fish-catch monitoring of reefs under different levels of perturbation, and undertakes experiments on algal herbivory, urchin predation, and coral recruitment. The knowledge-dissemination processes of these organizations range from centralized annual meetings in conjunction with the KFD, to more frequent dissemination at individual landing sites in Diani–Chale. However, these processes reveal biases in the focus and distribution of research efforts. For instance, fisher groups, more so than beach operators, hoteliers, and other stakeholders are the primary focus of research and knowledge-

Table 1. Priority ranking of the most important sources of environmental knowledge as perceived by fishers in Mombasa ($n=70$) and Diani–Chale ($n=77$).

	Kenya Fisheries Department	Elders	Local fishers	Independent observation	Fisher associations	Diani–Chale Management Trust	Research organizations	Kenya Wildlife Service
Priority index for all fishers	0.62	0.53	0.46	0.37	0.35	0.19	0.17	0.13

Note: The priority index is based on scores for incidence (how many fishers ranked it as important) and severity (how highly the issue was ranked), and ranges from 1—0, the most important to the least important.

sharing activities at the local level despite the numerous other threats to coastal and marine environments noted in government documents, including deforestation, siltation, coastal development, pollution, and invasion of alien species (Weru et al. 2000, KFD 2005a). Research (in terms of long-term monitoring), investment by donors, and capacity building by nongovernmental organizations are then concentrated in Diani–Chale as opposed to Mombasa. This is in response to a perceived governance gap following the failed attempt to establish active management of the Diani Chale Marine Reserve. One research organization focuses all data collection and dissemination efforts in Diani–Chale. The other collects ecological and fisheries data from both Mombasa and Diani–Chale, but prioritizes Diani–Chale in feedback and knowledge-sharing activities (although fishers from Mombasa attend the more centralized meetings). A research organization representative highlights this focus on Diani–Chale, explaining it as a response to the governance gap in the area:

Interviewer: *So, there are the seminars with fishers on a yearly basis, with the Fisheries [Department]?*

Respondent: *With fishermen, yes, and it is only Diani.*

Interviewer: *So not with fishers in Mombasa? Why is that?*

Respondent: *Because that was a way to get*

resource managers and fishers [in Diani–Chale] to talk to each other... just show that this is what is happening to your resource and get them to start talking.

Interviewer: *Why has that not happened in this area [Mombasa]? Nyali and places on the edge of Mombassa Marine National Park?*

Respondent: *Already the projects that were being done in Mombasa were more distinct...But Mombasa fishermen do come for that meeting... So it is not only the Diani fishermen. But it is dominated by the Diani ones. (Mombasa, May 2005)*

In contrast to many sites in Diani–Chale, numerous landing sites in Mombasa continue to use illegal beach seine nets. Therefore, these fisher groups are arguably most in need of research, knowledge sharing, and cross-scale links to promote alternatives to existing practices. The continued prioritization of Diani–Chale to some extent reflects the reification in the development literature of the *traditional* and the *community* (see Agrawal 1995, 1999), both of which are seen to be more coherent in Diani–Chale.

Fisher engagement with external knowledge networks also affects how research-based knowledge feeds into local decision making. Several factors influence this engagement,

including: 1) traditional institutions and newer ones tied to more recent fisher associations and Beach Management Units, 2) sociocultural issues related to resource use, gear, and age of fishers, and 3) historical conflict and ongoing distrust of government and their partners. For example, fisher associations play a dominant role in mediating the linkages between landing site stakeholders or fisher association members, which are not necessarily the same thing, and external processes and stakeholders. As explained by two fishers in Diani-Chale, the associations determine who of the fishers, traders, and female fishmongers can attend external meetings, as well as moderating the extent to which researchers and nongovernmental staff can interact with resource users at the local scale:

I have never been to the seminars, the ones that go are mainly the leaders of the group [fisher association]. (Net fisher, Gazi, April 2006)

I have never interacted with the Fisheries Department, they only talk with the people who are the members [of the association]. (Hook and line fisher, Mwaepe, March 2006)

There are also a section of fishers in all landing sites, typically younger speargun fishers, who prefer not to participate in external interventions, including research processes. This is an artifact of past conflicts and ongoing distrust of external intervention and what are perceived to be “co-opted” association structures. As stated by a speargun fisher in Diani-Chale:

I don't like the meetings because they are guiding us wrongly...Like they're telling us because we have been helped with some gears, we leave an area and fish another area...These people who want to make this park they...look for somebody who wants something. (Speargun fisher, Mwaepe, February 2006)

Another fisher confirms the antagonism toward research processes:

In our group [fish landing site] there are some people who don't want them [researchers] to record their fish or keep records of their fish....Some people are refusing their fish to be measured. (Trap fisher, Mwanyaza, March 2006)

