REPORT

Pastoralists in a changing environment: The competition for grazing land in and around the W Biosphere Reserve, Benin Republic

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Abstract Pastoralists face increasing competition for land with crop farmers and nature in and around the W Biosphere Reserve (WBR) in Benin. Our aim was to describe and analyse land use changes in order to understand their drivers, and to describe and analyse the viewpoints of relevant stakeholders in order to understand the competition for land. To this end, remote sensing data, regional statistics, and survey data were collected. We found that crop land expansion around the WBR was the direct driver of decrease of the grazing land area. Population growth and rising demand for food crops, and government support to the cotton sector were indirect drivers of grazing land reduction. Furthermore, competing claims on land among users arose from the complex interaction of crop expansion, presence of WBR and the way it is governed, the lack of support to pastoralists, and the increasing shift of pastoralists' lifestyle into one of settled crop farmers. Pastoralism is under threat and its survival depends on the successful implementation of policies to support pastoralists and protect grazing lands.

Keywords Competing claims · Crop production · Drivers · Land use change · Nature conservation · Pastoralism

INTRODUCTION

Drylands host nearly one-third of world's population, about half of the world's livestock and are traditionally used and managed by pastoralists (McDermott et al. 2010; Boval

et al. 2017). In sub-Saharan Africa, for example, about 25 million pastoralists and 240 million agro-pastoralists rely on livestock grazing on drylands for their livelihoods (Neely et al. 2009).

Dryland ecosystems are lands with an aridity index below 0.65, characterized by relatively low precipitation (FAO 2011; De Haan 2016). Almost all drylands experience high rainfall variability between and within seasons, between years, and in longer-term cycles (FAO 2011). In consequence, the availability of pasture resources is highly variable across time (seasons) and space (Scoones 1995). Mobility enables pastoralists to exploit this variability in pasture resources across time and space (Behnke et al. 1993; Mortimore 2010). Pastoralism, however, is not only a livestock-based livelihood strategy, but a recognized lifestyle with socio-cultural norms, beliefs and values, and traditional knowledge revolving around livestock (Niamir-Fuller 1999; Davies et al. 2013).

Despite the vital contribution of pastoral systems to food security and their ability to produce and thrive in lands unfavourable to agriculture (De Haan et al. 2016), pastoralism and pastoralist's lifestyle around the world are under pressure (Thornton 2010; Catley et al. 2013) and in persistent state of crisis (De Haan et al. 2016), more than ever before (Fratkin and Mearns 2003). Several driving forces (e.g. demographic, socioeconomic, political, technological, cultural and/or biophysical) are hindering the availability of and the accessibility to pastoral resources in Africa (Reid et al. 2004). In Africa, agricultural lands increased by 66 million hectares between 1985 and 2005 (Foley et al. 2011), at the expense of mainly forests, woodlands, and savannas (Gibbs et al. 2010; Chang et al. 2016). The encroachment of arable farming in pastoral ecosystems has led to a loss and fragmentation of pastoral lands, watering points, and livestock routes (Reid et al.

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2004). Hence, the mobile strategy used to sustain pastoral production in the drylands is being constrained (Thébaud and Batterbury 2001; Ayantunde et al. 2008), and the access to uncultivated lands and roadsides in the wet season hampered (Bassett and Turner 2007; Ayantunde et al. 2008), since pastoralists claim their traditional rights to lands, however, from a marginalized position.

The competition for natural resources, especially land, has become an issue of major concern and cause of conflicts (De Haan et al. 2016; Young et al. 2016), not only between pastoralists and crop farmers (Fratkin and Mearns 2003; De Haan et al. 2016), but also between pastoralism and nature conservation representatives (Reid et al. 2004). In general, pastoral communities are among the most politically and socially marginalized (IUCN 2011; Davies et al. 2016). Governments and international development agencies have usually neglected pastoral populations and supported them with poorly designed interventions (De Haan et al. 2016). The FAO (2016) acknowledged that “pastoralists have traditionally suffered from poor understanding, marginalization and exclusion from dialogue”. Therefore, policy interventions aimed at pastoralists have often resulted in negative or disastrous consequences (Fratkin and Mearns 2003; Fan et al. 2014). A sustainable land use policy for the drylands requires understanding the dynamics in land use and land use change in the area of concern, and providing voice to all actors involved, especially pastoralists. A fair amount of research has been done about causes of loss and fragmentation of grazing lands in West Africa (Turner 1999; Van Driel 1999; Toutain et al. 2004; Moussa and Amadou 2014). However, less is known about the potential effect of protected areas on loss and fragmentation of grazing lands, on pastoralists’ livelihoods, and on relationships with other land users. Moreover, pastoralists perspectives have been usually ignored (Fratkin and Mearns 2003; De Haan et al. 2016).

In, and especially in the periphery of the Biosphere Reserve of W in Benin Republic (WBR), some studies report an ongoing trend of land use change from a natural land cover (i.e. forest and savannah) into cropland (Clerici et al. 2007; Houessou et al. 2013; Avakoudjo et al. 2014). These studies focus on the regression of natural vegetation and the expansion of cropland, but little is said about the habitats and resources for pastoralists. Again, the viewpoint and consequences for pastoralists seem to be dismissed. Moreover, socio-ecological systems such as the WBR are very complex and dynamic, and consequently there is little understanding of the underlying drivers of land use change in such systems. The land uses and the competing claims among stakeholders (i.e. pastoralists, crop farmers and nature conservation representatives) in the region of the W Biosphere Reserve remain poorly studied, especially how the presence of the WBR and the way it is governed is affecting mutual relationships between pastoralists and other land users.

Therefore, the aim of this study was (i) to describe and analyse land use changes in order to understand their drivers and (ii) to describe and analyse the viewpoints of relevant stakeholders in order to understand the competition for land in and around the WBR. To this end, three different methodological approaches (i.e. remote sensing, regional statistics and surveys) were used, which allowed us to overcome the lack or inaccuracy of available data.

