BIODIVERSITY CONSERVATION

Problems and Policies

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TRADITIONAL ECOLOGICAL KNOWLEDGE, BIODIVERSITY, RESILIENCE AND SUSTAINABILITY

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1 Introduction

Much of the world's biodiversity has been in the hands of traditional peoples, societies of hunters and gatherers, herders, fishers, agriculturists, for a great many generations. Most living resources of the earth have been utilised for a historically long time; exceptions are few (e.g., open-ocean and deep-sea species). As Gomez-Pompa and Kaus [1990] observed, even tropical forests of the Amazon were not untouched environments but the result of the last 'cycle of abandonment' by traditional users. The fact is that pre-scientific, traditional systems of management have been the main means by which societies have managed natural resources for millennia [Berkes and Farvar, 1989; Gadgil *et al.*, 1993]. In many cases, the main reason we have any biological diversity to speak about is because of these systems of management.

This chapter is about the role of traditional ecological knowledge in biodiversity conservation. We use the term conservation not in the sense of preservation but in the sense of sustainable use for human benefit, without compromising the interests of future generations [WCED, 1987]. The chapter is organised around three major points. First, self-interest is the key to biodiversity conservation by indigenous communities. Second, traditional knowledge represents the summation of millennia of ecological adaptation of human groups to their diverse environments. Third, traditional ecological knowledge is important not just for its own sake but for its potential to help design more effective conservation for biodiversity and for ecological systems in general.

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The term indigenous knowledge (IK) is broadly defined as the local knowledge held by indigenous peoples or local knowledge unique to a given culture or society [see also Indigenous Knowledge and Development Monitor, 1992], and is used here interchangeably with traditional knowledge. More specifically, we use the term traditional ecological knowledge (TEK) as a subset of IK, and defined here as a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment [Berkes, 1993b]. Indigenous knowledge or TEK is an attribute of societies with historical continuity in resource use practices; by and large, these are non-industrial societies, many of them indigenous or tribal [Warren *et al.*, 1993].

Traditional knowledge is important for its own sake and for its social/cultural value. But, it is also significant for a number of practical reasons, many of them relevant to biodiversity conservation. The following list is adapted from the IUCN Programme on Traditional Knowledge for Conservation [IUCN, 1986] by Berkes [1993b]:

- TEK offers new biological knowledge and ecological insights;
- some TEK systems provide models for sustainable resource management;
- TEK is relevant for protected areas and conservation education;
- the use of TEK is often crucial for development planning; and
- TEK may be used in environmental assessment.

The chapter begins with a discussion of the nature and significance of TEK, exploring the similarities and differences between Traditional and Western scientific knowledge. Traditional ways of conserving biodiversity are then analysed as a set of social restraints leading to four widely used 'rules of thumb'. This is followed by some more detailed examples from traditional resource management systems that function in enhancing biodiversity. In the next section TEK is described in the context of ecosystem management, with emphasis on the importance of traditional, humans-as-part-of-nature world views which may be considered alternatives to the contemporary, dominant world view of the Western world. The final section attempts to extract some general principles from TEK systems, with emphasis on utilising the self-organising capabilities of natural ecosystems. We argue that principles of TEK can be applied to modern production systems.

2 Nature of traditional ecological knowledge

There are many similarities between TEK and scientific knowledge. Both are attempts to make sense of the world, to render it comprehensible to the human mind. Both are based on observations and on generalisations deriving from those observations. Many parallels can be drawn between these two kinds of knowledge. For example, Gadgil and Berkes [1991] suggested that a number of 'rules of thumb' developed by ancient resource managers and enforced by social means, parallel rules that may be derived from the science of ecology, and may function in much the same ways.

There are, however, also some notable differences between the two kinds of knowledge. In particular, indigenous knowledge differs from scientific knowledge in its:

- restricted geographical scale of observations;
- reliance on mainly qualitative (rather than quantitative) information;
- lack of a built-in drive to accumulate more and more facts;
- slower speed in the accumulation of facts;
- more reliance on trial-and-error, rather than on systematic experimentation;
- limited scope for the verification of predictions; and
- lack of interest in general principles or theory-building.

As well, a number of additional characteristics of indigenous knowledge systems are suggested by detailed studies of traditional ecological knowledge in indigenous cultures and tribal peoples [Freeman and Carbyn, 1988; Johannes, 1981; McNeely and Pitt, 1985; Morauta *et al.*, 1982; Posey and Balee, 1989; Ruddle and Johannes, 1990; Tanner, 1979; Niamir, 1990; Warren, 1991a; Warren, 1991b; Warren *et al.*, 1993; Berlin, 1992: Oldfield and Alcorn, 1991; Inglis, 1993]. A number of generalisations can be offered on the basis of these studies. It appears that indigenous knowledge differs from scientific knowledge in being moral, ethically-based, spiritual, intuitive and holistic; it has a large social context. Social relations are not separated from relations between humans and non-human entities. The individual self-identity is not distinct from the surrounding world. There often is no separation of mind and matter. Traditional knowledge is an integrated system of knowledge, practice *and* beliefs.

One major area of strength of indigenous knowledge lies in the long time-series of observations on particular local and regional ecosystems. That is, indigenous knowledge is based on diachronic data (long-term series), as opposed to synchronic data (short time-series over a large area) characteristically produced by Western science. Thus, the two kinds of data may be compatible and complementary. There is great potential value in a historical series of observations about particular areas, based on cultural transmission of knowledge from generation to generation, provided that the particular environment has not in the meantime been drastically perturbed.

Western science of resource management has until recently emphasised exploitation efficiency, in terms of physical and monetary yields, rather than sustainability in resource use. Resource harvesting proceeds most effectively with simplified systems, as in agriculture and forestry, and on the basis of understanding of only part of the larger system. By contrast, managing for sustainability requires an understanding of the system in all its complexity. The relevance of indigenous knowledge for the sustainable management of tropical forest, dryland, mountain and arctic/subarctic ecosystems is recognised not only by a few specialists but also by international agencies [WCED, 1987: 12; IUCN/UNEP/WWF, 1991]. Indigenous knowledge, with its long-term view and the contextual understanding of the local environment, can also be of value in developing a new science of biodiversity conservation. But there has been little discussion that directly addresses this area; exceptions include Oldfield and Alcorn [1991] who discussed the role of TEK mainly in biodiversity conservation in tropical forests, and Warren [1992] who emphasised indigenous knowledge mainly in crop genetic resources conservation.

