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Environmental report series 1

K E N Y A

ABERDARES NATURAL RESOURCES DEVELOPMENT PROJECT

Environmental Impact ASsessment Report

REPORT NO. 97/082 ADB-KEN

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
/AFRICAN DEVELOPMENT BANK COOPERATIVE PROGRAMME

The Environmental Report Series is a new series of publications produced by the FAO Investment Centre. The primary objective of the Series is to provide illustrative examples of recent environmental "best practices" in support of the design of agricultural and related investment projects. The intended users of the Series are Centre staff, their national counterparts and other interested professionals involved in investment project design. In most cases, the material presented in the Series is based on recent work of Centre staff supported through co-operative agreements between FAO and its partner institutions. The primary criteria used for the selection of material published in the Series are quality, degree to which the underlying work represents accepted "good practices" in the field, relevance to meeting Centre needs, and originality.

The present report was prepared by an Investment Centre led team on behalf of the Government of Kenya with support provided through the FAO/ADB Co-operative Programme. The report, together with the associated investment project, are to be submitted for finance under the ADB's soft-loan window. The FAO Investment Centre would like to express its appreciation to ADB for its permission to reprint the Environmental Impact Assessment Report in the present Series.

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KENYA

ABERDARES NATURAL RESOURCES DEVELOPMENT PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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CURRENCY EQUIVALENTS
(Year 1997)

Currency Unit = Shilling (KSh)
US$ 1.0 = KSh 45.0 (1995 Project Preparation Report)
US$ 1.0 = KSh 55.0 (July 1997)

ABBREVIATIONS

ADB	African Development Bank
AFRICOVER	Land Cover and Topographic Data Base for Africa
ANRDP	Aberdares Natural Resources Development Project
EIA	Environmental Impact Assessment
FACDT	Forest-Adjacent Community Development Team
FAO	Food and Agriculture Organization of the United Nations
FD	Forest Department
GEF	Global Environment Facility
GOK	Government of Kenya
GPS	Global Positioning System
KEFRI	Kenya Forest Research Institute
KIFCON	Kenya Indigenous Forest Conservation Programme
KWS	Kenya Wildlife Service
IUCN	World Conservation Union
MALD&M	Ministry of Agriculture, Livestock Development and Marketing
MENR	Ministry of Environment and Natural Resources
MLRRWD	Ministry of Land Reclamation, Regional and Water Development
MOU	Memorandum of Understanding
NEAP	National Environment Action Plan
NGO	Non-Governmental Organization
NMK	National Museums of Kenya
PA	Protected Area
PAC	Problem Animal Control Unit
PAMU	Problem Animal Management Unit
PAWS	Protected Areas and Wildlife Service Project
PPR	1995 Project Preparation Report
PRA	Participatory Rural Appraisal
TA	Technical Assistance

EXECUTIVE SUMMARY

INTRODUCTION

(i) The Aberdares National Resources Development Project (ANRDP) was identified in 1994 and prepared in early 1995, on behalf of the African Development Bank (ADB), by the Government of Kenya (GOK) with assistance from the Investment Centre of the Food and Agriculture Organization of the United Nations (FAO). Since the project, whose purpose is the conservation and sustainable development of the ecosystem encompassing the Aberdares National Park and Forest Reserve, could clearly have both beneficial and adverse environmental impacts, the 1995 FAO Preparation Mission recommended that a comprehensive environmental impact assessment (EIA) be carried out. The ADB subsequently assigned it a Category I rating, which requires a detailed field review and an EIA study.

(ii) The present EIA Report was prepared by the Investment Centre Division of the FAO on behalf of the ADB and the GOK, in accordance with the ADB Environmental Assessment Guidelines, the GOK's Draft EIA Guidelines and Administrative Procedures (October 1996), and the Draft Kenya Wildlife Service Environmental Impact Assessment Procedures Manual (April 1995). The report is intended to provide the GOK and the ADB with concise information about existing environmental conditions and potential environmental impacts which would result from project-supported investments and make recommendations designed to mitigate any potential adverse impacts.

(iii) While ideally the EIA should have been completed in time to facilitate the preparation of the project, it was delayed until mid-1997 and conducted in parallel with the ADB project appraisal mission. In view of the time constraints linked to the funding agency's timetable for processing the loan, it was agreed with the ADB mission that the EIA team would focus its efforts on assessing the environmental impact of the electric fence which was the primary investment proposed for reducing the level of human-wildlife conflict. Nevertheless, the project's road rehabilitation, ecotourism and other components were also addressed but unfortunately received less attention than was warranted.

(iv) Since the 1995 Project Preparation Mission, there have been a number of new developments, including policy changes both in the Kenya Wildlife Service (KWS) and the Forest Department (FD), which are likely to affect some of the project's main premises and subsequently affected the work of the EIA mission. In the light of the uncertainty associated with possible changes in the project's components, and in accordance with its terms of reference, the EIA mission assessed the environmental impact of the proposed project interventions as described in the 1995 Project Preparation Report (PPR).

THE PROJECT

The Project as Proposed in the 1995 Project Preparation Report

(v) The Aberdares National Park and Forest Reserve provide a vital function as a water catchment and represent the headwaters of four out of Kenya's five main drainage areas. In addition, the National Park and Forest Reserve (Protected Areas) are of outstanding national importance as a natural ecosystem and sanctuary for rare and endangered wildlife species, a repository of renewable natural resources, a recreational area and a cultural heritage.

(vi) Conserving these attributes is a high priority for the people and GOK. The ecosystem however, is threatened by growing pressure associated with the surrounding human settlements (consisting of approximately 125,000 forest-adjacent households), land encroachment, and unsustainable utilisation of forest resources. In many areas wildlife causes significant levels of damage to both agricultural crops and forest plantations. In addition to fostering a negative attitude towards wildlife conservation among local communities, these conflicts also result in significant economic losses which, together with poor community infrastructure, impedes local development. To ensure the future conservation of the two Protected Areas, the project has to address the challenge of protecting the ecosystem functions as a national benefit whilst enabling and promoting economic development for the people living on its periphery.

(vii) The objective of the Aberdares Natural Resources Development Project (ANRDP) is the conservation and development of natural resources of the Aberdares region which is to be achieved through supporting an integrated management approach involving local communities. The project area comprises the whole of the Aberdares National Park and Forest Reserve, Kikuyu Escarpment, the Ndaragwa and Kipipiri forests together with the adjacent communities living in and around the two Protected Areas.

(viii) The project consists of three main components:

- *(a)* ***Planning and organization of the ecosystem approach*** *(KSh 160.4 million or US$ 3.55 million). During the first year of the project, a Management Plan harmonising all activities within the ecosystem would be undertaken by the KWS and FD, in consultation with other concerned ministries (Ministry of Agriculture, Livestock Development and Marketing (MALD&M) and that for Land Reclamation, Regional and Water Development), local people and District officials. This would consist primarily of ecosystem data collection, data analysis leading to zoning of the Protected Areas, and subsequent detailed zonal planning;*

- *(b)* ***Rehabilitation of the Protected Areas*** *(KSh 856.4 million or US$ 19.0 million). The main element of this component is the completion of the construction of a 360 km. fence around the National Park and gazetted Forest Reserve (with the exception of Ndaragwa Forest, Kipipiri Forest and the southern part of the Kikuyu Escarpment), of which 78 km. had already been completed at the time of project preparation. Other elements include strengthening the Forest Department's capabilities in*

patrolling its boundaries, detecting illegal activities and preventing and controlling fires, ecotourism development (bandas and walking trails, information centres), rehabilitation of plantations to improve productivity, sustainable utilisation of 30,000 ha. of bamboo, and applied research; and

(c) ***Rural development activities*** *(KSh 205.0 million or US$ 4.5 million). This component consists of the upgrading of 120 km. of rural access roads, rehabilitation of small-scale water facilities for domestic and livestock use, small-scale irrigation, electrification, on-farm tree planting, on-farm livestock fodder production, and support for on and off-farm income-generating opportunities.*

Developments since Project Preparation

(ix) There have been a number of local developments since 1995 which are likely to affect the proposed project design and consequently the degree of relevance of the EIA. Of these, two important policy issues bear highlighting.

(a) *At the time of project preparation, the erection of electric fences around the perimeters of certain national parks and forest reserves was a major element of KWS' policy on preventing damage to property by wildlife. It appears that in the light of experience gained over the few years, KWS is moving towards adopting a new policy in which electric fences are only one tool among several barrier and non-barrier options designed to reduce human-wildlife conflicts and protect natural ecosystems; and*

(b) *The FD has issued new policy guidelines on problem-animal fencing of forest reserves which state that fences should be aligned so as to separate natural forests from plantation forests to protect the latter from animal destruction. This has serious implications on the original fencing alignment as proposed in the 1995 Project Preparation Report which followed the Forest Reserve boundaries and made provision for non-electric fencing around the forest plantations. Because of the siting of many of the forest plantations in the Aberdares Forest Reserve, this could mean that a considerable area of natural forest could be fenced out particularly on the south-eastern side. This raises the possibility that the new fence-line would be interpreted as a new Forest Reserve boundary and invite encroachment and eventual excision of the indigenous forest which would inevitably be fenced out.*

(x) Consequently, upon its arrival in Kenya the EIA mission was faced with three fence alignment scenarios: (a) the original alignment proposed in the 1995 PPR which followed the Forest Reserve boundary; (b) the alignment associated with the FD's new fencing policy; and (c) a future alignment likely to result from an on-going fence alignment study being conducted by Zoo Atlanta, an NGO that has been commissioned by KWS and paid with resources from the World Bank Protected Areas and Wildlife Services (PAWS) Project. These new developments were

identified early in the mission and were critical in shaping the subsequent approach to completing the EIA.

RESULTS OF THE EIA

(xi) As part of its methodology, the EIA mission considered three possible alternatives. These were: (a) "without project," (b) "with project" based on the project design proposed in the 1995 Project Preparation Report, and (c) a "modified project" scenario based on recognition of the previously mentioned changes which have occurred since 1995 and an evaluation of other alternatives particularly with regard to the fence. Mitigation measures were identified and costed per ADB guidelines for the proposed project interventions under alternative (b) above.

"Without Project" Alternative

(xii) Without the implementation of appropriate measures, human-wildlife conflicts around the boundaries of the National Park and Forest Reserve would likely continue unabated. Community involvement in natural resource management would continue to be minimal, and community attitudes towards wildlife and protected areas would deteriorate further. In some areas, the unchecked consumptive use of natural resources would threaten the viability of the ecosystem. Illegal forest activities and poaching could continue or intensify; forest plantation productivity would remain poor due to inefficient management and lack of appropriate infrastructure. In the absence of off-farm income-generating activities and improvement in rural infrastructure (road rehabilitation), there would be continued pressure on the land and the Forest Reserve, rising unemployment, lost income from possible ecotourism opportunities, and continued poor access to health and other key support services by the forest-adjacent communities. In both the medium and long term, demands for further excisions of land from the Forest Reserve would likely increase. For these reasons, the EIA mission considered that the "no project" alternative was inappropriate.

"With Project" Alternative
(Project as Proposed in the 1995 Project Preparation Report)

(xiii) Based on the EIA mission's evaluation of the 1995 documents and subsequent interviews and field observations, a number of significant impacts, both positive and adverse, were identified. In this analysis, the proposed fencing programme was examined in detail. As originally proposed, fence construction consisted of nine phases. The mission examined each segment on its own merit, looking at the topography, agro-ecological conditions, human population pressure, purpose of the fence in that segment, degree of human wildlife conflict, fence effectiveness, community involvement, and environmental impact. Following this evaluation, recommendations and, where necessary, mitigation measures were formulated for each discrete fence section.

Main Beneficial Environmental Impacts

The Fence

(xiv) The principal beneficial effects identified with the proposed electric fence were: (a) improved institutional protection for the newly fenced-in ecosystem; (b) improved monitoring and regulation of forest resources and control of illegal activities; (c) reduction in damage to exotic softwood plantations and, consequently, the enhancement of economic returns from these plantations; (d) reduction in human-wildlife conflicts and subsequent benefits associated with decreased damage to crops contributing to increased food security and farm income; and (e) reduction in the number of animals shot on control operations.

Roads

(xv) The principal beneficial effects associated with road-related activities would be: (a) improved access to timber sites resulting in greater efficiency in plantation management and an increased timber supply base; (b) improved soil stability and enhanced control of run-off patterns (if road rehabilitation is properly engineered); (c) increased tourism due to improved Park access and use of currently under-utilised areas; (d) expanded marketing opportunities for many products in the Aberdares; (e) reduction in wastage of perishable agricultural produce; and (f) possible decline in transport costs in the area resulting in lower prices of manufactured and other goods.

Other Project Component Activities

(xvi) Beneficial effects identified from the project's other activities were: (a) improved community infrastructure, in particular improved access roads and off-farm income-generating opportunities; (b) improved standards of living through upgrading of water facilities, rural electrification, and through support for horticultural marketing, livestock services, etc.; (c) other socio-economic benefits which should arise from the project (e.g., direct employment of local people in fence-line clearing and construction, road rehabilitation, and construction of ecotourism infrastructure); (d) improved ecotourism facilities and enhanced tourism revenues; (e) awareness of communities and tourists about the role of the ecosystem raised and environmental training provided through the establishment of the proposed information centres; (f) improved natural resources management due to improved coordination between KWS/FD and the local communities; and (g) improved soil stability resulting from properly managed forest plantations.

Main Adverse Environmental Impacts

The Fence

(xvii) Significant potential adverse impacts associated with the construction of the fence (as proposed in the 1995 PPR) would be: (a) removal of natural vegetation (including montane forest, bamboo and afro-alpine vegetation types) in a swath measuring some 7 metres wide over a distance of 280 km; a total area of 200 ha; (b) exposure of soil from which vegetation has been stripped to sheet and gully erosion, especially on steep slopes and during periods of heavy rainfall, with consequent sedimentation of adjacent water courses; (c) the loss or modification of existing vegetation, and damage to existing forest access routes due to heavy vehicles and machinery, and other impacts associated with the establishment of temporary construction camps and access routes for construction plant, materials and workers; and (d) "funnelling" of wild animals - especially elephant - by the fence, and consequent concentration of wildlife damage.

(xviii) The main environmental impacts associated with the fence during its operation would be: (a) potential encroachment and possible long-term excision of land from the Forest Reserve (assuming alignment does not follow the Forest Reserve boundary); (b) induced development in the form of agricultural intensification in adjacent areas outside of the fence and a reduction in human use in areas inside of the fence, thus diminishing the effectiveness of existing land-use buffers to human-wildlife conflict; (c) increased concentration of the elephant population, severance of traditional migration routes, and restriction of access to natural mineral licks and waterholes with consequent increased destruction of natural forest; (d) decreased species diversity due to habitat destruction and contraction of feeding/breeding areas, coupled with imbalances in predator-prey dynamics and reduced hybrid vigour; (e) inbreeding of critical wildlife populations (because of their low numbers) resulting in genetic imbalances; (f) acceleration of the creation of an "island" ecosystem, contributing to changes in flora and fauna composition, animal behaviour and population dynamics; (g) increased crop/property/livestock damage in unfenced zones (from elephant and lion); (h) increased forest destruction in the vicinity of the fence; (i) creation of a man-made linear feature (the fence and fence-line) in an otherwise pristine landscape; and (j) restricted access of forest-adjacent communities to forest products for subsistence (particularly fuelwood and water, grazing, construction materials, etc.).

Roads

(xix) Adverse impacts associated with road construction would include the: (a) sourcing of murram (previous murram excavation within the National Park created unsightly quarries which have not been rehabilitated), erosion on steep slopes, gullying, changes in drainage patterns and intrusion into sensitive, undeveloped landscapes; (b) increased access to the Protected Areas for illegal hunting and felling of trees; and (c) induced development associated with new road development placing more pressure on the ecosystem.

Other Project Component Activities

(xx) Potential adverse impacts associated with other project activities include: (a) intensified visitor use in areas of the National Park contributing to loss of vegetation, soil erosion, vandalism and litter problems (ecotourism); (b) changes in plant heterogeneity and species diversity, particularly in clear-cut areas and soil erosion and degradation in areas where access tracks/roads might be constructed (bamboo harvesting); and (c) potential risk of land degradation and mismanagement/depletion of vital water and other natural resources through intensified irrigated horticultural practices and issues of social equity (community development initiatives).

Proposed Mitigation Measures

(xxi) Many of the potential adverse impacts identified with the 1995 project design can be prevented and/or effects mitigated. It should be noted that most of the proposed measures do not require additional resources but, particularly with respect to fence and road construction activities, are more a matter of adherence to and enforcement of existing guidelines and regulations supported by strict supervision from KWS and FD or should be carried out under the Management Plan (see para. xxxvii). Given the range of issues to be resolved, the complexity of preparing the Management Plan, and the details to be elaborated during the first year of project implementation, the EIA Mission considers that additional technical assistance is required.

The Fence

(xxii) Mitigation measures with regard to fence construction would include, inter alia: (a) determination of the fence-line using aerial imagery and ground investigation to take into account surrounding land uses, ecological sensitivities and topographical constraints ***prior*** *to clearing vegetation for the fence-line; (b) clearance of the fence-line and fence construction should be undertaken* ***concurrently*** *and all areas of bare soil* ***immediately*** *reseeded; (c) revision, updating, dissemination and adherence of the existing KWS Draft Guidelines for Assessment, Implementation and Monitoring of Fencing Projects in Kenya (KWS Fencing Unit, April 1994); (d) steep slopes should be* ***prominently marked and cleared by hand****; (e) fence clearance and construction* ***should not*** *be undertaken during periods of high rainfall; (f) fence-line clearance and fence construction should be undertaken by* ***specialist contractors*** *using labour recruited to the extent possible from local communities and strictly supervised by KWS; (g) vegetation cover along the fence-line should be* ***manually cleared*** *rather than through the application of herbicides; (h) technical aspects of fence maintenance should be the responsibility of a trained fencing unit; (i) funds for maintenance should be assured (through setting up a Trust Fund or Fence Maintenance Fund); (j) maintenance should be undertaken on foot, bicycle, donkey or horseback and the construction of the proposed perimeter road halted; (k) animal control measures should be undertaken in an efficient and timely manner and patrols increased during the 2-3 months of the year when most damage occurs (when crops are ripe); and (l) subject to the necessary additional information, mineral supplements should be strategically distributed*

throughout the Protected Areas to reduce elephant movements, crop raiding and prevent localised habitat destruction.

(xxiii) The possibility of corridor routes to facilitate elephant migration out of fenced areas should be explored to relieve compression of elephant populations within the Protected Areas, allow ingress as well as egress, and facilitate seasonal movement cycles. At the very least, the feasibility of establishing a limited elephant "dispersal area" and involving communities in tourism/wildlife initiatives, particularly in the northern region in the area of the traditional migration routes, should be explored before foreclosing these and other options (e.g., through the completion of the Phase III fence).

Roads

(xxiv) Specific mitigation measures to be adopted with respect to road construction include: (a) all new and rehabilitated roads should be constructed with murram to give an all weather surface, cambered and provided with drains on the upslope side, with drainage culverted beneath the road where necessary; (b) murram for road construction should be obtained from ***outside*** *the National Park. If this is not technically or economically feasible in relation to Park roads, all borrow pits should be located out of sight and, following excavation, immediately rehabilitated. A plan, including artist's drawings, for restoration of degraded areas should be a prerequisite to construction; (c) all new roads and road widening should be constructed to prevent erosion by* ***immediate*** *topsoil covering and planting to ensure stabilisation; and (d) all new and rehabilitated roads should be subject to a sight specific environmental assessment prior to construction.*

"Modified Project" Alternative

(xxv) Under the "modified project" alternative, the EIA Mission examined several alternatives to the interventions proposed in the 1995 PPR relating to the fence. These were: no fence, partial fencing, and alternative fence designs, fence alignments, and barrier and non-barrier systems. In addition, options associated with the roads rehabilitation and ecotourism development components were examined, albeit in lesser detail than for the fence.

ANALYSIS and RECOMMENDATIONS

Changes in Project Design

(xxvi) The ANRDP is crucial for the conservation of the Aberdares National Park and Forest Reserve. The mission believes that the project's objective - conservation of the ecosystem and development of the natural resources through an integrated management approach involving the local communities and stakeholders - is appropriate. However, the mission has concluded that excessive emphasis was placed on the electric fence as a physical barrier both for protecting the

ecosystem and for reducing human-wildlife conflicts at its border. Whereas a fence along the Forest Reserve boundary, as proposed in the 1995 PPR, would undoubtedly provide a measure of protection against encroachment and other illegal activities, in the absence of a strong and efficient Forest Department and community support for its construction, its physical existence would be no guarantee of long-term protection for the enclosed ecosystem.

(xxvii) This conclusion is partially based on a preliminary economic analysis of the costs of fence maintenance. While the inclusion of economic analysis is normally outside the scope of an EIA, in the case of the fencing component the team found that the environmental impacts of the fence could not be considered in isolation from the issue of its physical sustainability, particularly its effectiveness and maintenance requirements.

(xxviii) In the 1995 Project Preparation document, capital costs of the fence were estimated at approximately US$ 10 million (likely to be an under-estimate) and the accompanying annual maintenance costs were projected to be US$ 0.5 million (likely to rise after about ten years). It is not clear how the costs of fence maintenance after the six-year period of the project would be funded. Neither KWS nor the FD can meet these costs, unless, as proposed in the 1995 PPR, revenue from forestry plantations can be retained for such purposes. At present, this revenue is remitted directly to the central treasury. It is the mission's view that ***secure funding for fence maintenance is a prerequisite to capital expenditure on fence construction****.*

(xxix) Related to the aspect of cost is the increased institutional capacity and human resources which would be required to support such a complex project. The Project Preparation Report foresaw an increase in the number of forest guards and other personnel, whereas ***KWS and the FD are currently in the process of retrenchment and a reduction of staff****.*

(xxx) The provision of power for the fence was also found to be an issue of critical importance. The three options previously identified for supplying electricity to the fence were: connection to the main grid, solar energisers, and connection to mini-hydropower schemes. Extension of the grid to serve remote sections of the fence would be technically difficult and expensive; solar-powered batteries were found by the Project Preparation Mission to be unreliable because of insufficient sunshine, low clouds and mist which persist for large parts of the year. Evaluating these alternatives, the Preparation Mission recommended mini-hydropower schemes; however, these have yet to be established as a viable option and may require substantial maintenance and, consequently, a high level of technical skill. The EIA mission considers that ***the feasibility of an appropriate energiser option needs to be clearly established as a prerequisite to constructing sections of electric fence in remote areas of the Aberdares****.*

(xxxi) In light of the aforementioned issues and the evaluation of the different alternatives, the EIA Mission has concluded that fencing of the ***entire*** *Protected Areas is not the most appropriate way of conserving this important ecosystem. Such an exercise is of doubtful cost-effectiveness, is unlikely to fulfil the needs of many surrounding communities and is liable to prove physically unsustainable owing to the requirements and high maintenance costs. Rather, the mission recommends* ***partial fencing****, and that as only one element in a broader strategy to conserve the ecosystem and reduce the level of human-wildlife conflict. The fence will likely be beneficial and*

sustainable only in those areas where there is severe human-wildlife conflict, where the local communities themselves opt for the fence as the most suitable alternative, where they are involved in the decision-making and negotiating process regarding continued access to forest resources, and where they are involved in all aspects of fence construction and maintenance.

(xxxii) While the importance of community and stakeholder participation in the project is highlighted in the Preparation Report, the EIA mission also recommends that ***community participation be given even greater emphasis****. As the primary users of the natural resources of the Forest Reserve, the forest-adjacent communities are the key to their long-term conservation. Incentives for such conservation are crucially dependent on the communities deriving a flow of benefits from the Forest Reserve. The mission further recommends that* ***additional opportunities for controlled, sustainable use of forest resources that directly benefit forest-adjacent communities should be explored further****. In this respect, consideration should be given to a more "bottom up", community-driven approach to identifying sustainable development initiatives, based on the communities' own priorities.*

(xxxiii) In the light of the above, the ***EIA mission recommends the "modified project" alternative in which partial electric fencing would be only one element in a more comprehensive strategy to conserve the ecosystem and reduce the level of human-wildlife conflicts****. A combination of barrier and non-barrier systems, particularly joint KWS/community management initiatives, rehabilitation of the extensive system of game moats, where appropriate, a strengthened Forest Department, deployment and/or establishment of additional Problem Animal Management Units and Problem Animal Control Units, particularly for the 2-3 months of the year (when crops are ripe) when most crop damage is caused by wildlife, would likely be some of the other central elements of the strategy.*

(xxxiv) Decisions regarding the best options for reducing human-wildlife conflict and conserving the ecosystem should be made on a section-by-section basis, taking into account, inter alia, the degree of threat to the ecosystem, severity of the human-wildlife conflict, topography and natural barriers, land-use patterns, human population pressures, socio-economic conditions and community development priorities and constraints. The approach to be adopted in each segment would be determined by KWS in close consultation with the communities. The respective merits of these measures need to be investigated further, including a cost-effectiveness analysis of the different possibilities, as well as a cost-benefit analysis of the recommended option. In this process, efforts should be made to identify additional opportunities for sustainable use of the resources with a view to linking more closely conservation and rural development activities.

(xxxv) The mission observed that existing roads within the Aberdares National Park and Forest Reserve, as well as in the forest adjacent communities, are generally in a very poor state and virtually impassable in the wet season. ***The mission considers that the rehabilitation of existing roads to all-weather standard is an important component of the project****. In this respect, it should be noted that communities' reactions to the proposed project interventions have consistently ranked road improvement as the highest priority, followed by milk and horticultural marketing support.*

(xxxvi) ***The mission supports the ecotourism component as outlined in the 1995 PPR*** *noting that only low-impact tourism based on small numbers of people, walking rather than driving, should be accommodated in the moorlands.*

(xxxvii) The EIA mission considers that the preparation of a comprehensive ***Management Plan*** *harmonising all aspects of managing the Aberdares National Park and Forest Reserve, including proposed project interventions,* ***is essential for the success of the project****. One of the important issues to be addressed in the Plan is that of land-use zoning within the National Park and Forest Reserve to delineate usage areas. The 1995 Preparation Report proposed that the Management Plan be prepared in the first year of operation of the project, and the EIA Mission recommends that* ***the satisfactory completion of the Management Plan be a condition for initiating all major investment/infrastructure activities - erection of the fence, road rehabilitation, ecotourism development.*** *A clear strategy for conserving the ecosystem and reducing human-wildlife conflict in the Aberdares should be elaborated, in close consultation with the forest-adjacent communities, as part of the Management Plan. During the development of the Management Plan,* ***sufficient provision should be made, both in terms of time and financial resources, for the redesign and costing of the aforementioned changes recommended under the "modified project" alternative****. The proposed mitigation measures would need to be reviewed and recosted to take into account the redesigned project, and the monitoring programme developed (see para. xxxviii).*

MONITORING

(xxxviii) The main objectives of the proposed monitoring programme are to: (a) assess the relative effectiveness and impact of the various wildlife-human conflict reduction measures (particularly the electric fence and game moats); (b) monitor effectiveness of the other mitigation measures; and (c) assess changes in biodiversity and species richness over time. It is recommended that monitoring responsibility should be given to KWS, FD, and the National Museums of Kenya with strong community participation. The monitoring programme would be drawn up and costed, indicators developed, and a baseline for monitoring the environmental impact of the project interventions established in the first year of the project, during the development of the Management Plan. Existing studies should be used to establish a baseline for monitoring purposes. Additional studies may be required to fill key gaps in information and data. An aerial survey of the Protected Areas and forest-adjacent communities should also be carried out to establish the baseline, particularly with respect to land-use patterns.

1. INTRODUCTION

1.1 The Aberdares Natural Resources Development Project (ANRDP) was identified in 1994 and prepared in early 1995, on behalf of the African Development Bank (ADB), by the Government of Kenya (GOK) with assistance from the Investment Centre Division of the Food and Agriculture Organization of the United Nations (FAO). Since the project, whose purpose is the conservation and sustainable development of the ecosystem encompassing the Aberdares National Park and Forest Reserve, could clearly have both beneficial and adverse environmental impacts, the 1995 Preparation Mission recommended that a comprehensive Environmental Impact Assessment (EIA) be carried out. The ADB subsequently assigned it a Category I rating, which requires a detailed field review and an EIA study.

1.2 This EIA Report has been prepared by the FAO Investment Centre Division on behalf of the ADB and the GOK, in accordance with the ADB Environmental Assessment Guidelines, the Draft Environmental Impact Assessment Guidelines and Administrative Procedures (October 1996) of the Government of Kenya, and the Draft Kenya Wildlife Service Environmental Impact Assessment Procedures Manual (April 1995)[1/]. The report is intended to provide the GOK and the ADB with concise information about existing environmental conditions and potential environmental impacts which would result from the project-supported investments and make recommendations designed to mitigate any potential adverse impacts.

1.3 While, ideally, the environmental impact assessment should have been completed in time to facilitate the appraisal of the project, it was delayed until mid-1997 and conducted in parallel with the ADB Project Appraisal Mission. In view of the time constraints linked to the funding agency's timetable for processing the loan, it was agreed with the ADB Appraisal Mission that the EIA team[2/] would focus its efforts on assessing the environmental impact of the fence, with the result that the roads rehabilitation, ecotourism and other components were also addressed but received less attention than was warranted.

1.4 Since the fielding of the Project Preparation Mission in late 1994/early 1995, there have been a number of developments, including policy changes both in the Kenya Wildlife Service (KWS) and the Forest Department (FD), which affected some of the main premises upon which the project was based and hence the work of the Environmental Impact Assessment Mission. These developments are highlighted in Chapter 2 (section B) below; paramount among them are new thinking in KWS about the role of electric fences in preventing damage to property by wildlife, and the new policy guidelines on problem-animal fencing of forest reserves, which were issued in late 1995 by the FD and significantly affect the alignment of the fence as proposed

1/ The mission did not succeed in obtaining a copy of the Kenya Wildlife Service Guidelines for Assessment, Implementation and Monitoring of Fencing Projects in Kenya (KWS Fencing Unit, April 1994).

2/ Ms. B. Cooney, Mission Leader; Mr. R. Harvey, EIA Specialist (consultant); Mr. Ian Hughes, Wildlife Specialist (consultant); and Ms. D. Topouzis, Sociologist (consultant). Messrs. S. Muriithi (Forest Department) and S. Managene (Kenya Wildlife Service) participated in the mission as resource persons. The team carried out its work in Kenya during the first three weeks of July 1997.

in the 1995 Project Preparation Report (PPR). The EIA team was furthermore, upon arrival, apprised of possible changes, not only in the fence alignment, but in the roads and ecotourism components of the project as well.