MATERIALS AND METHODS

Study area description

This study was carried out in the region of the WBR, in North Benin (Fig. 1). The WBR comprises about 56% of the W Transboundary Biosphere Reserve located in the countries of Benin, Niger, and Burkina Faso and covers about 5632 km². The WBR is located at 11°26′ to 12°26′ N and 2°17′ to 3°05′ E. The natural vegetation consists of tree, shrub and woodland savannah, gallery forest, and wetland. This vegetation allows the presence of wildlife valuable for conservation purposes, such as elephants, lions, buffaloes, cheetahs, waterbucks, monkeys, and birds. The regional water supply comes from the Niger River and its tributaries: the Alibori, Mekrou, and Sota watercourses. The overall area is characterized by two main seasons: a rainy season from mid-May through October, with an average minimum daily temperature of 12 °C, an average maximum daily temperature of 25 °C, and precipitation ranging from 700 to 1000 mm; and a dry season from November to mid-May, with an average minimum daily temperature of 30 °C, an average maximum daily temperature of 40 °C and hardly any precipitation (Billand et al. 2005). During the first part of the dry season, from November to February, a dry dusty wind blows through the North of Benin, also referred to as harmattan, which boosts the drying process of natural pastures. The harmattan facilitates burning of dried pasture, either from controlled or uncontrolled bush fire.

In Benin, the WBR is bordered by five districts, with a total of 759 300 inhabitants of which 23% are Fulbe (INSAE 2016). In these districts, the main economic activities are crop farming and livestock production. The WBR and its surrounding land are located in the so-called agro-pastoral contact zone in West Africa (De Haan et al. 1990), implying that land is suitable for crop farming and livestock farming, potentially enabling competition for land. The area under study was previously a tsetse fly-infested zone, which is, now more suited for livestock farming due to several years of tsetse fly eradication campaigns by the Beninese government. Crop farmers get their main income from production of cereals (maize,

Fig. 1 The W Biosphere Reserve (WBR) in Benin (small inset map left top corner), the study area relative to the Beninese section of the WBR (small inset map right top corner) and the study area

sorghum, millet, rice), roots and tubers (yam, cassava, potato and sweet potato), legumes (groundnut, beans, soybean and bambara bean), vegetables (tomato, pepper, okra, pumpkin) and cotton, and possess oxen for ploughing. They belong to the following ethnic groups: Baatonu, Dendi, Monkole, and Goumantche. In contrast, pastoralists obtain their main income from livestock and livestock products, and belong to the Fulbe ethnic group. The Fulbe pastoralists are dwellers of the districts surrounding the WBR and some of them come from the bordering countries Burkina Faso, Niger and Nigeria, during the dry season (Tamou 2002; Convers et al. 2007).

To prevent illegal activities in the WBR, such as clearing for cropping, grazing by livestock, poaching, and fishing, rangers are hired and trained for patrolling inside the WBR. To engage the surrounding people in the co-management of the WBR, the *Association Villageoise de Gestion des Réserves de Faune* (AVIGREF; in English, Village Association of Wildlife Management) has been set in the bordering villages. Members of the AVIGREF are often former poachers and current crop farmers now engaged in the co-management of the WBR, by for example informing the authorities of illegal activities. AVIGREF members receive game meat and subsidies after each season of hunting and tourism.

There is a buffer zone of 5 km width, set by the authorities of the WBR, which surrounds the WBR (Billand et al. 2005). According to the authorities of the WBR, three land use forms corresponding to three sub-zones are allowed: the cropping, the grazing, and the non-timber forest products (NTFP) sub-zones. The first sub-zone (outer from the border of the WBR) is for crop farming, under a payment of 7.6 EURO per hectare and per year. The second sub-zone (between the other sub-zones) is for grazing by domestic livestock under payment of 0.76 EURO per cattle and 0.30 EURO per goat or sheep per year. The third sub-zone (closest to the border of the WBR) is for harvesting NTFP, such as thatches for roofing houses and medicinal products; there is a fee to be paid depending on the amount of the harvested NTFP. In practice, there are several challenges in implementing the regulations of the buffer zone.

Data collection and analysis

To fulfil our objectives, we used remote sensing data, data from regional statistics, and data collected through surveys.

Remote sensing data and analysis

To present land use in and around the WBR, we defined three relevant land segments based on DeFries et al. (2005) and Clerici et al. (2007) which are presented in Fig. 1:

- *inWBR*: the land segment inside the WBR, on the west side of the WBR boundary with a width of 20 km;
- *buffer zone*: the land segment of 5 km width set by WBR authorities located outside the WBR, on the eastside of the WBR boundary;
- *outWBR*: the land segment of 20 km width located in the surrounding lands outside WBR, east of the buffer zone.

We used the satellite images Landsat-8/LDCM (*Landsat Data Continuity Mission*) from 2014 and we identified four relevant classes using the standard supervised maximum likelihood technique (Richards 2013):

- *Cropping zones*: cultivated land for food crops (cereals, roots and tubers, and vegetables) and cash crops, and short-term fallows; hereunder we use the term cropland to refer to any land used for crop production;
- *Forest*: land with closed forest canopy cover either along rivers (gallery forest) or elsewhere (woodland);
- *Savannah*: land dominated by grass or herbaceous plants, often associated with sparse shrubs and trees; and
- *Wetland*: land comprising water bodies such as rivers, ponds and streams, as well as lands along such water bodies.

Remote sensing data were analysed by comparing the area of each land use class across the land segments.

