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Land use evolution and management under recurrent conflict conditions: Umbundu agroforestry system in the Angolan Highlands

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ABSTRACT

The article analyzes the effects of long term armed conflicts on the characteristics and evolution of traditional land uses. The main focus is on the Umbundu agroforestry system, an endogenous and dynamic traditional African land use in the Angolan Central Highlands, an area that has experienced numerous conflicts during the last 200 years. The study used field research and a literature review to analyze the historical evolution of the system and its recovery after the conflicts. The results provided a characterization of the system's main traits and stakeholders through time. The main focus of the system was maintaining a continuous supply of food crops under changing ownership and security, constrained by soil fertility, and the availability of water and fertilizers. Land use conflicts moulded the system, allowing it to be rich during low and medium intensity conflicts, though constraining it when conflicts escalated to a military civil war. The evolution of the land use system was examined using the frame of multifunctionality. Additional focus is made on its current and future challenges to become a sustainable and profitable agrarian land use system. The study has implications for land use management (e.g. regarding the length of fallow period) as well as conflict management.

Introduction

The Umbundu Land Use System (ULUS) is practiced in the Highland plateau in Central Angola. It is a representative land use system which can serve as an example of how social and economic changes have affected the countryside. As with many African countries, Angola has experienced a tumultuous last couple of hundred years (e.g. Collier and Gunning, 1999). This period has included slave trade, tribal wars, Portuguese colonial rule and a long and destructive civil war which resulted in significant impacts on land use management in the country (Pacheco, 2004). One of the side effects of the frequent conflicts has, among other things, been the lack of scientific research on land use. During the Portuguese colonial period, there were limited studies on ethnography (e.g. Edwards, 1962; Childs, 1969; Esterman, 1971), agricultural census (e.g. MIAA, 1971; Rendinha, 1972), and rural sociology (e.g. Pössinger, 1973, 1986; Silva and Morais, 1973; Morais, 1976). Independence in 1975, and the subsequent increase in political instability and civil war, resulted in a halt in agricultural research. During the 1990s community based development projects and participatory surveys emerged, with several studies (e.g. Morais and Pacheco, 1991; Bossard, 1996; Neto, 1999; Pacheco, 2001) focusing on the livelihood strategies of traditional communities. Additionally, recently some technical reports in the framework of the new Land Law were produced. These reports provided an overview the land use and management systems (Pacheco, 2004; FAO, 2005b, 2006; Katiavala, 2005; Ferreira, 2005).

Morais and Pacheco (1991) and FAO (2005a) studied the ULUS during the post-independence military conflict (1997–2002), finding that most of the colonial farms were abandoned, with the area under agricultural plantations declining. The ULUS became the main source of food in the area (Neto, 1999). However, the intensification of the system and the tendency to use shorter fallow

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periods resulted in decreasing natural soil fertility, exacerbated by the lack of artificial fertilizers, causing land degradation and unsustainable land management, with significant potential for causing violent and non-violent conflicts (Raleigh and Urdal, 2007). However, these previous studies (i.e. Morais and Pacheco, 1991; FAO, 2005a) did not reflect on the incidence and effects of conflicts in the later evolution of the system and its adaptation to the new environment and socio-economic context. Additionally, there was a lack of systematic analysis of the dynamics of the land use system as well as the effects of the conflicts, including post-conflict recovery, how landscape and conflicts interact, and the potential land use conflicts that may emerge in the near future. This is the first study that considers conflicts in the context of the land use systems in Angola.

This study analyses the evolution and current characteristics of the ULUS, with special focus on its adaptation to the changing socio-economic conditions under different conflict intensities in the area. The main aim is to examine and describe the development of the land use systems in the region across time, and to identify potential sources of environmental conflicts inherent to the system. The analysis considers the effect of external management systems in the context of globalisation trends when traditional systems are in place. This study analyses the influence of conflicts on the evolution of the Umbundu Land Use System (ULUS). In addition, the study investigates the sustainability of the present system and whether the Umbundu system is able to evolve and adapt to changing and conflictive environments while providing fresh vegetable and commodity crops for the Angolan economy.

Theoretical framework

Conflict can be defined as a situation in which one or more parties pursue incompatible (including perceived incompatible) goals, through behaviour that impairs the interests of another party (Glasl, 1999). This can centre on incompatible interests and values, and power imbalances (Gritten et al., 2009; Patel et al., 2013). Conflicts, including those regarding natural resource management, can be seen as a motor for societal development and participatory decision making, i.e. conflict transformation (Dahrendorf, 1990; Dhiaulhaq et al., 2014), with implications for the ULUS. IUCN's (2002) guidelines for the management of protected landscapes aim at advising on the planning and management of landscapes, calling attention to the effects of conflicts as driving element in the landscape dynamic.

Conflicts have been relatively common in the Angolan Highlands particularly during the last two centuries, varying in intensity, impacts and involved actors. The hypothesis of this study assumes that the nature and dynamics of these conflicts determine the development of ULUS. In other words the landscape's evolution has largely been a result of conflicts, creating new landscape structures, as a consequence of changing the decision making processes and the land uses. The intrinsic characteristics of land use conflicts include complex natural systems and processes within large timeframes and high degree of uncertainty. Decisions done at sub-national and national levels are influenced by broader societal trends and superregional forces (Mann and Jeaneaux, 2009). The 200 years of ULUS landscape evolution gives the opportunity to test different theoretical perspectives to analyze its principal trends and dynamics.

Multi-functionality theory has been widely used for explaining landscape evolution in different systems around the world (Wiggering et al., 2003). Multi-functionality pre-supposes that all demands on landscapes are legitimate and are appropriately considered. This study looks at conflict, landscapes and traditional land use to see how they fit into this multi-functionality. Multi-functional land uses can be explained as the result of achieving consensus among stakeholders about the most sustainable land use combinations. Under the multi-functionality approach people's priorities affect the landscape, just as the landscape affects people's priorities (Klein and Wolf, 2007). Multi-functionality acknowledges that landscapes can simultaneously provide multiple socio-economic and ecological goods and services, potentially bridging the complex demands of an increasingly diverse set of interests and claims. Multi-functionality draws attention to interdependencies, it must balance competing claims among different actors (Klein and Wolf, 2007). The resulting landscape reflects the people's priorities and power relationships in the past (Raleigh and Urdal, 2007).

