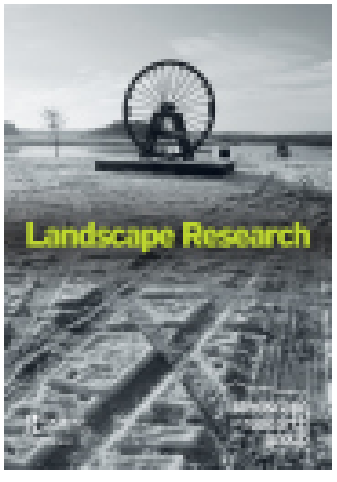

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Exploring Indigenous Landscape Classification across Different Dimensions: A Case Study from the Bolivian Amazon

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ABSTRACT *Decisions on landscape management are often dictated by government officials based on their own understandings of how landscape should be used and managed, but rarely considering local peoples' understandings of the landscape they inhabit. We use data collected through free listings, field transects and interviews to describe how an Amazonian group of hunter-horticulturalists, the Tsimane', classify and perceive the importance of different elements of the landscape across the ecological, socioeconomic, and spiritual dimensions. The Tsimane' recognise nine folk ecotopes (i.e. culturally recognised landscape units) and use a variety of criteria (including geomorphological features and landscape uses) to differentiate ecotopes from one another. The Tsimane' rank different folk ecotopes in accordance with their perceived ecological, socioeconomic, and spiritual importance. Understanding how local people perceive their landscape contributes towards a landscape management planning paradigm that acknowledges the continuing contributions to management of landscape by its inhabitants, as well as their cultural and land use rights.*

KEY WORDS: Indigenous people, ethnoclassification, ethnoecology, Bolivian Amazon, old-growth forest, Tsimane'

Introduction

Decisions on landscape management are often dictated by government officials based on their own understandings of how landscapes should be used and managed. In a seminal book, Hecht and Cockburn (1989) documented the entrance of the Amazon into modern circuits of commodities and politics. They argued that these modernisation processes were based on the assumption that the Amazon was an empty and hostile landscape that could be redeemed by the development of infrastructures, intensive agriculture, and the creation of extractive reserves. Cronon (1983) and Ogden (2008) described similar

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political decisions in North America leading to the conversion of some land uses undervalued by governments (such as forests) to others perceived as more valuable (such as agricultural or pasture lands). National conservation policies regulating the establishment of protected areas follow similar decision-making processes in the sense that they are based on considerations by agents other than local inhabitants (DeFries, Hansen, Turner, Reid, & Liu, 2007; Nagendra, 2008). Thus, governments make decisions on landscape conservation considering ecologists' or wildlife managers' understanding of landscapes, but very rarely considering local peoples' understandings (see Nadasky, 2003; Spak, 2005). And yet, most of the landscapes we observe today in areas where the highest levels of diversity are found, such as the Amazon basin, are to a great extent the result of local people who actively use, manage, and change their landscapes (Heckenberger et al., 2008; Lombardo, Canal-Beeby, Fehr, & Veit, 2011; Theobald et al., 2005) rather than the result of decisions taken by planners and policy makers.

In this context, the interest in local peoples' knowledge and perception of their natural environment has recently grown (Buijs, Pedroli, & Luginbuühl, 2006; Campos et al., 2012). Researchers have argued that local people classify the environment around them based on a multiplicity of elements. Such elements sometimes involve features usually considered in scientific landscape classification systems like plant indicator species, soil types, geomorphology, and hydrology (Campos et al., 2012), but often they also include features other than in science-based classifications, such as land use history associated with anthropogenic disturbance (Gilmore, Ros Ochoa, & Rios-Flores, 2010). Furthermore, local classification systems take into account characteristics that have been modified through long bouts of human history including geological formations, climate, and the distribution of life forms. Recent studies have argued that local landscape classifications help rural and indigenous peoples to predict the location of resources while hunting, gathering, or otherwise journeying around their territories (Davidson-Hunt and Berkes, 2010) and thus are key to sustaining their livelihoods (Roba & Oba, 2009; Trusler & Johnson, 2008). Further, local landscape classification systems also allow local peoples a clear identification of spaces of social and spiritual importance (Ellen, 2010; Johnson & Hunn, 2010; Krohmer, 2010). Therefore, understanding local classifications of the environment is important for at least three reasons: 1) they often reflect specific local needs; 2) they are rich in contextual qualitative information and based on well-defined diagnostic criteria; and 3) they are often more finely adjusted to the characteristics of a particular social-ecological system than other global taxonomic systems based on natural sciences (Alcorn, Bamba, Masiun, Natalia, & Royo, 2003; Wehbe et al., 2006). As a result, a better grasp of local landscape classification systems should help understand how the landscapes we observe today have been and still are managed by their inhabitants to support their livelihoods.

It may be argued that one of the reasons for neglecting local understandings of landscape at institutional levels is related to the lack of basic research on the topic. A review of the literature suggests that barring few exceptions (see Balee & Gely, 1986; Carneiro, 1978; Sillitoe, 1998), researchers have only recently turned their attention to the study of how local people perceive, classify, and use their environments (see Fleck and Harder, 2000; Halme & Bodmer, 2007; Johnson & Hunn, 2010; Jungerius, 1998; Roba & Oba, 2009; Scarpa & Arenas, 2004; Shepard, Yu, & Nelson, 2004). As a result, landscape ethnoecology has emerged as a field of inquiry in the tradition of ethnosciences, which approaches the study of local landscape classification systems

acknowledging that landscapes have both a physical and a human component (Johnson & Hunn, 2010). The origins of landscape ethnoecology are dual. On the one side, they can be traced back to Carl Sauer's (1925) understanding of the landscape as a result of human management of nature and comprising landforms, waters, and all life forms (see Anderson, 2010; Shepard, Yu, de Lizarral, & Italiano, 2001). On the other side, landscape ethnoecology is also rooted in ethnobiology, specifically in the study of local classification systems which were mainly developed around the classification and use of biotic elements (plants and animals) (Berlin, Breedlove, & Raven, 1974; Hunn, 1977). Arguably, the main strength of this new discipline lies in the fact that it helps researchers to understand how human societies conceptualise the environments on which they depend.

