

Biodiversity Conservation through Farming: A Landscape Assessment in KwaZulu-Natal, South Africa

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Abstract

The integration of agriculture and biodiversity has become an acknowledged solution to concurrently address the development of sustainable food production systems and the preservation of natural resources. However, there are few alternative farming systems combining agricultural commodities and ecosystem services. We examined the farm and landscape dynamics of an area in South Africa which has been isolated from mainstream agriculture during a large part of last century. We used a time series of aerial photographs as well as farm surveys and interviews to analyze how historical and present trends can explain land use features. Results show that today's landscape is the result of dramatic socio-economic transforms which have made original transhumant livestock keepers to become sedentary farmers. Although poverty is widespread, we found a well-balanced landscape with a regularly increasing tree cover and a high biodiversity potential. Beyond farm and household size, the main landscape impact factors are herd size and management as well as soil fertility management practices, including fallowing. We show that these conditions represent a good potential towards a multifunctional landscape, provided the relationships between farmers' practices and biodiversity are better formalized and there are tangible benefits for farmers to opt for this approach.

Key-words: agricultural practices, ecoagriculture, homelands, landscape, multifunctionality

INTRODUCTION

Farms do not exist as isolated units but belong to a network formed by relationships within the surrounding landscape. In fact, a modern view of agriculture has it that it is not so much a field-based enterprise as a landscape-based enterprise (Swinton *et al.* 2007) and that its value may best be viewed in a landscape context (Dale and Polasky 2007). Given that agriculture, including rangelands, covers about 40% of the world terrestrial surface (Gordon *et al.* 2010), it is the human activity which affects the greatest proportion of land. Agricultural land uses therefore influence the structure and function of many landscapes and the ecosystems therein.

Recognizing the inter-relationships between agriculture and the surrounding landscape, many authors now agree that satisfying people's livelihoods with agricultural production and protecting biodiversity need not be antagonistic visions (Robson 2007; Scherr and McNeely 2007). The word "ecoagriculture" has been coined to convey this idea (McNeely and Scherr, 2003, 2008). Under this approach, landscapes are seen as places where people and nature meet in order to sustain rural livelihoods. Ecoagriculture intends to contribute to the on-going debate raised by the Millennium Ecosystem Assessment (MEA 2005) that ecosystem services, i.e. the benefits of nature to man, can be provided by man-managed agro-ecosystems, and not only by natural ecosystems. However, for this complementarity between agriculture and biodiversity to exist, it is important to assess the impact on landscape of agricultural practices and also to consider how to integrate biodiversity into farm objectives. Given the long-time segregation between agriculture and nature, this is not straightforward and may require specific studies.

Enhancing biodiversity into farms and agricultural landscapes requires that agro-ecosystems reflect natural vegetation rather than always aiming at simplified monocultures (Ewel, 1999). Although ecological heterogeneity at multiple spatial and temporal scales has been widely praised to sustain biodiversity in agricultural systems (Benton *et al.* 2003; Tscharntke *et al.*, 2005), it is important that some form of integration exists between natural and cultivated components. For example, isolated fragments of natural vegetation surrounded by industrial farms do not lead to efficient biodiversity conservation (Perfecto *et al.*, 2009). Given that a lot of ecological factors sustaining biodiversity occur beyond plot or farm scale, it is also essential that the integration between agriculture and biodiversity is supported by cross-cutting policy

frameworks and management solutions fostering collective action and innovative social dynamics (Garcia et al., 2009).

In order to understand how farming practices shape the surrounding landscape and lead to different patterns of biodiversity conservation, we selected an area in KwaZulu-Natal, South Africa, where farming history, combined with contrasted agro-ecological conditions, have generated a fragmented landscape showing natural vegetation embedded in an agricultural matrix. The area has remained isolated from the rest of the country during a large part of last century (Kloppers, 2004) and happens to be today an informal, yet well balanced, ecoagriculture landscape combining farmed and wildlife areas, both protected and unprotected. We wanted to determine whether the unusual land use system found in this landscape can be used as model for an efficient mainstreaming of biodiversity into agriculture. We also wanted to assess whether these conditions can be stable in the long run while contributing to improving the livelihoods of the people living in the area who are small scale farmers often below the poverty line. To do this, we performed an analysis of farming systems, incorporating landscape dynamics, natural history and human history, in order to make an assessment into the future of both the farming systems and ecosystem services therein. Our main hypothesis has been that farming practices have played an important role in shaping today's landscape and that an analysis of these practices can help towards designing a formal ecoagriculture landscape.

MATERIALS AND METHODS

Study site

The study site is located at the extreme North of the KwaZulu-Natal Province, South Africa (lat 26°48'S to 26°54'S; long 32°00'E to 32°09'E; Figures 1 and 2). It shows an East-West altitudinal gradient (Figure 3) with three successive levels. Annual rainfall ranges from 500 mm in the Eastern lowlands (100 m asl) to 800 mm in the Western highlands (600 m asl). There is a markedly dry spell from June to August while the wettest months are the warm months, from November to March. Dramatic year-to-year rainfall variations are common. Mean annual temperature varies from 22 (lowlands) to 20°C (highlands), with mean maxima and minima around 30 and 10°C respectively. Most soils are shallow lithosols developed on acidic rhyolite bedrock which is little weathered and frequently apparent, giving rise to shallow, stony soils. Basalt is locally present, with corresponding deeper, clayey soils with calcareous nodules in upper layers. Sand is present towards the eastern part of the area. These conditions do not represent a high

agricultural potential, except for the basaltic spots. Soils do not show a good structural stability and mineral supply to plants is not adequate. Soils do not retain water during the rainy season, leading to runoff and erosion on steep, plantless slopes and to severe drought during the dry season. Only deep, level soils show a good agricultural potential. Water capture and erosion control schemes appear to be essential to secure good soil productivity. Soil fertility management through fallowing is only possible with long term fallows and cattle grazing in order to recover the initial low soil fertility.