An important step towards conflict transformation is the identification of the multiple environmental, social and economic land use functions, and the subsequent analyses of how well specific landscapes perform with regard to these functions (Bills and Gross, 2005). Understanding how agriculture land use, trade-offs, ownership and decision making are affected by conflicts determine these relationships (Brandt and Vejre, 2003). Land cover may indicate the delineation of ecosystem border and also an expression of human induced structures and changes (Mann and Jeaneaux, 2009). Other parameters like power structure, perceptions and resources are already targeted by these indicators or are indirectly affecting them.

In ULUS plot types, yields and agriculture land uses have changed during the last 200 conflict ridden years, with the landscape changing as a result. Ownership and decision making processes have been identified as key parameters linking ULUS sustainability, landscapes and conflicts (Delgado-Matas and Pukkala, 2010, 2011). Determining participation in land use decision making processes is a challenge considering the perceived benefits or threats to society. Stakeholders should represent the public's preferences, considering this representation as highly dynamic, often with discord within and among groups, and shifting of stakeholders between groups (Kangas et al., 1996).

Materials and methods

Study area

The study area is located in the Central Highlands of Angola (Fig. 1), in the agro-ecological and socioeconomic geographical unit called Zone 24 (MIAA, 1971; Diniz, 1973, 1998). This area covers 79,040 km^2, and it constitutes a flat plateau, crossed with valleys and low hills with an average altitude of around 1700 m (maximum 2200 m) and an annual precipitation between 1100 and 1400 mm. The soils are mainly acidic (pH between 5.5 and 6.5) and have a low nutrient content (Diniz, 1973; Delgado-Matas and Pukkala, 2010). During the colonial period, the area was densely populated with a third of the country's rural population. Additionally more than a hundred thousand European settlers were living in the area before independence. At that time, the region was considered the granary of Angola, producing exportable amounts of corn, beans, coffee, manioc and vegetables (MIAA, 1971; Delgado-Matas and Pukkala, 2011). Eucalyptus and pine plantations were established in the region for the local cellulose industry (see e.g. Sampaio, 1966; Silva, 1971). However, following independence, the population living in the area was decimated during 27 years of civil war (Pacheco, 2004).

Data origins

The data collection was organized in three steps. In order to analyze the current and past land uses in the region, the first step included a systematic review of the technical and scientific colonial documents as well as publications from Non-Governmental Organizations (NGOs) and development agencies. During the Portuguese rule, a significant number of technical and scientific studies were done in research stations both in Angola and Portugal, the

Fig. 1. Location of the study area in Angola, including the administrative boundaries and interview areas based on Google maps®.

focus of which was to support the expansion of European agriculture in the region. In spite of this, some investigations and technical papers about the traditional peasant agriculture were produced, especially by missionaries, rural capacity development organizations and the Missão de Inquerito Agricola de Angola ([Agricultural Mission Surveys of Angola] MIAA, 1971). Unfortunately, most of these documents were lost during the civil war.

The remaining documents were obtained from four sources:

1. Portuguese research institutions and historical archives related to the Angolan colonization (Annex 1).
2. Angolan institutions, including the Ministry of Agriculture library, Instituto de Investigação Agricola de Angola ([Institute of Agricultural Research, Angola] IIAA) library, Caminho de Ferro de Benguela ([Benguela Railway Company] CFB) documentary that still had non-catalogued information.
3. Documents from NGOs and development agencies covering recent decades which address the problem of food security strategies of rural communities.
4. Colonial officers, archivists and other people that have conserved some texts as personal property.

The second step included interviews with rural development officers from state and non-state organizations as well as with different actors including farmers, community elders and local administration officials in different communities of the area. Interviewees were selected according to their links to the land use system and their familiarity with Umbundu practice. The selected farmers had a long experience in the traditional agricultural system. These farmers were identified using rapid rural assessments (RRA) (Chambers, 1995; FAO, 2000) and discussions with administration officers. The interviewers were local NGOs officials with long term trusted relations with the farmers. RRA included rapid and

cheap techniques, falling between formal surveys and unstructured research methods. Furthermore, this methodology was already successfully applied in several other locations in other regions of Angola and in other countries like Mozambique and Brazil (FAO, 2000).

Finally, a third step involved field research, which was done in partnership with UN agencies and various NGOs' food security projects. A participatory RRA was conducted to identify land use practices and their related decision making processes in rural communities. The field work included rural participatory appraisals in 33 rural Umbundu communities located in the municipalities of *Caala*, *Ekunha*, *Longonjo*, *Ukuma* and *Chinjenje* (province of Huambo, in Zone 24). The field work also included 63 interviews with key informants, carried out during the period from January 2005 to December 2007. The interviews were carried out in several communities in Zone 24.

The main criteria for selecting the above communities were: existence of local organizations with long experience working with the communities, presence of all Umbundu plot typologies, and presence of former colonial farms and representation of community elders' councils to address the queries of the theoretical framework. The long period spent in the field enabled the development of trust between the research team and local people. According to Ander-Egg (2000), long term relations between communities and the research team would allow one to get verifiable information and to avoid conditioned answers, as well as increased shared understanding among community members.

The interviews were semi-structured (Chambers, 1995), including specific and open-ended questions with the aim of soliciting information on agriculture land uses, plot typology, productivity, ownership, decision making and conflicts. Relevant information was also recorded concerning past utilization and future trends (Fig. 2).

Other research techniques used in the field included Venn Diagram, natural resources management matrices and participatory mapping (Chambers, 1995; Mitchell, 1999; Ander-Egg, 2000). Historical satellite and Google Earth® images in combination with bibliography review and key informants were analyzed to understand the evolution of land use since early Portuguese settlements.