Much of the discussion of traditional knowledge centres around the loss of such knowledge. The decline of IK systems have been variously attributed to commercialisation, change of technology, pressures due to population growth, breakdown of traditional land tenure and marine tenure systems, loss of indigenous control over areas and resources, and changes in world view due to such factors as urbanisation and loss of intimate contact with land [Johannes, 1978; Berkes, 1985a; Rajasekaran *et al.*, 1991; Ruddle *et al.*, 1992].

Many rural people of the world cannot, with any stretch of the imagination, be called biodiversity conservers, partly due to above reasons. But in any case, no one can claim that the mere possession of traditional ecological knowledge necessarily leads societies to live in harmony with their surroundings. We can make an educated guess, however, that those societies with considerable environmental knowledge were more likely to have possessed resource management practices which were sustainable, and allowed the long-term survival of the group. One can also guess that the possession of appropriate social organisation to make sustainable management systems possible, and a world view consistent with ecological prudence were adaptive. After all, the basic rules of evolutionary ecology are applicable to the human species, too. The human species may reasonably be characterised as K-strategist, that is a species adapted to maintain populations close to ecological carrying capacity [MacArthur and Wilson, 1967, Gadgil, 1987].

3 Conserving biodiversity

Indigenous knowledge is characteristically an attribute of societies with historical continuity in resource use practices. Societies that have maintained long traditions of largely unchanged resource use patterns tend to depend heavily on natural resources of their own localities. Dasmann [1988] terms such groups as 'ecosystem people'. He contrasts them with 'biosphere people' who draw on resources from far and often transformed through industrial processing. With their own well-being based on the long-term availability of natural resources of their own localities, the ecosystem people may be expected to have a stake in their local environments. Indeed, extensive knowledge of the biota, the terrain, the waters, the climate and its seasonal changes would confer on them great survival advantage. Ecosystem people tend to be especially familiar with larger plants and animals, their habitat preferences and local distribution, life histories and their seasonal manifestations, behaviour and uses [Diamond, 1989a; 1989b]. Much of this knowledge is put to use in obtaining food, drugs and other necessities and in avoiding dangerous situations. While not formally systematised, such knowledge is maintained and transmitted as directly useful information amongst members of the society, within and across generations.

Ecosystem people are motivated not only to utilise natural resources prudently, but also to conserve them in the longer term. Such conservation calls for social restraints in resource use — restraints that might be against short-term individual interests. To arrive at an appropriate set of such restraints is clearly an order of magnitude more complicated than to employ knowledge of habitat preference and behaviour for arriving at efficient hunting strategies. To implement the set of restraints is also a difficult matter calling for continued co-operation of large number of individuals.

We understand little of how indigenous knowledge of nature and human social behaviour has been translated into resource use practices that tend to promote sustainable use of biological resources and conversation of biodiversity. What we do know is that many ecosystem people do exhibit resource use restraints that promote conservation. But knowledge, belief and practice leading to restraint tend to be intermingled, making it difficult

for us to trace linkages amongst them. Social restraints are often implemented on grounds that are not considered 'rational' in our world view, involving arbitrary social conventions and belief in supernatural forces, as in the case of taboos. Thus, the precise role of indigenous knowledge in the formulation of restraints cannot be determined; there are no doubt social, mediating factors.

World views or environmental ethics are also important in this regard. As White [1967] put it, 'what people do about their ecology depends on what people think about themselves in relation to things around them. Human ecology is deeply conditioned by beliefs about our nature and destiny...' Conservation-oriented practices of ecosystem people tend to be grounded in their humans-as-part-of-nature world view. They consider themselves to be members of a wider community of beings that includes animals, plants, rivers and rocks. They respect these beings even as they disturb, cut down, kill or consume them [Tanner, 1979]. This respect is manifested in the form of a wide variety of cultural practices that link cultural and biological diversity. Ecosystem people consider landscape elements and living creatures as kin or beneficiaries or, sometimes, as dreaded enemies. They ritually worship or placate them, burn or hunt them. Hence their dealings with nature are hedged by manifold prescriptions as to what, when, and how much is to be left undisturbed. These prescriptions are part of the rich tapestry of the traditional culture of societies of ecosystem people [Gadgil, 1987].

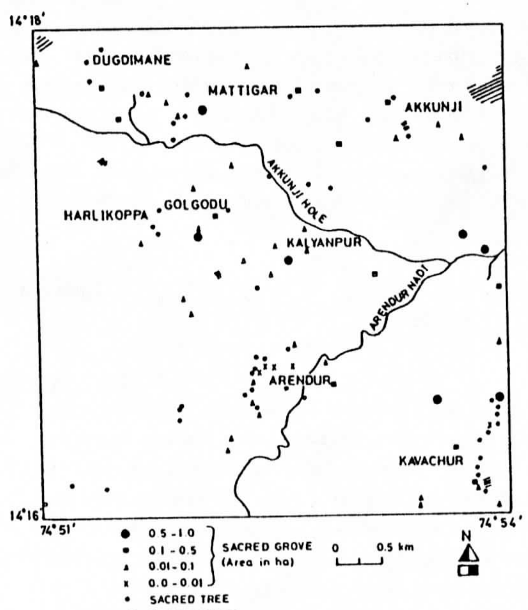
Gadgil and Berkes [1991] identified four kinds of widely used 'rules of thumb' as social restraints leading to indigenous biological conservation practice:

(i) *Provide total protection to some biological communities or habitat patches:* These may include pools along river courses, sacred ponds, sacred mountains, meadows and forests. For example, sacred groves were once widely protected from Africa to China[Gadgil, 1991, Yu, 1991], in fact, throughout the Old World (Figure 15.1). They continue to be so protected even after conversion to Christianity in the tribal state of Mizoram in northeastern India, now being called 'safety forest', while the village woodlot from which regulated harvests are made is called the 'supply forest' [Malhotra, 1990]. Ecological theory suggests that providing such absolute protection in 'refugia' can be a very effective way of ensuring persistence of biological populations [Joshi and Gadgil, 1991].

