



Analysis of Perceptions and Knowledge in Managing Coastal Resources: A Case Study in Fiji

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Sustainable management of coastal resources depends on human knowledge and perceptions of natural resources and coastal environments. However, empirical evidence has been limited in order to understand linkages between knowledge, perceptions and collective actions to achieve sustainable resource management. This case study analyzed perceptions and knowledge among diverse stakeholders: villagers, government officials, scientists and staff of a non-governmental organization who are collaboratively working in a Fijian coastal community to manage the local coastal resources. Analyses were made using the integrated local environmental knowledge (ILEK) concept and frameworks of discourse analysis to clarify interlinkages between perceptions, knowledge and collective actions for a variety of examples. Research was conducted in Kumi village on the island of Viti Levu in Fiji, and the investigated projects included the management of a locally managed marine area, seaweed aquaculture, sea cucumber restoration and ginger plantations. These initiatives have shown that diverse knowledge on coastal resources and environments influence perceptions among people in a complex way, and transformation of perceptions produced new sets of knowledge through the generation of hypotheses regarding the management of coastal resources. Collective actions were promoted by the transformation of perceptions, and social learning processes were mobilized by these collective actions. Traditional institutions, cultures and leadership roles deeply embedded in the local communities had strong influences on shared perceptions among community members to provide foundations for collective actions. Dynamic transformations of perceptions promoted by integrated knowledge among community members were critical enablers of collective actions to achieve sustainable resource management.

Keywords: coastal resource management, perceptions, integrated knowledge, stakeholders, collective actions

INTRODUCTION

Coastal communities across the Pacific Islands continue to face challenges in managing their marine and terrestrial resources effectively. Demand for seafood is growing (Delgado et al., 2003) and fisheries products are one of the highest traded food commodities worldwide (Asche et al., 2014). Pacific island developing countries experience slow economic growth and development, and almost 100% of the populations live within 100 km from the coast (Martinez et al., 2007). The fisheries resources are highly valued and provide 50–90% of animal protein in the Pacific islands

(Pacific Community, 2012). The life of people in these coastal areas depends on fisheries, tourism, agriculture, mining and small businesses, and they are vulnerable to various environmental problems in both terrestrial and marine areas (Kronen et al., 2009; Bidesi et al., 2011). Although Fijians are well renowned in adapting to their island environment (Veitayaki, 1995; Veitayaki et al., 2015), there have been continuously high levels of coastal fisheries exploitation in the past decade (Hand et al., 2005; Teh et al., 2009).

As the threats of resource depletion, overfishing, consumerism, population growth and climate change have become profound, there is a growing need for research regarding the knowledge and perceptions of communities to promote collective actions that can ensure a sustainable use of natural resources. In Fiji, people have been managing their coastal resources through the introduction of new crops, implementation of locally managed and protected marine areas, and small-scale projects to restore depleted coastal resources (e.g., mangroves). These adaptive responses among people have been promoted through collective actions supported by their knowledge and perceptions on the surrounding coastal environment and resources. Also, traditional social systems and decision-making processes in Fijian communities are likely to play significant roles in these responses. In previous studies, perceptions have been recognized as a promoting factor of the process of changes in fisheries management (e.g., Cinner and Pollnac, 2004; Brewer, 2013; Bennett and Dearden, 2014; Barley-Kincaid and Rose, 2014). However, less attention was given to the transformation mechanisms of perceptions and the underlining knowledge systems that influence collective actions by local people with regard to the complex management of their multiple coastal resources and environments. In this paper, perceptions are defined as the cognitive framework of people to see the external world, to extract meanings and create collective actions with regard to the coastal resources they utilize in their daily lives. We assume that perceptions are dynamically transformed by the emergence of knowledge that is also dynamically produced and translated through livelihood and practices among people living in an ever-changing world. Locally-based scientists, who are embedded in communities, play an important role to integrate and systematize diverse knowledge. This could be either a residential type of living in the community as a member and stakeholder, or a visiting type, having the research bases in remote areas to “use” local communities as a field research site (Sato, 2014). We also recognize that there are various types of “bilateral knowledge translators,” including residential and visiting researchers, government agencies, non-governmental or non-profit organizations (NGOs, NPOs) circulating and integrating transdisciplinary knowledge derived both from external scientists and from local communities (thus “bilateral”) to create meanings of various knowledge components for local communities (Sato, 2014).

In this paper, we analyze transformation mechanisms of knowledge and perceptions to promote collective actions and social learning among diverse stakeholders: villagers, government officials, scientists and NGO members, who are collaboratively working in a Fijian coastal community to manage the local coastal

resources. The renewable resources discussed in this paper include coastal marine resources (seaweeds, *Anadara* clams and sea cucumbers) and a land resource (ginger). We analyzed the cases of collective actions among villagers to manage or restore these resources, and discuss (1) how knowledge production and translation contribute to the dynamic transformation of perceptions among stakeholders, (2) how collective actions can be promoted based on shared knowledge and perceptions, and (3) how social learning in collective actions influence perceptions and knowledge systems. We discuss the importance of knowledge translations to promote these processes, with special attention given to the function of knowledge and perceptions rooted in traditional institutions, rules and practices. Results of these analyses contribute to elucidate interlinkages between knowledge, perception and collective action to achieve effective community-based management of coastal resources in complex social-ecological systems.

METHODOLOGICAL APPROACH

Study Area

The Republic of Fiji has 332 islands with a population of 909,389 (CIA, 2015), and a total area of 18,333 km² (Lane, 2008). There are more than 800 villages and settlements in Fiji, and these communities are dependent on both terrestrial and marine resources for survival and sustainable development (e.g., Kitolelei et al., 2011). Kumi village is located 17° South and 178° East on the eastern side of Viti Levu, the main island of Fiji (Figure 1). It has a population of 273 people with 84 households and is one of the seven villages in Verata District. The total area of the district is 235,95 km² of which are coastal and marine and 140 km² terrestrial. The terrestrial ecosystems of Kumi village include secondary forests and grasslands, as well as farmlands and plantations. The marine ecosystems include coral reefs, seagrass beds, intertidal flats and mangrove forests. The diverse marine ecosystems are home to a variety of marine resources, which the villagers of Kumi harvest for subsistence and commercial uses.

