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Research Article

VULTURE CULTURE MATTERS: INDIGENOUS KNOWLEDGE AND CHANGING LANDSCAPES OF NILGIRIS BIOSPHERE RESERVE, INDIA

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A B S T R A C T

Landscapes are essentially ecosystems that are an interplay between the environment and human civilizations. These landscapes represent the common unit of analysis for historical ecology as the landscape holds the record of human activity on earth. The Nilgiris Biosphere Reserve (NBR) in South India, enjoys the unique status of harbouring critically endangered mammals like tigers, elephants, hyenas, and an established corridor of Elephants and critically endangered Gyps vultures. Fieldwork was conducted from 2017-2019 with the tribal communities employing the standard anthropological method of participant observation. For bird identification, we used the photo-elicitation technique. We carried out semi-structured interviews and focus group discussions. Information was sought using a triangulation procedure. We documented the indigenous knowledge of the Irulas and Todas, the two dominant communities, their cultural roles, changes in tribal practices that impacted landscape changes that impacted the decline of vultures, and the carcass protocol among the three groups of vultures and the traditional names and practices were also recorded. The modern management tactics destroyed the cultural connection that existed between the indigenous populations and the vultures and other natural scavengers. Our study explores the associated indigenous knowledge of vultures and the changes that happened in the landscape of the NBR of India.

INTRODUCTION

Rural communities have relied on their local knowledge to conserve their environments (Ens *et al*. 2015) with their experiences and observation, and accumulated knowledge about forest and animal conservation through the centuries. Forests are indispensable for the provision of ecosystem goods and services, spiritual and cultural values, and nutrient cycles (Fisher *et al*. 2014; Porter *et al*. 2014). The degradation of forests over the last few decades has gradually led to losses in biodiversity, aesthetic view of landscapes, and ecological functions including the provision of goods and services for human needs, adversely affecting livelihoods, threatening food security, energy, and health security of traditional communities (Pudyatmoko *et al*. 2018). However, some forest and wildlife conservation practices based on indigenous knowledge (IK) continue to sustain rural livelihoods without endangering the biodiversity, morphological and functional integrity of forests and their associated ecological systems (Reniko *et al*. 2018).

Indigenous knowledge can be broadly defined as the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment (Rÿser 2011). Diverse bodies including the Intergovernmental Panel on Forests and the Intergovernmental Scientific interest in the application of IK in forest and wildlife conservation are on top growing despite some criticisms by other modern science and policy circles (Schroeder& González 2019; Verma *et al*. 2016). The management of forest and wildlife resources is part of the culture, history, and spirituality of the local community. Indigenous people worldwide are active in the conservation of biodiversity due to their strong ties to flora and wildlife (Camacho *et al*. 2015; Lee & Bond 2018).Interest in ecological restoration is growing, and it is increasingly recognized that ecological restoration should take into account cultural practices as much as ecological processes (Higgs 2003; Sarr&Puettmann 2008). Although the role of Traditional Ecological Knowledge (TEK) in ecological restoration has equally been recognized in recent years (Anderson 2001; Shebitz 2005; Parks 2009), its present or potential contribution has not been extensively studied (Perrow& Davy 2002; Shebitz 2005). To date, only a few attempts have been made to convert TEK into ecological restoration tools (e.g., Kimmerer 2000; Shebitz 2005; Douterlungne *et al*. 2010).

Vultures are efficient scavengers (Ogada *et al*. 2012) and by cleaning up carcasses and other organic waste in the environment, they provide critically important ecosystem services that also directly benefit humans (Botha *et al*. 2017).The vultures' habitat in India represents a striking example of biodiversity loss as an unintended consequence. Vulture sights were once common all over India. The decline in

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the vulture population is caused by various factors such as poisoning and pesticide use, habitat loss and degradation, decreasing food availability, fragmentation of remaining populations, human disturbance, collisions with wind turbines and powerlines, and electrocution on electricity infrastructure (Birdlife International 2001; Botha *et al*. 2017). Vultures are extremely susceptible to Non-Steroidal Anti-Inflammatory drugs (NSAID) especially diclofenac, a painkiller used by livestock farmers, in cattle and goat carcasses.