Secondary data collected from regional statistics

To describe the dynamics of the cultivated lands, livestock numbers, and human population, we selected three administrative districts (Karimama, Malanville, Kandi) bordering the north, the east, and the south part of the WBR, respectively. For these districts we collected regional statistics of land use, and human and livestock numbers, which we refer to as secondary data. Data about cultivated land for food and cash crops (cotton) in the three administrative districts were derived from the *Centre d'Action Régionale pour le Développement Rural* (CARDER, in English Agricultural extension services) of the province of Alibori. Livestock data were cattle number of the resident pastoralists (no distinction between the ages of the animals) and were derived from the reports of the vaccination campaigns by the Regional Office of Livestock in the province of Alibori. We did not collect data of foreign transhumant pastoralists and their herds since these were hardly present in the study area. Foreign transhumant pastoralists herd their livestock occasionally in the core of the park, where there is less risk of being trapped by park authorities for illegal grazing than in the WBR's periphery, where the study area is.

To assess the population density on cultivated land (person/ha) from regional statistics and human population, we have considered the census data of 1992, 2002, and 2013 and the cultivated land of 1997 to 2013. Since we did not have census data for 1997, we estimated the human population of that year according to the formula:

$$P_t = P_l(1 + r)^z \text{ (Swanson and Tayman 2012),}$$

where P_t is the population to be estimated at the time t in year, P_l is the population of the previous census year, r is the geometric growth rate of the population between census years, which was 3.3% between 1992 and 2002 (INSAE 2016), and z is the number of years between the previous census year and the year t of estimation.

Data collected through surveys

To analyse the competing claims for land by the stakeholders, information was collected through community meetings and individual interviews with land users in the selected villages (Sékalé, Antéré, Isséné, Gah-Béri, Loumbou-Loumbou Gourmantche, Loumbou-Loumbou Fulbe). Survey data collection was carried out from November to December 2014 and in April 2015. It started with a desk study and informal (without interview guide) interviews with officials from the WBR, the office of livestock management and the agricultural extension services, dealing with land use issues. Prior to the community meetings and individual interviews with farmers and pastoralists in the study area we asked (and were granted) permission to do the studies of local leaders. Consent was requested from district authorities, village chiefs, and from each individual interviewee. Permit was requested from the National Center of Wildlife Management (in French, Centre National de Gestion des Réserves de Faune (CENAGREF) and from its representative, which is the authority of the W Biosphere Reserve. We ensured that participation to community meeting and interviews was voluntary and the information collected would be treated confidentially. Participants were allowed to skip any

question, if the answer was unknown or they preferred not to address the question (see guide of discussion and questionnaire as Appendix S1 and Appendix S2). We conducted an exploratory study in 15 villages in *outWBR* and in the buffer zone. Out of these villages, we selected one in each district, according to following criteria: (i) being representative of the zone (in terms of climatic conditions and land uses), (ii) being close to the edge of the WBR, and (iii) representing ethnic diversity in the area (i.e. coexistence of Fulbe community and other ethnic groups) (Table 1).

In each of the selected villages, we performed community meetings and we held individual interviews with crop farmers, pastoralists, AVIGREF members, and rangers (Table 2).

We held six community meetings separately with crop farmers and with pastoralists. Participants in the community meetings were elders and members of the village council. Community meetings were facilitated by the researcher using a discussion guide containing questions in French that were translated into the local language by a trained interpreter. The questions in the discussion guide covered the following items: access to land, competing claims, conflicts and their causes, relationships between crop farmers and pastoralists, the use of the buffer zone, and the history of the settlement of villages. Community meetings lasted from 1.5 h to 2 h. Discussion guide and protocol for the meetings are given in the Appendix S1.

We conducted individual interviews with crop farmers, pastoralists, members of the AVIGREF, and rangers through semi-structured questionnaires with two sections (Appendix S2). The first section was about the socioeconomic characteristics, such as household size, farm type and land size, and livestock species and herd size. The second section of the questionnaire addressed quantity of change in land use during the last two decades (1994–2014), i.e. agricultural land availability in the *outWBR*, using a four-point scale *zero*, *small*, *medium* or *large*. Next to that, using the three-point scale *increased*, *decreased*, or *no change* (plus the *don't know* option,

Table 1 Basic characteristics of the surveyed villages

Villages	Basic characteristics			
	Location in the study area	Climatic condition	Ethnic group	Main livelihood
Sékalé	South of the WBR	Sudanian	Monkole	Crop farming
Antéré	South of the WBR	Sudanian	Fulbe	Pastoralism
Isséné	East of the WBR	Intermediate	Dendi	Crop farming
Gah-Béri	East of the WBR	Intermediate	Fulbe	Pastoralism
Loumbou-Loumbou Gourmantche	North of the WBR	Sahelo-Sudanian	Gourmantche	Crop farming
Loumbou-Loumbou Fulbe	North of the WBR	Sahelo-Sudanian	Fulbe	Pastoralism

Table 2 Number of interviewees per stakeholder group and per village

District Village	Kandi (South of WBR) Sékalé/Antéré	Malanville (East of WBR) Isséné/Gah-Béri	Karimama (North of WBR) Loumbou-Loumbou	Total
Stakeholders				
Crop farmers	10	10	10	30
Pastoralists	10	11	10	31
AVIGREF	5	8	5	18
Rangers	3	0	4	7

which was reported but not included in the analysis), we addressed the change of cropland area, area of grazing land, and area of watering points (natural or manmade ponds used for livestock watering). Finally, we addressed the main possible cause for changes in cropland areas, grazing land, and watering points through an open question. Participants of the individual interviews were those willing to share their views on the land use issues and participants were selected using the snowball technique. Before each interview, we asked the interviewee's consent after explaining objectives and way of dealing with information. Individual interviews lasted between 45 min and one hour. The researcher asked the questions in French and the questions were then translated into the local language by a trained interpret.