The marine resources that are sold in local markets include *Anadara* clams that are collected by women, and various finfishes. In Kumi and its district, the *Anadara* clams that can be found in shallow mudflats and seagrass beds, are a traditional totem that people respect and honor (Vunisea, 1996). Members of coastal communities in Fiji have traditional clan totems, including various marine species, that they revere and respect. The *Anadara* clams are totems and at the same time an important income source for Kumi villagers, and therefore enable community members to respect coastal management decisions that are relevant to protect their totems. Root crops such as cassava, taro and other vegetables are additional sources of income. Kumi villagers sell their marine and agricultural products in three main markets (Korovou, Nausori, and Suva), and at times products are also sold within the village itself. The average income of households in 2014 was \$79.2 FJD (~38 US\$) per week as a result of the sale of fisheries catch.

Kumi village has a community canteen and a truck that are managed by the community to provide services for its members. There are several other committees that are responsible for

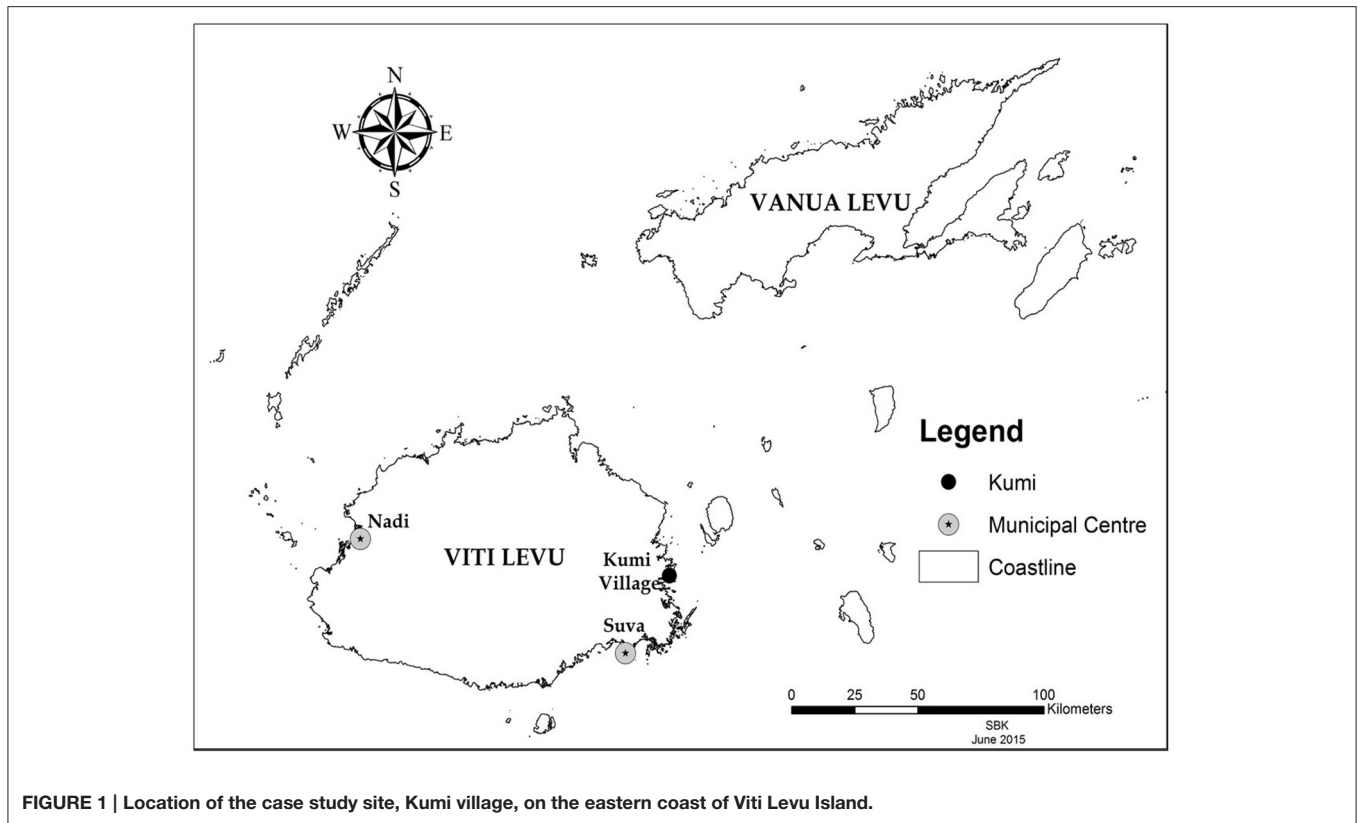


FIGURE 1 | Location of the case study site, Kumi village, on the eastern coast of Viti Levu Island.

various community-related decision-making, and development projects of the village, including committees for: women's group, water supply, education, a shop cooperative, seaweed, sea cucumber, and ginger. Fijian coastal villages such as Kumi are characterized as closely-knit communities with strong traditional decision-making systems. For example, the traditional fishing boundaries designated to villages (the *qoliqoli* boundaries) are shared and followed amongst the clan members (Kitolelei et al., 2014). The tradition of "*solesolevaki*" is one such rule, implying the importance of working together as a group to achieve a given task for the community. The *tabu* tradition, in which fishing areas are closed for a certain period of time, is a tool that is still commonly practiced throughout Fijian communities (Johannes, 2002). Following such traditional rules and customs is constructive behavior in the communities, and breaking them can result in traditional punishment and social shaming. And while they are increasingly questioned and partly eroding (Vunisea, 2002), these strong and still widely-existing traditional institutions and rules remain one of the outstanding characteristics of Fijian community life.

Field Research Methods

This research focuses on perceptions of diverse stakeholders from within and outside Kumi village (see **Table 1**), who are collaborating in the coastal resource management of the village. Particular emphasis was placed on dynamically transforming perceptions among the villagers, who are the major actors and caretakers of these resources. The research used a

transdisciplinary approach, including participatory observations, and individual as well as group interviews, which were conducted on three visits to the village and to different stakeholders' offices between October 2013 and June 2014. Twenty three stakeholders from a wide array of groups including government officials, university scientists, an officer of a conservation NGO, and Kumi villagers, were selected (**Table 1**). The rationale behind the selection was that they were actively involved in collective actions to manage Kumi's coastal resources, and built trust with the authors to collaborate throughout the research process. We could identify only a limited number of women who were actively taking responsibilities in decision-making of these collective actions, resulting in male dominance among interviewees from Kumi village. The exceptions were two elderly women who were respected among stakeholders and playing leading roles in these actions. Care was also taken to secure diversity among interviewees to avoid research bias (e.g., when several interviewees would belong to one clan) and to be able to triangulate and analyze the complex processes and interlinkages of knowledge production, transformation of perceptions, and individual as well as collective actions. Individual and group interviews were structured into two sets: the first one targeting Kumi villagers regarding ongoing collective actions, and the second one targeting external stakeholders regarding the roles and functions of "knowledge translators." All interviews and participatory observations were conducted by the first author, a graduate student of Kagoshima University at the time of this study. The university did not have a formal evaluation

TABLE 1 | Number of villagers and other external stakeholders involved in this study.

