

Sustainability and Land tenure: Who owns the floodplain in the Pantanal, Brazil?



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ABSTRACT

In seeking to achieve poverty alleviation and environmental conservation, public policy has often centred on guaranteeing land titles to local peoples. However, such approaches have brought unintended outcomes, replacing small-scale economies and natural areas by intensive exploitation of resources with no clear improvement in local people's wellbeing. To understand this, we go beyond a general political ecology framing to consider relations between sustainability and land tenure, focusing on the intersection of economics, ecology and anthropology to understand how land tenure, property and use play out on the ground. We draw together different concepts including bundle of rights, *de facto* and *de jure* resource use, property regimes, density-dependence and non-equilibrium theory. The significance of this three-discipline view is illustrated through a case study of the Pantanal wetland, Brazil, where conservationists, the government and the local population contest ownership of the Paraguay River floodplain. Government sought to address conflicts around tenure and access through a narrow view of property, which failed to encompass the overlapping layers of land tenure, property and use on the ground and only served to create further legal battles. This article concludes that a more complex view combining the three perspectives is needed in the case of the Pantanal, and in other cases of contested property rights, in order to resolve conflicting claims and foster sustainability. We dissect both the power plays involved between different groups competing for control of a valuable resource, and the legal frameworks which can and should provide checks and balances in the system. The more nuanced grasp that emerges of local systems of tenure and access, of how these diverge from western property concepts, and of their environmental implications favours a better understanding of local realities, allowing for better management policy and consequently contributing more effectively towards poverty alleviation and environmental protection.

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1. Introduction

Secure access to land and guaranteed property rights are assumed to be key elements in tackling poverty alleviation and environmental conservation (FAO, 2012). Insecurity of land tenure and lack of established property rights are singled out as the main causes of deforestation in the Amazon (Nolte et al., 2013), of failures to reduce poverty in Africa (Peters, 2004) and of the collapse of marine fisheries (Pauly, 2003). The main approach to deal with these challenges has been to grant property titles and to set up modern land registries (Zoomers and Haar, 2000). The conversion of collective and customary land rights into formal, individual rights,

and the creation of free land markets in principle gives poor people the ability to sell or rent land to third parties and to use land as a collateral for credit (De Soto, 2000). Moreover security of tenure is presented as a prerequisite for the establishment of protected areas, payment for ecosystem services projects and for most biodiversity protection schemes focused on specific sites (van der Ploeg et al., 2016). Since the 1990s, based on this view, a great international effort has gone into programs focused on providing land title to residents (Zoomers, 2010). In Afghanistan alone the US international development agency (USAID) invested \$56.3 millions on a program focused on Land titling between 2004 and 2009 (Manila, 2009). The Brazilian Government plans a similar investment, claiming that deforestation in the Amazon will only end when ownership is established across the area (MMA, 2013).

However, such approaches have precipitated outcomes rather different from their stated purpose. The liberalisation of land mar-

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kets led to land grabbing, with foreign investors buying land to expand forestry, mineral extraction and commercial plantation projects in and around the global south (Borras et al., 2011). In 2007, 500 billion USD was invested in developing countries; most of this went to those industries (Zoomers, 2010). Locally, the consequences involve replacement of small scale economies and natural areas by intensive resource exploitation (Nayar, 2012). Empirical evidence shows that in many cases far from improving local people's wellbeing, land titling has increased environment impact (Pinckney and Kimuyu, 1994; Sjaastad and Cousins, 2009; van der Ploeg et al., 2016). Therefore, although the link between sustainability and property regime is presented in official narratives as established, policymakers and management practices still fail to achieve sustainability in practice, leading rather to unanticipated outcomes. Understanding why land titling is failing is fundamental to proceed more effectively in poverty alleviation and biodiversity conservation. The first step in doing so is to unpack this assumed link (Von Benda-Beckman et al., 2006) to give a nuanced grasp of local systems of tenure and access, of how these diverge from western property concepts, and of the environmental implications of different systems. In doing so it is important to understand the political ecology behind the way the assumed link between property system and sustainability is used in the power plays between different groups competing for control of a valuable resource. It is also important to analyse the legal frameworks which can and should preclude silent violence towards marginalised groups on the one hand, and destructive environmental practices on the other. Even where in reality enforcement is currently weak, the law provides a foundation for ultimately more effective regulation.

1.1. Unpacking sustainability and land tenure

Economists, ecologists, and anthropologists have all theorised the relationship between property systems and sustainability. We first outline how each discipline has looked at these issues, and the intersections between them, then illustrate a more integrated interdisciplinary view in a case study from the Pantanal wetland, Brazil, where conservationists, local government and fishermen contest ownership of the floodplain. We conclude by exploring how one might better approach similarly contested property situations to foster sustainability in other ecosystems.

1.2. Economists' perspective

For most economists, land tenure and sustainability have long been grounded in ideas of private property, (Horsley, 2011). The nation state using the power of law can guarantee and enforce legal rights over property such as land, ensuring that the owner has the right to restrict use by others (Freyfogle, 2011). "Ownership" and the "right to exclude", came to be, for neoclassical economists, the defining features of a properly functioning property regime (Dagan, 2011), such that without them, there is no property (Blackstonian notion of property: Rose, 1998).

20th century neoclassical economists addressing anthropogenic impacts on common pool resources,¹ applied this western property concept to theorise sustainability. Hardin (1968), for instance, suggested that communities living on common pool resources such as grazing lands and fisheries lack regulated resource use. He saw the instinct for individual accumulation as inevitably driving resources to degradation: the "Tragedy of the commons". According to this

¹ For a more detailed definition: Common-pool resources (CPOs) are natural or human-made resources where one person's use subtracts from another's use and where it is often necessary, but difficult and costly, to exclude other users outside the group from using the resource (<https://dlc.dlib.indiana.edu/dlc/contentguidelines>)

idea, the only way to guarantee long-term use is to establish private ownership and the right to exclude through privatization or state control. More recently, building on multiple empirical examples, Ostrom pointed out that customary rules governing access to and use of common pool resources could function as collective ownership giving people the right to exclude outsiders and regulate use (Ostrom, 2009; Ostrom, 1999; Schlager and Ostrom, 1992); common property regimes (CPR), leading to sustainability in the absence of privatization or state control (Agrawal, 2001). Despite their opposing views, Ostrom and Hardin see "rules" on use (property regimes) as leading to sustainability and "lack of rules" (open access or non-property) to overexploitation (Behnke et al., 2016). Based on this view, property is commonly divided into four categories: private property (owned by an individual or corporate body), state property, common property (owned by a socially-defined group of individuals, often with flexible social and spatial boundaries), and finally, open access (no exclusive owners, "first-come-first-served"). Together these categories have become so widely accepted that they are known as the "Big Four" (Von Benda-Beckman et al., 2006).

However, empirical data suggest an even more complex reality underlying evolving notions of property (Rose, 1998). Places may have more than one owner, normally with different levels of ownership, and at each level a co-owner can share their rights within their own network, blurring the boundaries as to who is the owner and who can be excluded. Moreover, ownership is normally linked to a given time and place, changing according to external and internal factors (Freyfogle, 2011). Property, then, should be seen as evolving multiple layers of ownership perhaps best captured by the term "bundle of rights" (Klick and Parchomovsky, 2016). Some societies have very different notions of property and rights altogether. For instance, in some Amazonian groups, ownership may be attributed to a spirit world rather than to humans: access must be negotiated, and use propitiated (Brightman et al., 2016). Across a wide range of cases, defined ownership and the right to exclude are not clearly tied to any particular one of the given "Big 4" categories, and these categories do not map in any straightforward way to sustainability (Galik and Jagger, 2015).

In face of this more nuanced understanding of property, there have been many attempts to re-shape the so-called "Big 4", including suggestions for creating new categories of property (for example: "managed open access (MOA)": Moritz et al., 2014, 2013). However, we argue that just as for the "Big 4" categories, sustainability is not due to a specific property category but rather to multiple specific interacting factors (Dagan, 2011), as explored in more detail below. Creating new categories and labels will not help approximate theory to reality.

1.3. Ecologists' perspective

'Property' *per se* plays no formal part in ecological models, but these use related concepts of exclusion and territoriality to explain wildlife population dynamics and use of natural resources. Classical theories centred on the idea that species populations are auto-regulated around an equilibrium capacity by density-dependent mechanisms (May, 1974). Most ecological management actions focusing on sustainability build on key concepts of Optimal Foraging (OF: MacArthur and Pianka, 1966), Ideal Free Distribution (IFD: Kennedy and Gray, 1993) and Metapopulation (Hanski, 1998).

Optimal Foraging (OF) sees species' resource use as governed by underlying behavioural rules optimizing net energy gains. IFD postulates that individuals distribute themselves proportionally to resource availability because of OF, minimizing competition and maximizing resource access and use (Davies et al., 2012; Kennedy and Gray, 1993). IFD is in many ways equivalent to open access in economic theory. In ecological thinking, however, IFD leads to

distribution in equilibrium with resource availability (Behnke et al., 2016), where open access, in economists' thinking, combines with individual accumulation to lead to over-use. Although developed as concepts for "natural ecosystems", some authors have started to use OF/IFD to explain resource use behaviour of pastoralists, fishermen, etc. (Behnke et al., 2016; Beitel, 2015; Wallace et al., 2016), and the sustainability of socio-ecological systems (Moritz et al., 2014, 2013; Xiao et al., 2015).

Metapopulation constitutes another important dimension in theorizing sustainability and management of natural resources. Building on the "Theory of Island Biogeography" (MacArthur and Wilson, 1963), Levins (1969) applied ideas of spatial distribution and density-dependence to patchy mainland landscapes, elaborating the "meta-population" concept. Metapopulations are fragmented, spatially isolated populations linked by the continual dispersal of individuals, with repeated extinctions and re-colonizations in each population generating a dynamic sustaining the whole metapopulation (Hanski, 1998). Mobile systems (whereby resource users move between patches as a resource is locally depleted) have been hailed as indicating sustainable management for Non Timber Forest Products (Assies, 1997), grazing (Kothari et al., 2013), fishing (Berkes, 2006), agriculture (Sunderlin et al., 2005), and bushmeat hunting (Kupel et al., 2009). Rotational use helps to avoid exhaustion of natural resources because it allows different populations to recolonize depleted areas – as predicted by the metapopulation concept (Wilson et al., 1994).

Density-dependence is a significant driver of regulation mainly in very low or very high population densities (Turchin, 1995), but for many non-temperate systems, populations display chaotic changes rather than smoothly density-dependent responses (May, 1974). Ecological systems may shift between multiple alternative temporarily stable states, without ever progressing to a climax (Ellis and Swift, 2006; Wehrden et al., 2012) but also without undergoing irreversible degradation or collapse (Derry and Boone, 2010).

This thinking has tremendous implications for human use of biodiversity (Berkes, 2006). For instance, multispecies fish population growth is chaotic, and consequently enforcement designed around ideas of equilibrium in single-species population dynamics has little relevance for sustainability. Connectivity, number of suitable habitat patches and ecological variations through time may be more important determinants of local fisheries' sustainability than the size of fish stock itself (La Valley and Feeney, 2013; Wilson et al., 1994, 2013). Spatially explicit evaluations considering "how", "where" and "when" people fish should be added to the current focus on "how many" fish are taken (Wilson et al., 1994).