Community meeting data were analysed by coding, summarizing, and categorizing respondents' opinion in order to find patterns. Information gained from the individual surveys was analysed using descriptive statistics and analysis of variance. Stakeholders' perception of change in land use and their related drivers were analysed with frequency and corresponding percentage, whereas means of socioeconomic characteristics were tested for difference. Where appropriate, the post hoc Tukey test was used to test for significant difference between means. All statistical analyses were done using the "stats" package in R 3.2.2 (R Core Team 2015).

RESULTS

Remote sensing data analysis

In 2014, savannah and forest covered about 90% of the land in *inWBR* and only 9% of the land was used for crop production (Table 3). In contrast, about two-thirds of the land was used for crop production in the buffer zone (i.e. 66%) and *outWBR* (i.e. 64%), and only 25% of the land in the buffer zone and 30% of the land in *outWBR* was covered with savannah and forest. Since grazing lands for livestock are mainly the savannah and forest, grazing resources and therewith feed resources for livestock are relatively limited in the buffer zone and in the *outWBR*.

Secondary data analysis

Cultivated lands

Figure 2 shows cultivated land area used for production of food and cash crops in the buffer zone and *outWBR* between 1997 and 2013. In this period, the total amount of the cultivated land used for production of food and cash crops nearly doubled from 92 000 ha to 185 000 ha, where more land is used for food crop than for cash crop production.

Cattle population

We distinguished two types of cattle farming in the study area: cattle farming by local pastoralists, and oxen kept by crop farmers. In Fig. 2, cattle is the sum of the number of cattle of resident pastoralists and the number of oxen (around 10% of the total) kept by crop farmers. Overall, the number of cattle decreased between 1997 and 2013. Information collected during surveys seems to indicate that many herds of cattle left the region, because of the difficulty to feed cattle with natural pasture.

Human population and population density on cultivated land

Population (for the districts of Karimama, Malanville and Kandi) more than doubled, from about 202 000 in 1997 to 416 000 in 2013 (see Appendix S3). This growth mainly results from growth of the local population by 4.3% per

Table 3 Land use class (in ha and %) per land segment in 2014

Land use class	Land segment					
	<i>inWBR</i>		Buffer zone		<i>outWBR</i>	
	ha	%	ha	%	ha	%
Cropping zones	27 811	9	60 891	66	182 370	64
Savannah	215 942	73	20 604	22	67 107	24
Forest	50 007	17	2482	3	17 679	6
Wetlands	3678	1	8266	9	16 429	6

Fig. 2 Development of cultivated land area and resident pastoralists' cattle numbers (for the districts of Karimama, Malanville and Kandi)

year, which is caused by a high birth rate of 5.6 children per woman (INSAE 2016). Such a growth is characteristic for Sub-Sahara Africa, and quite comparable to the 3.5% annual population growth in Benin between 2002 and 2013 (INSAE 2016). The population density on cultivated land remained relatively stable between the considered periods and was 1.5 to 2.2 people ha^{-1} (see Appendix S3).

Survey analysis

Socioeconomic characteristics of stakeholders

Crop farmers, pastoralists, and AVIGREF members were all involved in crop and livestock farming (Table 4). The area of crop land was larger for crop farmers and AVIGREF members than for pastoralists, whereas the number of cattle was higher for pastoralists than for crop farmers and AVIGREF members. The number of goats was lowest for crop farmers, while the number of sheep did not differ between stakeholders. These results indicate that there are no strict crop farmers or livestock farmers in the study area. All the land users were practicing mixed farming, where cropping was the most important activity for crop farmers and AVIGREF members, and livestock farming was the most important activity for pastoralists.

People's perception of the drivers leading to an expansion of cropland and a reduction in pastureland and watering points

In *outWBR*, 78 out of 86 respondents argued that no new agricultural land was available, 6 respondents stated that new agricultural land availability was small, and 2

Table 4 Means (and standards deviation) of socioeconomic characteristics of the stakeholders

Socioeconomic characteristics	Stakeholders			P value
	Pastoralists <i>n</i> = 31	Crop farmers <i>n</i> = 30	AVIGREF members <i>n</i> = 18	
Food crop area (ha)	3.3 (1.85) ^b	8.2 (6.18) ^a	8.1 (4.85) ^a	<0.001
Cash crop area (ha)	0.8 (1.03) ^b	6.6 (7.00) ^a	5.4 (4.79) ^a	<0.001
Number of cattle	41 (24.7) ^a	5 (3.2) ^b	6 (6.9) ^b	<0.001
Number of goats	18 (20.4) ^a	4 (4.2) ^b	8 (16.3) ^a	0.003
Number of sheep	9 (10.2)	4 (3.5)	9 (14.4)	0.7
Household size (no.)	11 (3.6)	12 (8.5)	13 (4.8)	0.5

Mean values in the same socioeconomic characteristic with different letters are different ($P < 0.05$)

respondents stated that new agricultural land availability was medium.

Moreover, 79 out of these 86 respondents indicated that cropland expanded over the past 20 years. Population growth was seen as the major cause for this expansion, followed by increased incentives (supported by the government) for cotton cultivation (Table 5). Additional factors perceived to drive expansion of crop land were a decline in soil fertility and the shifting from production of food crops for subsistence to a more market-oriented production.