Types of stakeholders		Number of organization	Number of interviewees	Men	Women
KUMI VILLAGERS (TOTAL)		N/A	15	13	2
Categories	Community leader		2	2	
	Youth leader		1	1	
	Elders		2	2	
	Leader of collective action		4	4	
	Active participants of collective action		3	2	1
	Women group leader		1		1
	Fishermen		1	1	
	Farmers		1	1	
EXTERNAL STAKEHOLDERS (TOTAL)		4	8	6	2
Categories	Government	2	2	2	
	The University of the South Pacific	1	5	3	2
	NGO	1	1	1	

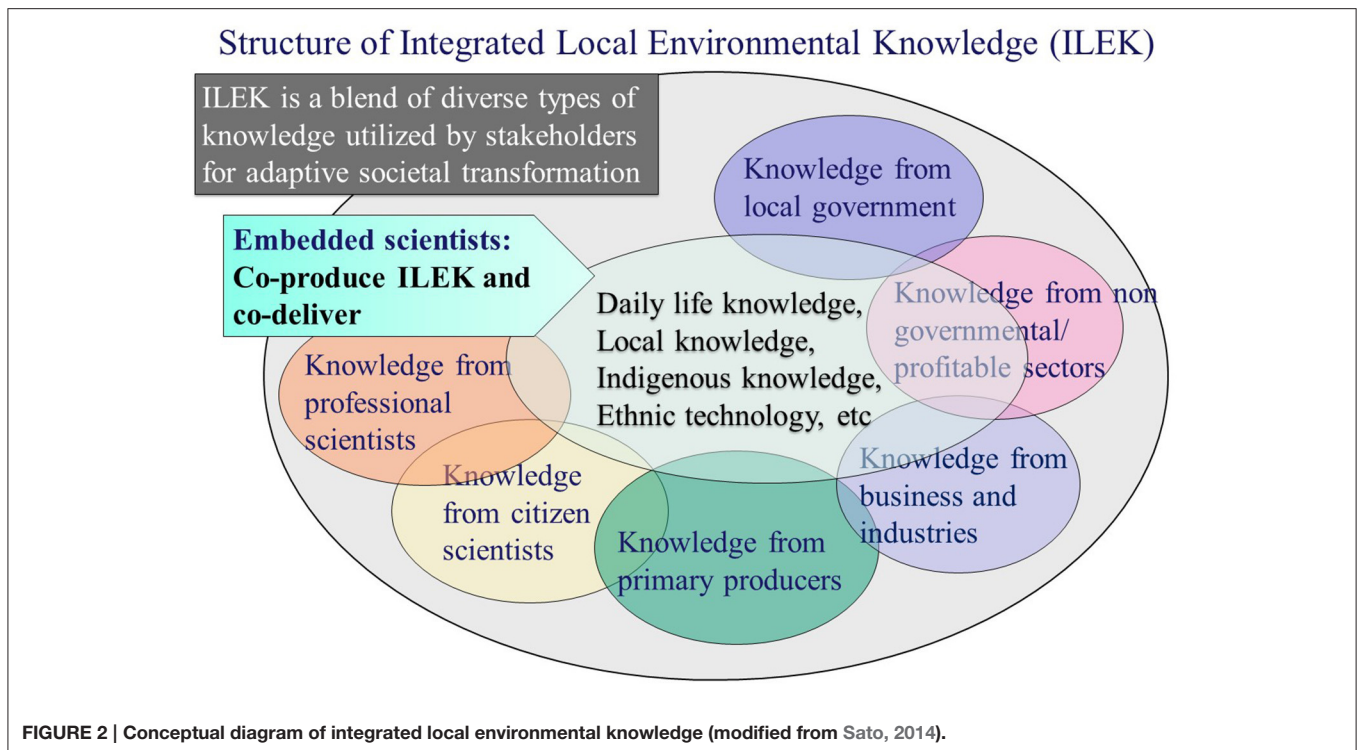
committee for the ethical considerations related to social science field studies, which is why we strictly followed the Code of Ethics of the International Sociological Association (Section 2 Data Gathering, see International Sociological Association, 2011), including security, anonymity and privacy of the stakeholders involved in our study, and prior informed consent.

Discourse analyses were conducted using a simplified form of qualitative sociological discourse analyses summarized by Ruiz (2009). The memos of interviews and group discussions as well as informally obtained narratives of these stakeholders in participatory observations were analyzed to extract their knowledge systems, perceptions and collective actions. In our preliminary field survey, we identified four ongoing collective actions in the village: a seaweed culture project, sea cucumber restoration, a ginger project, and the management of locally managed marine area (LLMA). Textual analyses were conducted with the accumulated discourses to extract sentences related to or containing words related to these collective actions. Contextual analyses were performed with these discourses to extract knowledge and perceptions behind these collective actions. In the analysis, knowledge was identified from discourses containing a set of information with regard to characteristics, status and modes of utilization of relevant coastal resources, and it was distinguished from those identifies as containing perceptions that represented the functional meanings of the available knowledge. The knowledge and perceptions thus extracted were then classified and mapped on the conceptual framework described below to visualize interlinkages between knowledge, perceptions and collective actions. All processes were interrelated so that, for example, the interpretations provided by categorization and mapping influenced the textual and contextual analyses. The processes were repeated until we reached an unambiguous interpretation as described in the results.

