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The challenges of maintaining indigenous ecological knowledge

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ABSTRACT. Increased interest in indigenous ecological knowledge (IEK) has led to concern that it is vulnerable amidst social and ecological change. In response, multiple authors have recommended the establishment of programs for the maintenance and revitalization of IEK systems. However, few studies have analyzed the methods, opportunities, and challenges of these programs. This is a critical gap, as IEK maintenance is challenging and will require layered and evidence-based solutions. We seek to build a foundation for future approaches to IEK maintenance. First, we present a systematic literature review of IEK maintenance programs ($n = 39$) and discuss the opportunities and challenges inherent in five broad groups of published approaches. Second, we use two case studies from the Republic of Vanuatu to illustrate these challenges in more depth. The first case study takes a community-based approach, which has inherent strengths (e.g., localized organization). It has, however, faced practical (e.g., funding) and epistemological (changing modes of knowledge transmission) challenges. The second case study seeks to facilitate IEK transmission within the formal school system. Although this model has potential, it has faced significant challenges (e.g., lack of institutional linkages). We conclude that supporting and strengthening IEK is important but that serious attention is needed to account for the social, situated, and dynamic nature of IEK. In closing, we use the review and case studies to propose four principles that may guide adaptive and flexible approaches for the future maintenance of IEK systems.

Key Words: *cultural revitalization; indigenous ecological knowledge; Malekula; traditional ecological knowledge; Vanuatu*

INTRODUCTION

A wealth of evidence indicates the need for diverse solutions to challenges in social-ecological systems (Ostrom et al. 2007). Indigenous ecological knowledge (IEK) represents a key source of ideas because it is grounded in diverse and creative understandings of local environments (Berkes 2012). Not only does IEK represent detailed ecological information (e.g., Johannes 1998a, 1998b), but it also underpins management strategies (e.g., Fernandez-Gimenez 2000) and fosters adaptive capacity to environmental variability (McIntosh et al. 2000). Perhaps most importantly, active support for IEK systems can be a vehicle for shaping just, people-centered resource governance approaches (Ross et al. 2011).

There is, however, mounting evidence that IEK is at risk (reviewed in Zent and Maffi 2009). All aspects of culture are dynamic (Gómez-Baggethun and Reyes-García 2013) and components of IEK do persist over time (Zarger and Stepp 2004), but as globalization continues apace, the transmission of IEK is increasingly threatened. This is corroborated by an established body of quantitative evidence showing the degradation of IEK (e.g., Benz et al. 2000, Brosi et al. 2007), as well other indicators, such as the parlous state of the world's vernacular languages (Moseley 2010). The degradation of IEK is a critical concern given that IEK is the foundation for local management strategies across large parts of the planet and shapes both local livelihoods and the trajectory of local biodiversity (e.g., Pungetti et al. 2012).

In response, there has been a groundswell of calls for the maintenance and revitalization of IEK systems (e.g., Harmon 2002, Maffi 2002, Harrison 2007). Such calls have come from academia (e.g., Zent 1999), conservation practitioners (e.g., Ford and Martinez 2000), indigenous groups (e.g., Maffi and Woodley 2010), and intergovernmental agreements (e.g., the UN Declaration on the Rights of Indigenous Peoples, Articles 11 and 31). Discussion and action on IEK maintenance has paralleled

developments in other fields (e.g., linguistics, education, and development studies) that have focused on support of cultural diversity (e.g., Florey 2009). However, unlike in other fields, there has been little theoretical and practical development of methods, best practices, and constraints of IEK maintenance. This is a critical gap, as the maintenance of IEK systems is rife with theoretical and practical challenges.

We begin to address this literature gap and provide a foundation for future approaches to IEK maintenance. Our analysis is organized into three sections. First, we present a systematic review of published studies of IEK maintenance ($n = 39$), and discuss the approaches used and challenges faced during these projects. Second, we demonstrate the practical challenges of IEK maintenance with two case studies from the Republic of Vanuatu. We close by suggesting four principles that will help guide IEK maintenance projects in the future.

STRATEGIES FOR THE MAINTENANCE OF INDIGENOUS ECOLOGICAL KNOWLEDGE (IEK)

What is IEK maintenance?

We treat IEK as largely synonymous with related terms (e.g., traditional ecological knowledge), and define it as “a cumulative body of knowledge, belief and practice, evolving by adaptive processes and handed down through generations by cultural transmission” (Berkes 2012:7). We prefer the term “indigenous” over “traditional” because it better represents the dynamic and fluid nature of IEK. We recognize, however, that all definitions in the field are contentious: for instance, important environmental knowledge is held by nonindigenous groups (Nadasdy 1999).

Following this, we define IEK maintenance as “practical efforts designed to ensure the continuation of, or a revival in, the application and transmission of IEK.” This definition is broad and is meant to encompass the variety of approaches in use, which span from large government-sponsored programs to small

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Table 1. Summary of studies included in review of indigenous ecological knowledge (IEK) maintenance approaches.