(ii) *Provide total protection to certain selected species:* Trees of all species of the genus *Ficus* are protected in many parts of the Old World. It is notable that *Ficus* is now considered a keystone resource significant to the conservation of overall biodiversity [Terborgh, 1986]. Local people seem to be often aware of the importance of *Ficus* as affording food and shelter for a wide range of birds, bats and primates, and it is not difficult to imagine that such understanding was converted into widespread protection of *Ficus* trees at some point in the distant past. Taboos with apparent functional significance may also be placed on some less obvious species within the ecological community. For example, some Amazon fish species considered important for folk medicine are taboo and are avoided as food, as statistically shown by Begossi and de Souza Braga [1992].

(iii) *Protect critical life history stages:* In south India, fruit bats may be hunted when away foraging, but not at daytime roosts on trees that may be in the midst of villages. Many waders are hunted outside the breeding season, but not at heronaries, which may again be on trees lining village streets. Cree Indians of James Bay in the subarctic are avid hunters of the Canada goose, a major subsistence resource, but never kill or even disturb nesting geese [Berkes, 1982]. The danger of overharvest and depletion of a population is clearly far greater if these vulnerable stages are hunted and the protection afforded to them seems a clear case of ecological prudence [Slobodkin, 1968; Gadgil and Guha, 1992].

Figure 15.1 Remnant network of sacred trees and sacred groves presently existing in an area of 25 km^2 on the Western Ghats of Karnataka State in South India.



Note: It is estimated that 6% of the land area was originally under sacred groves. This has now been reduced to 0.31% under 54 groves in addition to 45 sacred trees. These groves cover all the topographic elements from hill top to stream bank, and harbour a large number of wet, evergreen forest species that have otherwise disappeared from the neighbouring forest area.

Source: See text.

(iv) *Organise resource harvests under the supervision of a local expert:* Many traditional resource harvesting systems rely on the guidance of a traditional expert to organise the harvest, control access, supervise local rules and generally act as a 'steward' [Feit, 1986]. Examples may be found in diverse geographical areas such as the Canadian North, Central Africa and Oceania [Berkes, 1989]. This practice ensures the proper [illegible] of TEK expertise. Further, in some societies major events of

resource harvest are carried out as a short-term, prescribed group effort. Thus, many tribal groups engage once a year in a large scale communal hunt. Similarly, fish are permitted to be killed by using poisons only once a year at the time of a communal feast in the month of April in the river Yamuna in Mussoorie situated in the State of Uttar Pradesh in India [Bahuguna, S., personal communication]. Such a group exercise may have served the purpose of group level assessment of the status of prey populations, and their habitats. This in turn may have helped in continually adjusting resource harvest practices so as to sustain yields and conserve diversity.

It may be noted that even today's scientific prescriptions for conservation of biodiversity are little more than such 'rules of thumb', as witness debates such as SLOSS concerning the desirability of protecting some large or many small reserves. Indeed, as Slobodkin [1988] argues, current ecological theory helps us little in arriving at practical prescriptions for resource use and conservation. Such prescriptions are best derived from long-term observations of a particular ecosystem — very much the forté of indigenous knowledge [Ehrlich, 1987].

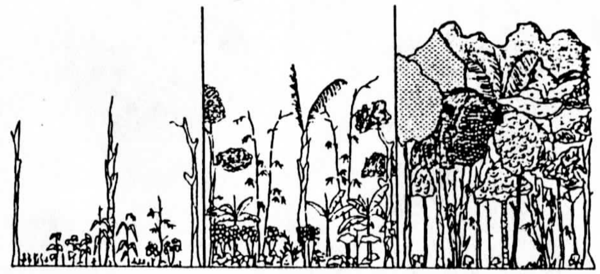
4 Enhancing biodiversity

Many practices used by indigenous peoples serve to manage species diversity, create habitat heterogeneity on the landscape scale, and manage intensity of use, thereby enhancing the diversity of biological resources available. We assume that for the most part, *biodiversity conservation is the indirect outcome, rather than the objective, of these practices.* Nevertheless, conscious conservation of biodiversity in some situations should not be ruled out [Ruddle *et al.*, 1992]. Examples from diverse geographical areas show that there are a number of ways in which indigenous practice may enhance biodiversity.

The overall productivity of agricultural systems may be increased by making full use of the available temporal and spatial opportunities for growing a diversity of crops. Intercropping, multiple cropping, agroforestry, shifting cultivation (swidden), and integrated farming systems are all traditional approaches that help maintain biodiversity. Given their apparent ecological sophistication, these systems could hardly be called 'primitive' [Stocks, 1983], and the knowledge of the traditional agriculturist in managing these systems should never be underestimated [Altieri, 1989]. The two most common traditional agroforestry systems in West Java are *kebun-talun* (rotation between mixed garden and tree plantation) and *pekarangan* (home garden intercropping system), summarised here from Christianty *et al.* [1986] and Cleveland and Soleri [1987].

Kebun-talun is a system that increases overall productivity and serves multiple functions by sequentially combining agricultural crops with tree crops. The system consists of three stages, each serving a different function. The first stage is *kebun,* a planting of a mixture of annual crops, mainly for the market. After two years, *kebun* evolves into *kebun-campuran,* a transition stage in which annuals are mixed with half-grown perennials. When the harvesting of annuals is completed, the field is usually abandoned for two or three years and becomes dominated by perennials (*talun* stage) (Figure 15.2).

Figure 15.2 Successional stages of the *kebun-talun* system (Java).



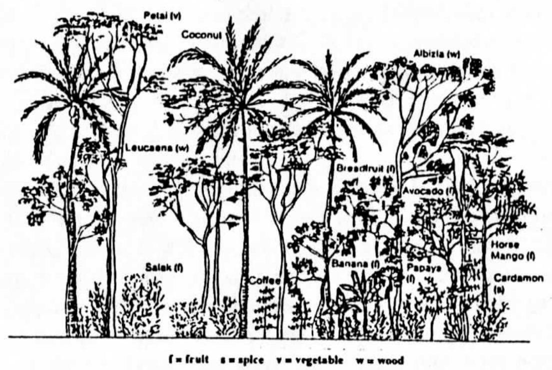
Source: Christianty *et al.* [1986].

Pekarangan (home garden) is a mixture of annual and perennial crops on the land surrounding a house. A *kebun-talun* may be converted to a home garden by building a house on it. Instead of clearing the trees to plant field crops as in *kebun-talun*, some of the home garden trees are usually kept as a permanent source of shade for the house and the garden. Field crops in the home garden are planted continuously under the trees. There is no rotation but year-round (irregular) harvest. Plant species diversity is higher than in *kebun-talun* and often in the hundreds. As well, animals are always an integral part of the home garden. The emphasis is on making full use of available space and diversity of resources (Figure 15.3).