In the present study, we documented the IK of the dominant communities of NBR viz; Todas and Irulas and their changing cultural role. In recent decades, the long-term study of landscapes has witnessed rapid international growth. There have been several studies that have indicated the importance of landscapes that tie many diverse species together in relationships (Anderson 2014; Berkes 2008; Johnson & Hunn 2009; Terrell *et al*. 2003). The study highlights the contribution of IK and practices of the local communities towards ecological restoration, understanding the changes in the landscape and its unintended impact on Vulture conservation in NBR. We focused on all the resident populations of NBR viz. White-rumped vulture *Gyps bengalensis*, Long Billed Vulture *Gyps indicus*, Red-headed Vulture *Sarcogyps calvus*, and Egyptian Vulture *Neophron percnopterus.* Perception of vultures and their role in the ecosystem were recorded. This study attempts to seek restoration of indigenous knowledge-led conservation science application on the ground.

METHODS

Study Area

The Nilgiri Biosphere Reserve (NBR) was the first Biosphere Reserve in India and is under consideration by UNESCO for selection as a World Heritage Site. It is located in the Western Ghats between the co-ordinates of 11°15' to 12°15'N and 76°0' to 77°15'E lying at the trijunction to the three States of Kerala (1,455.4Km²), Karnataka (1,527.4 Km²) and Tamil Nadu (2,537.6 Km²) covering an area of about 5,520 Km2. The Nilgiris is situated at an elevation of 900 to 2636 meters above MSL. The NBR is known for its rich biodiversity and is recognized as one of the 14 hotspots of the world because of its unique biodiversity. Moyar Valley of Mudumalai Tiger Reserve (MTR) is also part of NBR and serves as the main corridor connecting the Eastern Ghats and the Western Ghats. It also abuts the Bandipur Tiger reserve of Karnataka and connects both the core area of MTR and Sathya Mangalam Tiger Reserve**.** This is one of the most challenging and keyareas for conservation in the landscape.

Ethnic communities in Nilgiri Biosphere Reserve

The Government of India recognized75 primitive tribal groups based on the prerequisite as margin of 'a pre-agriculture level of technology, a stagnant or declining population, extremely low literacy, and a subsistence level of the economy, six tribal communities live in the Nilgiri District of TamilNadu. These six primitive tribes are Todas, Kotas, Irulas, Kattunayakas, Paniyas and Kurumbas.

The pastoral Todas immigrated into the Nilgiris during the 2nd century Before Christ. They are the first to introduce their native domestic cattle and buffaloes. It is also believed that some of the free-ranging feral buffaloes in the upper Nilgiris are abandoned by the Todas. (Thurston 1896).Todas, the munds (toda villages) are situated at considerable distances apart, and their inhabitants migrate periodically from one to another for a change of pasture. The primary source of occupation of the Toda tribe is cattle herding and dairywork and are dependent upon their buffaloes. Toda breed of buffaloes was named after this ancient tribe of southern India which is quite categorical from other breeds and primitive to the Nilgiri hills of Western Ghats.

Irulas are a small tribal community that is part of the Dravidian language group that is spoken in South-Eastern India. They are recognized as a Scheduled Tribe (ST) by the Government of India. Cattlebreeding is the main source of income for the Irulas tribe. The Irulas are the pre-Dravidian inhabitants of the scrub jungles of Southern India. Hunter-gatherers by tradition, their expertise in catching snakes is legendary. Before the Indian Wildlife Protection Act of 1972, the Irulas were one of the leading suppliers of snake skins to the global exotic skin industry. So successful they were hunting snakes for their skins was eventually banned in 1972 to prevent the local extinction of several species. This deprived them of their main source of livelihood and initially, the outlook for these skilled hunters was bleak. They are distributed in the lower altitudes of the Nilgiri district. They form the second largest tribe in Tamil Nadu and are distributed in ten districts. In the Nilgiris, Irulas living in the southern part are called Muduvars, and in the northern part living groups are called Kasabas. Their settlements are called Arai. They have several exogamous clans and are non-vegetarians. They are hunters, minor forest producers, collectors, and shifting cultivators.

Data Collection

Fieldwork was conducted from 2017-2019 with the indigenous Irula communities of six villages of the Moyar Valley namely Anakatti, Kallampalayam, Seriyur, Bhoothanatham, Tengumarda, and Hallimoyar. A field survey was also conducted in a similar way among the Toda tribes at Pudumund, Thalappatherimund, Pagalkodumund, Arthollmund, Kopuminmund, ThuvalkoduMund, Taranadmund, Pillkodumund, Garden mund, Tamilagamund, Kunthitholmund of Nilgiri hills.