Approach to IEK maintenance	Domains of IEK targeted	Scale	Challenges	Exemplar reference
Securing intellectual property	Knowledge [†]	National	Commensurability of intellectual property and IEK	Tobin (2001)
Databases	Knowledge	Local to international	Dynamism of knowledge; control over indigenous knowledge	Agrawal (2002)
Formal education	Knowledge, practice	National	Modes of knowledge transmission	Kimmerer (2002)
Biocultural conservation	Knowledge, practice, worldview	Local, regional	Balancing multiple objectives	Maffi and Woodley (2010)
Community-based IEK maintenance	Knowledge, practice, worldview	Local	Scalability; lack of resources	Bates (2009)

[†] Recent legal instruments also seek to protect Traditional Cultural Expressions and Intangible Cultural Heritage.

Although some databases seek to record practice (e.g., United Nations Framework Convention on Climate Change), they are not inherently linked to the practice of knowledge in everyday life.

community-based efforts. Our use of the term “maintenance” is not meant to infer the preservation of a static body of knowledge because IEK systems are dynamic. Other authors have used other terms with broadly the same meaning (e.g., IEK conservation, IEK revitalization). We interpret these to be subsets of, or synonymous with, IEK maintenance.

IEK maintenance approaches

We systematically reviewed published case studies of IEK maintenance within the scientific literature using keyword searches in Google Scholar and Web of Science. Following the definitions presented above (see *What is IEK maintenance?*), we used combinations of “maintenance/conservation/revitalization of indigenous/traditional knowledge” (total of six searches in each database, returning 719 results). We included in our analysis only studies that were case studies of direct and explicit approaches to IEK maintenance, and where possible, restricted our sample to publications in peer-reviewed journals. This was aimed at assuring the rigor of our sample; however, we included a limited number of books (e.g., Maffi and Woodley 2010), book sections (e.g., Zent 1999), and electronic resources (e.g., TKDL 2013) where no peer-reviewed case studies of particular IEK maintenance approaches existed. We also included the limited set of commentaries on IEK maintenance (e.g., Agrawal 1995, 2002, Bates 2009). The final sample consisted of 39 studies (Table 1).

We recognize that our sample may have certain biases (e.g., toward case studies published in English) and may not capture all the work that has been done on the topic (e.g., publications in grey literature). The sample does, however, provide an indicative survey of the types of approaches to IEK maintenance that have been attempted thus far, and a structure for discussion of their relative strengths and weaknesses.

In general, approaches to IEK maintenance have been located at a number of scales, have targeted different aspects of IEK, and have a number of inherent challenges. We briefly describe each approach in turn. We note that these approaches to IEK maintenance are not exclusive or bounded—for example, formal education may also include aspects of database or community-based solutions.

Securing intellectual property

Securing intellectual property (IP) was the most widely documented approach for IEK maintenance (e.g., Nordin et al. 2012). This approach has been the subject of extensive commentary in recent years, as scholars have sought to develop legal protections for holders of the IP of IEK (Ramcharan 2013). This has largely been through seeking to create *sui generis* (custom-built) legislation, which can seek to grant perpetual and inalienable rights over IEK to knowledge holders (Forsyth 2013). In many cases, such efforts have been targeted at national (e.g., Tobin 2001) or regional (e.g., SPC 2002) scales, and have sought to protect specific domains of knowledge that are considered to be at risk of exploitation (e.g., ethnomedical knowledge). Recent efforts have been targeted at protecting wider dimensions of IEK by protecting intangible cultural heritage (Forsyth 2013). In general, such efforts are underpinned by an established body of international agreements (e.g., the Convention on Biological Diversity) and legislation (Jonas et al. 2013).

There are, however, numerous challenges in codifying IP for IEK systems (Tobin 2001). For one, legislative solutions typically compartmentalize aspects of IEK (e.g., medicinal knowledge and agroforestry techniques), which does not reflect the fact that such knowledge is inseparable from practice and belief (Jonas et al. 2010). For another, IEK is usually communally held, whereas legislative IP protection typically seeks to assign property rights to individuals (Agrawal and Gibson 1999). Moreover, legislative protections may contradict customary management laws, and there is doubt that such programs can address the root causes of IEK degradation (Ogummanam 2004). As such, it seems unlikely that IP legislation alone will be able to effectively maintain IEK systems.

Databases

Another group of approaches has sought to create databases of IEK. Such databases have become increasingly common as organizations seek to harness technological innovation to address IEK loss (Rahmann 2000, Agrawal 2002). Databases have been used at several scales and with a variety of aims. At international and national levels, databases have often been underpinned by economic motives, seeking to preserve and use IEK (in particular,

ethnomedical knowledge) in order to drive novel business ideas (e.g., the Indian Traditional Knowledge Digital Library [TKDL 2013]). Other databases at this scale aim to assist in resource governance by documenting and distributing IEK (e.g., UNFCCC 2013). For example, the People's Biodiversity Register in India had some success in documenting IEK, and hopes to provide a platform for the mobilization of indigenous knowledge for conservation (Gadgil et al. 2000).

Databases for IEK maintenance have also been deployed at local and regional scales. In a long-running program at Marovo Lagoon in the Solomon Islands, researchers have used widespread wireless broadband Internet and cheap laptops to create a locally run Wikipedia-style encyclopedia of IEK (Hae Rokona 2013). Community members have been trained in updating and checking the database, with the aim of facilitating local control over online resources. In another example, the Vanuatu Cultural Center maintains a database of IEK, and has trained a network of volunteer indigenous anthropologists ("fieldworkers") to collect and document knowledge (Tryon 1999).

