

Indigenous territories and governance of forest restoration in the Xingu River (Brazil)

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ABSTRACT

During the early 2000s, indigenous and non-indigenous peoples inhabiting the headwaters of the Xingu River (Mato Grosso state, Brazil) engaged in a collective decision to undertake the 'Y *Ikatu* Xingu Campaign, a social phenomenon and forum for the restoration and protection of Xingu's headwaters and riparian forests—a common-pool resources shared by indigenous, farmers, and urban populations in the region. These areas have been significantly deforested over the last 50 years due to public policies and land privatization aiming at economic development, agricultural and agribusiness expansion in Central and Amazonian Brazil. These political and economic drivers contributed to the conversion of five million hectares of Seasonal Evergreen Forests and *Cerrados* (Brazilian savanna) into agricultural land. In order to reverse the damaging trends of the future of the Xingu River and promote common benefits to indigenous and non-indigenous peoples, the Campaign fostered the creation of the Xingu Seed Network to promote exchange and commercialization of native seeds demanded by farmers and landholders for planting and restoring permanent preservation areas, such as riparian forests, and vegetation associated with lakes and springs of the Suiá-Miçu River Basin. The aim of this study is to examine the role played by the 'Y *Ikatu* Campaign in the conservation of these common-pool resources – Xingu's headwaters, riparian forests and rivers—and in mobilizing heterogeneous social groups living in this region to engage in the protection of the watershed. Our analysis focuses on socially and culturally diverse inhabitants (indigenous and farmers) of the Suiá-Miçu River Basin, who are searching for innovative technologies for the recovery of riparian areas, and for income generation for local communities. The Institutional Analysis and Development framework was adopted as an approach for understanding interactions of multiple social agents, governmental and non-governmental organizations, engaged in the process of restoration and protection of common resources. Spatial and temporal land-cover changes analysis of the Suiá-Miçu River Basin show an increase in deforestation during the past 40 years, primarily for soybean farming and pastures. We showed that indigenous people have a fundamental role in questioning and advancing the outcomes of restoration efforts, and monitoring environmental impact on water quality of rivers, as well as on conditions of forests and other ecosystems surrounding indigenous lands. We discuss the perspectives of *Kĩsêdjê* indigenous inhabitants of the environmental governance related to restoration efforts and monitoring, and their concerns with a dynamic scenario of agribusiness expansion in the Xingu River Headwaters region.

1. Introduction

During the early 2000s, indigenous and non-indigenous peoples inhabiting the headwaters of the Xingu River (Mato Grosso State, Brazil) engaged in a collective decision to undertake the 'Y *Ikatu* Xingu

Campaign – a social phenomenon and forum for the restoration and protection of Xingu's headwaters and riparian forests (Sanches and Futemma, 2019; (Schmidt et al., 2019). Riparian forests, considered in Brazilian law as Permanent Preservation Areas (PPAs¹), have been markedly affected by deforestation during the 1990s that started to

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¹ PPAs, or permanent preservation areas, according Brazilian environmental law (Forest Law n°12.651 of May 25 in 2012) are designated to protect forests in private rural landholdings. They include riparian forests, forests on steep slopes, hilltops and around springs and lakes, among other areas (Stickler et al., 2013). The Brazilian State determines the legal duty, obligations and sanctions for PPAs protection and balanced use (Brondízio et al., 2009; Sanches and Futemma, 2019, p. 147).

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decrease only after 2004, as a result of national public policies and local efforts in the solution of socio-environmental dilemmas and land tenure conflicts (Castro and Fudemma, 2015). This article examines the development of the collaborations between indigenous and non-indigenous people around the 'Y *Ikatu* Xingu Campaign. This collective action has been a driving force in mobilizing heterogeneous social groups living in this region to restore and protect the watershed, conserving it as common-pool resource (Ostrom, 1990). In 2004, the 'Y *Ikatu* Xingu (meaning in the *Kamayurá* indigenous language 'good and healthy Xingu water') began in response to an urgent appeal by indigenous leaders to protect the Xingu River headwaters (Brondízio et al., 2009). While the *Parque Indígena do Xingu*² (PIX) maintained an intact forest cover, the surrounding areas were experiencing development of high-yielding soybean crops, and chemicals pollution, which were also affecting water quality and forests outside and inside the indigenous territory (Sanches et al., 2012; Schiesari et al., 2013). One of the main initiatives of the Campaign was the development of the *Rede de Sementes do Xingu*, or Xingu Seed Network, which opened an opportunity to reach an agreement among multiple social actors (mainly local indigenous and non-indigenous communities and households) towards restoring riparian forests within private lands (Campos-Filho et al., 2013; Durigan et al., 2013; Urzedo et al., 2016).

In 2007, participants of the Xingu Seed Network crafted a series of principles and rules to define participation of local actors as seed collectors and members of this network (Sanches and Fudemma, 2019; Schmidt et al., 2019), thus establishing the functional basis of the initiative. In what follows, we analyze the extent to which the 'Y *Ikatu* Xingu Campaign has contributed to reversing the process of degradation of the Xingu River Headwaters. By using the Institutional Analysis and Development (IAD) framework (Ostrom, 1990) as a diagnostic tool, we analyze the Campaign, in particular the Xingu Seed Network, as an arena of social interactions, and examine the effectiveness of the Campaign in protecting the Xingu springs, restoring riparian forest and other permanent preservation areas (PPAs). Schmidt et al. (2019, p. 391) considered this initiative as a success case of "the large-scale restoration efforts" by "the involvement of local communities and the use of agricultural machinery to reduce restoration costs".

We contextualize our analysis of institutional arrangement with an examination of land use and cover changes during the last 40 years. We focus our analysis on the Suiá-Miçu River Basin, where actions towards forest restoration have also been taking place. We pay particular attention to the contributions and perspectives of the *Kĩsêdjê* (men and women), one of the 16 indigenous groups living in the *Terra Indígena Wawí* (or *Wawí* Indigenous Land-WIL), in the *Parque Indígena do Xingu* (PIX). The *Kĩsêdjê* people, speakers of the *Jê* language family, inhabited the region of the headwaters of the Xingu River since the 19th Century (Coelho de Souza et al., 2010).

The article is organized as follows. Below we present a description of the application of the IAD framework to the analysis of the 'Y *Ikatu* Xingu Campaign with particular focus on the Xingu Seed Network. This is followed by an overview of the history of occupation of the Xingu River headwaters and a description of the study area, and by an analysis of land use and cover changes that have been taking place during the past 40 years. We then discuss the perspectives of the *Kĩsêdjê*, bringing their concerns about Campaign efforts and environmental governance. Despite of an increase of restoration areas and growing demand for native seeds, the water quality of the Suiá-Miçu River Basin remains not so good, according *Kĩsêdjê*. We recommend to considering the role of indigenous people in monitoring process of degradation of the Xingu River Headwaters, in addition to Xingu Seed Network efforts.

2. Applying the IAD framework to the 'Y *Ikatu* Campaign–Xingu Seed Network

The biophysical and sociocultural attributes of the Suiá-Miçu River Basin, as a common-pool resource, can be analyzed through the components of the Institutional Analysis and Development (IAD) framework (Ostrom, 2007, 2010, 2011; Ostrom et al., 1994), a theoretical-methodological tool we adopted to study the 'Y *Ikatu* Xingu Campaign and restoration activities. The concept of governance follows Davoudi et al. (2008, p. 351): "the ability to constitute—between public and private social agents—an organizational consensus to define common goals, as well as the contribution of each partner to fulfill them, in addition to sharing a common vision for the future of their territories".

Fig. 1 shows the analytical categories from the IAD framework (Ostrom, 2011). Action situation allows isolating the immediate structure that affects the process of interest to the analyst (object or phenomenon). According to Ostrom (2011, p. 11) "action situations are the social spaces where individuals interact, exchange goods and services, solve problems, dominate one another, or fight (among the many things that individuals do in action situations)". In this study, we represented the action situation by the multiple stakeholders involved in the 'Y *Ikatu* Xingu Campaign, more specifically the Xingu Seed Network and envisage the common dilemma to protect and recover the riparian forests in face of the increasingly pollution of water bodies and springs.

The action situation can be influenced or modified by external variables: biophysical conditions, community attributes and rules-in-use. Biophysical conditions correspond to characteristics of Xingu's headwaters with an emphasis on the diversity of Suiá-Miçu River Basin wetland and riparian forests, the water quality of rivers (Sick, 1997; Campos-Filho et al., 2013), the Seasonal Evergreen Forest (Ivanauskas et al., 2008), and the importance of the riparian forests to maintaining ecological corridors between forest fragments (Stefanello et al., 2010).

The attributes of the community are defined by the diversity of local social agents of Suiá-Miçu River Basin and the heterogeneous group of stakeholders involved in the 'Y *Ikatu* Campaign, and how they interact with one another at multiple scales (local, regional, national and international). These groups of stakeholders are composed of Xingu indigenous communities, agrarian reform settlers and ranchers/large-scale landholders around the PIX and the WIL and, non-governmental organizations, technicians and researchers from universities, and other aid organizations (e.g., material and financial resources).

Rules-in-use refers to operational or constitutional rules that regulate actions and behavior of social agents within a specific context, i.e., by prescribing those who should (by obligation) or not (by prohibition), who can or cannot (by permission), exercise certain actions (North, 1994). In the forest restoration projects, several rules were crafted to define rights and duties of different stakeholders involved in the 'Y *Ikatu* Xingu Campaign. For example, at the constitutional level, the Brazilian Federal Decree n° 6321 of 2007 has determined stop purchasing soybeans grown from embargoed areas in the Amazon Biome (Rausch and Gibbs, 2016). The Native Vegetation Protection Law (n° 12,651 of 2012) regulates use and establishes standards of protection in PPAs and legal reserves (these areas at least 20% and up to 80% of all rural properties) to conserve within private properties, and that land converted irregularly should be restored (Lima et al., 2008; Campos-Filho et al., 2013; Schmidt et al., 2019).