Where fishers do participate in data-collection and dissemination meetings, their involvement is not usually driven by an interest in knowledge, but by other incentives including personal compensation (per diems, food and drink) and the belief that involvement in research may attract donor agencies to their area for investment purposes. This is outlined by fishers in different areas of Diani-Chale:

The interest is in two things. First, the pocket, and second, there are some other small things there. Maybe you sit from 8:00-10:00 you go and have a cup of tea with something and then you get a good lunch, then after lunch there is 4:00 tea. That is the interest of these people, most of them. If they go for a seminar and they come back and you ask them “what was the seminar about?,” “ah, I didn't understand.” (Association leader, Mwaepe, May 2006)

First of all you get the information...then if there is aid, you get the aid after the information. (Speargun fisher, Gazi, April 2006)

Fishers in general did not consider external information to be demand-driven or development-oriented. Often, the information presented at landing sites in Diani-Chale is simplified to encourage widespread understanding (Louisa Evans, *personal observation*), but this effectively limits the potential of these processes to increase the *depth* of local ecological understanding. A gill net fisher explains:

We already know the information. We just go so they [government/research agencies] cannot say “you have ignored us.” (Mwaepe, February 2006)

Nevertheless, despite fisher perceptions, the research and dissemination processes, including the training of enumerators for participatory data collection, the involvement of Fisheries Department personnel in scientific data collection, and the regular dissemination of information to fishers have encouraged shared explanations of many ecosystem dynamics, as is demonstrated by the detailed, technical explanations that fishers, including a beach seine fisher in Mombasa, now give for changes to the environment:

They [government and research] say that they [beach seine nets] are ruining the environment and...it is true, because let's say if today you catch a fish of this size [indicating a fish that is half a palm's length], what are you going to catch tomorrow? And sometimes we break the corals. I did not know it before. I have just come to know it after the Fisheries [department] have been after us and after I myself... because sometimes I myself go in the water and see myself what is happening in the water. (Msanakani, April 2006)

Fishers who attend dissemination meetings state that they consider the information to be accurate. Other fishers also identify particular activities that they have found particularly effective as learning opportunities. For instance, a number of fishers who have had the opportunity to participate in study tours, organized by research agencies and government, see these exchange visits as a particularly useful way of learning about options for fisheries management. Study tours have been arranged among fishers in Diani–Chale and both Tanga, Tanzania and Kiunga, northern Kenya. Their value is highlighted by fisher association leaders in several sites:

We were taken to a seminar in Tanzania to see how the Tanzanians were doing their fishing... [and also] to Lamu and Kiunga to see how the other groups were working. When we came back here we started forming our group [fisher association]. (Association secretary, Mvuleni, March 2006)

There is this Tanga coastal zone. It is going very well. This is what is hurting me in my heart because I learned about them by seeing them practically like that. When I tried to bring the example of those people here...that is the problem with us. If you talk of the conservation of areas...for example conserve your area for yourself... they will think that you are KWS [Kenya Wildlife Service]. I believe that there is a time...they will all come to this. They will come and pick their areas for conservation by themselves. Nobody will ask them. I know this will happen because this is what happened with the Tanga people, that when

they were starting nobody could agree, but as soon as they started with one place and found the product of that place, so many places started. (Association leader, Mwaepe, May 06)

In some cases, these learning opportunities have led to direct action. In Kuruitu, an area north of Mombasa, a study tour to Tanga helped initiate the establishment of Kenya's first community-based fish sanctuary:

The East African Wildlife Society has taken the whole committee to Tanga, where there is a project going on in conservation. Before we came to decide on this no-fishing zone we learned from Tanga, they have established those areas as a community. They have communities and they are running their own things and there are those no-fishing zone areas and they are doing very well. We were taken round, we saw, so when we came back we had to go round all the landing sites to tell the fishermen what we saw, what we learnt from Tanga. Yeah, so we tried and some were convinced and so we thought we could start our own area here. In Tanga they are doing very well. (Association secretary, Kuruitu conservation group, February 2006)

Knowledge integration is limited by a number of factors that mediate learning and knowledge exchange in these case-study areas. Yet some degree of shared understanding is evident. However, does this lead to changed behavior by fishers? We now explore to what extent environmental feedback has led to collective action at the local level, which might be expected to contribute to more resilient small-scale fisheries.

Adapting Institutions and Behavior

Adaptive governance requires environmental stakeholders to not only register and interpret ecological feedback, but also to integrate this information into updated governance institutions (Pahl-Wostl and Hare 2004) and to modify behavior, where necessary. However, shared conceptualizations of desirable ecosystem configurations and disturbance regimes, the “of what” “to what” (Carpenter et al. 2001), are only one component of informed decision making. How different

stakeholders perceive different means of addressing these threats also influences behavior and institutional reform.