The size and accessibility of databases mean that they may be powerful tools for IEK maintenance. However, scholars have raised concerns over their use (Agrawal 2002). For instance, removing IEK from its practical and situated context can distort knowledge (Zent 1999) and can negate the dynamic and fluid nature of ethnobiological knowledge (Agrawal 2002). Moreover, such approaches raise questions about IP and access to knowledge, and can lead to the appropriation and exclusion of IEK from source communities (Agrawal 1995). Technological innovations (e.g., the storage and dissemination of IEK in CDs and books) may also misunderstand the nature of knowledge transmission in IEK systems (Bates 2009).

Formal education

National formal educational programs have also been proposed as a mechanism for the maintenance of IEK systems (e.g., Aikenhead and Ogawa 2007). This has largely been achieved by introducing IEK and vernacular languages into education curricula, either within existing units such as science (e.g., Kimmerer 2002) or in novel programs for local involvement in school (e.g., Klein 2011). Case studies indicate a number of potential opportunities in this approach to IEK maintenance. For one, the infrastructure of formal education systems is usually large and designed to reach all school age pupils, making it a powerful tool (Snively and Corsiglia 2001). Moreover, the formal education systems can become de facto "arbiters of truth" within society, meaning that the inclusion of IEK in schools can raise the prestige and perceived validity of local knowledge (Van Eijck and Roth 2007). The integration of IEK in formal education may also facilitate new structures for IEK transmission where older social networks are no longer functional (Batibo 2009).

Integration of IEK in formal schooling can also have a positive impact on educational outcomes by contextualizing curricular content (Castagno and Brayboy 2008, see examples in Ruiz-Mallen et al. 2010, Bains and Zarger 2012, Hamlin 2013). Moves to increase the practice of IEK in school can reconnect students with the surrounding environment (Bates 2009) and may be a means of countering the "acquisition deprivation" that is thought to result from removing students from the traditional learning context (Hunn 2002). Moreover, such moves may be able to

mitigate the negative impact that formal education can have on systems of IEK (Simpson 2004).

Proposals for the integration of IEK in formal school curricula are, however, controversial (e.g., Warner 1999). Some have noted that such moves risk impacting IEK systems by forcing a change in the nature of IEK transmission (McCarter and Gavin 2011). Others have observed that including IEK in formal education runs the risk of replacing "one form of colonial mindset with another" by oversimplifying the dynamic nature of culture (Burnett 2007). Moreover, such moves may do little to address the underlying power imbalances that can drive discrimination against local and indigenous knowledge in the first place (Sundar 2002).

Biocultural conservation

An emerging area of scholarship—biocultural conservation—emphasizes the benefits of linking biological and cultural conservation approaches. This is premised on the observation that addressing the shared drivers of biological and cultural change can be an efficient and effective use of limited conservation resources (Maffi and Woodley 2010, see also Gorenflo et al. 2012). In a recent volume, Maffi and Woodley (2010) describe a number of biocultural conservation case studies that have the potential to maintain IEK, for example by maximizing indigenous self-determination or securing land title based on IEK of land and resources (e.g., studies by Dessisa, Barnard and DeMarco in Maffi and Woodley 2010).

While linked biological and cultural approaches to conservation do have the potential to maintain systems of IEK, there is much we do not know about how such programs might work. For one, drivers of cultural and biological change, while closely linked at some scales, may differ at finer resolutions. Moreover, it is not assured that any single program could effectively address complex challenges in social-ecological systems (Brosius and Hitchner 2010). Similarly, biocultural conservation approaches will need to explicitly address the multiple objectives inherent in the concept and design effective mechanisms for weighing the tradeoffs between objectives (Berkes 2007).

Community-based IEK maintenance

Finally, a number of scholars have recommended community-based maintenance (also termed in situ maintenance) of IEK systems (e.g., Agrawal 1995, Brodt 2001, Simpson 2004, Bates 2009, Singh et al. 2010). Broadly, such programs seek to promote the transmission of IEK within communities, and emphasize that the potential role of outsiders in the maintenance of IEK is likely to be small (Brodt 2001). Community-based approaches for IEK maintenance have taken a number of forms, such as attempting to reconnect knowledge holders with younger generations (Plotkin 1993); seeking to increase experiential learning and connection with the land and resources (Bates 2009); or revitalization projects that are based in subjects of local importance (e.g., traditional food knowledge [Pilgrim et al. 2009]). Community-based approaches typically use locally appropriate methods for knowledge transmission, and may be well placed to ensure that power and control over IEK remains with knowledge holders. Most importantly, they may ensure that IEK is maintained inside a relevant cultural context.

However, there is much we do not know about community-based approaches to IEK maintenance. Notably, the need for locally

appropriate methods for knowledge transmission means that such projects have limited scalability (i.e., it is unlikely that methods used in one location will be relevant in another); therefore, we know little about the factors that may help or hinder community-based IEK maintenance (McCarter and Gavin 2014b). Moreover, although the locally situated design of such projects is critical, access to funding and resources (which can often be obtained only by national and international organizations such as universities) is likely to be limited. Finally, “communities” are not homogenous entities, meaning that question of power dynamics (e.g., whose knowledge gets taught, by who?) are also important to this approach to IEK maintenance (Agrawal and Gibson 1999).