Noy-Meir, (1975), theorizing grazing patterns, added consideration of unexploitable reserves. Some plant growth is available for grazing, inaccessible through, for example, seasonal flooding or as underground storage organs (roots, bulbs). Temporarily "ungrazeable" reserve biomass means even high herbivore grazing pressures can be sustainable and represents an important part of the real-world system dynamics. In the Logone Floodplain, Cameroon, two-thirds of the biomass is stored underground and the above ground vegetation is inaccessible due to floods during four to six months of the year (Scholte, 2007). Thus, due to the presence of natural reserves and the continual process of recolonization, high densities of livestock can be kept by pastoralists, even to the point of temporary overgrazing in some resource patches, with no cumulative effect on the long-term sustainability of the system (Homewood, 1994; Homewood and Rodgers, 1987). The importance of unexploitable reserves has been shown to be part of many systems and is fundamental to population dynamics and evolution (Berryman and Hawkins, 2006)

However, density-dependence, equilibrium, OF/IFD, and metapopulation all remain important drivers of socio-ecological systems. For instance, IFD dynamics can partly explain how

resource users are spread over the landscape and its sustainability (or lack of it) (Behnke et al., 2016) and metapopulation theory can give important insights to deconstruct overuse narratives (Hayden et al., 2015). The temporal and spatial combination of these many factors dictates species population responses and their distribution. Therefore the best way to guarantee sustainability of natural resource use is to monitor the most important drivers in any given time and place and constantly re-evaluate that potentially changing importance and whether they should be replaced or aggregated with others: an approach now called adaptive management (McLain and Lee, 1996; Rist et al., 2013; Westgate et al., 2013).

1.4. Anthropologists' perspective

Anthropologists see property concepts as land tenure arrangements embodying relationships among individuals or groups. From this perspective formal property ownership is just one of a number of ways access is granted (Ribot and Peluso, 2009), including *de facto* and *de jure* factors (Ribot, 1998). *De facto* mechanisms (friendship, status, age, historical ties, etc.) are social constructions being constantly reworked with some gaining access and others losing it (Benjaminsen and Lund, 2002). Changes through time leave their marks imprinted in continuing patterns of use (Behnke et al., 2016). Therefore, historical understanding is fundamental to comprehending the current status of access and use in any socio-ecological system.

De jure factors involve politico-legal institutions recognizing and supporting the claims of a group of people (Sikor and Lund, 2009), giving them the right to use a resource, creating property (Ribot 1998). *De jure* rights also change through time as a consequence of changes in power structures or in legal and political perspectives on the target natural resource (Benjaminsen and Lund, 2002). Communities thus need to be understood as continually evolving products of ongoing social, economic and political negotiations; and as comprising groups of different actors or stakeholders with different entitlements and preferences for resource use (Allison and Ellis 2001), operating through local politics and strategic interactions, with the possibility of layered alliances spanning multiple levels of interactions (Agrawal and Gibson, 1999; Haller et al., 2013). Formal and informal land tenure access and use are not clearly separated. Each continually influences institutions and governance, and continually morphs into the other (Benjaminsen and Lund, 2002).

Empirical and ethnographic analyses support the idea that property is better seen as a "bundle of rights", in which resources, rights to their access and use can be broken up and reorganized into uncountable layers depending on time, space, and history (Von Benda-Beckman et al., 2006; Kay, 2015). However, ethnographic analysis shows that indigenous communities have very different understandings of property from that conceptualized by western groups (Hann, 1998). It is common to find property incorporating emotive claims of identity for small-scale societies; in some Amazonian groups, concepts of ownership bind places together through relations between non-human persons with whom humans must interact in a variety of ways, and may span hunting, gardening and shamanism (Brightman et al., 2016). For such societies property itself appears as a process, it is a way of establishing relations between people and things. The encounter between the western and non-western cultures is not an encounter between societies with and without property (Brightman, 2010), but rather between very different concepts of property, making conflict almost inevitable. To propose sustainable solutions for this it is essential, therefore, to better understand the full range of notions of property.

1.5. Sustainability and a multi-faceted view of property

Although these three views of property come from different disciplinary backgrounds, they intersect on the current understanding that sustainable outcomes are best explained by a combination of the different layers that dictate how people and other species control and access natural resources (Berkes, 2007, 2004). Thus, rational choice theory, property categories, and ecosystem complexity need to be integrated with understandings gained from history and other social drivers, and vice versa (Hayden et al., 2015). This paper uses these different yet complementary views of property to better tackle sustainability. It uses a conservation conflict regarding different understandings of floodplain ownership in the Western Border of the Pantanal wetland, Brazil, where policymakers have sought but failed to resolve competing claims through a single economic view of property. It illustrates how this idealized economic notion of ownership differs from reality due to social, historical and environmental factors. It shows then that this divergence between reality and management practice is one of the main reasons for the failure of property rights to achieve poverty alleviation and biodiversity conservation. It explores the power plays involved between different groups competing for control of a valuable resource, and the legal frameworks which can and should provide checks and balances in the system. A nuanced grasp of local systems of tenure and access, of how these diverge from western property concepts, and of their environmental implications delivers insights as to how a wider view of property rights could perhaps foster more sustainable development in other dynamic ecosystems experiencing periodic fluctuations similar to the Pantanal.

1.6. The study site

The Pantanal is considered one of the biggest wetlands in the world, straddling three countries (Brazil, Bolivia and Paraguay) and covering over 160 000 km² (Keddy et al., 2009). The annual flood pulse is mostly driven by the Paraguay River (Fig. 1), starting in the northern region and finishing in the south. Due to the slight gradient of the terrain in the Pantanal (2–3 cm/km north to south, and 5–25 cm/km east to west) the flood pulse takes 3–4 months to pass through (Junk et al., 2011).

The Pantanal catchment area receives very variable precipitation, and depending on the quantity of rain, flood size and extent of areas inundated differ from year to year (Junk et al., 2011), ranging from 11,000 km² to 110,000 km² (Hamilton et al., 1996).

The unpredictable nature of the Pantanal floods and, therefore, the ever-changing river drainage network leads to profound fluctuations in access to natural resources, including fish (Assine et al., 2015). Depending on the characteristics of each year's flood pulse, water bodies can gain or lose their connection with the main river, which dictates people's access to individual sites (Mourão et al., 1996).

In the Western Border of the Pantanal there is intense conflict over land tenure (Chiaravalloti, 2016). The region hosts rare and endangered species such as jaguars (*Panthera onca*), bush dogs (*Speothos venaticus*); endemic species of amphibians, reptiles, plants, and a putative new primate species (Tomas et al., 2010). To protect this region, environmental NGOs imposed physical and economic displacement on fishing communities who have been living in the Pantanal for at least 150 years (Chiaravalloti, 2016). Grassroots NGOs supporting local people's rights brought in Federal Prosecutors to review the restrictions. Although they assured local people of their rights to use the area, the land tenure conflict became a legal battle among environmental NGOs, local people and, ultimately, prosecutors trying to define ownership and rights over the Pantanal floodplain, Brazil.

1.7. Data collection and analysis

Over a period of almost three years, qualitative data were collected with local stakeholders in the Pantanal to understand the conflict over property rights (April 2014 till March 2015; January 2016 till June 2016).

First, in order to better understand historical and customary rights, participant observation was carried out in Settlement 1 (Fig. 1). Sharing activities such as gathering bait, fishing, logging, collecting manioc, cooking and cleaning fish, helped to understand the patterns of land tenure, access, and natural resource use that characterize the local people and to check the validity of findings from other research methods such as interviews and participatory mapping. The field trips were divided into dry season (April–June, 2014 to May–June/2016), flood season (August–October, 2014), and closed fishing season (November/2014–February–March/2015). During each trip semi-structured interviews were held focusing on current and historical resource use. To better represent issues related to natural resource use by local people, new Brazilian “Rapid Eye” satellite (5 m resolution; 1:20 000 scale) were used in all interviews. All maps were printed on a special plastic paper, which people could draw on, easily erase, and then draw again. Hence, after all interviews pictures were taken of these locally-created maps and all the information on the maps was then erased. In total 46 local people were interviewed, most (40) being from Settlement 1. Two families used handheld GPS to record their daily activities and boat or canoe tracks. In each GPS, we installed an individually-adapted version of Sapelli software allowing them to record their geographic position, time and type of resource use activities throughout the year (Lewis, 2007; Vitos et al., 2013).

To understand the legal battles in the region seven prosecutors involved in the case were interviewed and all legal processes reviewed and analysed. Moreover, eight protected area staff and 10 local scientists working in the region were interviewed.

2. Case study

2.1. Colonization, land titling and conservation in the Pantanal

The Portuguese Empire conquered The Pantanal region in the 18th century; after initial military occupation they started to give land to people willing to settle in the area (Costa, 1999). The first land was given in 1727 (Silva and da Silva, 1995), and soon the first cattle ranches were established, with accounts of cattle already emerging in 1737 (Abreu et al., 2010). Nonetheless land title was only ratified in 1850 through the “Law of Land” in an attempt to formalize the occupation promoted during the 18th century (Silva and da Silva, 1995).

Although formally occupied, it took another three centuries for the Pantanal region to be integrated into the national economy. It was only in the 1960s and 1970s in the Military Period, that the Brazilian Government started to promote the local economy through national plans of integration, such as: National Rural Credit, Development Council of Beef Cattle, and construction of highways connecting Brazil's north and south, west and east (Franco et al., 2013; Silva and da Silva, 1995). In the Pantanal, after these plans were put into action the production of cattle went from an offtake of 700,000 to 5 million animals annually in the beginning of the 1970s (Abreu et al., 2010). The expansion of cattle ranches was favoured by a coincidental sequence of dry years in the Pantanal. From the early 1960s till the middle 1970s was the driest period ever recorded; low flood levels exposed and maintained a great abundance of natural grassland (Mourão et al., 2010).