1.5 These new developments were identified early in the mission and were critical in shaping the subsequent approach to assessing the environmental impact of the proposed project interventions. As a consequence of the uncertainty associated with possible changes in the project's components and in accordance with its terms of reference, the EIA mission elected to assess the environmental impact of the proposed project interventions as described in the 1995 Project Preparation Report. As part of its methodology, the team considered three possible project options: without project, with project as designed in 1995, and a modified project scenario. The merits and deficiencies of each option are described in Chapter 4 below. The environmental impacts of the project, both beneficial and adverse, are discussed in Chapter 5. Mitigation measures (Chapter 7) were identified and costed for the project as designed in 1995. The EIA mission, however, recommends a modified project option which is described in Chapter 9 ("Conclusions and Recommendations").

1.6 While the inclusion of economic and financial analysis (Chapter 6) is normally outside the scope of an EIA, in the case of the fencing component the team found that the environmental impacts of the fence could not be considered in isolation from the issue of its physical sustainability, particularly its effectiveness and maintenance requirements. Recommendations, especially with respect to changes in project design, are therefore partially influenced by the financial and human resources requirements related to maintaining a 360 km long electric fence.

2. PROJECT DESCRIPTION

2.1 The Aberdares National Park and Forest Reserve (see Map 1) provides a vital function as a water catchment and represents the headwaters of four out of Kenya's five main drainage areas. In addition, the Park and Forest Reserve (Protected Areas - PAs) are of outstanding national importance as a natural ecosystem and sanctuary for rare and endangered wildlife species, a repository of renewable natural resources, a recreational area and a cultural heritage.

2.2 Conserving these attributes is a high priority for the people and Government of Kenya. The ecosystem however, is threatened by growing pressure associated with the surrounding human settlements (consisting of approximately 125,000 forest-adjacent households), land encroachment, and unsustainable utilisation of forest resources. In many areas wildlife causes significant damage to both agricultural crops and forest plantations. In addition to fostering a negative attitude to wildlife conservation among local communities, these conflicts also result in significant economic losses which, together with poor community infrastructure, impede local development. To ensure the future conservation of the two Protected Areas, the project has to address the challenge of protecting the ecosystem functions as a national benefit whilst enabling and promoting economic development for the people living on its periphery.

2.3 This chapter of the EIA report provides a summary of the project as originally formulated, a review of developments since project preparation, and a description of the project components assessed by the EIA mission, including modifications to the design which were explained to the mission during its visit.

A. PROJECT DESCRIPTION IN THE PROJECT PREPARATION REPORT

2.4 The objective of the Aberdares Natural Resources Development Project (ANRDP) is the conservation and development of natural resources of the Aberdares region based on an integrated management approach involving local communities. Total project costs would be KSh 1,597 million (US$ 35.5 million)[1/] of which 42% would be foreign exchange. The project area comprises the whole of the Aberdares National Park and Forest Reserve, Kikuyu Escarpment, the Ndaragwa and Kipipiri forests together with the adjacent communities living in and around the two Protected Areas.

2.5 The project comprises three main components:

(i) **Planning and organization of the ecosystem approach** (KSh 160.4 million or US$ 3.55 million) - During the first year of the project, a management plan harmonizing all activities within the ecosystem would be undertaken by KWS and the FD, in consultation with other concerned ministries

[1/] Rate of exchange in 1995: US$ 1.0 = KSh 45.0.

(Ministry of Agriculture, Livestock Development and Marketing (MALD&M) and that for Land Reclamation, Regional and Water Development), local people and district officials. This would include ecosystem data collection, data analysis leading to zoning of the Protected Areas, and subsequent planning for each zone.

(ii) **Rehabilitation of the Protected Areas** (KSh 856.4 million or US$ 19.0 million) - The main element of this component is the construction of a 360 km fence around the National Park and gazetted Forest Reserve (with the exception of Ndaragwa Forest, Kipipiri Forest and the southern part of the Kikuyu Escarpment), of which 78 km had already been completed at the time of project preparation. Other elements include strengthening the FD's capabilities in patrolling its boundaries, detecting illegal activities and preventing and controlling fires, ecotourism development (bandas and walking trails, information centres), rehabilitation of plantations to improve productivity, sustainable utilization of 30,000 ha of bamboo, and applied research.

(iii) **Rural development activities** (KSh 205.0 million or US$ 4.5 million) - Upgrading of 120 km of rural access roads, rehabilitation of small-scale water facilities for domestic and livestock use, small-scale irrigation, electrification, on-farm tree planting, on-farm livestock fodder production, and support for on and off-farm income-generating opportunities are among the planned activities.

B. DEVELOPMENTS SINCE PROJECT PREPARATION

2.6 There have been a number of local developments since 1995 which have affected some of the main premises on which the project was designed and hence the work of the EIA mission. Of these, two important policy issues bear highlighting.

(i) At the time of project preparation, the erection of electric fences around the perimeters of certain national parks and reserves was a major element of KWS' policy on preventing damage to property by wildlife[1/]. In the Memorandum of Understanding for the Joint Management of Selected Forests, which was concluded between the FD in the Ministry of Environment and Natural Resources (MENR) and the Kenya Wildlife Service in 1991, the Aberdares National Park and Forest Reserve are identified as having highest priority for national conservation. Another important element was the initiative spearheaded by Rhino Ark, a national NGO, to establish a rhino sanctuary in the Aberdares. Construction of the

[1/] Kenya Wildlife Service, A Policy Framework and Development Programme 1991-96. This policy document commits KWS to a significant fencing programme - 1,500 km over the five-year period.

fence around the Salient area was initiated in 1987. To date, approximately 80 km, enclosing the Salient and the Karemeno Triangle (Phases I and II), have been fenced. Rhino Ark's stated intention is to fence the National Park and the entire perimeter Forest Reserve for the purpose of protecting the ecosystem[1/].

The Director of KWS is concerned that the feasibility and cost of erecting an electric fence around the entire Aberdares ecosystem has not been thoroughly evaluated. He furthermore indicated to the EIA mission that KWS is not in a position to take on the large financial liability, estimated at US$ 500,000 per year, of maintaining the fence. The merits of other game barriers and deterrents should therefore also be investigated, including a cost-effectiveness analysis of the different possibilities. It seems that, in light of experience gained[2/] in the last few years, KWS is moving towards a new policy to reduce the level of human-wildlife conflict and protect the ecosystem, - a policy in which electric fences, where appropriate, would be but one component in a broader strategy.

(ii) The FD has recently issued new policy guidelines (November 1995) on problem animal fencing of forest reserves which state that the fence should be aligned so as to separate natural forests from plantation forests to protect the latter from animal destruction. A joint memorandum supporting this approach was issued by the Directors of KWS and the FD on 1 February 1996. This has serious implications on the fencing alignment proposed in the Preparation Report which followed the Forest Reserve boundary and made provision for additional, non-electric fencing around the forest plantations. Because of the siting of the forest plantations in the Aberdares, this could mean that a significant strip of natural forest could potentially be fenced out on the eastern side. The EIA mission is very concerned that this could be perceived as a new Forest Reserve boundary and invite encroachment and eventual excision of the natural forest and plantations.

2.7 Related to these policy changes is the issue of institutional capacity. At the time of the Preparation Mission, KWS was receiving significant financial support from the Protected Areas and Wildlife Services (PAWS) Project, a US$ 143 million initiative funded by the World Bank and several other donors. This project is scheduled to end in September 1997, and, as a result, KWS is currently retrenching. A new project is under discussion with the World Bank and is contingent upon KWS putting forward a plan to become self-supporting.

1/ It was originally envisaged that construction of the entire perimeter fence would be carried out in nine phases.

2/ The electric fence at Mt. Elgon was taken down by the communities, apparently because of lack of consultation with the stakeholders. At the other extreme, the communities around Meru requested KWS to assist in constructing an electric fence; KWS provided the materials and the communities have assisted in its construction and even contribute to a Fence Maintenance Fund to pay casual labour to maintain it.

2.8 The Forest Department, as a potential conditionality of the loan agreement, had apparently indicated to the Preparation Mission that it would be prepared to recruit 50 forest guards for the Aberdares Region to bring it up to full strength of 214 forest guards. The FD is also presently retrenching; the EIA mission was informed that there are only 140 forest guards working in the Aberdares and that this number may be reduced to 110 within the next 3-6 months.

C. PRINCIPAL COMPONENTS REVIEWED BY THE ENVIRONMENTAL IMPACT ASSESSMENT MISSION

Fence

2.9 As a result of local developments since project preparation, the EIA mission, upon its arrival in Kenya, was faced with three fence alignments (instead of one): (i) the alignment proposed in the Project Preparation Report which essentially followed the boundary of the Forest Reserve; (ii) the alignment - not yet plotted - associated with the FD's new fencing policy which stipulates that forest plantations should be fenced out to the extent possible; and (iii) a future alignment likely to result from the on-going fence alignment study for the Aberdares National Park and Forest Reserve which is being conducted by Zoo Atlanta, an NGO contracted by KWS and paid with resources from the PAWS Project. Assessing the fence alignment(s) was further complicated by the fact that July was one of the wettest months in the Aberdares, causing the roads to become impassable, thus precluding visits to many of the proposed fence-line areas.

2.10 The merits of alternative fence alignments are discussed in Chapter 4, paras. 4.26-4.27.

Roads

2.11 Rehabilitation or construction of a total of 710 km of roads and track within the National Park, Forest Reserve and surrounding areas is proposed in the 1995 Project Preparation Report. Of this total, 590 km would lie in or beside the Protected Areas and 120 km in the forest-adjacent area. The major road components planned within the Protected Areas include: 280 km of new perimeter road along the proposed fence-line, and the rehabilitation of 180 km of internal and access roads to improve the management of the plantations. The roads to be rehabilitated were not specified, nor were road maps of the Protected Areas made available to the mission.

Other Components

Ecotourism

2.12 Tourism development under the project will introduce low-impact visitor facilities to a wider area of the ecosystem (walking trails and self-help bandas). The tourism development objective, as stated in the Project Preparation Report, is to establish a network of self-catering walking trails with a series of trails-linked camps separated by a 4- to 6-hour walk, or less. The purpose of the trails is to expand the tourist use of the Park in a manner more in keeping with the wilderness nature of the upland region of the Park where large numbers of animals would not normally be seen.

2.13 The mission was advised on arrival, however, that the ecotourism component had changed; KWS and the FD were now considering constructing two new lodges, the locations of which were not specified, instead of a system of bandas and walking trails. Towards the end of the mission, a different KWS official informed the mission that the ecotourism component in the Project Preparation Report was still valid. The ADB Appraisal Mission should have clarified this component of the project.

Bamboo Management[1/]

2.14 Of the 65,000 ha of bamboo in the Aberdares ecosystem, only 30,000 ha are exploitable within the Forest Reserve. The harvesting programme proposed under the project is to arrive progressively at an optimal production level of 15,000 ha, a level which, according to the Project Preparation Report, should be compatible with sustainable management practices.

[1/] There is currently a ban on bamboo exploitation, although this has been partly lifted to satisfy the increasing demand of the flower trade.

3. THE EXISTING ENVIRONMENT

A. PHYSICAL ENVIRONMENT

Location and Extent

3.1 The Aberdares Mountains are situated just south of the equator, running in a north-south direction for 120 km north of Nairobi, the capital of Kenya (latitude 00°08' to 00°42' south). The range is about 40 km across at its widest point, between longitude 36°31' and 35°57' east.

3.2 The project area is 222,711 ha in extent, including the Aberdares Forest Reserve (103,315 ha), the Kikuyu Escarpment Forest Reserve (37,619 ha), the Kipipiri Forest Reserve (5,077 ha) and the Aberdares National Park (76,700 ha). The area of surrounding communities included in the project has been defined in the Project Preparation Report as a belt approximately 3 km wide around the Protected Areas.

Topography

3.3 The maximum elevation of the Aberdares Mountain Range is 4,000 m (Oldonyo Lesatima, at the northern end of the range). Most of the Aberdares National Park is at an elevation of more than 2,600 m above sea level. The eastern boundary of the Forest Reserve is at an altitude of 2,000 m, whilst the western boundary is at the foot of the Aberdares escarpment at an altitude of about 2,600 m.

3.4 In the north of the Park, the topography is characterised by undulating hills, deeply incised river valleys and remnants of volcanic vents and sheets. The south, around the peak of Il Kinangop, is a steep horst with faults in the north, east and west. The central area comprises a large plateau of rolling hills at an elevation of 3,000 - 3,300 m. A Salient extends along the eastern flank of the mountain range.

Climate

3.5 Although situated on the equator, the climate is extensively modified by the high altitude, being both cooler and wetter than most of Kenya. Rainfall in the Aberdares is between 1,000 and 2,200 mm per year, with the south-east of the range receiving the highest precipitation. At the northern end of the range, which has 3-4 dry months each year, the seasonable distribution shows three rainfall peaks: March-May (long rains), July-August and October-November. Elsewhere, rainfall distribution is bi-modal, with peaks in April-May and October-November, and only one-two dry months each year.

Map 2: Major rivers

Hydrology

3.6 Numerous rivers rise in the Aberdares Mountains, and the project area includes the watersheds of four out of Kenya's five main drainage discharge areas (see Map 2). These are the northern Ewaso Ng'iro, Tana, Athi and Rift Valley catchments. The Sasumua and Ruiru dams in the southern Aberdares provide the main water supply for the city of Nairobi.

3.7 A feature of several of the streams rising in the moorlands of the Aberdares is a number of spectacular waterfalls, of which the principal ones are Chania Falls, Karura Falls and Gura Falls, all situated in the south-central part of the National Park.

Soils

3.8 Soils on the upper eastern slopes of the mountains are of basaltic origin, dark reddish brown in colour, very deep, well drained clays which are naturally highly fertile. Soils on the western boundary are more variable, being generally of medium to high fertility but interspersed with areas of lower fertility and poor drainage.

Infrastructure

Aberdares National Park

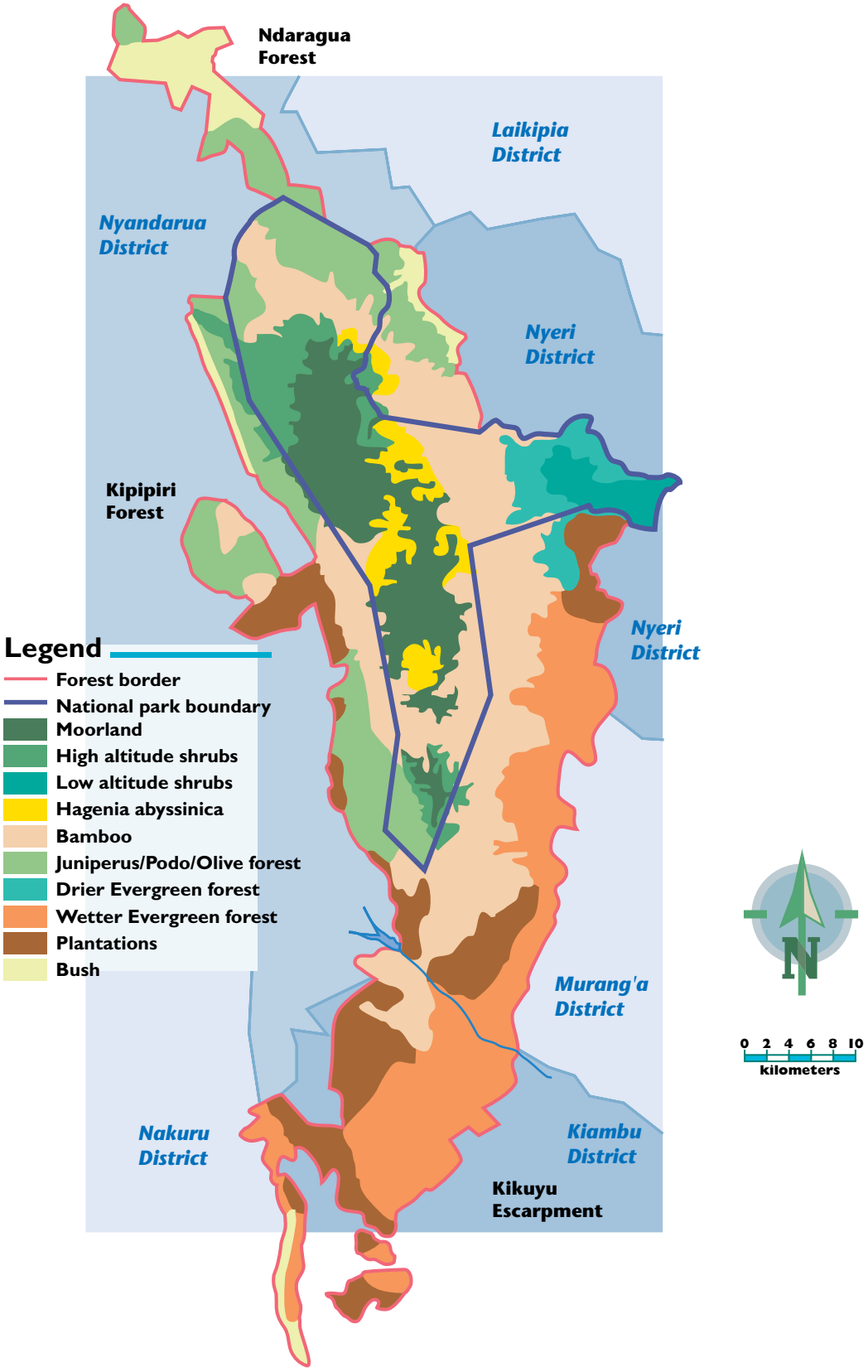
3.9 There is limited infrastructure within the Aberdares National Park. The Park Headquarters is located outside the Park at Mweiga (not far from the Nyeri). The two major tourist lodges of the Park, Treetops and the Ark, are both within the Salient area. Other, basic, tourist facilities include a fishing lodge within the moorland area near Kiandongoro Gate, and Tusk Camp bandas situated near Ruhuruini Gate.

3.10 None of the roads within the Park are surfaced with tarmac, but some have been murramed to provide a reasonable level of all-weather access for four-wheel drive vehicles. However, many of the Park roads, particularly on steeper terrain, become extremely difficult to use during the wet months of the year.

3.11 There are eight Park gates, all permanently manned; four are in the Salient area. Access to the Park gates outside the Salient is, however, very difficult, particularly on the western side where the approach roads have to traverse the escarpment, and few vehicles use them (Mutubio West Gate on the escarpment was reported to have only about five vehicles passing through per week).

3.12 A number of fire towers, most in dilapidated condition, are situated in the Park, particularly in the moorland and other areas prone to burning during dry months.

Map 3: Vegetation



Aberdares Forest Reserve

3.13 Roads within the Forest Reserve are poor, with little or no grading or surfacing. Many become very difficult or even impassable by vehicles other than tractors during the wet months of the year.

3.14 Permanent human settlement is not allowed within the Forest Reserve, but semi-permanent structures have been erected in some areas and occupied by *shamba*[1/] tenants.

3.15 The Forest Reserve is administered by 16 Forest Stations, each staffed by a Forester, several Forest Guards and other ancillary personnel. The Forest Stations within the Reserve are divided administratively between the Districts of Nyandarua, Nakuru, Kiambu, Muranga and Nyeri.

B. BIOLOGICAL ENVIRONMENT

Natural Vegetation[2/]

3.16 The Aberdares is one of several African high mountain regions which became separated from its neighbours during the break-up of Gondwanaland some 100 million years ago. It forms part of the Afromontane phyto-geographical region, a region consisting almost exclusively of endemic or near endemic plant species. For descriptive convenience, it may be divided into four main vegetation zones: submontane, montane, subalpine and alpine. Variations in rainfall (3,200 mm per year in the south and 940 mm in the north) and decreasing temperatures with increasing altitude are the principal determinants of such variation. Broadly, these vegetation zones are represented by a high moorlands region (tussock grassland, giant heather) bordered by a lower belt of bamboo which, in turn, is bordered by 'dry' evergreen forest (Cedar, Podo, Olive) to the north and west, and 'wet' evergreen forest (*Neoboutonia macrocalyx, Macaranga capensis, Ocotea usambarensis*) to the east and south (see Map 3). In terms of vegetation/habitat types, the region's natural flora can be further categorised in five distinct zones.

The Salient Shrub Zone

3.17 In the Upper Salient, secondary *Toddalia asiatica* bush has developed on large areas of grassland which had previously been maintained by shifting cultivation and grazing of livestock. Due to the presence of wild herbivores, *Pennisetum* grassland has persisted on ridges

1/ *Shamba* is the Swahili word for a plot of agricultural land. In this context, it refers to a non-resident system of plantation management whereby plots of clear-felled plantation land are temporarily leased to tenant farmers (normally for a period of 3-4 years) in exchange for tending plantation tree seedlings.

2/ Based on the "Vegetation of the Aberdares National Park, Kenya" by Klaus Schmitt.

and in glades. In the Lower Salient, extension of grassland has occurred due to the destruction of the forest. This destruction has been the result of fire, felling of trees and elephants. High concentrations of elephant occur in this region. When they attempt to migrate out of the Park (during the rains) they are prevented from doing so by the existing electric fence. The zone also includes patches of dense remnant forest with undergrowth. The dominant bushes are *Ocimum suave, Hypoestes verticillaris* and *Toddalia asiatica*, with the grass layer dominated by *Cynodon dactylon*. The forest remnants include *Albizia gummifera, Juniperus procera, Podocarpus spp., Olea spp., Calodendrum capense* and *Cassipourea melasona*. The common understorey trees and shrubs are *Teclea spp., Hypoestes verticillaris*, and *Ocimum suave*, whilst the ground layer is often dominated by *Setaria plicatilis, Pseudechinoleaplicatilis, Pseudechinoleana polystachya* and *Cyperus spp*.

3.18 To the east of the Salient, cultivation extends right up to the fenced Park boundary, whilst to the north of the Salient there is an area of indigenous forest known as the Karemeno Triangle. Immediately south of the Salient are extensive patches of indigenous and plantation forest, with *shamba* cultivation of the plantations extending right up to the Park boundary in parts.

The Bamboo Forest Zone

3.19 This zone is dominated by bamboo (*Arudinaria alpina*), but there is also a considerable amount of shrubby growth. Except for an area to the north-west, bamboo forest encircles the Aberdares and covers an area of 647 km^2 (of which only 193 km^2 are located within the Park). The bamboo forests on the gentle slopes of the wetter south-eastern and eastern side of the Aberdares form a wide zone between 2,400 m and 3,150 m, thinning out towards the north-eastern side of the range. The steep western slopes, which receive additional precipitation even during the dry season, support an extensive bamboo zone which reaches an elevation of 3,300 m. On the dry north-western slopes bamboo is completely absent. At the limits of its altitudinal distribution, bamboo may become a dominant understorey shrub or form scrubby patches. The general limits of bamboo growth would appear to be determined by a combination of rainfall and temperature. In terms of annual precipitation, annual minima of 1,000 mm and seasonal minima of 60 mm are the limiting factors. In terms of temperature, pure bamboo forest is restricted to areas with temperatures of between 10 and 12 degrees Celsius, whilst bamboo-*Podocarpus* mosaic forest is confined to areas with temperatures ranging between 12 and 16 degrees Celsius.

3.20 Bamboo requires decades before flowering. Flowering is a synchronous phenomenon which initiates a series of vegetation changes over wide areas, beginning with the die-back of the bamboo and invasion by *Sambucus africana* before the bamboo regenerates. This unique flowering cycle results in habitat diversification and is of prime importance in the management of the region's wildlife.

3.21 The bamboo forests on the western slopes of the Aberdares are particularly susceptible to fire.

The Northern Forest Zone

3.22 The northern forest zone consists of open forest with only a fairly small amount of dense forest and shrub. The forest is contiguous with the Karemeno Triangle forest. In this area, evaporation remains fairly constant throughout the year, and the forest is dominated by *Juniperus procera*, an important indigenous tree species (termite-resistant, used extensively for fencing/building poles) with xeromorphic leaves. *Olea europea ssp. africana* (excellent firewood), *Podocarpus latifolius* and *Nuxia congesta* (valuable hardwood timber) are also commonly found in this region. The submontane and montane *Juniperus* forests of the northern Aberdares represent a sub-climax which, in the absence of regular fire, would otherwise develop into forest exclusively dominated by broad-leaved trees. Like the western bamboo forests, these cedar forests are particularly susceptible to fire.

The Southern Forest Zone

3.23 The southern forest zone consists of complex closed-canopy indigenous evergreen tree communities. The forests are multi-storey and the south-east part of the zone receives the highest precipitation in the region. These forests are dominated by *Macaranga capensis*. Other major components are *Neoboutonia macrocalyx* and *Tabernaemontana stapfiana*.

3.24 In addition to many commercially valuable hardwood trees, the forest has a range of trees which are considered sacred by the Kikuyu tribe. These include Mukuu (*Ficus spp.*), Mugumu (*Ficus thonningi*), and Muthara (*Indigofera errecta*).

The Moorlands Zone

3.25 The moorlands zone consists of both open and dense vegetation communities. The open moorlands are characterised by grasses and sedges with almost no shrubs, while the dense moorlands are characterised by shrubs and giant heather.

Forest and Tea Plantations

Forest Plantations

3.26 There are 35,444 ha of forest plantations in the Aberdares. This represents more than one-third of the total forest plantations in forest areas managed under the Joint Memorandum of Understanding (MOU) between the FD and the KWS. The main species grown are the exotic softwoods *Cupressus lusitanica* and *Pinus patula*. In North Kinangop and Ndaragwa, there are almost pure stands of African Pencil Cedar (*Juniperus procera*).

3.27 The forest plantations provide timber for the domestic construction market. They are poorly managed and many are situated in inaccessible areas. Large tracts of clear-felled plantations have not been replanted, and many over-mature plantations have not been thinned.

The *shamba* system of management - short-term inter-cropping management of clear-felled plantations by non-resident 'tenant' farmers - has recently been reintroduced after a ten-year moratorium.

Tea Plantations

3.28 The forests of the eastern Aberdares are bordered by a narrow, discontinuous zone of tea plantations known as the Nyayo Tea Zone.

3.29 A parastatal venture, the Nyayo Tea Zone Development Corporation was established by Presidential Order in 1986, and an Act of Parliament in 1988, with the aim of establishing tea plantations which would serve: (i) as a buffer zone between forests designated for protection and high-density agricultural communities; and (ii) as a cash crop to provide forest-adjacent communities with a source of employment and income.

Fauna

Large Mammals

3.30 Seventy-two species of larger mammal have been identified within the Protected Areas. Of these, the elephant, rhino, bongo, wild dog, black-fronted duiker and giant forest hog are notable for their conservation value. Five primate species occur in the region: baboons, sykes monkey, vervet monkey, colobus monkey and the lesser galago. Six major carnivore species live in the region: lions, hyaenas, leopards, serval cats, caracal and golden cats. The pig family is represented by three species: warthogs, bushpigs and giant forest hogs. Of these, the warthogs are the most common.

3.31 The Aberdares National Park/Forest Reserve contains four threatened bird species and six threatened mammal species, including the jackson mongoose and the golden cat. Melanistic (black) varieties of leopard and serval cat also occur.

3.32 In terms of species abundance, the Salient region is the most significant with at least 23 species, followed by the Northern Aberdares with 21, the Southern Aberdares with 16 and the Central Moorlands with 12. The Salient region provides suitable environmental conditions for: elephants, buffaloes, rhinoceros, elands, lions, leopards, hyaenas, warthogs, waterbucks and bushbucks. Other minor species are represented by, among others, giant forest hogs, bushpigs, porcupines, genet cats and several primates.

Birds

3.33 One hundred thirty-eight species of birds have been recorded in the Aberdares, of which 31 are forest specialists and 20 are considered rare.

Fish

3.34 Both Brown and Rainbow trout were introduced into the rivers and streams of the Aberdares in 1905 and 1915, respectively.

Insects

3.35 The diversity of insects in the Protected Areas is considerable but presently unquantified.

C. THE SOCIO-ECONOMIC ENVIRONMENT[1/]

3.36 The population occupying the forest-adjacent area, which comprises more than 125,000 households within 3 km of the edge of the Aberdares National Park and Forest Reserve, and the agro-ecological zones in which they live, is diverse. Average net farm income may average about KSh 60,000[2/], of which three quarters is typically provided by crops. There is considerable fluctuation from region to region: the highest income, KSh 94,000, was reported in Ichichi sub-location in Muranga district, while the lowest income was almost three times less, or KSh 26,500 in Bathi sub-location, in Kiambu district.

3.37 The north side of the forest is generally drier than other forest-adjacent areas and supports limited possibilities for rainfed agriculture. Water is a major constraint faced by most households. However, generally large farm size and limited irrigation developments have contributed to improved cropping and livestock management systems. Irrigated export vegetable crops in particular have been introduced on a limited scale into these areas. For traditional cash crops, marketing facilities are especially poor, worsened by bad roads. Generally, business and employment opportunities are fewer than in other parts of the forest-adjacent area, and forest use is mainly focused on meeting domestic needs.

3.38 The west side of the forest contains farms with above-average landholdings and agricultural potential is generally good. However, infrastructure and services are limited, and the road network is extremely bad. Milk and horticultural production are major sources of

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1/ This section relies extensively on Lucy Emerton and Hezron Mogaka, "A Socio-Economic Profile of the Region Surrounding the Aberdares Forest," Center for Biodiversity, National Museums of Kenya, 1994, see executive summary and p. 24.

2/ Just under US$ 1,100 at the exchange rate of US$ 1 = KSh 55 (July 1997).

income, although marketing structures are poor, and vegetable prices are among the lowest in the forest-adjacent area. Employment and business opportunities are below average, and forest use combines domestic and income-generating activities.

3.39 The east side of the forest has extremely high rainfed agricultural potential, with milk and tea being major sources of income for most farmers. Horticultural fruit and vegetable crops are commonly sold, although there is little organized marketing, and farm-gate prices are low. The level of infrastructure and communications varies, but the overall area has relatively good links with nearby economic and urban centres. Employment and business is well-developed in parts of the eastern forest-adjacent area, including tourism and forestry-related industries. There are areas where commercial use of the forest is high.

3.40 The south side of the forest is generally well-served with infrastructure, transport and communications. This facilitates the marketing of milk and traditional and export horticultural and floricultural crops. These are major sources of income for most households, and marketing is generally better organized than in other parts of the forest-adjacent area. Employment and business opportunities are also enhanced by good infrastructure, transport and communications and proximity to urban centres, and the forestry sector supports a range of secondary industry and labour opportunities.

Table 1. Aberdares Forest-Adjacent Population Data

District	Area (km^2)	Number of households	Population	Average density (persons\km^2)	Number of sub-locations
Kiambu	793	43,992	205,704	431	36
Laikipia	235	1,906	9,154	39	1
Murang'a	549	13,848	70,848	232	15
Nyandarua	1,850	40,795	212,854	178	32
Nyeri	1,341	21,336	106,314	253	32
Nakuru	886	5,024	24,877	28	2
Total	**5,654**	**126,901**	**629,750**	**270**	**118**

Source: 1989 Census (Government of Kenya Central Bureau of Statistics), cited in Emerton & Mogaka, A Socio-Economic Profile of the Region Surrounding the Aberdares Forest, 1994, p. 9.

