Deciphering landscapes through the lenses of locals: The "Territorial Social-Ecological Networks" Framework applied to a Brazilian maroon case

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Abstract: Landscape approaches are prominent in current policy debates about how to achieve ecological, economic and social sustainability. These approaches assess local social-ecological contexts to plan adaptive management and often include indigenous peoples and local communities (IPLC). An important aim of landscape approaches is to integrate different scientific disciplines, indigenous and local knowledge systems (ILK) and Western science, and global and local needs. In practice, such integration tends to favor globalized knowledge models and global needs over local ones. This article introduces a Territorial Social-Ecological Networks (TSEN) Framework for an integrated assessment of landscape settings and dynamics to overcome such tendencies. We argue that both scientific knowledge and ILK are entwined with practice and informed by worldviews. Moreover, these assemblages of knowledges-practice-worldviews are produced by social and ecological interrelations (or networks) that shape human appropriation of territory. We use an approach of methodological bricolage to apply the TSEN Framework to the case of the Brazilian Malhada Grande Maroon Territory. The results highlight how social-ecological networks of different space-time scales co-produce landscapes. Trade-offs and synergies between global and local needs are also discussed and used to identify priority needs that can be addressed by a landscape approach in the area. The analysis suggests that the TSEN Framework may be used by both scientists and practitioners to perform environmental assessments that are inclusive of social and ecological disciplines, of local and Western scientific knowledge, and of global and local needs in a landscape.

1. Introduction

For more than a decade, landscape approaches have been advocated to address sustainability in an integrated manner by addressing multiple disciplines, knowledges, and needs that span science-society-policy interfaces and policy sectors and scales (Agnoletii and Rotherham, 2015; Arts et al., 2017). International organizations, including FAO and others, increasingly look to landscape approaches to inform policy development and implementation. Landscape approaches make use of environmental assessments of local social-ecological contexts to inform environmental planning that promotes adaptive co-management. In doing so, they attempt to integrate various disciplines, forms of knowledge and needs of global to local stakeholders, including indigenous peoples and local communities (IPLC) (Sayer et al., 2013; Turnhout et al., 2017). Accordingly, landscape approaches engage with and reshape pre-existing resource management and local governance to achieve sustainability and resilience (Freeman et al., 2015).

Global estimates suggest that IPLC include up to 2.5 billion people who directly depend on territory for their livelihoods. They manage over 50% of global land surface, while having formal ownership or land use rights of less than 10% of their territories (Oxfam, 2016). Indigenous territories alone cover 22% of the world's surface, and IPLC are the custodians of 80% of the global biodiversity (FAO, 2017). IPLC are widely recognized for contributing to biodiversity and ecosystem services via indigenous and local knowledge systems (ILK) and interconnected practices (Berkes, 2012; Descola, 2013; Nolte et al., 2013; Díaz et al., 2015). However, pressure from agribusiness and other external drivers threaten traditional land use and management practices, land tenure, and access to livelihoods. Such threats highlight the importance of landscape approaches that address land management in line with ILK (Toledo and Barrera-Bassols, 2009).

Landscape approaches seek to integrate different disciplines, knowledge, and needs. First, they consider a landscape from a social-ecological system (SES) perspective and aim to integrate knowledge from both social and ecological disciplines to assess landscape settings and dynamics and to inform planning (Angelstam et al. 2013). Second, they adopt a participatory approach to integrate different types of knowledge. The idea is that engagement of and trust between relevant stakeholders from global to local scales – including planners, locals and other stakeholders – allows for the integration of their knowledge, practices, and worldviews (Freeman et al., 2015). Third, landscape approaches rely on adaptive co-management to integrate the multiple needs and interests of these global, local, and intermediary actors in the constitution of multifunctional landscapes (Arts et al., 2017).

Scholars of landscape approaches have identified multiple challenges to integrating disciplines, knowledges, and needs (Freeman et al., 2015; Sayer et al., 2013). First, landscape approaches struggle to overcome disciplinary boundaries, which is thought to

prevent a full understanding of landscape settings and dynamics (Reed at al., 2016). Second, while trying to integrate scientific and non-scientific knowledges, participatory approaches often struggle to give enough voice to locals and tend to privilege Western scientific knowledge over ILK (CBD, 1992; Turnhout et al., 2012). This has also prevented ILK from informing planners about social-ecological interrelations that are entwined with landscape settings and dynamics (Escobar, 2008; Turnhout et al., 2013; Díaz et al., 2018). Third, landscape approaches fail to sufficiently recognize trade-offs and synergies between the different global and local needs and interests in a landscape. Thus, landscape approaches have sometimes run counter to the needs they are expected to address (Cooke and Kothari 2000; Berkes, 2009; Turnhout et al., 2010; Clay, 2016).

Critiques associated with integration challenges have pointed out that landscape approaches run the risk of becoming depoliticized and of reinforcing power inequalities between stakeholders during policy development and implementation (Reed at al., 2016). Specifically, scholars have emphasized the incommensurability of different knowledge systems (Nadasdy, 2003; Tengö et al., 2017) and the gap that exists between universalizing tendencies of Western policy models and the diversity and particularity of non-Western or Southern ILKs (Escobar, 2008). They also emphasize the importance to comprehend landscape in an integrated way, as entwined with a territorial context, and as a whole SES (FAO, 2005, 2016; McCall, 2016; Raffestin, 2014). A lack of focus on integration may lead to misrecognition of how certain forests contribute to local food security. Moreover, it may make environmental planning more likely to favor global interests (e.g. use-restricted nature conservation) over local needs (e.g. food sovereignty). In turn, this may lead to disrupt the resilience of an SES (Bohensy and Maru, 2011; Ayana et al., 2015; Behagel et al., 2017).

To address the above challenges and critiques, scholars have proposed relational perspectives that consider nature and society as entwined, knowledge systems to be co-produced, and global-local scales to be interconnected (FAO, 2005; Latour, 2005; Folke, 2006; Ostrom, 2007; Bodin and Tengö, 2012). We draw on these perspectives to introduce a framework for an integrated assessment of landscapes that focuses on understanding how landscapes are co-produced by social-ecological interrelations (or networks) of multiple space-time scales. Our central argument is that ILK and scientific knowledge are both part of assemblages of knowledge-practices-worldviews (k-p-w). These k-p-w's result from and are the expression of social-ecological networks that co-produce landscape settings and dynamics. We illustrate the framework with a case study of the Malhada Grande Maroon territory in Brazil. The results highlight how a landscape is co-produced at a local scale and identify priority needs that can be addressed by landscape approaches. We conclude with a reflection on the potential of the framework to support landscape approaches that are interdisciplinary, participatory, and inclusive of global-local needs.

2. Territorial Social-Ecological Networks (TSEN) Framework

Below, we present the TSEN Framework to inform integrated assessments that focus on understanding landscape settings and dynamics that include IPLC and ILK. This assessment provides crucial information for environmental planning that integrates different disciplines, knowledges, and needs from stakeholders of different spatial scales. We detail the framework by drawing on three bodies of literature: critical geography and studies on territory (Haesbaert, 2004; Raffestin, 2014), SES studies on adaptive and natural resource (co)management (Folke, 2006; Ostrom, 2007, McGuinnes and Ostrom, 2014), and ethnoecology and post-colonial studies (Toledo, 2002; Escobar, 2008; Kincheloe, 2008).

2.1. Landscape and territory

In the TSEN Framework, we define landscape as a material or visible dimension of territory that is shaped by social-ecological networks through knowledge, practices, and worldviews of multiple scales, and that constitutes a totality which includes a mosaic of patches of land use and resource management.

Historic definitions of landscape in the eighteenth century connect to the Dutch *landschap* (landscape) painting style and already emphasize visibility, for example when Humboldt used this word to refer to natural elements of inhabited regions (e.g. seas, valleys, buildings) (Kwa, 2005). Later, Vidal de La Blache (1928) describes landscapes as inclusive of both natural conditions and social choices. Critical geographers in the 1970s define landscape as the visible result of territorial processes that carry social functions and meanings (Santos, 2006). More recently, geographers explicitly add cultural, cognitive, symbolic, historical, and political dimensions to the understanding of landscape (Ingold, 1993, Lorimer, 2013; Raffestin, 2014). Finally, the current policy-oriented use of the concept adds the dimension of agency to landscape. For example, the European Landscape Convention defines landscape as "part of the land, as perceived by local people or visitors, which evolves through time as a result of being acted upon by natural forces and human beings" (European Landscape Convention, 2000, webpage). The Latin American Landscape Initiative (LALI, 2010, p.5) defines it as "a whole that human beings conceive as an integral actor in its evolution".