The area is known as the Mathenjwa Tribal Authority (MTA) and belongs to the savanna biome of South Africa (Mucina and Rutherford 2006), with dominant thorn trees (*Acacia* spp, Mimosoideae) and bushwillows (*Combretum* spp, Combretaceae) in the low and medium altitude lands, becoming more open grasslands towards the ridge plateaus. Closed canopies can be found in a number of remote areas while mixed forests thrive in deep valleys. Poor soils are covered with thickets of xerophytic shrubs such as *Aloe marlothii* (Asphodelaceae) and *Pachypodium saundersii* (Apocynaceae). The area is part of the Maputaland-Pondoland-Albany biodiversity hotspot. It harbours many endemic plants and comprises of one of the most endangered vegetation types in South Africa, classified as vulnerable (conservation target: 24%; actually conserved: 4% to 10% ; Mucina and Rutherford 2006). Farms are scattered in the landscape, with both near-by and distant plots. Virtually all people grow corn, with other crops being irregularly distributed. Livestock is present, mostly grazed in distant lands or freely roaming. The resulting landscape is a beautiful blend of farmed and wild zones on a hilly terrain showing obvious potential for a long-term, balanced environmental management. Population density is about 67 people km⁻², with about 10% of households having more than 10 members. Gender proportions show an average 82 men for 100 women (across all ages). About 48% of households have an annual income of less than US\$ 660 while 10% of the adult population is considered employed, 15% unemployed and 75% not economically active.

The MTA land covers approximately 547 km² out of which 19% is under the provincial nature conservation service (Ezemvelo KwaZulu-Natal Wildlife Service) in the Ndumo Game Reserve and a further 6.4% under the "Usuthu Gorge Community Conservancy Area" (UGCCA), a protected area managed by the local villagers. Another 8.2% are designated to become a "wilderness area" (pending community agreement), bringing the area under conservation to 33.6% and leaving 66.4% for human establishments. Since 2002, the MTA land is part of the Lubombo TransFrontier Conservation Area (Lubombo TFCA), under an agreement signed by the Governments of Mozambique, South Africa and

Swaziland. Southern Africa TFCAs are governed by the Peace Parks Foundation status, defining a TFCA as “An area or component of a large ecological region that straddles the boundaries of two or more countries, encompassing one or more protected areas as well as multiple resource use areas” (www.peaceparks.org). This status gives TFCAs the possibility of including both protected areas and human dwellings, making them innovative situations where the questions of nature conservation can be addressed against the framework of human use of natural resources. As a consequence, part of the MTA is under conservation within the limits of the recently established UGCCA, designed to be managed by the community for the improvement of people’s livelihoods.

About 37,000 people presently live in the area, following the isolation of former generations during the apartheid regime. About two thirds of the households are located in the west, upper zone, less than a third in the lower zone and only a tenth in the middle zone. Higher population in the upper zone is congruent with higher rainfall, a smoother topography and deeper soils. Wealth status appears better here than in the other zones, with bigger, iron-roofed houses, and more schools, clinics and boreholes. The middle zone is the less endowed, showing no secondary schools, clinics or electricity. In this zone, people have to walk long distances to reach water and are more dependent on natural resources from the wild, with more natural vegetation available than in the upper zone. Although it is much drier and with poorer soils, the lower zone is better equipped with infrastructures than the middle zone and located along the main road as well as along the UGCCA access road.

Methods

We used FAO’s (1999) Guidelines for agrarian systems diagnosis as a methodological framework. The agrarian diagnosis involved the following steps: (i) zoning (identification of homogenous agro-ecological zones), (ii) landscape analysis (identification of within-zones units according to ecological and socio-economic characteristics), (iii) agrarian history and dynamics (analysing historical and present trends explaining landscape changes), (iv) farming systems analysis (analysing farmers strategies) and (v) ecosystem services assessment (investigating in-kind benefits obtained from the natural environment by farmers and other stakeholders). We utilized aerial photographs and satellite imagery together with field data and secondary information to perform the zoning and landscape analysis. Data and other observations were obtained from May to July 2009 through formal questionnaires with farmers (n =104) and semi-structured interviews (n=38) as well as interviews with key informants (local leaders,

agronomists, conservation officers, elders) and focus group discussions (n=3). We used local interpreters, carefully trained previously, for translation from *isiZulu* into English and vice versa. Given that our objective was to detect major factors explaining landscape structure at a coarse grain, we did not perform any statistical analysis on quantitative data but rather report qualitative findings in the form of major trends and important facts. All monetary figures are reported in US Dollars (\$), using the approximate exchange rate with the South African Rand (ZAR) of August, 2009 (US\$ 1 = ZAR 7.9).

RESULTS

Some historical facts on the Mathenjwa people

To our knowledge, and with the exception of the work by Kloppers (2004) that we used for some historical milestones, there is no consistent monograph on the history of the Mathenjwa tribe or on its agricultural practices. Our interviews with old people have allowed us to draw a tentative evolution of land development over the last sixty years, as shown on Table 1. The Table depicts how, through a series of historical events, transhumant livestock keepers have eventually become sedentary farmers who sometimes still own cattle. The reasons for these dramatic changes can be traced back to the isolation of the area during the apartheid and has led to modifications in land development practices which, in turn, have led to correlative transformations of the original savannas landscape.