3.41 Population densities are markedly higher on the eastern and southern sides of the forest (see the above table), with correspondingly high land pressure. Although the districts surrounding the Aberdares have relatively good infrastructure and communications, these services tend to decline towards the forest. Roads and water facilities are poorly maintained and partial in coverage. In the absence of adequate provision and maintenance of infrastructure by the

government, several forest-adjacent communities have formed self-help groups with the aim of bringing new services to the community or upkeeping existing infrastructure.

3.42 Agricultural land forms the major resource base and provides for much of the livelihoods of forest-adjacent dwellers. Off-farm income through employment and small business is not insignificant, but there are few permanent work opportunities in the forest-adjacent area, and enterprise is poorly developed. Labour migration is widespread, especially among men and youth. Employment in forest-adjacent districts includes seasonal and permanent labour on large-scale floricultural, horticultural, coffee and dairying enterprises and various types of work in urban centres.

Community Use of Forest Resources

3.43 Forest activities contribute to a range of household subsistence and cash needs, but few households depend solely on the forest for subsistence and income: forest resources supplement other on- and off-farm sources. Use of the forest for basic subsistence needs, such as fuelwood and grazing, is practised by the majority of forest-adjacent communities and a significant proportion of households regularly obtain domestic and stock water, wild foods (honey, meat and fruits), medicines, construction materials and other subsistence items from the forest. Levels of subsistence forest use are especially high in areas of high land pressure, where alternative common tree and land resources are fewer. During drought, the use of a variety of forest products increases (timber and posts for sale, honey, thatching grass and medicinal herbs). The incidence of hunting also increases during drought. Forest income-generating activities, including charcoal production, extraction of poles and posts, and pitsawing are also important sources of income for a minority of households, and especially benefit more marginal poor and landless households and the unemployed male youth.

3.44 The reintroduction of the *shamba* system of non-resident cultivation in 1993, which renewed access to over 2,000 ha of Aberdares Forest land to local communities, is another major forest resource. In principle, *shamba* plots are allocated by ballot and an annual rent of KSh 220 is charged. However, in practice, the *shamba* system is subject to considerable abuse: the ballot system is often bypassed and high fees are charged for use of the land. Even though permanent structures are not allowed, it is sometimes hard to distinguish between temporary and permanent structures. Finally, in some cases, *shamba* farmers do not take care of the tree seedlings and/or do not move out after three or four years as foreseen in the agreement. In extreme cases, as witnessed by the EIA mission, farmers even uproot tree seedlings.

3.45 Overuse of forest products in the Aberdares, for example, pitsawing and post extraction, has been linked by the local communities to impoverishment[1/]. In the past, people were able to fulfil their needs for forest products without having to utilise the Forest Reserve. By the early 1990s, however, this was no longer the case; most trees had been cut down and local communities "had no alternative but to overuse the forest," according to a 1992 community

[1/] KWS-Forest Department KIFCON Aberdare Community Conservation and Fencing Workshop, 1992.

conservation and fencing workshop report. "Recent serious overuse was attributed to the belief that the forest had been sold off and the fence would totally exclude local people; hence they were removing as much as possible from the forest before the fence was constructed"[1/], concluded the report. It should also be stated, however, that over-exploitation of forest resources, and particularly certain tree species (such as cedar and podo) is usually not carried out by local people but by wealthier, influential people, who often bypass the official channels and employ locals to cut down trees and remove them from the forest with lorries.

3.46 The question of access to forest resources is critical to forest-adjacent communities. In fact, the above example illustrates the need for local communities to be consulted regarding any external intervention that may limit or modify their access to or use of forest resources. "At present, many local people perceive the Forest Guards as their enemies!" argues the same conservation workshop report. This mistrust between the FD officials and local communities is a key constraint to development intervention and needs to be tackled before any community-based initiative can be successful and sustainable.

Human-Wildlife Conflict

3.47 The prevalence and degree of human-wildlife conflict differs substantially from region to region. Human-wildlife conflict is most acute around Gatare and Kimakia forest stations; at the southern end of the Kikuyu Escarpment around Gatamaiyu, Kijabe and Lari locations in Kiambu, and around the northern end of the forest in Nyeri and Nyandarua districts where elephants travel between the Aberdares and Laikipia district.

3.48 Elephants, buffalo, baboons and other primates, wild pigs and porcupines are mostly responsible for crop and fencing damage while lions, leopards and hyenas attack livestock (particularly cattle, goat and sheep). Human-wildlife conflict is responsible for considerable damage to crops (estimated at US$ 0.4 million per annum for the entire Forest Reserve-adjacent area), livestock and farm infrastructure as well as for human injuries and deaths. Most of the damage to crops takes place when these are ripe. During this time, women have to spend entire days and weeks guarding their crops. Livestock predation takes place all year round. Wild animals also pollute water supplies and break water pipes in the forest.

3.49 According to a 1992 survey on wildlife damage to forest-adjacent households from Wanderis to Rhino Gates (what is now Phase II of the fence), 61% of forest-adjacent households suffered some damage to farm fencing, 36% lost a proportion of their crop, and 37% lost part of their livestock herd in a one-year period. According to the same survey, the annual value of animal damage to the forest-adjacent area in terms of net income losses is about KSh 3.8 million[2/].

1/ KWS-Forest Department KIFCON Aberdare Community Conservation and Fencing Workshop, 1992, p. 10.

2/ KIFCON, A Survey to Assess the Damage Caused by Wild Animals to Farm Households Adjacent to the Aberdares Forest Reserve, 1992.

3.50 According to a survey conducted by KIFCON in 1992 to assess the damage caused by wild animals to farm households adjacent to the Aberdares Forest Reserve, and the EIA mission's brief discussions with the forest-adjacent communities, households respond as follows, they:

(i) reinforce guarding procedures
(ii) use dogs as guards
(iii) build better shelters for humans and livestock
(iv) construct better fences
(v) leave a lit lantern or other sources of light at night
(vi) keep watch both day and night
(vii) make noise to scare away wildlife
(viii) use scarecrows.

3.51 Such actions have costs associated with them, either in terms of time and energy expended, or inputs applied. When able to do so, a household will expend its resources to protect property up to the point where such expenditures equal the value of the avoidable damage by wildlife.

3.52 Forest-adjacent households may adopt specific strategies to avert human-wildlife conflict.

(i) They may switch from crops highly prone to damage by wildlife (such as maize, bananas, etc., which are vulnerable to damage by elephants, warthogs and baboons) to crops less prone to such damage (such as tea, pyrethrum, trees for timber) and to activities such as bee-keeping.

(ii) They move farther away from the National Park/Forest Reserve. Some households may sell their farm next to the Park or forest and move some distance where damage by wildlife is less. This behaviour is based on the assumption that damage by the wildlife diminishes the farther away one is from the Reserve area.

3.53 Game moats, many of which were constructed during the colonial period, have been largely abandoned. The FD is currently rehabilitating some (e.g. in Keratia, Kieni) with local community involvement. It appears that, as long as the moats were well maintained, they were effective against wildlife. However, as local communities were in the past not involved in game moat maintenance, once the FD funds became depleted and full-time staff for moat maintenance were laid off, the moats rapidly disintegrated.

Community Development Priorities and Constraints

3.54 The major constraints and development priorities of forest-adjacent communities broadly relate to existing farm subsistence and income-generating activities, improving farm production possibilities, infrastructure improvements and off-farm employment and income-

generation. The relative importance of priorities and constraints varies for different groups and in different areas.

3.55 **Existing farm activities** are constrained by small farm size, population pressure on land, limited access to inputs, and poor marketing possibilities and prices.

3.56 **Improving farm production** relates to increasing yields through better and more intensive land-use practices, and by irrigation development. A major goal is also improving farm income sources through better marketing organisation, particularly milk and horticultural crops. Currently, land sizes are small, and marketing networks and prices poor. Crop marketing structures are poor in most parts of the forest-adjacent area, although they are comparatively well-developed in parts of the southern side of the forest.

3.57 **Infrastructure** is generally inadequate and poorly maintained, especially road, water and energy facilities. This constrains general welfare, as well as limiting transport, communications and income-generating possibilities in the forest-adjacent area. Infrastructure is especially poor in western parts of the forest-adjacent area, water is a major constraint in northern forest areas, and adequate provision of water and energy is a particular priority for women.

3.58 **Off-farm activities** are generally undeveloped in the forest-adjacent area. Income-generation and employment are priorities for the unemployed, the landless and the youth who lack a cash resource base.

Table 2. Community Reactions to Proposed Project Interventions [1/]

Project Intervention	Rank in order of preference
Road improvement	1
Milk marketing support	2
Horticultural marketing support	3
Irrigation development	4
Advice on land-use intensification	5
Game fence	6
Water and energy improvements	7
Off-farm activities support	8
Development of forest activities	9
Ecotourism development	10
Agro-forestry	11

[1/] See Emerton and Mogaka, op. cit., p. 64. The table is based on reactions of six communities.

3.59 According to the socio-economic profile of the people surrounding the Aberdares conducted in 1994, road improvement and agricultural activities were identified as top priorities by forest-adjacent communities. The construction of an electric game fence ranked 6th[1/] among identified priorities, while ecotourism and agro-forestry ranked last.

[1/] The game fence, which is a major component of the proposed project, ranked 8th among identified priorities in Thatha sub-location (Nyeri District, eastern Aberdares, Phase IV of proposed fence), 7th in Amboni sub-location (Nyeri District, northeast Aberdares, Phase II of the fence), 5th in Simbara sub-location (Nyandarua District, north-western Aberdares, Phase III of the proposed fence), 8th in Ichichi sub-location (Murang'a District, eastern Aberdares, Phase V/VI of the proposed fence), 5th in Kamae sub-location (Kiambu District, south-west Aberdares), and 1st in Bathi sub-location (Kiambu District, south Aberdares, Phase VII of the proposed fence).

4. PROJECT ALTERNATIVES

4.1 As part of its methodology, the EIA mission considered three possible alternatives. These were: (i) "without project"; (ii) "with project" based on the design proposed in the 1995 Project Preparation Report; and (iii) a "modified project" scenario based on recognition of the previously mentioned changes which have occurred since 1995 and an evaluation of other alternatives, particularly with regard to the fence.

A. NO PROJECT OPTION

4.2 As the prime organization concerned with the conservation and management of wildlife in Kenya, KWS has the responsibility for protecting human life and property from damage by wild animals. In the past there existed a system of compensation for such damage, but this has changed. While there is still compensation for loss of human life (KSh 30,000) or human injury (KSh 15,000), compensation is no longer provided for crop damage and livestock loss. Consequently, more than ever before, KWS must strive to minimise human-wildlife conflict.

4.3 In parts of the project area, crop raiding - particularly by elephants, baboons and other primates - has a devastating impact on small-scale farmers whose very survival is dependent on subsistence agriculture. Such depredation results in a negative attitude towards wildlife, its habitat (the Forest Reserve and National Park) and its managers (KWS).

4.4 The Aberdares Forest Reserve is also threatened by several human activities including encroachment, illegal logging and poaching of wildlife, as well as by the ever-increasing demand for agricultural land, with several areas excised for this purpose.

4.5 The forest plantations of exotic softwoods are also threatened by wildlife damage. These plantations provide timber for Kenya’s growing construction sector. Under proper management, they could also provide timber for the export market, thus providing the country with a valuable source of foreign exchange.

4.6 The Aberdares Forest Reserve and National Park represent a *de-facto* "island" ecosystem of rich biodiversity surrounded by intensive human settlement. This ecosystem harbours such rare and endangered animal species as the rhinoceros, the giant forest hog and the bongo.

4.7 The Aberdares is also a water catchment area of vital importance to the country. It is the source of three major rivers - the Athi, Tana and Ewaso Ng’iro - and contributes to the water supply of Lake Naivasha.

4.8 In the absence of the project, the following can be expected:

- continuing human-wildlife conflicts;
- deteriorating community attitudes towards wildlife, KWS and the FD;
- minimal community participation/involvement in natural resource conservation;
- poor forest plantation productivity due to inefficient management and lack of appropriate infrastructure (poor road conditions), and damage by wildlife;
- continued or intensified illegal felling and poaching of trees;
- continued unsustainable use of other forest resources;
- unrealised income opportunities from ecotourism initiatives;
- continued poor access to health and other key support services by forest-adjacent communities;
- increasing pressure on the land (and by extension on the Forest Reserve) in the absence of off-farm income-generating opportunities (the poor condition of the roads being a contributing factor);
- rising unemployment in forest-adjacent areas (given increasing population pressure, landlessness, etc).

4.9 From the foregoing, it is clear that a 'No Project Option' is costly both in socio-economic and conservation terms, and the mission does not, therefore, recommend it.

B. WITH PROJECT OPTION

4.10 This report reviews the environmental impact of the project as described in Chapter 2 above. The mission's findings with respect to positive and adverse impacts, as well as its conclusions and recommendations are described throughout the remaining Chapters of this report.

4.11 In contrast to the "no project option", the project would address many of the problems and constraints discussed above and provide a number of conservation, social and economic benefits. Improved National Park and forest management systems would contribute to the long-term conservation of the Aberdares ecosystem by providing a measure of protection against agricultural encroachment, uncontrolled harvesting, and other illegal forest activities. The electric fence could significantly reduce damage to crops, livestock, and farm infrastructure as

well as reduce human injury and death from wildlife. It might also increase productivity and food security, particularly of the forest-adjacent households.

4.12 Planned project activities to rehabilitate roads and improve plantation management could reduce the pressure on natural forest areas by providing other sources of forest produce and controlled areas for crop production (*shamba* system), stimulating employment opportunities for local communities, and generating revenues for the Forest Department. Increasing legal access to minor forest products would also improve the livelihoods of the forest-adjacent communities and could influence their attitudes towards the Protected Areas.

4.13 The ecotourism component, if properly developed, could generate employment and increase income in the forest-adjacent communities, as well as generate revenue for KWS and the FD. The proposed information centres could raise awareness about the role and importance of the Aberdares ecosystem and, combined with potential increased benefits derived by the local communities from the forest and wildlife, perhaps induce a positive change in their attitudes and behaviour towards the Protected Areas.

4.14 The rural development activities, particularly infrastructure improvement (road rehabilitation) could expand marketing and employment opportunities. Improvement of water facilities, provision of technical advice on land intensification and livestock management practices, and agro-forestry would contribute towards raising the standard of living of the adjacent communities.

4.15 The EIA mission has concluded that it is essential to conserve this important ecosystem and that the project's objective - conservation of the ecosystem and development of the natural resources through an integrated management approach involving the local communities and stakeholders - is appropriate. Notwithstanding the positive benefits mentioned above, the mission is concerned about the potential adverse environmental impacts, believes that excessive emphasis has been put on the electric fence as a physical barrier for protecting the ecosystem, and would recommend a modified project option in which electric fencing would be but one element of a more comprehensive strategy for conserving the ecosystem and reducing the level of human-wildlife conflict.

C. ALTERNATIVES TO THE PROPOSED ELECTRIC FENCE

4.16 The EIA mission explored a number of alternatives to the 360 km electric fence which was proposed to be constructed around the perimeter of the Aberdares National Park and Forest Reserve, thereby effectively creating an "island" ecosystem. As mentioned previously, approximately 80 km of the fence have already been constructed and additional 280 km would be erected under the project. Options include: no fence, partial fencing, alternative fence designs, alternative fence alignments, as well as other possible barrier and non-barrier systems.

No Fence

4.17 The fence has already been constructed in Phases I and II, and its complete removal would not be a practicable or desirable proposition in these areas. The mission considers that, subject to certain criteria (see para. 9.17), electric fencing may be the most appropriate option in some areas of high human-wildlife conflict which lack any natural buffer zones between incompatible land-uses. The option of no fence at all is not therefore recommended.

Partial Fencing

4.18 In the wildlife context, a fence almost always means there is a perceived problem in the interaction between people and wildlife, particularly the larger mammals. Fencing is seen as the most powerful tool in this process of land-use division and high expectations of fences are held by people adversely affected by wildlife activities as well as by many conservationists. To date, the main determinants in the siting and construction of fences have been political pressure or the availability of funds. Wildlife fencing is perhaps the only factor having a substantial influence on ecosystems and animal populations that has remained virtually devoid of the input of ecological knowledge, of systematic investigation or of environmental legislation.

4.19 Partial fencing would entail the construction of fence sections only where they were found to be most appropriate, having considered technical, social, economic and environmental factors. There is a great deal of variation in topography and land-use around the margin of the Aberdares, and a number of natural barriers to both animal movement and fence construction (e.g. gorges, waterfalls and escarpments) exist. This makes it possible to evaluate the feasibility of constructing discrete sections of fence individually.

4.20 A major advantage of partial fencing is that it would be less expensive to construct and maintain than total fencing, particularly if fencing were constructed only in areas where the local community has decided that the fence is a priority to them as evidenced by their preparedness to contribute funds or labour towards its construction and/or maintenance (such as the Meru fence). If fences are confined to areas where access roads already exist, usually the case where agricultural land abuts onto the Forest Reserve boundary, the logistics of fence maintenance will also be easier.

4.21 Partial fencing would have a number of environmental advantages. First, by not undertaking construction in remote, steep or wilderness areas, the impact on soil erosion, loss of natural vegetation and wildlife poaching will be significantly reduced. Operationally, a partial fence will not compress and isolate animal populations to the same extent as complete fencing (though it may lead to “funnelling” of animals around the end of the fence).

4.22 The merits of fencing particular sections of the Aberdares perimeter are discussed in paras. 9.19-9.26. In general terms, the steep scarps of the western side of the Aberdares mountains already preclude movements of large mammals in an east-west direction, so there is no requirement for a fence in this region. Similarly, there are areas to the east and south of the project area where construction of a fence may not be the best option.

Alternative Fence Designs

4.23 In constructing an electric fence, it is desirable both economically and ecologically to target animals that are the prime problem species in each area of high human-wildlife conflict. In some areas of the Aberdares, elephants are the main problem species, while in others it is baboons and other primates. Wild pigs and porcupines may also cause more damage to crops than elephants and baboons combined. It is important that fence design reflects these area- and/or animal-specific variables. More work should be undertaken in this field, especially on elephant- and baboon-proof designs, in collaboration with the local communities, followed by extensive field trials.

The Mission found that the existing sections of fence-line are only partially effective against elephants (which can break through the fence to migrate or reach food or salt-licks) and are virtually ineffective against baboons, which can climb over the fence posts avoiding contact with the live wires. These problems have led to negative community reactions towards the existing fence in some areas and call into question the cost-effectiveness of the design in reducing crop damage.

4.24 Alarm systems should also be incorporated into the fence design to warn of damage or of pilfering of fence materials.

4.25 The question of fence materials also requires further attention. Durability and ease of maintenance are vital factors. Short-term savings on materials may result in increased long-term maintenance and escalating costs. The options available are presented below.

(i) Blue-Gum (*Eucalyptus*) fence poles, even when chemically impregnated, may have an unacceptably short life-span, estimated around 10 years, in the wet environment of the Aberdares.

(ii) Cedar fence poles are relatively durable and termite resistant. One disadvantage is that they split easily, and elephants can - and do - exploit this weakness. Furthermore, indigenous cedar trees are included in the moratorium on felling of indigenous hardwood trees.

(iii) Steel posts are believed to be more expensive than timber, but have the greatest durability and the lowest maintenance requirements. A number of private game ranches have fences constructed with steel posts, and it appears that some steel posts have been used in Phase II. Steel posts set into a concrete base are likely to offer the greatest level of defence against breakage by elephants.

(iv) Posts made from recycled plastic is another option which merits further investigation.

Map 4: Fence alignment proposed in the Preparation Report

Map 5: Fence alignment proposed by Zoo Atlanta

Alternative Fence Alignments

4.26 A number of different approaches to fence alignment have been proposed and discussed in relation to the Aberdares. The principal alternatives are:

(i) fencing the boundary of the National Park, excluding the Forest Reserve. This has many disadvantages in terms of reducing habitat availability to wildlife, fencing out many animals within the forest, and failing to provide any level of protection for the Forest Reserve. The mission does not recommend this option.

(ii) fencing the whole Forest Reserve, including the National Park. This is the proposal contained in the Project Preparation Report, although for practical reasons some areas of outlying forest (Kipipiri and Ndaragwa forests, Kikuyu Escarpment) have been excluded (see Map 4). The benefits of this approach are that the maximum amount of both natural and plantation forest is encompassed by the fence, reducing the likelihood of encroachment of people onto forest land or wild animals onto agricultural land. However, this option does nothing to reduce levels of wildlife damage to the plantations within the fence-line (the Project Preparation Report envisaged secondary, non-electric fences for this purpose, but in the view of the mission these would not be effective against elephant, the main problem animal).

(iii) the new fencing alignment policy, which was developed in 1995 by the FD and endorsed in 1996 by the FD and KWS. The fence would be aligned so as to separate natural forests from plantation forests to protect the latter from animal destruction. Although the mission was advised that the alignment has not yet been plotted,[1/] the implication is that ALL forest plantations are to be fenced "out". Those that are relatively inaccessible deep inside the Forest Reserve would be left to revert to natural forest. This approach is perceived to have benefits in terms of both protecting natural forest from human encroachment and protecting both agricultural land and plantations from wildlife damage. However, in practice it is difficult to achieve because there is a mosaic of plantations and natural forest in some areas, so a dividing line cannot be drawn between them. In practical terms, this means that any alignment that fences out all the plantations will also fence out substantial areas of natural forest. This alignment could be perceived in effect to establish a new Forest Reserve boundary and, given rising population pressure on land, thereby eventually encourage encroachment. The mission has serious concerns about this approach.

[1/] Clearance of Phase IV in accordance with this new policy has been initiated around the area of the Ruhuruini Gate. The mission was advised that the alignment is being determined 5 km at a time in advance of the clearing of the fence-line by the Kenyan Army.

(iv) Zoo Atlanta fence alignment. Zoo Atlanta has been commissioned by KWS and paid with resources from the World Bank PAWS Project to carry out a fence alignment study for the Aberdares National Park and Forest Reserve. Although the report is not yet completed, the alignment under consideration (see Map 5) seems to be an intermediate among the various options, fencing in as much of the natural forest as practicable while fencing out as much of the plantations as possible.

4.27 In summary, the EIA mission considers that, if an electric fence is to be erected, the most ecologically acceptable alignment is along the outer boundary of the existing Forest Reserve, as proposed in the Project Preparation Report. With this alignment, all forest plantations would be fenced "in". This differs from the current option being adopted by the FD/KWS and that being investigated by Zoo Atlanta. Further ground and aerial surveys (G.P.S., aerial photography) would be required to refine any alignment option that would be adopted.

Alternative Barrier and Non-barrier Systems

4.28 In addition to the technical limitations of electric fences outlined above, there is the important aspect of community ownership to be considered. Where electric fences have not been identified as a key priority by the local communities themselves and where other barrier options have not been explored in close collaboration with local men and women, electric fences may be perceived to be externally imposed. This could pre-empt stakeholder ownership, which is vital for the successful operation and sustainability of the fence.

4.29 Current evidence suggests that electric fences can be an efficient way of minimising human-wildlife conflict under certain conditions in some problem areas. Such fences, however, at the same time create "hard edges" between dissimilar forms of land use, thus causing long-term inflexibility that limits integrated planning and forecloses alternative management options. Electric fences are "high-tech solutions" to wildlife depredation problems and, consequently, require intensive maintenance. If power is lost, for example, through breakage (by elephants) or short-circuiting, their effectiveness is curtailed. Furthermore, they are largely ineffective in controlling the movements of baboons and other primates.

4.30 The existing topographic, climatic and socio-economic conditions of the Aberdares are also constraints to the construction of a perimeter electric fence. Alternative "low-tech" protection systems may prove to be more appropriate methods for conserving the ecosystem and reducing the level of damage caused wildlife. These may include barrier options, such as moats, vegetative barriers, stone walls, and non-electric fences, or non-barrier options, such as vegetative buffer zones, traditional community-based wildlife control options, problem animal control measures (use of thunder-flashes, shooting of persistent problem animals), or joint KWS/community management of wildlife.

4.31 Annex 1 contains a review of the different barrier and non-barrier options, including the EIA mission’s view of the positive aspects as well as the drawbacks (pros and cons) of each of the different options. A number of alternative systems for conserving the Aberdares ecosystem

and decreasing the level of damage caused by wildlife are currently being practised. The most commonly found measures include: game moats, vegetative barriers and buffer zones (the Nyayo Tea Zone), and problem animal management and control measures. Map 6 illustrates the location of some of the existing barrier systems in the Aberdares.

4.32 The EIA mission considers that the different barrier, particularly the extensive system of game moats, and non-barrier systems have an important role to play in a comprehensive strategy to conserve the Aberdares ecosystem and decrease human-wildlife conflicts. Specific recommendations in this regard can be found in Chapter 9. Greater emphasis should be given to **engaging the communities in joint management initiatives with KWS**, which would include the identification of additional opportunity for controlled, sustainable use of forest resources that directly benefit forest-adjacent communities. As the pressure for land becomes more acute, the control of wildlife depredation by both barrier and non-barrier options needs to develop into a specialised field of its own based on sound ecological, sociological and economic principles within the ever-expanding scope of responsive and adaptive wildlife management.

D. ALTERNATIVES TO PROPOSED ROADS

4.33 The project includes rehabilitation of existing roads within the Forest Reserve and surrounding communities, together with construction of a new road within the National Park for maintenance purposes along the perimeter of the fence.

4.34 In the case of the rehabilitated roads, the alternative options available are “do nothing” or construct new roads on a different alignment. “Do nothing” would lead to a continuation of the existing access difficulties which limit both community development and plantation management, as well as drain scarce resources for vehicle maintenance. The severity of existing access problems is such that the mission considers the “Do nothing” option to be inappropriate. The alternative of constructing new roads on different alignments is liable to be significantly more costly than rehabilitating existing roads, and will have significantly greater adverse environmental impacts in terms of vegetation clearance, soil erosion, intrusion into the landscape and opening up access to areas of wilderness which can presently be reached only on foot. The mission therefore endorses the aim of the Project Preparation Report to rehabilitate existing roads rather to construct new ones.

4.35 The mission considers that the proposed perimeter fence maintenance road is an environmentally unsound and economically non-viable proposition. The unsurfaced road along Phase II of the fence-line is already showing signs of serious erosion (cattle are herded along it), and there is evidence that it is being used for illegal forest activities such as logging and poaching. The alternative is a “no road” option, with fence maintenance carried out on foot, bicycle, donkey, or horseback. Because of the adverse environmental impacts of constructing a perimeter road, this alternative is recommended. Where such roads have already been built, vehicles and livestock should be prohibited from using the fence-line as an access road to the forest. A more expensive alternative would be for the road to be rendered physically impassable to vehicular traffic and cattle by breaking it up and constructing fences and ditches. As a matter

of urgency, the existing road surfaces also need to be reseeded and drained so as to minimise landslip and sheet and gully erosion.

E. ALTERNATIVES TO OTHER COMPONENTS

4.36 The other project components have not been defined sufficiently to enable detailed discussion of alternative locations and designs. Recommendations on the approach to determining these details are included in Chapter 9.

4.37 The ecotourism component of the project, whilst being ecologically viable, is oriented more towards adventure tourism and is therefore not likely to increase the volume of tourism to such an extent that it will be of serious economic consequence. The feasibility of establishing self-service bandas or scaled-down versions of Treetops and the Ark in parts of the under-utilised southern section of the National Park and Forest Reserve should be investigated. In view of the vegetative destruction that has occurred around the Treetops site, the establishment of artificial salt-licks, access roads, etc. would need to be carefully considered.

4.38 Similar consideration should be given to the possibilities of establishing community-driven touristic ventures in selected areas adjacent to the Forest Reserve. These might include both sustainable consumptive (e.g. sport hunting)[1/] and non-consumptive (e.g. viewing lodge) utilisation of wildlife.

[1/] Sport hunting has been banned in Kenya since 1977, but may be reintroduced for certain animal species in the near future.

Map 6: Examples of other existing barrier systems

5. ENVIRONMENTAL IMPACTS

5.1 The assessment of environmental impacts is based on the information about the project components contained in the Project Preparation Report, as amplified and amended by discussions with the project stakeholders (Chapter 2). In its analysis, the EIA mission examined the fencing programme in detail. Information on the different alignments proposed in the Project Preparation Report and by the KWS/FD was not available at a level of detail which would enable identification of its position on the ground for most of the length, and the Zoo Atlanta fence alignment study is still under preparation. Despite this limitation and the inclement weather which precluded visits to much of the possible fence-line area, the mission examined each segment, to the extent possible, on its own merit, looking at the topography, agro-ecological conditions, human population pressure, purpose of the fence in that segment, degree of human wildlife conflict, fence effectiveness, community involvement, and environmental impact. Annex 3 contains a summary of the mission's preliminary findings relating to each phase of the fence-line.

5.2 In respect of the other project components, these have yet to be defined in terms of their design details or locations. Accordingly, the EIA has been conducted in terms of the impacts of the overall strategy, rather than identifying site-specific project impacts. Where appropriate, the issues arising in each zone of the project area have been identified separately, particularly in relation to the individual phases of the proposed fence.

5.3 Construction of the fencing component of the project is already underway, using privately raised funds, and some of the associated environmental impacts are currently evident on the ground. Similarly, evidence of the environmental impact of previous road construction can be observed within the National Park.

A. LAND USE

5.4 Land use in the project area includes a number of distinct uses:

(i) Aberdares National Park, within which wildlife conservation, research and tourism are the predominant uses. Ninety-five per cent of tourism is confined to the Salient, which is the most accessible part of the Park and within which the existing two Park lodges are situated. Visitor use of the remainder of the Park is limited by poor road access and limited game viewing opportunities (except in the moorlands there is dense vegetation on either side of the road).

(ii) Aberdares Forest Reserve, which includes the following distinct zones of use:

- natural forest, managed primarily for its value to conservation and watershed protection;
- plantation forest, managed primarily for economic benefits from sustainable forestry;
- tea, grown as a cash crop and to provide a buffer zone around parts of the natural forest;
- subsistence cultivation under the *shamba* system, which is intended to act as part of the plantation rotation.

(iii) Permanent settlements adjacent to the Park and the Reserve, including a number of small towns, together with rural areas within which both subsistence and cash crops are grown.

5.5 The proximity of these contrasting land uses is a primary cause of the human-wildlife conflicts, which the fencing component of the project is intended to address. The nature of the boundaries between the different land uses varies, ranging from abrupt, clear-cut changes where the National Park is bounded by settlements and cultivation (i.e. much of the Salient) to indistinct buffer zones comprising a mosaic of different uses (natural forest, plantations and tea cultivation) between the National Park and human settlements.