Shifting cultivation or swidden systems are common in all tropical areas and were once common in temperate areas as well. Swiddening involves the clearance and abandonment of small areas over a multi-year cycle, and has received much attention as one of the major degradative processes in tropical forest areas when population pressures increase and the rotation time is shortened. Furtado and Ruddle [1986] indicate that swidden can be conservative in preserving soil fertility. If fallow is less than 5-7 years, however, land degradation occurs and species diversity may be reduced as a result of repeated intervention in the regeneration process, and the exposition of soil to erosion and nutrient loss.

Detailed studies on shifting agriculture (*jhum*) in northeastern India by Ramakrishnan [1992] have described multispecies systems (four to over 35 crop types) based on locally-adapted native strains. The indigenous practice requires sophisticated local ecological knowledge. The farmers optimise the use of soil nutrients by appropriate changes in the crop mixture depending on the length of the *jhum* cycle and the consequent high/low soil nutrient levels. On hill slopes, farmers combine r-strategist species (cereals and legumes) [Ramakrishnan 1992] with *K*-strategists with emphasis on vegetative growth, such as leafy vegetables. The aim is to maximise production from the site by mixing these two kinds of species with different reproductive strategies, in imitation of early successional forest fallows following *jhum*.

Figure 15.3 Profile of a typical Javanese home garden, *pekarangan*.



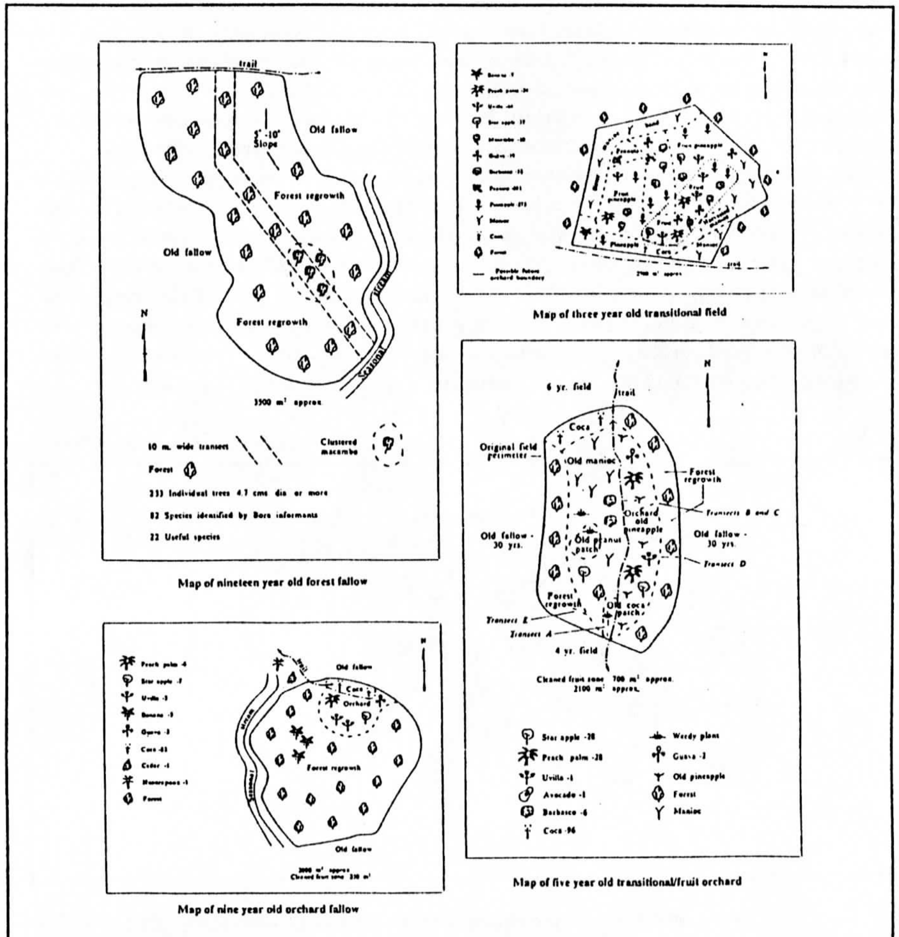
Source: Christianty *et al.* [1986].

It appears that the shifting agriculturists studied by Ramakrishnan [1992] had an understanding of C-3 and C-4 species. The soil on steep hill slopes is highly heterogeneous and the availability of nitrogen uncertain. The C-4 species with high nutrient-use efficiency could grow well in nutrient-poor microsites, while C-3 species with low nutrient-use efficiency are suited to nutrient-rich microsites. 'Such a C-3/C-4 strategy helps in coexistence of species through mutual avoidance. The positioning of the C-3 and C-4 crop species under *jhum* in northeastern India imitates the local natural communities, with the more nutrient-use efficient species being located in the nutrient-poor upper parts of the slope and less efficient species situated at the base of the slope' [Ramakrishnan, 1992: 381].

Much of the earlier work on tropical forest swiddens concentrated on how swiddens opened up temporary clearings in the canopy and protected the soil in the cleared area with a mix of crop species. Flowers *et al.*, [1982] found that each of the four groups that they studied had polyculture, but the crop mix was highly patterned. Different crops were planted in the same swidden plots from year to year, and there were single crop stands at certain stages. In general, swiddens did not compare in complexity to the surrounding forest. However, when shifting cultivation is analysed as an agroforestry system, i.e., the use of trees also taken into account, then the overall result of managing forest patches may be an enhancement of biodiversity. Such are the findings of Alcorn [1984] with Huastec agroforestry in northeastern Mexico, Posey [1985] with the Kayapo who create 'forest islands' at the southern limit of the Amazon rain forest, and Irvine [1989] with the Runa in the Ecuadorian Amazon.

Figure 15.4 illustrates the dynamics of indigenous agroforestry systems of the Amazon, based on the work done with the Bora of Peru [Denevan *et al.*, 1984]. The investigators selected fields of different ages (four shown here) to examine vegetation structures and the process of abandonment. The Bora plant a wide variety of crops, the main staple being manioc (a starchy root crop) of which the Bora recognise some 22 varieties. Peanuts, another major crop, are grown in second or third-year fields. The three-year old field contained at least 20 cultigens and the fruit trees had not reached peak yields. The five-year old field, with maturing fruit trees, looked more like an orchard and had little manioc left. Coca was the most valuable crop in the nine-year old field which consisted mainly of bushes and a 10-15m tall secondary regrowth.