Understanding how societies perceive their natural environments calls for place-specific analyses (Berkes & Jolly, 2001) and this article contributes to that goal. Specifically, we contribute to landscape ethnoecology by providing a description of how an Amazonian group of hunter-horticulturalists, the Tsimane', perceive their landscape. We explore how the Tsimane' 1) classify their landscape and 2) perceive the importance of different landscape types across ecological, socioeconomic, and spiritual dimensions.

The Tsimane' and their Environment

The Tsimane' are the third largest ethnic group in the Bolivian lowlands. The latest census (Censo Indígena, 2001) registered about 8000 Tsimane' living in fewer than 100 villages, but more recent informal estimates set their population at 12,000 in 125 villages. Most Tsimane' villages are in two indigenous territories (adding up to about 786 000 hectares) in the province of Beni, along the Maniqui, Apere, and Quiquibey Rivers and along logging roads (Reyes-García et al., under review). The Tsimane' live in areas comprising lowland tropical forests and wet savannahs. Lowland forests cover most of the territory and comprise some deciduous species owing to a marked seasonality (Guèze et al., 2013). Wet savannahs consist of lakes and swampy areas subject to periodic flooding due to flat topography and poorly drained soils (Guèze et al., 2013), but include permanent patches of forest on mounds not subject to inundation (Lombardo & Prümers, 2010). The mean annual temperature is 25.8°C, but the temperature is considerably lower during the wet season with the arrival of cold southern winds. The mean annual rainfall is 1743 mm, varying greatly according to topography and seasonality. During the four-month dry season the average is less than 100 mm per month (Guèze et al., 2013).

Despite attempts to settle them in missions since the seventeenth century, until the late 1940s the Tsimane' mostly lived in relative isolation (Daillant, 2003; Huanca, 2008). This situation ended in the 1950s when the opening of new roads, the arrival of highland colonist farmers, and the logging boom put them in continuous contact with other segments of the Bolivian society, processes that transformed their lands, their land tenure system, and their economic activities (Chicchon, 1992; Pacheco, 2002; Reyes-García et al., 2012). Nowadays, the Tsimane' economy still centres on hunting, fishing, and slash-and-burn farming, although they are increasingly becoming integrated into the market economy, mainly selling rice (Vadez, Reyes-García, Huanca, & Leonard, 2008) and engaging in wage labour in forest concessions, illegal loggers,

colonist farmers, and cattle ranchers operating within or around their territory (Godoy et al., 2005). The Tsimane' also sell or barter non-timber forest products (e.g. thatch palm) in nearby market towns or with travelling traders who visit their villages.

Traditionally, the Tsimane' lacked a system of individual land tenure and considered land and natural resources as common properties (Reyes-García et al., 2012). In 1979, parts of their ancestral lands were reduced by a colonisation project that gave several hundreds of hectares to highland colonists as private property (Pacheco, 2002). Soon after, during the 1980s, the Bolivian government granted long-term commercial forest concessions to logging companies and established two protected areas (Pilón-Lajas Biosphere Reserve and Beni Biological Reserve) in the territory inhabited by the Tsimane'. During the 1990s, the Bolivian government started a land titling process, yet to be concluded, that recognises the Tsimane' claim over part of the land they had traditionally occupied, establishing communal lands, or *Tierra Comunitaria de Origen* (TCO). Most Tsimane' villages are settled in the Territorio Indígena Tsimane' (400 000 ha) and in the Territorio Indígena y Parque Nacional Pilón-Lajas (386 000 ha) (Reyes-García et al., under review).

The Tsimane' believe that they share their territory with a number of spirits (*a'mo'*) who guard animals, animal breeding grounds (*chui'dye*), trees, water bodies, and other elements of the environment (Huanca, 2008). The Tsimane' believe that spirits tend to occupy places that were inhabited in the past, often atypical spaces within the forest, such as open areas. Traditionally, the Tsimane' had specific rules that regulated their behaviour in situations that involved the use of areas and resources protected by a spirit. For instance, the Tsimane' believe that tall thick trees have spirits, and that humans must warn those spirits before felling a tree. If a person performs an appropriate song beforehand, the spirit would understand and look for another tree house. Neglecting to follow this ritual has negative consequences for humans, as the spirits have powers they use to protect or harm humans, depending on their behaviour (Huanca, 2008).

Research Methods

Fieldwork was conducted during September and December 2009. The Great Tsimane' Council approved the study, and we obtained prior informed consent from each village and participant. We worked with Tsimane'-Spanish translators who wrote landscape-related terms in the Tsimane' language, using standard linguistic notation.