The defining characteristic of territory is that it is a space that is appropriated or "claimed" by people (Storey, 2001). This implies that a geographic area consists of both an immaterial sphere (i.e. cognition, worldviews) and a material sphere (i.e. forest, tools). Together, these spheres produce a specific setting of social-ecological relationships; in other words: territoriality (Raffestin, 2014). Such relationships encompass social and ecological

dimensions. These include cultural dimensions (i.e. identity, behavior) (Restrepo, 1996), political dimensions (i.e. bounded areas, management decisions) (Storey, 2001), and economic dimensions (i.e. production, social reproduction) (Harvey, 2011), as well as ecological dimensions related to Earth spheres (i.e. biosphere, lithosphere), ecosystems (i.e. services), and ecological renewal (i.e. resilience states) (Raffestin, 2014). These dimensions interact across multiple, porous spatial scales (i.e. place, region, globe) over time (i.e. historical phases, geological ages) (Massey, 2005; Haesbaert, 2004).

We consider landscapes and territories as entwined. They are co-produced by the social-ecological interrelations that both define territory as a space appropriated by people and define landscape as a visible totality that interacts dialectically with this appropriated space. These social-ecological interrelations are dynamic and become manifest in concomitant de- and reterritorialization processes. Deterritorialization describes processes where material and immaterial control over territories is lost, for example when modern states expropriate peasants via agribusiness schemes (Haesbaert, 2004; Yukpa, 2016). Re-territorialization corresponds to the (re-)gaining of control over territory, for example when IPLC occupy new lands and return to traditional practices (Holmes, 2014; Sletto, 2016). These territorial processes result in landscapes as visual expressions of territories. Landscapes also influence territorial processes via emergent properties that are inherent to its functioning as a whole (Ponge, 2005; van Mierlo, 2010). These emergent properties provide social-ecological feedback that occur in territorial contexts and affect the resilience and sustainability of SES, amongst others.

2.2. Social-ecological networks

Both social and ecological components of territorial social-ecological networks (TSEN) are active agents in the co-production of territory and landscape. Social-ecological networks are arrangements of human and non-human entities (i.e. people, ecosystems,

things, practices, ideas) and include social-social, ecological-ecological and social-ecological interrelations (Bodin and Tengö, 2012). While humans and non-humans are qualitatively different, non-humans can also have agency and behave as "actants", as they stimulate and respond to actions (Latour, 1997). For example, both global policies and soil fertility may change over time and each may affect land use change.

TSEN are assemblages of different components of multiple spatial scales and behave in not fully pre-determined ways (Deleuze and Guattari, 1987; Grosz, 1994; Varela, 1999). Local social and ecological components may interact actively with, without necessarily being subsumed to, components of other spatial scales within a landscape (Westley et al., 2013; Folke, et al., 2016). These cross-scale interactions may happen between local resources and external inputs, as well as between local and global institutions, knowledges and needs (Cash et al., 2006; Folke, 2006). In other words, a landscape and a territory are co-produced by networks of different scales. The global to local needs present in these networks may also work in synergy or lead to trade-offs. For example, interests in conservation can compete with local needs for food production, but they can also be aligned in win-win processes for different actors in a multifunctional landscape (e.g. sustainable resource management).

Across temporal scales, networks show emergent properties resulting from the network as a whole, alternatively organizing themselves as spontaneous or as hierarchical arrangements (Grosz, 1994). Landscape dynamics follow this emergent behavior through modes of both uncertainty and path-dependency. Accordingly, landscape settings may change due to emergence, new agency, and new territorial arrangements (DeLanda, 1997). Folke (2006) explains how SESs evolve via adaptive cycles that alternate between periods of increasing stability and periods of creative destruction, including social-ecological re-organization and renewal. Moreover, SESs develop new states of relative stability

(equilibrium) or resilience when they face social-ecological changes whose accommodation is beyond their carrying capacity. Humans act in these adaptive cycles by introducing and responding to social-ecological changes through adaptations of knowledge, perceptions, and practices (Sterling, 2007; Folke et al., 2016). For example, the resilience and dynamics of Amerindian landscapes resemble adaptation of indigenous knowledge and practices under territorial changes that were shaped over millennia (WinklerPrins and Barrera-Bassols, 2004). Of course, modernity has accelerated such processes. In any case, the continuous territorial reconstruction makes temporal scales and historical phases of a landscape relative to the content of change analyzed.

2.3. Knowledges, practices and worldviews

IPLC landscapes can be studied by considering how results of interactions between components of TSEN are expressed as k-p-w. Territorial appropriation by IPLC is usually centered on local resource management to obtain food and secure livelihoods (CBD, 1992; Escobar, 2008). According to Toledo and Barrera-Bassols (2009, p.41), this management is achieved via ILK that are established by means of a triad of *corpus* (knowledge), *praxis* (practices), and *kosmos* (worldviews), or k-p-w. This triad is also understood as an assemblage of knowledge, practices, and beliefs by other scholars (Berkes, 2012; Sterling, 2007). As IPLC are not isolated from society, their k-p-w is not limited to ILK and is also shaped in relation to the k-p-w of stakeholders across scales. It is increasingly recognized that the divide between scientific and non-scientific knowledges is an artificial construction and that all forms of knowledge are influenced by worldviews and shaped in entwinement with practice (Agrawal, 2005; Raffles, 2002). Thus, social-ecological interactions that include multiple k-p-w co-produce the territory and landscape of IPLC. Accordingly, studying k-p-w emphasizes the contribution of human cognition, values, and practices to SES (cf. Westley, 2002).

ILK refers to cumulative bodies of k-p-w of IPLC and can include both local, indigenous, folk, and traditional ecological knowledge (Díaz et al., 2015). ILK is co-produced between people and between people and nature, through social learning, social-ecological feedback on experimental practices, and the adaptation of knowledge (Berkes, 2012; Toledo and Barrera-Bassols, 2009). ILK is often found to be structured in classificatory systems of landscape compartments (i.e. floodplain, highlands); soil properties (i.e. color, texture, fertility); and vegetation character (i.e. fallow, primary) (Barrera-Bassols and Zinck, 2003). These criteria may correspond to indicators for ecosystem services, soils, landscape compartments, and land suitability that are often applied in the Western approaches to land use planning and management (Barrios et al., 2012). The transmission of ILK involves knowledge acquisition, oral exchanges, and empirical demonstrations of k-p-w across generations (Turnbull, 2009; Berkes, 2009). The ILK legacy is thus associated with the maintenance of related values and practices and with access to knowledge resources.

IPLC practices are expressed in specific forms of nature appropriation and environmental behavior (Sterling, 2007). They include the adoption and distribution of land use types (i.e. agriculture) and resource management strategies (i.e. shifting-cultivation) that shape the landscape setting (Fagerholm et al., 2012). Resource management is important as IPLC relate to lands according to how these provide livelihoods and associated services or contributions for local consumption and development. IPLC also have the agency to adapt practices and by extension k-p-w to social-ecological feedback, for example when new leadership in a community lifts customary restrictions to harvest fodder in a patch of spiritual forest (cf. Behagel et al., 2017).

The worldviews of IPLC are constructed by both a cognitive and affective interrelation with nature (Escobar, 2016). Worldviews include social beliefs, values (i.e. cultural, economic and ecological values developed in relation to nature), and aspirations that

influence how IPLC address their needs, engage with nature, and interpret the social-ecological interrelations they experience (Escobar, 2008). For example, spiritual animist values are infused with birds, rivers, and the earth, and are shaped within indivisible social-ecological worlds that generate a sense of place or of belonging to a homeland (Restrepo, 1996; Masterson et al., 2017). IPLC worldviews are also referred to as "cosmovision" because they conceive living and non-living beings and phenomena in a cosmological way – e.g. agricultural, spiritual, and astronomical calendars are often linked (Toledo and Barrera-Bassols, 2009). While IPLC worldviews are mostly different from Western worldviews, they are often also forged in relation to them (Maturana and Varela, 1987; Descola, 2013).

