INTRODUCTION

Land-cover change in the rangelands can be manifested in different ways, including bush encroachment, increased bare ground, reduced herbaceous biomass, changes in species diversity, and more profoundly, reduced crop productivity in cultivated areas. Ruma National Park, in Lambwe valley, is a high potential rangeland, surrounded by a multi-ethnic community of cultivators all round. Ecological stress is commonly manifested by progressive growth of bush cover, which is a common cause of herbaceous vegetation loss in dry savannahs, and is responsible for a decline in range condition (Oba, 2000). Bush cover becomes a problem when it exceeds 30% and induces a decline in range condition, and is symptomatic of rangelands where the production systems are under environmental stress. In East Africa, an increase in bush cover by 10% reduces grazing by 7%, and grazing is eliminated completely by 90% bush cover (Van Wijngaarden, 1985).

The Lambwe Valley, a settlement scheme, is one of the earliest foci for human sleeping sickness in East Africa, and widespread animal trypanosomosis, both spread by tsetse. This was a deterrent to human occupation despite the suitability of the land for most agricultural practices. In order to encourage settlement, concerted efforts by foreign donors and the Kenya government have seen a significant reduction in both human and animal trypanosomosis. Due to the proximity within which people have settled to the park and the abundance of wildlife, bush encroachment is seen as a potential threat not only to the mainly grazer wildlife, but also to agricultural development in the area, due to the challenge posed to livestock by the disease. Experiments to control tsetse by trapping and selective bush clearing began in 1935 (Welde, 1989a). During the late sixties and early seventies, tsetse control was aimed at isolation of the tsetse-infested thickets within the park. Consequently, bush clearing, aerial spraying, ground spraying, traps and targets, have all been applied principally in the Park, with different aims and levels of success (Davies, 1993).

Despite the enormous scientific attention in this park owing to tsetse and its control, there has been no examination of trends in land cover, which are a main determinant of tsetse habitat, and are crucial in the sustenance of the wildlife, the preferred tsetse host, and in the case of the Ruma park, are important to the survival of the roan antelope, the only herd in East and Central Africa. This study was therefore designed to examine the trends in land-cover change in the Park, and to assess the perception of the local inhabitants of the valley on the park and therefore explore potential conflict areas crucial to its survival.

STUDY AREA

The Ruma National Park is situated in the Lambwe valley, south-western Kenya, located in present day Suba district, about 72 km south of the equator, and lying within latitudes 34° 10’ and 34° 20’ East and longitudes 0° 30’ and 0° 50’ South (Allsopp, 1972; Welde, 1989a; Kenya, 1994). It has a total land area of 120 km² in the valley bottom and has a variety of wildlife, and is the only park in East and Central Africa that is home to the roan antelope (Hippotagrus equinus). The Lambwe Valley is classified as sub-humid to semi-arid and having a medium agricultural potential (Jaetzold, 1983). The Park is basically a wooded grassland which supports a wide range of flora and fauna. The most prominent tree species are Acacia senegal, Acacia drepanolobium and Balanites aegyptica. Common grasses include Hyparrhenia filipendula, Themeda triandra and various species of Setaria.

Since the first appearance of sleeping sickness in the valley in 1901 (Welde, 1989a), numerous epidemics have plagued the residents of the valley, with the park acting as the prime habitat for tsetse. At the same time, efforts to control both bush and tsetse have reduced with
dwindling budgets, while human population in
the surrounding areas has burgeoned.

METHODS

Aerial photography has long been used for
the survey of soils, vegetation, grazing value and
land use (Hunting, 1997). For monitoring landscape
changes prior to the launch of Landsat 1 in 1972,
aerial photography is normally the only form of
remotely sensed information available for moni-
toring. Aerial photo interpretation was therefore
the most appropriate in this study as it spanned
over 50 years. Repeat photography is the single
best means for recording landscape features
(Turner et al., 1998). Owens (1985) supports this
view by contending that in the semi-arid range-
lands, where sampling requires a substantial
amount of resources, aerial photographs of the
same area at different times provide valuable
information not easily available by other means.
By repeating the analysis on photos acquired at
intervals of several years, one can monitor and
show changes in land cover over a specified
period of time. Aerial film is usually obtained in
35mm, 70mm, and 9-inch film formats. Clegg and
Schertz (1975) found that for mapping patterns of
vegetation and land cover, soils or water pollution,
the 9 inch cameras often exceed the accuracy and
cost requirements for a typical land cover project.