The action-situation of the 'Y *Ikatu* Campaign comprises the creation of the Xingu Seed Network, which is a collective effort of a large chain of producing and supplying native seeds for forest restoration and it involves: (i) the characteristics and number of staff; (ii) the specific positions of participants; (iii) potential results; (iv) the level of decision power authority of each participant; (v) rules and information available to participants on the structure of the action-situation; and (vi) costs and benefits – incentives and deterrents – assigned to actions and results (Ostrom, 1990, 2007).

The 'Y *Ikatu* Xingu Campaign and the Xingu Seed Network have

² Xingu Indigenous Park, an indigenous territory officially demarcated in 1991, but originally created in 1961, with an area of 2.6 million hectares (Heckenberger et al., 2003).

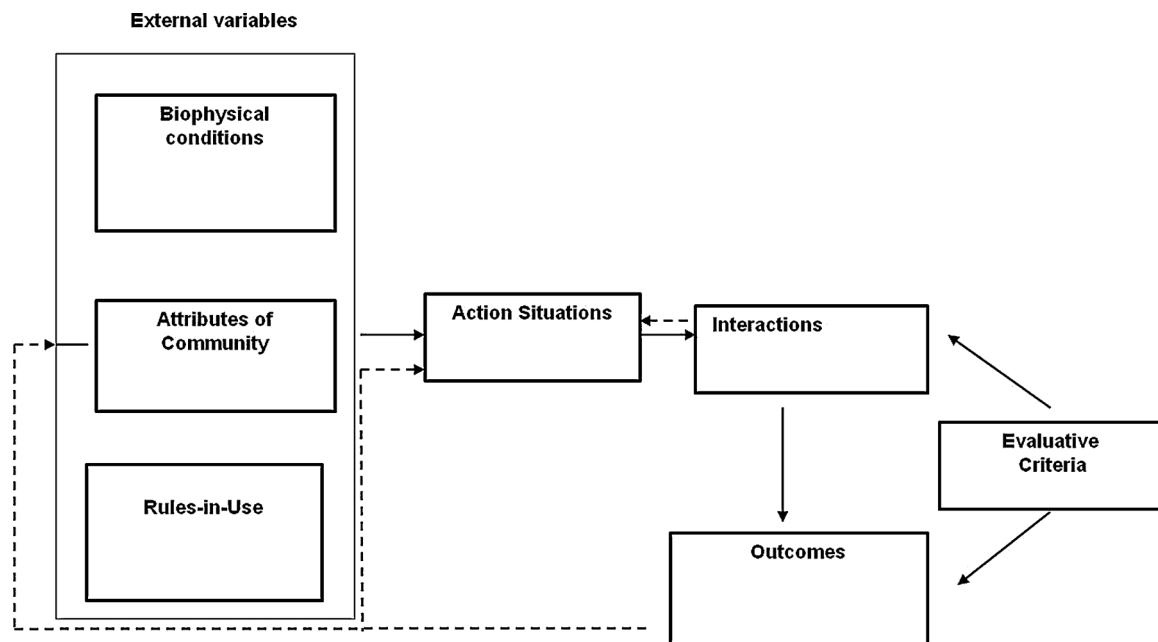


Fig. 1. Representation of the theoretical-methodological framework of the Institutional Analysis and Development (adapted from Ostrom, 2011, p. 11). Continuous lines with the arrows indicate the direction of the relationship and the direct influence among a set of external variables (biophysical conditions, attributes of community, and the rules-in-use) of the “action-situation.” The analytical situation of an action can allow for strong or weak inferences about the outcomes, as individuals must make choices based on complete or incomplete knowledge of all possible alternatives and their results. The action situations also influence and are influenced by the interactions (for example, information known by others with whom individuals interact), and these ones directly influence the outcomes. The joint outcomes depend on actors contributing inputs that can be costly and difficult or not to measure, and incentives individuals to behave opportunistically, or cooperatively to solve their commons problems. The outcomes can also indirectly (dotted lines) influence external variables. The evaluative criteria may refer to economic efficiency, accountability and or sustainability.

been considered an innovative multi-scale and multi-level environmental governance model (Tucker, 2010) for forest restoration (Campos-Filho et al., 2013; Sanches and Fudemma, 2019; Urzedo et al., 2016). The Campaign governance structure was initially composed by 88 organizations, most of them Brazilian (85%), while only 16% were international. The majority was non-governmental organizations (53.4%), 28.4% were public, 15.9% were private, and 2.3% were informal organizations (Sanches and Fudemma, 2019). This institutional arrangement was supported at the onset by the Socio-Environmental Institute (ISA³), a key non-governmental organization in the Xingu Basin. However, overtime the Xingu Seed Network developed a more robust structure and agreements among social agents involved in restoration (Sanches and Fudemma, 2019).

Among the *Kĩsêdjê* people decisions are centered in few individual leaders, when men gather in a large cleared plaza in the village. In such spaces, the *Kĩsêdjê* male leaders deal with political issues, plan activities, and solve conflicts or set negotiations that may arise among group members or with non-indigenous neighbors (Seeger, 1981; Ricardo, 1995). Thus, meetings in the center of the village are a traditional *Kĩsêdjê* forum for making decisions, monitoring the actions of the Xingu Seed Network and establishing agreements on a collective basis, even though the leaders have the autonomy to decide when to participate or not in the community's forum.

Interactions among and across multiple stakeholders within the 'Y Ikatu Xingu Campaign and the Xingu Seed Network governance take place for different purposes and in different contexts: (i) information sharing among users; (ii) deliberative processes; (iii) conflicts between users; (iv) investment activities; and (v) lawyering. Through these interactions, on one hand, agreements can be reached and successfully (Chuenpadgee and Jentoft, 2009) – such as the Xingu Seed Network—that provide collective benefits to maintain the quality and

quantity of water in the Xingu River. On the other hand, these interactions reveal asymmetries of power among stakeholders that affect the Suiá-Miçu Basin land tenure, resource use and access (Schmink and Wood, 1992; Martinez-Alier and O'Connor, 1996). It is possible to predict potential outcomes, for example, increasing of incentives and demands for riparian forests restoration, or to analyze existing ones using evaluation criteria, measuring efficiency, equity or ecological or social indicators (Urzedo et al., 2013).

3. Study area and methods

3.1. Historical occupation of the Xingu River headwaters (Mato Grosso, Brazil)

Until 1940, the headwaters of the Xingu River, hereafter Xingu, remained unknown to the great majority of the Brazilian population (Oliveira, 2001; Villas Bôas and Villas Bôas, 2012). It was thought as collective imagery of virgin and sparsely populated landscapes – an “El Dorado” or an “Amazon frontier” (Schmink and Wood, 1992; Brian and Browder, 1996; Browder et al., 2008). This imagery had already been depicted in the reports of missionaries and European naturalists in the seventeenth and eighteenth centuries, who referred to it as the “true heart of Brazil”. In the first exploratory phase of the Xingu (1884–1887), the Brazilian military performed expeditions in co-operation with the German Scientific Commission, which had the objectives of discovering the location of the headwaters of the Xingu River and conducting ethnographic and biophysical studies (Perrot, 1998; Sick, 1997).

The geopolitics of occupation and the stereotype of a “demographic void”, to the detriment of the official recognition of indigenous peoples, reinforced the search for new land in the northern region of Mato Grosso state (Oliveira, 2001; Menezes, 2008), a region strategically connecting South and Southeastern Brazil to Amazonia. As in other tropical regions of the world, “available” land, the low-cost of clearing

³ In Portuguese, Instituto Socioambiental – ISA.