Summary: Challenges for IEK maintenance

This review has briefly described five approaches to IEK maintenance. While there are several opportunities inherent in these approaches, this literature indicates the presence of multiple cross-cutting challenges. For one, the “maintenance” of dynamic IEK systems is problematic, and programs must avoid stifling the innovation and change that characterize healthy systems of knowledge (Gómez-Baggethun and Reyes-García 2013). Moreover, IEK is a complex body in which knowledge is intrinsically linked to practice, institutions, and belief (Berkes 2012). Empirical information cannot be separated from its cultural context, and the political and social setting in which knowledge is taught can fundamentally alter the meaning of IEK. Therefore, the maintenance of IEK is intrinsically linked with the distribution of power and self-determination of knowledge holders. For this reason, IEK maintenance is likely to be best served by community-based or in situ maintenance approaches.

These issues indicate that the maintenance of IEK is a complex problem, which will require nuanced and multilevel responses. The difficulty of this task emphasizes the need for a bank of case studies and robust discussion around the opportunities and constraints of different modes of IEK maintenance.

With this in mind, we describe case studies of two approaches from the Republic of Vanuatu. These studies demonstrate the complexity of IEK maintenance in real-world situations, and illustrate the interactive and complex nature of the challenges we have noted. Following the case studies, we discuss lessons learned and outline a set of four principles for future approaches to IEK maintenance.

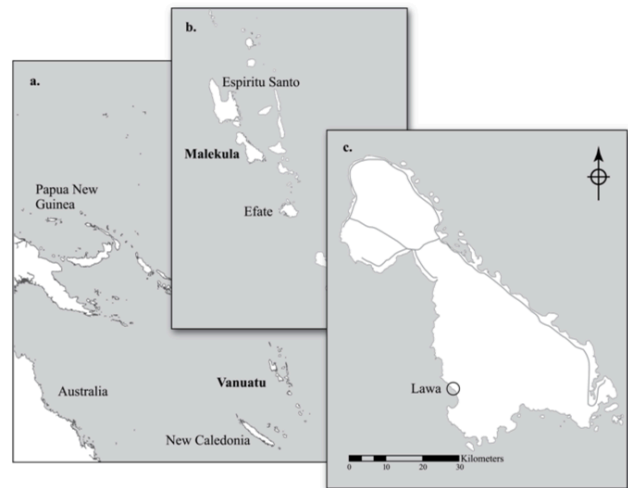
CASE STUDIES: MAINTENANCE OF IEK IN THE REPUBLIC OF VANUATU

Background

Vanuatu is an ideal country in which to discuss IEK maintenance. It is comprised of more than 80 islands scattered across the southwest Pacific (Fig. 1), and IEK is an important dimension of daily life (Huffman 2013). Eighty percent of the population lives in rural areas and relies on natural resources for most of their nutritional needs (Regenvanu 2005). Land ownership is largely vested with local people, and resource management often relies on customary, IEK-based, techniques (Hickey 2006). Indigenous knowledge and practice also underpin other dimensions of daily life: most people speak at least one vernacular language (of which there are more than 100 [Lynch and Crowley 2001]), participate in traditional ceremony and dance for important events (Regenvanu 2005), use ethnomedical knowledge for health care

(Bradacs et al. 2011), and rely on networks of kin and clan that are regulated through tradition (Huffman 2013). This complex of lived knowledge, praxis, and social institutions is locally referred to as “kastom” (Tonkinson 1982, Bolton 2003).

Fig. 1. Map of case study sites: (a) Southwest Pacific, showing Vanuatu; (b) Vanuatu, showing Malekula Island; (c) Malekula, showing Lawa village.



The attrition of IEK is an important issue in Vanuatu (McCarter and Gavin 2014a). Since the archipelago obtained independence in 1980, rapid urbanization, language shift, and the penetration of market economies have altered norms of cultural transmission (Regenvanu 2005). Preceding this, missionary activities from the late 1800s resulted in widespread disruption through population loss and internal migration (MacClancy 2002). In response, the Vanuatu Cultural Centre ([VCC] a semigovernmental body charged with the revitalization of kastom and vernacular language) has stressed the importance of IEK maintenance. Efforts to “indigenize” the economy (Rousseau and Taylor 2012), national progress measures (VNSO 2012), and education systems (Sanga et al. 2004) have garnered significant publicity and fuelled debates within both academia and popular media.

We describe two approaches to IEK maintenance in Vanuatu: the first of a community-based approach, and the second using the formal school system. The case studies are necessarily brief, and are intended as illustrative sketches of the challenges of IEK maintenance.

The case studies are based on the unpublished field notes of authors Mark Love (ML) and Sue Baerelo (SB). For the first case study, ML conducted seven months of fieldwork between 2009 and 2011, and drew data from extensive semistructured interviews ($n = 135$), focus groups ($n = 6$), and participant observation. For the second case study, SB designed and wrote IEK guidebooks for the VCC. The data are drawn primarily from a structured survey conducted with teachers and practitioners ($n = 25$), as well as extensive participant observation. For both case studies, data were analyzed using standard deductive coding methodology (as described in Bernard 2005), and are corroborated by findings in McCarter and Gavin (2011, 2014b).