Figure 15.4 Bora agroforestry from the Peruvian Amazon.



Note: Clockwise from the top right: A three-year old transitional field; a five-year old transitional field/fruit orchard; a nine-year old orchard fallow; and a 19-year old forest fallow.
Source: Denevan *et al.* [1984].

The oldest field studied, a 19-year old fallow, contained some 22 useful tree species including those for edible fruit, medicinal products, construction wood and other materials.

Denevan *et al.* [1984] found that the most productive fallow stage was at 4-12 years. Before that, the fruit trees had limited production; after that, many of the useful species were shaded out. Harvesting of some species continued, however, for up to 20-30 or more years.

5 World views and conservation

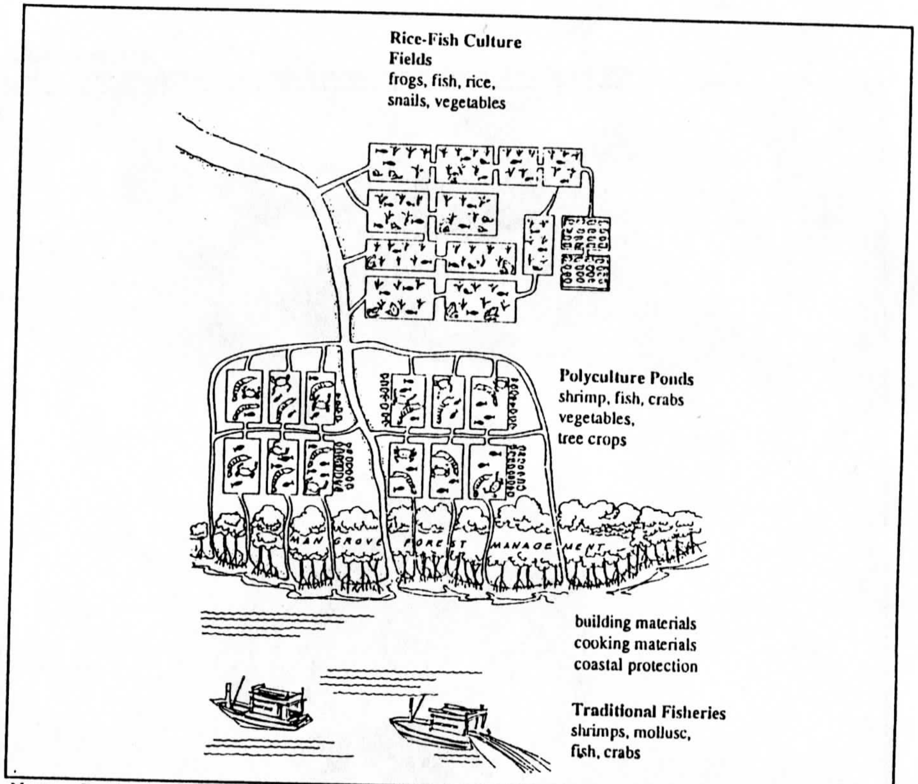
Many traditional societies view the biophysical environment and human societies as being linked together in a web of relationships. This view, common among many traditional Amerindian [Tanner, 1979; Berkes, 1988], Asian [Callicott and Ames, 1989] and African [Engel and Engel, 1990] peoples, was probably common among pre-Christian European peoples as well [White, 1967]. The contemporary Western assumptions that the basic human relationship with nature is one of separation and dominance [Leiss, 1972; Callicott and Ames, 1989; Engel and Engel, 1990], is not shared by great many traditional cultures. For example, from North America to Oceania, many traditional cultures cannot accept the idea that land can be bought and sold. Instead, they maintain that humans can only have use-rights over the land resource, which is something permanent and can only belong to a supreme power, not to mortals [Berkes, 1989].

A view of nature involving a web of relationships is significant from the conservation point of view because it resembles the systems view of nature in modern ecology. If traditional peoples had a pre-scientific conceptualisation of ecosystems, we might expect to find traces of it today in the way ecosystems are locally conceived and used.

One evidence of an ecosystem-like view comes from Indonesia where traditional systems combined rice and fish culture (*subak*), and wastes from this system often flowed downstream into brackish water aquaculture systems (*tambak*). The *tambaks* themselves were polyculture ponds, often combining fish, vegetables and tree crops [Costa-Pierce, 1988] (Figure 15.5). The *subak* itself was often part of a water temple system, and the entire regional rice terrace irrigation system was often managed as a system, as in Bali. Thus, the integration of *subak-tambak* systems for combined production of rice, fish and downstream crops is an ecologically sophisticated application.

Ancient conceptualisations of ecosystems, especially as watershed-based units, exist in several Amerindian, European and Asian cultures [Gadgil and Berkes, 1991]. But it appears that it is southeast Asia and Oceania which had, and to some extent still have, a wealth of such pre-scientific ecosystem concepts and applications. Examples include ancient Hawaiian *ahupua'a* [Costa-Pierce, 1987], the Yap *tabinau*, the Fijian *vanua*, and the Solomon Islands *puava* [Ruddle *et al.*, 1992]. Figure 15.6 shows the cross-section of the *puava*, which refers to an intimate association of a group with land, reef, lagoon and all that grows on or in them. It is an integrated corporate estate [Ruddle *et al.*, 1992], but effectively the 'personal ecosystem' of the group in question: '*puava* is a defined, named area of land and in most cases sea. A *puava* in the widest sense includes all areas and resources associated with a *butubutu* (descent group) through ancestral rights, from the top of the mainland mountains to the open sea outside the barrier reef' [Hviding, 1990]. Similarly, in the Hawaiian *ahupua'a*, river drainage basins were managed as integrated systems, fishponds and agriculture were combined, and headwater forests were protected by taboo [Costa-Pierce, 1987].