From a resilience perspective, management should, among other things, maintain and enhance functional response diversity (Hughes et al. 2005), through protection of biodiversity, broad functional groups (e.g., herbivores), and key-stone species (McClanahan et al. 2002). At the operational scale, various management tools can be used to do this, including gear management, effort management, and protected-area management. In these case-study areas, agreement exists between fishers (see also McClanahan et al. 2005b) and other stakeholder groups on the key threats to the marine environment. In some areas, this has resulted in progress in marine governance. For instance, there is widespread recognition that the beach seine net is destructive, even by those that continue to use it. Once these gears were made illegal by the Fisheries Department in 2001 (Kenya Gazette Notice No. 7565, in McClanahan et al. 2005b), fishers in Diani–Chale were able to mobilize traditional authority and collective action to prohibit the use of these gears in their lagoons. Fishers from different landings in Diani–Chale recall these events:

The Wapemba [fishers from Pemba in Tanzania] were using the small mesh [beach seine] so we banned the net and chased the Wapemba. Five years ago. The government even banned the small meshed nets for the same reason. It is destroying the smaller fish. (Net fisher, Mwaepe, March 2006)

After three months of struggle they [Wapemba] left and have not returned with that gear [beach seine]. Since they have left the sea has been recovering. (Speargun fisher, Mvuleni, March 2006)

According to a respondent from the Fisheries Department, more than 70 beach seine nets were removed from the coastal zone between 2000 and 2003 (Mombasa, February 2005).

Yet, knowledge of the destructive nature of the beach seine net and the support of the Fisheries legislation banning the gear has not been enough to prevent its use by fishers in other areas, including Mombasa. Several other factors related to power and rights are involved. In contrast to many areas

in Diani–Chale where beach seine fishers were foreign, migrant fishers, beach seine crews in Mombasa and Gazi are a mixture of foreign and local fishers. In these instances, fishers refer to the inherent right of local Kenyan fishers to access a livelihood in the context of few alternatives. The use of discourses around stealing from one's communities—which is highly taboo in traditional African and Islamic culture—emphasizes the strong feelings involved:

We don't feel bad about the people who come to fish in this area because...the beach belongs to them, everybody can use it and everybody is trying to find his living so you cannot stop them. (Beach seine fisher, Nyali, April 2006)

If you stop them [illegal gears] abruptly, these people will turn to our homes and start stealing our things. (Line fisher, Mwaepe May 2006)

These fishers also refer to the vested interests of the gear owners, or middlemen (sensu Crona et al. 2010), who might otherwise provide alternatives:

I found fishing to be a good life, but the gear we are using is passed by time...We can only improve by changing the gears. Fishermen want to change. The owners [gear owners] are not interested in changing. (Beach seine fisher, Nyali, April 2006)

Nevertheless, grounded research suggests that at high concentrations of fishers, all gears are destructive, as a result of cascade effects on the ecosystem as species are removed across all functional groups (McClanahan et al. 1997). This makes fishing effort the primary issue. Fishers rank destructive gears, extraction pressure (fishermen), and natural causes as the top three threats to the marine environment (Table 2), and so recognize the role of fishing effort in environmental change.

However, agreement does not necessarily exist on the best way to mitigate these threats (see also McClanahan et al. 2005a,b). For instance, fishers in these two case-study sites rank management measures that regulate both foreign and local fishers highly (Table 3).

Table 2. Priority ranking of threats to environmental health as perceived by fishers in Mombasa ($n=70$) and Diani–Chale ($n=77$).

	Destructive gear	Fishermen	Weather	Management	Trawlers
Priority index for all fishers	0.82	0.51	0.51	0.34	0.30

Note: The priority index is based on scores for incidence (how many fishers ranked it as important) and severity (how highly the issue was ranked), and ranges from 1–0, the most important to the least important.

Yet, traditional and local institutions do not impose access restrictions on individuals. All they do is impose gear restrictions on those who join a landing site where certain gears are banned, and an access fee for nonlocal fishers. A beach seine fisher in Mombasa explains:

When foreign fishermen were coming here they were charged for the month they were staying here and also there was some tax [per kilo of fish caught] they were paying... We agree with the new fishermen how long they are going to stay and what fishing they are going to do. (Marina, March 2006)

Further, fishers across the case-study sites perceive Fisheries Department licensing, the primary tool for regulating fisher numbers, as illegitimate. Fishers in Diani–Chale on the whole do not obtain licenses, as highlighted by a speargun fisher:

One person comes from the Fisheries. They ask us to cut the fishing license. Then we say we don't like it, we tell him to go to the people...that makes farming. We tell them to take that thing there first to cut the farming license and so then we can cut for fishing license. (Mwaepe, February 2006)

Fishers in Mombasa obtain licenses only to deflect added attention to their area where they use illegal gears, or in response to additional enforcement by the KWS.