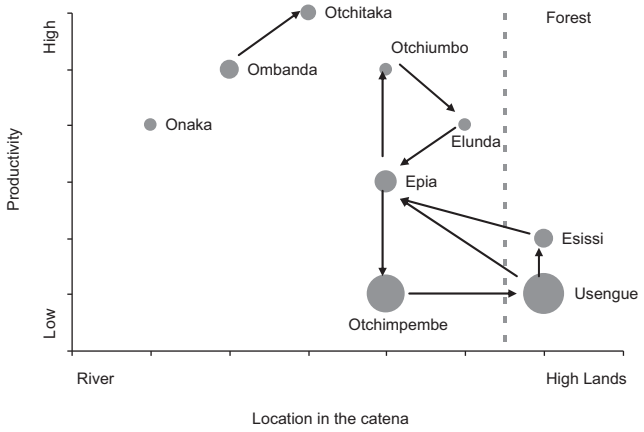

Fig. 2. Main Umbundu land uses according to the productivity of the use, and its location in the topographic catena. Size of the points represents the average size of the plot. Arrows represent the observed transitions between land uses.

The used imagery included Landsat 1990/TM Scenes, 2000/ETM+ Scenes and 2005/ETM+ Scenes. These collections were used to build preliminary maps that were later used in participatory mapping techniques to understand the land use evolution during the last 200 years.

Results

Umbundu plots and characteristics

Nine different plot types in the management system were identified using participatory research. Table 1 summarizes their characteristics (soil type, fertility and drainage), socioeconomic aspects (gender roles, ownership and decision making process), and main uses including list of main crops. Soil type varied from hydromorphic to paraferralitic and ferralitic (Oxisols types under USDA classification). Fertility and drainage varied among the plots. The richest site *Onaka* shows poor drainage capacity whereas the less fertile *Epia* and *Otchipembe* have good drainage characteristics.

Table 1
Plot characteristics and main uses.

Plot name	Soil characteristics	Fertility	Drainage	Gender roles	Property and decision making	Main uses	
						Subsistence	Cash crop
Onaka	Hydromorphic	High	Poor	Women work land, men responsible for drainage	Individual	Maize, beans, pumpkin, vegetables	Vegetables, potato
Otchitaka	Paraferralitic	Medium high	Medium good	Women do most of the work	Individual		Vegetables, potato
Ombanda	Paraferralitic	Medium-high	Medium		Individual	Maize, beans, pumpkin, banana, cassava	Maize, beans, potato
Epia	Ferralitic and paraferralitic	Low	Good		Individual	Maize, beans, pumpkin, cassava sweet potato,	Maize, beans, potato, wheat
Otchiumbo	Ferralitic and paraferralitic	High after manure	Good	Women do most of the work	Mainly individual	Maize, beans, pumpkin	Tobacco
Elunda	Ferralitic and paraferralitic	Medium after manure	Good		Individual		Maize, beans
Otchipembe	Ferralitic and paraferralitic	Very low	Good		Mainly individual	Pasture	
Usengue	Ferralitic and paraferralitic	Low	Good	Women do most of the work	Mainly community	Pasture, fuel, medicines, fruits	Charcoal, fungi, medicines, honey, fruits
Esisi	Ferralitic and paraferralitic	Low	Good	Women do most of the work	Community	Pasture, fuel, medicines, fruits	Charcoal, fungi, medicines, honey, fruits

Table 2
The cultivation period typology.

Period	Name	Cereal	Leguminoses	Tubercules	Cucurbitaceae
First year	*Osenda*	Maize	Beans, Akunde	Potato, Sweet potato	Pumpkin
Second year	*Omundi*	Maize	Beans, Akunde	Cassava, rape, yam	Pumpkin
Third year	*Osangulula*	Maize	Beans	Cassava, rape, yam	–
Fourth year	*Osangosango or Epia*	Maize	Beans	Cassava	–
Fifth year	*Otchipela*	–	–	Cassava	–
Sixth year	*Otchipela*	–	–	Sweet potato	–
Seventh year	*Otchipembe*	Fallow	Fallow	Fallow	Fallow

Only *Ombanda* and human-altered plots like *Otchitaka*, *Elunda* and *Otchiumbo* present both fertility and good drainage capacities. This study shows clearly identifiable gender roles for each plot. Apart from *Epia, Ombanda*, *Elunda* and *Otchipembe*, women do almost all the work in the rest of the plots. They also actively participate in several management tasks related to decision making concerning these plots. Property and decision making responsibility are mainly individual or family based, although, community and village elders decide on *Otchiumbo*, *Usengue* and *Esisi* plots. *Epia*, *Otchitaka* and *Ombanda* plots are highly important on cash crop uses, while *Onaka* and *Otchiumbo* remain as mainly subsistence agriculture plots.

The current land uses are structured following a catena (Fig. 2), determined by the topography of the area, the position on the slope and the human–nature interaction in the plot. Several different land uses were identified based on the interviews and the literature review. In general, the whole system can be divided into three main units: the *Onaka*, in the low land and depressions; the *Ongongo* or highlands and the *Ombanda* situated in the intermediary. In each particular case, the catena can have varying number of plot types, depending on the ecological and socioeconomic conditions. Subsistence plots, *Onaka* and *Otchiumbo*, are the smallest, being less than 100 m^2 in size, on average, *Epia* and *Otchipembe* are the largest plots with around 1–2 ha maximum. The slope catena varies from river shore *Onaka* to highest hills of *Epia*, *Otchipembe*, *Usengue* and *Esisi*.

Current Umbundu fallow

The interviews, natural resources matrices and participatory mapping enabled the characterization of the current fallow period. It constitutes an inherent component of the Umbundu system, having an important effect on the landscape, and it is the main source of food for the local communities (Table 2). Considering a typical *Epia* plot, the system can be characterized by five different fallow cycles (Fig. 3). These cycle types diverge regarding time under fallow, shorter than 10 years when the fallow period includes just short grass shrub to more than 25 years period when it changes to *Esisi* plot, after *Usengue* and *Otchipembe* periods. The cultivation period ranges from three to seven years depending on the duration of the fallow period and the natural fertility of the site. Crops also change in the different steps based on their nutrient demands, pH needs and market value.