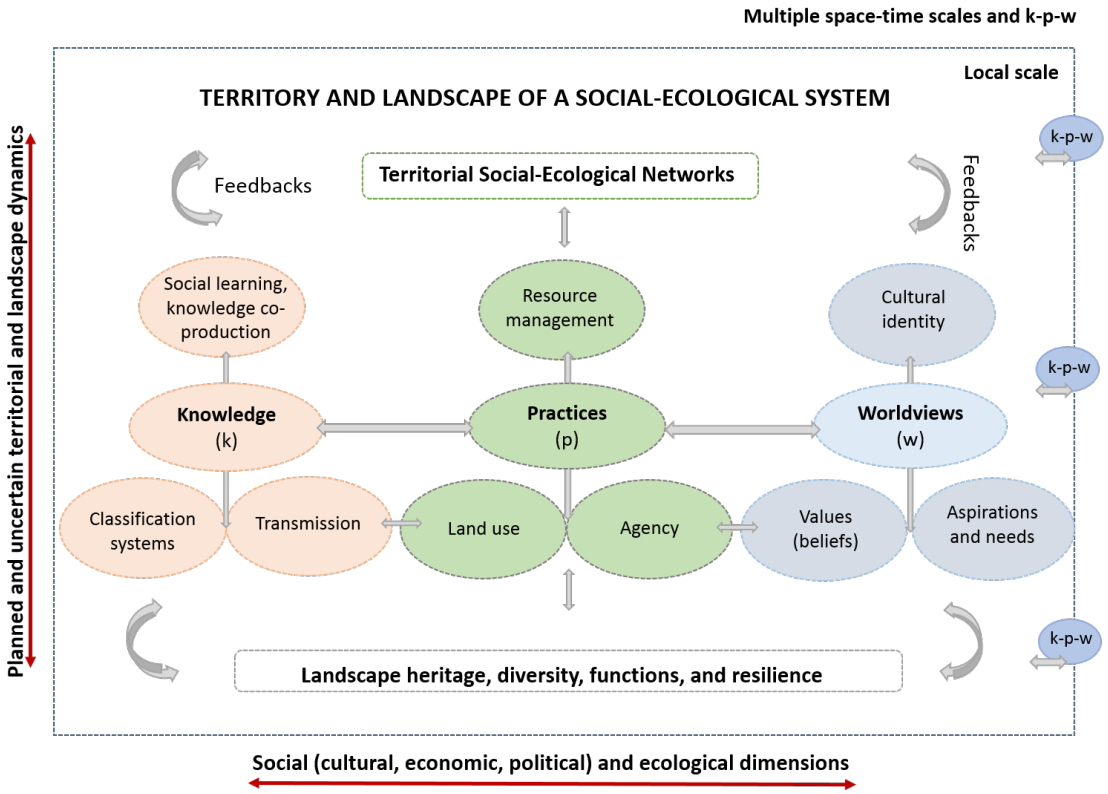

Fig. 1. Schematic representation of the TSEN Framework proposed by the authors in this paper to be applied for the environmental assessment of social-ecological contexts of resource management of IPLCs. It represents a complex SES that entwines territory (a space appropriated by people that contains components of social – cultural, economic, political – and ecological dimensions) and landscape (conceived as visual emergent wholeness that operates through both path-dependency and uncertainty). The emphasis on networks highlights

social-ecological interrelations and the influence of both social and ecological agencies on SES. The focus on k-p-w stresses how these social-ecological interrelations are expressed in a landscape. The framework implies that social and ecological components of the TSENs of multiple space-time scales result in diverse k-p-w that interact with local k-p-w. Via k-p-w, these different TSENs trigger territorialization processes and co-produce the landscape. As a visible sum of parts of the system, the landscape assembles the results of these processes, whose functioning influences TSEN and territorial processes. Moreover, it exposes feedback associated with interactions within the system, as well as the resulting heritage, diversity, functions, and resilience.

The TSEN Framework schematically presented in Figure 1 represents the landscape settings or the SES where landscape approaches intervene in social learning processes, resource management, and ultimately cultural identity. It highlights how TSENs are expressed in k-p-w and how emergent feedback on various scales trigger deterritorialization and reterritorialization processes that co-produce territory and landscape. While integrating global to local scales, the TSEN Framework places special emphasis on the local scale and on local agency. TSENs can be studied via a multitude of variables or components that literature on SES and environmental assessment identify (i.e. Berkes et al., 2009; Ostrom, 2009; Tengö et al., 2017). Table 1 lists a broad range of these variables. Selection of categories proposed in both Figure 1 and Table 1 may be done according to the needs of each study and assessment and may include additional categories.

Table 1. Possible variables or components of social-ecological systems associated with k-p-w that can be selected to be investigated when assessing local contexts using the TSEN Framework. Variables are presented per scales, per territorial dimensions, and per elements that constitute networks associated with knowledge, practice and worldviews.

Scales			
Space	*Time*		
Patches Properties Landscape compartments/patches Local Regional National Global	Periods of the day Daily Seasonal Annual Past history Present Future Temporal phases		
Territorial dimensions			
Cultural	*Economic*	*Political*	*Ecological*
Population growth, density and organization Gender Cultural conjuncture, diversity and heritage Conceptions of contributions to people as ecological benefits or threats Adaptive cycles Social robustness	Economic organization Income, poverty Social-ecological reproduction Infra-structures Subsistence or self-consumption Markets and trade Land use Planning Crisis Competition Social changes Partnership	Leaderships, stakeholders (State, NGO, researchers, practitioners) Agency, conflicts, impositions Structures of organization Institutions, rules, taboos Governance, power Associations, partnerships Policies accessed Relation with other stakeholders	Assets (geology, climate, relief/geomorphology, soils, flora, water resources, fauna) Earth spheres Diversity and state Livelihoods, including food and other associated ecosystem services or contributions to people Ecosystem regulation, functions Carrying capacity Path-dependency Geo-chemical cycles Resilience and heritage Environmental impacts Sources of diseases and risks
Knowledge networks			
Social learning		*Transmission*	Classification systems
Co-production of knowledge Cognition, representation Response to feedbacks to empirical experimentation Observation Chosen changes, innovation (e.g. adoption of a crop) across and within genders/stakeholders Adaptation Cognition, knowledge systems	Technology Choices, methods and principles of practices Awareness	Knowledge sharing, acquisition, transferences, exchanges within/across generations and genders, and with other stakeholders Loss of knowledge Innovation	Landscape compartments; soils/forests Water resources; fauna utilities Lands agricultural suitability Social cultural/ economic/political criteria and ecological indicators Power Integration, weaving and cross-fertilization of knowledge Inter and transdisciplinarity Goals to apply knowledge
Practice networks			
Land use		*Agency*	*Resource management*

Conservation Agriculture, grazing, hunting, gathering fishing Leisure, handicraft (e.g. clay ceramics) Food system/culture Land restoration Consumption Ecological behavior and attitudes Abandonment of practices K-p-w innovation (e.g. agency innovation)	Distribution across relief sectors, soil landscape approaches, and vegetation types of the landscape Land cover	Local leaderships Associations Partnerships Governance Power relations, conflicts Decision-making Acceptance and crafting of influences and impositions	Techniques, labor, labor relations, purchasing power Motivations, needs, goals Potentials/vulnerabilities Adaptation Impacts/sustainability Regulations of use/assessment (e.g. taboos of use) Rituals
Worldview networks			
Values (beliefs)		*Aspirations and needs*	*Cultural identity*
Values in relation to things/beings, people, nature Spirituality, religion Holism, reductionism Cosmovision Ontology Positioning before the world, nature and people Perceptions, conceptions Sense-making to decide Gender values Cultural background Understandings of the world	Transformative learning	Wishes and dreams for the future Decision-making motivations Influences Market engagements Sovereignty Transformability Demands for territory, land, food Self-consumption, security, shelter Livelihoods Identification	Alterity Self-determination Ethnicity, tribe, Knowledge, practices and worldviews Heritage, memory, transmission Sense of belonging

3. Methodological approach

3.1. Study area

Malhada Grande is the territory of one of 32 Gurutuba Maroon communities in the north of the Brazilian state of Minas Gerais. It is located in the municipality of Catuti, in the São Francisco Depression (Egger, 2006), on the transition between the Caatinga tropical dry forest and the Cerrado savannah (Ab'Sáber, 2003). The area is characterized by a calcareous geomorphology and by fertile soils that are associated with deciduous seasonal forests (Arruda et al., 2013); it also includes the degraded version of *carrasco* vegetation, which results from historic human fire management (Andrade-Lima, 1981). While IPLC are a regional majority, large-scale cattle grazing dominates as a land use type, making this the most conflict-prone area of Minas Gerais (D'Angelis Filho et al., 2009). Semi-arid climate, vulnerability to desertification (PAE/MG, 2010), and poverty all threaten the food

sovereignty of IPLC in the area (Londres, 2014). Political mobilization of IPLC has nonetheless resulted in public policies that address their land tenure, food security, and co-existence with drought conditions.

3.2. Methodological principles

We used three key methodological principles to apply the TSEN Framework and assess social-ecological contexts. The first principle was to safeguard participation of locals. Local actors were explicitly encouraged to proactively contribute to data collection. This principle builds on the recognition that ILK is crucial to informing local settings and supporting environmental planning attuned to these settings. Ensuring separate engagement of locals (without other stakeholders present) in part of the assessment helps to guarantee the inclusion of local needs.

The second principle was to be sensitive to diversity. This entails an ethical concern to understand and include the diversity of k-p-w that influences each context, recognizing that different needs and interests can be favored differently by the information assessed. It emphasizes that different power dynamics and political ecologies co-exist in a landscape, and that policy agendas should align with local needs (Escobar, 2008). The third principle was to use methodological bricolage (Kincheloe, 2008). This entails allying participatory methods with social and natural sciences and ILK, seeking a bottom-up and transdisciplinary dialogue to integrate ILK, and carrying out a holistic analysis with flexibility. In this case, we used an ethnoecological action-research approach, based on collecting and validating data with locals, and cross-checking the data collected with different methods (Almekinders et al., 2009; Toledo and Barrera-Bassols, 2009; Albuquerque et al., 2014).