In the technique employed here, common
basic characteristics such as shape, sizes,
patterns, tone, texture, shadows, site and associa-
tion were used to classify land use into any of
eight pre-determined land use classes. The pro-
cess was greatly aided by stereoscopic viewing
and the use of a key describing characteristic
features of each land use. Where distinct land-
marks were evident, these were used to aid in the
ground truthing exercise. Because there is approx-
imately 66% overlap between consecutive frames
on each flight line and 33% overlap between
adjacent flight lines, there is no need to examine
all aerial photographs. Given that each print is 9”
x 9”, the "unique" central part of every second
frame is contained within a 6” x 6” portion, with a
redundant peripheral 1.5” margin on all sides. This
is the area that was examined and classified.

This method is based on a technique of land
use pattern analysis described by Brunt (1967),
The "unique" central area of every frame was
sampled by means of a transparent overlay with
a 6 x 6 array of 36 sampling points, tallies compiled
and percentage covers plotted.

A socio-economic survey complemented
photo interpretation, and filled the gap in land
use history, which is not readily available for most
places, and remains the weakest link in nearly all
studies of historic vegetation change in Africa
as well as other places in the world (Bahre, 1991).
It highlighted the local people’s perceptions of
land cover change, the role of tsetse in the park,
and areas of conflicts with wildlife in the park.

RESULTS AND DISCUSSION

Land-cover Change

A total of thirty six (36) photos were interpreted
(Table 1). Mean scores of tallies under each
category of land use was recorded and converted
to percentages as shown in table 2.

Of the eight pre-determined land-cover
classes, Riverine forests, open woodlands, and
grasslands decreased, while dense woodlands,
shrublands, roads and tracks and bare ground
increased. Cultivation ceased altogether from the
park.

Woodlands increased by about 3% absolute,
increasing at .22% relative annual growth rate over
the study period. Shrublands increased by over
10% (absolute), at an annual relative rate of .89%,
and tracks by just over 3% (absolute). Local
residents accede to the merging of distinct

<table>
<thead>
<tr>
<th>Year of photography</th>
<th>No. of photos</th>
<th>Photo scale</th>
<th>Month of photography</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948</td>
<td>12</td>
<td>1:31000</td>
<td>Feb</td>
<td>RAF (UK)*</td>
</tr>
<tr>
<td>1961</td>
<td>5</td>
<td>1:50000</td>
<td>Jan</td>
<td>SK**</td>
</tr>
<tr>
<td>1979</td>
<td>4</td>
<td>1:50000</td>
<td>Aug</td>
<td>SK</td>
</tr>
<tr>
<td>1993</td>
<td>15</td>
<td>1:20000</td>
<td>Mar</td>
<td>PHOTOMAP(K)</td>
</tr>
</tbody>
</table>

*RAF = Royal Air Force, United Kingdom
**SK = Survey of Kenya
thickets (Otuok, Masangla, Nyaboro and Riamakanga) in the park over the years to a continuous mass of impenetrable shrublands. Bush encroachment, an important biophysical indicator (Sserunkuuma, 1998), is clearly evidenced in the park. These increases have been coupled by a converse decrease in various other categories, which have therefore recorded a downward trend in percent cover over the years. Those with a downward trend include grasslands, Riverine forests, open woodlands and complete elimination of cultivation from the park.

Between 1948 and 1961, there was a marked increase in cultivation in present-day Ruma National Park. This was because the park had not been demarcated. The Olambwe River cuts across the middle of the park, and the valley floor is the recipient of fertile runoff from all the surrounding hills, and therefore initially had attracted more settlers than any other part of the valley. This has since ceased, with fencing virtually excluding the community from entering the park. The most profound change in vegetation is that of shrublands and dense woodlands, and the decrease in grasslands. A closer investigation of the vegetation communities revealed about four distinct vegetation communities in the park. These include; bushed grasslands, with two subtypes namely Acacia - Loudetia bushed grasslands and Hyparrhenia - Balanites bushed grasslands, impenetrable thickets and open Loudetia grasslands. The majority of the shrubs are fire-resistant types, and grasses that proliferate with burning. These include Rhus natalensis, Harrissonia, Ramnus staddo, Scurrtia myrtina, Cissus rotundifolia, Euclea divinorum, Sanseveria spp., Acacia brevispica, Grewia bicolor, Carrissa edulis, Jusminum spp., and Phylanthus sepiaris among others. Besides being fire-resistant they are of low browse value to the majority of wildlife currently in the park. Fire resistant legumes such as Rhynchosia usambarensis are also found interspersed with the tall Hyparrhenia filipendula H. dissoluta,
Sorghum sudanense, S. halopensis and sedges such as Cyperus rigidifolia.