System and landscape evolution under conflicts

The system developed under continuous conflicts (Table 3, Fig. 4), starting with tribal wars between Mumuila and Tchoqwe bantu people (called Nano wars), Portuguese occupation after the Berlin Conference of 1885, conflicts between European settlers and Umbundu villagers, nationalism and revolutionary movements

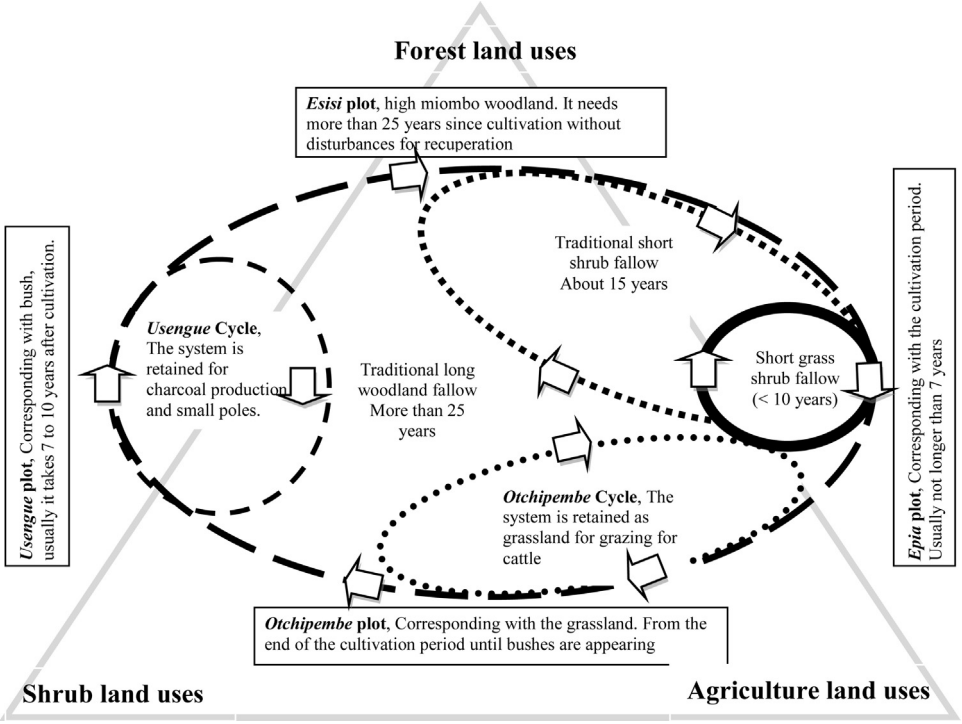

Fig. 3. A conceptualization of the characterization of fallow typologies and cycles in the Central Highlands of Angola.

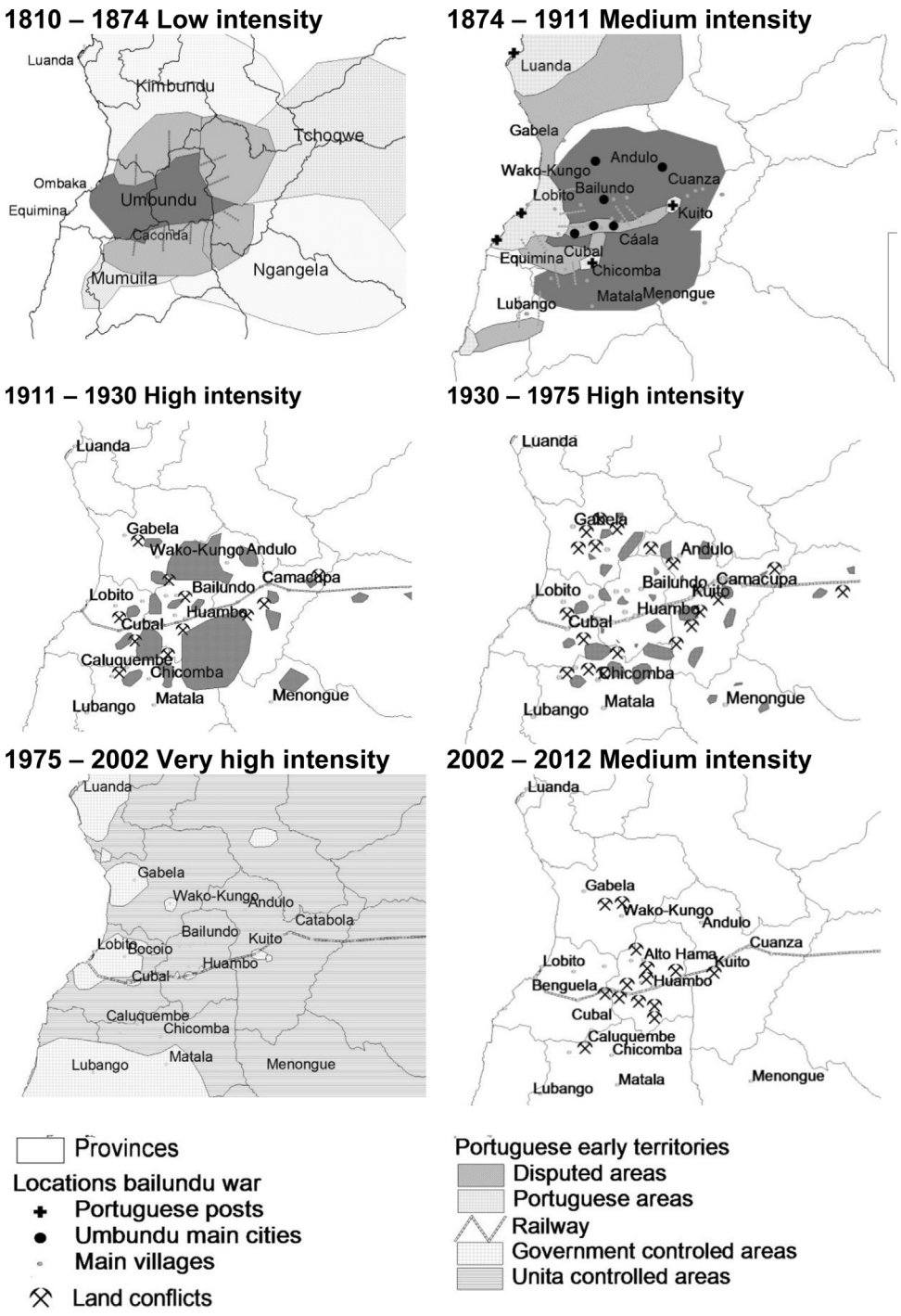

Fig. 4. Spatialization of the conflicts affecting Central Angola during the last 200 years.