Impacts of the Fence

(i) Construction Impacts

5.6 The direct impact of the fence on land-use will be that some 200 ha of natural and semi-natural vegetation (including montane forest, bamboo and afro-alpine vegetation types) will be permanently removed to accommodate the proposed 280 km of fence within a cleared strip of land 7 m wide. It should be noted, however, that clearing of Phases III and IV exceeds this recommended limit. In Phase III, strips of up to 20 m in width have been cleared with devastating effects - serious erosion, gullying, unnecessary felling of cedar forest, and invasion by weed.

(ii) Operational Impacts

5.7 The erection of the fence will have long-term, indirect impacts on adjacent land uses. In particular, the presence of a physical and psychological barrier to human activities may be expected to lead to a decrease in human use within the fenced zone, and increased intensification of use (including cultivation) outside the fence. Thus, what is currently for much of its length a relatively indistinct boundary between land primarily in conservation use (natural forest) and land in intensive human use (cultivation) is likely to become a much more abrupt transition along the fence-line. One implication of this is that areas of forest and plantations excluded from the

fenced area are more liable in time to be encroached upon by agriculture, with the possibility that they will eventually be excised from the Forest Reserve (excision of a number of encroached areas of forest has recently taken place). Clearly, such a loss of forest would represent a negative environmental impact. Furthermore, a trend towards abrupt land use changes either side of the fence would be undesirable from the point of view of managing human/wildlife interactions, since intensive agriculture and conservation areas do not make good neighbours (as has been found to be the case around the Salient). The existence of a multiple-use buffer zone around a conservation area, as presently exists around much of the Aberdares, has generally been found to be a preferable land-use model in various countries around the world.

5.8 One of the stated aims of the project, of which the fencing component is a major part, is to reduce human dependence on forest resources. Existing uses allowed, under license, within the natural forest include gathering firewood and grazing. These uses, together with others, are in principle sustainable. Restricting such use carries the danger that rather than building support for forest conservation, local people will become more hostile and resent their exclusion from the forest by the proposed fence.

Impacts of the Roads

(i) Construction Impacts

5.9 The construction impact on land use of rehabilitating roads would be very small, confined to areas of land required temporarily for storing materials and construction camps.

(ii) Operational Impacts

5.10 The principal operational impact of road rehabilitation on land use would be improved access to the affected parts of the Protected Areas. The effect of this would differ according to road type.

(a) In the case of Park roads which are rehabilitated and brought up to all-weather standard with murram surfaces, improved access to the Park will benefit tourists (and potentially enhance tourism revenues), and will also benefit KWS staff in undertaking their wardening duties, including fire-fighting and anti-poaching patrols. The overall effect on land use will, therefore, be positive. The increased accessibility of parts of the Park to tourists may, however, lead to intensification of use in these areas.

(b) Access roads to a number of National Park Gates may also be upgraded, and this could have the effect of opening up parts of the Park to significantly increased numbers of tourists. This would particularly be the case if the access road between Naivasha and the Mutubio West Gate of Aberdares National Park were improved, since it would open up a through route across the highlands of the Aberdares between Naivasha and Nyeri.

This could increase tourism pressures on key visitor sites in the south central part of the Park (e.g. Chania and Karura Falls) to several times their present level.

(c) In the case of access roads to plantations and local communities, both social and economic benefits will be derived. In some cases, improved access will allow more efficient land use, such as for harvesting timber and crops.

(d) The proposed service road for the fence will open up a line of access through areas of natural forest, bamboo and moorland which are presently relatively inaccessible. Although this access will benefit Park staff in undertaking fence maintenance, it will also provide new routes, as has already been evidenced, into the forest for poachers. This is a potentially significant adverse environmental impact.

Impacts of Other Project Components

(i) Ecotourism

5.11 The ecotourism component of the project will introduce visitor pressures to land uses in areas where visitor numbers are presently low or non-existent. The walking trails and banda accommodations proposed in the Project Preparation Report are generally low-impact forms of tourism, though impacts may arise as a result of walkers trampling sensitive vegetation, and from litter. Locating the suggested tourism lodges in the Forest Reserve (not proposed in the 1995 PPR) would have much more serious potential impacts on surrounding land uses, including the need to provide supporting infrastructure (roads, water, electricity) and the effects of opening up wilderness areas to large numbers of people (staff, visitors and local communities).

(ii) Plantation Management

5.12 The rehabilitation of plantations would not involve major changes in land use since the FD's policy is not to extend the present area of plantations.

(iii) Bamboo Management

5.13 The Project Preparation Report proposes the sustainable utilisation of existing bamboo forest, which is 50% of the area of the Aberdares Forest Reserve presently covered by bamboo. There could be a negative environmental impact on this important habitat and, consequently, on wildlife if not harvested in a sustainable manner.

Key Issues and Conclusions

(i) Beneficial Impacts

5.14 The proposed fence will have a beneficial impact on land use in areas used or intended for cultivation, by reducing wildlife damage and permitting higher crop yields.

5.15 The proposed rehabilitation of roads within and providing access to the Park will have a beneficial impact by allowing increased tourism use of currently under-utilised areas.

(ii) Adverse Impacts

5.16 The fence is likely to have a long-term adverse effect on land uses by encouraging excision from the Forest Reserve of areas which are fenced out, and the consequent intensification of cultivation up to the boundary created by the fence.

5.17 Road rehabilitation would improve access to the Park and natural forest which could result in increased felling of indigenous trees, poaching and other illegal uses, especially in the case of the proposed road along the fence-line, which will traverse remote areas which are difficult to patrol.

B. ECOLOGY AND WILDLIFE

5.18 Ecology is the interaction of plants and animals with their environment. Wildlife, in the context of this study, refers to the larger mammal species occurring within the Protected Areas.

5.19 Within the project area, certain animal species are of particular ecological importance, either because they are rare, because they are 'keystone' species (fluctuations in the populations of which have a disproportionately large impact on the environment), or because they are responsible for a major part of the wildlife depredation/damage to adjacent communities, their crops, their physical structures, their water supplies and their livestock.

(i) **Rare Animals**
These include the bongo, rhinoceros, giant forest hog, white-fronted duiker.

(ii) **Keystone Animals**
These include elephants and lions.

(iii) **Marauding Animals**
These include elephants, buffaloes, baboons, sykes monkeys, wild pigs, lions, leopards, hyaenas and porcupines.

5.20 It should be noted that because of the difficult nature of the terrain (dense forest, deep valleys, etc.), the fauna of the forested area has not been extensively studied. Statistics on animal numbers, density and seasonal distribution are consequently difficult to obtain. For the same reasons, fluctuations in animal populations are difficult to monitor.

5.21 Little is known about the long-term viability of the Aberdares as an island ecosystem, although increasing development and settlement in the area surrounding the Aberdares has gradually been enclosing and isolating the ecosystem over a long period. Without active management intervention, in the long term, there is a risk that the size, habitat categories and biodiversity of this island will not prove viable, dynamic or self-supporting. Of the larger mammals, populations of elephant, lion and buffalo are already growing rapidly and may be close to their threshold levels (although little is known about the capacity of the existing habitats to support increases in these key species).

5.22 Elephants (*Loxodonta africana africana*) - the prime problem animal throughout much of the area - are estimated to be in the region of 2,000 animals. They show a high preference for the dense vegetation in the Salient and in the bamboo and bamboo/montane forest zones of the National Park-Forest Reserve complex. These elephants are reported to be big-bodied, savannah types. There is no evidence to suggest that they are forest types (*Loxodonta africana cyclotis*).

5.23 Large-scale elephant movements in the region ("migrations") are triggered by rainfall which occurs between April and June and also from August to November, reflecting the bi-modal pattern of rainfall over most of the region. Generally, movements are along river valleys, are made during the night, and may be in response to mineral or forage requirements. More simply, migrations may be in response to the cold, wet slippery conditions in the Aberdares during the rains. Peak crop damage occurs from August to November when the maize is ready for harvesting. Two migration routes have been identified to the north of the project area and there is also a minor migration route to the east of the Salient. There does not appear to be a migration route in the south of the project area, although in this region elephants engage in local movements both within and without the Protected Areas.

Impacts of the Fence

(i) Construction Impacts

5.24 The direct impact of the construction of the fence on the ecology of the Protected Areas will be the permanent removal of some 200 ha of wildlife habitat. The indirect impact of the construction of the fence on wildlife will be disturbance and possible poaching by road construction workers. In addition, other impacts would vary according to progress in fence construction; there could be a funnelling effect of the elephants. In the northern part of the project area (around Phase III of the fence), elephants are the key problem animals, and closure of their migration routes by the fence will result in fence breakages and funnelling of migrating animals towards unfenced areas. In this region, lions - especially sub-adult males seeking new territories to occupy - will also be affected by fence construction. Animals fenced out during

construction are likely to cause increased crop/property/livestock damage to the communities, and will consequently be exterminated by these communities.

(ii) Operational Impacts

5.25 The presence of an electric fence along the entire project boundary will have a crucial impact on two keystone wildlife species: lion and elephant. The direct impact on other wildlife species will be less noticeable, the fence serving merely to further isolate what is for the most part a *de facto* "island" ecosystem. The containment of elephants and lion behind the fence will have significant indirect impacts on both wildlife habitats and wildlife biodiversity. Predicted effects include:

- increased damage to forest by an expanding - but range-restricted - elephant population and consequent degradation of forest habitat. The indirect effects of such habitat destruction could be increased animal and plant species diversity (as in the Salient)[1/]. Assuming a present-day population of 2,000 and an annual population growth rate of 4%, the Aberdares elephant population could double within the next 40 years;

- inbreeding of critical wildlife populations (because of their low numbers) resulting in genetic imbalances and loss of hybrid vigour;

- reduction of floral biodiversity outside the protected ecosystem. The wide-ranging movements of animals (especially elephants) provide an important contribution to floral biodiversity by spreading manure and scattering seeds carried both within their dung and by their hooves. Elephants are important agents of seed dispersal for many plant species;

- increase in the numbers of lions within the Protected Areas and consequent increased predation of favoured prey species;

- increased lion predation of less-favoured prey species (including, possibly, such rare species as bongo and giant forest hog) as favoured prey species disappear;

- increased poaching of animals fenced out leading to eventual elimination;

- increased predator hunting efficiency (lions). Predators may take advantage of the fence and cleared fence-line to trap and stalk their prey. In the case of some species, such as buffalo and zebra, this could result in stampedes and possible fence breakages;

[1/] Elephants are natural landscapers: by opening up forests they increase the heterogeneity of plant communities which in turn leads to increased animal species diversity.

- increased crop/property/livestock damage in unfenced zones (lion and elephant);
- increased forest destruction in the vicinity of the fence (elephant);
- increased crop/property/livestock damage by animals fenced "out".

Impacts of the Roads

(i) Construction Impacts

5.26 The construction impact on the ecology and wildlife of rehabilitating roads will be very small. Aside from temporary local disturbance of animals, there should be little adverse effects. Similarly, provided environmental guidelines for the excavation of road-surfacing murram are followed (landscaping of excavation pits, reseeding), there should be no long-term effects on the ecology of the region.

(ii) Operational Impacts

5.27 The operational impact on the ecology and wildlife of rehabilitating roads will vary according to location. The rehabilitation of roads within the Forest Reserve will allow easy access of vehicular traffic and could conceivably lead to increased illegal forest activity, including illegal felling of indigenous trees and poaching of wildlife. In this respect, the proposed fence service road will play a potentially negative role.

5.28 Because of the system of gates used to control access to the National Park, such illegal activity is unlikely to be impacted by the rehabilitation of roads within the Park's existing road network.

Impacts of Other Project Components

(i) Ecotourism

5.29 The impact on the ecology and wildlife of the ecotourism component of the project will be low. The walking trails and banda accommodations proposed in the Project Preparation Report are essentially low-impact forms of tourism and, aside from the potential impacts of continual trampling of sensitive vegetation (eg. of afro-alpine flora), neither the ecology nor the wildlife of the region will be significantly affected.

5.30 The proposed tourism lodges of which the mission was advised were presently being considered by KWS and the FD - to be located in parts of the Forest Reserve - would have potentially much more serious impacts on the ecology and wildlife of the region. Supporting infrastructure (roads, electricity, water) and the effects of opening up wilderness areas to large

numbers of people (staff, visitors) would all impact on the ecology of the region and on the wildlife. Construction of artificial waterholes and/or saltlicks would have a significant impact on the ecology of the areas in the immediate vicinity of the lodges.

(ii) Plantation Management

5.31 The rehabilitation of existing plantations, by fencing out wildlife, could lead to increased damage to the indigenous forests (especially by elephants).

(iii) Bamboo Management

5.32 The proposal for the sustainable utilisation of 15,000 ha of bamboo will have a significant impact on the ecology and wildlife of the region. Bamboo forest, especially mixed bamboo/montane forest, is an important elephant habitat, particularly during the dry season. It is also favoured by bongo and buffalo. Disturbance/modification of this habitat could have far-reaching consequences for these important wildlife species, as well as for other species of plant and animal life.

5.33 Construction of access roads into undisturbed wilderness regions for the purpose of bamboo harvesting will compound the problem.

Key Issues and Conclusions

(i) Beneficial Impacts

5.34 The proposed project is likely to result in improved institutional protection for the fenced-in ecosystems and wildlife of the Forest Reserve and the National Park.

5.35 There would probably be a reduction in numbers of animals shot on control operations (especially elephants and lions).

(ii) Adverse Impacts

5.36 Adverse impacts on the ecology and wildlife resulting from proposed project interventions include:

- potential dietary and social imbalances in elephant population due to restriction of natural range;
- increased destruction of forest by elephants (compressed, but increasing population);

- reduction of ecosystem biodiversity outside the Protected Areas;

- increased predation of rare/endangered species such as bongo and giant forest hog by lions (increasing lion population, reduction in numbers of favoured prey species);

- removal of natural and semi-natural vegetation (including montane forest, bamboo and afro-alpine vegetation types) in a belt about 7 m wide over a distance of 280 km; a total area of 200 ha;

- genetic imbalances (dangerous constriction of the gene pool, reduction of hybrid vigour) due to inbreeding of enclosed wildlife populations. Lion, rhino, wild dog, bongo, giant forest hog and elephant are key species likely to be affected by such inbreeding;

- increased destruction of natural forest and wildlife (tree-felling, poaching) due to improved access roads;

- encroachment (and potential long-term excision from the Forest Reserve) of those areas fenced out;

- loss of/modification to prime wildlife habitat, especially for elephant, buffalo and bongo, by clear-felling bamboo (as is currently practised);

- heavy poaching of all animals excluded from the fenced areas.

C. FORESTRY

5.37 The Aberdares Forest Reserve is managed under the Joint Management Memorandum of Understanding between the FD and the Kenya Wildlife Service. It consists of 236,257 ha of natural (indigenous) forest and 35,444 ha of plantation forest. It is the third largest area of natural forest in the country (after the Mau and Mt. Kenya forests), and the second largest area of plantation forest (after the Mau plantation forest).

5.38 The indigenous forests of the Aberdares rank high in their protective aspects of conservation of biological diversity, water and soil. For the local communities, they are also a source of forest produce. Legal use includes collection of firewood from dead trees, some honey extraction and medicinal plant collection. It is clear that there is also a large illegal use of forest resources, including: intrusions to set up smallholdings, timber extraction, fence-pole extraction, charcoal burning, honey extraction, hunting (especially with dogs), trapping, trout poaching and cattle grazing.

5.39 In the past, these forests have been subjected to large-scale destructive and non-sustainable uses such as conversion to farmland and estate crop or forest plantations, as well as illegal logging. The Kenya Forest Master Plan (MENR, 1994) provides an analysis of the

present state of the forest sector and presents an action programme for the coming 25 years. The document recognises the seriousness of excisions and states that the pattern of excisions "contravenes the 1968 forest policy which states that no more forest land should be lost".

5.40 In addition, the National Environment Action Plan (NEAP) sets forth recommended actions to address environmental issues in Kenya. This document earmarks the Aberdares/Kikuyu Escarpment forests as a priority area for biodiversity conservation.

5.41 Forest plantations within the indigenous forest provide timber (mainly exotic softwoods such as cypress and pine) for the nation's growing construction industry. The *shamba* system of management leases clear-felled land to tenant farmers who are permitted to grow food crops (inter-cropped with nursery trees) for a period of 3 - 4 years.

Impacts of the Fence

(i) Construction Impacts

5.42 The direct impact of the fence on forests will be that some 200 ha of Forest Reserve land, including indigenous forest, will be permanently removed to accommodate the proposed 280 km of fence within a cleared strip of land 7 m wide.

(ii) Operational Impacts

5.43 The erection of the fence will have long-term, indirect impacts on the indigenous forests. In particular, and notwithstanding the provision of access gates, the presence of a physical and psychological barrier to human activities may be expected to lead to a decrease in human use within the fenced zone. Existing uses allowed under license within the Forest Reserve include the gathering of firewood, collection of water and livestock grazing. Restricting such uses may result in negative attitudes towards conservation of the forest as well as towards the forest authorities by the local communities who resent their exclusion from the forest by the fence.

5.44 Areas of indigenous forest and plantations excluded from the fenced area are more likely over time to be encroached upon by agriculture and permanently settled, with the possibility that they will eventually be excised from the forest altogether. Abuse of the *shamba* system of non-resident cultivation within forest plantations could easily lead to this state of affairs.

5.45 Based on anecdotal information and observations in the field, it appears that many *de facto* excisions are already taking place[1/]. In this respect, the formal legal excision of the

[1/] In an article that appeared in the newspaper "Nation" on 5 October 1997, it was reported that authorization of non-resident cultivation in Lower Imenti and East Njukini forests accelerated the destruction of the forests. After the official allocation of the *shambas* at the Nchiru beat of Lower Imenti Forest, illegal encroachment is reported to have started on the other side of the forest.

Forest Reserve is only the last step in a lengthy process. Even before this process has started, the Forest Reserve can be encroached and converted to other land uses without the official degazettment of the Reserve[1/] .

5.46 Damage to exotic softwood plantations by trampling, bud-nipping and debarking would be reduced (as would damage to *shamba* crops). However, depredation by baboons, sykes monkeys and other primates would still continue.

5.47 Breakages and failure to maintain the fence adequately could lead to even greater damage to softwood plantations than currently occurs. Having been funnelled into the breach, the elephants would now, however temporarily, be fenced in.

5.48 Exclusion of elephants from the plantations may result in increased damage to the indigenous forest.

Impacts of the Roads

(i) Construction Impacts

5.49 The construction impacts on forestry of rehabilitating roads will be minor and confined to temporary obstructions to vehicular traffic.

(ii) Operational Impacts

5.50 The operational impacts on forestry of rehabilitating roads will be an improvement in the transportation network and consequent broadening of the timber supply base by allowing access to previously inaccessible plantation sites. This, in turn, will lead to increased efficiency in plantation management and a resolution of forest resource distribution problems.

5.51 Improved forest access roads could also lead to an increase in illegal forest use, including the felling of trees (notably *Juniperus procera*) and poaching of wildlife.

1/ A major problem regarding the legal excisions of Forest Reserves lies with the Forests Act, which is the principal legal instrument governing excisions and additions to Forest Reserves. Unlike other legislation, the provisions of the Forests Act do not require that excision be subject to parliamentary approval. Excision of forest areas can occur simply by giving 28 days notice in the "Kenya Gazette".

Impacts of Other Project Components

(i) Impacts of Ecotourism

5.52 The environmental impact of walking trails and the construction of self-help bandas on the forest is not considered to be significant. However, the construction of tourist lodges along the lines of Treetops and the Ark would have significant impacts on the surrounding forest, including destruction of trees by elephants and collection of firewood.

(ii) Impacts of Bamboo Utilisation

5.53 The impact of sustainable utilisation of bamboo on the forest is not known. The unique bamboo flowering cycle creates a very high plant heterogeneity in the Protected Areas which is of central importance to their carrying capacity and biodiversity. Clear-felling of bamboo could result in the disturbance of the main flowering areas and consequent loss of important wildlife habitats (notably for elephants, buffalo and bongo), as well as the loss of an outstanding example of a natural biological process.

Key Issues and Conclusions

(i) Beneficial Impacts

5.61 The proposed project activities relating to the physical protection of the ecosystem and strengthening the capacity of the FD should result in improved institutional protection for the fenced-in areas of natural and plantation forests.

5.62 Should the electric fence be aligned in accordance with the new FD fencing policy, there would be improved protection of plantation trees in fenced-out areas from damage by wildlife (especially elephants).

5.63 A strengthened FD, in combination with improved access roads, could result in better plantation management.

(ii) Adverse Impacts

5.64 Adverse impacts on forestry of the proposed project interventions include:

- potential threat to indigenous and plantation trees, and possible long-term excision of land from the Forest Reserve, if the alignment does not follow the Forest Reserve boundary;
- potential increase in illegal tree-felling (from improved access roads);
- increased destruction of indigenous forest by elephant;

- increased fire-risk (lightning strikes to fence);
- potential loss of the full development of the unique bamboo flowering cycle;
- loss of important wildlife habitats (clear-felling of bamboo).

D. COMMUNITIES

5.54 The Aberdares has a poor history of involving local communities in forest conservation and wildlife management. KWS is well aware of this and is trying to create partnerships between its staff and forest-adjacent communities. Recently, KWS partnership officers have been conducting Participatory Rural Appraisals (PRAs) to identify felt needs and priorities. Little or no consultation with local communities took place during the construction of Phase I of the electric fence. Some consultation with local communities took place before the construction of the fence in Phase II and some PRAs were conducted in Phase III, but judging from the proceedings of both exercises, it appears that the electric fence was largely taken for granted as the most appropriate means to curtail human-wildlife conflict.

Impacts of the Fence

(i) Potential Construction Impacts

5.55 Local labour for clearing the fence-line, digging holes for fence posts, and ferrying fence posts in inaccessible areas should be employed to the extent possible in order to directly involve the communities in the project. This would help instill a sense of ownership toward the fence by making a substantial economic contribution to the community. The KWS/FD KIFCON Aberdare Community Conservation and Fencing Workshop conducted during Phase II proposed that those local people who assist with fence-line clearing be given free access to felled trees where the fence-line is bulldozed (e.g. in hilly areas where the bulldozer does not work) in lieu of payment[1/].

5.56 If local labour is not utilized in fence-line clearing and construction, an opportunity to create goodwill and cooperation between KWS and the communities will have been lost and ownership of the fence will undoubtedly be compromised.

5.57 The use of non-local labour by contractors is likely to lead to negative socio-economic effects on adjacent communities. In particular, there is a possibility of diseases such as AIDS being transmitted into the local population.

[1/] KWS-Forestry Department KIFCON Aberdare Community Conservation and Fencing Workshop, 1992, p. 14.

(ii) Potential Operational Impacts

5.58 Most wildlife would be confined to the Forest Reserve and damage to crops, livestock and farm infrastructure would be substantially reduced. In areas where there is no conflict with primates, against which the electric fence is ineffective, the fence is likely to raise smallholders' standard of living due to increased food productivity and security. It may also release household members from guarding their crops and allow them to engage in other on- and/or off-farm subsistence or income-generating activities.

Kakamega Forest Case Study in Community Participation

Until 1986, use of forest resources in Kakamega was allowed on the basis of licenses. Control over forest use through licenses combined with planting programmes was supposed to ensure sustainable forest use. Largely due to mismanagement, however, this did not work. The system was therefore abolished and replaced by an almost complete ban on the use of forest resources.

A few commercial licenses were still issued, and use by local people was limited to collection of deadwood, thatching grass and forest fruits. Forest guards were given the task of making sure that people did not use the forest illegally. This policing function contributed to the growing distrust of the communities towards the FD as well as to the Forest Reserve. Due to population and economic pressures, combined with an ineffective system for forest protection and corruption among forest guards, this system also failed.

The approach KIFCON advocates is legalized but controlled forest use by local people in return for village-based management and protection of forest areas.

Source: Adapted from KIFCON, Village Negotiations Agreement Preparation for Village-based Forest Management and Protection, 1993.

5.59 The fence will regulate access to the forest and help control illegal activities in the Forest Reserve, thereby assisting in the conservation and management of forest resources for future generations. By limiting human access to the Forest Reserve and Park areas, the fence will also allow the FD to determine sustainable levels of Protected Area use.

5.60 Cultivation is likely to intensify along the border with the electric fence. In some areas, the erection of the fence may also increase the usable size of some farms, allowing them to cultivate closer to the forest boundary.

5.61 The electric fence will restrict local people'saccess to forest resources for subsistence and income-generation purposes. This may cause some resentment among local communities: some will have to walk longer distances to access the forest, grazing rights will be restricted, and certain practices might be discontinued. This could have an adverse impact on the livelihoods of most disadvantaged groups (the landless and unemployed) and will necessitate mitigation measures, such as appropriate off-farm income-generating project initiatives.

5.62 The fence will primarily benefit smallholder farmers but will have little beneficial impact on the rural landless and/or the unemployed, who may well pose a greater threat to the forest, unless they are specifically targeted.

5.63 If local communities are not consulted regarding the construction of the fence and find it detrimental to their interests, they may tear it down, as has been the case in Mount Elgon.

Impacts of the Roads

(i) Construction Impacts

5.64 Road rehabilitation/construction using local labour will benefit the forest-adjacent communities and generate support for the project, provided that the location of the roads is previously negotiated with the communities.

(ii) Operational Impacts

5.65 Product marketing opportunities in the Aberdares, which have so far been very limited due to the difficulty of access to and from villages (with the exception of the south side of the forest), will expand substantially. Thus, in the future, crops may not necessarily be selected for subsistence use and local exchange but will be easily available for sale in small towns or other regional markets. Moreover, by improving access to markets, it will be easier to introduce new crops, new varieties, or new cultivation techniques that are less threatening to the environment.

5.66 The improvement of roads will decrease wastage of perishable agricultural produce which can presently not be transported out of the region, making business and enterprise difficult.

5.67 Transport costs for the marketing of produce are likely to decline with the improvement of roads and the number of traders operating in the area may increase; the prices of many goods (including farm inputs) in forest-adjacent areas may decrease.

5.68 Roads that provide or improve access to regional product and labour markets are highly valued and can serve as powerful incentives to the adoption of more intensive agricultural and forestry techniques[1/].

5.69 The improvement of existing forest roads will enhance access for illegal hunting, timber cutting and settlement.

5.70 Access to health and other support services will be improved.

5.71 Improved roads could increase migration to forest-adjacent areas, thus placing more pressure on the ecosystem.

[1/] Wells, Michael and Katrina Brandon. People and Parks: Linking Protected Area Management with Local Communities, World Bank/WWF/USAID, 1992, pp. 36-37.

Impacts of Other Project Components

5.72 **Ecotourism**, if properly developed, could generate employment and raise income for forest-adjacent communities.

5.73 **Improvement of water facilities** is likely to free women from many hours of work, as at present, water collection is laborious and time-consuming (many rivers and streams lie at the bottom of deep valleys). A regular supply of safe water for domestic consumption is likely to improve the health of many households.

5.74 **Technical advice on land intensification** (including cropping and livestock management practices) in order to maximise production and increase income from small farms is likely to become increasingly important, given the current pressure on land and over-intensified land-use. Rapid population growth, the continuous fragmentation of landholdings and low input application further exacerbate the problem.

5.75 **Agro-forestry** is critical in making farm households less dependent on forest resources for fuelwood. However, given the small size and increasing fragmentation of landholdings, particularly in the eastern and southern areas of the Aberdares, on-farm tree planting may only be a viable alternative for bigger landowners. Those, for instance, with less than one hectare of land, who can barely grow enough food to feed their families are unlikely to grow eucalyptus trees which take 7 years to mature and have no immediate return. In brief, in areas where landholdings are small, woodlots cannot compete with agriculture.

Key Issues and Conclusions

(i) Beneficial Impacts

5.76 The fence could significantly decrease damage to crops, livestock and farm infrastructure, as well as reduce human injury and death from wildlife. It may also increase productivity and food security, particularly for those households which are directly adjacent to the Forest Reserve. The fence will help to regulate the sustainable use of forest resources as well as access to the forest, and help control illegal activities in the Forest Reserve, thereby assisting in the conservation and management of forest resources for future generations.

5.77 Roads will expand marketing opportunities for many products in the Aberdares; they will reduce wastage of perishable agricultural produce and contribute to the decline in transport costs in the area and in prices of manufactured and other goods.

(ii) Adverse Impacts

5.78 The electric fence will restrict local people's access to forest resources for subsistence and income-generation purposes. Population pressure and the increasing fragmentation of landholdings makes local people's access to forest resources critical to their survival. If communities decide that the electric fence is absolutely necessary and that it is the best means of reducing human-wildlife conflict, further consultation needs to take place before the erection of the fence. The purpose and objectives of the fence need to be discussed at length, and the types of access to the forest needed by the local communities must be negotiated and jointly decided upon, and fence maintenance modalities need to be worked out. The issue of who is going to man the access gates is equally critical and should be decided upon by the local communities, KWS and the FD.

5.79 The improvement of existing forest roads will enhance access for illegal hunting, timber cutting and settlement and may increase migration to forest-adjacent areas, thus placing more pressure on the ecosystem.

E. TOURISTS

5.80 Tourism in the project region is largely limited to two lodges lying in the Salient area of the National Park. Tourism statistics give a misleading picture: while some 65,000 people visit the Park annually, most confine their activities to visiting these two lodges. No tourists visit the forest zone, and very few visit the other parts of the Park (limited trout fishing is carried out by the resident expatriate community). This under-utilisation has more to do with poor game viewing opportunities (except for the moorlands, dense forest/bush on either side of the roads) and inclement climate (wet, cold, low cloud and mist) than it has to do with the condition of the roads.

5.81 In addition to those tourists attracted to the region by the game-viewing facilities of the two established tourist lodges, a different type of tourist will be attracted by the establishment of walking trails and self-service bandas. It is expected that these tourists will be mainly Kenyans, or resident expatriates.

Impacts of the Fence

(i) Construction Impacts

5.82 Although construction of the fence is unlikely to be witnessed by tourists visiting the established lodges, the work will be visible to tourists visiting the Park in their own vehicles.

(ii) Operational Impacts

5.83 Tourists using the walking trails may encounter more keystone wildlife species than expected (eg. lion and elephant) whose range and/or habitat has been modified by the presence

of the fence. In the case of lion, the fence will serve to restrict sub-adult males seeking unoccupied territories. The lions in the moorland region may be aggressive (many will be descendants of a particularly aggressive male translocated from a nearby ranch). Properly-trained escort guards will be required to deal with the occasional aggressive incidents from lion, buffalo and elephant.

Impacts of the Roads

(i) Construction Impacts

5.84 Provided that borrow pits are sited outside the Protected Areas - or, if within, out of sight of existing roads - the impact on tourists of rehabilitating roads will be of minor significance and confined to the sight of construction camps, machinery, etc.