According to the Kenya Wildlife Service (KWS), Ruma National Park was established with the objective of conserving this "fire-induced" grassland community, and to protect the threatened population of roan antelope (KWS, 1990b). The current vegetation composition therefore, has negative implications in terms of bush control, as fire alone would perhaps only serve to increase the bush vigour, and therefore would require a combination of other methods such as mechanical and biological (e.g. browsers).

**Tourism and Wildlife**

It is reported that in 1931, there was an estimated 500 elephants in the Lambwe valley (Wellde, 1989b). The large elephant population apparently interfered with development in the area and was perceived dangerous to the growing human population. In 1948, the elephants were driven out, into the Transmara area. Populations of lions (*Panthera leo*), Cheetahs (*Eflis ocreatus*) and Rhinocerus (*Dicerorhinus b. cornis*) were present in the valley as recently as 1936, but have since moved from the area (Muthuri, 1993; Wellde, 1989). In 1966, while plans were underway to develop the southern area of the Lambwe Valley for agricultural purposes were in progress, it was proposed that the area is preserved in its natural state as a game reserve, and the Lambwe Valley Game Reserve was created. The status of the Game reserve was upgraded in 1975 to The Lambwe National Park. However, it was returned to Game Reserve status in 1976 (Kenya, 1984). The Game reserve was once again upgraded to National Park status and the name changed to Ruma National Park in 1983. This declining trend has put the roan antelope in the endangered species category.

The potential of such could also be damaging to tourism by way of negative publicity, stagnation in agricultural growth, and losses due to the human disease should it occur. In 1972, Allsopp (1972) reported that the proximity of human populations to communities of large animals and the existence of tsetse and infective trypano-
somes creates suitable conditions for the transmission of zoonotic diseases such as trypanosomosis.

**Tsetse and Human Settlement in the Proximity of Ruma National Park**

Livestock production plays an important role as subsistence, for draught power and as an income earner in the Lambwe valley. This is usually small scale, and almost every household in the valley keeps one form or other of livestock (Wellde, 1989d; Opiyo, 1995; Olubai, 1998). The importance attached to livestock in the valley is exemplified by the existence of up to 54 non governmental organisations (NGOs) in Homa Bay and Suba Districts involved in livestock related development projects (Kenya, 1997). Notwithstanding, the livestock sector especially in the Lambwe valley has registered very slow growth in as far as animal health and production are concerned. In the social survey, livestock diseases were ranked first among constraints to the sector development, with trypanosomosis, transmitted by tsetse, being first, followed by tick-borne diseases. All of the respondents (n=34) had witnessed some form of tsetse control in the valley. The main benefits of control were listed as increased livestock numbers, healthier bulls for cultivation, and more milk and meat among others as shown in Table 3.

The majority of farms are cultivated using animal draught power, and any improvement in the livestock sector therefore has implications on agricultural development. This study exemplified trypanosomosis as a major constraint of the development of the livestock industry in the larger valley. Due to its association with tsetse, the Ruma park has had a role to play in the stagnation or slow growth of this sector, and for harmonious co-existence, it is imperative that tsetse control, through modification of their habitat, be taken seriously. Bush control should therefore be a priority. Since the turn of the last century, tsetse and trypanosomosis were recognised as a major impediment not only to the settlement of people in the Lambwe valley but also to the survival of their livestock.

About half (51.5%) of the settled community were against the maintenance of the park in its present status (conservation), while the rest (48.5%) were for its maintenance. The former cited crop destruction by wildlife (91%), tsetse maintenance (56%), scarcity for land to cultivate (24%), and lack of tangible benefits from its existence. It was further reported that numerous benefits were foregone by restricting entry into the park. They included game meat (56%), medicines and herbs (44%), and firewood and grazing (35%). Crop destruction by wild pigs (91%), land hunger for settlement and cultivation (23%), and a source of tsetse (56%) were aggravating influences for residents' negative attitude. Some tangible direct benefit to the park neighbours was the improvement of infrastructure as a result of the park proximity, two wells and a school built by the KWS.

There exists potential for conflicts in resource use in this valley between the settled community and the wildlife conservation body, the Kenya Wildlife Service. This was re-emphasised in a community timeline in the social survey, where it was reported that in 1982, around the Magunga area of the valley, the Kisii community were evicted from the hills where the majority preferred to settle. Many settled at the valley bottom and several returned to the neighbouring Kisii district. Owing to rapid human population growth, the preservation of a large tract of land for conservation purposes, and the multi-ethnicity of the inhabitants who are mainly settlers, conflicts seem inevitable. People are many, resources scarce, and communities are not naturally cohesive due to their diverse origins.