In any case, licensing does not regulate extraction effort, and in almost all areas we studied, fisher density exceeds the estimated sustainable density of

approximately 10 individuals/km² (McClanahan et al. 2006, *unpublished data*, Mangi and Roberts 2007).

Another management tool for controlling extraction pressure is the no-take zone or marine park. No-take zones can lead to increased abundance, biomass, and species richness (McClanahan and Graham 2005) and protect sensitive species, which can include functional key-stone species and long-lived individuals with high fecundity (McClanahan 2000). They can thereby contribute to ecological resilience, although see Graham et al. 2008 for a critical take on the performance of no-take MPAs in the context of climate change. In this research, a small majority of fishers surveyed (53%) answered “yes” to the question: “are marine parks good for the environment?,” but almost all fishers, without prompting, added the caveat that they were not good for people. Hence, fishers do not rank spatial closures, whether temporary or permanent, highly as an option for management of their areas (Table 3). McClanahan et al. (2005b) also found that fishers had low perceptions of the benefits to communities from closed areas.

The high level of regulative enforcement of marine parks in Kenya, including Mombasa, is generally effective in curtailing extraction and promoting recovery of resources and processes (McClanahan et al. 2005a). However, the conflict over MPA designation in Diani–Chale in the mid 1990s (International Union for the Conservation of Nature 2003) demonstrates the level of antagonism that can be leveled at this management tool (see also Evans 2009). More than 10 years on, fishers in Diani–Chale continue to be wary of marine-conservation

Table 3. Priority ranking of preferred management options as perceived by fishers in Mombasa ($n=70$) and Diani–Chale ($n=77$).

	Gear regulation	Regulation of local fishers	Regulation of foreign fishers	Regulation of trawlers	Reserves	Closed areas	Regulation of catch composition
Priority index for all fishers	0.76	0.40	0.34	0.25	0.21	0.19	0.17

Note: The priority index is based on scores for incidence (how many fishers ranked it as important) and severity (how highly the issue was ranked), and ranges from 1–0, the most important to the least important.

initiatives that they see as vulnerable to co-option by government. During data collection, one author was warned:

If you talk of conservation of areas....first they [fishermen] will think you are KWS [the Kenya Wildlife Service]. Conservation is very important for us to do but I always try and warn you people who are coming here [researchers] not to talk this question to other people because conservation means another thing to them. (Association leader, Mwape, May 2006)

Even in Kuruitu where fishers established a community-based sanctuary, relationships among fishers are sometimes strained because of the reputation of marine parks in Kenya.

The problem is with those who are not members [of the conservation association]. They just don't believe it...They have said they have seen this happening in Mombasa and Watamu. They are worried.... Most of them think we [the Fisher Association] are deceiving them, that we want to bring, they call it 'the marine park'. They think we want to introduce a marine park governed by the government, which is not true...We just tell them, if the government wants to do a project then nobody will stop them but this project is for the community, is only for the community themselves and it will be run and managed by the community and no government will come in but they just don't

want to understand. So there is a little bit of conflict there. (Association secretary, Kuruitu, February 2006)

These statements demonstrate ongoing disillusionment with top-down models of protected area management in Kenya. Indeed, the establishment of no-take areas by the government may no longer be feasible in Kenya, suggested by the fact that the Kenya Wildlife Service has been unable to establish new no-take zones since the late 1980s (Wells et al. 2007). Instead, new models of community-owned closed areas, both temporary and permanent, appear to be emerging in some areas (Dr. Joshua Cinner, *personal communication*), boosted by learning from other examples of community-based management such as the Tanga experience, although the contribution of such initiatives to ecological resilience is yet to be seen.

Whereas the removal of destructive gears in certain areas has led to some recovery of ecosystems (McClanahan et al. 1997, McClanahan and Mangi 2001), the story in these areas of Kenya is still one of environmental decline (McClanahan 2007). Fishers note this decline, and yet other factors play a more prominent role in driving local institutional response and collective action, including perceived rights to access resources for “daily bread,” past experiences and feelings of distrust that undermine some management options, and the perceived lack of viable alternatives which, in terms of gear choice, is related to a lack of capital and the powerful role of gear owners in determining gear choice in some areas.

THE STATE LEVEL

We now turn to processes of state decision making to query the potential for adaptive management at this level. We look first at state-based understanding of complex system change, then at the integration of knowledge and its use in decision making, and finally at processes of reform.