In 1974, however, the region faced major changes. A large flood inundated most of the grasslands and reportedly killed half of

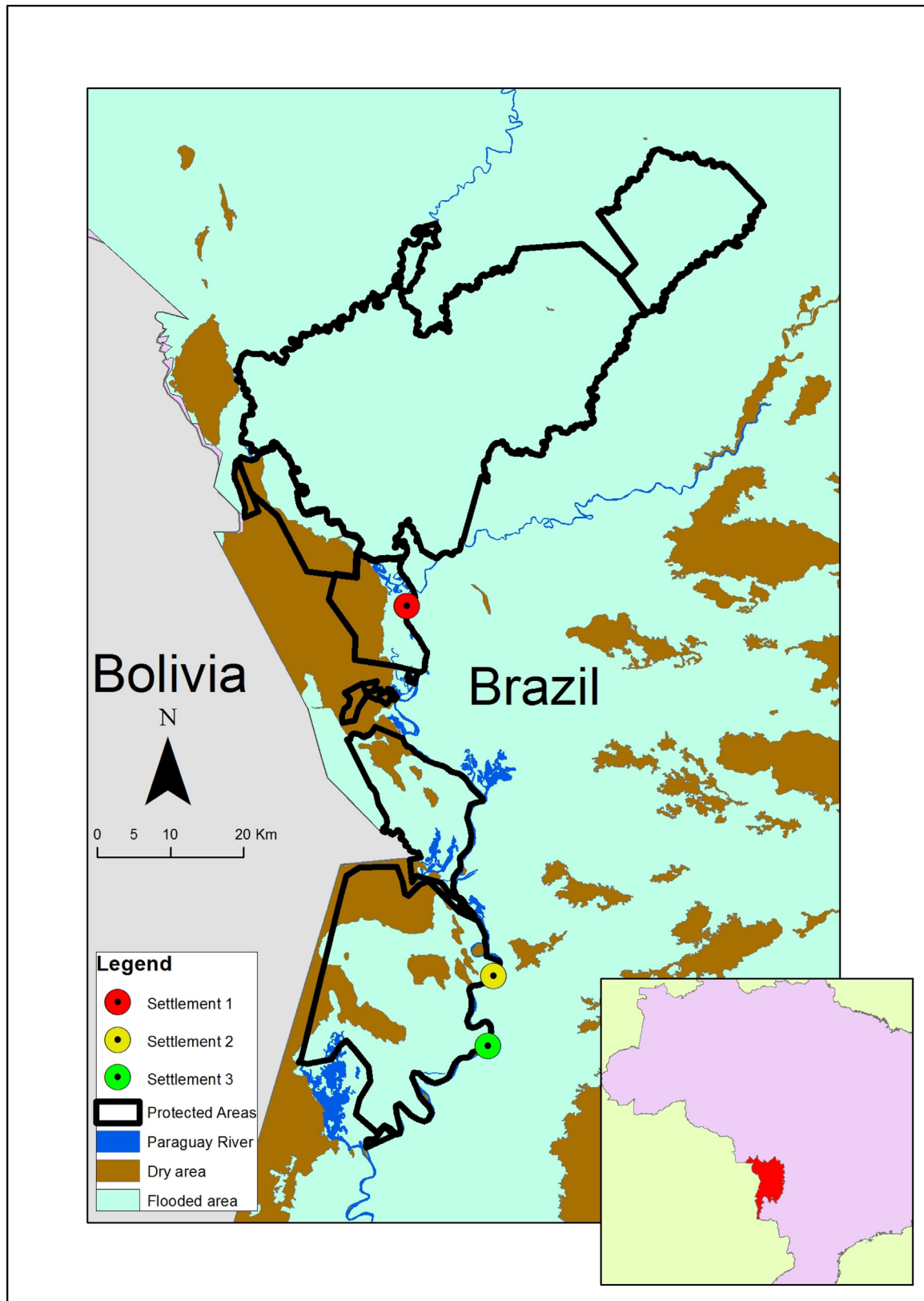


Fig. 1. Protected Area limits overlaid on flooding and dry areas. The inside map on the right highlights the location of the Pantanal in Brazil.

the Pantanal's cattle population (Junk et al., 2011). The extent of annual floods and permanent flooding has remained high since then and in the western region, where water is retained as large lakes (Padovani, 2010), many farms went bankrupt (Bello, 2014). In

the face of economic collapse in the region and increasing international pressure from well-known environmentalists (Schaller and Vasconcelos, 1978), in 1975, the Brazilian Institute of Forest Development (IBDF) established a project buying these farms to expand

a Protected Area first created in 1971 (Couto et al., 1975). In 1981, the Federal Government created the Federal National Park of the Pantanal, expanding the area protected from 80 000 to 130 000 ha (Jesus and de Lima, 2003). 10 years later, in the early 1990s, with support from the NGO The Nature Conservancy, three other large farms were bought and converted into Private Protected Areas (Bello, 2014). In 2005 and, then in 2006, two other Private Protected Areas were aggregated, leading to the establishment of the environmental group “Protection and Conservation Network for the Amolar Region” (PCNAR). This is a partnership among all Protected Area managers, including the federal agency of Protected Areas, NGOs and local Forest Policy agents, aiming to monitor resource use across 310 km linear river distance and adjacent channels, securing strict conservation of 262,000 ha of Protected Areas in the Western Border of the Pantanal (Bertassoni et al., 2012). According to informant 28, 29, and 30, all of them part of the group, PCNAR started with 5 million BRL [1.44 million USD] from a Brazilian mining company owning one of the Private Protected Areas, and then continued activities funded by an endowment from a Brazilian investment bank owning another Private Protected Area.

It is important to note that because this area is been partly inundated since the 1970s, most Protected Area boundaries are either permanently under the water, or partially inundated during the flood season (Fig. 1). However, even so, they have been recognized by the federal government through the Brazilian Agency of Protected Areas (ICMBio)² and their land titles certified by federal prosecutors during lawsuits (MPF, 2013).

2.2. Fishermen communities and their traditional right over the floodplain

Present-day non-indigenous communities were formed 100–150 years ago by a mix of workers from gold mines at Cuiabá-MT, local indigenous people (mainly Guatóes who had survived colonization), several soldiers from the Paraguayan War (the War of Triple Alliance, 1864–1870, fought over this region) who stayed on after the war rather than returning to their places of origin, and Paraguayans who came to live in this region due to the wave of poverty and disease experienced by their country as a consequence of the same war (Ribeiro, 2005; Silva and da Silva, 1995). Their livelihoods alternated between working for landowners in the cattle ranches, poaching (especially 1950s–early 1980s), and most importantly, fishing – a long-term activity, with records of fishermen communities selling fish in the nearest city Corumbá already in the 18th century (Silva, 1986). In the present study, 95% of local interviewees self-identified as fishermen.

Although currently there are around 400 people within some 60 nuclear families living in three main settlements (Fig. 1), extended families with between 15 and 20 people used to live on man-made or natural mounds over the floodplain moving their settlements according to changes in the landscape: “when I was young we used to keep moving trying to find a better place to live, we eventually moved three or four times in one year” (informant 15, male, 65 years, fisherman). Some of the old settlements were located within private farms. However, there are no reports of disagreements between local people and farmers, perhaps because there was no conflict of interest, the first using floodplain areas and the latter dry land. Some people still hold formal letters from farmers authorizing them to use and live inside the farm boundaries with the obligation to take care and report any invasion or cattle robbery in their areas, as reported by informant 38 (fisherman, male, 55 years).

Settlement 1, where this study was focused, was, according to local people, created as a consequence of the Protected Areas displacement. The first displacement was in the 1980s, soon after the National Park was set aside, as claimed by some informants “when they created the National Park we were living in Porto Brazil, they gave us 3 days to leave the place, we put all our belongings in two canoes and sailed for two days trying to find a dry land” (informant 4, female, 46 years, bait gatherer), and “When we were living in the region of the National Park, they came and tied Informant 13 hands and feet and beat him until he fainted” (informant 6, male, 57 years, bait gatherer). The second alleged displacement occurred in the 1990s, when the first Private Protected Areas were created. In the area where some families used to live there are still remnants of their former houses.

Currently there are three extended families living in Settlement 1, comprising 23 nuclear families totalling 71 people. However, there were likely to have been more living in the region when the Protected Areas were created. The area has seen a great exodus from rural areas in the last few decades, and local people remember as many as 10 other extended families living in the region. According to local people, Settlement 1’s current location was used by one of the extended families in the region from roughly 1960s–1980s, and then abandoned because the matriarch of the family died from snakebite. Settlement 1 is surrounded by rivers, and all families are clustered in roughly 20.5 ha. The region is referred to as “the island”. No information was collected about claimed displacements in the other settlements.

People from Settlement 1 were able to record and point out important locations of their historical and customary use throughout the floodplain (Fig. 2) and surrounding these sites they drew on the satellite images what they called “their area” (referred to here as territory) demarcating the limit beyond which someone from another settlement cannot enter to fish, gather bait, plant, or settle. Although no data on exact limits of traditional territories were collected in the other two settlements, the same idea of “each group has its own area” was mentioned in their interviews, with clear notions as to the number of people allowed access, as to who controls the use of specific spots and with whom each person shares the information about fishing spots. The area defined as the territory of Settlement 1 covers 33,651 ha.

The territory encompasses a Rotational Fishing System (RFS). Chiaravalloti (2017) showed that RFS in the Pantanal is undertaken by constantly moving fishing sites according to the flood pulse changes, and especially the appearance of drawdown areas. Hence, after the inundation starts people move their fishing sites to the northern region of the territory and slowly follow in the wake of the flood pulse as it progresses south, finishing at the southern-most limits of their territory. The information about fishing sites is shared among those settlement members, creating a parallel with Ideal Free Distribution and foraging theory’s patch choice models. The author showed too that changes in connectivity between areas, through landscape changes or blocking of passages by floating vegetation, are factored into people’s livelihood adaptations. The simple fact that bays and river channel entrances are closed off by floating vegetation mats can turn these areas into naturally unexploitable refuges for aquatic species (Mourão et al., 1996). The combination of rotational use, customary rules and loss of connectivity is likely to create a sustainable use of natural resources in local people’s territory. Separate analyses of local people’s movements, their fishing practices and of tourist fish catches in the light of changing quota regulations all support the sustainability of local resource use (Chiaravalloti, 2017).

Apart from the historical displacement involving the location of Settlement 1, there is a conflict regarding the fishing area of this group. Managers from Protected Areas claim that local fishermen should not access fishing sites inside the Protected Area boundaries, and argue that in doing so they are committing a crime. Indeed,

² <http://sistemas.icmbio.gov.br/simrppn/publico/rppn/MS/>.