Eighty-four out of the 86 respondents perceived that the grazing area had declined over the past 20 years. Clearing of pasture land for crop farming was perceived as the main cause of this decline in grazing area. Some crop farmers also mentioned the increase in number of livestock

Table 5 Frequency of drivers mentioned by the stakeholders for cropland expansion, pastureland decrease, and the reduction of area of watering points

Drivers	Stakeholders				
	Pastoralists <i>n</i> = 31	Crop farmers <i>n</i> = 30	AVIGREF members <i>n</i> = 18	Rangers <i>n</i> = 7	Total
Cropland expansion					
Population growth	17	22	15	5	59
Cotton cultivation	5	1	1	0	7
Other drivers	7	2	2	2	13
Unknown	2	5	0	0	7
Pastureland decrease					
Clearing for cropping	29	23	15	7	74
Livestock increase	0	3	1	0	4
Other drivers	1	3	2	0	6
Unknown	1	1	0	0	2
Reduction of area of watering points					
Cropping in the riverbanks	19	14	12	4	49
Precipitation decrease	3	6	3	2	14
Pond and streams siltation	4	7	2	0	13
Other drivers	0	2	0	0	2
Unknown	5	1	1	1	8

(Table 5), which could be associated with an overall increase in feed requirement, hence a relative reduction in the availability of grazing land. Additional factors perceived to drive this decline in grazing area were herbicide use, cotton cultivation, availability of tractors for ploughing, and cropping in the riverbanks. Indeed, herbicide use is facilitating the cleaning of weeds on fields, and boosts the expansion of crop land. The government provides incentives to cotton farmers to stimulate economic growth of the country, such as provision of free seed, subsidized access to fertilisers, pesticides and herbicides, free extension services, guarantee to sell the entire cotton yield (to the government), and offer of credit schemes. In the dry season, riverbanks of Niger are increasingly used for production of vegetables and rice, creating competition with livestock who grazed these areas previously. Tractors for ploughing are facilitating the ploughing of farm fields, and, as such stimulate cultivation of additional cropland; their use, moreover, is supported by the government.

A reduction of the area of watering points for livestock was perceived by 78 out of 86 respondents. This reduction was perceived to mainly result from the increase in crop farming in riverbanks, and near ponds and streams (Table 5), whereas a decrease in precipitation and siltation of ponds and streams were perceived as additional explanatory factors.

The competing claims for land among stakeholders

Several competing claims for land were identified among the stakeholders. Narratives of the competing claims for lands in the three land segments (*inWBR*, buffer zone and *outWBR*) are summarized in Box 1. The most recurrent arguments to claim land were (i) ownership due to expropriation in the past, (ii) the unfair and/or incomplete implementation of the regulations in the WBR and the buffer zone, and (iii) the shifting of pastoralist's lifestyle.

Ownership of land due to past expropriation The competing claims related to land expropriation in the past are between crop farmers and the WBR authorities and between crop farmers themselves.

There were people settled in the current core of the WBR before its establishment as a National Park in 1954. Soon after the establishment, these people were displaced from inside the WBR, often by military force. This caused the resettlement of people in the current border of the WBR. Nowadays, these resettled people and their offspring claim ownership of land in the *inWBR* segment due to the prior expropriation of ancestors' lands. In addition, some competing claims appear between the crop farmers who were already living in *outWBR* and the crop farmers that were resettled.

Box 1 Narratives of competing claims for land among stakeholders in each land segment (into brackets)Close-border crop farmers versus far-border crop farmers (*inWBR*)

Close-border farmers: “We are close to the WBR but we are not cropping inside the WBR and people far away from the border of the WBR come to do so. They had no right to do so.”

Far-border crop farmers: “Only the Government owns the WBR and therefore, it is only the government that allows someone to cultivate inside the WBR and we are also residents of the peripheral zone of the WBR”

Crop farmers versus crop farmers (*outWBR*)

Crop farmer A: “This area is where our parents have been cultivating since we were young. But the head of this family B is now claiming the area because it belongs to his grandparent”

Crop farmer B: “When the parents of family A arrived in this village from a neighboring village they requested a land to cultivate and this land was not given but borrowed, now we want it back”

Pastoralists versus crop farmers (buffer zone)

Pastoralists: “We claimed this area that crop farmers were clearing because it is devoted to grazing, according to the rules relating to the use of the buffer zone. They were doing so because the area soil has been enriched by the manure of our cattle.”

Crop farmers: “Pastoralists will clear the area for cropping one day. They are also cultivating in the buffer zone, so we should also crop in the grazing area of the buffer zone. Moreover, they are not autochthones of this area, so they had no right to claim any land in this area and nobody knows the border between cropping zone and grazing zone.”

Pastoralists versus crop farmers (*outWBR*)

Pastoralists: “Nowadays, even hills and some stony land have been cultivated, so we have to go far away from crop fields in the rainy season until the harvest time.”

Crop farmers: “The land where pastoralists crop and graze was handed down to us by our grand-parents. Pastoralists are livestock keepers not crop farmers. Pastoralists should stick to keeping livestock.”

Pastoralists versus crop farmers (wetlands and riverbanks, *outWBR*)

Pastoralists: “Nowadays, watering points dry up fast because crop farmers plough close to the ponds or in the lowlands and riverbanks. They have accelerated the siltation of these watering points. Moreover, we could not use this area for grazing in the dry season.”

Crop farmers replied: “Soils are not fertile anymore, only the lowlands and the riverbanks are fertile. We want to feed people but pastoralists want to feed animals. In my opinion, it is better to do the former than the latter”

Pastoralists and crop farmers versus WBR officers (*inWBR*)

Crop farmers: i) “Our village has been resettled by the rangers in this current location but the tombs of our ancestors are still over there, in the WBR”; ii) “WBR officers are not fair because they allow people to crop or graze in some areas of the WBR but not in others, like ours for instance”

Pastoralists: i) “Why do rangers kill our animals to protect other animals, as they know that we don’t have any grazing area?” ii) “WBR officers are conserving wild animals for future generation. When was this Park created? Our grand-parents were grazing in this so-called Park many years ago without being bothered by anyone”

WBR officer: “Cropland is encroaching into the Reserve and pastoralists are grazing in the many lands inside the Reserve. The most threat to the reserve is crop farming. We know that pastoralists are forced to graze inside because there is no grazing land outside. However, these activities are illegal, and we have to get them all out”

Unfair and incomplete implementation of WBR’s regulations The incomplete implementation of the regulations of the WBR and in the buffer zone is the argument of claims for land among crop farmers; between crop farmers and pastoralists; and between farmers and the authorities of the WBR.