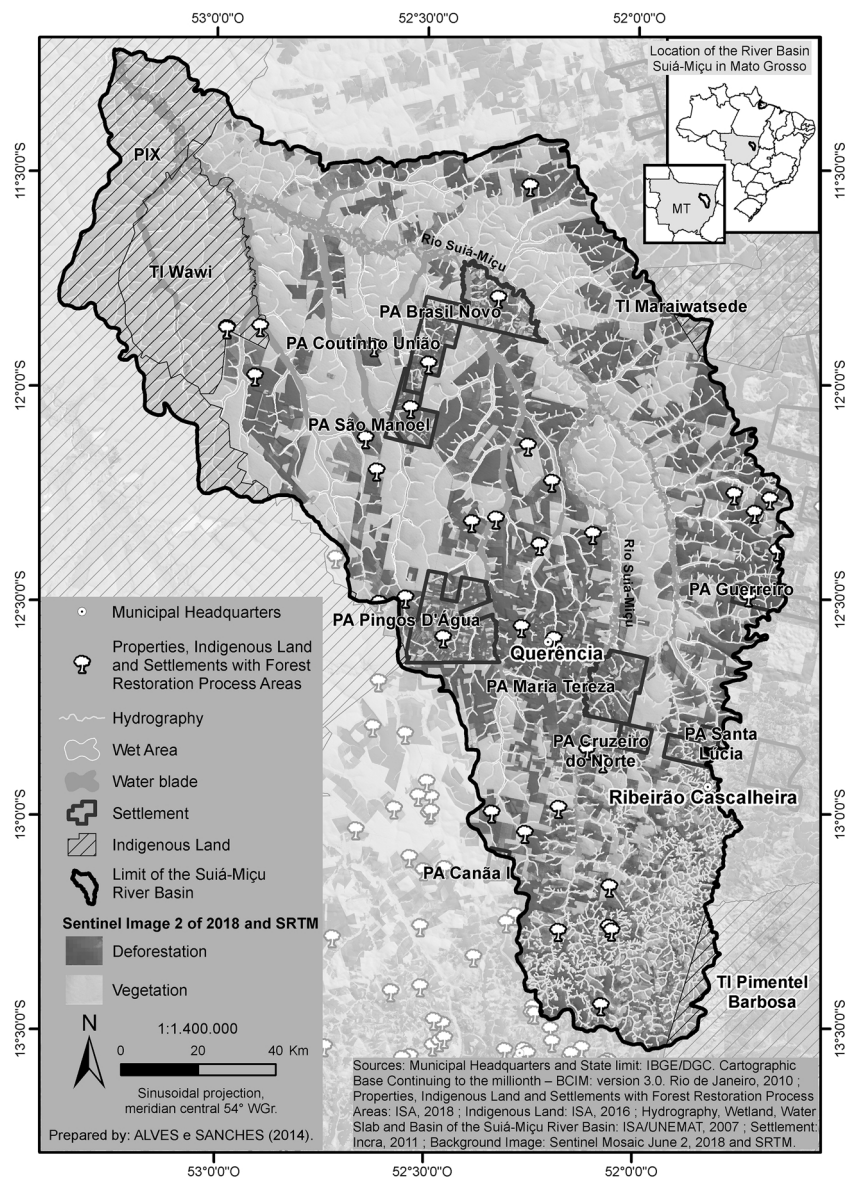


Fig. 2. The Suiá-Miçu River Basin (23,700 km²) and its wetlands within and outside the boundaries of the Wawi Indigenous Land (TI Wawi) and PIX, and the Querência and Ribeirão Cascalheira headquarters, in Mato Grosso state (Brazil). The green trees mark the 'Y Ikatu Xingu Campaign restoration areas on farms in agrarian reform settlements (or *projeto de assentamento* (PA) such as, for example, PA Brasil Novo, Coutinho União, Píngos D'Água, Canaã I), in indigenous lands and in Querência. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

vast areas, and government programs of frontier occupation (Becker, 2005) contributed to successive phases and waves of migration to the region. In the second exploratory phase of the Xingu during the 1940s, the "Roncador-Xingu Expedition" led by the Villas Bôas brothers promoted the definitive contact between indigenous peoples of the Xingu and the national society (Villas Bôas and Villas Bôas, 2012), and heavily impacted the lands occupied by the indigenous peoples. For those Upper Xingu indigenous people contacted, the Brazilian government delimited the *Parque Indígena do Xingu* (PIX) in 1961, which initially protected their populations and traditional lands, but excluded the headwaters of the Xingu River (Franchetto, 2011; Villas Bôas and Villas Bôas, 2012).

After 1960, the third and intensive occupation phase of the Xingu began, when the acquisition of previous public lands by private capital opened the Xingu region to national and international economic interest. The Brazilian State justified the allocation of land to private capital with the motto "occupy in order to not surrender" (Schmink and Wood, 1992; Oliveira and de, 2001; Menezes, 2008), meaning that

undeveloped land could be eventually occupied by foreign powers. In the 1970s, farm entrepreneurs bought vast areas at derisory prices to create private colonization project while receiving official tax incentives to deforest large areas around the Xingu (Martins, 1981; Oliveira and de, 2001; Barrozo, 2008). Lastly, these phases have a common baseline of changes in Latin America throughout public policies and State interventions, and the concept of "geopolitical frontiers" as reserves of land (Becker, 2005; Oliveira and de, 2001; McCarthy and Cramb, 2009), available to development in general road, infrastructure and official colonization projects (Tole, 2001; Browder et al., 2008).

Beginning in the 1990s, a new wave of expansion of agribusiness converted pastures and occupied forest and *Cerrado* (Brazilian savannas) areas, flat and easily mechanized, for large-scale soybean production. The region underwent a fourth land-use and land-cover change phase with the arrival of a new wave of entrepreneurs and large-scale farmers, consolidating an agribusiness economy in municipalities such as São Felix do Araguaia, Feliz Natal, Nova Ubiratã (Rausch and Gibbs, 2016), Canarana and Querência (Oliveira and de,

2001; Sanches and Fudemma, 2019). All of these municipalities overlap the PIX.

Moving by the idea of occupying the wild frontier and disregarding indigenous and local communities, the establishment of private settlements in lands previously inhabited by indigenous peoples followed (Sick, 1997; Menezes, 2008). To date, this process has led to the disappearance of more than 55,000 km² of forests and *Cerrado*, including 3,170 km² of areas considered in Brazilian law as PPAs in the Xingu River headwaters (Maeda et al., 2008; Sanches et al., 2012; Campos-Filho et al., 2013). This scenario has been documented in several other areas of Amazonia (Brondízio, 2004; Browder et al., 2008; Schiesari et al., 2013; Rausch and Gibbs, 2016) and tropical forest regions around the world (McCarthy and Cramb, 2009).

Therefore, the many drivers of land-use and land-cover change in the Xingu River Headwaters, such as agricultural clearance, the growth and development of high-yielding crops and population effects, have connected the region to international markets, macroeconomic and international policies, and political organizations around the world, as in Amazonia and other tropical regions (Nepstad et al., 2000; Tole, 2001; Alencar et al., 2005; VanWey et al., 2005).

3.2. Biophysical and socioeconomic conditions of the Xingu and the Suiá-Miçu River Basin

The Xingu River basin (510,000 km²) is one of the main hydrographic basins in Brazil, with an area equivalent to that of Spain. An estimated 568,000 Brazilians live in the Xingu River Basin that feed the right bank of the Amazon River. Its headwaters in the Center-West of Brazil (10°30' and 14°30' S, and 51°30' and 55°30' W), and the northern Mato Grosso (MT) encompass an area of 170,000 km², a predominantly flat relief and seasonal climate with high temperatures (Sanches et al., 2012).

The Suiá-Miçu River Basin encompasses an area of 23,000 km², equivalent to twice the surface of the Caribbean island of Jamaica (Fig. 2). The Suiá-Miçu is a tributary of the Xingu River and its watershed is covered by *Cerrado* (Brazilian savanna) and Seasonal Evergreen Forest, predominantly. The species composition of this vegetation reflects the rainfall and the well-marked seasonality of the region (Ivanauskas et al., 2008). This basin includes wetland areas composed of fluvio-lacustrine habitats, native grassland, flooded forests and *veredas*, a swamp dominated by *Mauritia flexuosa* palms. Floodplain areas encompass 10% of the Suiá-Miçu River Basin (Sanches et al., 2012). These ecosystems are poorly known by the scientific community, but have a high biological productivity and contribute to recharge of underground aquifers, protect the soil and reduce sediment erosion (Junk, 1993; Maeda et al., 2008).

Fig. 2 illustrates the Suiá-Miçu Basin and five municipalities that have their territories inside the basin: Alto da Boa Vista, Bom Jesus do Araguaia, Canarana, Ribeirão Cascalheira and Querência (this one represents 53% of the basin). Fig. 2 shows that the largest preserved areas are inside indigenous lands as PIX and Wawi Indigenous Land.

However, PPAs extend beyond the boundaries of riparian forests and indigenous lands, encompass and connect to the wetlands areas and water sheets. Stefanello et al. (2010, p. 145–146) showed the "strong relationship between the vegetation and animals in the maintenance of plant populations in the riparian environment", and of conserving ecological corridors between forest fragments outside the indigenous lands. This connectivity creates a complex institutional arrangement for both informal and legal protection across indigenous, private, and public lands (Sanches et al., 2012; Fudemma et al., 2002; Alencar et al., 2005; Batistella et al., 2008; Brondízio et al., 2009).

The land tenure in Suiá-Miçu River Basin is predominantly private (79.7%), but also includes 14.4% in indigenous land homologated by the Brazilian law (PIX, WIL, and Pimentel Barbosa and Maraiwatsede, Xavante Jê-speaking indigenous lands), and 5% in agrarian reform settlements. The urban areas of Querência and Ribeirão Cascalheira

represent 1% of the basin (Sanches, 2015). The Wawi Indigenous Land is entirely situated in the basin. There are an estimated 20,000 indigenous and non-indigenous inhabitants, or less than 1.0 inhab./km², living in the Suiá-Miçu River Basin; 49.3% live in rural areas including agrarian reform settlements (as such PA Brasil Novo, PA Coutinho União, PA São Manuel, PA Maria Tereza, in Fig. 2), and the remainder in urban centers such as Ribeirão Cascalheira and Querência (Sanches and Fudemma, 2019).

Newcomers attracted by tax incentives and colonization projects have production systems that transform natural landscape according to their previous experiences, knowledge and symbolic relation to the land (Sanches, 2015). Their production systems vary in size, technology, employment of labor, profitability, and the purpose of productive activities. Locally, the oldest farmers are still designated as "pioneers" (Martins, 1981; Oliveira and de, 2001; Barrozo, 2008; Carvalho et al., 2014; Sanches, 2015), a title officially given to the first settlers who migrated to that region by a private cooperative known as COOPERC-ANA. Depending on the extent of cultivated land, labor, and property arrangement used, these social agents are also referred to as large-, medium-, or small-scale farmers or ranchers. The small-scale farmers (most of them concentrated in agrarian reform settlements) and indigenous people have a more diversified productive system, incorporating agroforestry knowledge and crop rotation–cassava (*Manihot esculenta*), corn, bananas and peanuts. There are also rural entrepreneurs, landholders or renters, who belong to capitalized groups, and have land holdings larger than 100–200 km², and who depend on hired labor and tax incentives during and after the planting/harvesting periods.