Case study 1: Community-based IEK maintenance in Lawa village

Our first case study is located in the southwest of Malekula Island in northern Vanuatu, close to Lawa village (Fig. 1). Since 2009, local leaders have been promoting IEK using a locally designed model known as a “kastom school,” a community-based approach to the maintenance of IEK (McCarter and Gavin 2014b).

The Lawa area (also known as Mewun) has a resident population of slightly more than 730 (M. Love, *personal observations*). Lawa village was established around 1945 when families migrated to the coast from inland to settle close to the mission station. The area is relatively isolated, and access to the market town on the east coast requires an arduous boat and truck trip. Commercial occupations in the area are rare, and the bulk of cash income comes from the sale of kava (*Piper methysticum*), cacao (*Theobroma cacao*), and coconut (*Cocos nucifera*). Many families maintain gardens on their ancestral land inland.

The kastom school is situated away from the village in a specially constructed building, and recently obtained funding from the Christensen Fund to support operation through to 2015. Activities at the school include Friday classes, in place of formal schooling; week-long bush camps for the practical application of IEK; development of local resources, including dictionaries; and local research and capacity building. Teachers are local experts, both male and female, who are paid a small fee for their participation. Topics are determined by a locally based committee, and span a range of subjects, including vernacular kinship terms, wild food finding, and local handicraft construction. Teaching is conducted using exercise books and chalkboards, as well as traditional methods such as sand drawing (Huffman 2013). Technical and other support come from national-level institutions (i.e., the VCC), and from personnel at the University of Queensland, Australia.

The kastom school at Lawa was established in response to a number of intersecting pressures. Extensive land clearing has reduced local botanical diversity, which has led to a loss of useful plants for medicine and firewood. Language loss, driven by pressure from Bislama, English, and French, is a key concern: a recent survey found that only 27% of the population ($n = 43$ households) used vernacular language in the home (M. Love, *personal observations*). Ultimately, this pressure relates to widespread social change, especially the increased prevalence of marriage from outside language groups, and the practices of the formal education system (Sanga et al. 2004; see the second case study). The kastom school also seeks to allay time constraints, as life within the community is heavily regulated: between the obligations of community, church, and subsistence agriculture, there is little time for the practice of kastom and IEK. In short, the kastom school was initiated in response to concerns that indigenous knowledge and practice was becoming like an “item of clothing” rather than being a living, valuable, and practical part of community life.

Interview data highlighted a number of strengths of the Lawa kastom school. For one, curriculum items are locally formed, and IEK is encapsulated within relevant units (e.g., appropriate kinship terminology for family). Moreover, the kastom school

committee has been able to leverage national and international linkages (e.g., via the VCC and the Christensen Fund) to secure funds for the school. Access to funds has been an important enabling factor in the success of the school thus far: despite the centrality of kastom to life in Vanuatu, the costs of hiring teachers for the kastom school are significant. Payment here fills two needs: it compensates for the opportunity cost of not working but also serves as an acknowledgement of ownership over the traditional “copyright” of the teacher’s information. Such copyright payments are founded in pre-Christian social systems, which were based on graded rank systems in which individuals paid to acquire knowledge and rank over the course of a lifetime (Bonnemaison 1996). Although the school seeks to re-open customary lines of transmission between elders and youngsters (Florey 2009), the setting (a “school” environment) and strategies (payment of cash for copyright) for knowledge transmission are novel. Indeed, they represent a proactive adjustment of kastom to the contemporary context (McCarter and Gavin 2014b). In this sense, the kastom school represents an adaptive approach to the transmission of kastom and culture, akin to the “contextual flexibility” of marine management regimes in the region (Hviding 1998).

The kastom school has faced a number of challenges, however. For one, accommodating the diversity of the wider community has proven to be difficult. The Mewun area is made up of at least 20 distinct clans (“nakamals” speaking seven different languages [M. Love, *personal observations*]). Although one language (Ninde) is dominant, each nakamal has particular cultural traditions and IEK that may not be appropriate for transmission to members of other groups. Similarly, some knowledge is gendered (e.g., male sacred musical instruments) and cannot be taught while the opposite sex is present. Moreover, some groups within the community (especially those aligned with evangelical churches) are opposed to the teaching of IEK in the schools, often fearing that the reification of any aspect of kastom risks an increase in “dark” forms of tradition, such as sorcery (Rio 2010). This emphasizes, once again, that communities are not homogenous entities (Agrawal and Gibson 1999).

A second tension has been between the multiple levels within the kastom school organization. In particular, there have been differences in how IEK is conceptualized by national-level and international partners (e.g., donors) and the kastom school leaders. While the former have focused on the instrumental utility of IEK for resource management (e.g., as adaptive capacity to climate change), local people are interested in maintaining a broader range of knowledge and practice (e.g., vernacular kinship terms). In Lawa, these are perceived to be critical to maintaining social order and cohesion. In the kastom school, then, IEK is imbued with identity politics at the village level, and knowledge cannot be separated from the wider dimensions of kastom and culture.