Sample Selection

This study was conducted in 12 villages (~10% of all Tsimane' villages) within two of the TCO inhabited by the Tsimane' (*Territorio Indígena Tsimane'* and the *Territorio Indígena Multietnico*) (Figure 1). Village selection was based on theoretical and logistical considerations. On the one side, we selected villages comprising all the ecological habitats where Tsimane' villages are currently found except savannahs. Some of the studied villages were located along the main local rivers (the Maniqui and Apere) and some along logging roads. Within the villages by the Maniqui, some were upstream (in *terra firme* forest) and others downstream (in inundated forest) (see Guèze

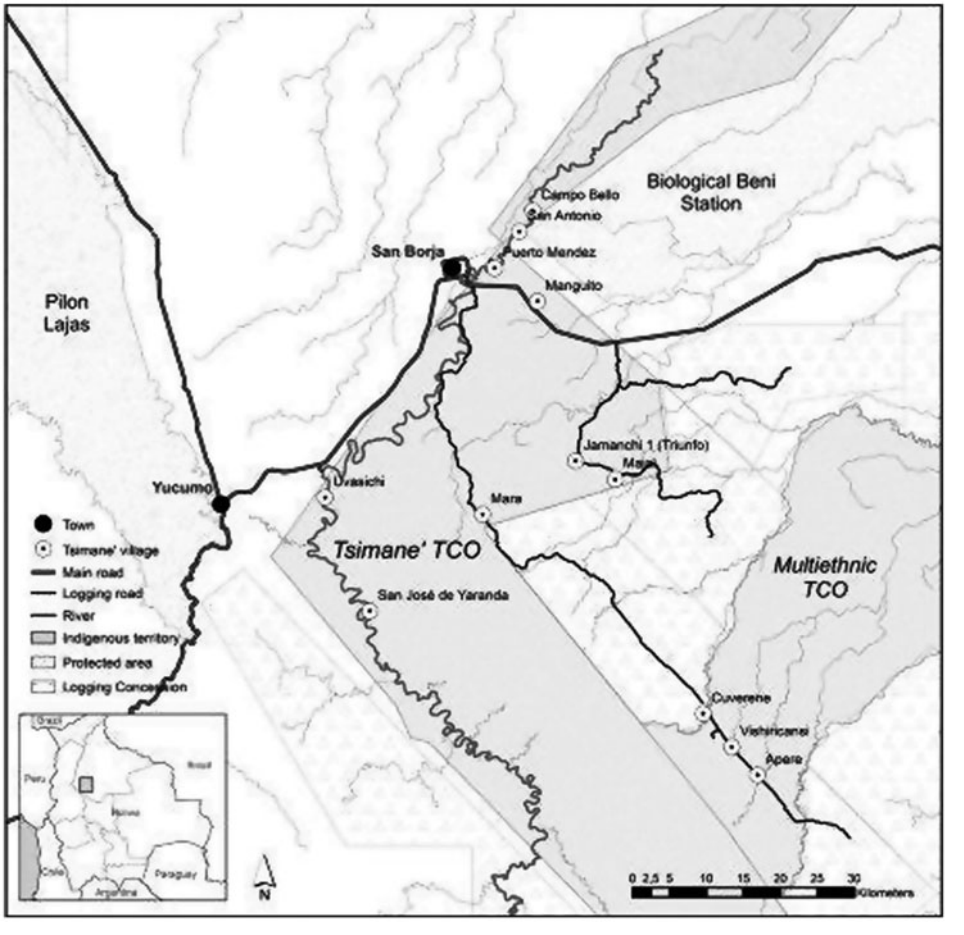

Figure 1. Tsimane' indigenous territory (village place names on the map are restricted to those included in this research).

et al., 2013, for a description of the structure and composition of these forests). Villages along the Apere river and logging roads were settled in *terra firme* forest. On the other side, we selected villages where we had institutional contacts and logistical facilities to conduct the research.

Semi-structured Interviews

To explore the validity of the concept of landscape among the Tsimane', we used a standard academic definition of *landscape* as "spatial units where region-specific elements and processes reflect natural and cultural goods or history in a visible, spiritual and partly measurable way" (Wascher, 2000, p. 25). We conducted semi-structured interviews with 10 household heads living in four villages. During interviews we asked respondents to assess, according to their perception, the validity of different features that define a landscape, including whether they considered that the surrounding

Table 1. Tsimane' folk ecotopes

Folk ecotope	***Ecological correspondence***	**Description**
Cum	Early-growth forest	Young regenerating forests following perturbation (agriculture, intensive logging). Typically composed of a dense number of small trees (5–10 m high).
Därsi därä	Old-growth forest	Old-growth, *terra firme* forests, well drained and with low levels of disturbance. Mature trees form a dense and structurally complex closed canopy with some emergent trees.
Jaman	River bank	Sand banks along rivers with no forest structure.
Mayes	Floodplain forest	Forest inundated during part of the rainy season. They are different in structure and composition to *terra firme* and riverine forests.
Múcú	Montane Amazonian forest	Forest in hilly areas which represent the last transitional zone between the Andean highlands and the eastern Amazonian forests. Forests are moister than *terra firme* forests.
Sajras	Clearing in *terra firme* forest	Clearing in old-growth *terra firme* forest, with bush and ferns, and open canopy.
Sinves ojñi	Riverine forest	Forests that follow creeks, rivers, and lakes. Different in structure and composition to adjacent forests.
Tsäquis därä	Fallow forest	Closed *terra firme* forest with a dense plant understorey, abundant lianas, and less mature trees than old-growth forest.
Tajñi'	Savannah patch	Low relief areas seasonally flooded and forming swamps or marshes. Semi-natural grasses dominate these areas albeit scattered small trees may also form patches.

environments were 1) products of the interaction between natural and cultural processes, 2) dynamic systems, 3) important ecological resources, 4) economically productive and 5) important for Tsimane' identity.

Identification of Landscape Units

To elicit the full range of units perceived by the Tsimane' in their landscapes, we combined information from two techniques: free listings and field transects. Free listings provide a fast method to identify elements in a given cultural domain (Martin, 1995), whereas field transects allowed us to validate free listings' information (Mark, Turk, & Stea, 2010).