Furthermore, the Suiá-Miçu River Basin is composed by areas of cultural and material importance to the *Kisêdjê* from Wawi Indigenous Land and the PIX (Fig. 2). This indigenous group was first reported in 1884 in an expedition led by Karl Von den Steinen at the confluence of the Xingu and Suiá-Miçu rivers, where today the *Diauarum* Indigenous Post stands (Seeger, 1981; Bôas and Villas Bôas, 2012). At the end of the 19th century, the *Kisêdjê* villages moved up the Suiá-Miçu River (Seeger, 1981; Coelho de Souza et al., 2010) along tributaries such as the Pacas River. In this village – *Ngôkathátxi* – the Villas Bôas brothers contacted the *Kisêdjê* for the first time in the 1950s (Coelho de Souza et al., 2010; Villas Bôas and Villas Bôas, 2012).

Until 2019, there are 457 individuals in the WIL distributed among five villages. *Kisêdjê* people traditionally cultivate mainly bitter and sweet manioc, sweet potato, banana, corn, peanut, pepper and *pequi* (*Caryocar brasiliensis*). *Kisêdjê* have used *pequi* seedlings to restore degraded areas inside indigenous land, due to their importance to local food security, and increasingly oil consumption (as delicacy) in national market. Different habitats along the floodplain and the high course of the Suiá-Miçu River are sources for provisioning of edible foods, games, fishes, fruits, medicinal plants, honey bees, fibers, and *buriti* (*Mauritia flexuosa*) leaves for building houses. They trek in these habitats and visit sacred sites and ancient villages along the Suiá-Miçu River or *Ngôtxi*, the Paranaíba River (*Ngôsakhatxi*), the Jandaia Stream (*Ngôtxire*), the Darro River (*Ngôwikahôntxi*), and the *Horenhongô* in Suiazinho River, called by *Kisêdjê* as *Taquarinhas* River (Sanches, 2015).

For more than 40 years, *Kisêdjê* villages have been assisted by professionals through an academic program of monitoring indigenous health in the Xingu, which is coordinated by the medical school of the Federal University of São Paulo (Mazzucchetti et al., 2014). There are also members of the community who receive salaries, such as health and education agents, or have maintained relations with the neighboring towns, or intensified their contact and handicrafts market with adjacent society (Coelho de Souza et al., 2010; Mazzucchetti et al., 2014). Over the years they have achieved important victories such as a population comeback, influenced by moderate birth rates, a drop in mortality, and a negative migratory coefficient (Mazzucchetti et al., 2014).

However, most of the housing architecture, social and political

organization, and gender labor division maintain many traditional characteristics, not to mention the central plaza in village – the men's house –, where leaders and community members meet and make decisions. Kinship groups are identified by long and elaborate chants during ceremonies that can be performed daily or annually, and is considered a particularity of the *Kĩsêdjê* culture (Seeger, 1981; Coelho de Souza et al., 2010). Women prepare food using crops from home gardens, manioc flour and corn, and cook fish and game provided by their husbands. Adult men clean the land for collective agricultural crops, trek for hunting and fish. Every year, *Kĩsêdjê* spend days on trek and carry out river expeditions to visit ancient villages outside the indigenous land, where they harvest seeds, fruits, manioc roots, sweet potatoes and other natural resources. So, the forest and wetland areas provide raw material for the construction of canoes and houses, and edible foods.

The *Kĩsêdjê* are also formally organized by the association called locally *Associação Terra Indígena do Xingu* (ATIX) or Association of the Indigenous Land of Xingu,⁴ through which they take political decisions in assemblies with other Xingu indigenous people, and including the *Kĩsêdjê* Indigenous association (*Associação Indígena Kĩsêdjê-AIK*). Through AIK, the *Kĩsêdjê* also carry out trading activities with the purpose of generating income, such as the marketing of handcrafted goods, honey, *pequi* oil and pepper, with public support or/and financial support from non-governmental organizations, such as the *Instituto Socioambiental-ISA* (Socioenvironmental Institute).

Large and medium-scale farmers are also politically represented by rural unions (*sindicatos rurais*); smallholder farmers and agrarian reform settlers are represented by workers' union (*sindicato de trabalhadores rurais*) and other formal local organizations, which are linked to national level organizations. This heterogeneity of organizations and institutions is partially reflected in the 'Y Ikatu Xingu Campaign and in forest restoration activities (Sanches and Futemma, 2019).

3.3. Data collection and analysis

3.3.1. Socio-institutional data collection and analysis

Each component of IAD is linked to the structure of the 'Y Ikatu Campaign governance, identified by Sanches (2015) and from 63 semi-structured interviews (Bernard, 2006) conducted between 2011 and 2015 (Sanches and Futemma, 2019). The selection of key interviewees was intentional and based on previous knowledge and successful meetings with local actors during fieldwork (Sanches, 2015). The protocols were applied to: (i) 18 (20.5%) of 88 representatives of organizations participating in the 'Y Ikatu Xingu Campaign; (ii) 15 (20.5%) of 73 farmers in Suiá-Miçu River Basin; (iii) 14 (or 46.7%) of the 30 pilot restoration project of PPAs in smallholder and large-scale farms (Fig. 2) of the Suiá-Miçu River Basin; and (iv) *Kĩsêdjê* native people from the Wawi Indigenous Land. There were about 30 adult individuals male and female, whose answers in their native language were recorded, transcribed and translated into Portuguese by an indigenous translator chosen by the community and following the Brazilian Indigenous Agency's protocol (Sanches, 2015).⁵

All interviews were held and registered through Skype calls, or in person during the fieldwork, individually or collectively, as with the

Kĩsêdjê interviewees in the *Ngôjhwêrê* village. The interviews sought also to identify the arrangements of local governance, the impacts on land use, and *Kĩsêdjê* people's perceptions related to environmental changes and the Campaign outcomes (Sanches, 2015).

3.3.2. Land Use and Cover Change (LUCC) analysis of the Suiá-Miçu River Basin (SMRB)

According to Chazdon (2003, p. 53), the human legacy of historical land-use and resources appropriation interacts with natural forces to influence recovery processes. This assertion is evident in some ancient village outside the Wawi Indigenous Land known by the *Horenhongô* or the Taquarinhas river (Sanches, 2015), where the oldest women of the group were born. That village on the Upper of Suiá-Miçu River Basin is where *Kĩsêdjê* collect *hore*, a small endemic bamboo used to make arrows.

We investigated the evolution of land use and cover change (LUCC), and its impacts on wetlands of the vast territory of Suiá-Miçu River Basin using remotely sensed data and geographic information system (GIS). The following criteria were used: (i) the base year of 1984 was adopted for visual interpretation of TM/Landsat images (spatial resolution of 30 m and a mapping scale of 1:40.000)⁶. This sensor is considered the most suitable for mapping natural and anthropogenic vegetation cover in *Cerrado* areas; (ii) we assumed that more than 80% of the basin was preserved before this base date, in agreement with the analysis by Maeda et al. (2008),⁷ who showed that only 13% of the natural vegetation of the Suiá-Miçu River Basin had been replaced by pastures prior to 1984⁸; and (iii) the Native Vegetation Protection Law n° 12,651 of May 25, 2012, was considered for analyzing deforestation in Permanent Preservation Areas (PPAs) of the basin (Junk, 1993; Maeda et al., 2008).

Digital classification procedures may not be able to differentiate vegetation and surface features with similar spectral patterns, such as areas affected by fire, islands of *Cerrado* in forests, as well as other elements, such as water bodies and cloud shadows. Because the region undergoes periodic fires due to the opening of new areas and pasture management, we opted for a method of visual interpretation. Piromal et al. (2005) argue that this method is the most adequate for extracting and classifying these particular areas in the Suiá-Miçu River Basin. Visual interpretation of LUCC using TM/Landsat sensor images was taken and interpreted at five-year intervals (1984, 1989, 1994, 1999, 2004 and 2009) and four scenes were used for each year – composition of the bands R(3)G(4)B(5); R(4)G(3)B(5) – covering the entire basin. Most images were from similar seasonal periods to avoid images with excessive coverage by clouds due to heat or rain.

For comparative purposes, we used and reclassified the annual mapping of LUCC between 1985 and 2017 produced by *MapBiomass* (<http://mapbiomas.org>). This is a Brazilian Project carrying out annual Land Use and Land Cover analysis; it involves a collaborative researcher network that rely on Google Earth Engine platform to map biomes and land uses, through a combination of automated classifiers that generate annual series of land use and cover data for the entire Brazilian territory.

⁴ Associação Terra Indígena do Xingu was one of the indigenous organizations to win the Equator Prize (UN Development Programme) in 2017 and AIK in 2019, as a result of their innovative solutions for tackling poverty, environment and climate challenges. ATIX is the first community-based organization to achieve organic certification in Brazil, and produces tons of certified organic honey every year. AIK was also recognized for production of vegetal oil of *pequi* (*Caryocar brasiliense*) – UN Development Programme, (Brazil), 2019.

⁵ The Formal Consent (TCLE) is part of the Human Subject Research and it is mandatory for research involving indigenous communities, as established by the Convention 196 of the International Labor Organization (ILO) and the Fundação Nacional do Índio (FUNAI), or National Indian Foundation.

⁶ The images are available for free at the US government website (<http://earthexplorer.usgs.gov>). Georeferenced data used the WGS_1984 datum coordinate system, Universal Transverse Projection of Mercator (UTM), zone 22 North.

⁷ The land use and cover maps for each of the analyzed periods (1973, 1984 and 2005) were plotted by the third author using sensor images of MSS/Landsat-1, TM/Landsat-5 and MODIS/Terra.

⁸ Mostly in old *Cerrado* areas in the southern portion of the basin in the municipalities of Canarana and Ribeirão Cascalheira.

4. Results and discussion: Institutional analysis of the 'Y Ikatu Xingu Campaign environmental governance

4.1. From the "unwanted hug" to the mission of protecting the Xingu River Headwaters

If the economic development is vital to the most of the people in the Xingu River Headwaters, the infrastructure investments, for example, road paving and hydroelectric power, are inevitable, according Nepstad et al. (2002, p. 629). But, on the other hand, these perceptions of the inevitable future of "frontiers regions" contributed to seeing Xingu River basin "in terms of absences, or lack of productive uses of land" (McCarthy and Cramb, 2009, p. 112–113), and to conceal existing livelihoods forms and land uses (Brondízio, 2004).