The Nilgiri Biosphere Reserve supports four resident vulture species and for Vulture identification, we used the photo-elicitation technique. We carried out semi-structured interviews and focus group discussions among both sexes and various age groups. Information was sought using a triangulation procedure. The standard anthropological method of participant observation was followed. Important information was cross-referenced using several key informants, written materials, and other sources. Recordings were transcribed later. The goal of the work was to understand and document the cultural linkages of these indigenous communities with the Vulture population of NBR. We asked questions about the Vulture populations of the past and present, agricultural practices, forest living practices, the local names of vultures and the ecology, the landscape changes in NBR over the last five decades, and its impact on the Vulture population. Finally, we analyzed the similarities and differences between the indigenous knowledge and scientific knowledge areas and the ways to improve conservation strategies.

RESULTS

A total of 126 people were interviewed. Approximately 79.3 % of the population were aged≥50 including 11.11 % were between 50 and 70 years and the rest were below in the age group of 31-40. Females accounted for 19.84% whereas the balance was males. Males were more dominant because they used to work outside the villages in forest and areas nearby and was more familiar with Vultures and livestock kills. The cultural information and the landscape-related changes were not precisely in the time scale, since these are gradual changes that happened over a while. The past or early periods are in general considered from 1972 to the 1990s (from the time of implementation of the Wildlife Protection Act 1972 to the period of the dramatic decline of the Vulture population).

Traditional names

Todas in NBR have some unique names for vultures, they are known as "*padhs*", mostly used for white-rumped vultures. Another name "*koshk*" means "*moodadiyar*" (they don't call by the name) since they believe that the soul of the dead ones has come. They come with permission from the other world since they don't believe in rebirth. It walks like a crow, showing similarity to the Egyptian vulture. They eat fruits. They are considered *moodadiyar* since they don't eat dead remains. King vulture (Red-headed vulture) or popularly called "*poosarikazhugu"*. (Poosari is priest and kazhugu is vulture).

Fire

During the dry season, that's from the beginning of January to the end of April, Todas are in the habit of setting fire to the grass, intending to promote its better growth. (William 1870). Irulas had thatched houses and cattle as a source of livelihood during the '70s and'80s. As the grass grows longer, they cut the long grass to cover the roof of their houses, and the rest is grazed by the herbivores including the cattle they had. During the dry season, they also set fire to the grass and controlled the excess growth. This also allowed the prevention of new invasive species infesting the landscape.

The present dry deciduous area of the study area was grasslands with only a few tall trees in between, so it was easy to see the forest from a long distance. Earlier there were a lot of cattle and so vultures comfortably survived by feeding the carcass left inside the reserve by carnivores. Another major aspect was since the area was grasslands, it was also a favourite hunting place for wild dogs, but now even their numbers also have reduced due to lack of food. Later, these new invasive plant species like *Lantanacamara*, etc. created a heavy undergrowth and it became difficult to see elephants even next to the bushes. This increased the possibility of human-animal conflict. By the 1970s the forest department banned cattle inside the forest. And this resulted in overgrown weeds and lots of other grasses. After consulting with fellow tribes, a controlled forest fire was done. This cycle continued every year. So, the growth of grass was contained and no major fire accidents occurred.

Cattle pens (Pattis)

Each Toda mund has an enclosure or pen called as *tooel,* in which buffaloes are confined at night; it's generally circular and consists of a low wall of loose stones surrounding a sunk area within. Though they have numerous large herds of these animals, the todas never kill them for food, keeping them solely for the sake of their flesh only (William 1870). Early in the morning, the cattlepens are opened. After milking, the buffaloes are sent out to graze, and the milk is taken. By sunset, the buffaloes return home and are penned for the night.