during the Cold War, civil war after the independence, and land grabbing by government officials and foreign companies in recent times. Under all these conflicts, the system underwent changes. These changes included new plots typologies, crops, gender roles and ownership. Table 3 summarizes the changes in typologies during the different conflict periods. The new plot typologies increased the landscape mosaics while including new functions, such as producing cash crops for the urban markets. Additionally, decision making processes and ownership drastically changed from a community based structure to an individual/family ownership. These have consequences on natural resources governance and institutions and, as an outcome, less capacity to deal with community conflicts and a more homogenous landscape than in previous communal lands. Locations where traditional institutions lose their role as the owner of *Esisi*, had more fires, and more savannah like landscapes started to evolve.

The literature review, participatory mapping combined with historical satellite and aerial photography collections resulted in estimates of land use changes linked to the conflict periods (Fig. 5). The forest uses, *Esisi* and *Usengue*, declined rapidly even before the first colonial settlements, and extensive cultivation plots like *Epia*, and fallow plots like *Otchipembe*, were occupying more areas,

Table 3
Evolution of the land uses in Umbundu.

	African tribal and neighbours conflicts (Nano war)	Portuguese occupation conflicts (Bailundo war)	Portuguese colonization and land conflicts	Nationalist and revolutionary conflicts	Post-Independence conflicts	Oligarchy occupation and land conflicts
Period	1800–1874	1874–1911	1911–1930	1930–1975	1975–2002	2002–2010
Activity	Hunting and gathering	Trade and caravans	Extensive agriculture	Intensive agriculture and paid workers	War and subsistence agriculture	Administration, Intensive agriculture
Main crops	Aluko, yam, millet	Tobacco, maize, beans, aluko	Maize, beans	Maize, beans, vegetables, potato	Sweet potato, cassava, millet	Maize, beans, vegetables, potato, sweet potato, cassava, millet
Plots	*Otchiumbo*, *Esisi*	*Otchiumbo*, *Onaka*, *Asisi*	*Otchiumbo*, *Onaka*, *Ombanda*, *Elunda*, *Epia*, *Esisi*, *Otchipembe*	*Otchiumbo*, *Onaka*, *Ombanda*, *Otchitaka*, *Elunda*, *Epia*, *Otchipembe*	*Otchiumbo*, *Onaka*, *Ombanda*, *Otchipembe*, *Esisi*	*Otchiumbo*, *Onaka*, *Otchitaka*, *Ombanda*, *Elunda*, *Epia*, *Esisi*, *Otchipembe*
Ownership	Community	Community	Community and individual	Individual	Individual	Individual

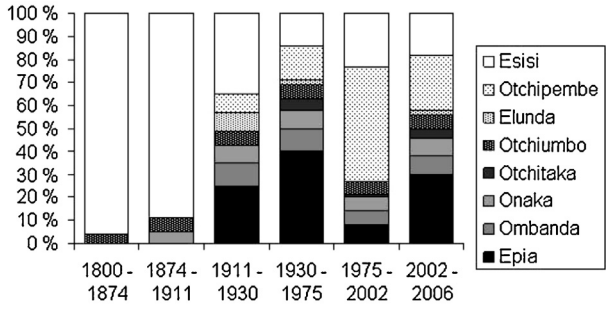

Fig. 5. Estimation of the evolution of the land uses (percentage of land) in the Central Highlands of Angola. 1975–2002: civil war period. 2002–2006: post conflict period. Based on Landsat images combined with bibliography review interpretation, completed by participatory mapping within key informants.

changing the landscape composition. Fallow seems to be a main predictor of conflicts and changes in the landscape. Fallows can occupy a smaller or larger area contributing to the mosaic landscape composition. During the more intense conflict periods after the independence, many areas occupied by *Epia* had an enforced fallow, and the forest plots recuperated in the most inaccessible and insecure zones, with an increase in the landscape monotony.

The evolution of the highlands landscape can be explained regarding its jigsaw composition, conflict intensity, while governance and functionalities framed within the multi-functionality theory presented earlier (Fig. 6). A low level of conflicts may increase landscape heterogeneity, functions and addressing different stakeholders' demands. However, severe conflicts drastically reduce heterogeneity.

Discussion

Information sources

The few research works on traditional land uses in the Angolan Highlands mostly originate from the colonial period, focusing on export-oriented agriculture run by European settlers (Pacheco, 2004). Recent development projects (e.g. CARE, 2004; FAO, 2002, 2003, 2006) have produced some technical reports on the African agriculture systems using descriptive approaches, without considering externalities and conflicts. They maintain the view of this agriculture system as subsistence production only. This lack of interest on the production and externalities of the ULUS makes it difficult to get further understanding on how the system works, and what are its trade-offs and internal dynamics. This is a significant limitation for analysing the land uses in the area. The strength of this study is that it builds upon the scattered information from the former Portuguese research stations and archives as well as private collections, and complements the historical analysis with two years intensive fieldwork in order to reveal essential aspects of the Umbundu system through time.