(ii) Operational Impacts

5.85 In the case of Park roads which are rehabilitated and brought up to all-weather standard, improved access to the Park will benefit tourists and potentially enhance tourism revenues.

Impacts of Other Project Components

5.86 The establishment of Information Centres operating as extension-cum-education arms of KWS and the FD and reflecting the multiple-use aspects of the Protected Areas, will be of considerable educational value to tourists.

Key Issues and Conclusions

(i) Beneficial Impacts

5.87 Beneficial impacts of the project include:

- improved access to the Park;
- improved ecotourism facilities;
- enhanced tourism revenues;

- improved educational facilities;

- rational use of those parts of the Protected Areas so far under-utilised by tourists.

(ii) Adverse Impacts

5.88 Potential adverse impacts are:

- visual disturbance caused by construction works;

- aggression from wild animals (especially lions). Aggression from elephants and buffalo could be a significant hazard in walking trails set up in gazetted forest areas.

F. HYDROLOGY, WATER QUALITY AND SOILS

5.89 Hydrology is the study of water in the environment, from rainfall, through runoff to streamflow and eventual discharge into lakes or the sea. Water quality is the physical and chemical characteristics of the water, particularly insofar as they affect its fitness for particular end-uses. The rivers flowing from the Aberdares are of critical importance to Kenya, both for the nation's water supply (much of which is drawn from these rivers) and for hydropower (the Tana River has a series of dams for power generation). Protection of water quality for these uses is therefore a very high priority.

5.90 For interventions such as the Aberdares Natural Resources Development Project, impacts on hydrology and water quality are closely connected to the behaviour of soils. This is because surface runoff is the main agent of soil erosion, and eroded soils is the main potential influence on water quality in the form of sediment in streams and rivers. Sedimentation reduces the usefulness of water for potable and irrigation purposes, and shortens the life of reservoirs and hydropower schemes through deposition.

Impacts of the Fence

(i) Construction Impacts

5.91 The main potential impact of fence construction is during and after vegetation clearance, when soil is exposed to rainfall and runoff. This is particularly likely to occur on steep slopes (more than 10 degrees), in valley bottoms which act as temporary runoff channels, and during periods of heavy rainfall. The effect of indiscriminate vegetation clearance can be observed adjacent to the Ruhuruini Gate of the Aberdares National Park, where clearance has already been undertaken on a steep slope for the proposed Phase IV of the fence. A section of hillside some 10-12 m wide has been stripped of vegetation and much of its topsoil using bulldozers, by a unit of the Kenya Army working under contract to KWS. This has exposed the

underlying soil to both sheet and gully erosion during the wettest months of the year, resulting in substantial quantities of soil sliding down the hill, smothering vegetation and polluting a stream. The location, method, seasonal timing and lack of soil stabilisation methods used for this clearance are environmentally unacceptable[1/].

5.92 The mission has examined the Memorandum of Understanding between KWS, the FD and the Army for this clearance. The only environmental protection measure specified is avoiding the cutting of trees in construction camp areas. No soil conservation measures are specified, and procedures for manual clearance of steep slopes are limited only by mechanical access. The mission was not able to obtain a copy of KWS Draft Guidelines for Assessment, Implementation and Monitoring of Fencing Projects in Kenya (KWS Fencing Unit, April 1994), but was advised that it stipulates that steep slopes should be cleared by hand.

(ii) Operational Impacts

5.93 The fence-line may affect natural drainage patterns, either by interrupting or diverting existing runoff, or by creating new runoff alignments. The need to maintain a 7 m wide strip around the fence clear of woody vegetation and tall herbaceous vegetation may lead to soil erosion, particularly if herbicides were to be used to control regrowth, as has been tried in the past.

Impacts of the Roads

(i) Construction Impacts

5.94 The potential construction impacts of the proposed perimeter road on hydrology, soils and water quality will be the same as for the fence clearance. Erosion is particularly likely on steep gradients and where roads are graded by constructing embankments.

(ii) Operational Impacts

5.95 Roads can interrupt drainage lines, and on slopes act as new drainage lines. Both these impacts are apparent in the case of existing roads within the Aberdares National Park. In the case of both new roads and existing roads for which rehabilitation is proposed, there is a need to address these problems by careful road grading, routing to minimise steep slopes and engineering the roads with an impervious surface, a proper camber and drains. This will not only reduce adverse environmental impacts, but will also enhance the durability and useability of the roads themselves.

1/ It was reported to the mission that clearance of Phase IV has been completed from Ruhuruini Gate to the Chanya River. The EIA mission was advised (but was unable to verify) that the Army cannot cross the river because of the rugged terrain, and is now clearing a path eastward through indigenous and plantation forest in order to find a suitable place to cross the river.

Impacts of Other Project Components

5.96 Those project elements which involve land-use changes or construction, particularly on steep slopes, could potentially have impacts on hydrology, water quality and soil. This is particularly likely to be a problem if permanent or temporary access tracks are constructed in steep areas for the purpose of bamboo harvesting. Rehabilitation of existing plantations should have a beneficial effect on soil stabilisation and conservation.

5.97 Sewage and solid waste from the proposed ecotourism developments could pollute surface water or ground water if not properly controlled.

Key Issues and Conclusions

5.98 **Beneficial Impacts**: the rehabilitation of existing roads (if properly engineered) and plantations will improve soil stability and assist in controlling runoff patterns.

5.99 **Adverse Impacts**: clearance of vegetation for constructing the fence and the proposed perimeter road, especially on steep slopes, is liable to lead to soil erosion and sedimentation of streams and rivers.

G. LANDSCAPE AND VISUAL IMPACT

5.100 The existing landscape of the Protected Areas is the result of a mixture of natural and human influences, as reflected in the different land uses (Chapter 3 and paras. 5.4-5.17).

5.101 Within the National Park and adjacent areas of natural forest, the landscape is dominated by wilderness, with only small human influences in the form of roads, lodges, bandas and other Park infrastructure. The landscape character of the National Park varies from the wide, open vistas of the high moorland to the tightly confined landscape of the montane forests and bamboo zones. The essentially unmodified nature of the existing landscape within these areas means that they are highly sensitive to adverse impacts from new structures, development activities or land-use changes.

5.102 In contrast, the landscape of the plantations, which are dominated by exotic trees, and the adjacent agricultural land, is almost entirely man-made. These areas are much less sensitive to the introduction of new structures or other landscape changes.

Impacts of the Fence

(i) Construction Impacts

5.103 During construction, the stripping of vegetation for the fence-line exposes bare soil, which has a strongly adverse impact on the landscape of natural and semi-natural vegetation. A particularly graphic example of this exists adjacent to the Ruhuruini Gate, where vegetation clearance for the proposed fence has created a wide scar on the hillside, visible from the National Park access road, both within and outside the Park boundary. The presence of construction plant and bulldozers within the Forest Reserve is also an adverse, albeit temporary, impact on the landscape.

(ii) Operational Impacts

5.104 When complete, the fence will constitute an alien, linear feature in the landscape. Although the fence structure itself is not particularly intrusive, except when viewed at close quarters, the requirement to maintain a 7 m wide clearing makes the fence a dominant landscape feature. However, there are relatively few viewpoints within the National Park from which the proposed fence will be visible. The fence will be visible from adjacent plantations, *shambas* and settlements close to which it is routed.

Impacts of the Roads

(i) Construction Impacts

5.105 In common with fence construction, road construction and rehabilitation will have temporary adverse impacts on the landscape from vegetation clearance, ground preparation and the presence of construction vehicles. These will only be of landscape and visual significance within the National Park and the natural forest.

(ii) Operational Impacts

5.106 The landscape impact of rehabilitating existing roads will be very small, but positive. New roads have potentially more significant impacts, although it is understood that the only new road proposed within the Park and the natural forest is along the fence-line, the landscape impact of which would be somewhat greater than that of the fence itself.

Impacts of Other Project Components

5.107 The only component which is proposed to be sited within the National Park is the ecotourism bandas. The siting of these needs to be carefully selected to optimise views from the bandas, without compromising existing views of the natural landscape. This is especially the case if bandas are sited within the moorland, owing to the wide extent of views across this area.

Key Issues and Conclusions

(i) Beneficial Impacts

5.108 The construction of appropriately-sited new tourist facilities such as lodges or bandas will, if carefully undertaken, provide visitors to the Protected Areas with new views of attractive landscapes. Similarly, sensitive rehabilitation of roads will enable more people to reach existing landscape viewpoints than is the case at present.

(ii) Adverse Impacts

5.109 The fence will have a moderately adverse impact on the landscape, but will be seen from relatively few viewpoints. The impact of the roads will be insignificant in plantation and agricultural areas, but potentially significant if the new perimeter road is built in the National Park, especially where visible from existing roads, trails or viewpoints. Lodges and bandas will have to be carefully sited and appropriately landscaped to avoid being intrusive in wilderness areas.

H. CONSTRUCTION MATERIALS

5.110 The requirement for construction materials can give rise to environmental impacts at the locations from which they are obtained, which may be outside the project area. These may relate to the use of renewable or non-renewable natural resources, or the need to process materials for use in construction. These impacts can only be identified in general terms, since the locations from which construction materials are to be obtained (and in may cases their specifications and quantities) are not known at the present time.

Impacts of the Fence

(i) Construction Impacts

5.111 The main construction materials required for the fence, based on a length of 280 km, will be approximately 56,000 timber poles (if current specifications remain valid) to serve as fence uprights, 3 million m of single strand wire and 500,000 m^2 of wire mesh, together with solar panels, batteries and energiser units. The sources of these materials is not determined at

this stage, but the timber poles are likely to be of local origin and would require the felling and utilisation of substantial numbers of eucalyptus from the Forest Reserve or other plantations.

(ii) Operational Impacts

5.112 Construction materials required during operation will be quantities of timber poles, wire and wire mesh to replace or repair fence sections which have been broken by animals, damaged or removed by people or are worn out. The mission has been advised that the life of Eucalyptus fence posts in the climate of Aberdares averages around 10 years. This implies an ongoing requirement averaging some 5,600 new fence posts per year during the life of the fence. The mission, however, would recommend the use of metal poles.

5.113 The operational electricity demand of the fence will be 45 W per 100 km of wire. Supply mechanisms are discussed in paras. 6.6-6.7.

Impacts of the Roads

(i) Construction Impacts

5.114 For the reasons discussed above, it is recommended that all new and rehabilitated roads be murramed. Based on a road length of 720 km, a road width of 4 m and a murram depth of 200 mm, the volume of murram required could be of the order of 580,000 m^3. The source of murram has not been determined, but for cost reasons is likely to be local. A number of existing Park roads have been murramed using material excavated from borrow pits within the Aberdares National Park, and the exposed quarry face of these sites is clearly visible adjacent to the road at several locations in the Afro-alpine moorland[1/]. This practice has had a number of significant adverse environmental impacts:

- It is contrary to the purpose of National Parks, as understood internationally, to permit extractive uses of this type.

- Moorland vegetation has been lost and damaged, and no attempt appears to have been made to rehabilitate the quarried areas.

- The exposed quarry faces present a highly adverse visual and landscape impact to Park visitors.

[1/] The EIA mission was advised that the original plan identified areas that could be quarried within the National Park and were less environmentally sensitive, away from the roadside and fence, and not visible to tourists. The contractor apparently found it easier to quarry murram along the roadside, and his contract was subsequently terminated. Road construction has stopped until KWS submits a plan, including artist's drawing, to rehabilitate the devastated areas.

5.115 Unless stricter controls are introduced, similar negative impacts are liable to occur when murram is obtained for road construction and rehabilitation.

(ii) Operational Impacts

5.116 Road maintenance will require smaller quantities of murram[1/], for which the same issues will arise as are identified in (i) above.

Impacts of Other Project Components

5.117 With regard to ecotourism development, the proposed new bandas are likely to be constructed mainly of timber, probably sourced from plantations in the Aberdares Forest Reserve.

Key Issues and Conclusions

(i) Beneficial Impacts

5.118 The requirement for timber, if sustainably harvested, could lead to positive socio-economic effects on plantation management, including the creation of jobs and income in adjacent communities.

(ii) Adverse Impacts

5.119 If it is not properly managed, the large timber requirement could lead to negative effects, such as deforestation and soil erosion, as well as using timber which is in demand for other purposes.

5.120 The extraction of murram for constructing and rehabilitating roads will have significant adverse environmental effects, unless carefully managed and controlled with the application of appropriate mitigation measures.

[1/] Operational losses are estimated to be about 25 mm per year per 100 vehicles/day, but could be higher in the Aberdares owing to the steep topography and wet climate.

6. TECHNICAL AND ECONOMIC ISSUES

6.1 The inclusion of technical and economic issues is normally outside of the scope of an Environmental Impact Assessment, and belongs within that of the project feasibility study. In the case of the fencing component of the ANRDP, however, the EIA team found that the environmental impacts of the fence could not be considered in isolation from the issue of its physical sustainability, particularly its effectiveness and maintenance requirements.

A. COST IMPLICATIONS OF THE FENCE

6.2 Electric fencing is extraordinarily expensive, both in terms of capital costs and recurrent costs. The capital costs of the fence, based on a length of 280 km, are estimated in the Project Preparation Report at approximately US$ 10 million and the maintenance costs at US$ 0.5 million per year. Following discussions with a number of project stakeholders, the mission believes that the capital cost is liable to be under-estimated, since the actual length of fence required to enclose the entire Aberdares system is likely to be longer than 280 km. Zoo Atlanta tentatively estimates the required length may be up to 40% longer. Based on experience with maintenance of the existing 80 km fence in the Salient section of the Aberdares, and making some allowance for the much greater difficulty of access to most parts of the proposed fence alignment, the maintenance costs of some US$ 0.5 million per year are not unreasonable, but this does not take into account the likely need to replace fence posts in the future.

6.3 It is furthermore not clear how the costs of fence maintenance after the six-year period of the project will be funded. Neither KWS[1/] nor the FD can meet these costs, unless, as proposed in the Project Preparation Report, revenue from forestry plantations can be retained for such purposes[2/]. At present, this revenue is remitted directly to the central treasury. It is the mission's view that secure funding for fence maintenance is a prerequisite to capital expenditure on fence construction. A poorly maintained fence would have serious environmental implications: the efficacy of "electrified" fences is dependent on Pavlovian avoidance conditioning. Sections of "dead" fencing would lead to frequent and recurrent breakages - even after power has been restored - with consequent funnelling of animals (especially elephant) into what now would likely be completely unprotected/undefended agricultural land.

6.4 Related to the aspect of cost is the increased institutional and human resources support which will be required by such a complex and multi-sectoral project. In addition to the

1/ The Director of KWS confirmed to the EIA mission that KWS cannot meet the large financial liability required to maintain the fence and considers that other game barriers and deterrents should be investigated.

2/ As part of the its new Forest Policy, the FD is considering leasing the forest plantations to private contractors as one of the possible modalities of improving the management of the forest plantations. How the revenue generated from the plantations would be allocated towards maintaining the fence has yet to be determined. The establishment of a fund or other mechanism, which would be included as part of the contractual agreement to cover fence or other barrier maintenance costs as well as road maintenance and improvement, should be investigated.

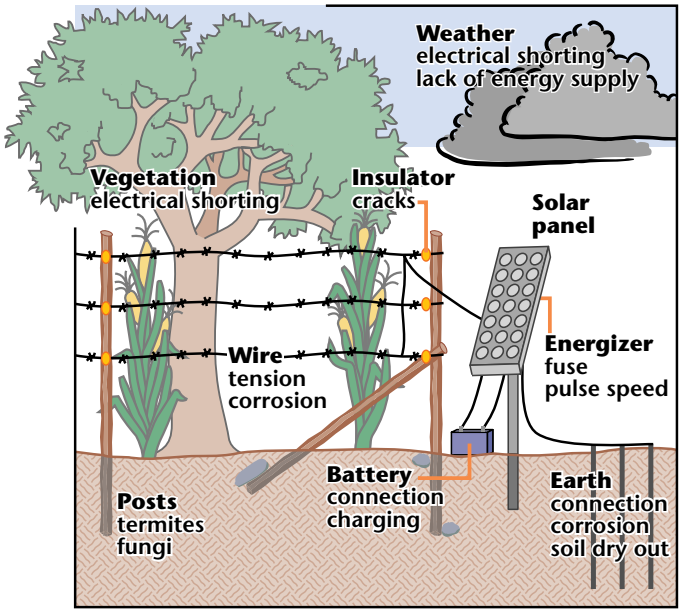
need to increase the number of forest guards, it is estimated in the Project Preparation Report that two persons will be required to maintain each 8 km section of fence-line, which would mean that some 90 persons would be required to maintain the entire 360 km fence. This does not include the scores of persons who would be required to man the Forest Reserve access gates if these are to be constructed, as has been proposed, at intervals of approximately 5 km. Presently, however, both KWS and the FD are in the process of retrenching (see paras. 2.7 and 2.8).

6.5 Proposed fencing of the entire Aberdares ecosystem is unlikely to be physically sustainable due to the high costs of maintenance. Arrangements to cover the human and financial requirements for providing adequate and appropriate maintenance should be agreed, if not in place, **prior** to constructing the fence.

B. ELECTRICITY SUPPLY TO FENCE

6.6 The existence of so many deficiencies in fence design/operation in Phases I and II of the fence, an area of relatively gentle terrain, poses the question of how effective the fence will be in areas of extensively rugged terrain, such as will be encountered in Phases IV to VII. Of critical importance in these areas is the provision of power for the fence[1/]. A number of options have been discussed for supplying electricity to the fence:

Maintenance points on a powered fence



(i) Connection to the main grid

This is only likely to be practicable where the fence is located close to existing grid connections, as is the case around the Salient. Extension of the grid to serve remote sections of fence would be technically difficult, expensive (in terms of the construction and maintenance of the infrastructure required for a high voltage, low wattage supply), and would give rise to adverse impacts on the landscape and on adjacent communities (pylons, overhead power lines).

1/ The Mission was informed by the Coordinator of the KWS Fencing Unit that the electricity demand of the fence is 45 Watts per 100 km. of electrified wire, which equates with a total demand of 650 Watts for a four-wire fence of 360 km in length. The average voltage will be 5,000 Volts, with a maximum of 9,000 Volts, delivered in low impedance pulses.

(ii) **Solar Energisers**

These are the most common sources of energy for electric fences in tropical countries, since they are relatively inexpensive to install and maintain, can be placed in remote locations and are ideally suited to generating low wattage supplies. However, the Project Preparation Report states that solar-powered batteries have been found to be unreliable in the constructed sections of fence in the Aberdares, because of insufficient sunshine. In the mission's view, this problem is likely to be more acute along some other parts of the fence-line, particularly in the south-eastern section, where low clouds and mist persist for large parts of the year.

(iii) **Connection to mini-hydropower schemes**

This is the solution recommended in the Project Preparation Report for energising remote sections of fence. Whilst it is the case that there are many streams in the Aberdares which could be tapped, the feasibility of this option has yet to be established. In particular, mini-hydropower schemes are liable to require substantial maintenance, as they will be vulnerable to damage from landslides, major floods, mechanical breakdown and vandalism. The technical skills needed to repair such faults will limit how quickly they can be resolved. This implies that there would need to be a dedicated repair team, together with a high degree of back-up in the electricity generation capacity, if a continuous supply to the fence is to be assured.

6.7 The mission considers that the feasibility of an appropriate energiser option needs to be clearly established as a pre-requisite to constructing sections of fence in remote parts of the Aberdares. If mini-hydropower is the only available option, then a demonstration scheme should be established beforehand. This could most appropriately be done in association with a local community, which would benefit from a proportion of the power, in return for undertaking basic maintenance tasks and reporting major breakdowns.

C. EFFECTIVENESS OF THE FENCE

6.8 The EIA mission believes that the fence in Phases I and II, which was primarily erected for the purpose of establishing a rhino sanctuary, has been successful in protecting rhinos. According to Rhino Ark, KWS and Zoo Atlanta, it has also been very effective in reducing human-wildlife conflicts and is popular with the local communities. The EIA mission considers, however, that while it is also effective against buffaloes, lions and other large mammals, it is less so against elephants. Elephants continue to break through the fence seasonally, principally along main migration routes, causing considerable damage to crops and livestock[1/].

[1/] According to KWS reports, there were 31 breakages in 1996.

6.9 Moreover, the fence has proved to be ineffective against primates, which cause even more damage than do elephants as they raid year-round. Baboon-specific design adjustments to the fence in Phases I and II have failed to date. Women, who are largely responsible for guarding household farms against primates, invest a considerable amount of time chasing away primates - time which could otherwise be used productively. The ineffectiveness of the electric fence against primates is clearly an important issue for these women and merits greater attention.

Agnes, a woman in her 60s, reported that elephants had broken into her farm five consecutive times in one week last August, ruining her crops. She said that the old game moat, which was abandoned in 1990 when work on the electric fence began, in conjunction with Mauritius thorn (a traditional vegetative barrier), was more effective than the electric fence. However, she recalls uprooting the Mauritius thorn when the fence was being constructed as she was told that the latter would be fully effective against elephants.

Partial Effectiveness of the Fence in Phase I

6.10 The mission noted that there were several places along the Phase II fence where the wire-mesh (intended as a barrier to burrowing species such as porcupine and wild pigs) was not serving its purpose. This was because:

- the mesh had not been sunk beneath the ground due to the rocky nature of the terrain;
- erosion gulleys had scoured soil from beneath the mesh, thus exposing "invasion" routes;
- culverts had been incorporated into the fence below the level of the mesh, thus providing access for may small- to medium-sized animals.

6.11 Prior to the construction of any new fence, problem animals should be targeted and, wherever possible, animal-specific designs should be adopted to maximise effectiveness. Local communities should be informed about the shortcomings of the fence **before** construction, otherwise unreasonable expectations that cannot be met will be raised, compromising stakeholder ownership of the project.

D. CONCLUSION

6.12 The mission considers that whilst the existing fence provides a measure of protection for the Protected Areas against encroachment, illegal logging and hunting, without a strong FD and community support, its physical existence is no guarantee of long-term protection for the ecosystems.

6.13 The mission considers that the proposed fencing of the **entire** Aberdares ecosystem is of doubtful cost-effectiveness, is unlikely to fulfil the needs of many surrounding communities, is liable to prove physically unsustainable owing to the requirements and high costs of maintenance, and may not be the most appropriate way of conserving this important ecosystem.

The shortcomings evidenced in Phases I and II of the fence would likely be witnessed in other sections, including its ineffectiveness in protecting plantation forests from village damage. The merits of other measures for protecting the Aberdares ecosystem and reducing human-wildlife conflict, which may take the form of other barriers, community-based conservation, and, particularly, a strengthened FD, should be investigated, including a cost-effectiveness analysis of the different possibilities, as well as a cost-benefit analysis of the recommended option.

7. MITIGATION MEASURES

7.1 The measures that follow are recommended to mitigate the potential adverse environmental impacts of the investments as proposed in the 1995 PPR. In the course of its work, however, the EIA mission became convinced that a modified project alternative, in which construction of an electric fence would be only one element of a more comprehensive strategy, would be the most effective means of conserving the ecosystem and reducing the level of human-wildlife conflict (see Chapter 9 below "Conclusions and Recommendations"). Tables summarizing the potential environmental impact, proposed mitigation measures and indicative costs can be found at the end of this Chapter. Because of the numerous variables relating to unresolved issues, the costs of the mitigation measures are only tentatively estimated. An indicative budget for the proposed mitigation measures is attached as Annex 1. In the development of the Management Plan during the first year of the project, when most of the issues should be resolved, the costs of the mitigation measures will need to be more accurately estimated.

A. THE FENCE

7.2 The following mitigation measures are based on the assumption that the major investment of the project would continue to be the construction of a perimeter fence, eventually amounting to a length of approximately 360 km, around the **entire** Aberdares National Park and Forest Reserve (with the exception, as stipulated in the 1995 PPR, of the Kikuyu Escarpment and Kikipiri and Ndaragwa forests).

Specific Mitigation Measures during Fence Construction

7.3 Where sections of fence are to be constructed, the following measures should be implemented.

(i) The whole fence-line should be determined using aerial imagery and ground investigation, to take into account surrounding land uses, ecological sensitivities and topographical constraints (avoiding steep gradients), prior to any fence-line clearance being undertaken. The primary criterion for fence alignment should be the inclusion within the fenced area of all natural forest areas to the greatest possible extent, in order to minimise human encroachment of excluded areas and the severance of existing wildlife habitat.

(ii) Clearance of the fence-line should be undertaken concurrently with fence construction, and all areas of bare soil should be re-seeded immediately after construction, so as to minimise soil erosion.

(iii) Clearance for and construction of the fence should be undertaken in accordance with clear and precise fencing guidelines which would include an environmental management plan drawn up by KWS, the FD and an environmental specialist (from MENR, KWS, or project-supported). The KWS Draft Guidelines for Assessment, Implementation, and Monitoring of Fencing Projects in Kenya (KWS Fencing Unit, April 1994) should be revised and updated for this purpose and widely disseminated. A framework environmental management plan could form part of the KWS fencing guidelines and then be adapted specifically for the Aberdares fencing programme during the preparation of the Aberdares Management Plan.

(iv) Mechanical vegetation clearance should **not** be carried out on steep slopes (more than 10 degrees); such areas should be prominently marked out in the field by KWS and FD and cleared by hand.

(v) Fence clearance and construction should not be undertaken during periods of high rainfall.

(vi) Contractors undertaking fence-line clearance and fence construction should be supervised daily by an officer from KWS or another appropriate environmental specialist, to ensure that all environmental protection measures, including conservation of soils and vegetation, are implemented.

(vii) Fence-line clearance and fence construction should be undertaken by specialist contractors using labour recruited to the extent possible from local communities. This would enable community sensitivities to be addressed, and build a sense of fence ownership in the communities.

(viii) The use of metal rather than timber poles is recommended because they are expected to be more effective against elephants, and would last much longer and require less maintenance.

Specific Mitigation Measures during Fence Operation

7.4 The following measures are proposed to reduce adverse environmental impacts once the fence has been constructed.

(i) Technical aspects of fence maintenance (repair of broken wires, insulators, replacement of posts, servicing of electric units etc.) should be the responsibility of a trained fencing unit.

(ii) Wherever possible, routine maintenance patrols should be carried out on foot, bicycle, donkey and horseback to avoid the need for a permanent perimeter road along the fence-line which could be - and currently is - used

for illegal felling of indigenous trees and poaching. The perimeter road has provided easy access to areas of forest which were previously inaccessible.

(iii) Vegetation growth around the fence should be controlled by manual cutting, ideally by the beneficiaries of the fence, and not by the application of herbicides.

(iv) Funds for fence maintenance should be assured; the setting up of a Trust Fund or a Fence Maintenance Fund, such as that established by the communities for the repair and maintenance of the Meru fence, should be investigated.

(v) Problem animal control (PAC) measures should be undertaken in an efficient and timely manner. PAC units should be deployed at either end of the fence to deal with any "funnelling" of problem animals. The units should be well-equipped (large-calibre rifles, radios, thunderflashes), staffed by trained KWS personnel, and patrols should be carried out on horseback. Where the fence crosses a known elephant migration route (see paras. 7.6-7.8 below relating to elephant corridors), during the rainy season (peak elephant movement) additional PAC staff should be deployed for rapid reaction to fence breakers. This applies specifically to Phases I, II and III of the fence. Before elephants begin to respect the fence, it may be necessary to shoot fence-breakers as a deterrent to others.

(vi) Where baboons are a specific problem in regularly raiding crops, KWS should undertake control in affected areas by shooting individual animals. This would be expected to have a deterrent effect on other individuals.

Mitigation Measures Relating to Adverse Environmental Impact on Wildlife

(i) Artificial Saltlicks

7.5 It is generally accepted that the lack of natural saltlicks in the northern sector of the Protected Areas is one of the causes of elephant movements to saltlicks found on private land. It is recommended that, subject to an environmental assessment, mineral supplements be strategically distributed throughout the Protected Areas to reduce elephant movements, crop raiding and to prevent localized habitat destruction such as is seen in the immediate vicinity of the Treetops and Ark lodges. The effectiveness and environmental impact of the artificial mineral licks should be systematically monitored. Whether as a long-term solution or as an experiment, such a strategy should be tried before attempting to establish elephant "corridors".

(ii) Elephant Corridors

7.6 The possibility of corridor routes to allow elephant migration out of fenced areas should be further explored to relieve compression of elephant populations within the ecosystem, allow ingress as well as egress, and facilitate seasonal movement cycles.

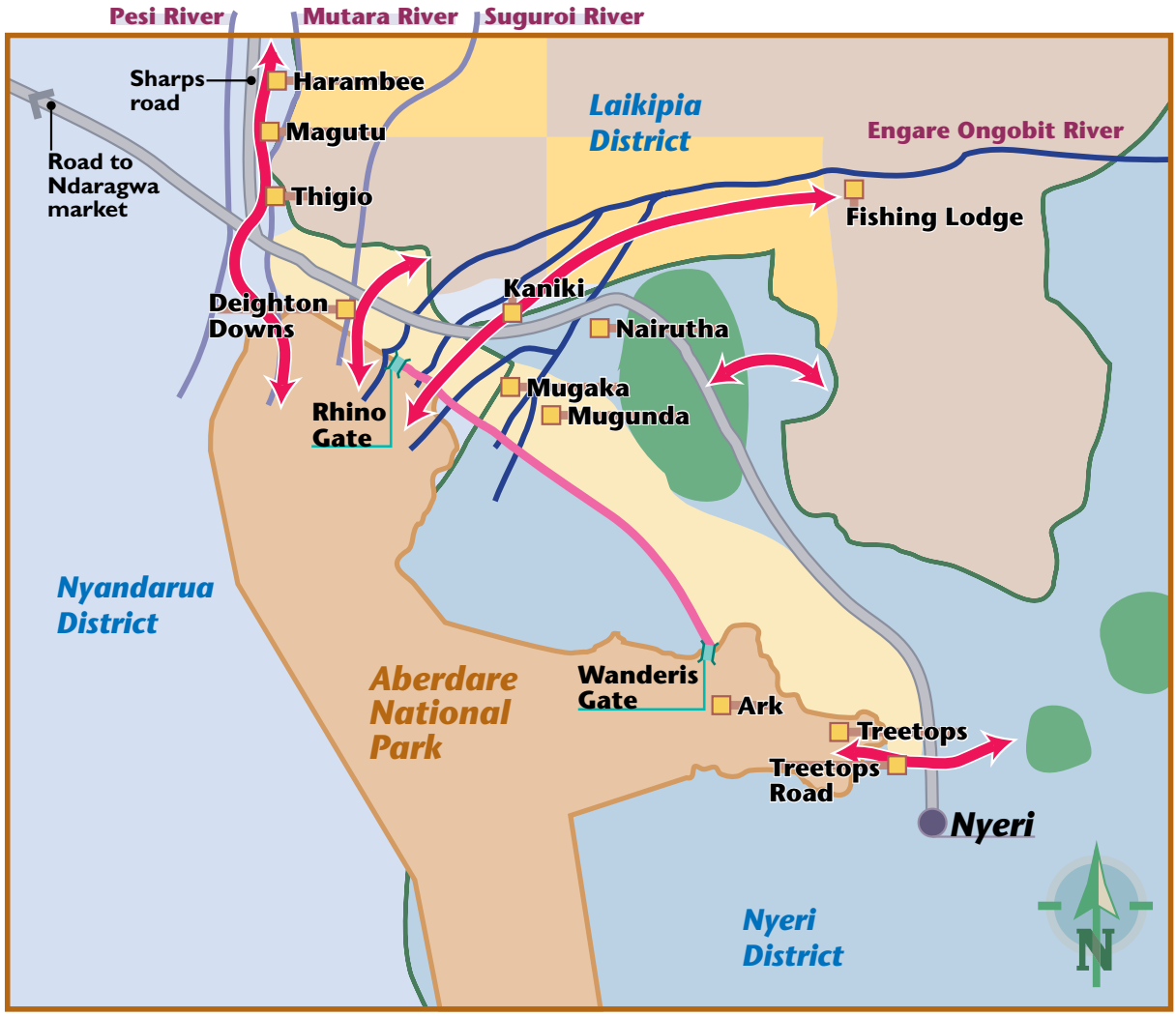
At the very least, the feasibility of establishing a limited elephant "dispersal area" in the region and of involving communities in tourism/wildlife initiatives should be explored before foreclosing on these and other such options by completing the Phase III fence.