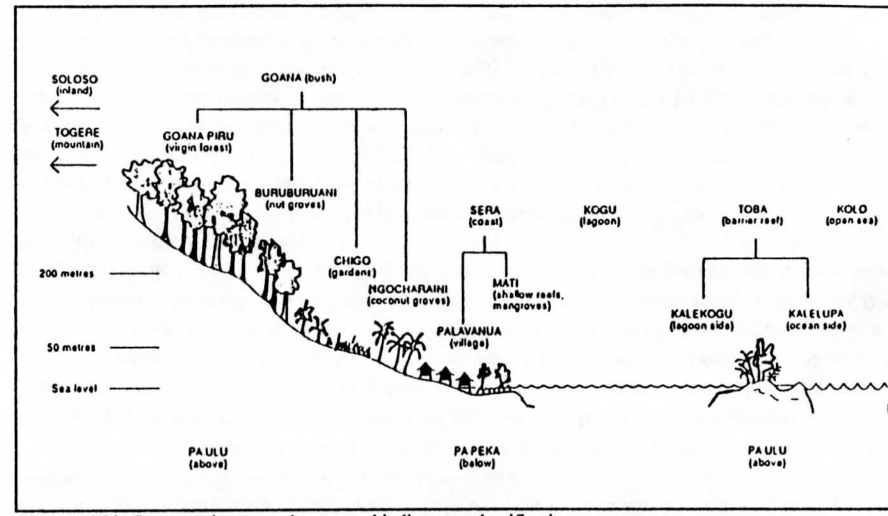
Figure 15.5 Traditional Indonesian integrated rice-fish culture (*subak*) and inshore polyculture pond management (*tambak*).



Note: Land and water systems are integrated, with the outflow of *subak* feeding the *tambak* system, and both supporting the coastal fishery.
Source: Modified from Costa-Pierce [1988].

A more explicitly religious use of ecosystem-like concept of nature is provided by Yu [1991] who explored the ancient Chinese ideal of 'living in harmony with nature' (*Feng-shui*). Ancestor worship is a distinctive part of native Chinese religious culture, and finding appropriate burial sites is as important as finding settlement sites for the living. The conceptual model for an ideal *Feng-shui* (literally wind and water) site has been described in ancient books as 'Azure Dragon crooking in the left, White Tiger squatting in the right, Red Bird flying in the front, and Black Tortoise bending at the back' (Figure 15.7, upper). Yu [1991] then shows the translation of this ideal *Feng-shui* site model into a real landscape model, with mountains and hills embracing the burying or living site, water flowing in front (Figure 15.7, lower).

Figure 15.6 An example of the South Pacific 'integrated corporate estate' concept, the Marovo (Solomon Islands) *puava*.



Note: This figure environmental zones and indigenous classification.
Source: Ruddle *et al.* [1992].

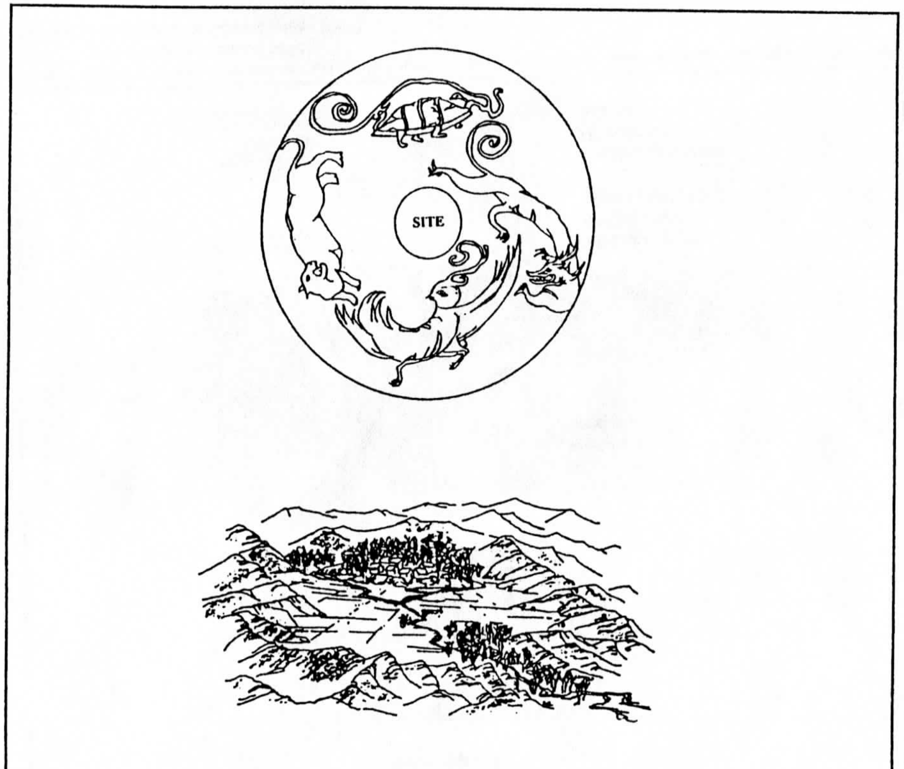
6 Ecologically sustainable systems and 'new TEK'

Traditional systems of knowledge are not just curiosities; they are important for rediscovering new principles for the more sustainable uses of the natural environment. Traditional knowledge and management systems, developed by trial and error through millennia, enable many societies to use their environment in a way that maintains the integrity of their local ecosystems.

The process that gives rise to TEK is the natural process of adaptation. Thus, the evolution of TEK can be seen as part of the general self-organising process of all natural systems. Related to increasing the potential for survival, TEK evolves from the necessity for the society to deal with feedbacks from the environment. It is a capital of knowledge that contains not only the simpler, 'Is this good to eat?' type of information, but also the codified essential information on how to respond to changes in the environment, such as game depletion, soil exhaustion and forest succession. In short, it contains the recipes for responding to and managing ecological feedbacks.

What insights do TEK systems offer for biodiversity conservation? Consider for a moment that the northeast Indian *jhum* system described by Ramakrishnan [1992] employed a monoculture crop on the hill slopes year after year regardless of the ecological feedback. Such an approach may produce a reasonably good crop one year, perhaps even several years in a row. But it is not likely to produce food that would sustain a group of people in the long run. It is much more likely that a different strategy would work better for long-term survival: plant a diversity of species and varieties, make a note of which species grow best where, apply this information to adjacent areas and pass the knowledge on to your offspring. As Ramakrishnan [1992] has shown, the multispecies strategy using a mix of C-3 and C-4 species does in fact make a great deal of ecological sense, as well as minimising the risk of total crop failure by making sure that at least some of the crops will grow well in any given year.

Figure 15.7 The concept model of the ancient Chinese ideal of 'living in harmony with nature'.