During the mid-2000, the alarming rates of deforestation in the Brazilian Amazon were linked to the expansion of industrial soybean production and ranching (Nepstad et al., 2002; Rausch and Gibbs, 2016). Meanwhile, indigenous people from PIX began to reveal their surrounding perception about the "unwanted hug" created by deforestation around the park's borders (Brondízio et al., 2009; Villas Bôas and Villas Bôas, 2012), and related to changes to quality of water of the Xingu River. The water resources were being degraded by intensifying deforestation and loss of riparian forests, and pesticide and fertilizer pollution, threatening the livelihood of indigenous people inside and surrounding PIX (Sanches et al., 2012; Schiesari et al., 2013) deforestation in the region has been documented by numerous studies (Maeda et al., 2008; Brando et al., 2013; Rausch and Gibbs, 2016), attested during our visits (2011–2015) to riparian restoration projects in Suiá-Miçu River Basin, and described in accounts of LUCC by the Kĩsêdjê (Sanches and Fudemma, 2019).

The conceptual map of Fig. 3 shows the governance arrangements for the 'Y Ikatu Xingu Campaign and their components—external variables, action-situation, outcomes, interactions and evaluative criteria—identified according the IAD framework. The Campaign sought to meet several targets through collective action. Its main goal is the restoration of riparian forests in private areas outside of the indigenous territory (Campos-Filho et al., 2013). The action-situation that started the process of governance was marked by the creation of forums for discussion, and the involvement of local communities to reduce restoration costs, in order to reach a consensus toward the protection of Xingu River (Fudemma et al., 2002; Tucker, 2010; Urzedo et al., 2016; Schmidt et al., 2019), that is the pact for the 'Y Ikatu Xingu Campaign, a multi-stakeholders' agreement.

The result arising direct from the pact underlying the Campaign was an institutional arrangement involving the Xingu Seed Network, the main seed production network in the region (Fig. 3), and currently a formal association consisting of 568 collectors (individual or family) from 16 municipalities of Mato Grosso state. The members are distributed in 20 indigenous villages and 14 agrarian reform settlements, where they collect seeds from forest matrices at a lower cost than planting seedlings (Urzedo et al., 2016; Schmidt et al., 2019). The action situation launched by Campaign and Xingu Seed Network is regulated by external variables as: (i) multiple and heterogeneous stakeholders and the sociocultural diversity of local population; (ii) biophysical characteristics of the headwaters and springs, of the wetlands areas, the quality of river water, and of the flat landscape covered by Cerrado and Evergreen Seasonal Forest areas and; (iii) rules of protection and restoration of PPAs and other legal requirements (as Native Vegetation Protection Law). For produce and purchase native seeds, for example, there are "Law no. 10,711/2003 and Decree No. 5,153/2004 that established obligatory National Registers of Seeds and Seedlings (RENASEM) and the Register of Cultivars (RNC), supervised by the Ministry of Agriculture, Livestock and Food Supply- MAPA" (Schmidt et al., 2019, p. 394). All these rules inducing and shaping restoration (Schmidt et al., 2019) and the other external variables are the main factors directly influencing the Xingu Seed Network and its outcomes.

The Xingu Seed Network organizes all seed collectors from the Xingu region, and comprises an institutional structure that is responsible for coordinating different types of activities, such as collecting, treating, supplying and selling seeds for restoring of PPAs (Durigan et al., 2013; Urzedo et al., 2016). These interactions and decisions are discussed at annual meetings, where collectors have the authority to determine and define the rules (or criteria) to collect and process seeds, and define who has a legal obligation to restore forests (e.g., private rural properties), who may be a seed collector and a participant in the Xingu Seed Network decision-making (Sanches and Fudemma, 2019).

There are bridge organizations (Cash et al., 2006) in the Campaign institutional arrangements, such as ISA and Association of the Indigenous Land of Xingu (ATIX) that provided support to local agents in creating and launching the Xingu Seed Network. These organizations have authority to make decisions, monitor the process of restoration and also perform a variety of functions, such as participating in seed collection, facilitating communication between participants, indigenous and State officers or performing administrative services.

Another actor who was part of the Campaign structure is a funding organization—for instance, the non-governmental organization Rainforest Foundation from Norway—but it does not participate in the Xingu Seed Network decision-making process neither is a direct user of the headwaters. Additionally, members of the network can decide who (organizations or individuals) may become a new member (Urzedo et al., 2016). The Xingu Seed Network, therefore, consists of a functional institutional arrangement at different levels that comprises several processes aiming to meet the demands of ecological restoration, and achieve environmental adequacy of rural properties (Urzedo et al., 2016). But, the local knowledge, the engagement and decision of soybean producers are also important for environmental governance (Rausch and Gibbs, 2016; Schmidt et al., 2019).

The Xingu Seed Network promotes interactions among multiple stakeholders, such as PIX indigenous people, local rural producers, public officers and managers, teachers, family farmers, and practitioners of non-governmental organizations in order to protect and recover the springs of the Xingu (Sanches and Fudemma, 2019). Furthermore, institutional linkages at multiple levels occur and are fundamental for proposing the governance of common resources and in the long-term protection of ecosystems (North, 1994; Brondízio et al., 2009). In these public-private institutional arrangements, despite following the decentralization model, the State has still a central role to enforce environmental laws.

One important finding is that more than 60% of the Y Ikatu Xingu Campaign's participants have a direct relationship with the shared resources (river water, headwaters and riparian forests). This direct relationship is one of the aspects that attract these multiple stakeholders to participate in the governance arrangement of the Campaign. This participation strengthens the institutional arrangements and increases the chances of forest restoration efforts. However, the rights of ownership of common resources and land tenure (Schlager and Ostrom, 1992, p. 252–253; Ostrom, 2010) are external variables that influence the 'Y Ikatu Xingu Campaign action-situations (Fig. 3). Thus, in the governance analysis, the attributes of the community (heterogeneous and multiple stakeholders) help to understand the impacts of human-environmental dynamics (Brian and Browder, 1996; Browder et al., 2008) on the outcomes of the 'Y Ikatu Campaign.

Social interactions, sharing of information and management techniques, and economic incentives, are contributing to the governance of restoration in the region (Sanches and Fudemma, 2019) and to overall outcomes as: (i) the increased demand for forest restoration projects beyond the Xingu basin; (ii) the increased dissemination of the Xingu Seed Network at national media and in the academics researches; (iii) the reduction of economic costs for recovering riparian forests and; (iv) technological innovation of forest restoration, for instance, the mechanized direct seeding to perform restoration in the large areas, and