The long period of instability is reflected in the farmers' reluctance to share data with researchers (Pacheco, 2004). On the other hand, the humanitarian aid during the post-independence conflict emergency period promoted an aid-dependence attitude in many of the rural communities. Furthermore, the responses from rural communities reflect a desire of getting more external support, resulting in the respondents reporting production figures lower than the reality (CARE, 2004). Diversified sources of information both in nature and typology was necessary for obtaining reliable information; for example, the combined use of participatory

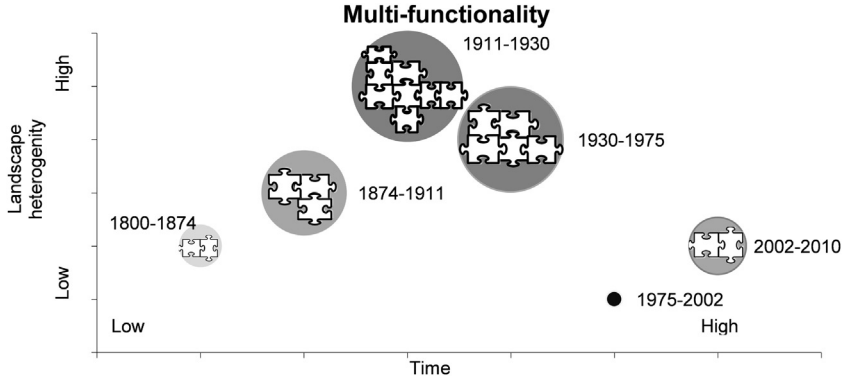

Fig. 6. Landscape evolution in Umbundu Land Use System (ULUS) considering conflict management Multi-functionality theory. Dark tone implies high conflict intensity with size representing number of functions.

mapping and satellite images reduced the bias on land use description. As Fagerström et al. (2003) state, under a post-conflict environment different mechanisms and steps must be combined to acquire a sound appraisal information base. This research shows that participatory methodologies investing in strengthening the relationship between the researchers and the research subjects facilitated more accurate information (e.g. using the local NGO officials to conduct the interviews).

In order to deal with the lack of proper information, the analysis first focused on the characterization of the ULUS system as an initial step to allow later the comparison within the theoretical framework. Some of the considered factors were not necessarily addressing conflicts, but as White et al. (2009) remark, provide valuable insights helping to build a more comprehensive analysis integrating different perspectives. Results showed that factors like perceptions and structure powers were integrated in other more broad factors like institutions.

Characterization of the current Umbundu system landscape

In day-to-day terms the key conditions affecting the system include soil fertility, and water and manure availability. Plots are cultivated at different times of the year depending on their position on the slope. More fertile plots are used for growing cash crops and supply fresh vegetables for sale in the urban areas (Neto, 1999). Natural fertility dictates the duration of the fallow period. The fallow cover can be managed as grassland, bush or forest, depending on the availability of land. The fallow plot offers some products such as charcoal, medicines and fuel, which are important in addressing the needs of most of the community stakeholders (Silva and Morais, 1973; Morais, 1976; Bossard, 1996).

Recent developments in the region are marking the return of the Umbundu system with new possibilities and potential for adaptation to the new conditions (Pacheco, 2004). The peace process is consolidating the return of the main commercialization routes making it possible to re-establish markets as well as creating new ones. Internal migration movements, from rural areas in the Highlands to fast growing coastal urban areas have led to the creation of family based networks between the regions (Katiavala, 2005). The reactivation of the country's economy and especially the enormous cash flow of oil revenues are strengthening the internal consumer market (FAO, 2009). As this study shows ULUS is addressing externalities better than colonial or oligarch farms managed. How these new dynamics and stakeholders are going to affect the ULUS, economically, environmentally and socially, and how the ULUS will address the new challenges remains uncertain.

Concerning the decision making and land tenancy, the individual and family ownership trend is likely to accelerate (FAO, 2009). The Land Law (2004) states that the State is the ultimate land owner but land use concessions may be granted to individuals and enterprises. The Land Law also recognizes the customary tenure systems, including the traditional Umbundu practices (Groppo et al., 2004). Under this perspective, there is a risk of involution if the community lands become a mere cultural reserve at the expense of its production role. Records clearly show the system has a strong adaptive capacity to changing economic and political environment. Therefore, policy makers should facilitate the dynamic evolution of the system. Nevertheless, under a private concession approach, the intrinsic characteristics of the system, such as different plots along the slope, mosaic of land uses and temporal sequences of uses may restrict the economic interests.

A large focus of the Land Law is to minimize property conflicts, differentiating between commercial and traditional land use, creating a more sustainable system based on their compatible functioning. In the past, governmental institutions could prioritize plantation farms to the detriment of land under ULUS. This approach can produce dormant conflicts that can move beyond latency if increasing pressure for scarce fertile lands is not appropriately addressed, for example, land grabbing. Additionally, the increased demand for agricultural products also increases the likelihood of conflict occurring. This is based on the assumption that increased land value within a weak tenure system underpinned by a long period of instability and weak governance, will see increases in, for example, land grabbing and boundary disputes (Deininger and Castagnini, 2006; Patel et al., 2013). This is important considering that this is a conflict-prone environment with a potential for large scale civil strife (André and Platteau, 1998).

Regarding the sustainability of the Umbundu system, some environmental issues were noted already in colonial studies (e.g. Pössinger, 1973; MIAA, 1971), development aid reports (e.g. Pacheco, 2004; Katiavala, 2005; FAO, 2006) and during the fieldwork for this study. The reduced fallow period is impacting fertility, production capacity and self regeneration in different plots. The mineralization and loss of organic matter in the poor *Epia* soils when the fallow is too short, reduces soil fertility and its self-recuperation capacity. When the agrarian system expanded, the most abundant *Epia* plots needed to have a fallow period. Therefore, large areas are going to be under fallow, affecting the whole landscape. This would change the landscape composition and nature, impacting the system and the conflict prone environment. The originally forested *Esisi* fallow was clearly adapting agrarian land uses to natural ecosystems. Improvement of fallow techniques, especially on the *Epia* plots, could minimize the loss of fertility and increasing landscape heterogeneity and functionalities (Muchiri et al., 2002; Keil et al., 2005; Ram et al., 2007).