The Irulas throughout the landscape had cattle pens (pattis). Some of the old lists of pattis covering the present Mudumalai and Sathyamangalam Tiger reserves of NBR are (On the banks of Moyar river from the present Moyar power stationare Mattalapatti, Palthattipatti, Chikkaholaipatti, Gundipatti, Gulthaltipatti (Karnataka border), Belimeenpatti, Bidargandi (Karnataka), Periyakaramalapatti, Chinnakaramalapatti, Munisagandipatti (Karnataka), Bhoothipatti, Kothuraipatti, Mangalapatti. Another line starting from Mangalapatti included Palathurai, Kappukudipatti, Parisalthorai, Mugagundipatti, Berthuraipatti, Gulthuraipatti, Gejalatti, Bhoothikuppai, Kaarachikorai.Third line of pattis--Palamaraipatti, Thottapatti, Namakkalpatti, Thulukkanpatti, Gundattipatti, Bhoothipatti, Atharapatti, Kallikadavupatti, Kaikottupatti, Thattalapatti, Siriyur. Fourth line of pattis were Bangalakadavupatti, Kodaimasapatti, Masipatti, Neermanpatti, Adikombai, Osathipatti, Arakadavupatti, Godalpatti, Anakatti. The next line included Gollapatti, Attukadavu, Moolaipatti, Udagaraipatti, Dhanaltipatti. Another line of pattis were Anaikoil (earlier it was a patti), Mylarpatti, Malappurapatti (near dargah), Chokkanalli. Another patti line was Chadapatti, Mavanallah, Chemmanatham, Congressmattom, Santhamadam (this area had earlier agriculture and even irrigation facilities).

Each pattis held around a few hundred cattle and was separated by less than five kilometers apart. Earlier, any loss of livestock by one or two numbers by tiger kills was left without any conflict. The left-over carcass served as food for vultures in the area.

Carcass Protocol of Vultures

King vulture (Red-headed vulture) or popularly called *poosarikazhugu* according to Todas, are a special species too. When the king vulture finds a carcass, they are the first to land on it. Only the king vulture opens the carcass so that others could feast on it. Generally, *poosari* (priest-Tamil language meaning) open the temple sanctum for devotees to see the deity. Similarly, the king vulture opens the carcass for others since its beak is straight and sharper than others. The other species like the white-rumped vultures which area majority in the area then pull the carcass out and feed, followed by the smaller Egyptian vulture pecking on the leftover food.

Habitat loss, degradation, and fragmentation

Samson and Ramakrishnan (2017) reported that carcass utilization by vultures may be constrained by the surrounding vegetation, as high vegetation densities may leave insufficient space for the vultures to takeoff. From these findings, it is evident that the presence, as well as the survival of vultures, is based on the vegetation structure in the forest ecosystem. The tiger population in MTR is more concentrated in the undisturbed core areas (Nanthini *et al* 2017) as this area is considered to be the tiger breeding area. As the tiger population increases in the core area, food for vultures would also be available to feed on their kills. In recent days, in MTR, invasive alien species such as *Lantana camara, Chromolaenaoderata, Stachytarbheta Jamaicacensis, Prosopisjuliflora, Opuntiadillenii,* and *Senna spectabilis* have invaded all types of forests especially higher proportionate in

dry and moist deciduous forests where vultures could easily find the tiger kills if it is open. The rapid growth of this undergrowth in the landscape does not allow the vulture population to increase as they found it difficult to locate the wild carcasses.

DISCUSSION

Primarily through the result of this study, we can relate to the cultural relationship between both the indigenous communities of Todas and Irulas with Vultures in NBR. This accumulation of knowledge from the traditional aspect could help to do more scientific research to keep the only viable breeding population of Vultures in Southern India.

Relevance of Indigenous Knowledge in Vulture Conservation

Modern science and technology are usually myopic in their view of the traditional management of sustainable resources. Many traditional systems are rapidly vanishing as indigenous people face biological and cultural extinction in many parts of the world (Bodley 1991). The impact of habitat change on vulture populations is complex although it is often cited as a contributing factor to vulture declines. Both cliffs and tree-nesting vultures (Long-billed and White-rumped) have specific breeding site requirements, which are easily affected by human activities such as the construction of tourist or leisure facilities near breeding cliffs; widening of roads and highways; logging, other forms of deforestation, and clearance of large trees in agricultural areas. Habitat loss and degradation are suspected to have contributed to the dramatic declines of vultures (Hooded, Rüppell's, White-backed, White-headed, and Lappet-faced) outside protected areas in West Africa (Thiollay 2006; Ogada & Buij 2011). In East Africa, specifically in and around the Masai Mara National Reserve, Virani, *et al*. (2011) showed that declines in large vultures (Rüppell's, White-backed, White-headed and Lappet-faced) were linked to changes in land use and tenure systems (grazed, buffer zones, reserve) with declines largest outside the reserve area.