3.3. Data collection

With a multidisciplinary team and with the prior informed consent of the community (Brazilian Law n. 2186/2001), we performed an ethical immersion where we encouraged the Maroons' trust and engagement by establishing a horizontal power relation between the community and the research team (Freire, 2017) and by clarifying and negotiating research contributions and activities with locals and local leaders. We applied the TSEN Framework following the steps below.

For the first step, we carried out circles of conversation in a focus group. During these conservation circles, we facilitated the Maroons to identify and list the main changes associated with resource management experienced in the territory and observed in the landscape settings and dynamics, as well as their causes (from the remembered past until the present). We also facilitated conversation about the main temporal phases that locals recognize along these changes until the present. We problematized planned and unexpected changes, including the needs and interests of multiple stakeholders that guided them (Coelho, 2014).

A second step was to use focus groups, individual interviews (with young and old females and males from different landscape sectors), and ethnographic participant observation (of everyday life and fieldwork) to investigate separately knowledge, practices, and worldviews and associated TSENs, as well as their interplays. To foster a deeper understanding of the landscape history, we focused on the following: (1) the main social-ecological changes and adaptation of k-p-w regarding the categories highlighted in Figure 1 (knowledge transmission, agency, aspirations, etc.) along historical phases previously identified, and (2) social and ecological components of TSEN from local to global scales that exercised agency in those changes.

The third step of data collection was geared towards comparing ILK with scientific types of classification systems. In multiday workshops, we performed participatory mapping, guided-tours, and interviews (Barrios et al., 2012; Fagerholm et al., 2012) to assess Maroon classifications of landscape, soils, and lands suitability. In parallel, we developed scientific classifications of landscapes (Tricart and Kiewitdejonge, 1992), of soils (dos Santos et al., 2005; Santos et al., 2013; IUSS Working Group WRB, 2015), and of land suitability (Ramalho Filho and Beek, 1995), following standardized methodologies. To make sense of this data, we integrated the local and scientific classifications by contrasting and combining their convergences/divergences (Krasilnikov and Tabor, 2003).

3.4. Data analysis

We carried out a qualitative data analysis through a coding process of interviews and scientific literature that was focused on identifying landscape components following the TSEN Framework. We searched for examples of material and immaterial appropriation of territory or loss thereof and for interrelations between social-social, social-ecological, and ecological-ecological components of networks of different spatial scales over time that have influenced local k-p-w.

We connected the coded data to the three steps of data collection. We did so to reconstruct a historical timeline of (more or less) separate phases of territorialization associated with the landscape settings that were identified. Moreover, we focused our analysis on identifying the role of specific agencies of social and non-human components of SES in the shaping of landscape dynamics. We also coded our data to identify the main needs and interests of locals and of other stakeholders that have influenced the landscape. We identified and counterbalanced synergies and trade-offs between these needs, and selected priority needs that could be addressed by landscape approaches in the area, to be used when planning adaptive co-management.

4. Results

Below, we first report on the historical phases and TSENs that have co-produced the landscape of Malhada Grande. After that, we discuss each dimensions of k-p-w separately (e.g. knowledge, practice, and worldviews) to highlight how various social-social, social-ecological, and ecological-ecological aspects contribute to co-producing landscape settings and dynamics**.**

4.1. Assessing landscape history

The origins of the population from Malhada Grande dates to the eighteenth century, when African slaves escaped from gold and diamond mercantilist mines and forged the Gurutuba Maroon in the Gorutuba River's shores and *Jahyba* valleys (a Tupi term for inhospitable wetlands). There, calcareous sinkholes and fluvial dissection favored the presence of malaria and kept black people as well as the Caiapó, Xacriabá and other indigenous ethnicities who inhabited the region isolated from white colonialist people, who are less resistant to this disease (cf. da Mata-Machado, 1991; D'Angelis Filho et al., 2009). In the 1940s, malaria was eradicated to allow the passage of state railroads, and both white settlers – cattle farmers who bought or grabbed lands – and other traditional peoples (farmers, gatherers and fishers) introduced new k-p-w in Gurutuba (Costa Filho, 2008). Maroons whose lands were grabbed moved from Gurutuba and constituted the Malhada Grande territory in the surrounding lands. There, the first historical phase remembered was "loose time" (in allusion to a period when cattle/people were free). This phase was characterized by having a landscape setting similar to the one of the Gurutuba Maroon, including relative isolation of any institutional networks of "white" people; political autonomy based on collective decisions; property transferal based on kinship and *compadrio* (marriage-based political loyalty); local consumption based on local livelihoods; and collective and traditional land use and resource management.

The Maroons from Malhada Grande reported that they were impelled by government entities to adopt the Green Revolution technological package of cotton monoculture, leading to a new temporal phase called "cotton time". This matches with the period in the 1970s and 1980s when the Northern Minas Gerais was integrated into the national development project as a meat exporter region. As happened to all Gurutuba communities (Costa Filho, 2008), new social-ecological networks, including land-grabbers, and farmers changed the Maroons' lives. Cotton time was implemented with a "dual economy" (Toledo et al., 2003, p.9), with a production for local consumption and a capitalist market trade that reduced time dedicated to traditional practices. In the 1990s, a decrease in the price of cotton and a pest outbreak led the Maroons to become financially indebted and triggered the abandonment of cotton monoculture, land sale, and migration. Malhada Grande was then reduced to 64% of its previous area, leaving the current 864 hectares, which are distributed among fifty family residences (around 13 ha/family) and communal areas. Despite population growth, the available labor decreased because of children's access to formal schooling, the permanent migration of young people who cannot access lands and are attracted by the urban life, and seasonal migration of married men to the Minas Gerais and São Paulo States to supplement the family income. Moreover, temporary adoption of *Eucalyptus* monoculture to sell charcoal regionally and to pay off debts led to increased forest/land degradation and water scarcity. This interviewee from the Maroon community reports the changes experienced from loose time to the cotton time:

> "Everyone was suffering […] Only sometimes did we buy soap, salt, coffee, or meat. When my mother died, no one had a retirement allowance. A neighbor would kill a cow, he would share. People would plant rice and fish together. Everybody slept peacefully [...] Then we picked up a loan with the government to plant cotton and became indebted. Many people sold land. Today people live more individually, the plantation became difficult because the

rain is less, and the land is harder. There is no land for all the population, and many people go to the city." (woman, 65 years old).

The Maroon's adaptations to a new TSEN gave rise to a new and more recent temporal phase that is reported by locals as the "rescue time" and continues today. These include the territorialization of the Bico da Pedra dam on the headstreams of the river Salinas-Pacuí to supply agribusiness, which changed the landscape and led to a reduction in the river's water level. Moreover, a strong drought, which was reported by locals and was associated with climate change (Eiró and Lindoso, 2014), has affected local ecosystems and intensified agricultural losses. During rescue time, the Maroons engaged with national grassroots IPLC movements that fought for the recognition of rights and that linked to the global recognition of commons' rights in the Indigenous and Tribal Peoples Convention n.169 (ILO, 1989). These movements culminated in the promulgation of Art. 68 of the Transitory Constitutional Provisions Act (ADTC) in the Brazilian constitution of 1988, for which the State must legitimize identity and territorial rights to remnant Maroon communities. Engaged in these movements, Maroons have tried to repair the social-ecological disruption caused by monocultures, land grabbing and externalities, by rescuing and reinforcing traditional k-p-w.

4.2. Knowledge networks

During loose time, Malhada Grande and the Gurutuba Maroons had very similar territorial conditions of climate, vegetation, relief, and soil. Moreover, the two Maroons shared cultural, political, and economic organization, practices, and aspirations. These similarities and interactions with other spatial scales enabled the Maroons to maintain the knowledge inherited from the Gurutuba. This knowledge was obtained via social learning

before feedback of natural resources manifested in the landscape and before relations with animals, plants, and so on changed (Table 2). During cotton time, the reduced dedication to traditional practices to focus on the cotton monoculture and the unfamiliarity with monoculture delayed the Maroons' perception of social-ecological impacts. Eventually, however, the Maroons noticed that sediments from eroded soils started causing respiratory diseases and that pesticides changed the soil quality and caused stomach diseases. Forest and land degradation had already changed the resilience of the landscape, preventing the perpetuation of agricultural practices. These social-ecological impacts led to changes in knowledge co-production and the rescue time saw the Maroons re-establish an attentive monitoring of nature's feedback.

Table 2. Knowledge networks of the maroons from Malhada Grande, and landscape configuration per territorial historical phase (Catuti, Minas Gerais - Brazil).