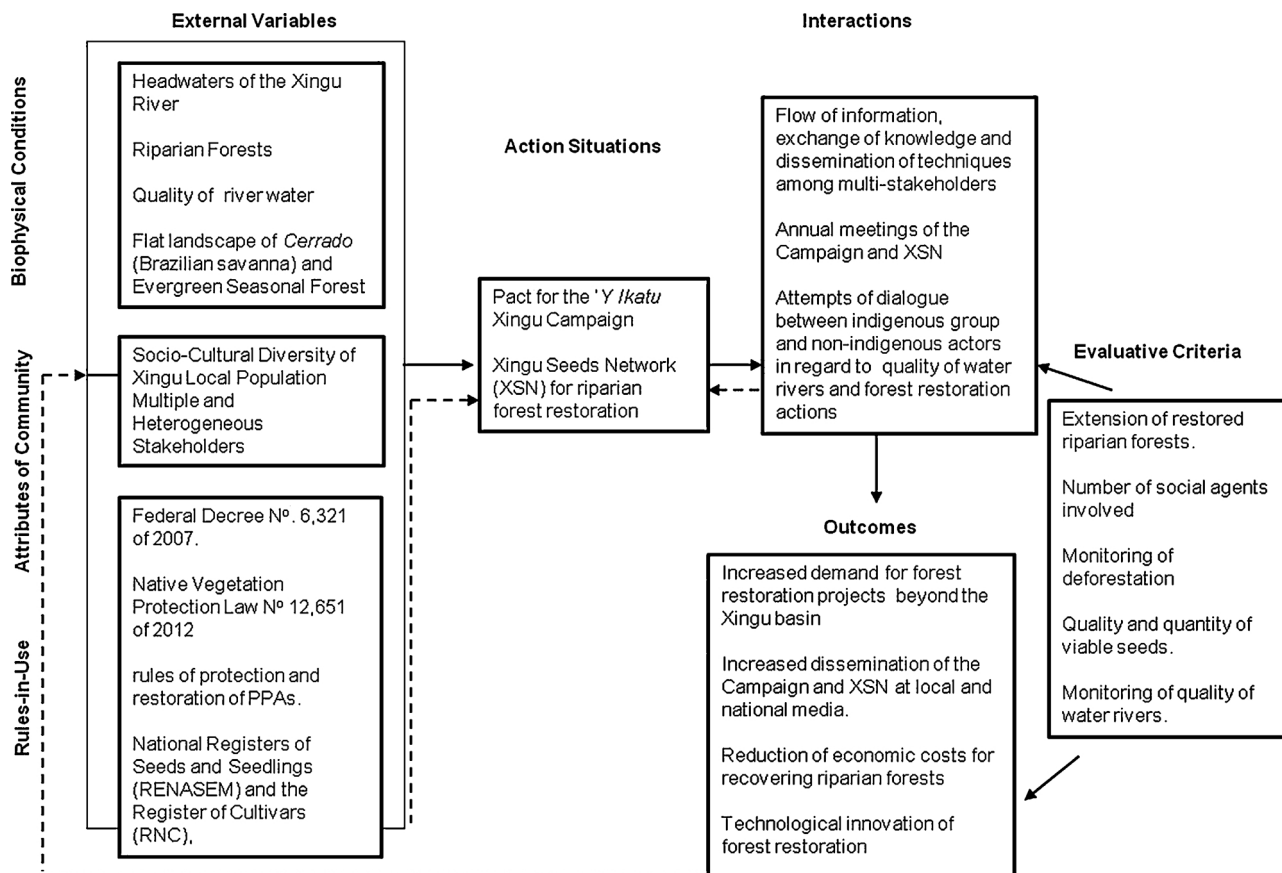


Fig. 3. Conceptual map of governance of the 'Y Ikatu Xingu Campaign showing the influence of the main factors and institutional arrangements for the protection and restoration of the Xingu River Headwaters (Mato Grosso, Brazil), modified from Sanches and Futeemma (2019) diagram. Continuous lines with arrows indicate the direction of the relationship and direct influence of sets of variables (biophysical, sociocultural conditions and the rules-in-use) on the action-situation. This one is based on decisions made at the initial Campaign and annual meetings of the Xingu Seed Network members, according to Sanches (2015). The likely outcomes have been based on our fieldwork investigation, and in the scientifically evidences according to literature available (Campos-Filho et al., 2013; Urzedo et al., 2016; Schmidt et al., 2019). These outcomes can also modify indirectly (dashed lines) water resources degradation and, as a result, improve the water quality. *Kĩsêdjê* indigenous people may contribute to monitor the outcomes by introducing their direct observations as evaluative criteria on the Suiá-Miçu River Basin.

the technique called “*muvuca*”. This one involves the mixing of forest seeds of various plant species with forage species, with no-tillage application in degraded riparian areas. This “*muvuca*” technique has been shown to be a successful method for forest restoration in degraded areas in the Suiá-Miçu and Xingu River basin (Campos-Filho et al., 2013; Urzedo et al., 2016; Schmidt et al., 2019).

According to Schmidt et al. (2019, p. 293), the final costs of seed collection involves collectors’ labor to collect, transport, process and store seeds, the costs of equipment, the organizational and administrative costs of seed production. So, the members of the Xingu Seed Network define the seeds production, their price and the amount applied to pay for all costs related to the network governance.

Regarding the evaluation criteria used to assess the results of the Campaign and Xingu Seed Network (Figs. 3 and 4), our data show a 52% increase (from 5.22 km² to 7.94 km²) in PPAs monitored in the Suiá-Miçu River Basin, between 2015 and 2018. According to Schmidt et al. (2019, p. 391), the Xingu Seed Network activities has contributed to recover more than 50 km² of PPAs within the Xingu River Headwaters, since it was created. While still modest in terms of areal extent—regarding 3170 km² of PPAs deforested in the Xingu River headwaters (Campos-Filho et al., 2013)—this trend shows the interest of farmers in receiving technical assistance (Fig. 4) and seeds from the Xingu Seed Network to restore riparian areas according to legal requirements.

4.2. Land Use and Cover Change (LUCC) in the Suiá-Miçu River Basin: 1984–2017

The biophysical characteristics of the Suiá-Miçu River Basin, flat wetlands, low population densities, and remoteness from urban and industrial centers in south and southeastern Brazil have attracted large-scale soybean producers since the 1990s. Changes in biophysical attributes, such as prolonged droughts that make environments more susceptible to forest fires (Nepstad et al., 2000; Chazdon, 2003) might compromise the collection of native seeds (seed bank).

Currently, soybean farming has expanded to industrial scale and is considered one “of the most important economic activities in the Brazilian Amazon”. Soybean production has more than tripled since the early 2000s, and Mato Grosso has become Brazil’s top soybean-producing state (Rausch and Gibbs, 2016, p. 12). The increasing value of soybean as an international commodity transformed the municipality of Querência⁹ into the second largest soybean producer in the state of Mato Grosso (Sanches et al., 2012). Between 2000 and 2010, the municipality had a population growth rate of 6% per year, almost three times the rate of Mato Grosso (1.95%), and that of Brazil (1.18%).

The *Kĩsêdjê*’s frequent expeditions around the Suiá-Miçu River Basin include visits to neighboring farmers and observation of land changes;

⁹ Currently, the total estimated population of the municipality of Querência (17.786,195 km²) is 17, 479 inhabitants, and 0,73 inhab/km². Source: <https://www.ibge.gov.br/cidades-e-estados/mt/querencia.html>



Fig. 4. Overview (a) and detail (b) of a riparian forest undergoing forest restoration (0.12 km²) near the Darro River (Querência, Mato Grosso), since 2008. Reforestation includes native species (*Cerrado/forest*) such as urucum (*Bixa arborea*), jatobá (*Hymenaea courbaril*), baru (*Dipteryx alata*), cafezinho or taquari (*Mabea* spp.), emabúba (*Cecropia* spp.), xixá (*Sterculia striata*), and buriti (*Mauritia flexuosa*). The area undergoing restoration, in this particular farm, includes 0.42 km² using the “*muvuca*” method (seed and forage mix) and seedlings transplant (0.8 km²). Photo: A. Nascimento (2013).

they dialogue and establish tacit rules to solve conflicts associated with the degradation of quality of river waters, fisheries, and riparian forests. Around 2016, the *Ngôjhwêrê* village moved once again downstream the Pacas river (east boundary of *Wawi* Indigenous Land), further into the interior and away from the border with non-indigenous neighbors; 150 km of the dirt road to Querência. This road is maintained by large-scale farmers of the region with support from the municipality; as observed in 2017, there are no longer Evergreen Forests or vegetation near river springs. In many areas, Seasonal Evergreen Forests have been replaced by energy lines, which is now part of the landscape of the Suiá-Miçu River Basin.

Since the early 1980s, when deforestation started to expand in the region, the *Kĩsêdjê* started to perceive and feel the impact of changes in quality of water. The first alarming impact occurred in the Darro River and revealed a sudden shifting of the water color due to sediments of red soils. The *Kĩsêdjê* conducted an expedition up the Suiá-Miçu River and found an enormous dredger digging the bed of the Darro River upstream of the WIL. Since then, some *Kĩsêdjê* have decided to live at the borders of the WIL as a way of keeping watch on the occupation of its surroundings (Sanches, 2015).

Our analysis of TM/Landsat images from the 1980s shows that

natural vegetation covered 80% of the Suiá-Miçu River Basin at the time (Fig. 5), a result was also confirmed by *MapBiomass*. There were few deforested and cleared areas, mostly for rice production and extensive cattle ranching, in the south of the Suiá-Miçu River Basin (Maeda et al., 2008). Fast population growth rate in Querência (2000–2010) and agricultural expansion led to rapid changes and pressures on the watershed. By 2009, only 52% of the Suiá-Miçu River Basin had some form of forest cover (we consider forest with trees older than 15 years and with canopy heights above 15 m), including old fallows; 37% of the area covered predominantly with agricultural fields, pasture, cleared areas with sparse trees. Areas with *Cerrado* vegetation accounted for 10% of the watershed. Finally, less than 1% of the Suiá-Miçu River Basin is covered with rubber tree (*Hevea brasiliensis*) cultivation.

Our analysis shows that the average annual deforestation rates in the Suiá-Miçu River Basin ranged around 0.93% per year, between 1984 and 1989, and 0.97% per year, between 1989 and 1994. The earlier represent an economy based on extensive cattle ranching and timber extraction, coinciding with the political emancipation of Querência. Deforestation rates increased to 1.3% per year between 1994 and 1999, and further to 1.8% per year, between 1999 and 2004,

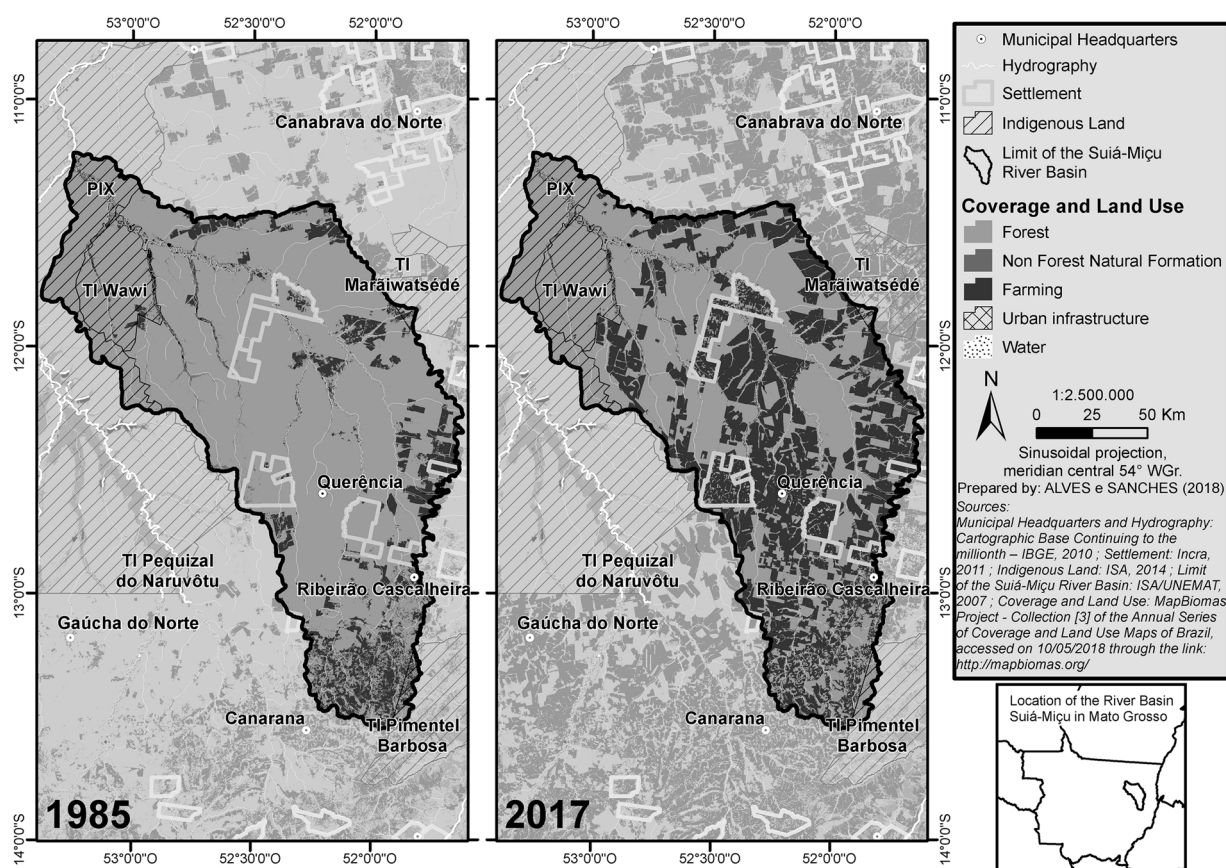


Fig. 5. Evolution of land use and cover in the Suiá-Miçu River Basin between 1985 and 2017, according to MapBiomias. Note the remaining vegetation (light gray) outside indigenous lands (PIX and Wawi Indigenous Land) decreased in contrast to increased deforested areas (dark gray) in 2017.