Fire has been used by indigenous people since prehistoric times, not only to increase resource availability but also to restore forest species, habitats, and landscapes (Anderson1995; Anderson & Barbour2003; Shebitz2005; Miller *et al*. 2010). Fire is particularly important for pest control, site preparation, wildlife habitat maintenance, production of basketry materials and other non-timber forest products, and fuel reduction to prevent catastrophic crown fire (Kimmerer 2000; Berkes 2008; Pyke *et al*. 2010). Indigenous people often set fires to keep areas in earlier successional states that harbour greater plant biodiversity and landscape heterogeneity (Anderson & Barbour 2003). Excessive fuel accumulation, which creates conditions that inhibit the seedling establishment and encourage disease and insects, is prevented by frequent burning. Fire exposes bare mineral soil, increasing seed germination rates of annual herbs and vegetative reproduction of perennial herbs. Such burning practices often create a two-storied forest with a tree canopy and an understory of grasses and forbs, ultimately leading to an increase in plant species diversity (Anderson & Barbour 2003). Such TEK is consistent with ecological restoration practices and lends support to fire ecologists and advocates of prescribed burning, who emphasize the role of fire in the renewal cycle of ecosystems and challenge the widespread idea that all fires should be suppressed (Berkes 2008). Also, fires for land clearance may kill small wild animals for vulture consumption. Our study also shows the controlled fire used by local communities falls in line with the scientific practices followed elsewhere.

The present study had shown the changes in agricultural practices from cattle rearing, and milk harvesting to other occupations related to the present ecotourism has changed the landscape affecting the overgrowth of the forest floor affecting the food availability for Vultures. Agriculture is negative for vultures if their predominant food source, large ungulates killed by predators, declines. In many cases, livestock rearing is good for vultures, especially if the vultures are permitted to eat the carcasses of dead domestic livestock. Vulture relations with agricultural activities are particularly important, due to the recent catastrophic decline in vulture numbers in Asia and Africa.

Cultural salience and implications

In low- to middle-income nations where these birds have successfully replaced expensive infrastructure to appropriately dispose of animal corpses, the removal of carrion from the environment by vultures becomes more crucial. Although there are other scavenging species, they are inadequate replacements for vultures. Non-vulture scavengers are just not as effective, as they tend to leave some of the flesh behind (Subramanian 2011). While some animal species will feed on carrion if available, for vultures, it is the only source of food. Livestock killed by carnivores served as a portion of food for Vultures earlier. The present undergrowth had led to less visibility for the vultures in search of food. Vegetation is a very important factor for vulture foraging and nesting. Carrion removal is a broad activity and a vital service for ecosystems (Sekercioglu 2006). Most animal carcasses are consumed by other vertebrates (Brewer 1994; DeVault *et al*. 2011). These vertebrate scavengers include not only obligate scavengers such as vultures but predators such as raptors and carnivorous mammals (termed facultative rather than obligate scavengers). Disturbed or highly altered habitats may have less efficient ecosystem services (including scavenging) than intact, diverse habitats (Perfecto *et al*. 2004; Sekercioglu 2010).

For the Old-World vultures that lack a sense of smell and forage by sight, it is necessary to see the carcasses upon which they feed. Vultures are aerial scavengers and they will spot carcasses with their acute eyesight if the terrain is free from dense vegetation. Thus, vegetation structure has an important influence on the vultures' ability to find their carcasses. Brown (1985) established two hypotheses namely Search Efficiency and Runway Hypothesis against vegetation structure and carcass finding of vulture species. Increased vegetation density caused by bush encroachment decreases the likelihood of vultures locating a carcass; as they rely almost entirely on eyesight when foraging was explained by the search efficiency hypothesis. This hypothesis was confessed by Schultz (2007) showed that Cape Vultures *Gyps coprotheres* in the Waterberg region of Namibia were unable to locate carcasses when the vegetation density was greater than 2600 trees per ha. In the runway hypothesis of vultures, which are heavy birds adapted for soaring and unsuited for flapping flight in confined spaces, will not land at carcasses they have located if they do not have sufficient space in which to take off again. This hypothesis was endorsed by Bamford *et al*. (2009). The above two hypotheses envisaged that the open area is highly warranted for vultures for efficient search and runway during the time of

take-off and landing to the carcasses. The changes in the grassland ecosystem to the scrubland due to highly invasive species in NBR had led to the drastic decline of Vulture populations.