The wide scope of teaching within the kastom school is enabled by local ownership over curricula, which offers the chance to make time and space for kastom in the contemporary context. However, the success of the kastom school in maintaining IEK will require the constant negotiation of the rights and power of the various parties concerned. Indeed, the challenge of maintaining IEK in the kastom school is finding a constructive road through

socioeconomic intricacies and the politics inherent in the education system, so as to allow the adaptation of IEK in the contemporary context.

Case study 2: Teaching IEK in the formal school

Our second case study profiles an attempt to teach IEK in schools in Vanuatu (“Teaching Indigenous Knowledge and Resource Management in Primary Schools in Vanuatu” [Baereleo 2010]). This project stems from more than a decade of work by the VCC, national organizations (e.g., the National Council of Chiefs), and international agencies (e.g., the UNESCO LINKS program and the Christensen Fund) to increase the profile of *kastom* throughout the archipelago (e.g., Rousseau and Taylor 2012). While there has been a number of successes, the project has also faced some significant challenges that are illustrative for IEK maintenance in other areas.

This work addresses a key driver of change in IEK in Vanuatu: the formal education system (Sanga et al. 2004). Scholars have pointed out a number of flaws with the current system: it removes children from traditional learning contexts at a critical age; it focuses on etic, “western” models of education (e.g., science, mathematics) at the expense of local knowledge and diversity; it does not train pupils in the critical skills needed to live in the village context, in which 80% of the population lives; and it ignores vernacular languages and teaches exclusively in English and French (Sanga et al. 2004, Regenvanu 2005). As a result, commentators argue that formal schooling is a driver of erosion in IEK and vernacular languages, and that pupils are poorly prepared for the realities of rural village life (Niroa 2004).

The program sought to create a series of guides for teachers for the first eight school years, in order to assist teachers in facilitating the transmission of IEK. Importantly, the books did not seek to record knowledge for teachers to pass on to children, but rather gave advice on how teachers might be able to more effectively work with older community members. Moreover, the guides provided an introduction on the importance of older members in the community passing on IEK. The guides were deployed alongside short awareness-raising leaflets, a set of display posters, and relevant supplementary material (e.g., copies of Johannes and Hickey 2004).

The guidebooks focused on topics covered by the primary science syllabus. They also sought to encourage the understanding of traditional resource management practices (e.g., such as the use of the correct signs for restricting access), customary art forms (Huffman 1996), and oral histories and songs. An important aspect of the work was the expectation that IEK would be handed on through the use of the children’s own vernacular rather than in English and French.

In 2010, the guidebooks (consisting of 46–60 pages) were completed and printed, and were distributed to all schools with pupils up to year eight throughout the country (more than 430 schools). Initial training workshops were held in one of the five provinces, and interview data indicated a positive response from teachers and officials (e.g., regional curriculum advisors).

However, the further development of the guidebooks was stymied by parallel developments elsewhere. For one, funding shortages at the VCC meant that training with curriculum advisors and teachers, as well as monitoring, did not go ahead. Moreover, the

same funding shortfalls ensured that the French translation of the books was significantly delayed. On another front, in 2010, the Ministry of Education announced a review of the entire school curriculum (Vanuatu Ministry of Education 2010). This necessitated major changes to the guidebooks, as the syllabus on which they are based became outdated. The guidebooks are currently being revised, but this is proving difficult because the new curriculum units do not have appropriate gaps for the inclusion of IEK. For example, in the first edition of the books, there was a major section on the study of marine life and the importance of traditional coastal resource management. However, there does not appear to be a place for this unit in the new syllabi.

In general, the potential benefits of top-down IEK maintenance (especially the scope and infrastructure of formal schools) remain unrealized. Although the agencies involved in developing the new curriculum (e.g., the National Education Commission) have emphasized the importance of local knowledge in education, this has not been reflected in syllabi that would allow the transmission of IEK. Moreover, where there is such a focus, it is on isolated, empirical knowledge (e.g., knowledge of plants) rather than on fostering a deeper understanding of what *kastom* is, the organization of *ni-Vanuatu* society, and its relationship with its environment. It is, therefore, difficult to know how the revised versions of the books will be greeted on publication. There seems to be scope to introduce aspects of IEK to school; however, teachers will need support to do this. This seems unlikely to occur, given the lack of strong and formalized institutional linkages between the VCC and Vanuatu Ministry of Education.

There are additional concerns about how the books will be received at the community level, where there are several potential limiting factors. Similar to the first case study, evangelical church organizations frequently oppose the teaching of *kastom* and traditional knowledge. Moreover, there are likely to be similar issues with payment for knowledge, given the time constraints in the village. Finally, other work on this topic has revealed significant ambiguity within communities as to the desirability of teaching IEK in school, with significant concern from stakeholders that the introduction of *kastom* into school will detract from topics that are considered to have more economic value, such as English and French (McCarter and Gavin 2011).

The guidebooks profiled here represent an innovative attempt to use the formal school system to maintain IEK, following the recommendations of international (e.g., Kimmerer 2002) and regional (e.g., Sanga et al. 2004) scholars. In particular, the use of the school system to connect IEK holders with pupils represents an important opportunity to address the limitations of classroom education for transmission of IEK (Warner 1999). However, the success of the guidebooks has been limited thus far, and the program has been seriously constrained by a lack of robust institutional linkages (e.g., between the VCC and the Ministry of Education) and the financial burden of supporting such a large IEK maintenance program. Addressing these challenges will require ongoing dialogue and commitment from the key actors.