Understanding Environmental Change: the Role of State Knowledge

There are three government agencies that collect data for the purposes of marine management in Kenya: the Kenya Fisheries Department (KFD), the Kenya Wildlife Service (KWS), and the Kenya Marine and Fisheries Research Institute (KMFRI), which supports both of the former. The KFD deploys scouts along the Kenyan coast to collect data on inshore fish catch (total weight), with individual fish scouts covering relatively large areas in some cases. These data are used to monitor inshore coastal fisheries production and are reported on annually (e.g., KFD 2002). In Diani–Chale and Mombasa, fish scouts also work closely with one of the research organizations collecting other catch metrics. These data are also reported on annually in joint meetings with the KFD and fishers, and published internationally in scientific papers. With the introduction of new fisheries legislation on the formation of Beach Management Units along the coast, the KFD aims to transfer responsibility for inshore catch monitoring to fishers themselves (KFD 2005b).

The KWS conducts relatively more comprehensive monitoring. The agency undertakes standardized, taxonomically broad monitoring of fish abundance, benthic cover, and invertebrate counts (urchin and crown of thorns), across all its MPAs on an annual or biannual basis, in partnership with a research organization (Kenya Wildlife Service 2004, Obura et al. 2004, *unpublished data*). These data are presented in yearly reports disseminated to Nairobi headquarters and communicated to the Assistant Director of the Coast. Park rangers also record boats in dive sites, occurrences of illegal entry into the park, and mooring damage, but this information is rarely aggregated and reported on (KWS, n.d.). According to a park warden, information on the number of tourists in the park or number of fishers in the reserve, which could be gleaned by assessing park tickets or fisher licenses, are not analyzed and

reported on by either the KWS or the KFD (Park warden, KWS, April 2005).

The KMFRI undertakes in-depth (species-level) fish-catch monitoring and water-quality monitoring alongside targeted research programs on different issues, including seagrass habitats and ornamental fisheries, among others. According to a KMFRI scientist, analysis of catch monitoring data is not conducted routinely, but the data are available should the KFD request them (July 2006).

The Kenya Coast Development Authority (CDA), responsible for integrated coastal area management, does not conduct its own research and monitoring, but relies on information from the above agencies (CDA 1996, 2005). Similarly, the Kenya National Environmental Management Agency (NEMA) relies on information from the above agencies for the marine component of the “Status of the Environment Report” (Kenya NEMA 2004, 2010).

The research capacity of these government agencies appears to be growing, with staff members following opportunities for education abroad and conducting research projects of their own (Louisa Evans *personal observation*; Coastal Ecology Conference IV, Mombasa, May 2006; WIOMSA 5th scientific symposium, Durban, October 2007). The monitoring programs are also expanding and growing in strength. However, from a complex-systems perspective, many metrics are not captured by these programs as currently designed. For instance, species-level catch data are either not collected or are not regularly analyzed, and ecological monitoring in MPAs is at the broad taxonomic level. Therefore, biodiversity and functional change may be missed. The MPA monitoring program does not assess the impact of sanctioned uses of the park, and does not compare data from within and outside the protected areas, so it does not assess different disturbance regimes. Some of these gaps are filled by the research-based knowledge systems developed by the research organizations working along the Kenyan coast. However, to what extent this knowledge, and indeed local ecological knowledge, can inform state decision making depends on the openness of decision making.

Using Knowledge to Inform Decisions

There is a broad literature on issues concerning processes of inclusive decision making at the level of the state. Participatory processes of decision making at this level are expected to improve the legitimacy and effectiveness of environmental management (Jentoft 2000, Raakjaer-Nielson 2003, Francis and Torell 2004). On one hand, the inclusion of stakeholders can improve compliance and collective action. On the other hand, the inclusion of more diverse knowledge and value systems can expand the information pool on which decisions are based, thus improving problem framing and solving, understanding, and innovation (Berkes 2009). However, the inclusion of stakeholders, as knowledge holders, and of knowledge itself may not necessarily occur in tandem, which is relevant to both local and research-based knowledge. The issues around incorporating diverse knowledge systems, particularly local knowledge, into the often highly structured, linear processes of management are widely documented (see Scott 1998, Walley 2002). Our data suggest several “lost opportunities” with regard to knowledge integration at this level.

Different types of collaborative fora have been created by the government agencies involved in coastal management in Kenya. They include integrated coastal area management planning and implementation (CDA 2005), issue-based task forces to identify research and management priorities (scientist, KMFRI, July 2006), and inclusion of stakeholders in policy review for some sectors, namely Fisheries and Tourism, as observed during fieldwork and confirmed by participants interviewed. These collaborative fora appear to perform different functions as environmental feedback mechanisms. For instance, fora such as policy review are essentially a debate over interests related to a preformulated document rather than opportunities for ecological knowledge to inform governance processes. By contrast, issue-based task forces, such as task forces on urchin degradation of seagrass, ornamental fisheries, or ring-net fishing, prioritize demand-driven research for decision making and so are more likely to function as effective, ongoing mechanisms of environmental feedback into government decision making. However, these fora have different criteria for participation. Local resource users, including fishers, were included in policy development with the Department of Fisheries and Tourism, but have not been included in planning phases of integrated

coastal area management or in the issue-based task forces. The reasons for this are not clear, as there is extensive reference to participation and indigenous knowledge in new policy documents (e.g., NEMA 1999; see also Walley 2002).