twice the rate of the previous decade. This expansion was fueled by tax incentives, increases in soybean prices, public and private investments in road infrastructure, storage, machinery, and development of the soybean supply chain; deforestation rates were similar for the state of Mato Grosso (Alencar et al., 2005).

From 2004–2009, the annual deforestation rate decreased significantly to 0.47% per year. After 2004, the 'Y Ikatu Campaign and the formation of the Xingu Seed Network contributed to promote interactions among indigenous people, farmers, non-governmental organizations, and academic researchers. There was an increase in the exchange of scientific and local knowledge, more resources (financial and technical support), and innovative techniques for PPAs restoration using native plant seeds. There was an increased in native seeds demand by small- to large-scale farmers (Durigan et al., 2013; Campos-Filho et al., 2013). This reduction in deforestation was also a result of the soybean moratorium,¹⁰ which suspended purchase and export of soybean from newly deforested areas. The publication of the Brazilian Federal Decree no. 6,321 of 2007 resulted in joint actions between federal and

municipal governments to control deforestation in the Amazon region. Among these actions, the Ministry of the Environment published a list of municipalities with the greatest rates of deforestation, sanctioning them with cuts in rural credit lines until they could show significant restoration and registration of rural properties (with respective land cover) in the national cadastral system, CAR (Lima et al., 2008).

The LUCC analysis in the Suiá-Miçu River Basin shows that the loss of common resources (clearing of riparian forest or PPA) occurred mostly on private lands outside indigenous lands. However, the remnant vegetation areas are increasingly susceptible to fires in drought season (between March and September), turning the Suiá-Miçu River Basin vulnerable to degradation (Brando et al., 2013; Nepstad et al., 2000).

Our results and the IAD analysis show how actors can organize themselves cooperatively to reduce tropical forest destruction (Ciriacy-Wantrup and Bishop, 1975; Davoudi et al., 2008; Tucker, 2010), and the costs and benefits associated to customary rules, that can preserve and/or intensify the land use, depending on the strategies available to such choices (VanWey et al., 2005). Nevertheless, the 'Y Ikatu Xingu Campaign has not yet contributed to reversing the process of degradation of the Suiá-Miçu River Basin. These results corroborate the study of the rational choices background and common-pool resources theories (Ostrom, 1990, 2011) to explain both the decision-making by actors (individuals, families, communities, social groups and organizations) and social forces in scale context (household/individual, local, regional, or global), as drivers to explain environmental changes (Schmink and Wood, 1992; Futemma et al., 2002; VanWey et al., 2005).

Finally, monitoring the use of the Xingu River Headwaters and the availability of graduated sanctions are important to avoid or deter violators, or free-rider users (Brondízio et al., 2009); or enduring structure that effectively promote the well-being of populations and

¹⁰ The Brazilian Federal Decree n° 6,321 of 2007 was highly impactful law-known as the soy moratorium. Querência and other Amazonian municipalities have been placed on the Ministry of the Environment's list sanctioned for their high rates of deforestation since 2008. This rule was resulted from the actions of both the private sector and civil society to control deforestation, when "globally positioned commodity traders, such as ADM, Bunge, Cargill" (all them represented in Suiá-Miçu River Basin), who collectively purchase around 90 percent of the soy produced in the Brazilian Amazon, agreed to impose a restriction on deforestation for the production of soybeans in the Amazon biome" (Rausch and Gibbs, 2016, p.12). Under the moratorium, traders were not supposed to purchase soybeans grown on embargoed areas from municipalities not in compliance with the national environmental and property cadastral registration system (Cadastro Ambiental Rural-CAR).

prevent environmental degradation (Futemma et al., 2002; Brondízio et al., 2009; Young, 2010). Even so, it is important to note that the environmental laws are being modified in Brazilian government (Little, 2001; Nesptad et al., 2002; Brando et al., 2013), and there is a lack of State enforcement, or decrease on field-level monitoring. When the institutions are still not firmly established, we may presume the Xingu headwaters and other remote Amazon regions still become accessible to unprecedented levels of land clearing and habitat degradation (Nepstad et al., 2000; Soares-Filho et al., 2006; Rosenthal et al., 2012, p. 296; Carvalho et al., 2014).

4.2.1. According to the *Kĩsêdjê* indigenous people “water matters”

The participation of socio-culturally heterogeneous groups in collective decision-making and monitoring has been still scantily analyzed from the perspective of environmental governance. There are gaps in how the outcomes and monitoring are contributing to collective actions to protect the tropical forests (VanWey et al., 2005), but the institutional arrangements of the Xingu Seeds Network promoted agreements between social actors towards recovering of the riparian forests within private lands (Durigan et al., 2013; Urzedo et al., 2016; Sanches and Futemma, 2019).

However, Seeger (1981), who has followed the musical manifestations and oratory of the *Kĩsêdjê* since the 1970s, reinforced the need to explore the physical and cultural transformations of this people in their territories circumscribed by the advance of the agricultural frontier. *Kĩsêdjê* women leaders have been raising concerns about the transformations in this region since the 1960s, and about the consequences for the health of their population. If the ‘Y *Ikatu* Xingu Campaign, originating from an indigenous appeal and legitimized by participants at Canarana, is fulfilling its mission, then it would be expected that such results would be acknowledged by Suiá-Miçu River Basin inhabitants, particularly with regard to better quality of water. While the data collection and analysis of river water is still unavailable, the *Kĩsêdjê* indigenous people observe changes in quality of water during fishing and daily activities (drinking, cooking, and bathing).

Kĩsêdjê have played a major role over the years in the defense of their territory and in dialogue with their neighbors for the protection of the Xingu River. Seventy years after Villas Bôas brothers’ expedition, the *Kĩsêdjê* acknowledge their cultural dilemmas and the uncertain future of their younger generation in the face of an abrupt and accelerating environmental destruction beyond their territory in the Suiá-Miçu River Basin. A critical vision stands out in their statements with repeated concerns since the launching of the ‘Y *Ikatu* Xingu Campaign regarding the poor quality of water of the Suiá-Miçu River. While adult men highlighted the Campaign as a major milestone marked by the “meeting of Canarana”, *Kĩsêdjê* women did not clearly understand its mission. They have expressed concern over increased incidence of diseases, such as diarrhea and allergies, among children and the elderly due to the deteriorated health of the river. Some excerpts of statements during the interviews of *Kĩsêdjê* leaders demonstrate these different perceptions of the Campaign and its effects:

Can I start from the beginning again? The ISA joined all the chiefs for the Canarana meeting, then the governor arrived. That day we were discussing all of this (‘Y *Ikatu* Xingu) and we were talking a lot about it. We were first discussing ‘Y *Ikatu* Xingu, like the dam. At the meeting they invited us to discuss it. At this meeting we had conflicts with the governor, as well as with other authorities who were present then and at the other meeting. At the other meeting we discussed about ‘Y *Ikatu* Xingu, but I was not liking it. The rivers are not good, that’s why the whites are doing it to make it better, but I did not like it.¹¹ I do not like at all to talk about the ‘Y *Ikatu* Xingu. I

was just hearing about it, thinking of it, that it will never improve. If the Xingu River remained good, for example, its tributaries remained as they were before, I would feel good about it. The whites only lie and the ‘Y *Ikatu* Xingu is just faddle, but it’s not good, anyway, they did a project on top of that. They only said that ‘Y *Ikatu* Xingu means ‘good Xingu water’, but it is not. On that day, the whites asked us what language we are going to choose to put on the Campaign. It has to be something good for us to put into this Campaign, it was when the language of the *Kamayurá* was voted and won. For example, you have the custom to vote, the name ‘Y *Ikatu* Xingu won. Even so, the ‘Y *Ikatu* Xingu is not good.

This statement was made when the Campaign was made public concomitantly with the announcement of the construction of a small hydroelectric power station—the Paranatinga—at the headwaters of the Culene River, the main tributary of the Xingu River (Sanches, 2015). At the end of the meeting in Canarana in 2004, the indigenous community exhorted to Blairo Maggi, Governor of Mato Grosso (2003–2010), and to representatives of federal institutions (the National Indian Foundation, the National Agency of Waters, and the Ministry of the Environment) that the construction of the small Paranatinga hydroelectric plant should be immediately interrupted. However, the public authorities did not heed the indigenous demand and the construction continued. The indigenous warned about the impact on sacred sites in the Upper Xingu (Franchetto, 2011), and the habitat of the Paranatinga plant, generating conflicts during the meeting. Members of the Y *Ikatu* Xingu Campaign felt a need to re-discuss the Campaign pact/agreement. At the same time, the social relations quivered with the episode of the Paranatinga small hydroelectric plant on the Culene River, as reported by a *Kĩsêdjê* leader.