The Mathenjwa people are said to have migrated from Nyasaland (current Malawi) in the 16th century, first reaching Swaziland then Manyiseni in the area where they still live today during the 17th century. Their territory extended up to East Swaziland and South Mozambique and was split by the demarcation of international boundaries. They initially settled on the upland plateaus where they kept cattle and established trading links with Mozambique and the nearby eastern lowlands. Strong links still exist today with Swaziland, with many people in the upper, west zone claiming a Swazi rather than Zulu culture, speaking *isiSwati* rather than *isiZulu* and regularly commuting to Swaziland (no border fence) for trading or shopping. The area has been a trading route for long and several conflicts historically took place for the respective influence of the Zulu, Portuguese and British. The apartheid government allowed the land to being ruled by the Zulus, and because of regular tensions with the KwaZulu homeland government during the Mozambican civil war, even tried to give away the land to Swaziland. The idea never materialized but this shows that the area was not given high consideration except for establishing an army camp during

civil unrest in Mozambique. As a result of these series of historical events, parts of today's inhabitants are also related to the Tembe-Thonga people of Mozambique.

Since the settlement in Manyiseni, 13 chiefs (*Inkosi*) have ruled. The Mathenjwa people fought a war (1970) and lost land to the Mngomezulu tribe (helped by Zulus) under *Inkosi* Mtshelgwane. *Inkosi* Mbekwane (1972-2002) has remained very popular for promoting education and banning the use of fire as a land clearing tool. This latter decision has probably had a major effect on today's landscape. The division of land amongst tribes by the government in the 1960's and the gazetting of some areas for nature conservation (Ndumo Game Reserve) led to several changes in land tenure and to land conflicts still active today and presently looked into by the Land Affairs Department.

Land administration and household characteristics

There are three forms of administration: the Municipal Administration, the Tribal Authority and a Community Trust. At the tribal level, the *Inkosi's* leadership is hereditary and his kingdom is sub-divided into 21 communities each run by a local leader called *Induna*. The 21 *Izindunas* are elected by the people and make up the Tribal Authority (TA) which has a key role in all major decisions. The land tenure system is under customary rules: land belongs to the *Inkozi* who is responsible for land distribution. Land is granted in perpetuity, giving the tenant full control. In addition, the TA land is registered under the Ingonyama Trust which functions as landowner-in-law of some 2.7 million ha of Community land spread throughout the Province of KwaZulu-Natal. The trust's aim is to protect communal lands from evictions and make sure that land development benefits to local people and not only to would-be developers. Although power is vested in the TA, no major development is possible without the approval of the trust and neither can the trust foster development without the approval from the TA.

The MTA belongs to the Jozini Municipality, a small town about 80 km to the South. In the 2009-2010 review of the municipal Integrated Development Plan, it is indicated that the MTA is an area of environmental interest and concern. It is classified as an area of high poverty and as an intervention area showing opportunity for project cluster. However, no specific infrastructure development or other initiative has taken place until now, except a consultant's report on the potential of adventure tourism, with no follow-up so far. Obviously, and as confirmed in informal discussions with local people, this multi-level administrative scheme and its associated, sometimes unwritten rules, make technological and societal

changes cumbersome, if not unlikely. This probably explains the relative uniformity of farming practices observed in the area. It can perhaps be also hypothesized as a causal factor of poverty.

A majority (63%) of households are headed by men, with more than 40% aged 50 years and above. Age of household head could not be obtained in about 25% of the interviews. Forty eight per cent of the respondents never attended school, 30% from grade 1 to grade 7, 14% from grade 8 to grade 12 and only 1% above grade 12 (no answer: 7%). The two major sources of income are government grants and farm sales, followed by external remittances. About 53% of the people mention income from the sale of natural resources: *Marula* beer (brewed from the fruit of *Sclerocarya birea*, Anacardiaceae), fuel wood, thatching grass and handicrafts. A third of the respondents could not tell what their income was, mainly for lack of records, except for the government grant. Out of those who responded, 9% have a monthly income of less than \$ 63 per month, 45% between \$ 63 to 126, 26% between \$ 127 to 189 and 20% above \$ 190.

Recent history as it is narrated by senior people can be confirmed by the analysis of aerial photos of the area, ranging from 1942 to the present. Figure 4 shows a same location in the upper zone in 1942, 1990 and 2010 respectively. A striking feature is the increase of tree cover, virtually absent in 1942 except on steep slopes and deep valleys, while trees are widespread today. The complementary analysis of aerial photos and people interviews thus confirms that tree cover development is no older than 60 years. However, these tree covered areas are not homogeneous neither similarly distributed in the three altitudinal zones. In order to get an idea of the diversity of today's landscapes in the area, we selected a 2.5 x 1.5 km scene for each of the 3 altitudinal zones, along the West-East gradient shown on Figure 3. The comparison of the 3 scenes (Figure 5) shows that a landscape mosaic, resulting from the combination of cropped land, tree cover and wooded savanna, is always present, but in different proportions, indicating that today's strongly heterogeneous mosaic landscape is a consequence of past agricultural development. In order to understand the development of today's landscape, it is thus necessary to analyze the origin and diversity of farming practices.

Relationships between farming systems and landscape structure

Today's farms are characterized, across the 3 zones, by the omnipresence of corn, grown by 99% of the farmers, while other crops rank much lower, except pumpkins (Table 2). Corn is normally intercropped

with pumpkins and water melons while other crops are grown as single crops. The average cultivable land size per household is 2.5 ha, excluding grazing land. Cropland is fenced, with both dead (thorny branches) and live fences. Slash and burn agriculture is still practiced in places. Land opening is done by tree felling and occasionally fire. Oxen are used to prepare land or reclaim fallows, with 44% of the farmers owning oxen and the other borrowing or renting them. Both animal manure and fertilizers are used, the former mainly around homesteads and in vegetable gardens, the latter in corn fields. Crop rotation is practiced between corn and legumes. Scattered trees in cropland and agroforestry homegardens are present but not widespread. Hired labour is sometimes used for weeding. Some farmers have cattle and small stock which graze freely during the dry season and are taken to wooded rangelands during the cropping season. Farming systems in the 3 zones are defined by the presence *versus* absence and different proportions of these common characteristics, explaining why the entire landscape appears as mixed mosaics of land uses.