We asked 23 male household heads in two of the studied villages to list all the landscape units they knew within the area surrounding their community. Specifically, we asked, "Could you please list all the different 'patches' you can differentiate around the community?" If informants included toponyms within their list, we provided them with further explanations to centre the lists on environmental units. Finally, we asked them to provide a short description of each item listed.

We also conducted nine 5 km-long field transects in the vicinity of three other villages. As the selection of villages for field transects and free listings covered the same ecological habitats, we do not expect any methodological problem arising from the two methods being conducted in different villages. Field transects followed hunting

paths along different directions from the village school (regarded by the Tsimane' as the village centre) and were carried out together with translators and local guides. At periodic intervals and whenever we observed a change in the surroundings, we asked the guide: "What is the name of this patch?" We noted all the names. For new names, we asked the guide to describe the elements that allowed him to differentiate that patch from others.

Classification of Landscape Units

We compiled information from free listings and field transects to generate a list of units that compose the Tsimane' landscape. We used descriptions provided by informants to categorise items in our list as a) *folk ecotopes* or b) *ecotopic patches*. Following Johnson & Hunn (2010, p. 2), we use the term *folk ecotope* to refer to the different units of the environment culturally recognised by the Tsimane'. Ecotopes are very useful for stratifying landscapes into ecologically distinct units, since they are the smallest ecologically distinct landscape features in a landscape classification system (Meyer, Krönert, & Steinhardt, 2000). Different from toponyms, *folk ecotopes* constitute classifications of elements which are repetitively distributed across the territory. We use the term *ecotopic patches* to refer to smaller areas within *folk ecotopes*, often characterised by the dominance of an indicator plant species. *Folk ecotopes* can comprise several *ecotopic patches* of the same or different plant species. In addition, one type of *ecotopic patch* might be included in more than one *folk ecotope*. Table 2 shows the correspondence between the *ecotopic patches* recognised by the Tsimane' and the scientific name of the dominant plant species in the patch. The scientific name of a species was determined using the local name provided and species identification conducted in previous studies (Guèze, 2011; Huanca, 1999; Reyes-García, 2001).

Assessing the Importance of Folk Ecotopes

We also collected information to assess the importance of different *folk ecotopes* across ecological, socioeconomic, and spiritual dimensions as perceived by the Tsimane'.

Ecological dimension

We assessed the ecological importance of a *folk ecotope* by the percentage of different *ecotopic patches* reportedly found in it, with larger numbers indicating higher ecological value. To do so, we asked 33 informants in six of the 12 studied villages a set of questions following the format: "Can X (*ecotopic patch*) be found in Y (*folk ecotope*)?" To reduce the burden to informants, we only asked about 12 *ecotopic patches* per informant, or 108 questions (12 *ecotopic patches* times nine *folk ecotopes*). Questions were distributed across informants in such a way that we asked about each *ecotopic patch* in each *folk ecotope* from three independent informants. If the three respondents did not provide a consensual answer, we asked the same question to two additional respondents and considered as correct the most common answer.

Table 2. Presence of ecotopic patches in listed folk ecotopes

Ecotopic patches \ Folk ecotopes		*Därsi därä*	*Múcú*	*Tsäquis därä*	*Sajras*	*Mayes*	*Sinves ojñi*	*Cum*	*Tajñi*	*Jaman*
Ashabadyei'	Patch of *Poulsenia armata*	■	■	■	■	■	■			
Avadyei'	Patch of *Chrysophyllum argenteum*	■	■	■	■	■	■			
Bejqui'dyei'	Patch of *Hymenaea courbaril*	■	■	■	■	■	■			
Bitiredyei'	Patch of *Attalea butyracea*	■	■			■				
Bojboridyei'	Patch of *Lindernia crustacea*	■	■		■	■	■			
Bua'dyei'	Patch of *Costus scaber*	■	■	■	■	■	■			
Bucujdyei'	Patch of *Ficus* sp.	■	■		■	■	■			
Buruburudyei'	Patch of buruburu (undetermined)	■	■	■	■	■				
Buveidyei'	Patch of *Canna bangii*	■	■	■	■	■	■			
Cajñere'dyei'	Patch of *Ochroma pyramidale*	■				■	■	■		
Cajtafa'dyei'	Patch of *Geonoma deversa*	■	■	■	■	■				
Camdyei'	Patch of *Otoba parvifolia*	■	■	■	■	■	■			
Cavaquisdyei'	Patch of *Terminalia* sp.	■	■	■	■	■	■			
Cayayadyei'	Patch of lianas	■	■	■	■	■	■			
Chijchivadyei'	Patch of *Allamanda cathartica*	■	■	■	■	■	■	■	■	
Chunadyei'	Patch of *Myroxylon balsamum*	■	■	■	■	■				
Chura'dyei'	Patch of *Swietenia macrophylla*	■	■	■	■	■	■			
Cijtadyei'	Patch of *Tessaria integrifolia*						■			■
Cocomadyei'	Patch of *Cariniana estrellensis*	■	■	■	■	■				
Cojcodyei'	Patch of *Pachyrhizus tuberosus*							■		
Cojcopedyei'	Patch of *Bactris riparia*	■	■	■	■	■	■			
Cojmadyei'	Patch of *Dipteryx odorata*	■	■	■		■	■			
Cojnonodyei'	Patch of *Inga* sp.	■	■	■	■	■	■	■		
Conojfoto'dyei'	Patch of *Hura crepitans*	■	■	■	■	■	■			
Copotaredyei'	Patch of *Sloanea fragans*	■	■	■	■		■			
Coropandyei'	Patch of Coropan'(undetermined)	■	■	■	■	■				
Cotisondyei'	Patch of *Terminalia oblonga*	■		■	■	■	■	■	■	

Table 2. (*Continued*).