Knowledge networks	**Loose time**	**Cotton time**	**Rescue time**
Social learning	Reproduction of the traditional Gurutuban maroon knowledge Based on the experimentation of land use and resource management, and developed under close observation of social and ecological feedbacks to practices	Maintenance of the traditional Gurutuban maroon social learning and related practices, but with less attention to nature feedbacks, as maroons predominantly dedicated to monoculture The unfamiliarity with monoculture and the maroon trust in the Green Revolution technological package delayed the perception of monoculture feedbacks of environmental degradation	Re-establishment of the traditional social learning and practices Experimentation of new practices to restore the landscape resilience with support of the NGOCAA-NM
Co-production	During knowledge generation and transmission Based on the community social learning with nature's feedbacks Among maroons and regional IPLC	Remained as secondary among maroons, as reproduction of existent knowledge and acquisition of scientific Green Revolution knowledge via government projects predominated	Among maroons and Gurutubans, IPLC, and the NGO CAA-NM (using agroecology) An indispensable means for restoring the landscape resilience, and rescuing and adapting traditional k-p-w
Transmission	From old to young people from the same gender across generations Through acquisition and exchange of knowledge among maroons, with Gurutuban maroons and IPLC By farmers who hired maroons to work daily on cattle grazing	Traditional transmission was maintained for traditional land use/resource management Predominant top-down knowledge transmission by government entities, with transference of the Green Revolution technological package of cotton monoculture	Knowledge transmission within and across genders Bottom-up exchange of knowledge with the NGO CAA-NM, integrating the local and scientific knowledge, and considering local needs

*Classification systems**	The landscape classification considered the criteria relief (geomorphological sectors), soil classification and vegetation types The soil classification considered subsequently mostly soil morphology criteria (e.g. color, texture, consistence, structure properties), but also physical (e.g. drainage, porosity), chemical properties (fertility manifestation in the shape and size of crops), and soil formation processes (e.g. addition, removal, laterization) The lands suitability classification included as criteria climate, season, distance of water sources, and of residence, accessibility, susceptibility to flood, and soil classification criteria (color, texture, consistence, structure)	The landscape and soil classifications were maintained the same The lands suitability for different uses included classification criteria used by government institutions, based on the national lands agricultural suitability system (SAAAT) – e.g. mechanization was adopted as criteria to decide where the cotton monoculture would be cropped during this period	The maroon landscape classification adopted nomenclature that expresses ecological changes (e.g. the classification *Bush cover* represents Sandy belts of difficult accessibility, whose forests were maintained conserved in detriment of generalized deforestation in other landscape sectors) The soil classification added emphasis to the hard consistence of the soils associated with their degradation (erosion and densification) Maintenance of the lands suitability classification as it was in the "loose time"; however, with recognized intensification of water constrains for the use of soils

*We did not identify classifications used in each historical phase because they tend to take a long time to change (Toledo and Barrera-Bassols, 2009), and because they are articulated with traditional practices that were mostly maintained.

The knowledge co-production associated with social learning relied on the adaptation of both African and colonial knowledge, with the support of knowledge exchanges from regional indigenous people. For example, cassava, which is a Maroon staple, is of indigenous heritage. The Maroons also co-produced knowledge with farmers to reinvent cattle grazing on monocultures and adopted IPLC management techniques to incorporate them into their landscape setting. During cotton time, knowledge co-production was mainly top-down and influenced by government stakeholders such as the Technical Assistance and Extension Agency of Minas Gerais State (EMATER-MG). The EMATER-MG transferred the technology to produce cotton monoculture to the Maroons. Since rescue time, the Maroons have retrieved and reinforced their traditional knowledge and incorporated agroecological techniques with the support of IPLC and of the NGO Centre for Alternative Agriculture (CAA-NM). The CAA-NM has applied participatory approaches to promote environmental conservation and resilience and mediated between Maroons and other networks, from research by national universities to global institutions such as FAO (Londres, 2014).

Knowledge transmission involved determining when to apply acquisition between generations, broader oral exchange, and knowledge transfer between Maroons and various stakeholders. Locally, individuals who live in different landscape sectors have specialized differently regarding resource management and have added knowledge from different spatial matrixes to the Maroon body of knowledge. During loose time, knowledge transmission happened mainly within genders, through stories, rituals, everyday practices, and chants – defined by Machado Filho (1985) as African *vissungos* that guide collective practices. When the government transmitted knowledge to the Maroons during cotton time, knowledge related to abandoned practices was lost, similar to what Dayrell (2009) reported to have happened in the Gurutuba Maroon. For instance, the replacement of traditional short-pile cotton with arboreal cotton led to an abandonment of short-pile cotton and related practices (weaving cotton clothes, bedding in manual looms, and extracting vegetable pigments) – i.e. jenipapo (*Genipa americana* L.) and urucum (*Bixa orellana* L.). This caused a loss of related knowledge among Maroons. As part of the rescue time efforts, sparked by migration and a lack of labor, women added male practices (i.e. provision of livelihoods and territorial protection) to their customary tasks (i.e. domestic work, home gardening, and childrearing). Then, knowledge transmission started happening more across genders.

The aforementioned networks of social learning and transmission resulted in rich classificatory systems of nature. When deciding on which land uses and management styles to adopt, Maroons rely on soils, geomorphology, and vegetation as indicators to differentiate eight landscape compartments. We present these in Table 3, alongside the landscape compartments defined by our research team. Maroons distribute land use in eight soil classes that are associated with landscape compartments, and which we found as associated with the thirteen soil classes the research team identified using scientific classification systems. When comparing local and scientific knowledge, we noticed that Maroons emphasized soil-

related morphological properties (e.g. color, texture, and consistency), physical/chemical properties (e.g. porosity, drainage condition, and fertility); and pedogenetic processes (i.e. soil horizons and addition/removal) that science emphasizes. Both the Maroons' classifications and the scientific classifications elaborated by the research team of land suitability converged significantly and pointed to water scarcity or excess as the main constraining criteria of land use (Table 3). Nonetheless, criteria disregarded by science are locally relevant (i.e. distance of the house/river, shortage of lands, and food sovereignty). We understood that while the Maroons' classifications express landscape changes (e.g. "hard soil" and "bush cover" refer respectively to degraded soils and remaining forests), they remain mostly unchanged because the Maroons maintain mostly traditional land uses and management styles.

Table 3. Ethnoecological integration of the maroon and scientific knowledge on the landscape, soils and suitability of the lands of Malhada (Catuti, Minas Gerais - Brazil).

Landscape classification		**Soil classification**		**Land's suitability classification**		**Calssification[1] criteria**	
***Local**	**Scientific**	***Local**	**Scientific**	***Local**	**Scientific**	***Local**	**Scientific**
"*Topo da alta*" (Highlands' Tops)	Flattened tops	"*Terra vermelha*" (Red earth)	FRxady	Natural grazing and gathering	Goof for planted grazing	*Distance of water sources*, presence of "carrasco" vegetation	Fertility deficiency
			LXro/xa[2]	-	-	-	-
"*Baixa do topo*" (Lowlands of the top)	Top depressions with PTce [2]	"*Barro branco duro*" (White hard clay)	PTce[2]	-	-	-	
"*Furado*" (Dolines with degraded earth)	Endoreic depression with PTceeu and PLha2	"*Barro branco mais duro*" (White harder clay)	PTceeu	Natural grazing, fish farming	Good for planted grazing	*Season, soil classification (color, texture, consistence, structure)*	Water deficiency
			PLha[2]	-		-	
"*Alta*" (Highlands)	Pediment slopes with ARha (Typical)	"*Terra branca*"(White earth)	ARha (Typical)	Houses, annual crops and natural grazing	Restricted for natural grazing	Non-susceptible to the flood; close to water sources; soil classification (color, texture, consistence, structure)	Water deficiency
"*Baixa da Alta*" (Lowlands of the Highlands)	Slope depressions	"*Barro branco*" (White clay)	PTce[2]	-	-	-	
"Capão" (Bush cover)	Sandy belts	"*Terra branca mais cultura*" (More crop white earth)	RGeu	Environmental conservation	Restricted for natural grazing	*Difficulty of access in the rainy season, remaining seasonal deciduous forest patches*	Water deficiency
"*Vargem*" (Highest riverbed)	Flatland partially flooded	"*Terra preta dura*" (Dark tough clay)	PLhaeu	Natural grazing	Moderate for natural grazing	*Season, soil classification (color, texture, consistence, structure)*	Oxygen deficiency
			PTha[2]	-	-	-	

"*Vazante*" *(*Lowest riverbed)	Flood plain	"*Terra preta*" (Dark earth)	PThaeu (Typical)	Planted grazing, rice, sugarcane and environmental conservation	Restricted for crop	Season, soil classification (color, texture, consistence, structure), food security, labor; seasonal semi-deciduous riparian forest	Oxygen deficiency
			FLha[2], GLha[2]	-	-	-	-

Rxady: Dystric Xanthic Ferralsols (Clayic); LXro/xa: Rhodic/Xanthic Lixisols; PTce: Clayic Plinthosols; PTceeu: Eutric Clayic Plinthosols (Abruptic); PLha: Haplic Planosols; ARha: Haplic Arenosols (Typical); RGeu: Eutric Regosols (Typical); PLhaeu: Eutric Haplic Planosols (Solodic); PTha: Haplic Plinthosols; PThaeu: Eutric Haplic Plinthosols (Typical); FLha: Haplic Fluvisols; GLha: Haplic Gleysols. * Local classification (in italic) with maroon vernaculars (in Portuguese) in italic, and scientific classifications in non-stylized letter ; using reference of classification of landscape, based on Tricart and Kiewitdejonge (1992), of soils (dos Santos et al., 2013, and IUSS Working Group WRB, 2015), and of lands suitability (Ramalho-Filho and Beek, 1995).1 The System of evaluation of agricultural suitability used considers the main land use constrain criteria related to climate, relief, vegetation, soil, which are: management type, water, fertility or oxygen deficiency, water excess, erosion susceptibility; impediment to mechanization; whereas maroons consider all criteria as equally important. [2]Soils of rare occurrence have only morphological description and thus no land's suitability classification.