Table 3 is a typology of farming systems in the area, as found from farm surveys and interviews. We designed the typology so as to show linkages between farming practices and impact on the landscape. In terms of cropping practices, impact on the landscape is a function of soil fertility management. The history of changes in soil fertility management practices shows everywhere in the world the same succession, ranging from early practices requiring large land areas such as long fallows to much localised practices such as today's intensive use of mineral fertilizers. As a consequence, if land management is performed through long fallows, a strong impact on the landscape follows. For instance, 1 ha of crops with a 20-year long fallow requires 20 ha of available land. If long fallows are associated with cattle, impact on the landscape is maximized because additional grazing land (depending on herd size) is required. Fallow duration can be reduced when cattle graze in the fallow land, thus providing additional organic matter to the soil and allowing a quicker soil fertility recovery. This is not the case in Mathenjwa land, where wealthy people do buy mineral fertilizers. The Mathenjwa people have actually not used soil management practices based on the interactions between agriculture and livestock. They have quickly opted for fallowless practices such as crop rotations, intercropping and mineral fertilizers, all allowing continuous cropping.

The 9 farming system types shown in Table 3 thus have a different impact on the landscape (Figure 6). This impact is mainly function of whether or not there are cattle, of whether or not the herd is transhumant

and of its size. It is also a function of land size and of soil fertility management practices. However, data on the relative importance of the farming systems types and their spatial distribution are necessary to quantitatively assess the impact on the landscape. It is also necessary to know whether there are households with low income who rely on provisioning ecosystem services for a living (e.g. wood collection, harvesting natural products, hunting, fishing, stone collection). Finally, farming systems dynamics (i.e. change with time) will allow to detect major trends in landscape development.

Table 4 shows that medium size households (type B) make the majority of farming systems (70%). These households need to complement their income through the gathering of products from the wild. It is finally type B1 which has the strongest landscape impact (Figure 6). As shown on Table 3, the Mathenjwa territory is characterized by the coexistence of slash-and-burn, long bush fallow farming systems and intensive, continuous cropping farming systems with rotations and the use of chemical inputs. Any of these systems may or may not include cattle. This diversity in land development is the result of a differentiation which has occurred over the last sixty years, since former transhumant Mathenjwa herders were forced to become sedentary crop growers. Although the persistence of partly mobile cattle herds recalls the time of nomadic herders and although the persistence of long fallows is a mark of early changes from livestock keeping to crop growing, one can legitimately wonder whether these practices will survive and consequently, whether today's mosaic landscape is here to stay.

DISCUSSION

Agricultural dynamics and present land use

Farming history as it is told by elders (who are both actors and witnesses) shows a progressive intensification. The different stages of the intensification process still co-exist today, from grazing in rangelands and a few cultivated fields to intensive vegetable gardens. The progressive abandonment of grazing in favour of crop growing has led to the development of a dense tree cover. Although there are many cattle, livestock breeding has never been really coupled to soil fertility management in fields. As is well known in all non-mechanized agricultural systems, soil fertility management has relied on fallowing. In the present case, because of the inherent low soil potential of the area, long fallows were especially important. After five to seven years of cropping, the land is fallowed for at least twenty years. It has been shown in a neighbouring area that such duration is sufficient for a tree cover to establish (Gaugris and van Rooyen 2010). Consequently, when fallow land is brought into cultivation for the second time, it is a

wooded land which needs to be cleared again. This explains the widespread use of fire and slash-and-burn mentioned by elders. While such practice was banned in 1975, it still persists locally.

The years 1970's (about 20 years after the apartheid regime began) were a time when many people worked outside the area, especially in mines, in large commercial farms or as house employees. This was an advantage for large families who could send their members to work outside and get extra income in order not to depend solely on agricultural products. These conditions have remained until the years 1990's. Land isolation has thus generated household differentiation, with large families getting easier access to agricultural intensification inputs. When land isolation ceased at the end of the apartheid, people did not rely any more on agriculture only and household differentiation further increased. Some households further invested in agriculture (fertilizers, improved seeds, mechanization, etc.) while other survived with social welfare and long fallow-based minor cropping activities.

It is thus legitimate to ask whether today's landscape mosaics (mainly in the upper and lower zones) bear a potential for future development – including for a better integration between agriculture and biodiversity – or whether they are only a mark of the past. Are these heterogeneous landscapes an adaptive response to changing conditions, or do they just represent a degrading stage of land use? In the former case, good resilience can be expected and the landscape could easily be turned into a formal ecoagriculture landscape. Two contrasted scenarios can be envisaged to describe the future of the area.

Possible future scenarios

In a first scenario, the legacy of unfair past policies keeps influencing land dynamics. Farmers who have been forced to practice a poorly performing and non viable agriculture continue relying exclusively on social welfare and progressively stop farming. Household differentiation increases. Most people leave the area. The landscape progressively becomes entirely tree covered, especially in the upper and middle zones. More conservation areas are developed at the expense of people's land. Only a few healthy farmers remain, mainly in the upper zone (and partly in the lowlands) where they practice intensive farming. Such a scenario may lead to improved biodiversity conservation outside farmed areas, but certainly not to a sustainable land use system where natural resource management and farming are integrated in support to enhanced livelihoods.