Ecotopic patches \ Folk ecotopes		*Därsi därä*	*Múcú*	*Tsäquis därä*	*Sajras*	*Mayes*	*Sinves ojñi*	*Cum*	*Tajñi*	*Jaman*
Cotyij'cotyij'dyei'	Patch of *Maclura tinctorea*		■	■	■	■	■			
Do'ñedyei'	Patch of *Ischnosiphon* cf. *puberulus*	■			■	■	■			
Dyujdyudyei'	Patch of *Lauraceae* sp.	■		■	■	■	■			
Eejtseredyei'	Patch of *Chrysophyllum venezuelanense*	■	■	■	■	■				
Fujfujdyei'	Patch of *Cordia spinescens*	■	■	■	■	■	■	■	■	
Ibijquidyei'	Patches of *Rheedia gardneriana*	■	■	■	■	■	■	■		
Ijsi'tadyei'	Patch of *Pseudolmedia laevis*	■	■	■	■	■	■			
Itsidyei'	Patch of *Picramnia* aff. *sellowii*	■	■	■	■	■	■			
Jajru'dyei'	Patch of *Oenocarpus bataua*	■	■	■	■	■	■	■		
Jarüdyei'	Patch of *Bactris major*	■	■	■	■	■	■	■		
Jivindyei'	Patch of *Scleria malaleuca*		■	■	■	■	■	■	■	
Machadyei'	Patch of *Amburana caerensis*	■	■	■	■		■			
Mana'idyei'	Patch of *Attalea phalerata*	■	■	■	■	■	■	■	■	
Mañeredyei'	Patch of *Euterpe precatoria*	■	■	■	■	■	■			
Masedyei'	Patch of *Pourouma* sp.	■	■	■	■	■	■			
Mujperedyei'	Patch of *Sapium marmierí*	■	■	■	■	■	■	■	■	
Mu'surudyei'	Patch of *Clarisia biflora*	■	■	■	■	■	■	■		
Na'fadyei'	Patch of *Tetragastris altissima*	■	■	■	■					
Ñejñejdyei'	Patch of *Ruizodendron ovale*	■	■	■	■	■	■			
Ojdodyei'	Patch of *Iriartea deltoidea*	■	■	■	■	■	■			
Omidyei'	Patch of *Brosimum lactescens*	■	■	■	■	■				
Oveto'dyei'	Patch of *Uncaria guianensis*	■	■	■	■	■	■	■	■	
Pañedyei'	Patch of Pañe' (undetermined)	■	■	■	■	■	■			
Payadyei'	Patch of *Heliconia* sp.	■	■	■	■	■	■			
Pise'redyei'	Patch of *Duguetia spixiana*	■	■	■	■	■	■			
Pomodyei'	Patch of *Pseudolmedia macrophylla*	■	■	■						
Queruquerudyei'	Patch of *Ormosia* sp.	■	■	■	■					
Sequejdyei'	Patch of *Licania britteniana*	■	■	■	■	■	■			
Shaba'shabadyei'	Patch of Ferns	■	■	■	■	■	■			
Shafudyei'	Patch of *Virola* sp.	■	■	■	■	■				

Table 2. (*Continued*).

Ecotopic patches \ Folk ecotopes		*Därsi därä*	*Múcú*	*Tsäquis därä*	*Sajras*	*Mayes*	*Sinves ojñi*	*Cum*	*Tajñi*	*Jaman*
Shara'dyei'	Patch of *Acacia loretensis*	■	■	■	■	■	■	■		
Shayimodyei'	Patch of *Rinorea* cf. *viridifolia*	■	■	■	■	■				
Shesherenadyei'	Patch of *Sloanea obtusifolia*	■	■		■					
Shevindyei'	Patch of Shevin (undetermined)	■	■	■						
Shibo'dyei'	Patch of *Astrocaryum murumuru*	■		■	■	■	■	■	■	
Shuru'dyei'	Patch of *Gynerium sagittatum*						■			■
Shurushurudyei'	Patch of *Ardisia* sp.			■	■	■	■			
Simadyei'	Patch of *Ficus* sp.	■	■	■	■	■	■			
Siyamo'dyei	Patch of *Cedrela odorata*	■	■	■	■	■	■			
Tam'tacdyei'	Patch of *Galipea longiflora*	■	■	■		■				
Tavo'tavo'dyei'	Patch of Tavo' tavo' (undetermined)	■	■	■	■	■	■			
Tayen'tayen'dyei'	Patch of *Cordia nodosa*	■	■	■	■	■	■	■		
Tetesondyei'	Patch of *Mabea anadena*	■	■	■	■	■	■			
Tiribudyei'	Patch of *Cheiloclinum cognatum*	■	■	■	■	■	■			
Titijdyei'	Patch of *Ficus maxima or F. Insipda*	■	■	■	■	■	■		■	
Tsanajdyei'	Patch of *Cecropia polystachia*	■	■		■	■	■	■	■	■
Tserac'tseracdyei'	Patch of *Mouriri* sp.	■	■	■						
Tsocondyei'	Patch of *Rheedia acuminata*	■	■	■	■	■	■			
Tyi'dyei'	Patch of *Genipa americana*	■	■	■	■	■	■			
Tyutyuradyei'	Patch of *Mauritia flexuosa*	■	■	■		■				
Väijväijdyei'	Patch of *Clarisia racemosa*	■	■	■	■	■	■			
Vambasondyei'	Patch of *Aspidosperma* aff. *Rigidum*	■	■	■	■	■	■			
Vapidyei'	Patch of *Guarea* sp.	■	■	■	■	■	■		■	
Vayuridyei'	Patch of *Sparatanthelium burchelii*	■	■	■	■	■	■			
Vijiridyei'	Patch of *Socratea exorrhiza*	■	■	■	■		■			
Vojpinadyei'	Patch of Vojpina (undetermined: bamboos)	■	■	■	■		■		■	
Vojshinajdyei'	Patch of *Ceiba pentandra*	■	■	■	■	■	■			
Yacanidyei'	Patch of several *Leguminosae* trees species	■	■	■	■	■	■		■	
Yäjdyä'dyädyei	Patch of *Calophyllum brasiliensis*	■	■	■	■	■	■		■	
Yashin	Patch with evidence of previous flooding			■	■	■	■			■
Yütidyei'	Patch of *Randia armata*	■	■	■	■	■	■	■	■	
Percentage of ecotopic patches		91%	89%	89%	88%	85%	79%	21%	17%	5%