Similarly, one or other of the research organizations are included as “institutional members” in some decision-making fora but not in others (CDA 2005; scientist, KMFRI 2006). Interactions among state and research agencies are somewhat bolstered by the efforts of the research organizations to include government in their knowledge-sharing initiatives, including the annual dissemination meeting with the KFD, fishers, and other invited agencies, and coastal and regional conferences such as the Coastal Ecology Conference IV, Mombasa, May 2006 and those organized by the Western Indian Ocean Marine Science Association (WIOMSA). Yet, in general, evidence suggests that few government actions are underpinned by an in-depth understanding of the complexities of the marine environment. The acting warden of the Mombasa Marine Park confirms this:

Recommendations developed by researchers are rarely integrated into management action plans. (KWS, April 2005)

Adapting Management Institutions and Practice

To what extent is new state policy, legislation, and action informed by the ecological knowledge available in the coastal zone?

There is a diversity of knowledge applicable to coastal small-scale fisheries management in Kenya, from the local ecological knowledge systems of different fisher groups, to the state knowledge of different government agencies, to the knowledge developed through participatory and classical scientific research. An example of effective management response at the state level is the amended fisheries legislation designating beach seine gears, and more recently spearguns, as illegal (KFD 1989, 2001, 2003). However, there is evidence to suggest that, on the whole, this knowledge does not inform government decision making on an ongoing basis.

One example is the continued prominence of terrestrial or inland issues in new government policy

and legislation. For instance, the new fisheries policy developed in 2005/2006 continues to prioritize inland fisheries in Kenya (KFD 2005a). Similarly, the policies and legislation of the KWS reflect a core concern with terrestrial conservation and park management issues (KWS 1989, 2007), which is mirrored in the agency's strategies for training of staff, as outlined by one ranger:

Like for our case, we did not undergo training for handling gears like the boats and the like. It is a matter of maybe using different types of firearms like in the terrestrial and maybe the fire and movement techniques. (KWS, July 2006)

This core concern is also reflected in their interactions with many coastal communities, which is often focused on human-wildlife conflict with nonmarine species such as baboon and crocodile.

Factors behind the prioritization of terrestrial or inland issues in government policy and legislation include a disconnect among central ministries based in Nairobi, and the provincial departments at the coast, and the continued dominance of models of centralized decision making. These centralized structures are widely felt, as reflected in the comments of a beach operator explaining a response to local concerns about park fees:

They [the Kenya Wildlife Service] say "the order is from the top, Nairobi, and nothing can be done at the provincial offices." (Mombasa Boat Owners Association member in reference to changes to park fees, May 2006)

Mechanisms by which government agencies can strategically retain power in centralized structures of governance, despite the rhetoric and policies of decentralization, are documented in the literature (e.g., Ribot et al. 2006), with Berkes (2006) noting that this limits the sensitivity and effectiveness of environmental feedback.

Barriers to adaptive governance also exist at the level of action. In some cases, the issue is not a lack of understanding but, rather, a lack of regulation and enforcement capability. For instance, hoteliers continue to build seawalls on protected beach land to mitigate beach erosion when these structures are known to exacerbate the issue. In other cases, the issue is indeed one of lack of information or

knowledge or, perhaps more, the lack of effective use of available knowledge. For example, the ICAM initiative, with buy-in from the KFD and fishers, is directing investment into infrastructure and technology at select fish landing sites. Large plywood or fiberglass boats have been provided to some fisher groups, with engines and nets (Fig. 3). These technologies are expected to facilitate offshore, deep sea fishing, and the resting of inshore areas. However, fishers have not been provided with training in deep-sea fishing, or use of such nets with modern vessels. Fishers' own ecological knowledge is restricted to knowledge of inshore resources and local technologies.

The fishermen have been given a lot of nets but they cannot use the nets...They have not even gone to get even two kilos of fish because they don't know how to use the nets. (Association secretary, Mvuleni, March 2006)

In tandem, as observed during fieldwork, this means that fishers generally use these technologies to fish the *milango* (reef entrances) and reef edges just outside their lagoons.

They are using the boat when they are going to like, the milango, or different milango like Dzinani. (Line fisher, Mvuleni, March 2006)

Large numbers of fishers can participate in these fishing expeditions, attaching traditional canoes to the new vessel.