In the study area, crop farmers living far away from the border of the WBR have been cultivating inside the WBR for relatively few years. Crop farmers living close to the WBR mentioned that they requested the WBR authorities to get them out, but no prosecution, enforcement or sanctions were taken. This was frustrating for the crop farmers living close to the WBR, especially because the land in the WBR once belonged to their ancestors and they feel that if someone has right to use the *inWBR* lands it should be them (see Box 1). In addition, in the South West part of the

WBR (which is not part of the study area, but adjacent to it), thousands of hectares of lands are cultivated inside the WBR (Houessou et al. 2013) with no reaction from WBR’s officers. This situation, known by the inhabitants of the study area, has raised complaints and frustration among the crop farmers and pastoralists. Now, crop farmers and pastoralists in the study area request land for cropping and grazing inside the WBR. In the study area, therefore, an increasing number of people demand allowance of land for agricultural activities inside the WBR, in accordance to the law enforcement by the WBR authorities in the South West part of the WBR.

In the buffer zone, it was initially set to hold a cropping sub-zone, a grazing sub-zone, and a NTFP sub-zone (in consecutive parallel land segments from *outWBR* to *inWBR*) to be used by crop farmers, pastoralists and all

inhabitants, respectively. Each sub-zone was about to be delimited to avoid conflicting use of the sub-zones among these users. However, until now, these sub-zones have not been demarcated and regulations have not been fully implemented. As a consequence, cropland expanded into the grazing sub-zone (trend also seen in Table 3), and conflicts caused by the competing land claims have arisen between crop farmers and pastoralists.

The shifting of pastoralist's lifestyle Historically, Fulbe pastoralists have been related to a mobile lifestyle searching for grazing resources for their herds. Despite Fulbe have been related to cropping activities before (Turner 1999; Toutain et al. 2004), farming among Fulbe is currently becoming more important and they are turning savannah and forest land into crop land. The increasing cropping activity by Fulbe is part of their strategy to cope with the loss of grazing opportunities and becomes an asset to secure their pastoral activity and households. Crop farmers reacted by saying that pastoralists are allochthones and crop farmers are autochthones. Being autochthone involves a spiritual bond with the land, hence landownership and supremacy over the allochthones who were then denied to own land. The shifting of pastoralists' lifestyle into more cropping activities has led to the competing claims for land between pastoralists and crop farmers.

DISCUSSION

At regional scale, remote sensing data show that the WBR authorities have been relatively successful in maintaining natural land cover inside the WBR, while in the buffer zone and outside the WBR cropland has expanded and dominates. Secondary data (regional scale) show a steady increase of cultivated land area (food and cash crop) outside the WBR, a growth of regional population and a decrease of cattle numbers. At local scale, according to the surveys, there is a general agreement that cropland area expanded and grazing land area decreased. All together, these different sources of data indicate that the trend in cropland expansion was the direct driver of grazing lands' decrease, whereas the trend in regional population growth and the associated increasing demand for food and cash crops, were identified as indirect drivers. At local scale, data of community meetings show that competing claims have arisen among land users as a result of complex interactions between cropland expansion, presence of the WBR and the way it is governed, and the shift of pastoralists' lifestyle. Crop farmers and pastoralists claimed land as a means for livelihood, and the main arguments supporting claims were as follows: ownership of land because of past expropriation, unfair and incomplete implementation of the WBR regulations and shifting

lifestyle of pastoralists. In the following sections we discuss drivers of the expansion of cropland and arguments for the land claims.

Drivers of the expansion of cropland

Population growth and the increasing demand for food crops

The secondary data (regional statistics for the buffer zone and *outWBR*) showed that cropland expanded. We are aware that the data of such statistics are relatively unreliable, but the trends observed (doubling of land area allocated to food crops and cotton) from 1997 up to 2013 were confirmed by the results of the remote sensing analysis of the study area in 2014 and the narratives of interviewees. Hence, it seems justified to conclude that crop land expansion was important in the region.

Expansion of cropland could be a consequence of the population growth in the region and the associated increased demand for food and to a lesser extent of the conversion of uncultivated land to cropland by pastoralists. Population growth in the region is explained by an increase of the local population by 4.3% annually during the period of 1997 till 2013 because of a high fertility rate of 5.6 children per woman (INSAE 2016). About 76% of all people in North Benin live in rural areas (INSAE 2016), and population growth has resulted in the settling of new farming households. New farming households settled partly on inherited cropland, but also on new crop fields cleared on land belonging to their parents. The cropland expansion in response to population growth has been previously described in other studies, such as by Turner et al. (2011) in Niger, by Burgoyne et al. (2016) in the Mkuze Game Reserve in South Africa, by Hartter et al. (2016) in Uganda, and by Ningal et al. (2008) in Papua New Guinea. However, Giannecchini et al. (2007) in South Africa and Reid et al. (2000) in Ethiopia, observed that increasing regional population did not result in cropland expansion, because of land scarcity and strict legislation concerning land use. In our study area, land was apparently still available to be converted into cropland, under the present legislation and informal rules.

In addition to local consumption, crop expansion was also triggered by supra-regional drivers associated with good markets for cash and food crops. Cultivation of food crops increased in response to the increased demand for food in urban regions in Benin and by the bordering countries, such as Nigeria and Niger. Benin is self-sufficient for maize, but there are regional differences: maize is a staple food in the south, whereas it is a cash crop in the north (Lutz et al. 2007). The southern cities are supplied with maize by the northern regions (Lutz et al. 2007),

which encompass the study area. Regarding the bordering countries, Nigeria is the most populated country in Africa and, therefore, requires food to supply its people's needs; Niger is an arid country at risk of floods and droughts (Tarhule 2005), which affects stability of crop production. Niger has to rely, therefore, on the importation of food crops from Benin and other coastal countries (Blein and Soulé 2013). In this regard, the city of Malanville, part of the study area, is a strategic market (Walther 2009), since it borders Niger and Nigeria. Through this market, the area under study became an important food crop producer for Niger and Nigeria.