Socioeconomic dimension

Following insights from the utilitarian perspective on local landscape classifications (e.g. Davidson-Hunt & Berkes, 2010), we explored which were the socioeconomic uses of the nine *folk ecotopes* identified. We asked 66 informants in six villages to name the different activities that the Tsimane' typically perform in each of the nine *folk ecotopes* identified. We also asked informants to rate in a four-point scale how important those activities were for Tsimane' livelihoods. To assess the socioeconomic value of a *folk ecotope*, we then proceeded in three steps. First, we calculated the importance of a socioeconomic activity by averaging informant responses to ratings of socioeconomic activities. Second, we considered that a given activity was actually performed in a *folk ecotope* only when at least half of the people interviewed reported so. Finally, we defined the perceived socioeconomic value of a *folk ecotope* as a function of both the number of activities that can be performed in that ecotope and the importance of those activities for Tsimane' livelihoods. Specifically, we added the rank value of all the activities reportedly performed in each habitat by at least 50% of the informants.

Spiritual dimension

Several researchers have highlighted that a folk classification of landscapes might also take into consideration their spiritual significance (e.g. Gilmore et al., 2010). To explore the spiritual dimension of the *folk ecotopes* recognised by the Tsimane' we asked the same set of 66 informants whether each of the *folk ecotopes* identified was potentially home to one or more spirits. For affirmative responses we also asked them to name those spirits.

Results

The Tsimane' Concept of Landscape

Results from our semi-structured interviews suggest that, although the Tsimane' do not have a word that translates literally for 'landscape', they recognise the features in their surrounding environment that characterise this concept (as in Wascher, 2000). For example, it was clear from our interviews that all our informants acknowledged that the environment around them is the source of their livelihoods and important to sustain Tsimane' way of life. Most informants also recognised that the environment they inhabit results from a combination of natural features and human intervention and that it changes through time. For instance, some informants pointed out that in 2008 an arson had completely changed the view of a mountain close to one of the study villages, and many informants highlighted how early-growth forests were increasingly common due to agricultural practices. Most respondents also acknowledged the importance of landscape for their culture and identity.

Tsimane' Folk Ecotopes

Tsimane' respondents recognised nine *folk ecotopes* in their landscape (Table 1). Descriptions of those *folk ecotopes* suggest that the Tsimane' use a variety of criteria

(namely, geomorphological characteristics, presence of water, history of inundation, potential uses of the landscape unit) to differentiate ecotopes from one another. Thus, some terms mainly refer to geomorphological features of the landscape (e.g. the term *jaman* designates sand banks along rivers and the term *múcú* designates forests in hilly areas). Some other folk ecotopes are named after the dominant forest type, which in turn reflects human intervention. For example, the term *därsi därä* refers to old-growth forest (and literally translates as the 'big forest') whereas the term *cum* refers to early-growth forest. Some ecotopes are also identified in relation to the permanent or temporal presence of water. For example, the term *sinves ojñi* refers to forests along rivers, creeks, and lakes, whereas the term *mayes* refers to floodplain forest close to rivers and creeks, inundated during part of the rainy season.

From informants' descriptions of *folk ecotopes* we can also infer that ecotope use was an important criterion of classification. For example, informants reported that *sajras* or clearings in *terra firme* forests are good spots for hunting because game can be spotted more easily than in other folk ecotopes. They also reported that the semi-natural grasslands in *tajñi'* (or savannah patches) can be used for cattle grazing. The utilitarian criterion, combined with vegetation structure, is used to differentiate between old-growth forest (*därsi därä*) and fallow forest (*tsäquis därä*), which literally translates as 'dangerous forest'. Thus, Tsimane' reported that old-growth forest is good for hunting and adequate for opening patches to establish agricultural plots, whereas the dense plant understory and the abundant lianas present in fallow forest make it unsuitable for those activities.

The Ecological Dimension in Folk Ecotopes

In addition to the nine *folk ecotopes*, we found that the Tsimane' are able to identify at least 89 *ecotopic patches* (Table 2). Almost all the Tsimane' terms for *ecotopic patches* registered refer to the dominant plant species, followed by the suffix *–dyei'*. This suffix is used mostly to indicate a high concentration of a wild plant species or families, and rarely also to cultivated species. Among the terms registered, only one (*yashin*) refers to the soil condition of the area.

Table 2 also shows the correspondence between *ecotopic patches* and *folk ecotopes* (i.e. which *ecotopic patches* can be found in the nine *folk ecotopes* identified). There are two clear groups. Six of the nine *folk ecotopes* identified display a large ecological diversity, as more than 75% of the *ecotopic patches* listed can be reportedly found in each of those six *folk ecotopes*. By contrast, three *folk ecotopes* are characterised by a low diversity of *ecotopic patches*, with less than 25% of the *ecotopic patches* listed potentially found in each. The ecotope where the largest diversity of *ecotopic patches* can be potentially found is old-growth forest, whereas the less diverse *folk ecotope* is the river bank.