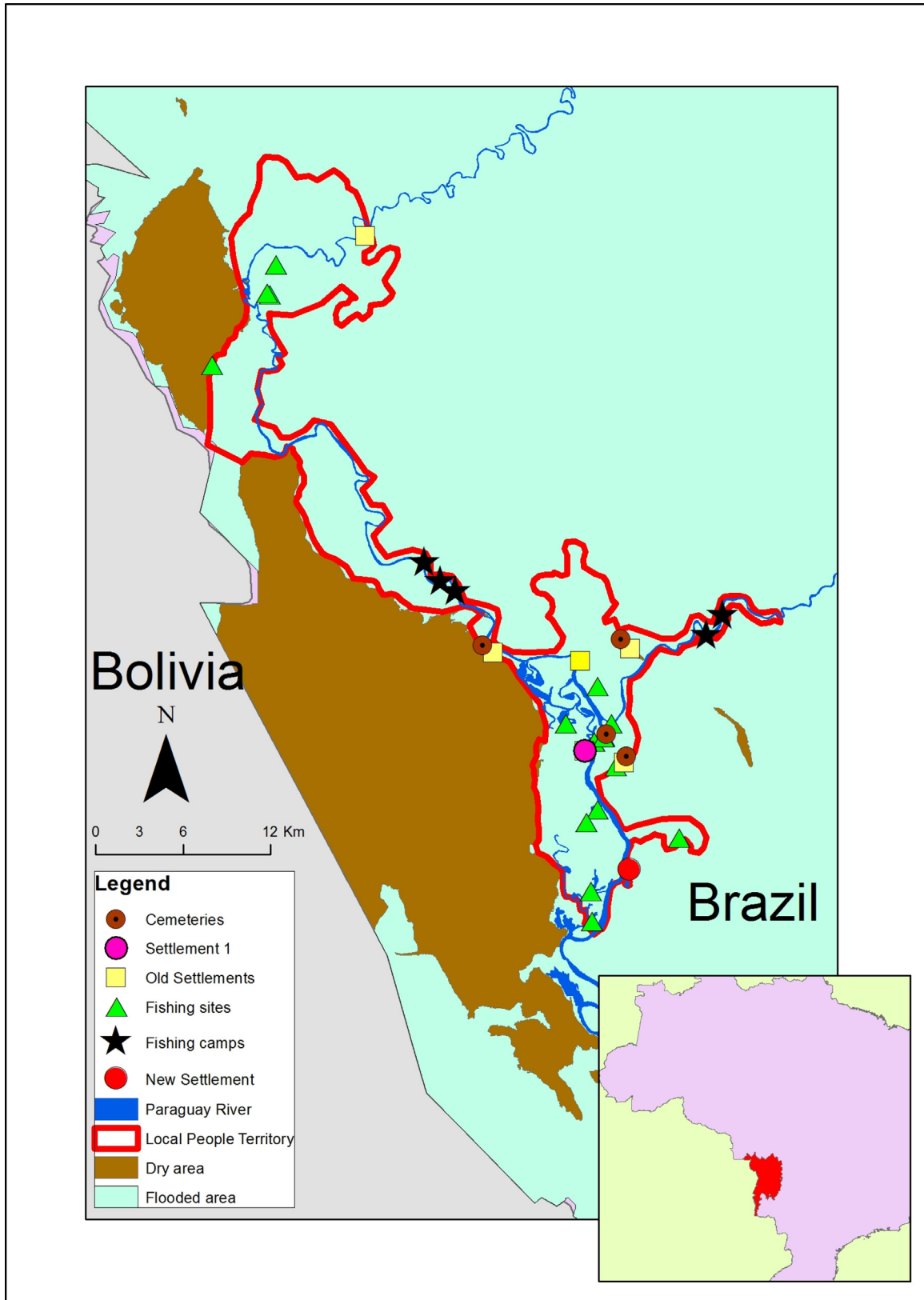


Fig. 2. Settlement 1 inhabitants' territory highlighting dry and flooded areas. The map on the right highlights the location of the Pantanal in Brazil.

managers are backed by the Conservation Units Law, which specifies that National Parks or Private Reserves do not allow any kind of use of natural resources from traditional communities (Law 9.885 from 2000).³

Environmental pressure on local people has led some grassroots human rights organizations to support fishermen and to publicise their conflict. They helped families create a Formal Association, which allowed them to access small grants; around 10 000 USD were invested in the community between 2007 and 2014.⁴ The local municipality built a new school in the Settlement, which all children attend; a public telephone was installed because there is no mobile phone signal, and every three months doctors and dentists go the region to assist in any disease or health problem. Federal Prosecutors brought in to review the case recognized local people's rights (MPF, 2013). It was established that due to their traditional occupation and sustainable use of natural resources they are backed by the Brazilian Constitution of 1988 (Articles 215 and 215), by the Indigenous and Tribal Peoples Convention – ILO 169 (ratified by the Brazilian Government through the Decree number 5051 from 19th April, 2004) and, especially, by the National Policy for the Development of Traditional Peoples and Communities (PNPCT – decree number 6070, 2007) to live and use resources throughout the so-called “traditional territory” (Shiraishi-Neto, 2007).

The terms and rules that dictate the use of “traditional territories” are not clear in the Brazilian legislation. These areas are neither Protected Areas nor Indigenous Lands. They still lack a proper regulation. The only binding requirement is to adhere to sustainable use of natural resources (Shiraishi-Neto, 2007). However, there are no definitions of what constitutes sustainable use of natural resources or how local people should manage these areas. In fact, the right to use traditional territories was established as a way to offer communities living in rural areas the means to secure their livelihood, social cohesion and individual rights in face of threats of physical and economic displacement (Calegare et al., 2014). The main idea underpinning this legal procedure is that once human rights are guaranteed, the management rules can be drawn up (Silva, 2007) and other legal agreements established to guarantee ecological sustainability. This can be done through fishing agreements (Pinedo-Vasquez et al., 2011) – common in the Amazon floodplains, commitment terms specially created to authorize local communities to use areas inside Strictly Protected Areas (Sautchuk, 2007), or even creation of Sustainable Use Protected Areas (Calegare et al., 2014) among other possibilities. However, although no further agreement was reached to regulate natural resource use in Settlement 1's traditional territory, there are strong indications from the RFS, the unexploitable reserves and tourist fish catch data that local people's use may guarantee local ecological sustainability (Chiaravalloti, 2017).

2.3. Federal government rights over the area and solutions to the conflict

The federal government's recognition of local people's settlement and use rights, however, led to a property rights overlap. As shown in Fig. 3, Settlement 1's traditional territory overlaps with Protected Area boundaries. Thus, on the one hand, the Conservation Units Law rules that fishermen are not allowed to access roughly 22 000 ha of the region or 70% of the local people's territory. On the other, National Policy of Traditional Peoples, Brazilian Constitution and ILO 169 assert their right to do so. To try to solve these conflicting understandings of overlapping ownership, federal prosecutors

used a third official layer of property rights, regarding national ownership of floodplains.

According to Brazilian legislation (decree n. 9660 from 1946⁵), federal rivers are a public good. Under this law natural features such as the Paraguay River crossing two states are part of federal assets and cannot be privatized nor their exclusive ownership claimed. It is important to note that prosecutors calculate river limits as follows: “We consider as the river limit the furthest point reached by water in an ordinary inundation during the flood period” (informant 34, prosecutor). In the Pantanal, the margin of the Paraguay River, in an ordinary inundation, extends across most of the floodplain, an area of 86 441 km² or roughly half of the Pantanal ecosystem (Padovani, 2010). Taking into account that 86.2% of the Protected Areas and 98.7% of the traditional territory are either permanently or periodically inundated by the Paraguay River during 3–4 months of the year, they are, according to law, federal river areas. Therefore, regardless of land titles or historical and customary ownership claims, the Paraguay River floodplain areas in the Pantanal are, in principle, state property. Moreover, recently, a new ordinance was published that authorized federal prosecutors to give provisional ownership to local peoples undertaking sustainable use of federal lands, such as rivers, marsh areas or floodplains (Ministerial ordinance n. 89, 2010⁶). This is a new provision of Brazilian legislation and it is a direct consequence of the Brazilian National Policy for the Development of Traditional Peoples and Communities. It was created to solve precisely these sorts of conflicts of land tenure in rural areas, giving local people a provisional authorization of use known as The “Term of Authorization of Sustainable Use” (TASU).

In an attempt to solve the conflict, federal prosecutors used both laws to “open” 18% of the Private Protected Areas to fishermen, and to give communities a small part (0.04%) of one of the Private Protected Areas to use as a temporary dwelling site during the flood period.⁷ However, this solution only led to further battles, and brought no land tenure security to either group (MPF, 2013).

On the one hand local fishermen still faced *de facto* restrictions on their use of the protected floodplain inside their customary territory, and were being prevented from undertaking their traditional rotational fishing, as claimed by local fishermen: “prosecutors came here and said that we could fish inside the Private Protected Areas, however, we went there and rangers took all our fishing gears; what should we do? We need to eat” (informant 9, male, 52 years, bait gatherer) and “Prosecutors do not live here, they come, say something and leave; how will they guarantee I will not be arrested if I use the Protected Area region?” (informant 1, male 27 years, fisherman).

On the other hand, Protected Area Managers did not see the rules as a feasible solution, as presented by informant 28: “prosecutors spoiled everything, we used to have good relations with local people” “These TASU given to local people threaten the core principle of protected areas: perpetuity – they are setting a dangerous precedent that can bring about the collapse of the whole Brazilian Protected Area System”. The environmental group took several actions to regain property rights over the protected floodplain. First they sued some prosecutors involved in the case, trying to repeal the property rights given to local people,⁸ as presented “they tried to revoke my act and it did not work, they did for a second time and it did not work either, now they are suing me in the Supreme Court” (Informant 35, prosecutor). The second approach was to decon-

⁵ http://www.planalto.gov.br/ccivil_03/decreto-lei/Del9760.htm.

⁶ http://patrimoniodebiodos.gov.br/pastaarquivo.2009-07-09.3759851862/SPU_89-2010-TAUS.pdf.

⁷ <http://www.prms.mpf.mp.br/servicos/sala-de-imprensa/noticias/2013/04/comunidade-do-pantanal-recebe-autorizacao-para-uso-sustentavel-de-area-tradicional>.

⁸ All legal and lawsuits were presented in the conciliation panel held in the Settlement 1 with all stakeholders on May 18, 2015.

³ http://www.planalto.gov.br/ccivil_03/leis/L9985.htm.

⁴ <http://www.casa.org.br/pt/>.

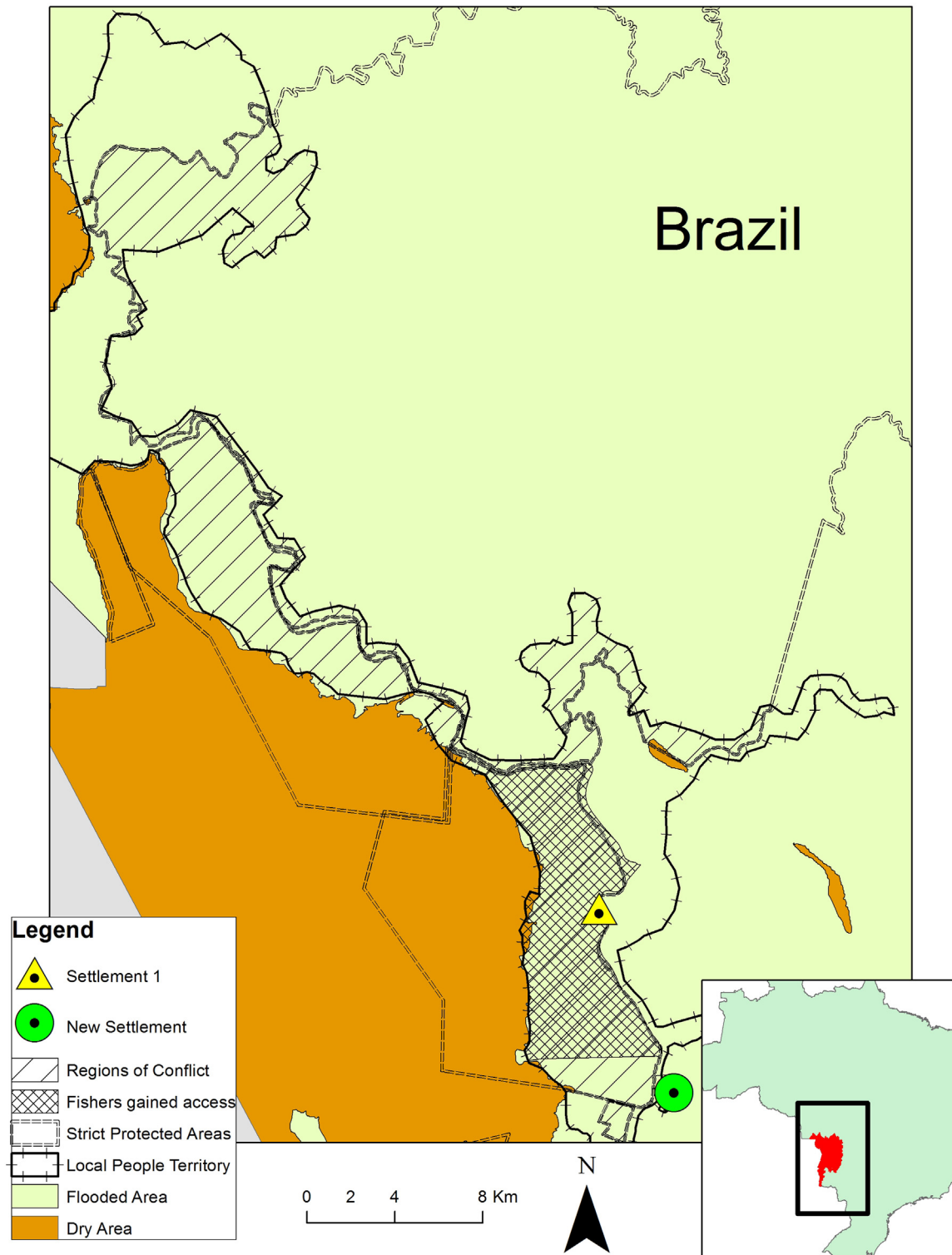


Fig. 3. Ownership overlap in the Western Border of the Pantanal. The red line indicates the traditional territory, the black line the Protected Area limits and the green area is, in principle, state owned. The orange area is the region prosecutors excised from Protected Areas to give to local people. The yellow dot indicates the location of the new settlement.