Analytical Framing of Knowledge, Perceptions, and Collective Actions

Over the years, various authors have documented diverse types of knowledge produced and shared in the Pacific Islands (Johannes, 1981; Thaman, 2002; Berkes, 2008; Campbell, 2009). The concept of integrated local environmental knowledge (ILEK) is introduced in this study as the key analytical element connecting knowledge, perception and collective action. The ILEK concept differs from previously introduced categories of local and empirical knowledge, such as traditional ecological knowledge (TEK; Berkes, 2008) or local ecological knowledge (LEK; Olsson and Folke, 2001), in its emphasis on dynamic and integrative views on knowledge (Sato, 2014). ILEK is generated by the interactions between diverse knowledge production processes in local communities, including scientific research, and integrates diverse types of knowledge produced and utilized by stakeholders (Figure 2). In this way, ILEK presents a range of solution-oriented knowledge systems in a transdisciplinary way, as it incorporates every relevant domain of science and technology as well as the empirical local knowledge and experiences required for the management of such complex social-ecological systems. ILEK is also characterized by its dynamic nature, constantly re-produced and transformed through interactions of the various involved stakeholders as knowledge producers. These stakeholders and “bilateral knowledge translators” play an important role in integrating and systematizing the diverse knowledge components that are used as bases for decision-making and collective actions. Such a dynamic and integrative view on knowledge with recognition of the diversities of knowledge producers and translators is essential in understanding its linkages with perceptions and collective actions in complex social-ecological systems.

The analyses on interlinkages between knowledge, perceptions and collective actions were made based on our own observations and referring to previously accumulated information on



diverse knowledge systems in Fijian communities (Sauni, 1999; Veitayaki, 2000; Lane, 2008; Govan, 2009; Teh et al., 2009) through the lens of ILEK. **Figure 3** shows the conceptual framework of analysis for this study regarding knowledge (components of ILEK), perceptions, and individual as well as collective actions modified from Gregory (1997). There are many types of knowledge being continuously produced that become part of the available ILEK for stakeholders, which dynamically influences people's perceptions. Transformation of perceptions in turn influences ILEK by stimulating hypothesis-generation and integration of new components of knowledge. Changes in a particular part of the perception systems influence behavioral patterns of each individual to create actions, which then sum up to collective actions to manage coastal resources and environments, especially when particular types of perceptions are shared among stakeholders. Individual and collective actions produce feedbacks to perceptions and knowledge by providing participants with opportunities of social learning. In other words, the perception arena in this framework is an agent connecting input (knowledge) and its outcome (actions). This analysis provided a set of snapshots of interlinkages between knowledge, perceptions and collective actions in the continuous processes of community-based coastal resource management, which extended beyond our study period. We aimed to extract important factors of collective actions by accumulating and analyzing these snapshots obtained in the limited study period.

This conceptual framework assumes that collective actions can serve as a platform for social learning processes of all participating stakeholders, including residential and visiting researchers, to transform their knowledge systems (ILEK)

and perceptions, thus resulting in adaptive improvements of the quality and impacts of actions. Transformed knowledge in this process may be disseminated to other villages in Fiji and potentially even beyond to be used for adaptive management of coastal resources in other regions. In this system, the transformation of perceptions by diverse stakeholders is assumed as a fundamental enabler of knowledge-based societal transformation toward sustainable futures of the coastal communities.

RESULTS

Diversities of Knowledge among Stakeholders

The knowledge production processes and characteristics of produced knowledge varied among stakeholders with different interests and prioritized values. **Table 2** represents diversities of prioritized values and framings of knowledge productions among major stakeholder groups working in Kumi village, extracted from the individual and group interviews. The gaps between the villagers and external stakeholder groups seem to be substantial, with little commonality and overlap expected for the knowledge produced from such framings and value systems. All these different knowledge components contribute to ILEK and are shared among villagers with different degrees of emphasis, which may result in individually isolated practices. Therefore, knowledge translation to extract and share new meanings of diverse knowledge sets is essential to create shared perceptions supporting collective actions.

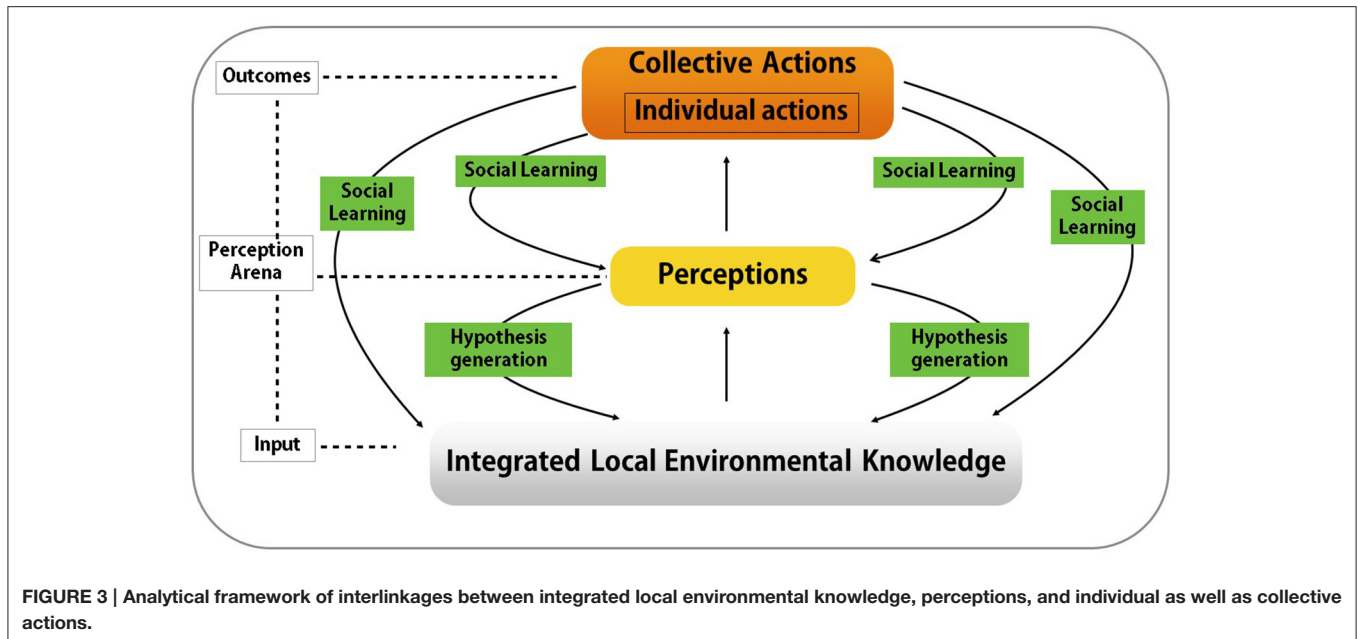


FIGURE 3 | Analytical framework of interlinkages between integrated local environmental knowledge, perceptions, and individual as well as collective actions.