4.3 Practice networks

The agency of local Maroons was important for building practices and responding to changes while interacting with agencies of other spatial scales; even when changes were only partially under their control. The agency of ecological components of the landscape also underpinned changes in land use and resource management. During loose time, regulation of access and use of resources was restricted to local rules that were enforced by local leadership. During cotton time, the Maroons adopted the cotton monoculture as a political strategy to become less dependent for their livelihood on their territory in the semiarid climate. Modernization introduced networks (state, farmers, and land-grabbers) that interfered with land availability, social-ecological resilience, local diversity, and sovereignty. However, it also invigorated solidarity bonds among Maroons and IPLC, and triggered additional changes during rescue time (Table 4).

During rescue time, the Maroons reshaped their agency by engaging with the political mobilization of other IPLC to attempt to restore their traditional k-p-w and landscape resilience and to claim territorial rights. The anthropologist Aderval Costa Filho assisted the Maroons from Malhada Grande and other Gurutubans to access the ACDT law. Despite obtaining recognition as Maroons, the territory of Malhada Grande was not formally recognized, as the Maroons moved from the Gorutuba watershed – which is considered the rightful original border of the Gurutuba Maroon by the National Institute of Colonization and Agrarian Reform (INCRA) – in the 1940s. This is because the decree 4.887/03 conditions territorial recognition to Maroon territories formed during the Brazilian Empire (until 1888) that were kept occupied until the ACDT promulgation (1988). Maroons disagree with this timeframe, as the ACDT was the first Brazilian law to protect the rights of the descendants of slaves, and they were forced by land-grabbers to

move from their original territory. Additionally, despite the ACDT assertion that the State will reattribute lands stolen from Maroons, these have not been reinstated, as the rural elite owners contest this State intervention. INCRA plans to legitimate Maroon territory within the Gorutuba watershed, and Maroons intend to send community members to those lands and keep others in Malhada Grande to claim this territory.

Despite the legal impasse, the Maroons' cooperation with regional and national IPLC networks on the recognition of rights and the enforcement of traditional k-p-w led to a new form of agency, which manifested in the political Association of the Gurutuba Maroons. This raised engagement with syndicates and improved access to public policies, including a food acquisition program (PAA) that grants right of sale of agricultural goods to local public schools and the Garantia-Safra policy, which reimburses semiarid crop losses. Furthermore, Maroons started a partnership with the NGO CAA-NM to restore traditional knowledge, practices, and environmental conservation. Many of these policies have been defunded under President Michel Temer's government, since the 2016 ouster of President Dilma Roussef, as part of a neoliberalist agenda, and this state configuration suggests uncertainty about Maroon rights.

During loose time, Maroons adopted various land use types to access livelihoods (see Table 4). During cotton time, many of those were maintained, but cotton played a more central role. With the cotton plague and the adoption of *Eucalyptus* monoculture, large deforestation intensified fluxes of matter and energy that unbalanced the soil quality and disturbed the chemical and water cycles of the Maroon landscape. Consequently, the sandy/silted highland soils of tops and slopes became densified and could no longer be used for annual crops and planted grazing. The same uses were abandoned in the clayey soils of the tops because water availability during the drought became scarce and the Planosols became unsuitable for agriculture. Most lakes disappeared and fish farming

decreased. Moreover, small cash incomes prevented the Maroons from recovering degraded soils using machinery and to irrigate soils of tops and depressions to restore previous uses. It is striking that most of the farmers' lands are allocated in the landscape tops with suitability for planted grazing under irrigation. Additionally, the purchase of goods in the Catuti market and a lack of labor stimulated a reduction of laborious rice cropping, medicinal plants cultivation, and cattle grazing.

During rescue time, land use changes reinforced traditional practices for food and livelihood security and sovereignty. Reduction of the diversity of bean species led to a decrease in its agrobiodiversity among Maroons. With access to public policies, Maroons replaced the *Eucalyptus* monoculture as a source of income with the trade of agricultural surplus (i.e. sorghum, milk, and vegetables) to public urban schools and received a water supply from the state. This made the consumption of water from the water table obsolete during drought. Finally, the CAA-NM supported the reintroduction of cotton short-pile and the adoption of beekeeping.

Traditional Maroon resource management during loose time included alternating seasonal dynamics; predominant familiar labor; collective production; hoe use to plow lands; cow use to transport livelihoods; and wood fuel for domestic use and to maintain the *carrascos* suitable for gathering and grazing. When cotton time introduced Green Revolution techniques (Table 4), Maroons incorporated the incidental use of agricultural external inputs and the hiring of daily workers. Collective production declined; however, since the Maroons had CAA-NM support during rescue time, deforestation was restricted to small areas. Furthermore, community leaders implemented rules to re-establish traditional soil management to maintain its quality (e.g. instituting a taboo that "pesticide is poison for people and earth").

Currently, the Maroons use land in the Malhada Grande territory (864 ha) and in part of the territory expropriated from Maroons that belongs to farmers (491 ha); as farmers allow Maroons to use the *carrascos* of the landscape tops. Land use is concentrated in the highlands of the pediment slope (10.36% of the used area), where sandy Regosols are strategically close to water resources of the plains and do not flood in the summer (rainy) season, allowing annual crops (i.e. beans, watermelon, pumpkin) and permanent residences/home gardens. During the dry season (January to October), seasonal rivers and lakes disappear and the water table of poorly-drained tops and slopes becomes these land units' water sources (Planosols/Gleisols). Thus, the land use becomes concentrated in the plains. Floodplain soils that conserve humidity for longer (Gleisols/Plintosols) are used for sugarcane, rice, and planted grazing (13.3% of the used area), and for the conservation of riparian forest (2%). Landscape changes associated with lower surface water levels have made Planosols of flood plains impermeable, restricting use to natural grazing. During the wet season (October to February), plains become flooded and river/lakes of top and slope depressions are used for fish farming. Top *carrascos* are used for natural grazing and gathering (9.34% of the used area) and top depressions for natural grazing (15%).

Table 4. Practice networks associated with the resource management of the maroons from Malhada Grande, and landscape configuration per territorial historical phase (Catuti, Minas Gerais - Brazil).

Practices	**Loose time**	**Cotton time**	**Rescue time**

Agency	Autonomy to shape and regulate the local knowledge, practices (e.g. land use) and worldviews with collective decision-making under leadership of elderly male leaders Conflict with land grabbers Sale of lands, and of labor to farmers Absence of the State political support	Acceptation of knowledge transference by government institutions to maroons, and adoption of modern values and practices via monoculture Interference of State laws in the maroon territory (e.g. the Forest Code – law 7.511/1986 – regulating logging activity, and conservation of riverside lands)	Articulation with Gurutuban maroons, regional and national IPLC, with an anthropologist researcher, and with the NGO CAA-NM Emergence the Association of the Gurutuba Maroon; Association of Gurutuba Maroon Women; and Association of Malhada Grande Residents and women leaderships Mobilization to regulate maroon land titles, identity recognition, Rescue of territorial sovereignty, and of traditional k-p-w, blended with agroecological scientific knowledge
Land use - types and distribution per landscape compartment below			
Flatted tops	Natural/planted grazing, gathering	Natural grazing, gathering	Natural grazing
Top depressions	Natural grazing (fish farming)	Natural grazing,	Natural grazing
Endorheic depression	Agriculture (annual crops of cassava, beans, corn, sorghum)	Agriculture (annual crops)	Agriculture (annual crops)
Pediment slopes	Residences, homegardens, self-consumption agriculture (annual crops), subsoil water tanks	Residences, homegardens, reduced self-consumption agriculture (annual crops, except from short pile-cotton), arboreal cotton and eucalyptus monoculture, channeled water	Residences, inclusion of fruit trees in homegardens, self-consumption agriculture (annual crops), channeled water
Slope depressions	Natural/planted grazing, and agriculture (annual crops), fish farming	Natural grazing, and reduced fish farming	Natural grazing, and reduced fish farming
Sandy belts	Conservation	Conservation	Conservation
Flat land partially flooded	Natural/planted grazing, and agriculture (annual crops)	Natural grazing	Natural grazing
Flood plain	Planted grazing, and agriculture (sugarcane and rice)	Planted grazing, and agriculture (sugarcane and rice crop)	Planted grazing, and agriculture (sugarcane and reduced rice crop)