The first time we were about 20 people, the following time there were...what I heard was about 40. (Association leader, Mwaepe, May 2006)

On occasion, fishers have been unable to catch fish with these nets and, where large catches have been achieved, often fishers have been unable to secure an adequate market for their catch (in Diani-Chale). This is demonstrated by the experience of fishers from two sites in Diani-Chale:

It was not good, we didn't catch the fish, but maybe next time. (Speargun fisher, Mwaepe, February 2006)

Fig. 3. A “modern” plywood boat donated to fishers in Diani–Chale contrasted against a traditional canoe. Photo by Louisa Evans.



We are getting a problem with marketing. Once we got 1000 kg. We phoned people in Mombasa to come and take, they came to take. But also there was some which was left even with some being sold to Ukunda. So we had to split the piles to be used by ourselves. (Association secretary, Mvuleni, March 2006)

There is nothing that can be done to develop fishermen. Like, the boat was brought but still we are not getting fish so I don't know what can be brought to improve us. (Speargun fisher, Mwaepe, March 2006)

There is little knowledge of the status of offshore stocks, only ad hoc monitoring of the impact of these new technologies on inshore stocks through price/catch records of fishers, and no analysis of the implications of this development agenda for the vulnerability of fishers. Observations of the use of these gears suggest that actually they may reduce the resilience of inshore lagoons by exploiting

source stocks more efficiently, and/or increase the vulnerability of fishers who may collectively fail to catch enough and who are required to cover costs of petrol and maintenance in the context of uncertainty and variable catch. The association secretary of a fisher group in Mombasa explains his concern:

One disadvantage is these engines are petrol engines and petrol is rather quite expensive for a fisherman. It should be a diesel engine. But they [donors/government] thought a diesel engine is rather expensive so they thought this is cheaper to buy this and give it to us. If we go there [fishing] and we get 100 kg, it won't pay for petrol, it is useless, rather somebody goes with their canoes. (Association secretary, Kenyatta, April 2006)

Existing knowledge networks have not seriously informed these decisions, nor are new feedback mechanisms initiated to monitor progress and inform adaptive responses.

DISCUSSION

We argue here that adaptive marine governance, in a contemporary developing country setting, is not likely to be a smooth process of learning, knowledge-sharing, and responding. There are institutional, sociocultural, and political factors, past and present, that are influential in each of the phases of the adaptive process discussed here. For instance, at the local scale, the introduction of new institutional structures for local organization, first into fisher associations and more recently into Beach Management Units, impacts: 1) direct learning processes, by encouraging fishers (members) to settle rather than migrate seasonally, 2) knowledge sharing, by “authenticating” members who pay fees as opposed to nonmembers who are excluded from some formal knowledge exchange processes, and 3) action, by enabling fisher associations and their members to engage more directly with external agencies. Some of these outcomes are contrary to what is expected from the “enabling” institutions of co-management. Similarly, political factors affect the potential for adaptive governance. In Diani–Chale, conflict between fishers and the KWS over a decade ago permeates relations among fishers themselves, as well as among fishers, government, and other stakeholders. This distrust continues to influence the extent to which these fishers engage in knowledge sharing and how they view options for marine management. At the state level, governance processes are evolving, with some processes becoming more inclusive. However, the institutions pertaining to participation, science, and local “indigenous” knowledge outlined in new conservation, fisheries, and environmental policy and/or legislation do not, in practice, ensure adequate representation of all stakeholders in opportunities for knowledge exchange and decision making. As such, new national policy relevant to coastal management continues to reflect a greater concern for inshore fisheries and terrestrial conservation, and state action does not appear to be rooted in an in-depth understanding of complex system interactions and change.

Much empirical work has focused on the inclusion of local ecological knowledge into formal, state-driven management. As noted by Wilson (2003), the role of institutions in such contexts is typically underplayed, with more focus placed on the sociocultural dichotomy among scientists, managers, and resource users. We support this argument and

expand on it in several ways. First, we show how institutions also mediate the integration of independent research-based knowledge into management and, that, in this context, science and management are not interchangeable. Second, we outline how institutions mediate the integration of knowledge systems at the level of resource-user decision making as well as within what are often recognized as the more formal structures of fisheries and coastal management. This is important because in many coastal small-scale fisheries in developing country contexts, the capacity of governments is often low, and a high proportion of both impact and responsibility to mitigate impact falls to the local level. Third, we suggest that institutions play a role earlier in the chain, during initial learning phases as well as in knowledge-exchange processes. In many instances, institutions influence learning and knowledge exchange in unexpected ways, often reflecting ongoing power struggles and blocking collective learning and knowledge networking.