7.7 Controversial as elephant corridors are, in the northern sector of the Protected Areas they are key issues (see Map 7). Establishment of elephant corridors involves sensitive land issues and necessitates complex, extensive and protracted land negotiations. Unless KWS and/or an NGO is prepared to undertake such negotiations, the establishment of corridors is unlikely to be successful. To a large extent, their viability as corridors depends on unhindered movement between the Aberdares and the Laikipia elephant populations, and, whilst the establishment of such corridors is a daunting proposition, it should not be dismissed out of hand. Although much of the area is subdivided, settlement is still sparse due to the discouraging farming conditions (thin soils, rain-fed agriculture uneconomical). Some landowners in the area have expressed interest in developing tourism ventures and do not oppose the setting up of a corridor. Despite the obvious constraints (presence of subsistence agriculture, human population) the opportunities for establishing elephant corridors should be investigated further, as should the potential for community-driven tourism/wildlife initiatives in such corridors.

7.8 One other elephant migration route occurs in the region: that between the Salient and the Nyeri Forest/ Thego Forest/Sangare Ranch area (previously between the Aberdares and Mt. Kenya). In the recent past, this route extended east to the forests of Mt. Kenya, but has since been cut off by settlement. The Salient side of the route is interrupted by the Phase I electric fence of the rhino sanctuary (although this is still being broken by elephants trying to "break-out"). Efforts are being made by the Save the Rainforest Trust to re-establish this ancient migration route as an elephant corridor. In view of the high density of human population on the Mt. Kenya side of this proposed corridor and the fencing activities in south-western Mt. Kenya, its viability - with stakeholder participation in a scheme similar in scope to that operating in the Shimba Hills - may be questionable. Nonetheless, as a matter of priority a feasibility study for such an option should be undertaken, especially since a remnant herd of some 60 elephants is currently marooned in the area and surrounded by settlement.

A herd of approximately 60 elephants is stranded in the Sangare Ranch-Nyeri Forest-Thebo Forest area. Their access to the forests of Mt. Kenya has already been cut off by settlements and will be further restricted by the electric fence being erected in south-western Mt. Kenya. Access to the Aberdares will be presented by the Phase I electric fence. They pose a considerable problem both to KWS and the farming communities surrounding them. Subject to community support, it might be possible to re-route the Phase I fence so as to provide a corridor for this threatened population. However, in the absence of external funding (in the form of compensation to landowners in the proposed corridor area), such an exercise will merely postpone the day when active management intervention by KWS (translocation/shooting) will become mandatory.

Map 7: Elephant migration routes, distribution of salt licks and land-use distribution – Northern Region



B. ROADS

Road Planning Strategy

7.9 The EIA mission endorses the priority given in the Project Preparation Report to rehabilitating existing roads within and leading to the National Park and the Forest Reserve to provide all weather access for staff, residents and visitors, and to rehabilitating existing access roads to meet identified needs of local communities living around the Forest Reserve.

7.10 However, as noted in various Chapters of this report, the mission recommends, that the proposed perimeter road to be constructed along the fence-line be dropped from the project because of logistical constraints and environmental impacts during construction, and because by providing access to the forest it would facilitate illegal forest activities. As an alternative, provision should be made for fence maintenance teams to operate on foot, bicycle, donkey, and horseback.

7.11 As part of the road planning strategy, guidelines should be drawn up for usage zoning of tourism within the National Park. These would allocate different areas to intensive use, less intensive use and wilderness. For example, rehabilitation and upgrading of the route from Naivasha to the Park via Mutubio West Gate would create a through route to Nyeri and substantially increase vehicular access to the south-central part of the Park. It is recommended that the northern part of the Park be allocated to less intensive use (four- wheel drive only) and wilderness (walking trails only).

Specific Mitigation Measures to be Adopted during Road Construction

7.12 All new and rehabilitated roads should be constructed with murram to give an all weather surface, cambered and provided with drains on the upslope side, with drainage culverted beneath the road where necessary.

7.13 Murram for road construction should be obtained from outside the National Park boundary. If this is not technically or economically feasible in relation to Park roads, then all borrow pits should be located out of sight from any road, trail, footpath or viewing point, and following excavation they should be contoured using spoil and rehabilitated with stored top soil and seeded with plants from adjacent areas. A plan, including artist's drawings, for restoration of degraded areas should be a prerequisite to construction being undertaken. No murram for roads outside the Park should be obtained from within the Park.

7.14 The siting of any new roads in the National Park and natural forest should be selected to be visually unobtrusive, to minimise the loss of existing vegetation and to avoid steep gradients wherever possible.

7.15 All new roads and road widening requiring new earthworks should be constructed to prevent erosion, by immediate topsoil covering and planting to ensure stabilisation. Particularly steep earthworks should be stabilised with a geotextile overlay.

7.16 All new and rehabilitated roads should be the subject of a site-specific environmental appraisal prior to construction. In the case of rehabilitating existing roads, this would take the form of a walk-over of the route by a suitably experienced environmental specialist, who would identify and report on any sections where minor re-routing is required for aesthetic reasons, to prevent erosion, avoid ecologically sensitive vegetation or improve drainage. Any proposed new roads would require more detailed attention, including environmental assessment of different route options with particular attention to topography, drainage, erosion, ecology and landscape impact.

C. OTHER PROJECT COMPONENTS

Ecotourism

7.17 The nature, scale and siting of all ecotourism developments needs to be determined as part of the National Park Management Plan, taking into account land-use zoning, access, the tourism market, views of KWS, the FD and, where situated outside the Park itself, local communities that may be affected.

7.18 The residential tourism potential of the high moorlands is considered to be limited in extent and seasonal. The EIA mission supports the proposal outlined in the Project Preparation Report that only low-impact tourism, based on small numbers of people, walking rather than driving, should be accommodated in this zone.

7.19 All new tourism developments would require provision for liquid waste disposal by means of cess pits and solid waste to be trucked out of the Park for disposal.

Plantations

7.20 The possibilities for planting indigenous trees (for example, Meru oak and cedar) or exotic species (such as *Cupressus japonica),* which may be less susceptible to wildlife damage should be investigated by the FD. Consideration might be given to conducting trials on plantations that have been clearfelled but not yet replanted. Species and seed sources indigenous to the site should be used.

7.21 The mission recommends that, if a fence is to be constructed, the most appropriate alignment would be along the Forest Reserve boundary, which would result in fencing in the exotic and indigenous plantations. In order to protect them from wildlife damage, existing game moats should be rehabilitated. Alternatively, considerable savings should result from fencing only critical problem areas rather than the entire ecosystem. Consideration could be given to constructing an electric fence around the plantations which suffer significant damage from wildlife. The mission considers the three-strand barbed wire fences around the plantations which are proposed in the Project Preparation Report to be ineffective against the primary problem animal - the elephant.

Sustainable Harvesting of Bamboo

7.22 Research on the unique flowering cycle of bamboo and its role in the ecosystem should be undertaken, and the sustainable level of bamboo harvesting determined. No clear-felling of bamboo should be undertaken. No permanent access tracks should be constructed into bamboo areas, and where there is no alternative to constructing temporary tracks, these should be broken up after use. No tracks or access routes should be constructed or used on slopes of more than 10 degrees. The selection of areas for bamboo harvesting should take these access constraints into account.

Specific Mitigation Measures and Estimated Costs based on the Evaluation of the 1995 Project Preparation

Table 3. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 1)

CONSTRUCTION IMPACTS

Project Intervention/Investment	Related Activities which May Result in Environmental Impact	Potential Environmental Impact	Proposed Mitigation Measures	Implementation Period	Responsibility	Cost US$
FENCE CONSTRUCTION						
Fence Construction	Inappropriate fence alignment	Increase in illegal felling of indigenous trees and poaching of wildlife (outside the fence)	Fence-line should follow the Forest Reserve boundary	1997-2003	KWS/FD	PC
		Encroachment into natural forest area up to fence-line and possible excision	Comprehensive fence alignment study to be undertaken for each section of the proposed fence-line, examining all barrier and non-barrier possibilities	1997-1998	KWS/FD	NC[1/]
			Use of aerial photography and remote sensing to assist in determining optimal alignment	1998	Contractor/FAO/KWS/FD	PC[2/]
			KWS Draft Guidelines for Assessment, Implementation and Monitoring and Fencing Projects in Kenya (KWS Fencing Unit, April 1994) to be updated, published and widely circulated. An environmental management plan for construction should be included and strictly enforced.	1998	KWS/FD/MENR	20,000[3/]

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Table 3. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 2)

CONSTRUCTION IMPACTS

Project Intervention/Investment	Related Activities which May Result in Environmental Impact	Potential Environmental Impact	Proposed Mitigation Measures	Implementation Period	Responsibility	Cost US$
Fence Construction	Clearance of fence-line	Landslip, erosion, gullying of cleared fence-line	Clearance and construction to be undertaken concurrently	1999-2003	Contractor/KWS/FD	PC
			All bare soil to be immediately reseeded with low-growing grass (e.g. Kikuyu grass)	1999-2003	Contractor/KWS/FD	40,000[4/]
			No clearance during high rainfall periods	1999-2003	Contractor/KWS/FD	NC
		Sedimentation of rivers and streams	All steep areas (>10^0) to be cleared manually and prominently marked as such in the field	1999-2003	Contractor/KWS/FD	PC
			No clearance during periods of high rainfall	1999-2003	Contractor/KWS/FD	NC
		Unnecessary destruction of trees and natural vegetation by exceeding strip-width specifications	Contractors to be strictly supervised daily by KWS and/or Environmental Specialist	1999-2003	Contractor/KWS/FD	PC
		Interruption of natural drainage channels	ditto	1997-2003	Contractor/KWS/FD	PC
		Invasion of cleared fence-line by secondary growth and weeds	All bare soil to be immediately reseeded following construction	1997-2003	KWS/Environmental Specialist	PC[5/]
	Progression of fence construction across elephant migration routes and consequent "funnelling" of elephants towards unfenced areas	Concentration of elephant damage (in forest/agricultural lands) in unfenced areas	Distribute mineral supplements in strategic locations within the Protected Areas	1998-2003	KWS/FD	10,000[6/]
			Deploy PAC Units during migration season	1998-2003	KWS/FD	600,000[7/]

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Table 3. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 3)

CONSTRUCTION IMPACTS

Project Intervention/Investment	Related Activities which May Result in Environmental Impact	Potential Environmental Impact	Proposed Mitigation Measures	Implementation Period	Responsibility	Cost US$
Fence Construction	Poaching of wildlife by construction workers	Loss of rare animal species	Strict supervision of construction workers by KWS	1998-2003	KWS/Contractor	NC
	Herding of livestock along fence-line (to access gates)	Overgrazing/Soil erosion	Render fence-line impassable to livestock	1997	KWS/FD/Communities	1,080[8/]
	Use of herbicides	Water contamination, health problems to fence-adjacent communities, livestock and wildlife	Manual clearance of vegetation regrowth	1999-2002	KWS/FD	PC
	Construction of pylons and overhead power cables due to inappropriate/inadequate power supply infrastructure (e.g. distance from electricity grid; inefficient solar power).	Adverse ecological and landscape (visual) impacts	Fence to be sited only in those areas where there is a reliable local power supply (solar, hydro-power or electricity grid)	1999-2003	KWS/FD/Contractor	NC
ROAD CONSTRUCTION						
Road construction/ rehabilitation	Quarrying of murram	Intrusion into sensitive landscapes, degraded ares	Murram to be obtained from outside National Park. Plan to be developed for quarrying of murram from least sensitive areas, including plan (with artists' drawings) for restoration or quarried areas	1999-2003	Contractor/KWS/FD	PC
			Location of borrow pits out of sight from public viewpoints	1999-2003	KWS/FD/Contractor	NC

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Table 3. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 4)

CONSTRUCTION IMPACTS

Project Intervention/Investment	Related Activities which May Result in Environmental Impact	Potential Environmental Impact	Proposed Mitigation Measures	Implementation Period	Responsibility	Cost US$
Road construction/ rehabilitation	Quarrying of murram	Intrusion into sensitive landscapes, degraded areas	Rehabilitation of borrow pits wit h soil and replanting immediately following construction	1999-2003	Contractor/KWS/FD	PC
			Daily supervision of quarrying activities	1999-2003	KWS/FD/MENR	NC
	Road construction	Alternation of drainage patterns	Rehabilitated roads to be murram ed, cambered and provided with drains on the upslope side with drainage culverted beneath the road where necessary	1999-2003	Contractor/KWS/FD	PC
			Daily supervision of road work	1997-2002	KWS/Environmental Specialist/Engineer	PC
	Road construction	Adverse ecological and landscape impacts	Site-specific environmental assessment prior to initiating road work	1999-2003	Contractor/KWS/FD/ Environmental Specialist	PC
		Soil erosion, gullying, downstream sedi mentation	Avoid steep slopes wherever possible	1999-2003	Contractor/KWS/FD	NC
			Stabilize all new earthworks with planting of geotextiles	1999-2003	Contractor/KWS/FD	PC
Construction of perimeter road along fence-line	Clearing of fence-line	Erosion, gullying, sedimentation of waterways (same as above)	(Same as above)	1997-2003	KWS/FD/Contractor	PC
		Soil erosion and degradation caused by movement of cattle along fence-line	Regulate livestock numbers entering Forest Reserve	1997-2003	FD/Communities	NC

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Table 3. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 5)

CONSTRUCTION IMPACTS

Project Intervention/Investment	Related Activities which May Result in Environmental Impact	Potential Environmental Impact	Proposed Mitigation Measures	Implementation Period	Responsibility	Cost US$
ECOTOURISM: CONSTRUCTION						
Ecotourism Development	Construction of bandas and walking trails	Visitor pressure on sensitive sites (no major impact expected)	Bandas and walking trails to be established in accordance with land-use zoning to be carried out as part of the Park Management Plan	1999-2003	KWS/KFD	PC[9/]
			Low impact tourism (walking) only to be accommodated in moorlands	1997-2003	KWS/FD/Communities	NC
		Pollution	Solid waste from bandas to be trucked out of National Park for disposal	1999-2003	KWS/FD/Communities	PC

FOOTNOTES

1/ Zoo Atlanta fence alignment study is presently under preparation. There may be a need for further investigation depending on results of this study.
2/ Already costed in the 1995 project design.
3/ Based on a projected two person months @ US$ 7,500 per pm and additional US$ 5,000 for publishing and dissemination.
4/ Figure based on a total of 200 hectacres costing US$ 200 per ha.
5/ Cost included under # 4 above.
6/ Costs to be confirmed.
7/ Three person team x three teams x 3 months/year x 6 years = US$ 600,000. Costs to be confirmed. Since KWS does not currently have additional trained/experienced rangers, and the extra teams would only need to be available during the three months of the year when crops are ripe, KWS may want to investigate putting the PAC operation out to tender. Competent professional hunter outfitters with experienced staff, vehicles and equipment could be considered to undertake the work.
8/ Construct ditches/barriers every 5 km (80 km - Phases I and II; 40 km - Phase III) = 120 km/5 km = 24 barriers. 5 days x 3 persons x US$ 3 x 24 barriers = US$ 1,080.
9/ Included in cost of preparation of Management Plan in first year of project.

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Specific Mitigation Measures and Estimated Costs based on the Evaluation of the 1995 Project Preparation

Table 4. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 1)

OPERATIONS IMPACTS

Potential Negative Impacts	Mitigating Measures	Implementation Period	Responsibility	Cost (US$)
FENCE: OPERATION				
Encroachment of natural and plantation forest in those parts of the Forest Reserve fenced OUT	Strengthen Forest Department to enforce existing regulations	1997-2003	KWS/FD	PC [1/]
	Routine aerial and ground surveillance, community liaison	1997-2003	FD/KWS	PC [2/]
Increased illegal forest activity (poaching, timber felling etc.) due to fence perimeter road.	Render road impassable for vehicles (ditches, fences)	1997-2003	KWS/FD	1,080 [3/]
(Increased access to PAs)	Fence maintenance to be carried out on foot, bicycle, donkey or horseback	1998-2003	KWS/FD	PC
	Increase forestry and anti-poaching patrols; law enforcement	1997-2003	KWS/FD	NC
	Increase public awareness of value of biodiversity (wildlife, plant/forest)	1997-2003	KWS/FD/Communities	9,500 [4/]
Increased poaching due to use of fence as an aid in hunting wild animals (especially in conjunction with dogs).	Increase anti-poaching patrols	1997-2003	KWS/FD	NC
	Community participation in ecotourism initiatives	1998-2003	KWS/FD/Communities	PC[5/]
	Increase public awareness of value of wildlife	1997-2003	KWS/FD/Communities	PC [5/]

Table 4. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 2)

OPERATIONS IMPACTS

Potential Negative Impacts	Mitigating Measures	Implementation Period	Responsibility	Cost (US$)
FENCE: OPERATION				
Damage to indigenous forest (increase in elephant population within the PAs)	Active management of the elephant population by: (i) Culling of family units (ii) Translocation to other Parks/Reserves (iii) Introduction of birth control/sterilization measures (iv) Establishment of elephant corridors to relieve elephant pressure on the PAs	1997-2003	KWS	NC [6/]
Aggression towards humans by confined lion population	Active management of the lion population by: (i) Culling of sub-adult males (ii) Translocation to other Parks/Reserves (iii) Introduction of birth control/sterilisation measures (iv) Provision of armed guards for hikers	1998-2003	KWS	NC [6/]
Increased pressure on fence along elephant migration routes	Distribute mineral supplements in strategic locations within the PAs Deploy Problem Animal Control (PAC) units to shoot persistent fence breakers Establish elephant corridors	1998-2003 1998-2003 1998-2003	KWS KWS KWS/FD/Communities	10,000 [7/] PC [8/] 22,500 [9/]

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FACTD = Forest-adjacent Community Development Team

Table 4. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 3)

OPERATIONS IMPACTS

Potential Negative Impacts	Mitigating Measures	Implementation Period	Responsibility	Cost (US$)
Increased elephant damage to trees in those forest plantations fenced IN	Deploy PAC units to deter marauding animals	1998-2003	KWS	PC [8/]
	Distribute mineral supplements in strategic locations away from the plantation zones	1998-2003	KWS	10,000 [7/]
	Rehabilitate existing game moats	1998-2003	FD	PC [10/]
	Abandon remote or unprofitable plantations	1998-2003	FD	NC
	Plant indigenous tree species (e.g. Meru oak) or exotics that are not subject to damage by elephants (e.g. Cupressus japonica)	1998-2003	FD	PC
Non-sustainable demand for water for irrigation purposes in marginal agricultural land (crops now protected by fence)	Regulate water supply	1998-2003	MLRRWD, MALD&M	NC
	Devise land-use plan	1998	KWS/FD, MALD&M, MLRRWD	45,000 [11/]
Entanglement of animals in fence	Improve fence design (trials)	1998-2003	KWS/FD/Rhino Ark	165,000 [12/]
	Maintain fence-line (cut down vegetation to improve fence visibility)	1997-2003	KWS/FD/Communities	NC [13/]
	Improve fence visibility with strips of plastic etc.	1998	KWS/FD/Contractor	PC [12/]

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Table 4. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 4)

OPERATIONS IMPACTS

Potential Negative Impacts	Mitigating Measures	Implementation Period	Responsibility	Cost (US$)
Instability of "island" ecosystem [14/]	Active management intervention to conserve optimum species mix and diversity of the ecosystem (especially the grazers/browsers, mix predators/prey, host/parasites relationshipsand balances)	1998-2003	KWS/FD/NMK/PAMU	NC [15/]
Decrease in bongo, giant forest hog populations through increased predation by lion	Active management of lion population by: (i) Culling of sub-adult males (ii) Translocation to other Parks/Reserves (iii) Introduction of birth control/sterilisation measures	1998-2003	KWS	NC
Reduction in the gene pool/inbreeding/decline in hybrid vigour of critical wildlife populations (e.g. rhino, bongo, giant forest hog)	Introduction of new bloodstock into the PAs (translocation) or introduction of artificial insemination measures	1998-2003	KWS/PAMU Programme/NMK/ Rhino Ark	PC [16/]
Increased human wildlife conflict caused by animals (especially elephant and lion) fenced OUT	Deploy Problem Animal Control Units (PACs) to eliminate problem animals Translocate problem animals to other Parks/Reserves Allow sport hunting of problem animals	1997-2003 1998-2003 1998-2003	KWS KWS KWS/Communities	PC [8/] PC [16/] NC [17/]
Bird-strikes and resultant deaths	Improve visibility of fence by hanging strips of plastic etc.	1998-2003	KWS/FD/Contractor	NC [12/]
Deaths of animals due to fire (unable to escape)	Improve fire-detection systems Improve fire-fighting systems	1998-2003 1998-2003	FD FD	PC [18/] PC [18/]

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Table 4. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 5)

OPERATIONS IMPACTS

Potential Negative Impacts	Mitigating Measures	Implementation Period	Responsibility	Cost (US$)
Over-grazing and soil erosion of Protected Areas due to channelling of livestock through fence access gates	Control livestock numbers entering the PAs	1997-2003	FD/KWS/Communities	NC
	Introduce rotational grazing within the PAs	1997-2003	FD/KWS/Communities	NC
Increased fire-hazard (lightning strikes; short circuits)	Ensure adequate earthing along the entire length of the fence	1997-2003	KWS/FD/Contractor/Rhino Ark	NC
	Ensure effective maintenance of fence and fence-line to prevent accumulation of combustible material (leaf litter etc.) and to remove overhanging trees	1997-2003	KWS/FD/Communities	NC [13/]
Increased grazing pressure on the Forest Reserve during periods of drought	Introduce rotational grazing systems	1997-2003	FD/Communities	NC
Lack of community involvement	Create partnerships between KWS, Forest Department and communities	1997-2003	KWS/FD/Communities	PC [4/ 5/]
	Communities to be involved in decisions about fencing and other options and routes (through Participatory Rural Appraisal)	1997-2003	KWS/FD/Communities	PC [4/ 5/]
	Communities to be encouraged to accept responsibility for routine aspects of fence maintenance (clearing of vegetation along fence-line)	1997-2003	KWS/FD/Communities	PC [4/ 5/]
	Clearance and construction to be carried out by specialist contractors employing labour force from local communities	1999-2003	KWS/FD/Contractors	PC

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Table 4. List of Potential Environmental Impacts and Proposed Mitigation Measures (Page 6)

OPERATIONS IMPACTS

Potential Negative Impacts	Mitigating Measures	Implementation Period	Responsibility	Cost (US$)
ROADS: OPERATION				
Increased poaching of wildlife (improved access to previously inaccessible areas)	Strict enforcement of the law by KWS/FD/Community personnel (Road barriers and patrols)	1999-2003	KWS/FD/Communities	NC
Increased illegal felling of indigenous trees (especially cedar)	Strict enforcement of the law by KWS/FD/Community (Road barriers and patrols)	1999-2003	KWS/FD/Communities	NC
BAMBOO HARVESTING: OPERATION				
Loss of bamboo flowering cycle	Selective harvesting only (no clear-felling)	1999-2003	FD/Contractor	NC
Loss/modification of elephant, buffalo and bongo habitat	Preliminary study on bamboo ecosystem Stem quantities to be determined following an environmental assessment of harvesting operation	1999 1999-2003	NMK/FD/KWS FD/NMK/Environmental Specialist	15,000 [19/] PC
Increased poaching of wildlife by harvesters	Strict enforcement of the law by KWS personnel	1999-2003	KWS	NC
Soil erosion, sedimentation of streams and rivers	Restricted vehicular access and selective harvesting only	1999-2003	FD	NC
Increased fire risk	Rigorous fire prevention measures	1999-2003	FD	NC

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FOOTNOTES

1/ Strengthening the Forest Department (provision of uniforms, motorcycles, bicycles, vehicles and training) is provided for in the Project Preparation Report. The report also notes that the FD will recruit an additional 50 forest guards to bring it up to full strength (214 forest guards). Since the PPR was completed, the number of forest guards in the Aberdares has been reduced to about 140. The Forest Department would need to recruit even more forest guards to bring it up to full strength, but this would not affect the project costs.

2/ Already costed in 1995 project design.

3/ Construct ditches/barriers every 5 km (80 km-phases I & II); (40 km - phase III); 120 km ÷ 5 km = 24 barriers; US$ 3/day x 3 persons x 5 days x 24= total US$ 1,230.

4/ Substantial training to promote the participation of the forest-adjacent communities in identifying problems and priorities and involve them in fence alignment and management issues is provided for use in the Project Preparation Report. Training sessions should be expanded to raise awareness of the value of wildlife, etc. Local staff of the KWS Partnership Programme, FD, and NMK should be involved. This may require an additional day at the planned FACDT worshops and district workshops. FACDT worshop - additional day at 1994 costs needs to be updated to 1997 costs. 1 day for 5 persons/district; total 25 at US$ 100 per day = US$ 2,500. District workshops 60 persons at US$ 100 per day = US$ 6,000. In addition, the KWS Partnerships Programme, in close collaboration with NMK, should include biodiversity conservation in their PRA wokshops. An additional US$ 1000 should be included in their budget for their purpose.

5/ Establishment of community-based self-help groups posters, talks and leaflets. Costs covered under FN4 above.

6/ This is assumed to be covered under KWS normal wildlife management activities.

7/ Costs to be confirmed.

8/ Three person team x three teams x 3 months/year x 6 years = US$ 600,000. Cost to be confirmed. Since KWS does not currently have additional trained/experienced rangers, and the extra teams would only need to be available during the three months of the year when crops are ripe, KWS may want to investigate putting the PAC operation out to tender. Competent professional hunter outfitters with experienced staff, vehicles and equipment could be considered to undertake the work.

9/ Feasibility study to establish animal corridors, including consultations with communities. 3 months consultancy @ US$ 7,500/ mo. (travel and visits to rantches/communities) = US$ 22,500.

10/ Some of the existing game moats are in poor condition, and the cost of rehabilitating them may be as high initially as constructing an electric fence. Project resources allocated for the construction of the electric fence could be diverted to cover rehabilitating game moats in those areas where it is selected as the most appropriate means of reducing the level of human-wildlife conflict.

11/ This would be one of the main components of the development of the Management Plan and is already provided for in the 1995 Project Preparation Report. The EIA missions, however, believes that the preparation of the land-use plan may take about 6 months. The budget allocation in the PPR for the preparation of the entire Management Plan is for only 6 person months, which may be under-estimated by about 50%. At least 12 person/month would be required. 6 persons/months @ US$ 7,500 = US$ 45,000 (needs to be recalculated for 1997 costs).

12/ Assuming testing different fence designs to target main problem animal, prevent entanglement, improve fence visibility etc. 5 km x US$ 33,000 = US$ 165,000; includes US$ 27,000 per km cost of constructing fence (Rhino Ark Figure).

13/ Part of normal maintenance activities.

14/ Some animal and plan species may not prove stable within the limited environment of the fence and populations may rise sharply or die out quickly. Unchecked, this may leas to a ™domino∫ effect on the populations of other plan and animal species.

15/ Activity of Management Plan/monitoring programme.

16/ Too early to calculate - will be monitored under the Management Plan.

17/ Sport hunting currently banned in Kenya.

18/ Strengthening the fire fighting capabilities of the FD and fire detection systems are foreseen in the Project Preparation Report.

19/ The impact of selective harvesting should be monitored over time. Two months consultancy to undertake initial study and to analyse and synthesize data over time @ US$ 7,500 x 2 = US$ 15,000.

8. MONITORING

8.1 During project implementation, monitoring should be carried out by KWS, the FD, and National Museums of Kenya (NMK) with community participation to assess potential environmental impacts of the project and to evaluate the results of mitigating measures. One of the main purposes of the monitoring programme will be to determine changes in biodiversity and species richness, as well as in land use in the National Park/Forest Reserve and forest-adjacent areas. The effectiveness and impact of the electric fence and of game moats (see Chapter 9 "Conclusions and Recommendations") should be monitored systematically, by KWS and the FD with community involvement.

8.2 Existing studies[1/] should be used to establish a baseline for monitoring purposes. Additional studies may be required to fill key gaps in information and data. An aerial survey of the Protected Areas and forest-adjacent communities should also be carried out to assist in establishing the baseline, particularly with respect to determining changes in land-use patterns. Land within 3 km of each section of the fence-line would be classified according to whether it is arable, grazing, housing, scrub or forest, and changes since the last survey would be determined. Where possible, the types of crops being grown will be identified, and for this purpose ground-truthing may be undertaken in selected areas. The first aerial survey should be undertaken during the preparation of the Management Plan - prior to fence construction.

8.3 Indicators for measuring changes in the physical, biological and socio-economic environments should be developed during the preparation of the Management Plan (by NMK, KWS and the FD) and the monitoring component fully costed.

A. MONITORING THE PHYSICAL ENVIRONMENT

8.4 The monitoring programme for the physical environment should cover, *inter alia*:

(i) land-use outside the fence to determine changes in land-use patterns following fence construction. This could be done annually by an aerial survey by KWS Park personnel along the fence-line once the baseline maps have been prepared.