In a contrasted scenario, collective land management is strengthened. A “landscape label” (or certification: Ghazoul et al 2008; Cholet, 2010) can be developed. It conveys the idea that today’s landscape mosaic can potentially be managed by the inhabitants and for their benefit through a value-adding process to products and services linked to documented landscape characteristics. Long fallows which protect shallow and fragile soils through their dense tree cover are improved through agroforestry, enrichment planting or selective management to generate additional income. Existing cropping areas are sustainably intensified so as not to require additional land clearing. This is the “ecoagriculture” option, a model which can potentially be adopted by nearly all farmers, especially medium-size households, the most numerous, which are headed by young people and have a potentially strong impact on the landscape.

Which conditions for an ecoagriculture option?

The Mathenjwa landscape as it is today is an informal ecoagriculture landscape as defined by Scherr and McNeely (2008). Its components provide for a mosaic of different land uses and the possibility of solid combinations between agricultural production and biodiversity conservation objectives. The fact that it is adjacent to protected areas (UGCCA and Ndumo Game Reserve), and actually part of the Lubombo TFCA, adds value to this statement. At a wider scale, the relevant landscape mosaic should include these protected areas as well as areas under special status because of the transfrontier conservation initiative.

The absence of extension services so far has probably played an important role in maintaining the landscape in its current form. Farmers tend to copy existing practices. This does not mean that extension is not desirable, but it should be targeting the right ecoagriculture practices, not any agricultural intensification. Experience has shown that extension for innovative practices (e.g. agroforestry) requires skilled extension officers (Chitakira and Torquebiau 2010). Local organisations such as NGOs and other agencies may greatly help in making the landscape keep (or change towards better) conservation of natural resources together with food production.

While there may be some local awareness about conservation, there must also be tangible benefits for conservation concepts to gain popularity among local people. On-going studies in the area (Chitakira and Torquebiau, in press) reveal that people’s perception of the fencing off of the UGCCA is not always positive. Nevertheless, when people are asked about the use of natural resources, including water (i.e.

provisioning and supporting services, according to MEA, 2005), a long list of resources and uses appears, ranging from wood to honey, fish, thatching grass and water points (Cholet, 2010). If local dwellers are held responsible for the maintenance of ecosystem services and the scenic beauty of the landscape, they should be rewarded for this. The payment for, or retribution of, ecosystem services and the effect this may have on poverty alleviation in developing countries is the object of a heated debate in recent literature (e.g. Leimona et al. 2009). Some initiatives nevertheless show that it is possible to develop procedures where people who maintain ecosystems or landscapes, make money or receive in-kind benefits (Wunder 2007 ; Swallow et al. 2009).

The bio-physical environment of the Mathenjwa area is also a clear opportunity to build on. The scenic, rolling landscape with hills, forested valleys, gorges, streams, caves and cliffs is in itself an asset, for viewing and adventure tourism and eco-tourism, but also for sport activities (e.g. hiking, mountain biking, abseiling, all popular among South Africa wealthy city dwellers) and the associated development of local skills. A case can also be made for the development of a different kind of tourism targeting the middle class people, who make huge numbers in South African towns among formerly disadvantaged people. Some of these people still have recent rural roots and may be interested by a tourism centred on agricultural traditions and scenic beauty rather than on conventional wildlife viewing. However, this sort of tourism has virtually to be entirely invented from scratch.

Local leadership of the king is highly respected. Together with a strong tradition of communal work, this makes information transfer and community mobilisation for training or implementation of innovations probably easy. Any implemented change should be based on existing practices and not trying to impose top-down innovations onto farmers. For instance, the existence of multi-purpose trees in the land and of fruit trees in homegardens leads towards a progressive move towards a greater role for agroforestry. The presence of contour farming or grass strips practices for land conservation is an existing step towards a greener agriculture. Fallow improvement, including through agroforestry, is a small change over an existing practice which can lead to major improvement in land productivity (Kwesiga *et al.* 2003). The presence of many fodder trees regularly browsed by cattle and small ruminants in wild areas represents a vast potential for improvement which is almost unexplored.

Several options thus seem to exist in order to strengthen the ecoagriculture value of the Mathenjwa landscape and lead to the long term improvement of people's livelihoods. However, for this to happen, the links between farmers' practices and landscape structure and function have to be understood and formalized into actual landscape-level management processes involving farmers and other stakeholders (Garcia et al., 2009). Multifunctional landscape mosaics as they are advocated by the ecoagriculture approach provide a framework for these processes and have so far not been implemented in this part of the world.

CONCLUSION

Although the MTA area is a poor, small-scale farming area, it harbours a high potential for biodiversity conservation, contrarily to common belief in South Africa that such communal farming areas are highly degraded because of non-sustainable farming practices and overgrazing (O'Connor & Kuyler, 2007). The area emerges as a remarkable landscape when compared with the general open-field landscape associated with intensive farming practices as they exist elsewhere in South Africa. It thus appears of interest for the further development of communities living in former homelands to rely on these landscape mosaics for their livelihoods rather than transforming their land into large scale monocultures. This can be achieved provided collective decisions are taken that lead to a formal ecoagriculture landscape. Key stakeholders potentially contributing to such decisions have to be identified and consulted, in order to establish a strong social process through which formal ecoagriculture innovations could take place. Under such a scheme, poor people would be able to make a good living out of their own land, combining some agricultural activities with other activities linked to the ecosystem services value of the landscape such as ecotourism, resource conservation (e.g. plants, animals, water, carbon) and interaction with neighbouring protected areas.