TABLE 2 | Prioritized values and framing of knowledge productions among diverse stakeholder groups working in Kumi village.

	Kumi villagers	Government officials	NGO	The University of the South Pacific scientists
Prioritized values	Improve livelihood and well-being	Policy development and implementation	Contribute to conservation and community development	Research and education
Framing of knowledge production	Utilize locally managed marine areas and other external projects for community development Management and restoration of fisheries resources Maintaining local culture and traditions	Sustainable management of coastal resources Promoting environmental conservation Ensuring food security	Conservation and sustainable management of coastal resources Promoting human health and wellbeing Improving own profile	Environmental sustainability Conservation of nature and ecosystem services Influencing national and international policies

In Fiji in general and also in Kumi village, sharing of knowledge among villagers is promoted through collaboration in activities such as fishing, farming, art and crafts, small-scale businesses and community functions. Fourteen among 15 interviewees in Kumi village stated that knowledge components created from community activities were shared in village meetings (5 interviewees) and through general customs and traditions of sharing knowledge (5), while others generally stated that it was shared (4). Younger generations were also mentioned to have an opportunity to share knowledge (1). A common practice in Fiji is producing and circulating knowledge during social functions where community members congregate during *kava* drinking sessions. During these events, local knowledge and experiences on coastal resources and their management are shared among members through informal conversation, and the members gain access to new knowledge sets when available. These social functions are basically open for the external stakeholders and therefore provide opportunities of

interactions between different knowledge systems. Another common knowledge sharing process observed in this study was based on the communal way of life. Most houses are built at close proximity in the village and people are living in a closely-knit community resulting in information being easily spread from one household to the other. The term “coconut wireless” is given to this spreading of knowledge without any formal form of information-sharing. Various knowledge and skills derived from external stakeholders, including scientists, seemed to spread into the village through such processes, with translation of their meanings to fit to the villagers’ context. On the other hand, opportunities for external stakeholders to learn and digest villagers’ knowledge sets and perceptions seemed to be relatively limited except for the channels of *kava* ceremonies, resulting in mismatches between external interventions and villagers’ perspectives and motivations. In this study, we found various types of knowledge translators contributing to mitigate these challenges, which will be described below.

Interlinkages between Integrated Local Environmental Knowledge, Perceptions, and Collective Actions

Figure 4 represents a snapshot of interlinkages between particular knowledge sets in ILEK, components of related perception systems, and relevant specific collective actions taken by the villagers during the study period. Through the discourse analyses, we identified seven categories of major knowledge sets, which were related to sea cucumber restoration, seaweed aquaculture, agriculture practices, and traditional resource management systems. These knowledge sets were classified into the basic knowledge often provided by external stakeholders such as government agencies and scientists (black), transformed knowledge sets translated from the basic knowledge by interactions among different stakeholders (blue), and traditional and empirical knowledge underlining almost all decision-making practices (green). Fourteen, seven and 11 villagers respectively referred to these three types of knowledge. Nine villagers mentioned that knowledge created and visualized shareable value in the community (indicating transformation of perceptions), and 13 stated that the knowledge motivated people to manage resources (mobilizing collective actions).

These knowledge sets seemed to influence villagers' perceptions on the effectiveness of new and traditional resource management systems and techniques, the economic as well as other benefits related to resource management and their livelihoods, and on the potentials of knowledge-based consensus-building practices in the village. This transformation of perceptions in turn produced a series of collective actions. For example, influx of knowledge and changes of perceptions related to the effectiveness of new techniques of sea cucumber restoration and its potential economic benefits resulted in collective actions to restore sea cucumber resources in 2012. Knowledge related to seaweed aquaculture influenced perceptions on effective techniques and marketability, resulting in the implementation of a seaweed project in 2013. Various knowledge sets on farming techniques visualized the plausibility of producing new profitable products, and influenced the local perceptions on marketability of agricultural products, bringing about the implementation of a ginger project in 2013.

On the other hand, we could not identify direct influences of particular knowledge sets on perceptions regarding implementation of the locally managed marine area (LMMA) in this study except for the indirect effects of knowledge and perceptions on traditional resource management systems and local leadership, which might be the prerequisites for the implementation of LMMA. This observation seemed to be reflected by the relatively longer time period after the initial launch of the LMMA in this village in 2007. The collective actions to manage the LMMA have been performed continuously to reach the stage maturity and stability of the management practices in this study period. Perceptions on the benefit of having a LMMA and its effective management systems might be less pronounced because they have already been shared and well-established among villagers.

Social Learning and Hypothesis Generating Processes

The original ideas and basic knowledge and skills for sea cucumber restoration and seaweed aquaculture were brought into Kumi village by Ministry of Fisheries and ginger farming by Ministry of Agriculture, while the LMMA system was disseminated by The University of the South Pacific scientists based on successful cases in other villages. However, these knowledge components and associated perceptions have been dynamically translated to allow new meanings through social learning in the processes of designing and conducting collective actions (**Figure 4**). Collective actions on sea cucumber restoration and seaweed aquaculture quickly transformed perceptions among participating community members on the effectiveness of materials and techniques of culture and restoration provided by the government agencies. People seemed to generate new perceptions on the value of more convenient, affordable and sustainable local materials for these practices, started testing these local materials based on the newly generated hypothesis, and brought about transformation of the knowledge system through social learning. Sea cucumber restoration also went through social learning processes regarding effective breeding of the species in small fenced enclosures in shallow waters. Villagers learned through their practices that sea cucumbers tended to congregate around the enclosure fence when sea cucumbers density in the enclosure was high. The knowledge derived from this observation transformed their perception on effective restoration techniques, generated a new hypothesis on density effects of sea cucumbers in the enclosure, and transformed their practices to induce possible spillover effects by breeding in the enclosure. On land, implementation of ginger planting supported by the government transformed their land use pattern for farming through learning by practice to utilize slopes on hills for ginger production, which had not been used for other crops so far. This collective action transformed their perceptions on improving livelihood and wellbeing by growing additional marketable products and produced new knowledge sets related to agriculture practices.