A survey carried out with employees of the KWS residing in Ruma (n=18) revealed that major changes had occurred in the Park over the past 10 years. The changes listed include increased acacia growth, and merging of thickets in the park. These changes were attributed to reduced wood harvesting by the locals, browser numbers, and

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>More livestock</td>
<td>26</td>
<td>76</td>
</tr>
<tr>
<td>Healthier bulls</td>
<td>21</td>
<td>62</td>
</tr>
<tr>
<td>Reduced mortality</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>No abortions</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>More milk and meat</td>
<td>18</td>
<td>53</td>
</tr>
<tr>
<td>Can keep donkeys</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Better life</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Better breeds</td>
<td>8</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 3: Benefits of tsetse control
fire frequency. On the potential and actual presence of conflicts in the valley, various incidences have been reported, differences are mainly related to the use of natural resources including grazing rights, destruction of crops by wildlife, access to water, fence destruction, poaching and illegal grazing. Positive publicity has boosted tourism in the park.

CONCLUSIONS

This study identified various factors contributing to the trends in land cover change in Ruma National Park. First, reduction in the incidence of fires, both wild (by poachers), and through prescribed burning. This was confirmed by the KWS that vegetation burning has declined over the years. Furthermore, the settled community, initially used to refer to the park as "Otemu", meaning "the burnt place", ascertained the decrease. It is likely that the absence or reduction in fires in the park has contributed to the trend towards increased bush and shrublands in the park.

Secondly, there has been no appreciable increase in the population of browsers, as compared to the number of grazers, the predominant browser being the Rothschild giraffe. This has encouraged the proliferation of thickets. Thirdly, restricted park entrance by local inhabitants. The social survey carried out with farmers indicates that previously, various benefits derived from the park included firewood, construction posts, water and grazing among others. These have now all been curtailed by the erection of the game fence and strict enforcement on poaching and illegal access. The complete exclusion of the communities from harvesting certain components of the vegetation has been a contributing factor to increased bush growth.

Finally, with the exclusion of settlement in the park, bushy vegetation is the first coloniser of abandoned farmlands, which then merged with pre-existing ones.

The implications of this land-cover trend in Ruma Park can be summarised as, the potential for tsetse re-invasion, deterioration of habitat for grazing wildlife, the potential for damaging tourism, and conflicts in land use. Zimyana (1995) found that in South Africa, conflicts in land use intensified, as rural poverty and dependency on land increased, and were worsened by economic stagnation and rural population growth. A comparable situation is observed in this valley, where the majority of inhabitants are farmers whose livelihoods are directly related to the use of resources from the land. Even though the park was established before the onset of population pressure in this valley, its central location in the midst of a rapidly growing population does not lessen but rather, aggravate the situation.

Given the importance of wildlife and tourism to the Kenyan economy, the problem of tsetse and trypanosomosis control within the park and in the immediate environs should be given priority if conflicts are to be minimised. Jordan (1992) sees the removal of tsetse flies in the periphery of game reserves as essential to the protection of the domestic livestock therein. Control interventions carried out to protect well-established farming systems from trypanosomosis risk are therefore seen to be beneficial, and positively contributing to agricultural intensification.

ACKNOWLEDGEMENTS

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KEY WORDS Land-cover. Tsetse. Aerial Photography. Ruma National Park

ABSTRACT Human population pressure and accompanying intensification of cultivation has exacerbated natural resource overuse in sub-Saharan Africa. This is evident in the Lambwe Valley of southwestern Kenya, where intensified cultivation could be a threat to natural resource conservation in Ruma National Park. Land-cover change in the park towards bush encroachment separates wildlife herds leading to reduced growth of these herds. It also favours the persistence of tsetse, Glossina pallidipes, which have been a threat to the survival of livestock and a hindrance to human settlement in the adjacent areas. This study sought to investigate land cover change in the park over the past 50 years, using four-time-series aerial photo interpretation, questionnaires and participatory rural appraisals. Findings showed a more than 10% increase in shrublands and a commensurate decrease in grasslands between 1948 and 1993. Considering the enormous efforts placed on tsetse control in the past, the proliferation of prime tsetse habitat could have serious implications on agricultural development and human health of the settled community in Lambwe Valley. The sustenance of tsetse and bush control to avert conflicts in resource use is a prerequisite for harmonious coexistence of the park with the people.
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