Note: *Feng-shui* (upper), and the real landscape model of ideal *Feng-shui* (lower).
Source: Yu [1991].

Other examples used in this chapter show a variety of ways in which feedbacks from the environment are used to arrive at a series of traditional resource management principles that make ecological sense. The following is based on the major examples used in this chapter; it is not meant to be an exhaustive list:

- maintain a system of refugia to minimise the risk of extinction of any of the biological populations you harvest (Figure 15.1);

- use the forest succession sequence to satisfy your needs, do not suppress succession and do not cut just once but over and over in a cyclical fashion (Figure 15.2);
- keep a diversity of crops at hand for continuous production of food and other commodities (Figure 15.3);
- enhance the diversity and resilience [*sensu* Holling, 1986] of your agroforestry system by planting and harvesting selectively (Figure 15.4);
- think of your environment as a whole from the height of land down to the edge of the lagoon — your social group is an integral part of your resource base (Figure 15.5);
- link your productive systems so you can do more with less, making sure that the waste from one system becomes the food for the next (Figure 15.6);
- manage your landscape to enhance human well-being, encoding environmental ideals in religious tradition (Figure 15.7).

From these examples and others, biodiversity conservation appears to be an adaptive practice in many traditional systems. One can also think of counterexamples, however, perhaps the elimination of competing predators. But there is little doubt that traditional systems commonly used several general strategies for maintaining relatively high levels of diversity in the managed environment. From the cases used in this chapter, examples include the manipulation of the local landscape to augment its heterogeneity [Nelson and Serafin, 1992]; the use of conservation 'rules of thumb' to help use populations and species sustainably; and the integration of the production of two or more systems.

Contrast this with the results of the more intensive applications of science and technology, such as the current practices of agriculture. Resource management based on Western scientific knowledge often generates simplified ecosystems, either directly through excessive resource extraction and monoculture-based production, or through pollution and degradation that cause ecosystem stress. Subsidies to these production systems, such as energy inputs or technological innovations or the use of a series of substitutions (often with the sequential depletion of resources from elsewhere) tend to mask the degradation of the resource base [Berkes and Folke, 1993].

As well, resource management practices are designed to lock out the feedbacks from the environment; resource management agencies work hard to avoid natural perturbations, as in fire management in forestry. Blocking out perturbations and feedbacks may be 'efficient' in a limited sense in the short-term, but may make the ecosystem 'brittle' by inviting even larger and less predictable feedbacks from the environment. These feedbacks, termed surprises by Holling [1986], may be even harder to cope with and can have devastating effects on the ecosystem and on societies that depend on these resources [Perrings *et al.*, 1992].

Resource management characterised by TEK systems allows unpredictable perturbations to enter the system, instead of locking them out. In indigenous cultures, a knowledge base has evolved to provide guidance on how to adapt to such perturbations, and how to respond to change. Such cultural practices are not only adapted to, but actively modify their natural environment by managing the feedbacks for the sustainable use of the resource base.

Just as species redundancy is a form of insurance for ecosystem resilience [Holling, 1992], we hypothesise that managing and enhancing the diversity of the landscape through TEK is an insurance for resilience of the local social system. These adaptations to the resource base have ensured that traditional societies have prevailed for extensive periods of time within the ecological carrying capacity; those which did not, disappeared long ago.

The awareness that society depends on functioning environments is returning, as reflected in the sustainability debate at all levels of society. As well, the scientific way of thinking is continuously moving away from the positivist emphasis on absolute objectiveness and truth, towards a recognition that fundamental uncertainty is large and not reducible, that certain processes are irreversible, that qualitative judgements do matter, and that world view issues are important. The gap between scientific knowledge and TEK is decreasing. Current Western science, with chaos theory and Holling's 'science of surprise', is more akin to 'savage thought' as portrayed by Levi-Strauss [1962] than anyone previously was willing to recognise!

New and more sustainable resource use practices have been emerging from new scientific approaches. For example, knowledge from natural forests suggests how forest managers can choose silvicultural strategies that optimise commodity and conservation objectives [Hansen *et al.*, 1991]. Planting clover alongside cereals not only substitutes the artificial fertilisers, but also protects the crop from pests because beetles and spiders make home in the clover, preying on aphids and other insects [Brown, 1991]. Restoring wetlands decreases the monetary cost for nutrient abatement to coastal waters in comparison with conventional and fossil fuel based technological measures [Andréasson-Gren, 1991], while at the same time enhancing biodiversity [Chung, 1989]. These are examples of the prescriptive field of ecological engineering recently established in the Western scientific community [Mitsch and Jörgensen, 1989]. The idea is to utilise the self-organising capabilities of natural ecosystems to design harmonious social and natural environments; that is, to try to integrate human production and consumption patterns, infrastructure and settlements with ecosystem processes of which biodiversity is a crucial part.

Many of the above examples are in line with TEK prescriptions, and may be considered part of what may be called a 'new TEK' of how to restore, conserve and enhance biodiversity. Despite much research, still very little is known about the role of particular species, or groups of species for ecosystem resilience, and for the generation of ecological services [Schulze and Mooney, 1993a]. Indigenous knowledge potentially holds valuable information on the role that apparently redundant species play in ecologically resilient systems [Walker, 1992b], and more generally, on how to make production systems more diverse and resilient. This is one of the areas in which TEK could be of value to ecological science and its application to resource management. The question is how to implement TEK into western-oriented institutions and management.

For example, Alcorn [1990a] has provided seven cohesive principles from the indigenous tropical forestry management systems of the Huastec and the Bora that could be of value for creating better management practices. These strategies take advantage of (i) native trees and native tree communities, (ii) rely on native successional processes (iii) use natural environmental variation (iv) incorporate numerous crops and native species (v) are flexible (vi) spread risks by retaining diversity, and (vii) maintain a reliable back-up to meet needs should other sources fail [Alcorn, 1990a]. This work is only one example of what TEK systems can contribute. Perhaps we need to systematise these and similar TEK-based principles for managing other kinds of resources and ecosystems as well.

7 Conclusions

Self-interest as key to biodiversity conservation

The case for involving local people and their traditional knowledge in the planning for biodiversity conservation is a pragmatic one: The local people are more familiar with a given area and the species in it than are outsiders. Their knowledge, especially if there is a tradition of knowledge in the area, is likely based on a longer time-series of observations and broader contextual understanding of the environment. The failure to ensure local co-operation in biodiversity conservation efforts may make the local people indifferent and perhaps even hostile to the effort because of the natural tendency of people to be suspicious of top-down initiatives. The situation will be exacerbated if conservation involves curtailing local resource-use rights, as in African national parks.