(...) and we talked a lot amongst ourselves and we thought how we could come and talk to our white neighbors so that **they respected our river**, left the woods to preserve the river, or that **they did not throw garbage on the river**, and we exchanged a lot of ideas about it and explained it among ourselves... **people were going to talk about the dam and on that same trip** they met with leaders of other ethnic groups to discuss this. They said let’s think about this type of Campaign, **see if whites and authorities help debate** about it, so they accompany us along, **so they do not throw garbage in the water** directly. They have to make the clearing not up to the river’s edge, at least leave it a little far, so that the river’s springs continue to be clean, or not, so they thought and made that Campaign. But we indigenous people did not tie our ideas (we did not make an agreement among ourselves) so that the whites would follow our agreement, **we indigenous people have to strive to talk, we have to follow closely with them**, but this did not happen, **the people just said that and their people created it** (the Campaign) within the ISA (our emphasis).

The Campaign was not firmly established with the *Kĩsêdjê* people although they have actively monitored and participated in that initial meeting. During the entire mobilization process, the *Kĩsêdjê* saw the problem of deforestation and poor quality of river water as caused by non-indigenous (“white”) and, therefore, they should be the ones to fix it. Since the *Kĩsêdjê* people did not participate in the choice of the Campaign’s name (‘Y *Ikatu* Xingu), and due to the Paranatinga dam episode on the Culene River, they did not follow the organizational consensus in Campaign.

These statements justify the *Kĩsêdjê* perceptions of the Campaign’s proposal as not really good. The disappointment of *Kĩsêdjê* chief and his critical vision towards the ‘Y *Ikatu* Xingu Campaign and forest restoration projects in general revealed his preoccupation with the fate of the river waters:

Why does it call ‘Y *Ikatu* Xingu? I’m not liking any of this ‘Y *Ikatu* Xingu. I think I’ll never accept saying this, so you can listen, I do not really like that it calls ‘Y *Ikatu* Xingu? That’s why I’m not happy with

¹¹ Leader and chief of the *Kĩsêdjê* (approximately 63 year-old) referring to the meeting at Canarana when the name ‘Y *Ikatu* Xingu was chosen.

that name, the day they made this dam on the Culuene. At the same time, they started this work of 'Y *Ikatu* Xingu, which is why I do not like it, until now I did not like it is that you as ISA told the *Kisêdjê* to work on this east side, then I thought and said, "you can do it only on this side, so I can watch how it works", I thought so, things have not changed or improved.

In my observation, I see that just on the edge of the road I saw planters planting a rubber tree, then I'm a bit content with it, I get a little pleased because the rubber trees are growing in the middle of the farms. I still worry about the plants on the riverside, which they have not planted, has not improved (...).

The whites are fooling us, planting just by the side of the road for us to think that they are regaining the river's borders, just so we think they are doing it on all the farms they dug holes along the main road, even so the erosion leads to dirt in the rivers and the rivers are not good, so far this river head (the Pacas) is dirty.

The headwaters of Paranaíba continue to be polluted, the headwaters of the Jandaia remain polluted (...).

One day, the poison that is being thrown by the soybean will enter deep into the earth, that the rain spreads (the water) will take the poison there to the bottom and one day will fall in the (water table, our translation), that is what is worrying me. I am worried about this region (Wawi) because it is like an island, because it has several rivers surrounding it. I'm worried because the soybean plantation is very big in the headwaters and I'm very worried about it, I think you know that very well. One day, it may be that the drop of rain that is entering the bottom of the earth will be almost arriving underground, and we will be using it today.

The proximity to the goods and services offered by the towns contribute to the fact that synthetic materials such as plastic, batteries and chemical waste are frequently found in villages and thrown away into the rivers, thus generating other concerns for *Kisêdjê* leaders. However, the most emergent problems were the rise in pesticides and other agrochemicals used in soybean production that also pollute river water.

Local and non-indigenous populations were also extremely worried about such changes on the Suiá-Miçu River and its tributaries. Despite their criticisms of the Campaign, the *Kisêdjê* leaders contributed in different forums of dialogue with non-indigenous people in order to maintain their strong position of vigilance and be active in the monitoring of water and springs of the Suiá-Miçu River.

There is an urgency need of more biological studies especially in the flood plains on the impacts that these imbalances will have on the *Kisêdjê* population (Silva and da, 1994), as well as on the non-indigenous population. In sum, the *Kisêdjê* narratives instigate new actions for environmental governance in the region of the Xingu River Headwaters, which is a region of high socio-environmental complexity, with various overlapping rights of appropriation (private, public and common resources) over springs and riparian forests (Benjamin, 1997; Lima et al., 2008). Their narratives offer an important counterpoint and as evaluative criteria in the institutional analysis of the governance and outcomes of the 'Y *Ikatu* Xingu Campaign, with respect to the protection of the Xingu River Headwaters.

5. Final Considerations: Challenges for Suiá-Miçu River Basin and Xingu Headwaters Conservation

In the study of human-environment interactions in tropical forest regions, national and international markets are major drivers of land-tenure and land-cover changes, aligned with dominant political views about economic development. This paradigmatic view is supported by old political and academic narratives about the Amazonian frontier, which remain in the imaginary of the Brazilian society.

In the northern Mato Grosso state, these narratives in official policies overlook existing cosmologies and long-term empirical experience and knowledge of indigenous people and *pioneers* farmers, converting the landscape and land tenure drastically and rapidly. The landscape of

the Suiá-Miçu River Basin reflects a mixed of ancient agricultural practices of indigenous with current highly mechanized and extensive agriculture, intertwined in diverse social, economic and political contexts. The positive outcomes of economic growth associated with the expansion of commodity production in the Xingu River Headwaters region contrast with the negative externalities it creates to peoples' health and to the ecosystem services at all scales provided by riparian forests, clean water, and wetland areas.

On the other hand, we showed in this study that there is a growing social capital emerging from the active local stakeholder participation in response to the impacts created by deforestation. The opportunity to recognize common interests triggered by the Campaign led to the creation of new institutional arrangement to restore riparian forests, progressively expanding to the entire region of the headwaters. We argued that the 'Y *Ikatu* Xingu Campaign actions along with legal compliance, monitoring of the quality of river water by *Kisêdjê* people, and decision-making process at rural property level have contributed to the environmental governance in the Xingu headwaters region. However, our analysis is limited in examining conflict resolution mechanisms among different social agents; we have also limited coverage of the intensive use of agrochemicals in cultivated areas, or very near of riparian forest and local communities.

The IAD framework contributed to better understand the institutional arrangements behind the environmental governance of the 'Y *Ikatu* Campaign and the Xingu Seed Network, helping to identify outcomes, bottlenecks and opportunities for the protection of the Xingu Headwaters. There has been an increase in the demands of rural producers and smallholder farmers to seek technical support for restoration required by law. New and innovative techniques, such as mechanized seed planting in riparian forests are also contributing to reduce the costs of forest restoration.

So, has the 'Y *Ikatu* Xingu Campaign contributed to reversing the process of degradation of the Xingu River Headwaters? Our answer is not yet. Since the creation of the Xingu Seed Network, there has been an increase of restoration areas and growing demand for native seeds, but the impact of restoration on water quality remains to be shown. In addition to these efforts, the implementation of both existing laws and regulations to protect the Suiá-Miçu River Basin and Native Vegetation Protection Law (n° 12,651 of 2012) has not been sufficient to guarantee the conservation of these wetland ecosystems. The protection of wetlands is directly related to the future of indigenous territories, as well as to agricultural production, economic development and maintaining the connectivity of ecological corridors between riverside and forested areas. Nonetheless, the restoration result remains unimpressive, since much of the Suiá-Miçu River Basin comprises large private areas, where the largest problems of degradation in riparian forests take place.

The negative changes in the water quality of the Suiá-Miçu River are noticed and denounced frequently by *Kisêdjê* indigenous leaders. Although reticent about the results of the Campaign, they have contributed to the Xingu Seed Network and to the monitoring of water quality. The attitude of the *Kisêdjê* indigenous leaders has been fundamental and should be incorporated into the Xingu Seed Network arrangements in order to strengthen the performance of governance, to facilitate dialogue between the *Kisêdjê* and their rural "neighbors", and to demand the presence of legal authorities for the protection of riparian forests and wetlands.

In terms of recommendations, the 'Y *Ikatu* Xingu Campaign should consider: (1) how to deal with different interests of heterogeneous social agents at multiple levels of decision-making as part of the rules and principles of the Xingu Seed Network; (2) the flow of technical and scientific information; (3) how to monitor forest restoration and quality of water rivers; (4) how to create more incentives (economic and social) for different social stakeholders to contribute and cooperate over time in forest restoration; (5) public authorities should recognize local forms of self-organization (self-governance) for forest restoration; and (6) how to incorporate local knowledge into alternative production

technologies, that can make forest restoration effective and efficient.

Accepting the inexorable frontier of "destruction" of forests and water resources is not the desirable scenario for the Xingu region. However, local and heterogeneous inhabitants—especially indigenous groups such as the *Kisêdjê*—are likely to mobilize themselves for the common interests to promote collective well-being and to protect their environment, even in regions of intense land use and tenure dynamics, such as in the Central-West Brazil.

CRediT authorship contribution statement

Rosely Alvim Sanches: Investigation, Data curation, Formal analysis, Writing - original draft. **Célia Regina Tomiko Fudemma:** Supervision, Conceptualization, Writing - review & editing. **Heber Queiroz Alves:** Conceptualization, Methodology, Software.

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