Developments in the cotton sector

Regional statistics show that land area for cash crops (namely cotton) doubled between 1997 and 2013, which accounts for 30% of the cropland expansion. Cotton accounts for nearly 40% of Gross Domestic Product and roughly 80% of the official export receipts, which sets cotton exports as vital to Benin's economy and an integral part of the country's development plans for poverty alleviation (Nicely 2014). One-third of Benin's population earns its income from the cotton sector (MAEP 2011). Therefore, cotton is a strategic product and its cultivation has been promoted by all ruling governments since the 1980s. For example, government provides cotton farmers with free improved seed, and subsidized fertilisers and pesticides. Another government intervention has been the regulation of the cotton sector by establishing associations of producers along the chain, e.g. village associations of cotton cultivators or associations of cotton manufacturers (Joachim 2008). Recently, the present government (in 2015), through credit provision services, has facilitated finance operating costs such as labour for cleaning fields and for harvesting cotton. Furthermore, some farmers reported that cotton is cultivated with the aim to have access to fertilisers, which are ultimately used for their food crop production (Maboudou Alidou 2014). All these incentives have made cotton cultivation attractive to crop farmers, potentially explaining the expansion of cotton farming, and its contribution to cropland expansion. Cotton cultivation expansion as driver of land use change is consistent with the finding of Clerici et al. (2007) and Baudron et al. (2009) in Benin, of Ouedraogo et al. (2010) in Burkina Faso, and of Baudron et al. (2011) in Zimbabwe.

Livelihood strategies in land use

Survey data showed that competition for land was an issue between the actors in the study area, as was found in De Haan et al. (1990) and in Turner et al. (2011). Although pastoralists mentioned the decrease of watering points, watering was not

considered as central issue. This may be due to the relative abundance of water, namely the Niger River and its tributaries Alibori, Mekrou and Sota, in the study area.

Crop farmers are claiming land to sustain their families' needs in terms of food, but also to profit through the trade of food products and cotton. This cropland expansion was unfavourable for pastoralists as it occurred at the expense of grazing lands (i.e. savanna and forest) outside the WBR and in the buffer zone. According to the customary land rights, land belongs to the person who occupies it, and occupying means clearing the land usually for cropping (De Haan 1997). Grazing does not imply ownership of the land. Hence, pastoralists' reaction has been an increasing shift to settlement, and they have initiated and expanded cropping activities. Cropping by pastoralists is, therefore, used as a strategy to own land and secure their grazing area and their livelihoods. Once the land is owned, it can be used (partly or entirely) either for cropping or for grazing. The mobile nature of Fulbe and the non-ownership of the land made them *invisible* land users. Facing shortage of land, the claims for lands devoted to grazing and the setup of cropping activities have made pastoralists become *visible* land users. The increasing shifting of pastoralists from mobile lifestyle (invisible land users) into a rather settled lifestyle (visible land users) has drawn the attention of the "traditional" crop farmers and claims for land have arisen. Crop farmers state that pastoralists should stick to livestock production only, as quoted by a crop farmer during individual interviews: "*pastoralists are known as livestock farmers [and] not [as] crop farmers; they should keep on with that [livestock] activity*". Additionally, crop farmers argue that Fulbe pastoralists are allochthone in that region compared to crop farmers, who are the autochthone in the region (Benoit 1999), implying that pastoralists cannot own land. Even though pastoralists are the last to be settled, it has been reported that pastoralists have been in the region since the 16th to 17th centuries (Benoit 1999) and have cropped farms for subsistence (Turner 1999; Toutain et al. 2004). However, cropping by pastoralists is becoming more important currently than in the past, as part of their strategy to cope with the increasing loss of grazing lands and as an asset to secure their pastoral production system and household. The shifting of pastoralists' mobile lifestyle into crop farming is similar to that found in Ethiopia by Tsegaye et al. (2010), in Nigeria by Hoffmann (2004) in Niger by Turner et al. (2011) and by McCabe et al. (2010) in Tanzania. However, in Ethiopia, this shift was not a strategy to own land but to cope with recurrent drought (Biazin and Sterk 2013).

With regard to the use of land in the WBR, crop farmers and pastoralists are using the same strategy, i.e. fight the unfair and incomplete implementation of regulations in the WBR and claim the right on lands from which they were

expropriated. Such arguments are similar to those reported for farmers in Uganda who were resettled to clear protected areas (Cavanagh and Benjaminsen 2015). In their strategies to claim land in WBR, crop farmers and pastoralists did not have a united view. Indeed, during community meeting, one pastoralist said: *“To be honest, if the rangers were not patrolling, the WBR would be entirely invaded by crop farming. In this case we, pastoralists are lost”*. This implies that pastoralists preferred the WBR to be under control of the WBR authorities than being invaded by crop farming. Indeed as reported by Butt (2011) in South Africa, protected areas are important for pastoralists’ coping strategies. Although incursion into protected areas is illegal, pastoralists preferred to do that and avoid conflicts with crop farmers (resulting from damaging the crops). The importance of such protected areas for pastoralists was also highlighted in this quote from a senior pastoralist: *“Though they [rangers] will fine me if arrested in the WBR, I prefer to do that since I can sell some cattle to pay the bill, and still have my herd”*.