The first LMMA in Kumi village was established to manage *Anadara* clams for the period from 2007 to 2009, and the success of this practice transformed perceptions of villagers with regard to potential impacts of LMMA upon their livelihood, wellbeing and sustainability of resources. Based on collaborations with The University of the South Pacific scientists, villagers also seemed to transform their perceptions on the values and impacts of their own management practices. This transformation of perceptions probably produced a new set of hypotheses regarding appropriate locations for LMMA setting and effects of shifting LMMA sites. The villagers had successively established and managed LMMAs from 2009 to 2011 and 2011 to 2016, but they had changed the LMMA site every time in between. This decision of selection and relocation of LMMA sites by villagers may be brought about by the transformed knowledge sets regarding appropriate environmental conditions of *Anadara* clam production, and impacts of shifting the LMMA location to improve environmental conditions. In all these

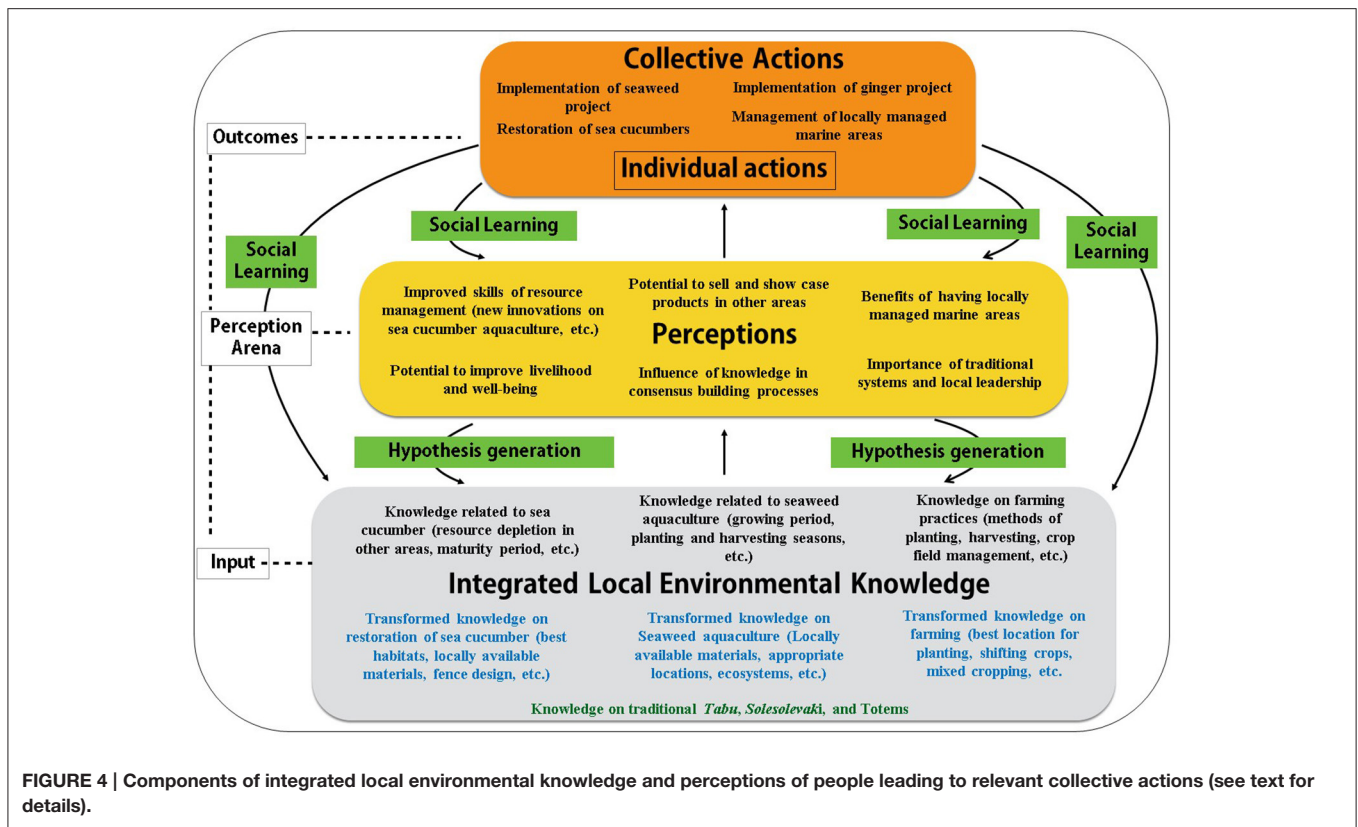


FIGURE 4 | Components of integrated local environmental knowledge and perceptions of people leading to relevant collective actions (see text for details).

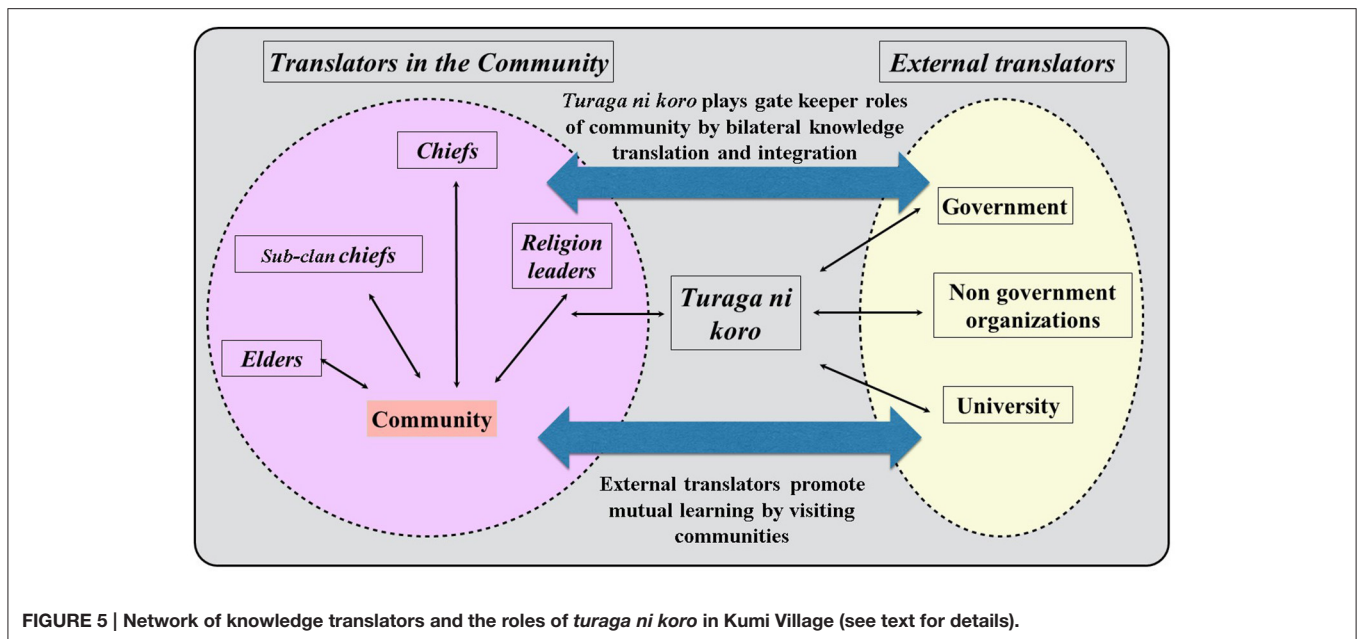
examples, collective actions provided a platform of social learning among participants to transform their perceptions and generate new hypotheses with regard to the resources and their own management practices, producing new knowledge sets within their ILEK.