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Legends of Tables and Figures

Table 1. Major milestone events of the Mathenjwa land history

Table 2. Major seasonal crops

Table 3. Farming system characteristics and corresponding landscape impact

Table 4. Supplementary farming system characteristics

Figure 1. Map of South Africa and its provinces showing KwaZulu-Natal, Maputaland and the Mathenjwa Traditional Authority

Figure 2. Map of Mathenjwa Traditional Authority showing the limits of the study area and UGCCA boundary

Figure 3. West-East transect of the study area. Rectangles on profile correspond to satellite images extracts shown on Figure 5.

Figure 4. Aerial photographs 1942, 1990, 2010, upper zone.

Figure 5. Land use mosaics in the upper, middle and lower zones, 2010.

Figure 6. Impact of farming systems on landscape

Table 1

Context Time	Environment	Political context	Agriculture	Landscape impact	Mathenjwa People
Before 1950		1951 Bantou Authority Act	Not widespread : sorghum fields near houses	Open savanna landscape in the 3 zones	Mainly Nguni cattle keepers
Years 1950	Locusts	Start of the apartheid (1948) Creation of Ndumo Game Reserve. Ingwavuma Authority Act.	Farm plots appear. Animal ploughing, contour lines, stone removal. Long fallows.	Differentiated agricultural development in the 3 zones. Upper zone : stone lines on contours and narrow fields	Starving. Increase of cropped area. People forcefully removed from Ndumo Game Reserve.
Years 1960	1964-65 : Drought, earthquake. 1967 : Floods	Government food aid program (yellow corn)	Sorghum progressively substituted by corn. Line sowing of corn.	Wooded savannas with cultivated plots, mainly in upper and lower zones.	Outmigration for employment in mines
Years 1970		Civil war in Mozambique and immigration	King Mbekwane bans slash and burn (negatively affects cattle because of increased difficulties in grazing land management)	Increase of tree-covered areas. Some land is reserved for grazing.	
Years 1980	1982-1983 : Drought 1984 : Floods and cyclone.		Introduction of Brahman cattle and crossbreeding with Nguni cattle Vegetable gardening starts	Fruit and vegetable gardens developed along rivers.	
Years 1990	<i>Lantana camara</i> (invasive plant) appears in the middle zone. 1996 : drought	1994: End of the apartheid regime. Beginning of social welfare grants.	Creation of a Community garden at Makwanga.	Increase of tree cover, mainly in the middle zone.	Cotton Project (KFCCP) and settlements in the lower zone.
Years 2000		Creation of the Lubombo TFCA (2002) and of the UGCCA (2006). Fencing off of UGCCA (2007). Dropping of fence between UGCCA and Ndumo Game Reserve (2011?)	More Community gardens (Mabona et Magwanga)	Upper zone : Mosaic. Middle zone : Matrix of woodland, fallows, wooded savannas. Lower zone : Mosaic of wooded savannas and cultivated fields. Increase of protected areas	End of cotton project.

Table 2

Crop	Percentage of respondents growing the crop*
Corn (<i>Zea mays</i>)	99
Pumpkins (<i>Cucurbita maxima</i>)	68
Vegetables (varied species)	55
Peanuts (<i>Arachis hypogea</i>)	47
Watermelon (<i>Citrullus lanatus</i>)	29
Beans (<i>Phaseolus vulgaris</i>)	22
Cassava (<i>Manihot esculenta</i>)	16
Sugarcane (<i>Saccharum officinarum</i>)	10
Bananas (<i>Musa acuminata</i>)	8

*Total adds to more than 100 because most farmers grow several crops

Table 3

	Farming system	Fertility management	Landscape impact (ha under use – min. / max.)
A – Large families	<p>Crops : 5 to 10 ha</p> <p>Animals : Cattle, poultry</p> <p><i>Cattle utilised as drought force</i></p>	<pre> graph TD A[No fertilizers => long fallow 20 to 30 years] --> B[Transhumant herds] A --> C[Sedentary herds] D[Fertilizers =>] --> E[Short fallow 5 to 8 years] D --> F[Continuous cropping] </pre>	<p>A1 100 / 300 + > 100 ha range land</p> <p>A2 100 / 300</p> <p>A3 25 / 80</p> <p>A4 5 / 10</p>
B – Medium size families	<p>Crops : < 5 ha (average = 2,5 ha)</p> <p>Animals : goats, pigs, poultry, no cattle,</p> <p><i>Cattle rented for land cultivation</i></p>	<pre> graph TD G[No fertilizers=> long fallow (20 to 30 years)] H[Fertilizers =>] --> I[Short fallow 5 to 8 years] H --> J[Continuous cropping] </pre>	<p>B1 50 / 150 + impact on range lands of goats and pigs</p> <p>B2 7.5 / 40</p> <p>B3 2.5 / 5</p>
C – Small families	<p>Crops : < 1ha (average : 0,5 ha)</p> <p>Animals : Goats, pigs, poultry, no cattle</p> <p><i>Manual ploughing</i></p>	<pre> graph TD K[Gardening] --> L[Long fallow 20 to 30 years] K --> M[No fallow] </pre>	<p>C1 10 / 30</p> <p>C2 0.5 / 1</p>

Table 4

	Location	% of total number of farms	Social welfare	Other activities		Natural resource impact
				Off-farm income	Collection of wild products	
Large families (> 10 people) A1, A2, A3, A4	Lower Zone	25%	Important	Yes	No	Low
Medium size families (from 4 to 9 people) B1, B2, B3	Upper and Middle Zones	70 %	Medium	Yes	Yes	Important
Small families (from 1 to 3 people) C1, C2	Upper and Lower Zones	5 %	Important	Yes	Yes	Medium