Summary

The two case studies are representative of the unique social-ecological context of Vanuatu, and the specific models of IEK maintenance and challenges they have faced will not transfer

directly to other scenarios. Although they do not represent panacea solutions for IEK maintenance (Ostrom et al. 2007), we suggest that they emphasize several lessons for practitioners seeking to maintain IEK. For example, a key strength of the *kastom* school model is the locally appropriate means of knowledge transmission. This allows the school committee to design nimble responses to issues such as community diversity, gender, and knowledge payments that would be impossible in a model that did not have a high degree of local control.

In addition, the practical limitations (e.g., funding, space, and time) of IEK maintenance will consistently constrain such programs. In the *kastom* school, for example, activities were enabled by funding from the Christensen Fund, which allowed the committee to reimburse teachers for time and copyright. In point of fact, other *kastom* schools initiated around the same time have foundered, largely due to lack of funding (McCarter and Gavin 2014b). In the formal schools, on the other hand, lack of financial resources was a key limiting factor—although the reach of the education system means it is a potentially powerful mode of knowledge transmission, distribution of resources across the country was an expensive proposition and was quickly halted by lack of finances.

Horizontal and vertical linkages between and within institutions are also critical (Barrett et al. 2001). The *kastom* school committee was able to leverage vertical linkages with national level (the VCC) and international level (donors and academics at the University of Queensland) institutions, which provided them the funding success that ultimately supports their operation. The formal school program, on the other hand, was hampered by a lack of horizontal linkages with other national-level institutions (e.g., the Ministry of Education), which meant the guidebooks lacked the institutional relevance to guarantee their uptake into state educational curricula.

PRINCIPLES FOR IEK MAINTENANCE

The literature and case studies presented have highlighted a number of issues for future IEK maintenance issues. Given the urgency and importance of the task, then, how might IEK maintenance approaches proceed?

In this final section, we attempt to address this question. We recognize that solutions will ideally be tailored to local needs and contexts, and so do not seek to outline further approaches to IEK maintenance. Instead, we seek to guide future IEK maintenance actions by proposing four broad principles that should, if taken together, ensure that robust IEK systems persist alongside social and ecological change. These principles will have different implications in different contexts. For example, the case studies presented manifest the principles in a variety of ways, some of which (e.g., lack of horizontal linkages in Case study 2) have ultimately impacted on their success (Table 2).

Link responses across and within scales

The case studies and literature presented demonstrate that panacea solutions to IEK maintenance are unlikely to succeed. IEK is a nested complex of knowledge, belief, and practice, each of which will require distinct maintenance responses at different scales. Top-down approaches, such as databases and formal education systems, may have the capacity to support certain types of knowledge over large areas. While this may be important for

some knowledge systems, the situated and land-based nature of IEK mean that in many contexts they are likely to be inappropriate or inadequate for long-term IEK maintenance at local scales (Bates 2009).

Progress in the field of vernacular language maintenance may be instructive here. Practitioners have developed a comprehensive framework (known as the Graded Intergenerational Disruption Scale, or GIDS), which provides a range of possible responses to language erosion based on the vitality of the language in question (Fishman 1991, 2001). While top-down, policy-based efforts may be effective for the most robust languages, only community-based efforts centered on language transmission in the home are likely to be appropriate for others (Fishman 2001). In less robust linguistic systems, the most effective revitalization efforts are likely to be based in source communities and focused on repairing lines of transmission between older and younger language speakers (Florey 2009).

Although IEK maintenance is a challenging task, it can be greatly enhanced by the presence of robust linkages between actors (e.g., IEK holders) and institutions (e.g., funders and researchers). Linkages must exist across (vertical) and within (horizontal) different scales, and must enable feedback loops. Such linkages allow the incorporation of multiple points of view, maximize the strengths of the various actors, facilitate the sharing of information, and allow activities to be targeted at appropriate drivers of change (Barrett et al. 2001). In this way, adaptive and flexible responses to cultural change can be formulated, based on explicit connections to land and IEK holders.

Allow learning and adaptation

Given that change is axiomatic in cultural systems, approaches for the maintenance of IEK must embrace flexibility and adaptation. IEK must be allowed to adapt, and practitioners must find a middle ground between romanticizing IEK and allowing it to change (Posey 2002). This is often challenging: in the *kastom* schools, for example, setting of curriculum topics has required a robust debate at the community level about the lived value of *kastom* in today's context (McCarter and Gavin 2014b).

The case studies also indicate that IEK maintenance approaches must explicitly grapple with the multiple objectives of the various stakeholders concerned. As with vernacular language revitalization, IEK maintenance is underpinned by “related dilemmas about the varying place of collective versus individual rights, preservation versus mobility goals, ethnicity versus class interests, and sentimental versus pragmatic motivations” (Canagarajah 2005:41). In natural resource management, it has become more common to view governance as a complex problem, where multiple stakeholders hold differing objectives, and where tradeoffs between these objectives are explicitly weighted (Berkes 2007). IEK maintenance approaches may benefit from similarly explicit methodologies.