struct the idea that fishermen from Settlement 1 are covered by the Brazilian National Policy for the Development of Traditional Peoples and Communities, and to argue that they should not be granted title to their traditional territory. To do so, PCNAR supported the publication of a book claiming that fishermen settled on the floodplain no more than 30 years ago, that they do not use traditional practices, and they are destroying the environment; as

illustrated by the following quotes: “their [local people’s] weak ability to organize themselves” and “Within the environmental impacts [...] can be counted their overfishing” (Franco et al., 2013, p. 91). PCNAR’s book was discredited by its lack of empirical evidence (Chiaravalloti, 2016): as already presented, available evidence suggests local communities’ resource use is sustainable (Chiaravalloti, 2017). Finally, the argument was used that Settlement 1 location

is suffering from erosion, claiming that is “*putting at risk the school structure and families’ security*” (informant 28, Protected Area manager). Specialists on Pantanal soils agree that “*the community area is exposed to marginal erosion*”. However, they give no timeline for this settlement site to be eroded to the point where it disappears, as explained by informant 36 (Pantanal researcher): “*to define whether it will be in one, two or three years is extremely hard [...] it will always depend on the flood regime*”.

Under mounting pressure, prosecutors made a second attempt to solve the conflict of property rights and use of natural resources on the Pantanal floodplain. They gave provisional land title to people from Settlement 1, excising a small part of a flooded cattle ranch on a site 12 km south from the original settlement location⁹ (Fig. 3). The area is a non-flooding, man-made mound of roughly 2 ha constructed by the federal government in the 1970s. The Prosecutors’ main rationale for doing so, however, is not the conflict itself but the erosion in the Settlement 1, “*the permanence of these people in the area is impossible because of the river dynamics [...] they will be safer in this new location*” (informant 35, prosecutor). The proposed deal is to build new houses and a new school for local people, to be delivered by a local NGO partner of the community association. Supporters of the deal point out that the new settlement is based on the idea of an “*Eco-Village, where people would live close by each other and will have a football pitch and a meeting centre*” (informant 40, NGO practitioner). According to prosecutors they will not be obliged to move to the new place, but the area currently made available from the protected areas will probably be restricted again: “*we are still under negotiation, it will be like an exchange, Protected Areas managers build the new school and I cancel the use of the Protected floodplain by local people*” they will be able to access the Protected floodplain but fishing will be restricted to just self-consumption” (informant 35, prosecutor).

Each group reacted differently in face of the new solution. Protected Area managers are supporting the new solution “*the new settlement is the best strategy for community development*” (informant 39, Protected Area manager). Researchers on the other hand are very concerned “*families have an identity with the place, this does not relocate with them [...] this will weaken the community*” (informant 37, researcher). The community itself is equally divided, the president of the local association linked with the NGO supposed to build the houses is very supportive, pointing out that 16 nuclear families out of the 23 are looking forward to moving, however, others argue that no more than 2 or 3 nuclear families are moving out. Local people raised many concerns. The first concerns spatial organization, as “*living very close to each other does not work*” (informant 9, male, 52 years, bait gatherer). The second is related to the size of the area designated for them: “*If they build a football pitch there, only two players will be able to play*” (informant 7, female, 48 years, fishermen). Finally, concerns regarding the location of the new settlement were pointed out “*there are plenty of dry areas around here*” “*the new location is five hours by boat from here*” (informant 41, female, 45 years, fishermen).

No exact date has been set for the resettlement, nor have agreements been made as to whether it really is going to happen. For instance, in face of the families’ criticism, the local NGO due to build the new houses has already put plans on hold.

2.4. Property and prospects in the Pantanal

The case in the Western Border of the Pantanal clearly illustrates overlapping understandings of property rights. On the one hand environmental NGOs have acquired land title to the flood-

plain to create Protected Areas, which in principle gives them the right to exclude outsiders. On the other hand, local communities established in the area roughly 150 years earlier than the Protected Areas claim access to those floodplain areas based on their historical customary use, and they are backed by the National Policy of Traditional People’s Development to do so. The government maintains that neither group is right, arguing that the Paraguay River floodplain is a public good and it is state owned. After a failed first attempt to solve the conflict, the second solution proposed by prosecutors to end the battle and promote sustainability in the region is to relocate local people giving them title to a new area further south.

However, no attention has been paid to the perspectives that different groups have on property. The government approach is to use a legal/economic view to solve the conflict, giving different stakeholders title for different parts, and the right to exclude non-owners. Therefore, the state does not consider local people’s customary property arrangements; yet the data collected showed that these are of central importance for local livelihoods allowing adaptation to the changes in landscape accessibility and flood pulse.

3. Discussion

The conflict in the Western Border of the Pantanal is an important case study in exploring the link between sustainability and land tenure, but also in analysing the power play between competing interest groups, and the potential for legal frameworks to add to or conversely minimise conflict. The Government, NGOs and traditional communities using different perspectives claim ownership rights over the same floodplain and, interestingly, each is backed by law. Moreover, ostensibly, the main goal of each of the three contenders is to promote sustainable use of natural resources, the common objective whether of the Protected Areas Law, the National Policy backing local communities’ territorial claims, or the law authorizing prosecutors to give provisional titles. However, stakeholders’ interests clash instead of converging. The consequence has been comprehensive mismanagement, with the prospect of further damage being done through the relocation of the weakest group – local communities of fishermen – if they are given land title in a distant area.

It becomes clear that the real intention of each group is to impose their own view over the other, rather than to aim for sustainable development or a clearer and more workable delineation of property regimes, tenure and access. Without reiterating the details, many features of the conflict suggest this: the conservation group funded by powerful corporations; the state’s intervention, which it is then powerless to enforce; the documented harassment and proposed displacement of the weaker community. The local situation can be understood as a power dispute, in which stakeholders use narratives of property ownership and environmental conservation to argue their interests.

This is not particular to the Pantanal. Political interests underpin most conservation conflicts (Robbins, 2004, pp. 13). Claims of overfishing, bushmeat overhunting or desertification are often not so much evidence-based conservation concerns, as narratives strategically deployed to impose the interests of the most powerful groups (Abbott and Campbell, 2009; Coad et al., 2013; Homewood, 1994). Historically misapplied narratives have often led to aggressive management interventions such as strong restrictions on the use of the natural resource or even physical displacement (Smith et al., 2005; Kittinger et al., 2013; Kolding and Van Zwieten, 2014). Scientific knowledge offers one set of tools to deconstruct these narratives, giving empirical evidence to support or reject a specific claim. For instance, claims of overgrazed rangelands triggering desertification in African and Central Asian drylands have been

⁹ <http://riosvivos.org.br/pagina-inicial/destaque-inferior/spu-declara-ser-de-interesse-publico-area-da-comunidade-da-barrado-sao-lourenco/>.

shown to be inconsistent or unfounded in a number of individual and in-depth studies (Homewood and Rodgers, 1987; Homewood, 2008). The case study presented in this paper illustrates how claims regarding the link between ownership and sustainable use are used to impose the interests of powerful groups. Deconstructing such claims is a fundamental step towards better management of natural resources and promotion of local development (Neumann, 2011, 2010, 2009). While a political ecology framework helps that process of deconstruction, progress towards a more equitable working compromise depends on bringing other tools to bear. This means understanding the resource use system and the way it maps both to ecosystem dynamics and to social organisation, and also understanding the legal frameworks from which different players draw their sense of legitimacy, and which can be invoked to rein in abuses of power or of resource extraction.

Case studies from around the globe show how important is to consider the combination of anthropological, economic and ecological perspectives to better understand the ways property regimes and resource use play out in reality and with respect to sustainability of socio-ecological systems. Many multidimensional property arrangements encompassing such multidisciplinary views are already formally implemented. An illustration is seen in the USA with conservation easements. These are legally recognized, voluntary, formal agreements between landowners and conservation organizations, in which the donor agrees to not use an area in exchange for a reduction of federal property tax; in practice the easements become strictly private protected areas, managed by an external NGO, with federal incentives (Kay, 2015). Today there are roughly 9 million hectares under this legal agreement of shared ownership in the USA (McLaughlin, 2013). Although pursuing a different goal, this is in many ways comparable to what happens with sharecropping, in which private properties belonging to a primary owner are let out to a tenant who then negotiates a sharecropping deal (de Almeida and Buainain, 2016; Ofuoku, 2015). In both cases, the “bundle of rights” embodied in a specific property is formally disaggregated into separable rights shared out between different stakeholders: owner, tenant, conservation organization, etc. Another interesting if less equitable example is seen in Tanzania’s Wildlife Management Areas, in which groups of villages are given title to pooled communal land, which is set-aside for conservation and tourism enterprise. However, the state owns any wildlife on that land; and also owns any minerals under that land; at the same time villagers who are resident “owners” are excluded from using the resource they “own” (for instance, pastoralists are banned from grazing the set-aside area). The income generated from game hunting and mining mostly flows direct to state and bypasses land ‘owners’ (Homewood et al., 2013; Noe, 2013; Noe and Kangalawe, 2015). Hence, although villages in principle own the land, they officially do not have rights over specific lucrative property layers. The breaking of the bundle of rights is not always backed by legal rights; and, indeed, multi-layered property arrangements are often informal. As illustrated by the example of Turkmenistan (Behnke et al., 2016), legal frameworks may change rapidly, leaving the imprint of historical regimes in actual practices, though with no formal recognition. In Turkmenistan, the imposition of a communist state onto a previously feudal system was followed by post-soviet conversion to a privatized system. The government owns all natural resources in the rangelands but half of all pastoralist livestock remains state property. The consequence is a plural legal system with state and pre-existing property institutions operating side by side: “the resulting tenure system was in practice a combination of abstract territorial principles and historical contingency, an administrative system with a memory” (Behnke et al., 2016). Simply giving title to land dwellers to tackle poverty alleviation or promote biodiversity conservation creates a disjunct between economic and

socio-historical aspects of property, given that property in many realities is not a matter of straightforward or exclusive ownership.