Figure 1



Figure 2

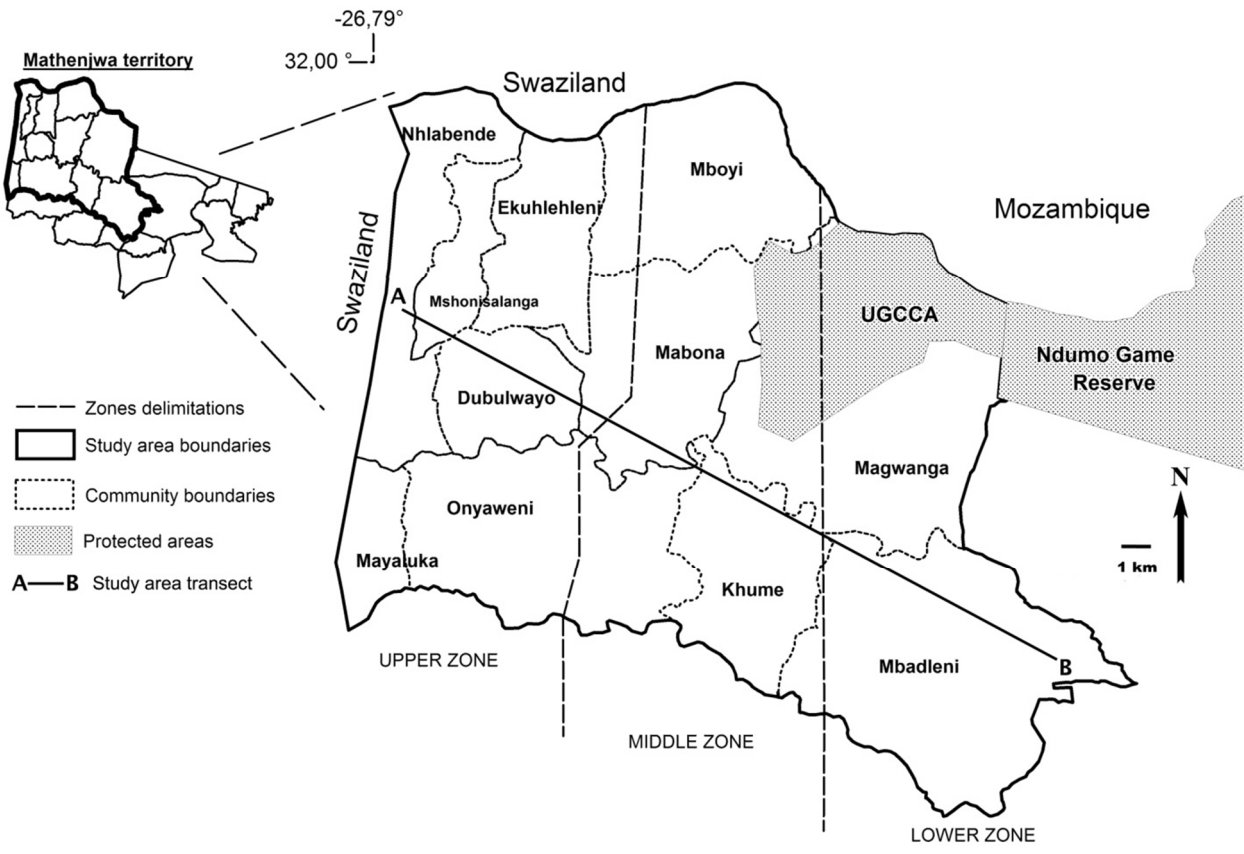


Figure 3

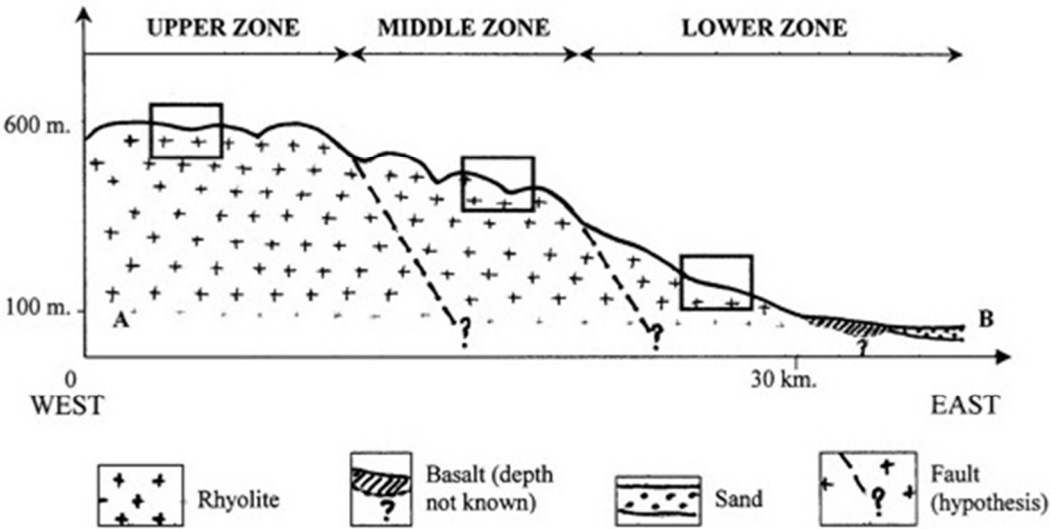
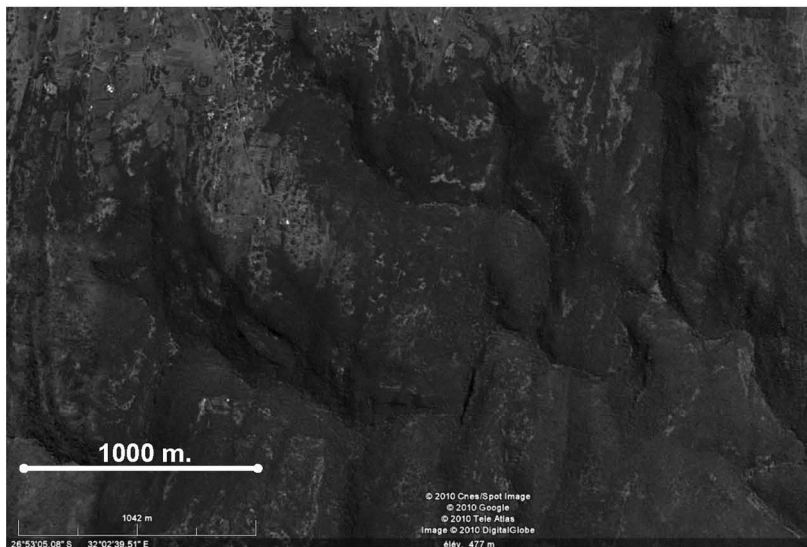