The Socioeconomic Dimension in Folk Ecotopes

Table 3 shows results on a) the perceived importance of the different socioeconomic activities for Tsimane' livelihoods, b) the percentage of informants reporting that the activity is performed in the *folk ecotope*, and c) the estimated socioeconomic value of

Table 3. Socioeconomic dimension in Tsimane' folk ecotopes

	Agriculture	Hunting	Fish	Fire wood	Medicinal plants	Wild edible plants	Honey	Thatch palm	Timber	c) Socio-economic value
a) Average rank of importance of the activity for Tsimane' livelihood										
	3.43	3.34	3.34	3.05	2.95	2.77	2.75	2.34	2.14	
b) Percentage of informants reporting that the activity is performed in the folk ecotope										
Därsi därä	88	100	92	94	85	100	100	71	73	26.11
Sajras	65	92	67	77	71	90	83	38	73	23.77
Sinves ojñi	84	72	100	86	53	67	60	35	65	23.77
Mayes	41	90	67	73	59	82	82	31	51	20.34
Múcú	26	100	70	52	70	100	87	48	48	18.20
Tajñi'	29	100	57	57	57	71	71	0	29	18.20
Cum	93	69	28	95	55	59	50	10	59	17.68
Tsäquis därä	36	77	45	53	49	64	68	30	34	11.91
Jaman	9	25	100	81	6	22	19	3	35	06.39

each of the nine ecotopes as a factor of the perceived importance of an activity and the number of activities that can be potentially performed in them.

Informants indicated that the most important activities for Tsimane' livelihoods are subsistence agriculture, hunting, and fishing whereas the commercialisation of thatch palm and timber extraction were considered less important activities. Regarding the distribution of Tsimane' socioeconomic activities across *folk ecotopes*, we found that there is only one *folk ecotope*, old-growth forest, where all the activities in our list can take place, and two more, clearings in *terra firme* forest and riverine forest, where all the activities except one (thatch palm collection) can take place. The *folk ecotope* where fewer activities can occur are river banks, where according to Tsimane' informants only fishing and firewood collection are feasible.

Results taking into account both the number of socioeconomic activities that can be performed in a *folk ecotope* and the importance of such activities suggest that the *folk ecotopes* with highest socioeconomic value for the Tsimane' are old-growth forest, clearings in forest, and riverine forest (Table 3). As with the ecological dimension, the *folk ecotope* with a lowest socioeconomic value for the Tsimane' are river banks where an absence of vegetation and smaller areas makes it impossible to carry out most livelihood-related activities.

The Spiritual Dimension in Folk Ecotopes

Informants also perceived the potential presence of different spirits (*a'mo'*) in each of the *folk ecotopes*. Table 4 shows the percentage of informants who reported the presence of one or more spirits in each *folk ecotope*. Most informants responded that spirits live in old-growth forest (69%), early-growth forest (62%), and forest clearings (60%). During fieldwork, we could not visit some of the places in old-growth forests, as our guides were afraid of entering sacred places that were inhabited by forest spirits. A lower percentage of our informants considered that spirits could live in fallow forest

Table 4. The spiritual dimension in Tsimane' folk ecotopes

Folk ecotope	% informants reporting the presence of at least one spirit	Name of spirits reported	No. of different spirits reported
Därsi därä	68.6	*Itsiqui', Jäjäbä, O'pito, Susunaqui, Vajedyedye*	5
Cum	62.5	*Tyäquij*	1
Sajras	60.0	*Jäjäbä, Oojpona, O'pito, O'tydyé, Sicurí, Sonsoñis, Tsëtsëquin', Tyäquij, Tyi'mu, Ujú*	10
Mayes	55.8	*Jäjäbä, O'pito, O'tydyé, Sonsoñis*	4
Tajñi'	52.0	*Chajrara, Idojoré, Jäjäbä, Onojnodye'*	4
Sinves ojñi	48.1	*Jäjäbä, O'pito*	2
Múcú	45.8	*Jäjäbä, Idojoré, O'pito*	3
Jaman	30.3	*Isujqui, Jäjäbä, O'pito, Sinconchoa*	4
Tsäquis därä	13.3	*Itsiqui', Jäjäbä, O'pito, Tsëtsëquin', Tyäquij, Ujú, Yashín*	7

Table 5. Ranking of the importance of Tsimane' *folk ecotopes* across dimensions

	Ecological dimension (Table 2)	Socioeconomic dimension (Table 3)	Spiritual dimension (Table 4)
Därsi därä	1	1	1
Múcú	2	5	7
Tsäquis därä	3	8	9
Sajras	4	2	3
Mayes	5	4	4
Sinves ojñi	6	3	6
Cum	7	7	2
Tajñi'	8	6	5
Jaman	9	9	8

(13%) or river banks (30%). While some spirits, such as *Jäjäbä* (the spirit of wild animals) and *O'pito* (the rainbow and the spirit of water), were potentially found in most ecotopes, some others, such as *Ty'mo* (a spirit that takes the form of the wind to make one lose direction), or *Sicurí* (a spirit that takes the form of an anaconda), were only potentially found in one *folk ecotope*.

Folk Ecotopes across Dimensions

In Table 5 we present the relative ranking of the nine *folk ecotopes* examined across the three dimensions presented in Tables 2 to 4. Most *folk ecotopes* were ranked differently from one dimension to another. For example, montane Amazonian forest ranked second regarding its ecological importance, fifth in the socioeconomic dimension, and seventh in the spiritual dimension. The three exceptions were old-growth forest that ranked as the most valued *folk ecotope* in the three dimensions examined; river banks that ranked as one of the less valued *folk ecotopes*; and floodplain forest that ranked in the intermediary positions for the three dimensions examined.