Many traditional communities claim land and resource use rights which are carefully guarded and often threatened, as in the case of native peoples of the Amazon, northern Canada, Australia and elsewhere. The issue has been raised that changes in property rights through western-oriented management, from communal ownership to private or state ownership have disrupted behavioural patterns, TEK and social-self-regulatory mechanisms that once ensured sustainable uses of species and ecosystems [Berkes, 1989; Gadgil and Berkes, 1991; Gadgil and Guha, 1992]. These changes have been in the background of subsequent discussions of empowering local peoples.

The concept of reconciling local economies with conservation objectives in protected areas was pioneered in the international arena by Unesco's Man and the Biosphere Programme [e.g., Ramakrishnan, 1992]. The Sustainable Use of wildlife Programme of the IUCN, and the work of the Specialist Group on Sustainable Use of Wild Species, IUCN Species Survival Commission, are also in line with the idea of providing simultaneously for conservation and local benefits. Integrated conservation-development projects (ICDP) have become common in national parks and other protected areas despite the absence of demonstrated success cases [see the chapter by Wells in this volume]. The ICDP concept has also been implemented in areas outside national parks [e.g., Lewis *et al.*, 1990; Smith and Berkes, 1993a].

Common property theory provides some general guidelines and policy prescriptions for community-based conservation: (i) eliminate open-access conditions in areas to be conserved, (ii) balance resource-use rights of the local population with responsibilities, and (iii) legally protect land tenure and marine tenure of the local communities [Berkes, 1989]. These measures would act to strengthen the local, traditional conservation ethic wherever it still exists, together with communal property management systems that sustain it. Sharing of conservation responsibility and benefits would require co-operative management (co-management) arrangements between the local organisation and the government, and the rights and benefits may be spelled out in a management plan.

In the past, Western conservationists have aimed to 'educate' local peoples on the need for conservation, and governments on the true economic values of biodiversity. But this has, by itself, not led to effective biodiversity conservation, and according to Alcorn [1990b], never will. What is needed instead is a paradigm shift in which 'traditional peoples will actively participate in developing a new conservation ethic linked to the emerging capitalist economy but grounded in local, traditional understanding of the ecological underpinnings of economic enterprises' [Alcorn, 1990b].

The adaptive significance of TEK

There is little doubt that traditional conservation with social restraints is real; there is little doubt also that traditional conservation has (or had) survival value. As stated by Alcorn [1990b], 'archaic conservation limited extraction according to local rules that prevented destruction of nature because nature was the pre-eminent resource base'. Carefully conducted recent studies have been revealing the ecologically adaptive value of food taboos [e.g., Begossi and de Souza Braga, 1992]. However, as traditional peoples are integrated into the global economy, they lose their attachment to their own restricted resource catchments. This could lead to a loss of motivation to observe social restraints towards the sustainable use of a diversity of local resources, along with the pertinent indigenous knowledge that goes with it.

Self-interest in conservation may be maintained, however, as long as the local population continues to have at least some expectation of benefits, economic or otherwise. Some of these benefits may be social and cultural, and may be related to the local people's perceived relation with the land, plants and animals. There is good documentation that people belonging to a number of cultures consider their relationship to the land as something which is intrinsically valuable; examples include some groups of Amerindians [Berkes, 1988], Pacific Islanders [Ruddle *et al.*, 1992], Chinese [Yu, 1991], and Africans [Engel and Engel, 1990]. Not all people of the world share the same world view. Many of those cultures who traditionally held the humans-as-part-of-nature world view, probably retain some elements of their environmental ethic [e.g, Callicott and Ames, 1989].

Traditional knowledge may be considered at several levels. First, there is the local TEK of animals, plants, soils and landscape; all such knowledge has obvious survival value but may not be sufficient by itself for the sustainable use of resources. Second, there is the traditional resource management system, as in the Bora agroforestry example, which uses local environmental knowledge *and* also includes an appropriate set of tools, techniques and practices. Third, such traditional systems of management require appropriate social institutions, examples would include the Indonesian *subak* and the Solomon Islands *puava*. For a group of interdependent hunters, fishers or agriculturists to function effectively, there has to be a social organisation for coordination, co-operation, rule-making (as in social restraints) and rule enforcement. Finally, the world view which shapes the environmental perception and gives meaning to social relations, may be considered a fourth level of traditional knowledge. Not all TEK may be adaptive, and a given practice such as a particular taboo for the killing or consumption of an animal may be of obscure adaptive value. But different levels of TEK may be adaptive at different scales, analogous to the proximate and ultimate levels of significance in evolutionary ecology.

These different levels of TEK need to be considered together. Our impression is that there has probably been a disproportionate amount of interest in local environmental knowledge held in TEK systems (Consider the photos of befeathered New Guineans peering at obscure medicinal plants on the cover of popular weekly magazines). But there has not been a great deal of interest in or work on traditional management systems, institutions or world views. And yet, the protection of local environmental knowledge held by TEK systems depends in the long run on the conservation of the integrity of TEK systems at all levels.

Learning from TEK systems

One of the ten principles of the *Global Biodiversity Strategy* concerns the linkage of biodiversity with cultural diversity, and the conservation of both together [WRI/IUCN/UNEP, 1992: 21]. At a broader level TEK offers, in addition to social and cultural values, practical benefits in terms of biological and ecological insights, sustainable resource management systems, implementation of protected areas, development planning, and environmental assessment [IUCN, 1986; Berkes, 1993b]. Each of these potential benefits is related to biodiversity conservation, either directly or indirectly. In this chapter, we have focused on sustainable resource management systems, and in the latter part, on ecological insights from TEK for the design of more diverse and more resilient systems of production.

As well, the alternative world views of traditional peoples could provide insights for redirecting the behaviour of the industrial world towards a more sustainable path. There is good reason to believe that the ethics of truly sustainable development will need to borrow much from the world views of some traditional societies [Engel and Engel, 1990]. The irony is that, just as globalisation has liberated traditional people from their local ecosystems on which they used to depend, they are receiving attention as a source of inspiration so that the industrial world does not destroy the larger global ecosystem on which all people depend.

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