Figure 4

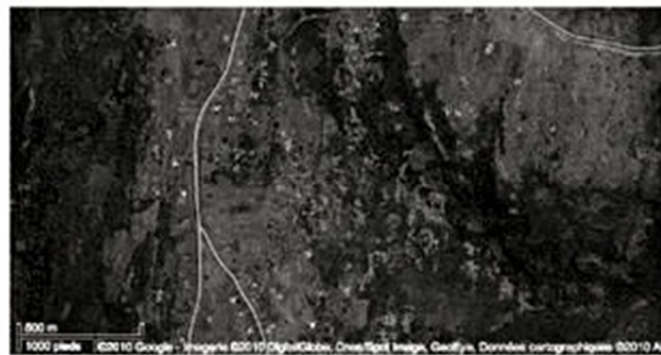


1942 (upper left): Wooded savanna on plateau and densely wooded deep valleys. Fields only on plateau and upper part of slopes. Cultivated fields mainly around scarce, scattered dwellings. Main land uses are grazing land for cattle and bushland / fallows of varied ages and tree cover. Fields and tree-covered areas not important.

1990 (upper right): More dwellings on plateau. Adjoining cultivated fields have appeared on plateau. Wooded areas have increased upwards from valleys. Former grazing areas are encroached upon by trees and shrubs. This encroachment marks a decrease of cattle grazing, while the clear demarcation of cultivated fields marks a lower importance of long fallows which are replaced by crops relying on purchased inputs with short or no fallows.

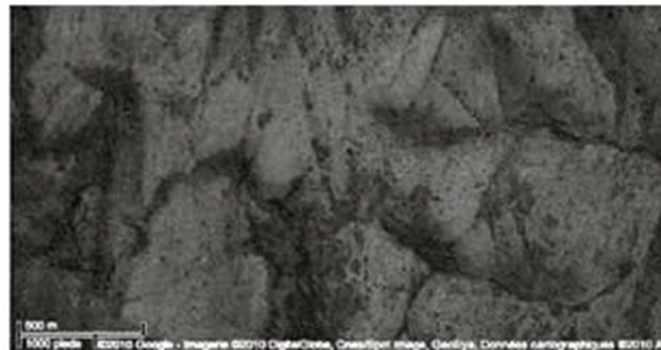
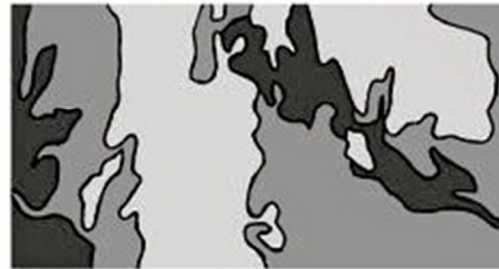
2010 (bottom left): Dwellings yet more numerous. However, areas with cultivated fields look similar to 1990 conditions, showing that not all farmers were able to purchase mineral fertilizers. Some of those who could not afford to buy inputs have moved to other activities with an increase in bushland and tree cover as a consequence. Some have remained and still rely on long fallows. As a result of this dual land use dynamics, tree cover has markedly increased in the landscape between 1990 and 2010.

Figure 5

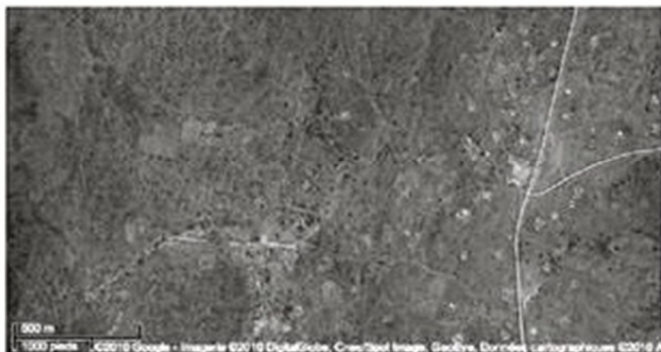


500 m

UPPER ZONE : More or less wooded areas and large areas of adjoining fields ; scattered dwellings.




MIDDLE ZONE : Savanna and wooded bushland ; forests and woodland in valleys, progressing upwards ; very few dwellings and fields.





LOWER ZONE : Mosaic of cultivated fields and shrubland ; few wooded areas ; scattered dwellings, mainly along roads.



LEGEND :

 Fields : mostly annual crops (cereals) and recent, herbaceous fallows.

 Mosaic of cereal fields, short herbaceous fallows and long woody fallows.

 Savana and fallow land, alternatively herbaceous, or shrubby, sometimes tree-covered.


 Densely wooded areas and valley bottom forests.

Figure 6