The power dynamics inherent in competing knowledge claims and knowledge integration for resource management is well recognized. Davidson-Hunt and O’Flaherty (2007) highlight the potential for conflict around competing knowledge claims (research-based and local) given the politics of resource-management decision making and the history of unequal relations between those making decisions and those impacted by decisions. Armitage et al. (2008a) ask questions around who is involved in learning and the nature of the risks involved in participating in social learning. We provide examples where different stakeholders and their knowledge systems are included or excluded at the level of local and state decision making, even including examples of where local stakeholders choose to exclude themselves in response to what they perceive as illegitimate processes of external involvement in their area. Power relations are both a driver of inclusion and exclusion in knowledge exchange and collective action, as well as an outcome of these processes (see also Walley 2002). Fishers who continue to use beach seine nets remain peripheral to the mainstream governance processes in these case-study areas, which, in turn, means they struggle to exchange ideas and develop alternatives with government and other agencies. Divergent perspectives and “illegal” behavior is seemingly not simply a matter of “ignorance” or lack of will, but is underpinned by fundamental beliefs, including basic rights, and past and present relationships. To get beyond this, Adams et al. (2003) advocate for

explicit mechanisms for conflict resolution and negotiation to come to terms with the inevitably difficult or “tragic” choices of coastal management.

Despite several challenges, in some instances, shared understanding emerges and institutions are reformed. Note that this does not simply refer to local ecological knowledge aligning with scientific or government knowledge or being co-opted for management. We provide examples where shared understanding emerges from local ecological knowledge challenging government perspectives, such as in the case of new legislation banning beach seine nets. We explore processes of learning and knowledge exchange at the local level, in a context in which resource users are themselves selecting the local and external knowledge they want to inform action. We also highlight where understandings and opinions diverge, and the importance of this in informing governance reform. For example, new models of area management in Kenya are emerging, to some extent as a result of the strong antagonism toward centralized models of MPA management at the local scale. Governance can often be strengthened by exploring differences in knowledge and value systems. More broadly, we argue that it is not necessarily knowledge per se, as a static and given, that is important for adaptive management, but the more dynamic processes of learning and knowledge exchange as the means by which environmental feedback continues to be captured and fed into institutional and behavioral change.

As such, the factors that mediate learning, knowledge exchange, and collective action are critical to future outcomes and are important entry points for governance reform to more adaptive governance. For instance, resilience perspectives are forward looking and emphasize uncertainty. This research suggests that different learning processes have different advantages in terms of capturing complex system change and that no single knowledge system captures all change. Therefore, knowledge sharing is central to systems understanding and ongoing learning in a context of uncertainty. It is likely that as environmental change becomes more abstract as climate change progresses or localized impacts from global change processes are felt, the role of external research organizations in making sense of these trends for local resource users will become increasingly important. Therefore, addressing the institutional, sociocultural, and political barriers to more effective knowledge exchange between fishers and research agencies

could be a vital intervention in response to expected changes in disturbance regimes. Strengthening processes of knowledge exchange could improve the contribution of this phase to a more effective adaptive governance process overall. As one example, in a focus group with local leaders, as an alternative or addition to current dissemination processes, they suggest that agencies should target the “strong opposition,” the younger fishers, for more intense and comprehensive environmental education to strengthen knowledge exchange at this scale.

Finally, the study also emphasizes that in many instances, considerable awareness and knowledge exists, and that substantial barriers to improved governance are found at the phase of institutional reform and collective action at the local and state levels. At the local level, poverty makes it both practically and ethically challenging to regulate or reform governance and collective action, that is, resource access and fishing effort (McClanahan et al. 1997, McClanahan et al. 2005*b*). At the level of the state, decision making remains highly centralized in Kenya. Institutional and policy reform occur, but are not necessarily tailored to needs at the coastal scale. In contrast, effective adaptive governance is expected to require flexible, responsive, and multiscale governance (Berkes and Seixas 2005). However, the costs of transforming governance from highly centralized to responsive and multiscale arrangements, alongside the ongoing costs of managing an adaptive system, may be limiting in a developing country context. Take for example, the rezoning of the Great Barrier Reef Marine Protected Area. This involved substantial reorganization of the Great Barrier Reef Marine Park Authority (Olsson et al. 2008), over 600 consultations with stakeholders (Sutton and Tobin 2009), and a structural adjustment package worth over 200 million AUD in compensation for fishers (McCook et al. 2010). These costs are prohibitive in most developing contexts. A tailored approach to governance reform is needed in these contexts.

CONCLUSION

As observed by Berkes (2009), the complexity of social–ecological systems makes it difficult for any one group or agency to possess the full range of knowledge needed to manage resources. This is particularly pertinent in the relatively data-scarce contexts of developing countries. The two case

studies presented here enjoy an advantage in their proximity to two world-renowned research organizations. In many other cases, knowledge-exchange networks are limited to government-resource-user interactions, or interactions with NGOs rather than independent research organizations. Yet, these examples indicate that it is institutional factors, rather than a lack of available information, that act as the primary constraint to knowledge integration, use of knowledge in decision making, and attitudinal and behavioral change for effective adaptive governance.

Responses to this article can be read online at:
<http://www.ecologyandsociety.org/vol16/iss2/art21/responses/>

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