Bilateral Knowledge Translators in the Community

The dynamic transformations of ILEK and perceptions among villagers have been shared with other external stakeholders (i.e., knowledge producers) in various ways. Officials of the Ministry of Fisheries were frequently observed to visit Kumi to monitor the outcomes of the sea cucumber and seaweed projects. They collected data on the growth and quality of the products and observed locally-shaped restoration and aquaculture techniques, which were already disseminated to other villages. At the same time, they contributed new knowledge on technical developments in other villages to be shared with Kumi villagers. In the case of the LMMA, The University of the South Pacific scientists (including the lead author) played similar roles to promote knowledge circulation among villages that take collective action to establish and manage LMMAs. One community member of Kumi working in a company outside the village had also disseminated the success stories of LMMA in Kumi to other villages. All of these knowledge producers in and outside of the village can be regarded as “knowledge translators” (Crosby, 1997). In this study, they mobilized bilateral knowledge circulation by visualizing new meanings of locally developed

knowledge and skills, to be shared with government, scientists and other communities in the area.

Among these knowledge translators, all external stakeholders interviewed in this study recognized that the *turaga ni koro* played a significant role for Kumi as a link between the community and external translators (see Biturogoiwasa, 2001). The *turaga ni koro* is the headman of a Fijian village, chosen by the villagers and endorsed by the provincial government. He advises the traditional chief and other decision makers within the village regarding interventions from the external world. At the same time, we found that the *turaga ni koro* in Kumi advised external stakeholders including government agencies, NGO and university scientists with regard to conditions and needs of the village in general, especially with regard to resource managements (Figure 5). The village chief, elders, sub-clan chiefs, and religious leaders occasionally played a role of knowledge translators by traveling out of the community and attending meetings or visiting other communities within the province or region. By observing and learning from the marine resource management practices in other areas, they also shared their knowledge and influenced perceptions of the members of their own community. In addition, external translators from government, NGOs and The University of the South Pacific also directly visited the village to convey scientific knowledge. In all these processes, the *turaga ni koro* played a significant role as the gatekeeper of the community by controlling and promoting interactions between different knowledge systems and perceptions of diverse stakeholders, both within and outside of



the village. He organized *kava* ceremonies in his house with the external stakeholders when they visited the village to promote knowledge exchange with the leader and decision-makers of the community. He guided these people around the village for interaction with other community members. Through these gatekeeping activities, the *turaga ni koro* seemed to translate the knowledge from both sides through the filters of his own perceptions, and blend external and local knowledge and skills to transform ILEK.

Perceptions Rooted in Traditional Institutions

In Kumi village, we found *tabus* in fishing practices, the sharing concept *solesolevaki*, clan totems, and traditional leadership as the fundamental institutions and decision-making systems of the community and its ILEK (Figure 4). Perceptions regarding the importance of these traditional aspects promoted collective actions based on consensus and collaboration among community members.

A previous record found that the *tabu* tradition had been practiced in areas of Kumi fishing boundaries (Tawake et al., 2001). In this study, we found that knowledge on the *tabu* tradition was shared among Kumi villagers, and perceptions on its importance for the community served as the bases for collective actions of fisheries resource management (including the LMMA and sea cucumber restoration). The tradition of “*solesolevaki*” was shared and regularly practiced among Kumi villagers, including collective actions identified in this study. This practice seemed to provide behavioral foundations to integrate individual actions among different gender and age groups, to share responsibilities and collaborate in various labor-intensive community tasks. All interviewees in Kumi recognized that these collective actions were the result of community customs in the village. It was also likely that the cohesion among villagers to

perform *solesolevaki* provided a platform for mutual support systems among group members, and mitigated potential conflicts of interest among participants of collective actions. The totem and related traditional knowledge on ecology and harvesting of the *Anadara* clams influenced the perceptions among Kumi villagers on the importance of managing the habitats of this important resource. This perception deeply rooted to their traditional culture provided a foundation to promote collective actions regarding the LMMA as well as the seaweed aquaculture on the mudflats, both of which were expected to contribute to improving the clam habitats.

All traditional institutions and rules mentioned above were supported by the traditional village chief, elders, sub-clan chiefs and religion leaders and other important actors involved in decision-making on community level (Figure 4). The clan systems, centered around leadership of the chiefs with various traditional institutions and rules (such as *tabus*, *solesolevaki*, and totems), have been the oldest and most long-enduring institutions in Fiji, formed much before other institutions were brought into the communities by the colonial and current governments. We witnessed that these ancient institutions were still functioning well in Kumi village to date, to promote sharing of responsibility and collaboration among community members.

DISCUSSION

In this study, we found that dynamic production and circulation of ILEK contributed to transformations of perceptions regarding the status and values of coastal resources, the importance of locally developed techniques for resource restoration and management, the impacts of such new techniques on improving livelihood and well-being, and the significance of traditional institutions in achieving effective implementation of resource

management projects. However, we also found that each component of knowledge in the ILEK such as knowledge on sea cucumber restorations or seaweed aquaculture did not directly correspond to particular sets of perceptions. Rather, the linkages between knowledge and perceptions seemed to be complicated in a way that each knowledge component influenced diverse sets of perceptions through different pathways of knowledge translations and meaning making. The resulting transformation of perceptions generated new hypotheses related to knowledge components which were often different from the original components. Our findings strongly suggest the importance of a complex systems approach to understand the interlinkages of knowledge and perceptions facilitated by knowledge translation and feedbacks through social learning and hypotheses generation.