[1/] Information and data found in three studies could be particularly useful. These are: Waithaka, J.M., "The Ecological Role of Elephants in Restructuring Plant and Animal Communities in Different Eco-Climatic Zones in Kenya and their Impacts on Land-use Patterns"; Schmitt, K., "The Vegetation of the Aberdare National Park"; Emerton, Lucy, "A Socio-Economic Profile of the Region Surrounding the Aberdares Forest". The Zoo Atlanta fence alignment study, which is currently under preparation, should also provide useful information for establishing a baseline.

(ii) soil erosion along fence-line. Qualitative observations of the degree of soil erosion occurring in cleared areas should be made, by recording signs of sheet and gully erosion, especially after heavy rainfall [1/]. Results are to be reported to the supervising engineer, environmental specialist (MENR or KWS), the FD and MALD&M.

(iii) operational effectiveness of fence. This will be monitored in the following ways:

- continuing to record fence breakages (particularly by elephants);
- interviews with local people as to their views on fence effectiveness;
- observations made by KWS staff as to the degree to which the fence deters primates from climbing over and burrowing animals from passing underneath.

(iv) operational effectiveness of other barriers. This should be the subject of experimental work undertaken by KWS in controlled conditions, as well as field observations and information gathered from talking to communities and the FD.

B. MONITORING THE BIOLOGICAL ENVIRONMENT

8.5 The monitoring programme for the biological environment would be carried out by KWS, the FD, and NMK and cover, *inter alia*:

(i) numbers and distribution of elephants in the Protected Areas (biennial; wet and dry seasons). Zoned sample surveys based on dung counts to be conducted by KWS/NMK/FD personnel, the sampling intensity to reflect the anticipated elephant density according to the zone and season.

(ii) numbers and distribution of lions in the Protected Areas (biennial; wet and dry seasons). "Total" counts should be attempted of the lion population in the moorlands. Elsewhere, estimates will suffice. Counts to be undertaken by KWS/NMK personnel.

[1/] This could be monitored by measuring levels of suspended sediment in streams draining the catchment within which construction is being undertaken. Levels of sediment should ideally be monitored twice per week from the period before construction starts until after rehabilitation of the area is complete.

(iii) status of rare and endangered wildlife species - bongo, giant forest hog and rhino -within the Protected Areas. In the absence of quantitative data, qualitative assessments should be made of known individuals/family units by KWS/NMK personnel.

Changes in Biodiversity and Species Richness

Some animal and plant species may not prove stable in this island ecosystem, and, in the absence of active management intervention, populations may rise or decline sharply, leading to a 'domino' effect on the populations of other animal and plant species.

(iv) numbers and distribution of livestock within the Forest Reserve. Routine aerial surveillance patrols should be conducted to provide estimates of livestock numbers/distribution within the Forest Reserve, as well as qualitative assessments of grazing condition/availability. Patrols to be conducted by KWS/FD/MALD&M.

(v) extent of natural forest destruction by elephants. FD/NMK/KWS should set up a long-term quantitative assessment monitoring programme which would be carried out through a series of vegetation transects and exclosures in strategic locations within the Forest Reserve[1/]. Qualitative assessments of forest destruction by elephants should be made during routine aerial surveillance patrols by KWS/NMK/FD personnel.

(vi) extent of forest destruction (by illegal logging) outside the fence. This should be assessed during routine aerial surveillance of the Forest Reserve boundary, and should be conducted by KWS/FD personnel.

(vii) extent of vegetation degradation in the walking trails zone. A quantitative assessment of vegetation damage should be made by establishing baseline transects and exclosures in the region. The monitoring of such transects and exclosures to be conducted by KWS personnel.

(viii) effect of harvesting on the bamboo flowering cycle and habitats and, consequently on biodiversity, should be monitored. Routine aerial surveillance patrols by KWS/FD/NMK personnel, supported by ground-truthing, should be used to determine the impact of bamboo harvesting on the integrity of the bamboo zone.

[1/] The transects conducted by Zoo Atlanta in carrying out its fence alignment study could provide baseline information.

(ix) grazers/browsers, predators/prey, hosts/parasites balances and relationships.KWS personnel should monitor such balances so that, if required, timely management interventions can be initiated to conserve the optimum species mix and the diversity of the ecosystem.

C. THE SOCIO-ECONOMIC ENVIRONMENT

8.6 The monitoring programme for the socio-economic environment would include, *inter alia*:

(i) community participation in project activities (including decision-making with regard to all conservation and rural development initiatives), such as fence construction and maintenance, game moat rehabilitation and maintenance, road rehabilitation and maintenance, construction and management of ecotourism facilities, etc.);

(ii) community and KWS/FD perceptions of the operational effectiveness of the fence in reducing human-wildlife conflict;

(iii) operational effectiveness of other barriers/buffers in reducing human-wildlife conflict;

(iv) farm productivity on fence-adjacent communities, including changes in cropping patterns, land use, etc. as a result of reduced human-wildlife conflict, road rehabilitation, etc.;

(v) plantation and bamboo productivity;

(vi) ecotourism productivity, including the effects of ecotourism on forest-adjacent communities and the perceptions of local people; and

(vii) the effects of road construction on population movements in the forest area and on the ecosystem (land use, land prices, etc.).

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Following its review of the different project options, the potential environmental impact of fencing the entire Aberdares ecosystem, the economic and financial ramifications of maintaining a 360 km fence, and stakeholders' attitudes towards the electric fence, the **EIA mission recommends that a modified project alternative be adopted** in which partial electric fencing would be but one element of a comprehensive strategy to conserve the ecosystem and reduce the level of human-wildlife conflict. A combination of barrier and non-barrier systems, particularly joint KWS/community management initiatives, rehabilitation of the extensive system of game moats, where appropriate, a strengthened FD, deployment and/or establishment of additional Problem Animal Management (PAMU) and Problem Animal Control (PAC) Units, particularly for the 2-3 months of the year (when crops are ripe) when most crop damage is caused by wildlife, would likely be some of the other central elements of the strategy. The primary changes suggested in project design concern the construction of the electric fence; other elements of the project as proposed in the 1995 Project Preparation Report - planning and organization of the ecosystem approach, roads and plantation rehabilitation, ecotourism development, rural development activities, etc. - should be implemented provided that measures are taken to mitigate any potential adverse environmental impacts.

A. CHANGES IN PROJECT DESIGN

9.2 The Aberdares Natural Resources Development Project is crucial for the conservation of the Aberdares National Park and Forest Reserve. In addition to their vital function as a water catchment, the Protected Areas are of outstanding national importance as a natural ecosystem and sanctuary for rare and endangered species, a repository of renewable natural resources, a recreational area and a cultural heritage. The EIA mission has furthermore concluded that the project's objective - conservation of the ecosystem and development of the natural resources through an integrated management approach involving the local communities and stakeholders -is appropriate. However, the mission believes that excessive emphasis has been placed on the electric fence as a physical barrier both for protecting the ecosystem and for reducing human-wildlife conflict at its border. Whereas a fence along the Forest Reserve boundary, as proposed in the Project Preparation Report, would undoubtedly provide a measure of protection against encroachment and other illegal activities, in the absence of a strong and efficient FD and community support for its construction, its physical existence would be no guarantee of long-term protection for the enclosed ecosystem.

9.3 In addition to the potential adverse environmental impacts of the proposed project-related investments, this conclusion is partially based on a preliminary economic analysis of the costs of fence maintenance. As mentioned above, while the inclusion of economic and financial analysis is normally outside the scope of an EIA, in the case of the fencing component the team found that the environmental impacts of the fence could not be considered in isolation from the issue of its physical sustainability, particularly its effectiveness and maintenance requirements (see Chapter 6 above). In the 1995 PPR, capital costs of the electric fence were estimated at approximately US$ 10 million (likely to be an under-estimate) and the accompanying annual maintenance costs

were projected at US$ 0.5 million (likely to rise after about ten years). It is not clear how the costs of fence maintenance after the six-year period of the project will be funded. Neither KWS nor the FD can meet these costs unless, as proposed in the 1995 PPR, revenue from forestry plantations can be retained for such purposes. It is the mission's view that **secure funding for fence maintenance is a prerequisite to capital expenditure on fence construction**.

9.4 Related to the aspect of cost is the increased institutional capacity and human resources which would be required to support such a complex project. The PPR foresaw, among other requirements, an increase in the number of forest guards, whereas **KWS and the FD are currently in the process of retrenchment and a reduction in staff**.

9.5 The provision of power for the fence was also found to be an issue of critical importance. The three options previously identified for supplying electricity to the fence were: connection to the main grid, solar energisers, and connection to mini-hydropower schemes. Extension of the grid to serve remote sections of the fence would be technically difficult and expensive; solar-powered batteries were found by the Project Preparation mission to be unreliable because of insufficient sunshine, low clouds and mist which persist for large parts of the year. Evaluating these alternatives, the Preparation Mission recommended mini-hydropower schemes; however, these have yet to be established as a viable option and may require substantial maintenance and, consequently, a high level of technical skill. The EIA mission considers that **the feasibility of an appropriate energiser option needs to be clearly established as a prerequisite to constructing sections of electric fence in remote areas of the Aberdares**.

9.6 In light of the aforementioned issues and the evaluation of the different alternatives, the EIA mission has concluded that fencing of the **entire** Protected Areas would not be the most appropriate way of conserving this important ecosystem. Such an exercise is of doubtful cost-effectiveness, is unlikely to fulfil the needs of many surrounding communities and is liable to prove physically unsustainable owing to the requirements and high costs of maintenance. Rather, the mission recommends **a modified project in which partial electric fencing would be but one element of a broader strategy** to conserve the ecosystem and reduce the level of human-wildlife conflict. The fence will likely be beneficial and sustainable only in those areas where there is severe human-wildlife conflict, where the local communities themselves opt for the fence as the most suitable alternative, where they are involved in the decision-making and negotiating process regarding continued access to forest resources, and where they are involved in all aspects of fence construction and maintenance.

Kaki Community Wildlife Conservation Self-Help Project
Kimakia Forest Station, Thika District

Average land holding in this area is 2 acres or 0.8 ha per family of 8. On average, each male head of household earns KSh 7,000 (US$ 127) per year from farming and KSh 1,000 (US$ 18) from off-farm sources. There is no electricity. There is much illegal felling of camphor "muthaiti" trees in the area. There is also extensive human-elephant conflict and, as assistance from the government has not been forthcoming, a self-help group was created to resolve the problem.

In mid-1996, the Kaki Wildlife Conservation Self-Help Committee drew up a proposal to build an electric fence of 8 km from Chanya river to the Thika river. The main reason for the erection of the fence is to protect crops, property and livestock from elephants. The group has opened a bank account and has approached the British High Commission and the United Nations Development Programme for funding. The proposed fence will follow the Forest Reserve alignment. Several members of the Kaki Wildlife Conservation Committee indicated to the EIA Mission that the electric fence should not include the plantations, as there are only 40 people working there at present.

What this case study shows is that in areas where human-wildlife conflict is a critical problem for forest-adjacent communities, people are mobilizing (or can potentially mobilize) their own resources. They are making their own decisions regarding which type of option is best suited to their needs and are working out the modalities involved. Most importantly perhaps, the Kaki Community Wildlife Conservation Self-Help Project is a community-driven project; the stakeholders feel ownership of the fencing project and of the entire process of human-wildlife conflict resolution. KWS only has a facilitating role in this process.

A Case Study in Community Mobilization for the Resolution of Human-Wildlife Conflict

9.7 While the importance of community and stakeholder participation in the project is highlighted in the Preparation Report, the EIA mission also recommends that **community participation be given even greater emphasis**. As the primary users of the natural resources of the Forest Reserve, the adjacent communities are the key to their long-term conservation. Incentives for such conservation are crucially dependent on the communities deriving a flow of benefits from the Forest Reserve. The mission further recommends that **additional opportunities for controlled, sustainable use of forest resources that directly benefit forest-adjacent communities should be explored further**. In this respect, consideration should be given to a more " bottom up", community-driven approach to identifying sustainable development initiatives, based on the communities' own priorities.

B. ECOSYSTEM APPROACH - ABERDARES MANAGEMENT PLAN

9.8 The mission considers that the preparation of a comprehensive Management Plan harmonizing all aspects of managing the Aberdares National Park and Forest Reserve, including proposed project interventions, **is essential for the success of the project**. The 1995 PPR provides for the Management Plan to be prepared in the first year of operation of the project, and the mission recommends that the satisfactory completion of the Management Plan be a prerequisite for the start-up of all major investment/infrastructure activities - erection of the fence, road rehabilitation, ecotourism development.

9.9 A comprehensive strategy, identifying the full range of activities to be undertaken to preserve the Protected Areas, including capacity-building and training requirements, responsible units, budget allocations, would need to be clearly indicated in the eventual Plan[1/]. One of the important issues to be addressed in the Plan is that of land-use zoning within the National Park and Forest Reserve to delineate usage areas. The siting of proposed investments would then be determined in accordance with the land-use zones. The development of the Management Plan should be co-ordinated closely with KWS' overall plans to prepare area conservation strategies (47 areas have been identified) which would, among other things, involve the identification of priority areas, including critical dispersal areas both inside and outside the protected areas.

9.10 With respect to technical assistance (TA), the allocation in the PPR for the development of a comprehensive Management Plan is 6 person months. The EIA mission believes that, given the number of issues to be resolved, the TA requirement for preparation of the Plan may be under-estimated by about 50%, and would therefore recommend increasing the amount of TA for this purpose to 12 months. In addition, it is proposed that a full-time Environmental Specialist be supported by the project for the first three years. The Environmental Specialist would assist KWS in developing the environmental management plan associated with the fencing guidelines (see paras. 7.3 and 9.13-9.16), establishing monitoring indicators, developing training programmes for KWS and FD staff (e.g. in environmental impact assessment, biodiversity conservation, monitoring and evaluation), and awareness-raising and conservation eduction programmes for forest-adjacent communities and other stakeholders[2/], and monitoring the environmental impact of road construction, barrier (electric fence, game moats) and non-barrier systems that would be used to conserve the ecosystem and reduce human-wildlife conflicts.

9.11 During the development of the Management Plan, sufficient provision should be made, both in terms of time and financial resources, for the redesign and costing of the aforementioned changes recommended for a modified project alternative. A number of issues which have a bearing on the proposed mitigation measures would also be resolved during this period, and the costs of the mitigation measures would need to be more accurately estimated. It is furthermore recommended that the study on elephant corridors (ref. paras. 7.6-7.8) and bamboo ecosystem harvesting (para. 7.22) be initiated during this first year of project operation when the Management Plan is being developed.

9.12 The monitoring and evaluation plan would be drawn up and costed, indicators developed, and a baseline for monitoring the environmental impact of the project interventions established by KWS, NMK and the FD (assisted by the Environmental Specialist). The Regional Project "Land Cover Mapping of East Africa Based on Satellite Remote Sensing", funded by the Government of Italy and executed by FAO, is one module of the continental AFRICOVER

1/ There was no provision for fence-line clearance or fence construction and maintenance in the Aberdares Management Plan (1991-1996), which has yet to be updated.

2/ Substantial training to promote the participation of the forest-adjacent communities in identifying problems and priorities and involve them in fence alignment and management issues is provided for in the Project Preparation Report. Training sessions should be expanded upon to raise awareness of the value of wildlife and forests. Local staff of the KWS Partnership Programme, FD, and NMK should be involved. This may require an additional day(s) at the planned FACDT workshops and district workshops.

programme[1/]. The regional project, which is based in Nairobi, tentatively plans to start activities in Kenya towards the end of 1997 or in early 1998. If the Kenyan national focal point so requests, the project might initiate work in priority areas, such as assisting in the preparation of baseline (land cover and topographic) maps for the Aberdares.

A Comprehensive Fencing Strategy for the Aberdares

9.13 In order to avoid costly mistakes both in terms of detrimental effects on the environment and of limited financial resources (such as the need to move the fence after construction in Phase II and the clearing of two fence-lines in Phase IV), a clear strategy for conserving the ecosystem and reducing human-wildlife conflict in the Aberdares should be elaborated, in close consultation with the forest-adjacent communities. This would include the identification of priority areas for action. Decisions regarding the best options should be made on a section-by-section basis, taking into account, *inter alia*, the degree of threat to the ecosystem, the severity of human-wildlife conflict, the severity of plantation damage, the topography and the existence of natural barriers,[2/] land-use patterns, human population pressures, socio-economic conditions, and community development priorities and constraints. The approach to be adopted in each segment would be determined by KWS and the FD in close consultation with the communities. The respective merits of the different measures (barrier and non-barrier systems) need to be investigated further, including a cost-effectiveness analysis of the different possibilities, as well as a cost-benefit analysis of the recommended option. In this process, efforts should be made to identify additional opportunities for sustainable use of the resources with a view to linking more closely conservation and rural development activities.

9.14 The strategy should at least provisionally indicate implementation arrangements, including, *inter alia*, responsible unit, optimal phasing, human and financial resource requirements (for planning, construction and operations), training, and community participation.

9.15 The mission strongly recommends that if a barrier system is selected as the most effective means of protection, it should, to the extent possible, be constructed along the Forest Reserve boundary so as to protect as much of the indigenous forest as possible and thereby

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1/ The overall development objective of the AFRICOVER project is to strengthen the capabilities of African countries in sustainable natural resources development planning and management by producing reliable land cover and topographical geo-referenced data bases (basic scale 1:250 000 which can be enlarged) and strengthening indigenous capabilities in preparing and using land cover and topographic information. Production of the land cover maps would involve the utilisation of earth observation satellite remote sensing data, maps and the results of aerial surveys and field verification. AFRICOVER has developed a Land Cover Classification System (LCCS) which, *inter alia*, distinguishes eight major land cover types which can be further defined in greater detail by adding different types of attributes: environmental attributes (e.g. climate, landform, soils/lithology and erosion); and specific technical attributes (e.g. floristic, crop type and soil type). A land cover/land use pilot study is already being carried out by the Kenya Soil Survey within the East African regional project.

2/ Wherever possible, such options should be linked with natural barriers: steep gradients, gorges, waterfalls, etc.

prevent encroachment and possible excision. In places where an electric fence would be constructed, the specific mitigations measured proposed in paras 7.3-7.4 should be adopted.

9.16 The draft fencing alignment guidelines prepared by KWS in 1994 should be finalized and widely distributed and an environmental management plan drawn up by KWS and the FD with support from the departments in MENR responsible for environmental guidelines and legislation, as well as with input from the local communities.

Establishment of Criteria for Fencing

9.17 Criteria should be established to guide decisions on whether or not to construct an electric or other type of fence. For example, fencing may be the best option if it can be demonstrated that:

(i) it will be cost-effective in reducing economic losses from human/wildlife conflict;

(ii) the design will target the wildlife species (elephants, baboons, etc.) responsible for conflict in that particular area;

(iii) the fence has been identified by affected communities as the best possible option for the reduction of the human-wildlife conflict, as evidenced for example by preparedness to contribute funds or labour towards construction and/or maintenance;

(iv) the physical sustainability of the fence is assured in terms of a dependable electricity supply and financing for its maintenance costs (for example, by setting up a Trust Fund or Fence Maintenance Fund).

9.18 The different options discussed in Annex 2 should also be investigated and evaluated, against the same criteria, as alternatives to electric fencing. Where sections of fence are to be constructed, the fence-line should be determined using aerial imagery and ground investigation to take into account the parameters recommended in para 9.13 (land uses, topographical constraints, community priorities, etc.), prior to any fence-line clearance being undertaken. Consideration should be given equally to both what is being fenced **in** and what is being fenced **out** of the ecosystem (e.g. salt and mineral licks).

Provisional Recommendations Regarding the Discrete Phases of the Proposed Fence-Line

9.19 On the basis of information[1/] and data gathered (see Annex 3), the EIA mission has reached the following provisional conclusions regarding the discrete phases of the proposed fence-line. Extensive community consultation and further ground-truthing[2/] are required.

Recommendations

9.20 **Phase I**: Maintain the existing fence, upgrade it to deter baboons and porcupines; involve the community in maintenance, upgrading and monitoring.

9.21 **Phase II**: Render existing perimeter road along the fence-line impassable to reduce illegal felling of indigenous trees and poaching; enforce regulations on forest access in consultation with communities; open the pedestrian access gates; distribute mineral supplements in strategic locations within the Protected Areas as an experiment in reducing elephant break-outs.

9.22 **Phase III**: Rehabilitate devegetated/eroded areas along cleared fence-line as a top priority; test both fencing option and alternative of rehabilitating existing game moats (which were seriously damaged in clearing the fence-line) against specified criteria.

9.23 **Phase IV**: Rehabilitate devegetated/eroded areas along cleared fence-line as a top priority; immediately halt further clearance of the fence-line until agreement is reached on an appropriate and environmentally sound fence alignment. Test both possible fencing alignments and other barrier and non-barrier options (including do-nothing option) against specified criteria.

9.24 **Phases V/VI**: Adopt community-based approach to examining different options within individual sub-sections defined by natural boundaries (e.g. escarpments, gorges, etc.) using Participatory Rural Appraisal; consolidate the tea zone with additional planting where feasible and better service infrastructure, especially roads (not necessarily under the auspices of this project); consider the full range of barrier and non-barrier options, taking into account particular topographical and climatic difficulties affecting construction and maintenance.

9.25 **Phase VII**: Rehabilitate existing game moat between Kinale and Ragia Forest Stations with participation from local communities; examine full range of barrier and non-barrier options for those sub-sections where no moat exists.

9.26 **Phases VIII/IX**: No fence or other barrier system required owing to topography.

1/ It should be borne in mind, however, that the month of July was unusually wet in the Aberdares, causing the roads to become impassable, thus precluding visits to many of the fence-line areas.

2/ The fence alignment study under preparation by Zoo Atlanta could provide important supplementary information.

Optimal Phasing for the Protection of the Ecosystem

9.27 On the basis of its visit to the field, discussions with stakeholders and review of data and background information, the mission has tentatively ranked the seven remaining phases of the proposed fence in terms of their priority both in terms of human-wildlife conflict and ecosystem protection.

9.28 It is the mission's view that the southern and south-eastern sectors (Phases V - VII) of the Protected Areas merit higher priority than the northern sectors (Phases III - IV), even though the fence-line for Phase III has been cleared and that for Phase IV is currently being cleared. The threat to the ecosystem in the southern and south-eastern sectors appears to be much more severe than in the northern sectors: encroachment and illegal forest activities are evident. Furthermore, there is a relatively high level of human-wildlife conflict along these sectors and the majority of the forest plantations are located in the southern sector.

9.29 Irrespective of their fencing priority, the devegetated and degraded areas of Phases III and IV of the fence-line should, as a matter of urgency, be reseeded and rehabilitated.

9.30 The steep escarpment in the area of Phase VIII and IX of the proposed fence acts as a natural barrier, consequently the erection of a fence or other barrier system is not required in these sectors. This is an area that could probably be best served by developing joint management opportunities with the communities.

C. ROADS REHABILITATION

9.31 The mission observed that existing roads within the Aberdares National Park and Forest Reserve, as well as in the forest-adjacent communities, are generally in a very poor state and virtually impassable in the wet season. **The mission considers that the rehabilitation of existing roads to all-weather standard is an important component of the project.** In this respect, it should be noted that communities' reactions to the proposed project interventions have consistently ranked road improvement as the highest priority, followed by milk and horticultural marketing support (see para. 3.59 and Table 2).

D. PLANTATIONS

9.32 The mission recommends that the optimal alignment of any fencing component would be along the Forest Reserve boundary, thereby protecting as much of the indigenous forest and forest plantations as possible from encroachment and illegal forest activities. With this alignment, forest plantations would continue to suffer damage caused by wildlife and would therefore require some form of protection. The mission considers that the fencing proposed in the Project Preparation Report - three strands of barbed wire - would not be effective against elephants which, together with sykes monkeys, are the prime cause of plantation damage in many areas. Instead, the mission recommends that the existing game moats be rehabilitated and maintained. Alternatively, in areas where this is not a viable option, consideration should be given to

constructing discrete sections of electric fence to protect those plantations that are most vulnerable to damage by elephants.

9.33 The mission endorses the FD's policy of privatization of the management of the forest plantations, possibly through leasing arrangements. This would free the FD from some of its operational duties and enable it to concentrate on regulation and law enforcement. It is further recommended that provision be made in the leasing or other agreement for resources to be allocated to barrier maintenance and road rehabilitation and maintenance. Small, commercially non-viable plantations, together with inaccessible plantations deep within the natural forest, should either be abandoned or harvested and then either allowed to revert to natural forest or planted with indigenous trees (these not to be harvested).

E. BAMBOO HARVESTING

9.34 Due to the role the unique flowering cycle of bamboo plays in the maintenance of plant heterogeneity and species diversity in the Protected Areas - and because it is the preferred habitat of many important wildlife species (including elephant and bongo) - no clear-felling of bamboo should be undertaken; selective harvesting, subject to a favourable environmental assessment, may be acceptable. No bamboo harvesting should be undertaken within the National Park, or in steep areas where clearance and access construction would be likely to cause soil erosion. No permanent roads should be constructed for bamboo harvesting.

9.35 The impact of bamboo harvesting on the ecosystem should be monitored closely by the FD, KWS, and NMK.

F. ECOTOURISM

9.36 Low-impact ecotourism developments within the project area, as proposed in the Project Preparation Report, are considered an appropriate and environmentally friendly means of increasing tourism in under-utilized areas of the National Park and Forest Reserve. If properly managed, they would have no significant negative impacts on the natural environment and could result in increased Park revenue. There is considerable scope for the development of other ecotourism projects within the Protected Areas, especially in the southern zone where proximity to Nairobi is an added incentive for such development.

G. LINKING CONSERVATION AND RURAL DEVELOPMENT ACTIVITIES

9.37 Rural development components proposed by the project aim to increase local incomes and raise living standards of forest-adjacent communities. What is less clear is how such activities can be expected to enhance the conservation of biodiversity in the Aberdares.

9.38 Although participation of local communities in project implementation is clearly acknowledged, there is a danger that in practice they may remain passive beneficiaries or paid

employees. Maximizing local employment in fence or other barrier construction and maintenance, road construction, ecotourism, plantation management, etc. could provide an important link between natural resource conservation and rural development, but it is only one aspect of a more complex process. Participation will require continuous dialogue with forest-adjacent communities at every stage of the conservation process, including negotiating real rights to local forest access, use and management. At present, very little of the direct and indirect use values from the Forest Reserve accrue to the local community; forest-adjacent men and women therefore perceive no immediate and tangible benefits arising from the conservation of these resources. On-going participation in the identification of problems and priorities, in decision-making, in project design and implementation, and in monitoring and evaluation of project components designed to benefit the local communities will be required.

9.39 While at present KWS is initiating a participatory process, further investments are needed in terms of staff, training and follow-up to help foster the desired partnerships. In the meantime, dialogue between local communities, KWS and the FD should be increased to improve the decision-making processes for natural resource conservation and rural development activities. In this respect, when Participatory Rural Appraisals (PRAs) are conducted in a given area, they should be swiftly followed up by action in order to build relationships of trust.

9.40 The mission considers that the linking of conservation and rural development activities is critical to the effectiveness and sustainability of the project as a whole, and an integral component of this process should be conservation education for forest-adjacent communities. Sufficient human and financial resources should therefore be allocated for this purpose to the operations of the proposed information centres which would be set up to provide information on the ecosystem and facilities for environmental training. The concept of the forest as a renewable resource and the key role of local communities in resource conservation needs to be highlighted. A two-pronged approach is required: on the one hand to encourage the controlled, sustainable use of appropriate renewable forest resources to benefit local people and hence build incentives for conservation, and on the other hand to encourage people to contribute to their own provision of resources (such as wood) for which demand is likely to outstrip the capacity of the forest in the medium to long term. Changing existing agricultural and domestic practices could be an integral part of conservation education. Conservation education is also closely linked with improved relations KWS, the FD and the local communities.

ANNEX 1

INDICATIVE BUDGET FOR PROPOSED ENVIRONMENTAL MITIGATION MEASURES

(US$)

Mitigation Measure	Cost (US$)
Management Plan	
Environmental Specialist/Technical Assistance	315,000[1/]
(i)(ii)Preparation of land-use/zonal plan	45,000
(iii)KWS Fencing Guidelines updated	20,000
(iv)Study to establish elephant corridors	22,500
Study on bamboo ecosystem/impact of bamboo harvesting	15,000
Training/Awareness Raising	50,000[2/]
Improve Fence Design	165,000[3/]
Wildlife Management	
Problem Animal Control/Problem Animal Management Units	600,000[4/]
Distribute mineral supplements	10,000[5/]
Road Rehabilitation	
Render perimeter road impassable	1,100
Reseeding cleared fence-line	40,000
TOTAL	1,283,600

[1/] Environmental Specialist for 36 mo. x US$ 7,500/mo. = US$ 270,000; plus additional 6 person months (US$ 45,000) for preparation of Management Plan.

[2/] Costs to be confirmed. Training component on environmental impact assessment, valuation of wildlife, biodiversity conservation, monitoring and evaluation.

[3/] This figure includes Rhino Ark's estimated fence construction cost of US$ 27,000; the additional cost to the project budget is therefore only US$ 30,000.

[4/] Costs to be confirmed for setting up three additional (three-person teams) problem animal control units. Since KWS does not currently have additional trained/experienced rangers, and the extra teams would only need to be available during the three months of the year when crops are ripe, KWS may want to investigate putting the PAC operation out to tender. Competent professional hunter outfitters with experienced staff, vehicles and equipment could be considered to undertake the work.

[5/] Costs to be confirmed.

ANNEX 2

ALTERNATIVE BARRIER AND NON-BARRIER SYSTEMS

A. GAME MOATS

Game moats may be used to reduce wildlife damage to specific agricultural or plantation areas. An extensive system of game-proof moats (some maintained; some not maintained) surrounds much of the forest plantations and National Park. The initial capital cost of rehabilitating existing game moats, particularly those which proved to be successful as long as they were properly maintained, may be somewhat high (although significantly lower than that of erecting an electric fence). When maintained, they are effective in controlling the movements of non-jumping animals (including elephants). Although moats have a high maintenance requirement (possibly similar to that of an electric fence), the technology required for such maintenance is less sophisticated. Communities can be organised to undertake maintenance themselves without requiring expensive tools, equipment or specialist knowledge brought in from outside. A further advantage is that, unlike electric fences where shorting renders the entire section of fence ineffective, breaching of one section of the moat does not render the whole moat ineffective.

Pros:

- Do not require special tools to construct or maintain.
- Utilise unskilled labour in construction and thereby help build stakeholder ownership.

Cons:

- Require intensive maintenance.
- Interfere with natural drainage system.
- Health hazard (water-borne diseases; mosquitoes).

B. VEGETATIVE BARRIERS

Several farmers have grown hedges of Mauritius thorn around their smallholdings. These are reported to be effective barriers to elephants and baboons, as well as to other species of wildlife. Field trials should be conducted on the effectiveness of this plant species as a vegetative barrier, including its environmental impact as an introduced species exotic to the Aberdares. Cacti are also reported to have been used in some areas.