Another important point to make about the case in the Pantanal is that all proposed solutions seek to secure the rights of their focal group by establishing fixed boundaries, establishing defined properties through title. However, such an approach runs counter to the current understanding of flood pulse and other dynamic ecosystems, which recognizes that temporally and spatially fixed boundaries cannot track changes through time and space (Hayden et al., 2015; Levin et al., 2012; Lourival et al., 2011). The natural resources distributions we see today are likely to be very different in the future and fixed solutions do not adapt to those changes (Rist et al., 2013; Westgate et al., 2013), leading to a further disjunct between the western economic view of property and ecological understandings of sustainable natural resource use in ecosystems with unpredictable dynamics.

Pastoralists in Mongolia provide a case for comparison here. Due to the unpredictable seasonal and annual changes in resource distribution in arid and semi-arid rangelands, pastoralists need extensive areas for grazing, moving around according to resource availability (Fernandez-Gimenez, 2002). Setting aside defined areas for pastoralists may undermine their livelihoods. The importance of appropriate adaptation to the natural changes and constraints goes beyond small-scale systems. In marine fisheries the presence of rotational harvesting, and the existence of inaccessible spots that could not be harvested, underpin sustainability (Hayden et al., 2015). Historically, shortage of fish resources were dealt with by moving along the coast and reducing fishing effort, allowing deep sea reserves to rebuild the biomass and export juveniles or adults to the coast (Pauly et al., 2002). However, government subsidies and technological advances have allowed vessels to harvest ocean deeps, entering previously unexploitable areas (Hayden et al., 2015). Although some authors point to the lack of ownership over the ocean as the main cause of marine overfishing (attributing lack of sustainability to the open access regime), authoritative analysis identifies the failure of adaptation to the natural system through technology’s accessing formerly unexploitable reserves as playing the most important role (Pauly, 2003). In the Pantanal, the on-going changes in river flow regulate fishermen’s territories, and their adaptation to those changes is likely the keystone for sustainable use of natural resources in the region (Chiaravalloti, 2017). Restrictions on this adaptive customary management of natural resource use, such as establishing defined areas that fishermen can use and others from which they are excluded, are likely to disrupt the rotational fishing system, which is emerging as underpinning both biodiversity conservation and income for local people.

The disjunct between property as it is held on the ground, and the hegemonic western view of property, can become the basis for environmental narratives justifying aggressive management practices and interventions, including displacements, implementation of alternative livelihoods, or heavy-handed enforcement around use of natural resources (Adams and Hutton, 2007; Rantala et al., 2013; Wright et al., 2016). These interventions are often adopted from quite different systems, opening space to financial capital and external investors in the region, allowing monetization of the area (Büscher et al., 2012). As a consequence small-scale users of natural resources are replaced by large investors, focusing either on (claimed) environmental conservation or on extraction of natural resources (Zoomers, 2010). It is no surprise, therefore, that, in the Pantanal, the “Protection and Conservation Network for the Amolar Region” (PCNAR), according to local informants, was funded by a mining company and an investment bank.

To conclude, secure access to land and guaranteed property rights are indeed key elements in tackling poverty alleviation and environmental conservation. The approach to guarantee such a link, however, needs to encompass a broader perspective than

simple land titling. Property is composed of multiple components involving social, economic and environmental dimensions. Empirical examples constantly reaffirm this understanding. Moreover, property is a mutable structure that adapts to internal and external changes. Therefore, setting defined ownership and rights to exclude through land titling may be a myopic view of property particularly in ecosystems subject to unpredictable dynamics, such as characterise many South CPRs. It will keep failing to bring the results expected; and, most importantly, does not necessarily secure access to land, guarantee property rights and, therefore, sustainability. The conflict in the Western Border of the Pantanal illustrates a case study of just such a persistent disconnect. Although land titling proved a poor way to solve land conflict in the region, prosecutors insisted on applying the same approach in a second attempt. The conflict between conservationists and local communities is likely to remain unresolved, and the state likely to continue to fail in enforcing rulings, all of which may jeopardize both biodiversity conservation and local people's livelihoods.

Public policies intended to bring sustainable development need to map better onto grassroots reality. We propose that before allocating land title to different groups or individuals, a first step should be to describe the most important drivers dictating property from the perspectives of anthropology, ecology and economics. This wider understanding is more likely to integrate management policies with local realities in sustainable ways. In the Pantanal, instead of setting aside reserves for use or non-use, policymakers could propose a more flexible property system, in which areas are protected but allowed to change according to flood pulse and area flooded. Although each case faces a unique combination of social and historical factors shaping their property regime, such approaches could be replicated in other floodplains facing similar biophysical dynamism and comparable conflict over tenure and access.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.landusepol.2017.03.005>.

References

- Abbott, J., Campbell, L., 2009. Environmental histories and emerging fisheries management of the upper zambesi river floodplains. *Conserv. Soc.* 7, 83–99, <http://dx.doi.org/10.4103/0972-4923.58641>.
- Abreu, U.G.P., de McManus, C., Santos, S.A., 2010. Cattle ranching, conservation and transhumance in the Brazilian Pantanal. *Pastoralism* 1, 99–114, <http://dx.doi.org/10.3362/2041-7136.2010.007>.
- Adams, W.M., Hutton, J., 2007. *People, parks and poverty: political ecology and biodiversity conservation*. *Conserv. Soc.* 5, 147–183.
- Agrawal, A., Gibson, C.C., 1999. Enchantment and disenchantment: the role of community in natural resource conservation. *World Dev.* 27, 629–649, [http://dx.doi.org/10.1016/S0305-750X\(98\)00161-2](http://dx.doi.org/10.1016/S0305-750X(98)00161-2).
- Agrawal, A., 2001. Common property institutions and sustainable governance of resources. *World Dev.* 29, 1649–1672, [http://dx.doi.org/10.1016/S0305-750X\(01\)00063-8](http://dx.doi.org/10.1016/S0305-750X(01)00063-8).
- Allison, E.H., Ellis, F., 2001. *The livelihoods approach and management of small-scale fisheries*. *Mar. Policy* 25, 377–388.
- Assies, W., 1997. *The extraction of non-timber forest products as a conservation strategy in Amazonia*. *Eur. Rev. Lat. Am. Caribbean Stud.* 62, 33–53.
- Assine, M.L., Macedo, H.A., Stevaux, J.C., Bergier, I., Padovani, C.R., Silva, A., 2015. Avulsive rivers in the hydrology of the pantanal wetland. In: Bergier, I. (Ed.), *Dynamics of the Pantanal Wetland in South America*. Springer, New York, pp. 83–110, http://dx.doi.org/10.1007/978-1-4939-9999-9_5.
- Büscher, B., Sullivan, S., Neves, K., 2012. *Towards a synthesized critique of neoliberal biodiversity conservation*. *Capital Nat. Soc.* 23, 37–41.
- Behnke, R., Robinson, S., Milner-Gulland, E.J., 2016. Governing open access: livestock distributions and institutional control in the Karakum Desert of Turkmenistan. *Land Use Policy* 52, 103–119, <http://dx.doi.org/10.1016/j.landusepol.2015.12.012>.
- Beitl, C.M., 2015. Mobility in the mangroves: catch rates, daily decisions, and dynamics of artisanal fishing in a coastal commons. *Appl. Geogr.* 59, 98–106, <http://dx.doi.org/10.1016/j.apgeog.2014.12.008>.
- Bello, C.M.A., 2014. *A formação do Complexo de Áreas Protegidas do Pantanal no Contexto da Inserção do Paradigma Ambiental nas Políticas Territoriais Incidentes sobre o Pantanal Brasileiro*. In: VI Congresso Iberoamericano de Estudos Territoriais Y Ambientales, São Paulo, pp. 1500–1523.
- Benjaminsen, T., Lund, C., 2002. Formalisation and informalisation of land and water rights in africa: an introduction. *Eur. J. Dev. Res.* 14, 1–10, <http://dx.doi.org/10.1080/0714000420>.
- Berkes, F., 2004. Rethinking community-based conservation. *Conserv. Biol.* 18, 621–630, <http://dx.doi.org/10.1111/j.1523-1739.2004.00077.x>.
- Berkes, F., 2006. *From community-based resource management to complex systems: the scale issue and marine commons*. *Ecol. Soc.* 11, 45.
- Berkes, F., 2007. Community-based conservation in a globalized world. *Proc. Natl. Acad. Sci.* 104, 15188–15193, <http://dx.doi.org/10.1073/pnas.0702098104>.
- Berryman, A.A., Hawkins, B.A., 2006. The refuge as an integrating concept in ecology and evolution. *Oikos* 115, 192–196, <http://dx.doi.org/10.1111/j.0030-1299.2006.15188.x>.
- Bertassoni, A., Xavier-Filho, N., Rabelo, F., Leal, S., Perfírio, G., Moreira, V., Rabelo, A., 2012. *Paraguay River Environmental Monitoring by Rede de Proteção e Conservação da Serra do Amolar*. *Panam. J. Aquat. Sci.* 7, 77–84.
- Borras, S.M., Hall, R., Scoones, I., White, B., Wolford, W., 2011. Towards a better understanding of global land grabbing: an editorial introduction. *J. Peasant Stud.* 38, 209–216, <http://dx.doi.org/10.1080/03066150.2011.559005>.
- Brightman, M., Fausto, C., Grotti, V., 2016. *Altering Ownership in Amazonia*. Bergham Books, Oxford.
- Brightman, M., 2010. Creativity and control: property in guianese amazonia. *J. Soc. Am.* 96, 135–167, <http://dx.doi.org/10.4000/jsa.11303>.
- Calegare, M.G.A., Higuchi, M.I.G., Bruno, A.C.S., 2014. *Povos e Comunidades Tradicionais: das Áreas Protegidas à Visibilidade Política de Grupos Sociais Portadores de Identidade Étnica e Coletiva*. *Ambient Soc.* 17, 115–134.
- Chiaravalloti, R.M., 2017. Overfishing or over reacting? Management of fisheries in the Pantanal wetland, Brazil. *Conser. Socie.* 15, 111–122, <http://dx.doi.org/10.4103/0972-4923.196632>.
- Chiaravalloti, R.M., 2016. Is the pantanal a pristine place? Conflicts related to the conservation of the pantanal. *Ambient Soc.* 19, 305–308, <http://dx.doi.org/10.1590/1809-4422ASOC142964V1922016>.
- Coad, L., Schleicher, J., Milner-Gulland, E.J., Marthews, T.R., Starkey, M., Manica, A., Balmford, A., Mbombe, W., Bineni, Diop, Abernethy, T.R., a, K., 2013. Social and ecological change over a decade in a village hunting system, Central Gabon. *Conserv. Biol.* 27, 270–280, <http://dx.doi.org/10.1111/cobi.12012>.
- Costa, M. de F., 1999. *A história de um país inexistente. Estação Liberdade*.
- Couto, E., Dietz, J., Mumford, R., Wetterberg, G., 1975. *Sugestões para criação do Parque Nacional do Pantanal*. Viçosa.
- Dagan, H., 2011. *Property*. Oxford University Press, Oxford, <http://dx.doi.org/10.1093/acprof:oso/9780199737864.001.0001>.
- Davies, N., Krebs, J., West, S., 2012. *An Introduction to Behavioural Ecology*, 4th ed. Wiley-Blackwell, Oxford.
- De Soto, H., 2000. *The Mystery of Capital*, 1st ed. Black Swan, London.
- Derry, J.F., Boone, R.B., 2010. Grazing systems are a result of equilibrium and non-equilibrium dynamics. *J. Arid Environ.* 74, 307–309, <http://dx.doi.org/10.1016/j.jaridenv.2009.07.010>.
- Ellis, J., Swift, D., 2006. *Stability of African pastoral ecosystems: alternate paradigms and implications for development*. *J. Range Manag.* 41, 450–459.
- FAO, F., A.O. of the U.N., 2012. *Responsible Governance of Tenure*. Rome. 10.3334/CDIAC/vrc.ndp072.
- Fernandez-Gimenez, M.E., 2002. *Spatial and social boundaries and the paradox of pastoral land tenure: a case study from postsocialist Mongolia*. *Hum. Ecol.* 30, 49–78.
- Franco, J.L. de A., Drummond, J.A., Gentile, C., Azevedo, A.I. de, 2013. *Biodiversidade e ocupação humana do Pantanal mato-grossense: conflitos e oportunidades*, 1st ed. Garamond, Rio de Janeiro.
- Freyfogle, E., 2011. *Taking property seriously*. In: Grinlinton, D., Taylor, Prue (Eds.), *Property Rights and Sustainability*. Martinus Nijhoff, Boston (p. 414).
- Galik, C.S., Jagger, P., 2015. Bundles, duties, and rights: a revised framework for analysis of natural resource property rights regimes. *Land Econ.* 91, 1–18, <http://dx.doi.org/10.1353/lde.2015.0000>.
- Haller, T., Fokou, G., Mbeyale, G., Meroka, P., 2013. How fit turns into misfit and back: institutional transformations of pastoral commons in African floodplains. *Ecol. Soc.* 18, 34, <http://dx.doi.org/10.5751/ES-05510-180134>.
- Hamilton, S.K., Sippel, S.J., Melack, J.M., 1996. Inundation patterns in the Pantanal wetland of South America determined from passive microwave remote sensing. *Arch. Hydrobiol.* 137, 1–23, <http://dx.doi.org/10.1007/s00393-014-1492-y>.
- Hann, C.M., 1998. *Property Relations: Renewing the Anthropological Tradition*. Cambridge University Press, Cambridge.
- Hanski, I., 1998. *Metapopulation dynamics*. *Nature* 396, 41–49.