The transformation of perceptions had significant impacts on promoting various collective actions in this case study, supporting our initial theory of their fundamental function as an enabler of collective actions. However, ILEK and its constituent knowledge sets do not always produce collective actions toward sustainable directions. Collective actions are often influenced by the prioritized values among stakeholders and prospects of tangible outcomes of the actions. Previous case studies in communities of developing countries even showed mismatches between knowledge of stakeholders and actions taken that led local communities away from conservation practices (Bennett and Dearden, 2014). However, we found in this study that various knowledge sets introduced by external translators and digested by villagers via their own “knowledge translators” had transformed their perceptions to incorporate important aspects including more sustainable management techniques, and potentials to improve local livelihoods and well-being. The *turaga ni koro*, knowledge translator and gatekeeper of the village, seemed to play an essential role in this process. The *turaga ni koro* in Kumi village was likely to function as a residential researcher (i.e., knowledge producer) in the community as he integrated various types of knowledge to visualize resource values, effectiveness of techniques, and visions of management outcomes. Detailed comparative analyses of various types of knowledge producers and translators are needed to elucidate their core functions to transform perceptions to produce collective actions toward more effective coastal management measures.

Collective actions among diverse stakeholders are essential for the success of community-based management of coastal resources, especially common property resources including forestry and fisheries (Cox et al., 2010; Ratner et al., 2013). Collective actions are promoted by perceptions among involved stakeholders and underlying knowledge systems, while participating in collective actions again influences perceptions and knowledge systems of the participants through social learning processes (Shackleton et al., 2009). This interactive process is assumed to promote dynamic and adaptive transformations of local institutions by the relevant stakeholders to cope with complexities associated with coastal marine resource management. Collective actions observed in this study provided ample opportunities of social learning for both villagers and external stakeholders, including government officials and

scientists, even though there were significant differences in prioritized values and the framing of knowledge. Collective actions apparently strengthened the perceptions of diverse stakeholders on the values of community practices and improved the local approaches to sustainable resource management. Continuous interaction between The University of the South Pacific scientists and villagers in the case of locally managed marine area was an essential factor to mobilize social learning processes of all parties involved. Monitoring activities by the Ministry of Fisheries and Agriculture officials were effective to promote social learning between these officials and members of the different communities they collaborated with. Understanding the functions of formal and informal mechanisms of knowledge translation, such as continuous networking and interaction of involved stakeholder groups, seems to be indispensable to support social learning.

This study clearly showed the persisting importance of traditional institutions, rules and decision-making systems for producing collective actions that contribute to the sustainable management of coastal resources in Kumi village. The *tabu* traditions, *solesolevaki* practices, and the clan totems played indispensable functions to create respect for community decisions, unified actions toward common goals, and platforms for introducing sustainable management practices. These institutions were implemented and utilized in a consistent way under the strong leadership by the traditional chief of the village. Such strong traditional institutions and leadership foundation may be regarded as having limited potential to apply to societies in other parts of the world. However, if we take a closer look at the mechanisms that support these institutions, we can identify the fundamental parts played by shared respect of local rules and community decisions (*tabu*), recognition of importance of working together for common goals (*solesolevaki*), and understanding of linkages between cultural values and sustainable use of natural resources (totems). Societal mechanisms to maintain trusted leaderships were another fundamental factor to provide platforms for various collective actions in the community. All of these factors may in fact have a universal value, as important components of perceptions among community members toward their own community environments (natural, social, and cultural) and their own collaborative practices. The processes toward the creation of ILEK to enable the transformation of local perceptions incorporating these universal values, are essential to manage coastal common property resources, and are of interest to resource management researchers and practitioners in Fiji and beyond.

This case study was conducted in a small coastal village with a relatively small sample size and gender imbalance as outlined above. The study period was limited to provide snapshots of a long and continuous process of resource management and community development practices in the village. Even though the research design had such drawbacks, it could reveal essential enablers of transformation of perceptions to promote various collective actions. In-depth interviews clearly focusing on specific collective actions combined with the qualitative analyses to extract knowledge and perceptions related to these

ongoing actions seemed to be an appropriate approach to bring about core findings of this study that suggested broader applicability in research of coastal resource management. A more comprehensive research design to obtain more detailed discourses from a larger and balanced sample are expected to verify the effectiveness and limitations of the qualitative discourse analyses. Furthermore, an in-depth analysis of the inequality/gender imbalance in decision-making would be required to provide a better understanding of the power of transforming perceptions and their relationship to collective actions.

CONCLUSION

In conclusion, a dynamic production and circulation of ILEK in Kumi village contributed to the transformation of perceptions, promoting a series of collective actions for the sustainable management of the local coastal resources (marine and terrestrial). These collective actions provided ample opportunities of social learning for both villagers and external stakeholders, transforming their ILEK to generate new hypotheses and in turn influence their perceptions. Traditional institutions, rules and decision-making systems played essential roles in producing collective actions contributing to the sustainable management of various coastal resources, and these collective actions transformed and strengthened local perceptions on the universal values of traditional systems for their community. These observations were in good accordance with Ostrom's eight principles for managing common pool resources (Ostrom, 1990). The collective actions had a well-defined boundary and reflected both local needs and social-ecological conditions. The rules and procedures of the actions were discussed and agreed among local stakeholders, and external stakeholders respected these decisions and drew lessons from them. The traditional rules and decision-making systems in place in Kumi village seemed to work well for preventing rule violation and solving conflicts. Probably the important remaining

challenge is the sharing of responsibilities for sustainable coastal resource management with actors from a broader context, connected to both coastal resources and local livelihoods, such as seaweed and sea cucumber middlemen and traders, exporters of agricultural products, as well as policy makers and development agencies at national and international levels. To tackle this challenge, knowledge translators such as the ones identified in this study may play a significant role to promote collaborative interactions between the coastal communities and potential external stakeholders through knowledge integration and transformation of perceptions.

AUTHOR CONTRIBUTIONS

JK conducted all field research, wrote initial manuscript of the paper, and contributed to finalizing revised manuscript. TS provided theoretical background, analytical framework and conducted analyses of the data, and participated in field research. TS and JK jointly made blurb of the manuscript.

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