Implications for policy

Pastoralists and their livestock are land users in the periphery of the WBR. Given the positive link between population growth and cropland expansion in the study area, and the ongoing population growth (INSAE 2016), it is likely that the cropland expansion will continue in the *outWBR*, as long as there is still savannah and forest area to be converted. Government measures promoting food crops and cotton cultivation to boost the economic growth of the country will increase this conversion of savannah and forest currently used by livestock and by pastoralists. Lack of policies to support pastoralism and to protect grazing land in the *outWBR* has favoured crop expansion. Hence, current policy interventions, or lack of them, will continue to threaten pastoralists and their lifestyle. The reduction in grazing land, the constrained mobility of livestock, and the shift in pastoralists’ lifestyle are likely to increase the competing claims between crop farmers and pastoralists in the *outWBR*. In the province comprising the study area, 87% of households depend on livestock for their livelihood (Nicely 2014). Therefore options are needed for integrating crop production, pastoralism and their lifestyle, and nature conservation in the area.

This study shows that displacement of the resident populations from the protected area not only affects relationship between different land users, but also results in additional pressure on the resource of that protected area. It therefore suggests that in designation of protected area, a more integrated approach that seeks to satisfy also resident populations’ livelihoods is necessary.

Land scarcity in the *outWBR* is expected to increase pressure and conflicts in the buffer zone of the WBR first. In fact, as seen in this study by means of remote sensing data, the poor implementation of regulations in the buffer zone and the lack of support to pastoralists has triggered the expansion of arable land (66% of the land) at the expense of grazing lands. After the buffer zone, the pressure inside the WBR may follow. This might increase tensions between crop farmers and pastoralists, and eventually, conflicts between them and the authorities of the WBR. Constrained mobility of pastoralists, weak implementation of regulations, and inappropriate integration of pastoralists in the policy agendas have been identified as source of conflicts (De Haan et al. 2016). According to Garcia et al. (2016) and Toutain et al. (2004), customary means of governance are barely recognized by governmental institutions, and pastoralists face the threat of reduced mobility and impoverishment, as sedentary life leads to reduced opportunities and increased costs. Policies seeking sustainability of production systems should explore the potential of traditional local governance systems that have ruled the coexistence of farmers and pastoralists for very long time.

Conservation depends on the attitude (Agrawal and Redford 2009) of the people living close to the WBR. Population growth, and the associated competing claims for land are important threats for the integrity of the WBR. In line with Reid et al. (2004), we need to better understand African pastoral systems: the causes of loss and fragmentation of pastoral lands, and the consequences for people and their livelihoods (Davies et al. 2016), their livestock and wildlife. Knowledge of these pastoral systems should be included in the policy process aimed at designation and implementation of protected areas since it affects the once powerful, but presently marginalized pastoralists.

Limitations of this study

Availability and accuracy of remote sensing and secondary data posed an important limitation to the interpretation of the study. For example, using remote sensing data of 1994, 2004, and 2014, as initially planned, could have yielded more insights into land use change in the study area. After consultation with an independent specialist, however, we were recommended not to use data of years 1994 and 2004 because of low accuracy (differences and deficiencies in resolution, resulting in dubious data, which could neither be verified nor explained). Hence, we decided to only use data from 2014 as source for current land use, and to triangulate this data with secondary data and interviews with local population to overcome uncertainty or lack of data. We are also aware that secondary data, such as cattle numbers (of resident pastoralists and of crop farmers)

obtained from vaccination campaigns and cropped area data obtained from extension services, may not be very accurate. However, in all, the combination of the 3 sources of information allowed us to understand the current situation and indicated that trends in land use changes are likely.

Participants of individual interviews were selected using the snowball technique and we interviewed only those willing to share their opinion with us. In doing so, the results of the interviews may have missed possible valuable information from people not willing to share their opinion and people out from the network of interviewees. In the context of this study, however, sampling through this technique seemed the most suitable one, since pastoralists are hard to meet, because they are living in fear, and consequently reluctant to discuss with researchers.

The non-inclusion of transhumant pastoralists from foreign countries (such as Niger, Burkina Faso and Nigeria) is a limitation in this study, although we planned to meet them. Non-inclusion of this group has two main causes. First, they move fast to avoid to be tracked inside the WBR. Second, they perceive researchers as a threat and potential informers to WBR authorities about their location and illegal grazing. The non-inclusion of opinion from transhumant pastoralist may mean that the situation is worse (higher population and livestock numbers, leading to more competing claims for the shrinking grazing land available) and of a higher concern than we describe in this paper. It also suggests that foreign transhumant pastoralists may be even more marginalized than local pastoralists.

CONCLUSION

This study addressed the dynamics in land use and land use change inside and in the periphery of the WBR and analysed the drivers behind this land use change using three sources of information. In addition, competing claims for land among stakeholders (i.e. pastoralists, crop farmers and WBR authorities) were identified, as a result of complex interactions among cropland expansion, presence of the WBR and the way it is governed, lack of support to pastoralists, and an increasing shift of pastoralists' lifestyle. In general, the WBR has been successful in maintaining natural land cover inside the WBR, cropland has expanded outside the WBR, and presence of cattle in the area has decreased. Cropland expansion was the direct driver of decrease of grazing land. Indirect drivers of the decrease of grazing land were population growth and the associated increases in demands for food crop products (at a regional and international level) and for cash crops, i.e. governmental policies to stimulate cotton cultivation. Cropland expansion by crop farmers, and increasing cropping activities by pastoralists, has triggered competing claims

for land among stakeholders, namely between crop farmers and pastoralists, among crop farmers themselves, and between crop farmers and pastoralists and the WBR authorities. The main arguments put forward for land ownership were right to land because of past expropriation, the unfair and incomplete implementation of the regulations of the WBR, and the shifting of the mobile lifestyle of pastoralists into settled crop farmers. This study suggests that pastoralism is under threat due to cropland expansion at the expense of grazing land and the lack of support to pastoralists. The survival of pastoralism will depend on the design and full implementation of policies to protect pastoralists and grazing lands.

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