- Hardin, G., 1968. The tragedy of the commons. *Science* 162, 1243–1248, <http://dx.doi.org/10.1126/science.162.3859.1243>.
- Hayden, A., Acheson, J., Kersula, M., Wilson, J., 2015. Spatial and temporal patterns in the cod fisheries of the North Atlantic. *Conserv. Soc.* 13, 414, <http://dx.doi.org/10.4103/0972-4923.179878>.
- Homewood, K., Rodgers, W.a., 1987. Pastoralism, conservation and the overgrazing controversy. *Conserv. Afr. People Policies Pract.*, 111–128.
- Homewood, K., Trench, P.C., Brockington, D., 2013. Pastoralism and conservation—whom benefits? In: Roe, D., Elliott, J., Sandbrook, C., Walpole, M. (Eds.), *Biodiversity Conservation and Poverty Alleviation: Exploring the Evidence for a Link*. John Wiley & Sons, London, pp. 239–252.
- Homewood, K., 1994. Pastoralists, environment and development in East African rangelands. In: Zaba, B., Clarke, J. (Eds.), *Environment and Population Change*. Oxford University Press, Oxford UK, pp. 311–322.
- Homewood, K., 2008. *Ecology of African Pastoralist Societies*. James Currey, Oxford, UK.
- Horsley, P., 2011. Property rights viewed from emerging relational perspectives. In: Grinlinton, D., Taylor, P. (Eds.), *Property Rights and Sustainability*. Martinus Nijhoff, Boston, p. 414.
- Jesus, F., de Lima, S.F., 2003. Plano de Manejo do Parque Nacional Matagrossense. Brasília.
- Junk, W.J., Silva, C.J.D.A., Cunha, C.N., Wantzen, K.M., 2011. *The Pantanal: Ecology, Biodiversity and Sustainable Management of a Large Neotropical Wetland*, 1st ed. Pensoft, Sofia-Moscow.
- Kay, K., 2015. Breaking the bundle of rights: conservation easements and the legal geographies of individuating nature. *Environ. Plan. A*, 1–19, <http://dx.doi.org/10.1177/0308518X15609318>.
- Keddy, P.a., Fraser, L.H., Solomeshch, A.I., Junk, W.J., Campbell, D.R., Arroyo, M.T.K., Alho, C.J.R., 2009. Wet and wonderful: the world's largest wetlands are conservation priorities. *Bioscience* 59, 39–51, <http://dx.doi.org/10.1525/bio.2009.59.1.8>.
- Kennedy, M., Gray, R.D., 1993. Can ecological theory predict the distribution of foraging animals? A critical analysis of experiments on the Ideal Free Distribution. *Oikos* 68, 158–166, <http://dx.doi.org/10.2307/3545322>.
- Kittinger, J.N., Finkbeiner, E.M., Ban, N.C., Broad, K., Carr, M.H., Cinner, J.E., Gelcich, S., Cornwell, M.L., Koehn, J.Z., Basurto, X., Fujita, R., Caldwell, M.R., Crowder, L.B., 2013. Emerging frontiers in social-ecological systems research for sustainability of small-scale fisheries. *Curr. Opin. Environ. Sustain.* 5, 352–357, <http://dx.doi.org/10.1016/j.coesust.2013.06.008>.
- Klick, J., Parchomovsky, G., 2016. The Value of the Right to Exclude: an Empirical Assessment (No. 16–8), Research Paper Contracts Without Terms.
- Kolding, J., Van Zwieten, P.A.M., 2014. Sustainable fishing of inland waters. *J. Limnol.* 73, 132–148, <http://dx.doi.org/10.4081/jlimnol.2014.818>.
- Kothari, A., Camill, P., Brown, J., 2013. Conservation as if people also mattered: policy and practice of community-based conservation. *Conserv. Soc.* 11, 1–15, <http://dx.doi.org/10.4103/0972-4923.110937>.
- Kupel, N.F., Milner-Gulland, E.J., Cowlshaw, G., Rowcliffe, J.M., 2009. Assessing sustainability at multiple scales in a rotational bushmeat hunting system. *Conserv. Biol.* 24, 861–871, <http://dx.doi.org/10.1111/j.1523-1739.2010.01505.x>.
- La Valley, K.J., Feeney, R.G., 2013. Reconciling spatial scales and stock structures for fisheries science and management. *Fish. Res.* 141, 1–2, <http://dx.doi.org/10.1016/j.fishres.2013.02.014>.
- Levin, S., Xepapadeas, T., Crépin, A.-S., Norberg, J., de Zeeuw, A., Folke, C., Hughes, T., Arrow, K., Barrett, S., Daily, G., Ehrlich, P., Kautsky, N., Mäler, K.-G., Polasky, S., Troell, M., Vincent, J.R., Walker, B., 2012. Social-ecological systems as complex adaptive systems: modeling and policy implications. *Environ. Dev. Econ.* 18, 111–132, <http://dx.doi.org/10.1017/S1355770X12000460>.
- Levins, R., 1969. Some demographic and genetic consequences of environmental heterogeneity for biological control. *Bull. Entomol. Soc. Am.* 15, 237–240, <http://dx.doi.org/10.1093/besa/15.3.237>.
- Lewis, J., 2007. Enabling forest people to map their resources & monitor illegal logging in Cameroon. *Before Farm.* 2, 1–7.
- Lourival, R., Drechsler, M., Watts, M.E., Game, E.T., Possingham, H.P., 2011. Planning for reserve adequacy in dynamic landscapes; maximizing future representation of vegetation communities under flood disturbance in the Pantanal wetland. *Divers. Distrib.* 17, 297–310, <http://dx.doi.org/10.1111/j.1472-4642.2010.00722.x>.
- MacArthur, R.H., Wilson, E.O., 1963. An equilibrium theory of insular zoogeography. *Evolution* 17, 373–387, <http://dx.doi.org/10.2307/2407089>.
- MMA, M. do M.A., 2013. Plano de Ação para prevenção e controle do desmatamento na Amazônia Legal (PPCDAm): 3ª fase 2012–2015 pelo uso sustentável e conservação da Floresta. Brasília.
- MPF, 2013. Apurar fatos acerca de conflitos na divisa entre a RPPN Acuzil e o Parque Nacional ocorridos entre comunidade tradicional da Barra do São Lourenço e funcionários do IBAMA e ICMBIO (1.21.004.000060/2013–30). Corumbá – MS.
- MacArthur, R.H., Pianka, E.R., 1966. On optimal use of a patchy environment. *Am. Nat.* 100, 603–609, <http://dx.doi.org/10.1086/282454>.
- Manila, P., 2009. Audit of USAID/Afghanistan's Land Titling and Economic Restructuring in Afghanistan Project.
- May, R.M., 1974. Biological populations with nonoverlapping generations: stable points, stable cycles, and chaos. *Science* 186, 645–647, <http://dx.doi.org/10.1126/science.186.4164.645>.
- McLain, R., Lee, R., 1996. Adaptive management: promises and pitfalls. *Environ. Manage.* 20, 437–448, <http://dx.doi.org/10.1007/BF01474647>.
- Mclaughlin, N.A., 2013. Perpetual conservation easements in the 21st century: what have we learned and where should we go from here? *Utah Law Rev.* 170, 687–725.
- Moritz, M., Scholte, P., Hamilton, I.M., Kari, S., 2013. Open access, open systems: pastoral management of common-pool resources in the Chad basin. *Hum. Ecol.* 41, 351–365, <http://dx.doi.org/10.1007/s10745-012-9550-z>.
- Moritz, M., Hamilton, I.M., Chen, Y.-J., Scholte, P., 2014. Mobile pastoralists in the logone floodplain distribute themselves in an ideal free distribution. *Curr. Anthropol.* 55, 115–122, <http://dx.doi.org/10.1086/674717>.
- Mourão, G., Campos, Z., Coutinho, M., Abercrombie, C., 1996. Size structure of illegally harvested and surviving caiman *Caiman crocodylus yacare* in Pantanal, Brazil. *Biol. Conserv.* 75, 261–265, [http://dx.doi.org/10.1016/0006-3207\(95\)00076-3](http://dx.doi.org/10.1016/0006-3207(95)00076-3).
- Mourão, G., Tomas, W., Campos, Z., 2010. How much can the number of jabiru stork (*Ciconiidae*) nests vary due to change of flood extension in a large Neotropical floodplain? *Zool (Curitiba, Impreso)* 27, 751–756, <http://dx.doi.org/10.1590/S1984-46702010000500012>.
- Nayar, A., 2012. African land grabs hinder sustainable development. *Nature* 3–5, <http://dx.doi.org/10.1038/nature.2012.9955>.
- Neumann, R.P., 2009. Political ecology: theorizing scale. *Prog. Hum. Geogr.* 33, 398–406, <http://dx.doi.org/10.1177/0309132508096353>.
- Neumann, R.P., 2010. Political ecology II: theorizing region. *Prog. Hum. Geogr.* 34, 368–374, <http://dx.doi.org/10.1177/0309132509343045>.
- Neumann, R.P., 2011. Political ecology III: theorizing landscape. *Prog. Hum. Geogr.* 35, 843–850, <http://dx.doi.org/10.1177/0309132510390870>.
- Noe, C., Kangalawe, R.M., 2015. Wildlife protection, community participation in conservation, and (Dis)empowerment in southern Tanzania. *Conserv. Soc.* 13, 244–253, <http://dx.doi.org/10.4103/0972-4923.170396>.
- Noe, C., 2013. Contesting village land: uranium and sport hunting in Mbarang'andu Wildlife Management Area, Tanzania (No. 15), LDPI Working Paper.
- Nolte, C., Agrawal, A., Barreto, P., 2013. Setting priorities to avoid deforestation in Amazon protected areas: are we choosing the right indicators? *Environ. Res. Lett.* 15039, <http://dx.doi.org/10.1088/1748-9326/8/1/015039>.
- Noy-Meir, I., 1975. Stability of grazing systems: an application of predator-prey graphs. *J. Ecol.* 63, 459, <http://dx.doi.org/10.2307/2258730>.
- Ofuoku, A.U., 2015. Sharecropping contract experience in delta state, Nigeria. *J. Northeast Agric. Univ.*, 62–68, [http://dx.doi.org/10.1016/S1006-8104\(16\)30020-4](http://dx.doi.org/10.1016/S1006-8104(16)30020-4).
- Ostrom, E., 1999. Revisiting the commons: local lessons, global challenges. *Science* 284, 278–282, <http://dx.doi.org/10.1126/science.284.5412.278>.
- Ostrom, E., 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325, 419–422, <http://dx.doi.org/10.1126/science.1172133>.
- Padovani, C.R., 2010. *Dinâmica Espaço-Temporal das Inundações do Pantanal Carlos*. Universidade de São Paulo.
- Pauly, D., Christensen, V., Guénette, S., Pitcher, T.J., Sumaila, U.R., Walters, C.J., Watson, R., Zeller, D., 2002. Towards sustainability in world fisheries. *Nature* 418, 689–695, <http://dx.doi.org/10.1038/nature01017>.
- Pauly, D., 2003. The future for fisheries. *Scienc* 302, 1359–1361, <http://dx.doi.org/10.1126/science.1088667>.
- Peters, P.E., 2004. Inequality and social conflict over land in africa. *J. Agrar. Change* 4, 269–314, <http://dx.doi.org/10.1111/j.1471-0366.2004.00080.x>.
- Pinckney, T.C., Kimuyu, P.K., 1994. Land tenure reform in east africa: good, bad, or unimportant? *J. Afr. Econ.* 3, 1–28, <http://dx.doi.org/10.1017/CBO9781107415324.004>.
- Pinedo-Vasquez, M., Ruffino, M.L., Padoch, C., Brondizio, E.S., 2011. *The Amazon Várzea: The Decade Past and the Decade Ahead*. Springer, London.
- Rantala, S., Vihemäki, H., Swallow, B., Jambiya, G., 2013. Who gains and who loses from compensated displacement from protected areas? The case of the derema corridor, Tanzania. *Conserv. Soc.* 11, 97–111, <http://dx.doi.org/10.4103/0972-4923.115721>.
- Ribeiro, M.S., 2005. *Um Ilha na História de um povo Canoeiro: O Processo de desterritorialização e reterritorialização dos Guató na região do Pantanal*. Universidade Federal do Mato Grosso do Sul.
- Ribot, J.C., Peluso, N.L., 2009. A theory of access. *Rural Sociol.* 68, 153–181, <http://dx.doi.org/10.1111/j.1549-0831.2003.tb00133.x>.
- Ribot, J.C., 1998. Theorizing access: forest profits along Senegal's charcoal commodity chain. *Dev. Change* 29, 307–341, <http://dx.doi.org/10.1111/1467-7660.00080>.
- Rist, L., Campbell, B., Frost, P., 2013. Adaptive management: where are we now? *Environ. Conserv.* 40, 5–18, <http://dx.doi.org/10.1017/S0376892912000240>.
- Robbins, P., 2004. *Political Ecology: a Critical Introduction, second ed*. Wiley-Braclwell, Oxford.
- Rose, C.M., 1998. *Canons of property talk, or, blackstone's anxiety*. *Yale Law J.* 108, 601–632.
- Sautchuk, C.E., 2007. *O arpaõ e o anzol: técnica e pessoa no estuário do Amazonas*. Universidade de Brasília.
- Schaller, G., Vasconcelos, J., 1978. *Jaguar predation on capybara*. *Z. Säugetierk* 43, 296–301.
- Schlager, E., Ostrom, E., 1992. Property-rights regimes and natural resources: a conceptual analysis. *Land Econ.* 68, 249, 10.2307/3146375.
- Scholte, P., 2007. Maximum flood depth characterizes above-ground biomass in African seasonally shallowly flooded grasslands. *J. Trop. Ecol.* 23, 63–72, <http://dx.doi.org/10.1017/S026646740600366X>.
- Shiraishi-Neto, J., 2007. *Direito dos povos e das comunidades tradicionais no Brasil*. PPGSCA-UFAM/Fundação Ford, Manaus.