Strengthen networks of cultural transmission

IEK exists within networks, and is given meaning from its expression in everyday life. Therefore, the strengthening of appropriate modes for cultural transmission is critical for approaches to IEK maintenance. Given that much knowledge transmission and acquisition within indigenous societies is tacit, experiential, and based in contact with the environment (Heckler

Table 2. The principles in practice

Principle	Case study 1: The <i>kastom</i> schools	Case study 2: Indigenous ecological knowledge (IEK) and formal schooling
Link responses across and within scales	Bottom-up approach with strong vertical linkages to national (Vanuatu Cultural Centre) and international (Christensen Fund) organizations. Some weak horizontal linkages within Lawa community (e.g., to church groups) are a challenge to the schools. Not scalable beyond local level.	Top-down approach employs the reach and scope of formal schooling, and seeks vertical linkages to communities by linking learners and elders. Weak horizontal linkages to other government institutions are the major challenge for implementation.
Allow learning and adaptation	Represent an adaptation of methods for cultural transmission. Use local curricula and teaching methods, so responsive to local needs. Risk of reification of <i>kastom</i> by elders.	Learning and adaptation is allowed by seeking to connect learners and elders rather than seeking to specify specific topics. Represents a creative adaptation of “western” education modality to strengthen lines of cultural transmission.
Strengthen networks before knowledge	Focuses on locally appropriate groupings and networks (e.g., by gender or by <i>nakamal</i>) for the transmission of knowledge. Provides structured and consistent opportunities for interaction between elders and learners.	Seeks to connect learners and elders using the reach and scope of formal schooling. Risk that formal school is an inappropriate medium for teaching some aspects of IEK (c.f., McCarter and Gavin 2011).
Focus on rights and power	The <i>kastom</i> schools are ultimately able to focus on local issues that are deemed important by the community (i.e., language shifts/loss). The schools are a means of resistance to the influence of formal schooling, which is perceived to have an adverse effect on IEK. Remain dependent on local power dynamics, which may continue to disadvantage some sectors of the community.	Represent a conscious effort to realign formal school curricula to local knowledge, practice, and <i>kastom</i> . This should empower local communities to teach locally relevant subject matter. There is a risk that, if forced, this may run against the ethical or religious preferences of parents and community members.

2002, Bates 2009), approaches for the maintenance of IEK are likely to be most successful if they reinforce these processes (Florey 2009). Indeed, inattention to locally appropriate means of knowledge transmission can change the nature of the IEK itself, and can serve to perpetuate power imbalances that underpin erosion of IEK (Simpson 2004).

Holders of IEK do, however, actively adapt systems of knowledge transmission to changing ecological and social conditions (Greenfield et al. 2000, McCarter and Gavin 2011), and support for experiential and tacit learning will not be appropriate in all communities (Bates 2009). However, it is critical that due consideration is given to locally appropriate means for knowledge transmission, as “the fact that a specific unit of knowledge is lost or kept by a society is not as important as whether the society retains the ability to generate, transform, transmit, and apply knowledge” (Gómez-Baggethun and Reyes-García 2013).

Focus on rights and power

The maintenance of IEK has, at its heart, issues of rights and power. On the one hand, strengthening networks of IEK is a chance to address power imbalances that can drive IEK degradation. These power imbalances may relate to the dynamics of post-colonial systems, which are often structurally weighted against local and indigenous people (e.g., systems of formal education [Simpson 2004]). In this sense, applied work toward the maintenance of IEK may be a critical tool to empower and support diverse ways of understanding and viewing the world (Berkes 2012).

However, the maintenance of IEK is contentious. In particular, the contested definition of “indigenous” raises questions of whose knowledge will be protected, and who will decide how this is done

(Sundar 2002, Dove et al. 2007). To date, work in this field is rarely explicit about the motivations and aims of the key actors, who may have different visions for the value of IEK and vernacular language in the future (Burnett 2007). We know that there are serious questions around ability of top-down approaches to adequately protect the intellectual property of IEK holders (Jonas et al. 2013). This article highlights, however, that issues of power and control are also present in bottom-up approaches to IEK maintenance because power is rarely evenly distributed within communities.

In general, the successful maintenance of IEK systems is likely to be predicated on a high degree of control by the IEK holders (Agrawal 1995). In many cases, this may necessitate the devolution of power over the ways in which knowledge is taught in communities. The process by which this is achieved, and the mechanisms by which issues of rights and power are negotiated, should form a critical area for future research.

CONCLUSION

We have used a literature review and case studies to summarize the current state of knowledge around IEK maintenance. What is now needed is sustained and detailed empirical attention to the process, case studies, and best practice analysis of IEK maintenance programs. In the long term, it may be useful to develop a version of the GIDS for IEK that describes a range of ideal maintenance actions based on an assessment of IEK vitality (e.g., the Vitality Index for Traditional Ecological Knowledge [Zent and Maffi 2009]). Such work is especially critical in the light of ongoing and rapid cultural change, as well as the potential damage that ill-supported interventions may cause.

Ultimately, drivers of social change (such as linguistic shift) will continue to influence, and in some cases degrade, IEK. Given the close links between IEK and community cohesion, social capital, and social-ecological resilience, effective programs for IEK maintenance will play a key role in facilitating locally adapted solutions to social and environmental issues.

Responses to this article can be read online at:
<http://www.ecologyandsociety.org/issues/responses.php/6741>

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