Pros:

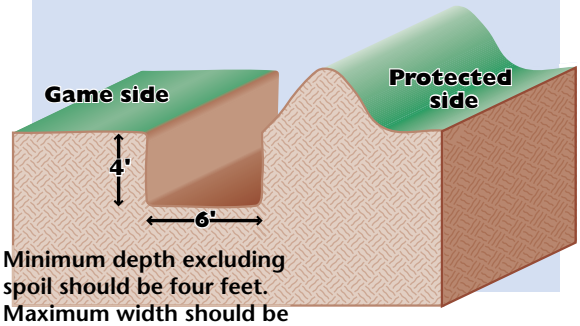
- Inexpensive to establish.
- Inexpensive to maintain.

Game moat construction

First Stage

Excavation and soil banking

Stabilize banks by planting grass



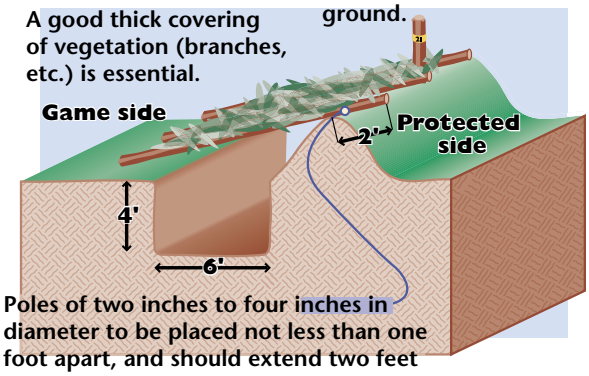
Minimum depth excluding spoil should be four feet. Maximum width should be six feet.

Second Stage

Covering the moat

A good thick covering of vegetation (branches, etc.) is essential.

Marker posts at 100 yard intervals four feet above ground.

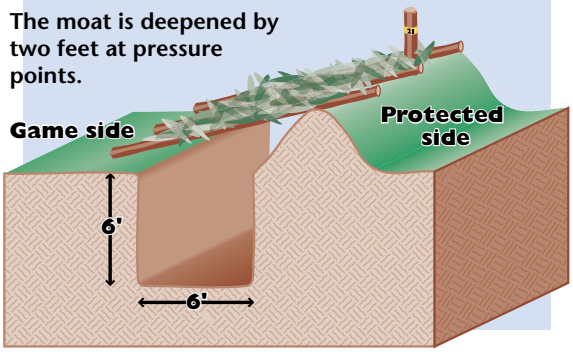


Poles of two inches to four inches in diameter to be placed not less than one foot apart, and should extend two feet across ridge of spoil bank.

Third Stage

Deepening the moat

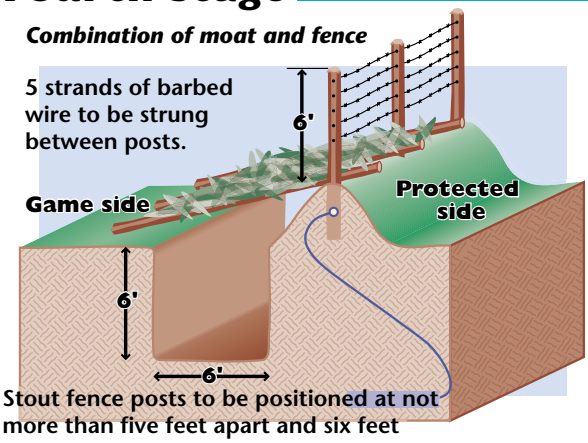
The moat is deepened by two feet at pressure points.



Fourth Stage

Combination of moat and fence

5 strands of barbed wire to be strung between posts.



Stout fence posts to be positioned at not more than five feet apart and six feet above ground.

adapted from plans by K. Clark

Cons:

- Danger of spreading (especially exotics).
- Uneven growth, even in apparently similar localities.
- Elephants eat cacti.

C. STONE WALLS

An effective barrier against non-climbing animals, especially if used in conjunction with a barbed-wire fence.

Pros:

- Inexpensive to construct (in stony areas).

Cons:

- Require intensive maintenance.
- Not effective against climbing animals.

D. NON-ELECTRIC FENCES

Stock Fences

An effective barrier against most non-climbing animals (**except** elephants).

Pros:

- Inexpensive to construct.
- Inexpensive to maintain (except where elephants are a problem).

Cons:

- Ineffective against elephants; ineffective against climbing animals.

High-Tensile Steel Fences

An effective barrier against most non-climbing animals (**including** elephants).

Pros:

- Inexpensive to maintain.

Cons:

- Expensive to construct.
- Prone to pilfering (high-tensile wire for snares).

E. NON-BARRIER OPTIONS

Vegetative Buffer Zones

The concept of a vegetative buffer zone is that it contains plants which are unattractive to animals (e.g. tea) and is therefore a deterrent to movement out of the forest. It also serves a function as a clearly defined boundary to deter human encroachment of the forest. In this way, incompatible forms of land use (Forest Reserve and agriculture) are separated. Despite its discontinuity, the Nyayo Tea Zone appears to be an effective buffer zone, separating the forest from cultivated areas. Its effectiveness as a "natural" land-use/wildlife barrier warrants further investigation. Consolidation of this buffer zone by planting tea in the already-cleared montane forest areas is also long overdue. Changes in land-use that will reduce human-wildlife conflict and, at the same time, act as a buffer zone between areas of natural forest and human settlements/agriculture should be encouraged.

Pros:

- Triple-purpose function: buffer/cash crop/boundary marker.
- Inexpensive to maintain.

Cons:

- Not fully effective as a buffer between Protected Areas and cultivation.

Traditional, Community-based Wildlife Control Techniques

Traditional, community-based wildlife control techniques. Activities, such as bee-keeping to deter baboons and other primates (as well as produce honey as an income-generating activity), warrants further investigation.

Pros:

- Inexpensive to establish.
- Income-generating enterprise.

Cons:

- Impacts of bees on human and domestic livestock.

Infra-sound

In respect of elephants, **infra-sound**[1/] as a possible means of controlling movements should be investigated.

Pros:

- Inexpensive to establish.

Cons: Unknown.

Controlled Shooting of Persistent Problem Animals

This is a traditional technique for deterring marauding animals[2/].

Pros:

- Proven method.

Cons:

- Involves killing of animals.
- Expensive to maintain.
- Response time excessive.

1/ Elephants are known to communicate over long distances by infra-sound.

2/ In most areas, elephants are a seasonal problem (2-3 months when crops are ripe). During this period, KWS should field additional Problem Animal Control Units (PACs) as rapid-response teams to assist the communities.

Thunderflashes

The use of **thunderflashes** (firecrackers) is also a traditional technique that has been extensively used for deterring marauding animals. Thunderflashes are used in some areas to frighten elephants. They can be quite effective, but repeated use can result in animals becoming habituated to them and even aggressive. Presently, thunderflashes are authorized for use only by KWS staff.

Pros:

- Proven method.

Cons:

- Expensive to maintain.
- Response time excessive.
- Animals become habituated to thunderflashes.

Joint KWS/Community Management of Wildlife

Joint KWS/Community Management of Wildlife as a sustainable, income-generating natural resource.

Pros:

- Potential high income generation from consumptive (e.g. sport hunting) and non-consumptive (game viewing/lodges) initiatives for forest-adjacent communities.
- Likely to trigger a **fundamental** change in attitude of local communities toward wildlife from negative to positive.
- Provides incentive for community conservation of wildlife.
- Likely to be sustainable by bestowing direct benefits on the community, instilling stakeholder ownership and linking forest conservation with income-generation.

Cons:

- A long-term process that is both time- and labour-intensive and expensive to establish, including significant human-resource investments on the part of KWS and the Forest Department at a time when both are retrenching.
- High risk of failure, if not undertaken systematically, in a bottom-up, participatory manner.
- System difficult to administer.

- Consumptive utilization of wildlife (e.g. sport hunting) presently illegal in Kenya.
- Potential social and cultural disruption of communities through increased tourism.

Distribution of Mineral Supplements in Strategic Locations

Distribution of mineral supplements in strategic locations within the Forest Reserve to minimize the movement of elephants out of the Reserve.

Pros:

- Inexpensive to establish on a trial basis.

Cons:

- May result in localised damage to forest.

ANNEX 3

PRELIMINARY FINDINGS RELATING TO EACH PHASE OF THE FENCE-LINE

A. PHASE I

Status: Fence-line cleared; fence constructed.

Purpose of fence: To create a rhino sanctuary within the Salient.

Description of area: Area of high biodiversity abutting directly onto settlement, high population pressure and high human-wildlife conflict. No buffer zone between the National Park and settlement. Elephants traditionally migrated between the Aberdares (the Salient) and Mt. Kenya.

Major cause of human-wildlife conflict: Elephant, baboons, porcupine.

Fence construction: Both the fence design and construction materials were changed. Cedar poles were used in the initial stages of fence construction; because of the ban on illegal felling of indigenous trees, treated gum poles are now used. Fence design was also changed to include wire mess to protect against burrowing animals; some primate loops have also been installed. The fence is relatively easy to maintain as the topography is gentle and the fence-line is well-served by access tracks.

Fence effectiveness: Ineffective against baboons. Partially effective against elephant. Elephants still breach the fence in an effort to re-establish their old migration root; breakages are seasonal, occurring frequently from August to early October. People have abandoned their traditional methods of protecting livestock and crops from wildlife damage.

Community involvement: No prior consultation with communities prior to fence construction.

Main environmental impacts:

Beneficial

- Rhino is protected.
- Buffalos remain inside the protected area.
- Reduction in crop raiding by elephants.

Negative

- Mixed community attitudes towards the fence. Sense of ownership does not appear to be as high as reported by Rhino Ark and Zoo Atlanta, particularly among women.
- Traditional migration route of elephants cut off.
- Vegetation damage in the Salient, particularly in the vicinity of Treetops salt-licks is aggravated by containment of elephants by fence.
- Use of herbicides in fence maintenance.
- Erosion along fence-line; destabilization of trees along fence-line.

- Elephants outside cannot get into the Protected Area, and could cause even more damage to adjacent communities.
- Approximately 60 elephants fenced out are marooned in Sangare Ranch/Thebo Forest/Nyeri Forest region.

Mitigation measures and recommendations:

- Investigate the feasibility of establishing an elephant corridor between the Aberdares and Mt. Kenya, even a restricted corridor linking the Salient with Sangare Ranch/Thebo Forest/Nyeri Forest region, as well as an appropriate funding mechanism.
- Explore possibility of developing community-driven tourism ventures within the potential corridor.
- Distribute mineral supplements in strategic locations to reduce elephant pressure in the Ark and Treetops regions[1/]. This could potentially have the same adverse environmental impact and should therefore be monitored very closely.
- Investigate feasibility of translocating the 60 marooned Sangare elephants to the Protected Areas[2/].
- Raise community awareness and involve them in monitoring and maintaining fence.
- Test alternative fence designs that target primary problems animals and upgrade/reinforce fence.
- Investigate other methods of controlling baboons.

B. PHASE II

Status: Fence-line cleared, fence constructed.

Purpose of fence: To extend rhino sanctuary and reduce the level of human-wildlife conflict, especially by preventing elephant damage to crops.

Description of area: Fence follows the Forest Reserve boundary of the Karameno Triangle and is bounded in the east by settlement. The area is prone to lower rainfall and poorer soils and therefore supports limited possibilities for rainfed agriculture. It is also an area of high population pressure and high human-wildlife conflict, situated on the traditional elephant migration route to Laikipia.

Major cause of human-wildlife conflict: Elephants, baboons, sykes monkeys and porcupines.

1/ The feasibility of alternative fence alignments, that would, among other things, take into consideration the location of salt licks, migration routes, etc., should be explored.

2/ Idem.

Fence construction: Same as above. In addition, it appears that metal poles have been used in some places.

Fence effectiveness: The Phase II fence was originally constructed along the perimeter of the National Park and was subsequently moved to follow the Forest Reserve boundary around the Karameno Triangle[1/]. It is ineffective against baboons, and only partially effective against elephants. The fence is subject to breakages (20 breakages in 1996) by elephants both from inside the park trying to get **out** and from outside the park trying to get **in**. The design of fence is such that it is easier for elephants to break **into** the Park and Forest Reserve, than to break **out**. Elephants are now "funnelled" around the north end of fence, where Phase III has been cleared but not fenced. Subterranean installation of mesh (to protect against burrowing animals) has not been done in some areas apparently because of the stony ground.

Community involvement: There has been some community consultation; KWS and the Forestry Department organized a few workshops in the area prior to fence construction, but the fence was presented as a *fait accompli*. Community reactions are positive until Muganda after which 87% appear to have a negative opinion of the fence and 17% are neutral[2/]. Communities are not happy with the loss of access to the Forest Reserve (not all access gates are open).

Main environmental impacts:

Beneficial

- Some reduction in crop raiding and property damage by elephants.
- Reduction in loss of livestock.

Negative

- Severe erosion along the fence-line.
- Restriction of (legal) access to forest by local communities, particularly in the northern section.
- Increased access to forest by vehicular traffic and possible increased illegal forest activities (some evidence of illegal logging and poaching was witnessed by the EIA mission). This could be attributed to clearing but not fencing Phase III, thereby providing easy access to large vehicles.

1/ The Karameno Triangle was subject to severe human encroachment. Communities were evicted, after discussion and consultation, and the fence was moved to the Forest Reserve boundary.

2/ Reference Fuller, J.L. 1997. Impact of fencing on adjacent communities: A tabulation and analysis of community activities, impact and attitudes in regard to the fence, forest and wildlife. Appendix I In Butynski, T.M. 1997. Preliminary Report: Aberdare National Park and Aberdare Forest Reserve Fence Alignment Study. Zoo Atlanta Unpublished Report for the Kenya Wildlife Service.

- Interruption of major elephant migration route to Laikipia, and "funnelling" of elephant to the north of the fence (around the end of the Phase II fence where Phase III has been cleared but not fenced).
- Adverse visual/landscape impact of fence and fence-line.
- Overgrazing and severe erosion caused by livestock (and wildlife) moving along the cleared fence-line/perimeter road (both inside and outside the fence).
- Important salt licks fenced out.

Mitigation measures and recommendations:

- Improve monitoring and enforcement capabilities of the FD and KWS.
- Install barriers or breakup fence service road by the construction of ditches or fences to prevent access to forest by vehicular traffic and to prevent movement of livestock and wildlife along the fence-line.
- Re-seed maintenance road with low-height grass such as Kikuyu grass to consolidate the soils and minimise erosion.
- Distribute mineral supplements in strategic locations within the Forest Reserve and National Park to minimise elephants' reliance on mineral licks situated on private land. This could potentially have the same adverse environmental impact as evidenced around Treetops lodge and should therefore be monitored very carefully.
- Improve fence specifications (metal posts, live wires to be routed on both sides, etc.) to minimise elephant breakages.
- Investigate feasibility of establishing elephant corridors or "dispersal areas" along established elephant migration routes[1/].
- Investigate feasibility of establishing community-driven wildlife/tourism initiatives within the elephant corridors/dispersal areas[2/].
- Provide greater community access to Forest Reserve (open existing access gates and/or install more access gates).
- Investigate possibilities for external funding for elephant corridors/tourism/wildlife initiatives.
- Deploy highly-mobile Problem Animal Control (PAC) Units to deter elephant fence-breakers and minimise elephant-human conflict during the elephant migratory period (i.e. during maize harvesting season).

[1/] If feasible, the fence could be realigned to incorporate elephant corridors.

[2/] Idem.

C. PHASE III

Status: Fence-line cleared, fence not constructed.

Purpose of fence: To reduce human-wildlife conflict, especially elephant damage to crops, and livestock predation by lion. To reduce human encroachment of the Forest Reserve and to reduce other illegal forest activities (i.e. logging and poaching of wildlife).

Description of area: Belt of indigenous cedar/olive podo forest within the Forest Reserve bounded in the north by larger agricultural plots and ranches than those surrounding Phases I and II. The area is sparsely populated and drier than other forest-adjacent areas; water is a major constraint and animal husbandry a major economic activity.

Major cause of human-wildlife conflict: Elephants, lions, baboons.

Proposed fence construction: The fence-line was cleared over a year ago by KWS using their own machinery, but the fence has yet to be constructed. The cleared fence-line is on **average 20 m wide** through cedar forest and open grassland and covered in shrubby undergrowth (mainly Sodom Apple) to a height of 1.5 metres. Severe erosion and gulling is evident. There is evidence that clearance of some areas was not required, such as where the fence-line follows the old game moat[1/]. Fence alignment is such that Ndaragwa Forest is excluded from the fenced area.

Potential fence effectiveness: The fence is likely to be ineffective against baboons, effective against lions, and partially effective against elephants.

Community involvement: The EIA mission was advised by the farmers interviewed that the communities were not consulted prior to fence-line clearance, nor were they involved in clearing the fence-line. Some negative community reaction to the fence was evident largely due to disappointment with the long delay between fence-line clearance and construction.

Observed and predicted environmental impacts:

Beneficial

- Partial reduction in crop raiding by elephants.
- Reduction in livestock depredation by lions.
- Reduction in illegal forest uses.

[1/] In interviews with several forest-adjacent farmers, the EIA mission was informed that, as long as they were maintained, the game moats were quite effective in reducing crop damage caused by wildlife. In the areas visited by the EIA mission where the fence-line has been cleared along the game moats, the game moats have been filled in thereby providing wildlife with easier passage to forest-adjacent farmland.

Negative

- Clearing has filled in areas of existing game moats thereby increasing crop damage by wildlife.
- Severe erosion and gulling in the cleared areas is evident.
- Illegal forest activities (wildlife poaching and felling of indigenous trees) were witnessed by the EIA mission.
- Excessive width - **20 m** - of fence-line was cleared as opposed to 7 m. specified in the 1995 Project Preparation Report[1/].
- Invasion of cleared fence-line by weeds and shrubby plants (up to 1.5 m high).
- Exclusion of the Ndaragwa Forest from the fenced area.
- Elephants would be cut off from a series of salt-licks in the north.
- Possible restriction of community access to Forest Reserve for legal forest uses.
- Possible increased forest destruction by elephants.
- Possible continued or increased crop damage by fenced-out elephants.
- Possible increased depredation of non-favoured wildlife species by enclosed lion population.
- Minimal community participation/involvement in natural resource management initiatives.
- Potential increased - and non-sustainable - demand for water for large-scale irrigated horticultural initiatives (i.e. flower-growing for the export market).

Mitigation measures and recommendations:

- Cut-back secondary growth along fence-line, harrow soil and plant with Kikuyu grass.
- Deploy highly-mobile PAC Units to deter elephant fence-breakers and minimize elephant-human conflict during the migrating period.
- Improve fence specifications (metal posts, live wires to be routed on both sides, etc.).
- Investigate feasibility of establishing elephant corridors or "dispersal areas" along established elephant migration routes, including the possibility of establishing community-driven wildlife/tourism initiatives within the elephant corridors/dispersal areas. Opportunities for external funding for elephant corridors/tourism/wildlife initiatives should be explored[2/].

1/ The mission was advised that KWS fencing guidelines also specify 7 m width.

2/ If the corridors are determined to be feasible, the fence could be removed and realigned to incorporate elephant corridors.

- Distribute mineral supplements in strategic locations within the Forest Reserve and National Park to minimize elephants' reliance on mineral licks situated on private land. This could have negative environmental impacts and should be monitored carefully.
- Raise community awareness and initiate conservation education activities.
- Explore the full range of options - barrier and non-barrier systems - for protecting the ecosystem and reducing the human-wildlife conflict. Action, including the rehabilitation of existing game moats if appropriate, should be immediately taken to complete Phase III **before** further clearing the Phase IV fence-line.
- Actively manage the lion population by walking/translocation of sub-adult males.

D. PHASE IV

Status: Two fence-lines have been partially cleared; no construction started.

Purpose of fence: To reduce human-wildlife conflict, especially elephant damage to crops, and to protect the forest plantations.

Description of area: Combination of natural and plantation forest. Topography (rugged terrain, steep slopes and gorges numerous rivers) persistent mist and cloud and high rainfall make this a difficult area in which to construct and maintain an electric fence. Soils are deep loam and more susceptible to erosion. Area of high potential rainfed agriculture and high population pressure. The Nyayo tea belt, which follows the Forest Reserve boundary, serves as a buffer zone. The *shamba* system appears to be abused with semi-permanent settlement within the plantations.

Proposed fence construction: In the absence of a feasibility study on fence alignment, partial fence-line clearance has been undertaken along two entirely different routes, one enclosing and the other excluding the softwood plantations. The first fence-line, in accordance with the 1995 Project Preparation Report, follows the Forest Reserve/Nyayo Tea Zone boundary and fences the forest plantations "in". This alignment has been abandoned. In the light of new Forest Department policy on fencing, and through a Memorandum of Understanding with KWS, the Kenyan Army is currently clearing a second fence-line which is being plotted 5 km. in advance of the Army. With the second alignment forest plantations will be fenced "out", along with a considerable area of natural forest. Clearance is reported to have been completed from the Ruhuruini Gate to the Chanya River. The EIA mission has been advised that the Army cannot cross the river because of the rugged terrain, and is now clearing a path eastward through indigenous and plantation forest in order to find a suitable place to cross the river.

Major cause of human-wildlife conflict: Elephants, buffalo, baboons, antelope. The mission was advised that it was not a high conflict zone, possibly because of the Nyayo tea zone functioning as a buffer zone. Because of limited time spent in the area, the mission has no data

to substantiate this report. Zoo Atlanta, however, reports that it is an area of high human-wildlife conflict. The *shamba* systems adjacent to indigenous forest and National Park are prone to suffer greater damage caused by wildlife.

Fence effectiveness: The fence would likely be ineffective against baboons and only partially effective against elephants.

Community involvement: Communities are not involved in the fence-line clearing. No evidence of community consultation. An opportunity has been lost in terms of both stakeholder ownership and income-generation.

Observed and predicted environmental impacts:

Beneficial

- Reduction in crop raiding by elephants.
- Reduction in plantation damage by elephants.

Negative

- Severe erosion and gulling due to mechanical clearing of steep gradients observed by EIA mission.
- In the absence of a feasibility on fence alignment study, partial fence-line clearance has been undertaken along two entirely different routes, one enclosing and the other excluding the softwood plantation.
- Sedimentation of nearby stream observed.
- Exclusion of large areas of natural forest which could potentially result in illegal felling of indigenous trees, poaching of wildlife, settlement and eventual excision.
- Infilling of existing game moats from clearing of fence-line which could possibly result in an increase in damage caused by wildlife to forest plantations and crops.
- Possible increased destruction of natural forest by elephants (range constricted).
- Increased destruction - possibly to the point of elimination - of those animals fenced out.
- Increased health hazards (notably sexually transmitted diseases) due to employment of non-local workers for fence-line clearance.
- Non-participation of communities in fence-clearing operations could lead to negative attitudes towards fence.
- Even greater potential exists, because of the rugged terrain, to cause the same adverse environmental impacts as experienced in Phases I-III of the fence, particularly with regard to soil erosion, gulling, and sedimentation of nearby waterways.

Mitigation measures and recommendations:

- Halt all fence-line clearing activities until optimum fence-alignment agreed and plotted.
- Re-seed devegetated and cleared areas, as a matter of priority, to stabilize soil and minimize soil erosion.
- Contracts for clearing and fence construction should be drawn up as a single operation to ensure work is completed.
- Deploy highly-mobile PAC units during the maize harvesting season.
- Consider full range of barrier and non-barrier options for conserving the ecosystem and reducing human-wildlife conflict (with active involvement of the communities).
- Site any barrier option along the Forest Reserve boundary, to the extent possible, in order to conserve as much indigenous forest as possible.
- Involve communities in all aspects of fence alignment, construction and maintenance.
- Enforce strictly the laws relating to non-resident plantation cultivation (*shamba* system).

E. PHASES V-VI

Status: Fence-line not cleared, construction not started. Fence alignment study undertaken.

Purpose of proposed fence: To reduce human-wildlife conflict, especially elephant damage to crops.

Description of area: Wide belt of natural forest in the Forest Reserve, separated from adjacent settlements by the Nyayo Tea Zone. Large softwood plantations within the natural forest at Gatare and Kimakia Forest Stations. Population pressure moderate to high, but the tea zone acts as a forest buffer belt deterring encroachment.

Major cause of human-wildlife conflict: Elephants.

Proposed fence construction: The electric fence alignment proposed in the Project Preparation Report is along the boundary between the tea zone and the settlements (the designated Forest Reserve boundary). There is also a proposal to provide an additional, non-electrified fence to enclose the softwood plantations from the natural forest. The alignment under preparation by Zoo Atlanta may also follow the Forest Reserve boundary in this area.

Fence effectiveness: The deeply-incised, numerous rivers and high rainfall of this area will make the fence difficult to construct and maintain in this section. Fence construction across large rivers is unrealistic. It is unlikely that access for fence maintenance can be ensured all year round. Persistent mist and low cloud in the rainy season may raise humidity to a level where

shorting of the electric fence becomes a persistent problem[1/]. On the basis of experience elsewhere, the proposed fence design is likely to be only partially effective against elephants. The enclosure of the softwood plantations within the fenced area means that the main fence will provide them with no protection against wildlife damage. Some form of protection will be required.

Community involvement: None to date.

Predicted environmental impacts:

Beneficial

- Reduction in elephant damage to crops **outside** the fence.

Negative

- Severe erosion likely on steep sections during construction.
- Lack of community consultation/involvement may lead to negative reaction and lack of ownership.
- Maintenance of access road likely to lead to further erosion.
- Adverse visual/landscape impact of fence on adjacent communities.
- Reduction in (legitimate) access to forest by local communities.
- Continued or possibly increased damage to softwood plantations.
- Continued or possibly increased damage to *shamba* crops within the plantations.

Mitigation measures and recommendations:

- Investigate full range of options, including both barrier and non-barrier options, within individual sub-sections defined by natural boundaries (e.g. gorges, waterfalls).
- All options to be evaluated in consultation with local communities using Participatory Rural Appraisal.
- Consolidate the tea zone with additional planting where feasible and by providing better infrastructure (especially roads).
- Ensure technical feasibility of constructing, operating and maintaining the proposed option(s), taking into account topographic, hydrological and meteorological factors.
- Rehabilitate and maintain existing game moats.
- Investigate feasibility of erecting discrete sections of electric fence to protect the forest plantations (instead of proposed barbed wire fence).

[1/] Poor visibility will also effect maintenance crews as well as increase the likelihood of animals stumbling into the fence.

F. PHASE VII

Status: Fence-line not cleared, construction not started. Fence alignment study undertaken.

Purpose of proposed fence: To reduce human-wildlife conflict, especially elephant damage to crops, as well as human encroachment of the Forest Reserve.

Description of area: Natural forest in the Forest Reserve, separated from adjacent settlements by plantations within which the *shamba* system is operated. There is no tea zone. Encroachment of permanent cultivation into the plantation zone and illegal tree felling appear to be particular problems in this section. Old wildlife moats exist along much of the boundary between the natural forest and the softwood plantations. Human-wildlife conflict in this area appears to be less severe than elsewhere, with fewer reports of elephant damage within settlements, though elephant damage to the softwood plantations is significant.

Adjacent to this section is the Kikuyu Escarpment forest, administered by Uplands Forestry Station. This lies **outside** the proposed fence-line. This forest is largely indigenous and, although parts of it are fairly inaccessible owing to the topography, illegal tree felling is reported to be a major problem.

Major cause of human-wildlife conflict: Elephants (seasonal), baboons, other monkeys, porcupines.

Proposed fence construction: The 1995 Project Preparation Report proposed an alignment which essentially follows the Forest Reserve boundary (with the exception of the Kikuyu Escarpment) and included most of the plantations within the fenced area. Additional barbed-wire fences were also proposed to protect the forest plantations. The electric fence alignment which may result from the Zoo Atlanta study may be along the boundary between the plantations and the natural forest, effectively fencing out the forest plantations and a significant area of indigenous forest.

Fence effectiveness: On the basis of experience elsewhere, the proposed fence design is likely to be only partially effective against elephants, and ineffective against primates. The fencing out of the plantations (possibly Zoo Atlanta and GOK alignment) means that the fence will not serve as a deterrent to encroachment; in fact it may create an incentive for cultivation up to the fence boundary.

Community involvement: None to date.

Predicted environmental impacts:

Beneficial

- Reduction in plantation damage by elephants.
- Reduction in human-wildlife conflict.
- Restriction of northward migration of elephants to Kinangop plantations.

Negative

- Possible increased elephant damage to natural forest due to range restriction.
- "Funnelling" effect of fence on elephants towards southern tip of Forest Reserve.
- Possible long-term loss of plantations which are excluded from the fenced area as a result of encroachment.
- Lack of community consultation/involvement may lead to negative reaction and lack of ownership.
- Adverse visual/landscape impact of fence.
- Reduction in (legitimate) access to forest by local communities.

Mitigation measures and recommendations:

- Rehabilitate existing game moats between Kinale and Ragia using labour drawn from communities, and set up a community-based maintenance programme.
- Investigate full range of options, including both barrier and non-barrier options, for areas where no game moat currently exists. All options to be evaluated in consultation with local communities using Participatory Rural Appraisal.
- Establish highly mobile PAC Units in the area (especially during the maize harvesting season).

G. PHASES VIII-IX

Status: Fence-line not cleared, construction not started. Fence alignment study undertaken.

Purpose of proposed fence: Not clear.

Description of area: The Forest Reserve boundary lies along the very steep slopes of the Rift Valley escarpment. The northern part of the section has been settled with no re-afforestation. Parts of the escarpment forest have been severely damaged by fire up to the moorland zone. Human-wildlife conflict is generally low as a result of the steep topography impeding animal movements, though there is some damage from elephants moving in from the south (Kinangop).

Major cause of human-wildlife conflict: Elephants (occasional), monkeys.

Proposed fence construction: The electric fence alignment proposed by the Government of Kenya and Zoo Atlanta is along the boundary between the natural forest and the plantations. The Project Preparation Report proposed alignment includes much of the plantations within the fenced area.

Fence effectiveness: On the basis of experience elsewhere, the proposed fence design is likely to be only partially effective against elephants, and ineffective against primates.

Community involvement: None to date.

Predicted environmental impacts:

Beneficial

- None.

Negative

- Erosion during construction.
- Adverse visual impact.

Mitigation measures and recommendations:

- No fence or other barrier system required in this area as the steep natural escarpment between Shamata gate in the north and the Kanangop forest in the south forms an effective natural barrier for most east-west wildlife movement (excluding primates). However, should the entire Aberdares ecosystem be fenced, elephants might be forced into east-west movements and may eventually begin exploring routes down the escarpment in this area.

ANNEX 4

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