Resource management	Traditional, with alternating seasonal land use; with use of hoe to plow lands, of cow as transport, and of fire to maintain the degraded semi-deciduous seasonal forests ("carrascos") Familiar labor Communal and collective land use Predominant livelihoods sovereignty, including food and other associated services or nature's contributions to people	Shorter dedication to traditional practices in areas of traditional land uses Predominant dedication to monoculture, with adoption of Green Revolution modern techniques (large deforestation, use of GMO, of pesticides, and of rented machinery) Familiar labor and hired daily workers Less communal and collective land use Dual economy and reduced food sovereignty	Abandonment of monoculture Trade of agricultural surplus Restriction of deforestation to small areas of planted eucalyptus for self-consumption Limited use of tractor and of pesticide Environmental conservation, with restoration of the local agrobiodiversity (with a bank of natural seeds); with reforestation of springs, riverside, and "carrascos"; and with the revitalization of agroforestry homegardens Processing of good for trade, including cassava flour, and bakery Rescue of livelihood sovereignty

4.4. Worldview networks

The Malhada Grande population was originally recognized by regional IPLC as Gurutuban: people who live in the *Jahyba* wetlands of the Gorutuba watershed (called Gurutuba by locals). Those IPLC, who also developed cultural identities and territorialities based on their relationships with their landscapes, as reported by Dayrrel et al. (2006) and D'Angelis Filho et al. (2009) include Caatingueiros, smallholder descendants of Italians and Portuguese who occupied the dry forests of the Serra do Espinhaço's hilly outskirts (regionally recognized as *Caatinga*), when these were free of malaria; Geraizeiros from the Cerrado savannahs of the Espinhaço tops, regionally called *Gerais*; and Vazanteiros, people from intermittent riverbeds of the *sertões* or semiarid São Francisco Depression's dry regions, called *Vazantes*. During loose time, when Maroons moved to Malhada Grande, which is closer to the Espinhaço outskirts, they became recognized as Gurutuban

Catingueiros, as they maintained the Gurutuban territoriality and identity. Maroons kept this identity during cotton time, as despite embracing modern Western values, they have conserved many traditional values and beliefs (see Table 5).

Table 5. Worldviews networks associated with the resource management of the maroons from Malhada Grande, and landscape configuration per historical territorial phase (Catuti, Minas Gerais - Brazil).

Worldviews	**Loose time**	**Cotton time**	**Rescue time**
Beliefs	Religious syncretism, combining the African animism with the Catholicism acquired during slavery Unity among people, nature and the abiotic environment Maintenance of the Gurutuban kinship and cultural bonds	Religious syncretism Modern beliefs Trust that monoculture could increase food security Conquest of higher independence of the semiarid climate	Reinforcement of ancestral values and beliefs that connect maroons with nature Rescue and reinforcement of traditional k-p-w, with new alliances towards a territorial and identity recognition
Values	Respect for people, nature, abiotic environment and people as sacred beings provided of soul Predominance of intrinsic values of nature, social-cultural, and non-capitalist economic value of nature	Maintenance of traditional values Preponderance of the capitalist economic value of nature (e.g. adoption of remunerated labor and sell of agricultural goods)	Rescue of traditional values for nature Reduction of the valorization of the capitalist economic value of nature (e.g. replacement of monoculture by traditional land use practices, with trade of agricultural surplus)
Aspirations	Reproduce social-ecological relations experienced in the Gurutuba Maroon	Reduction of the dependence on local natural resources to provide food security, in face of the water scarcity and agricultural losses caused by the semiarid climate	Enforcement of the traditional k-p-w Articulation with IPLC from the region and country Restoration of soils, forests, springs, and of the agrobiodiversity of seeds and crops Retrieving of both livelihoods and territorial sovereignty Conquest of political visibility, identity and land rights

Needs	Maintenance of the local social-ecological reproduction to access ecosystem services (e.g. territory, livelihoods, with emphasis for food security, using local resources Maintenance of the ecological resilience state to supply the current and next maroon generations	Supply of local needs of the past, through trade and complementary consumption of food and goods, instead of supplying local needs autonomously with local natural resources	Improvement of the environmental conservation and resilience Retrieving of food security, and of the territorial and livelihoods sovereignty Integrate with communities and others stakeholders for security
Cultural identity	Afro-descendants, Gurutuban "Catingueiros", recognized in a relation of alterity with regional IPLC	Gurutuban "Catingueiros"	Gurutuban "Catingueiros" maroons, recognized in relation to regional communities and to the country
Landscape outcome	Access to greater territorial extension Stronger harmony between the maroon territoriality and landscape resilience Collective structures (e.g. houses, and mill) Gurutuban social-ecological heritage	Disruption of the local territoriality Access to reduced territory, fragmented by farms Community and family fragmentation Community individualization And incorporation of urban/modern elements (money, access to pension, daily employees, market goods, schools, automobiles, home appliances)	Removal of monocultures Re-establishment of traditional territoriality elements (e.g. social collectiveness) Reinstallation of collective structures (e.g. association's headquarters)

During rescue time, the identity of the Catingueiros was reformulated as Maroon, or *quilombola* (in Portuguese), articulating it with national and global networks linked to the recognition of Maroon rights. The community's identity was legitimated as Maroon in the twenty-first century by exhibiting ADTC (Brasil, 1988) criteria: African physical traits, typical cultural heritage (i.e. preparation of food with pestles), and syncretism of Afro-animism with the colonial catholic religion. The identity reformulation encompassed external and internal reconstruction, similar to what happened in the rest of the Gurutuba Maroon (Costa Filho, 2008), as the slave past had been erased from the collective memory during loose time and cotton time. Halbwachs (1992) explains that obliterating a subaltern past is a way for social groups to enforce social resistance. Accordingly, the Afro-

ascendant ethnic identity is a "resistance identity" (Castells, 2000; Arruti, 1997), as it was embraced at the cost of the previous territoriality towards political justice.

The Maroon cultural identity is underpinned by worldviews embedded in beliefs, values, aspirations, and needs. These elements synthetize the local ontology and epistemology embedded in the Maroon k-p-w that incorporates and tailors ontologies/epistemologies of the k-p-w of stakeholders of other spatial scales. Accordingly, since the loose time (but mainly during the cotton and rescue times), Maroons have interacted with IPLC who have ILK and diverse territorialities; with Western actors whose k-p-w tends towards universalizing and colonial thinking (i.e. state and farmers); and with networks that travel across these universes and embrace plural rationalities (i.e. CAA-NM, policies that address communities' needs). Thus, the worldviews of Maroons encompass plural k-p-w inter-exchanges with stakeholders on global and local scales.

Values that have forged the Maroon identity since the loose time carry holistic Afro-animist beliefs (Clodd, 2017), for which all things and beings have a sacred spirit, consciousness, and soul. As nature is seen by Maroons as an entity of which they are part, and not as an external resource, it is respected for the intrinsic value Maroons attribute to it. Thus, unlike predominant Western-centered worldviews, Maroons perceive nature as inseparable from society (see Table 5). Social-cultural values attributed to nature also stand out in the Maroons' interrelations with nature and the landscape heritage. These values manifest via practices, symbolisms, and thinking that aim to foster a harmonic co-existence with nature. The capitalist economic value that nature has for locals assumed a centrality in the cotton time, as Maroons believed that the monoculture trade would ensure a higher level of food security than solely depending on subsistence agriculture. However, the non-capitalist economic value of nature has predominated in Maroon practices since the loose time. Moreover, when landscape feedback showed that environmental degradation was

depleting the Maroon's social-ecological reproduction (e.g. compromising the provision of ecosystem services), the Maroons reinforced the traditional values they carried regarding a harmonic coexistence with nature and abandoned monocultures, making space for the rescue time. Thus, in addition to the perceived environmental impact of monocultures, the confrontation of the Maroons' values with modern practices led to their abandonment:

> "The trees, fish, earth and community – everybody needs to be in harmony to survive. Nature always gives to you if you give back to it. But if you start only taking from it as we did with the cotton, it starts not giving livelihoods to you anymore" (man, 54 years old).