- Sikor, T., Lund, C., 2009. Access and property: a question of power and authority. *Dev. Change* 40, 1–22, <http://dx.doi.org/10.1111/j.1467-7660.2009.01503.x>.
- Silva, C.J., da Silva, J.A.F., 1995. *No Ritmo das Águas do Pantanal*, 1st ed. NUPAUB/USP, São Paulo.
- Silva, M.V., 1986. *Mitos e Verdades sobre a Pesca no Pantanal Sul-Mato-Grossense*. FIPLAN, Campo Grande.
- Silva, M.O., 2007. *Saindo da invisibilidade – a política nacional de povos e comunidades tradicionais*. *Inclusão Soc.* 2, 7–9.
- Sjaastad, E., Cousins, B., 2009. Formalisation of land rights in the South: an overview. *Land Use Policy* 26, 1–9, <http://dx.doi.org/10.1016/j.landusepol.2008.05.004>.
- Smith, L.E.D., Khoa, S.N., Lorenzen, K., 2005. Livelihood functions of inland fisheries: policy implications in developing countries. *Water Policy* 7, 359–383.
- Sunderlin, W.D., Angelsen, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L., Wunder, S., 2005. Livelihoods, forests, and conservation in developing countries: an overview. *World Dev.* 33, 1383–1402, <http://dx.doi.org/10.1016/j.worlddev.2004.10.004>.
- Tomas, W.M., Ishii, I.H., Strussmann, C., Pacheco, A., Salis, S.M., DeCampos, Z., Ferreira, V.L., Bordignon, M., Barros, A., Padilha, D., 2010. *Borda Oeste do Pantanal e Maciço do Urucum em Corumbá, MS: Área Prioritária para Conservação da Biodiversidade*. SIMPAM.
- Turchin, P., 1995. *Population Regulation: old arguments and a new synthesis*. In: Cappuccino, N., Price, P. (Eds.), *Population Dynamics: New Approaches and Synthesis*. Academic Press, San Diego, p. 429.
- Vitos, M., Stevens, M., Lewis, J., Haklay, M., 2013. *Making local knowledge matter Supporting non-literate people to monitor poaching in Congo*. *Proceedings of the 3rd ACM Symposium on Computing for Development*.
- Von Benda-Beckman, F., Von Benda-Beckmann, K., Wiber, M., 2006. *The properties of property*. In: Benda-Beckman, F., von Benda-Beckmann, K., von Wiber, M. (Eds.), *Changing Properties of Property*. Bergham Books, New York-Oxford, pp. 1–39.
- Wallace, A.P.C., Jones, J.P.G., Milner-Gulland, E.J., Wallace, G.E., Young, R., Nicholson, E., 2016. Drivers of the distribution of fisher effort at Lake Alaotra, Madagascar. *Hum. Ecol.* 44, 105–117, <http://dx.doi.org/10.1007/s10745-016-9805-1>.
- Wehrden, H., vonHanspach, J., Kaczensky, P., Fischer, J., Wesche, K., 2012. *Global assessment of the non-equilibrium concept in rangelands*. *Ecol. Appl.* 22, 393–399.
- Westgate, M.J., Likens, G.E., Lindenmayer, D.B., 2013. Adaptive management of biological systems: a review. *Biol. Conserv.* 158, 128–139, <http://dx.doi.org/10.1016/j.biocon.2012.08.016>.
- Wilson, J. a., Acheson, J.M., Metcalfe, M., Kleban, P., 1994. Chaos, complexity and community management of fisheries. *Mar. Policy* 18, 291–305, [http://dx.doi.org/10.1016/0308-597X\(94\)90044-2](http://dx.doi.org/10.1016/0308-597X(94)90044-2).
- Wilson, J., Hayden, A., Kersula, M., 2013. The governance of diverse, multi-scale fisheries in which there is a lot to learn. *Fish. Res.* 141, 24–30, <http://dx.doi.org/10.1016/j.fishres.2012.06.008>.
- Wright, J.H., Hill, N.A.O., Roe, D., Rowcliffe, J.M., K??mpel, N.F., Day, M., Booker, F., Milner-Gulland, E.J., 2016. Reframing the concept of alternative livelihoods. *Conserv. Biol.* 30, 7–13, <http://dx.doi.org/10.1111/cobi.12607>.
- Xiao, N., Cai, S., Moritz, M., Garabed, R., Pomeroy, L.W., 2015. Spatial and temporal characteristics of pastoral mobility in the far north region, Cameroon: data analysis and modeling. *PLoS One* 10, e0131697, <http://dx.doi.org/10.1371/journal.pone.0131697>.
- Zoomers, A., Haar, G. v.d. (Eds.), 2000. *Current Land Policy in Latin America*. KIT Press, Amsterdam.
- Zoomers, A., 2010. Globalisation and the foreignisation of space: seven processes driving the current global land grab. *J. Peasant Stud.* 37, 429–447, <http://dx.doi.org/10.1080/03066151003595325>.
- de Almeida, P.J., Buainain, A.M., 2016. Land leasing and sharecropping in Brazil: determinants, modus operandi and future perspectives. *Land Use Policy* 52, 206–220, <http://dx.doi.org/10.1016/j.landusepol.2015.12.028>.
- van der Ploeg, J., Aquino, D., Minter, T., van Weerd, M., 2016. Recognising land rights for conservation? Tenure reforms in the Northern Sierra Madre, The Philippines. *Conserv. Soc.* 14, 146, <http://dx.doi.org/10.4103/0972-4923.186336>.