Findings vs. theoretical framework

Our findings validate the theoretical framework applied to this work; multi-functionality theory helps to explain the ULUS evolution. This research shows that conflict is a key driving force in the Umbundu system in line with multi-functionality theoretical perspectives. Our findings show that the system can deteriorate and simplify under conflict conditions impacting on its sustainability, this deterioration and simplification are also a cause of conflicts (Gritten et al., 2012; Patel et al., 2013). These findings can be integrated under the multifunctional landscapes perspective (Bills and Gross, 2005; Stockdale and Barker, 2009), considering conflicts as a force influencing landscape structure, with economic, environmental and social implications (Gritten et al., 2012). This research contributes to the theoretical discussions on understanding the gradual effects of conflict intensity on multifunctional landscape structure. Increasing conflict-prone environments create conditions for more diverse functions of the landscape to answer the needs of the different actors. When the landscape no longer fulfils all the functions required by the stakeholders and the conflict intensity passes some system-specific limits breaking the previous consensus or power relations, it can lead to a less functional landscape.

As found in other land use conflicts (e.g. Wiggering et al., 2003; Dhiaulhaq et al., 2014) when power balances change and new stakeholders appear, decision making affects the landscape (i.e. ULUS). An example is the land allocation under ULUS, the monofunctional land under colonial settlers in the colonial times, and private companies in more recent times, with ULUS being concentrated in a few less favourable locations. In a parallel situation with rural-urban land use conflicts (Zellner et al., 2009), colonial and post-independence decision makers failed to sufficiently consider the functionality of ULUS, including failing to integrate traditional ULUS governance structures in the decision making.

During Portuguese rule, there was an institutional shifting from traditional governance structures to administrative government,

thereby opening the way for a more nuanced form of social control within the landscape system. Stockdale and Barker (2009) states that landscape interactions on environment and society will require an approach able to accommodate the complex nature of an ever changing socio-ecological system. Therefore, the occurrence of conflicts is unavoidable, though its intensity is determined by numerous issues including the parties' perception of the costs of the conflict itself (Gritten et al., 2012).

The multi-functionality theory highlights the importance of decision making structures, and how changes in the governance affect the whole ULUS, and subsequently is translated into landscape changes (e.g. more mosaic). Small-scale, low intensity conflicts between Portuguese and Umbundu people allowed the consolidation of the Umbundu governance and the integration of traditional and colonial governance institutions. However, when the colonial authorities started to see the area as a source of raw materials and allowed European farmers to settle, the previous institutional consensus broke. It created conditions for more intense conflicts, new power balances and a changing landscape. Changes in the power balance affect the decisions made at national or subnational levels concerning land uses (Wiggering et al., 2003). This inevitably changes the distribution of wealth and political power, usually without respecting consensus (Mann and Jeaneaux, 2009).

The analysis of multi-functional land use types contributes to a better understanding of potential inter-relations, synergetic effects and trade-offs of the different functions (Wiggering et al., 2003). Fallows, fertility management, *Onaka* and *Epia* land uses and institutional strengths are the main ULUS tradeoffs. Fallow deeply affects the landscape. Once a low fertility plot is cultivated, it has to remain under fallow for a certain period to return to its original fertility. Grass fallow functions, including externalities, are limited compared to the other land uses, including cultivation or forests, so it is less effective to address the need of an increasing number of stakeholders. Additionally, grass fallow can be an indicator of the lack of land use governance, lack of access to fertilization or land pressure. The fallow period can be shorter under an improved forested fallow, but lack of ownership, administration and social control increase the risk of fires, decreasing the self-regeneration capacity, and establishing a homogeneous savannah landscape.

Epia is by far the most abundant plot, with limited uses and functions. The decision on *Epia* land uses affects the whole landscape. *Onaka* plot uses are quite varied, but the pressure to be used as the main fresh vegetable and corn supplier during the dry season allocates it mostly to one specific use, making its landscape contribution quite obvious. However, when *Onaka* plots uses are abandoned, it is a clear indicator of high intensity conflict. Multi-functionality considers mutual effects of the different types of land use, as they influence each other (Wiggering et al., 2003). This theory can explain the diversification of the ULUS when more stakeholders were intervening in the region. Mono-functionality is not negative or unnatural principle per se, governance is the key (Patel et al., 2013), just as externalities in multifunctional system can be positive or negative. Socio-economic structures have not always been capable of managing multifunctional landscapes in a sustainable manner (Brandt and Vejre, 2003). However, mono-functionality planning approach induced diseconomies in the form of environmental problems and intensification of conflicts in the ULUS case. Plantations and European farms promoted a mono-functional landscape, with monoculture forest or agricultural plantations. Therefore, the previous consensual approach was destroyed, increasing conflicts with local communities. These reflected the power imbalances that existed at the time.

Multi-functionality theory could be used to predict the future landscape development in the ULUS. The ULUS has been able to adapt to changing conditions, including the impacts of conflicts. First, it transformed from a subsidiary sector of Arabic gum trade to become the main provider of goods to feed the trade system. Subsequently, in the colonial period, it became the main fresh vegetable and cash crop supplier (Morais, 1976). The land use system has developed under varied conflict intensity, increasing its complexity and diversity. Up to a certain level of conflict intensity the system was able to still have diversity in crop and plot types. However, when conflicts intensified, the system shrank and many of the crops and more diverse land uses almost disappeared from most of the areas. Furthermore, a simplification of the land use system can be observed as the conflicts escalated. Under a scenario of new demands on the system and increased number of stakeholders the landscape should increase its diversity and a jigsaw effect will be visible (Wiggering et al., 2003). However, this must be under a governance system that allows the participation of the different stakeholders in the decision making process (Fürst, 2004). New power groups and external actors can potentially change the power relationship limiting the functionalities and creating the conditions for a drastic landscape simplification (McCarthy et al., 2004). According to the theory, conflicts are likely to increase in the future under a context of economic growth and increased demand for more fertile lands. Large grabbing is affecting the Umbundu system, creating management problems for the administration and local governments. Developing the capacities of the local administration regarding natural resource conflict transformation is needed (Fischer et al., 2007). Developing and strengthening land tenure and maintaining the externalities of the traditional land use systems could be an example of transforming conflicts in non-European based land tenure traditions. The inclusion of the traditional governance institutions and representatives of different stakeholders in the Municipal councils has proven as a successful step to address the resolution of many land use conflicts (CARE, 2004; FAO, 2004).