The Maroon worldview is also shaped in relation to needs (e.g. water and livelihoods) and social aspirations for change. During the loose time, Maroons were isolated in their territory because of the global and national interest in slavery. Land was abundant, but Maroons were more isolated and dealt with the drought using traditional techniques (e.g. consuming water from the water table), people aspired to ensure basic livelihood needs for social reproduction. When the State showed an interest in expanding the Green Revolution to the Maroon territory, this converged with the Maroon interest in becoming less vulnerable to the semiarid climate. This worldview embodied an aspiration that endorsed new knowledge-practice networks that installed a transition to cotton time. Similarly, the adoption of the *Eucalyptus* monoculture was a vehicle for a need to pay off debts and achieve the aspired permanence in the territory. The Maroons' perception that the monoculture was threatening the resilience of the landscape stimulated them to hold on to their territory and identity and to confront the power imposed by land-grabbers and the government over their livelihoods. This aspiration converged with regional grassroots movements of IPLC for identity recognition and land tenure, and with the support offered by CAA-NM for environmental conservation. According to Maroons, the land was getting

harder, the drought was increasing, the dust was invading their homes, and the lands were closing in. Even so, the need to belong to an identity supports their ongoing appropriation of the territory.

5. Discussion

5.1. Co-production of the landscape

The results show how the TSENs of multiple space-time scales are expressed in specific k-p-w and co-produce landscape as entwined with territory. Both human actors and ecological actants have exercised agency to influence the constitution of TSEN and k-p-w in Malhada Grande. This agency, including what Folke et al. (2016, p. 41) refer to as "stewardship", led to several changes that constituted the landscape settings in the Gorutuba Watershed over time. While the role of social agency was clearly visible (e.g. government laws, local governance), ecological agency played an equally important role. As the results showed, malaria provided shelter from colonizers, the climate and soil affected land use, forests compounded cultural identities, and the carrying capacity of resources greatly conditioned resilience.

The interplay of k-p-w assemblages of different stakeholders and spatial scales highlights the crucial role of local agency in accepting or crafting imposed changes introduced in the territory. As Anthias (2017) argues, IPLC and other stakeholders may exercise agency simultaneously in a single landscape, which as a result will show emergent properties. Indeed, our results showed how national and global economic and ecological interests, political contexts, and cultural thinking manifested via the k-p-w of governmental entities, as well as of NGO and grassroots movements, co-produced landscapes with local k-p-w. Across time scales, the emergent properties of networks were also observed to dynamically shape the landscape through the simultaneous adaptation and renewal of

landscape contents and dynamics, which exhibited both qualities of path-dependency and uncertainty.

Each temporal phase identified in the results showed both processes of deterritorialization and reterritorialization, which influenced the material and immaterial appropriation of the territory. These processes involved the abandonment of k-p-w and social-ecological losses (deterritorialization) and re-visitation, and the reinforcement and renewal of territorial and landscape contents (reterritorialization). In this sense, the landscape evolved alternatively as a spiral of continuous historical reconstruction (Toledo and Barrera-Bassols, 2009) and as adaptive cycles of "creative destruction" (Folke, 2006). Path-dependencies were expressed in the maintenance and restoration of traditional k-p-w settings, in relation to new technologies, management practices, and perceptions of reality adopted by Maroons. Uncertainties were manifested in unexpected feedback to planned actions and in emergent dynamics, including the appearance of new components in the SES.

The TSENs of different space-time scales co-produced landscape settings as a mosaic of patches with specific land uses, social-ecological aspects, and related to specific temporal phases. Landscape dynamics led to a multidimensional and multifunctional totality, linked with territorial functions, meanings, heritage, diversity, and resilience of the SES. The territorial appropriation and constitution of the territory followed specific paths and shifts, including social-ecological patterns such as the maintenance of small-scale farming practices focused on subsistence agriculture and resilience. Considering the landscape as an integrated whole allowed for the visualization of feedback and changes. Such feedback was manifested in deterritorialization and reterritorialization processes and were seen to trigger the emergence of new social-ecological conditions, mediated by social learning and agencies manifested in local k-p-w.

5.2. Global-local priority needs

Various needs, demands, and interests were manifested in the social-ecological settings of Malhada Grande. These were associated with multiple k-p-w of local and other actors and presented synergies and trade-offs regarding the multiple functions they require from the landscape. Local needs were associated with functions that include the provision of food and other livelihoods, social-ecological reproduction, security, sovereignty, conservation, and a sense of belonging. Local needs have historically been guided by a central aspiration: to live in relative harmony with nature while maintaining local identity and territory. Along the three historical phases we studied, local needs were mostly in synergy and driving territorial processes towards conservation, modernization, and restoration. However, certain local needs also led to trade-offs; for instance, between increasing demand for food by the growing local population and increasing land scarcity, and between the aspiration to remain in the territory and the migration of Maroons.

When observing the needs of locals and other stakeholders, trade-offs predominated. These trade-offs were shown to derive from the different ways in which stakeholders cognize, value, and use the landscape. Values associated with mercantilism and modernization practices mediated global needs that ran counter to local interests in maintaining the traditional identity and territoriality. These needs presented trade-offs in relation to global and regional interests of government and farmers in expanding agribusiness in the region and advancing national neoliberalism. However, these needs did converge with the Maroon need to ensure food security by engaging in the market. Even so, trade-offs between market dynamics and the financial losses and environmental degradation that Maroons faced made them return to their aspiration of surviving in harmony with nature while having territorial sovereignty and access to supportive policies. Synergies were thus found between the interests of Maroons and NGOs in environmental

conservation, in global-local interests for rights recognition, and in national policies that address Maroons rights and livelihoods.

We agree with Fletcher (2012), who does not consider trade-offs between global and local needs to be insurmountable. To overcome these trade-offs, global and local needs must be aligned to reconcile environmental conservation and human well-being in a sustainable way. In the Malhada Grande Maroon, we found two specific needs that make up this global-local alignment and that may serve as a basis for integrated environmental planning via adaptive co-management. These needs are: (1) to co-produce knowledge with Maroons for sustainable resource management and economic development that enhances environmental conservation and resilience in coherence with local k-p-w; and (2) to strengthen the Maroon's political organization and engagement with (non)government entities and IPLC to better access policies and rights. Addressing these needs will link global interests in sustainability and resilience, social empowerment, and rights recognition with local needs for territorial identity, food sovereignty, and livelihood security.

6. Conclusion

We demonstrated the application of the TSEN Framework as a theoretical-methodological basis to perform an integrated assessment of landscape settings and dynamics, which in turn may be used for integrated environmental planning such as adaptive co-management. In doing so, we sought to foster a relational understanding of how landscapes are constituted on the local scale in entwinement with territory within an SES, and in association with multiple space-time scales. We argue that this understanding supports landscape approaches to assess and plan the use of landscapes while integrating different disciplines, knowledges, and needs. Specifically, a focus on cross-scale networks

emphasizes how both social and ecological components of SES exhibit agency, and that social-ecological interrelations are key to this. Apparent dichotomies (social-ecological, scientific-ILK, global-local) are shown to be entwined in the actual landscape, making it seem that whether to privilege one or another is often like thinking of what came first: the chicken or the egg. Furthermore, by shifting attention to both social and ecological agency, the framework showed the role of power and of a political ecology in producing sustainability and resilience. The framework thus supports a simultaneous analysis of landscape as scale, arena, multifunctionality, and cultural construct: aspects often studied separately by different disciplines. Additionally, the study of landscape dynamics on the ground gives planners an idea of how specific contents of landscapes can be reinforced in order to enhance sustainability and resilience.

The use of methodological bricolage and ethnoecology to apply TSEN in an interdisciplinary and participatory way favored a broad data collection strategy that emphasized the incorporation of local knowledge. In our case, the integration of local and scientific classifications enriched the understanding of resource management within the local landscape and of the criteria that influences its sustainability. These findings indicate that bottom-up participation empowers both IPLC and planners to comprehend the local context, to draw lessons from local social learning, and to better deal with uncertainty in planning. We recognize that the present study was largely illustrative in nature and that several aspects of the framework could be further explored, including trade-offs, synergies, and priority needs within the landscape. We also recognize that the framework includes broad concepts that may be adjusted and further specified to suit individual assessments and contexts.

We are confident that the TSEN Framework can be used by scientists and practitioners that perform environmental assessments to inform and develop landscape approaches, as well as to complement other environmental assessments. Its application may

help to establish a dialogue to understand landscape settings and dynamics over time. Moreover, when planning adaptive co-management and governance of landscapes, it helps to systematically consider social-ecological components and networks (cultural, economic, political, and ecological), and synergies and trade-offs between local-global needs.

We conclude by reiterating our belief that landscape approaches should consider land use as a whole and should be attentive to particular roles and interdependencies between different actors and k-p-w. While it is tempting to reproduce the customary scientific-technical superiority and dichotomized thinking, we also want to stress the importance of being careful when translating how locals cognize, value, and use their landscapes through their own lenses as scientific models to decipher their landscapes.

7. References

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