Discussion

Tsimane' Landscape Classification

The Tsimane' show a rich and complex knowledge regarding their natural environment which seems to be built on expertise in managing their land and on cultural bonds attached to it. The information presented here suggests that, although the Tsimane' do not have a term for landscape as we do, they classify the territory in which they live using a combination of biogeophysical characteristics (namely, forest composition and structure, forest successional stages, geomorphology, and hydrology), previous human intervention, and the potential uses of distinguishable territorial units for their livelihoods. These criteria are consistent with those that Martin (1995) suggests as the main domains of folk ecological knowledge: landforms, soils, climate, vegetation type, stages of ecological succession, and land-use. The combination of such characteristics leads to a fine-grained classification system. For example, within forest, the Tsimane' differentiate a type of old-growth forest with low levels of disturbance, mature trees

and a close canopy (*därsi därä*), from a more closed type of early-growth forest with a dense plant understorey (*tsäquis därä)*, and from the old-growth forest in mountainous areas (*múcú)*. And thus, although the three *folk ecotopes* share the presence of most *ecotopic patches* (see Table 2), the Tsimane' report different economic activities and attach the presence of different cultural elements to each of them (see Tables 3 and 4).

In contrast with the multiplicity of classificatory elements to identify *folk ecotopes*, Tsimane' finer classification of landscape sub-units (*ecotopic patches*) mostly relies on a single criterion: the dominance of a plant species in 88 out of 89 *ecotopic patches* identified. Such reliance on vegetation patches to identify elements of the landscape is not the norm among Amazonian groups. For example, Fleck and Harder (2000) documented the habitat classification system of the Matses indigenous peoples in Peru, finding that their system is based on both biotic and abiotic elements of habitats. Similarly, in their study of a classification system in southeastern Peru, Shepard et al. (2001) found that the Matsigenka distinguish forest habitats mainly according to vegetation features, but also according to abiotic traits. In contrast, among the Tsimane' we only found one *ecotopic patch* that relied on abiotic elements (soil type) for its identification. Reliance on vegetation patches to identify elements of the landscape resembles standard scientific classifications. From the point of view of landscape ethnoecology, this is interesting in itself, as it highlights the convergence between indigenous and scientific knowledge systems (Halme and Bodmer, 2007).

Importance of Folk Ecotopes across Dimensions

We found that the Tsimane' attach different importance to the nine *folk ecotopes* studied according to the ecological, socioeconomic, and spiritual dimensions, and that most *folk ecotopes* ranked differently from one dimension to another. In other areas of the ethnosciences, researchers have developed quantitative indices to assess the value of different elements in a cultural domain across several dimensions. For example, ethnobotanists have developed indices that allow them to assess the importance of a plant species for a given cultural group taking into account the species' ecological, economic, and cultural dimensions (Reyes-García, Huanca, Vadez, Leonard, & Wilkie, 2006; Tardío & Pardo-de-Santayana, 2008). Such indices are useful because they take into account more than one dimension when considering the importance of a plant species for a cultural group. To our knowledge, there has been only one previous attempt to evaluate landscapes with such a perspective. Specifically, Campos et al. (2012) developed the Landscape Perception Unit Importance Value Index (LPUIVI) to evaluate landscapes in the Mexican Pacific coast from a cultural standpoint, particularly considering their importance in providing environmental goods and services. Our results and the results of Campos et al. (2012) suggest that, as with plant species, ecotopes can be valued differently across dimensions. The fact that different elements of the landscape are differently valued across dimensions implies that using only one dimension (say ecological or economic) to assess the value of a given landscape could undermine the overall importance of the landscape for people.

Conclusion

To conclude we highlight two limitations and one policy implication of our work. The first caveat relates to the three dimensions used to examine indigenous perceptions of the landscape. Although this work explores local valuations and perceptions of the landscape, we do so using three pre-defined dimensions: ecological, socioeconomic, and spiritual. During fieldwork we realised that those dimensions were in practice intermingled, rendering our classification too static to fully capture local perceptions. Thus, future research should continue the line of thought presented here but emphasising dimensions that are locally defined, as well as exploring their interrelations. The second caveat relates to the dynamic nature of the knowledge system analysed. As mentioned, over the last few decades the Tsimane' have increasingly become integrated into the market economy and altered their relations with the national culture. Relations with other actors have probably affected the way they perceive and use the landscape, yet our data do not allow us to assert to what degree it might be occurring. Hence, the results presented here reflect current Tsimane' perception of the landscape, but we do not assess whether those perceptions are part of the Tsimane' traditional knowledge system, or product of the interaction between the traditional system and recently acquired conceptualisations of space. Future research should address how local perceptions change as indigenous groups interact with other sectors of society.

In regions of high biological diversity, landscape management decisions often respond to unintended processes of land use change, but rarely take into account local actors' landscape perceptions (see, for example, Nadasky, 2003; Spak, 2005). The concern that, due to conflicting driving forces and pressures, essential landscape functions and values could be permanently lost, calls for the development of novel approaches to landscape research, acknowledging local peoples' understandings, valuation, and classification of landscapes. Understanding how local people perceive their environments is an important part of participatory landscape management planning. When coupled with insights from other disciplines, such knowledge is likely to be very helpful to design landscape management initiatives that are more suited to local needs. This should augment the prospects for successful landscape management while strengthening local peoples' livelihoods. For example, assessing local priorities in landscape management could help determine current priority areas for community use, differentiating areas for strict conservation from areas for economic development. This research shows a model of landscape classification that is an alternative to commonly accepted scientific methods alone, and is arguably a more meaningful approach in places where land is not mostly a backdrop to human activities but the key source of sustenance and cultural identity.

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