Conclusions

The results provide a characterization of the system's main traits through time, suggesting the cultivation of different plots along a slope catena and a seasonal cultivation distribution with the objective of maintaining a continuous supply of food crops under changing ownership and security disturbances. The Umbundu system has developed under various levels of conflict intensity, and currently has increased its diversity being able to answer various differing needs. Most of the different plot types of the Umbundu system were developed to adapt to an environment under conflict while using the available technology and knowledge, resulting in the present day complexity. This complexity is again threatened by conflict, and future land management policies should include a clear analysis of latent conflicts and adapted technology to enhance the resilience of the system. Understanding that the Umbundu system should be based on family ownership but maintaining its useful externalities to community, would support peaceful and socially sustainable development, decreasing the risk of the conflict escalation. The proposed theoretical framework is able to explain the ULUS landscape evolution. Conflicts seem to be a main system changes driver, while fallows occupied area indicates governance institutions weakness or strength.

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Annex 1. Files and archives sources used for information related to technical issues relevant to the Umbundu system

Title	Author	Year	Type	Main subjects
A agricultura campesina no município do Ukuma.	NGO C.I.C	2004	Project report	Traditional agriculture
Programa de Reabilitação da Comuna da Calenga, Caala.	NGO ADMA	2004	Project report	Development
Programa de Reabilitação Municipal de Bailundo.	NGO ADRA	2004	Project report	Development
Produção de Eucalyptus saligna SM. Estudos das leis de crescimento na zona planáltica central de Angola.	Azevedo, A.M	1962	Technical study	Forestry
Quelques notes sur lálimentation et les apports nutritionnels occultes en Angola.	Bossard, E	1996	Technical study	Traditional agriculture
Avaliação do sistema de gestão de terra e dos recursos naturais, provincial do Bié, Angola.	NGO CARE	2004	Project report	Land management
Kinship and Character of the Ovimbundu	Childs, G.M.	1969		Ethnology
Programa de Expansão Florestal	Enterprise CCUP	1968	Technical study	Forestry
The Ovimbundu under two sovereignties. A study of social control and social change among a people of Angola	Edwards, A.C.	1962	Book	Ethnology
A vida econômica dos bantos do sudoeste de Angola	Esterman, C.	1971	Book	Ethnology
O relevo do Sudoeste de Angola. Estudo de geomorfologia	Feio, M.	1981	Technical study	Geography
As causas do fracasso da colonização agrícola de Angola	Feio, M.	1998	Technical study	Agriculture
Realidades Agrícolas de Angola	Ferrão, J.E.M.	1964	Technical study	Traditional agriculture
Ocupação de terras: Problemas de ontem e hoje	Ferreira, A.F.	2005	Technical study	Land management
Variação da densidade e diferenciação das madeiras de 14 espécies de pinheiros, com oito anos de idade, cultivados em Angola	Fonseca, F.M.A. and Louzada J.L.P.C.	1986	Technical study	Forestry
Cortinas de proteção contra os ventos	Gomes, A.L.	1972	Technical study	Forestry
A promoção primaria na região intertropical, o problema angolano	Guerreiro, M.G.	1972	Technical study	Agriculture
Planalto Central de Angola. A Extensão Rural como instrumento do desenvolvimento	Vitongue, M.	2004	Technical study	Traditional agriculture
Programa de Reabilitação Comunal de Chipipa, Huambo	NGO IED	2004	Project report	Development
Programa de Reabilitação Municipal de Ekunha	NGO IMVF	2004	Project report	Development
O papel das autoridades tradicionais na gestão das terras no Huambo	Katiavala, J.M.	2005	Technical study	Ethnology
Zonagem do milho de sequeiro em Angola. Primeira aproximação	Marcelino, F.A.B.	1963	Technical study	Agriculture
Algumas considerações sobre a agricultura em Angola	Mirrado, J.H.	1989	Technical study	Traditional agriculture
Sistemas de uso da terra agrícola em Angola: estudos de caso nas províncias do Huambo, Lunda Sul e Uige	Pacheco, F.	2005	Technical study	
Introdução Ao Estudo Técnico Econômico da criação de Gado Bovino em Angola	Pereira, J.L.	1962	Technical study	Agriculture
Aptidão dos planaltos de Angola para a cultura do café Arábica	Ponte, A.M.	1956	Technical study	Agriculture
O problema da batata em Angola. Medidas em curso para a sua resolução	Ponte, A.M.	1963	Technical study	Agriculture
A tragédia das queimadas e da erosão no Planalto Central de Angola	Quaresma, H.M.N.	1966	Technical study	Land management
Introdução ao estudo das sociedades e economias tradicionais de Angola	Rendinha, J.	1972	Technical study	Ethnology
Notas sobre a criação de gado bovino em Angola	Silva, J.B.	1960	Technical study	Agriculture
Espécies lenhosas da floresta aberta de Angola	Silva, M.R.M.	1971a	Technical study	Forestry
Radiação no interior de povoamento de Pinus patula com diferentes intensidades de desramaçao	Guerreiro, M.G.	1973	Technical study	Forestry

Sources: AO MF – Files of the Angolan Ministry of Finances, Luanda, Angola. IICT – Overseas Scientific Research Institute, Lisbon, Portugal. FCA – Faculty of Agriculture Science Central Library, Huambo, Angola. ADRA – Rural Development Angolan Association, Huambo, Angola. GoH – Provincial Government of Huambo files, Huambo, Angola. CARE – CARE NGO files, Kuito, Bie, Angola. CFB – Benguela Railway Company files, Huambo, Angola. IIAA – Angolan Agrarian Research Institute, Huambo, Angola.

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