The carcass removal by vultures in NBR also has scientific implications as noted by the indigenous information. In addition to having different feeding ranges and social behaviour, the three groupings of vultures, each specializing on a different part of the carcass. Together, they form scavenging "guilds" that are remarkably similar in both the old and the new worlds (Hoyo *et al* 2006). The first group of vultures is often referred to as 'tearers': these species, like the king vulture in the new world and the lappet-faced and white-headed vultures in the old world, have comparatively short necks and powerful, narrow beaks ideal for tearing off tough parts of the carcass and getting through the skin. While smaller vultures will often try to open a carcass themselves - usually starting at openings like the eyes and the anus. This can be related to the opening of the carcass by the king vulture (*poosarikazhagu*) as mentioned early. The smaller species of vultures, like the turkey and the American black in the new world, and the Egyptian and the hooded vulture in the old world are 'peckers.' These species will often eat smaller carcasses unopposed, but when they attend to a large carcass with members of other species, they are usually forced to hang around the edges, cleaning small pieces of meat off bones. These species generally have narrow skulls and pincer-like beaks. The third group, comprised of the griffons in the old world and the condors in the new, are often referred to as' pullers'. These vultures have long necks and sharp beaks ideal for reaching deep into a carcass to pull out the viscera and soft flesh. Because these components make up by far the majority of a carcass, throughout the old world, the griffon vultures usually comprise around 90 percent of the total vulture population (Konig1983).

In India, researchers have found that vulture absence has possibly led to an increase in the population of rats and feral dogs (Pain *et al*. 2003; Prakash *et al*. 2003; Selva &Fortuna 2007). The beneficial impact of vulture presence is most clearly seen when vultures are locally extinct, usually leading to increased but usually less effective scavenging by facultative scavengers, increased incidence of disease from the larger numbers of rotting carcasses, and possibly changes in human cultures that had adapted to vulture roles. These created problems for nearby human settlements, increasing dog attacks on people, infectious diseases, livestock, and wildlife. Diseases, such as rabies and bubonic plague, are endemic and common in India, and dogs and rats are the primary reservoirs. India has one of the highest rates of human deaths due to rabies in the world (World Health Organization 1998).

Investing in IK can help ensure that forest resources continue to provide a wide range of goods and services on a sustainable basis. Compared with conventional strategies, the IK approach is better because it avoids conflicts and requires fewer government resources to enforce wildlife and forest resource laws. However, IK has been lost over the years since it is usually communicated through oral stories of the past, legends, myths, and songs (Mavhura *et al*.2013).

CONCLUSION

If a particular landscape management method had positive results, it can be used to avoid past mistakes or to offer workable alternatives to similar modern difficulties. By assuming future conditions, we can infer a lot about these systems. The present is shaped and constrained by the past, and slight differences now lead to disproportionately great differences tomorrow. To fully understand how individuals interact with their environment, it is crucial to look at the effects of current landscapes on people. Since carrion is found in widely separated places and soaring birds outcompete terrestrial birds or animal scavengers, for instance, all avian carrion eaters will require a soaring flight. This alteration has also had an impact on the species. Vultures' relationships with humans have altered multiple times; nonetheless, it is the people, not the vultures, who have modified the connection. For vultures, habitat loss is complex. While food is the most important factor, vultures have a wide range of habitat preferences: some prefer mountains, some prefer forests, a few favour cities, and the majority prefer savannas and meadows. Any sort of landscape may be devoid of the carcasses that vultures require to survive.

Due to their expertise in management and conservation, India's indigenous people play a significant role in maintaining biodiversity. The modernization effort, however, has marginalised and denigrated traditional wisdom. When preserving local customs is advantageous, this has been detrimental to both the biotic environment and the wellness of the local population (Hunn 2002). Berkes (1999) shows that peoples' cultural core beliefs are part of IK. People in local contexts are aware of the consequences of vulture decreases, and they may also be aware that increasing sanitation to replace vultures may be more time and money-consuming than just allowing the birds to do the sanitation task. Participatory approaches between local people and the government may therefore pay off, but it is too early to make a long-term prediction about vulture survival. Government engagement in conservation is crucial, but local people's participation in a context is much more so.

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