



 THE  
MOUNT MERU  
CHALLENGE

Integrating conservation and development  
in Northern Tanzania









This publication is produced by:



Istituto Oikos  
Via Crescenzago 1  
20134 Milano (Italy)  
Tel: +39 02 21597581  
E-mail: [info@istituto-oikos.org](mailto:info@istituto-oikos.org)  
Website: [www.istituto-oikos.org](http://www.istituto-oikos.org)

Edited by: Caterina Carugati, Rossella Rossi and Guido Tosi

Contributors: Vincenzo Avitabile, Giorgio Cancelliere, Monica Carro, Caterina Carugati, Silvia Ceppi, Alessandra Confalonieri, Paola Ferravante, Giorgio Ghiglieri, Ramadhani Kupaza, Ruth Andilile Ibrahim, Matteo Leonardi, Stefano Macchetta, Andrea Mandrici, Elard Mawala, Robson Mtae, Elisante Ngowi, Jane Mary Ntalwila, Daniele Pittalis, Margherita Porzio, Marina Oliver Blattler, Rossella Rossi, Giuseppe Selvaggi, Guido Tosi

Maps: Monica Carro, Paola Codipietro, Stefano Macchetta, Andrea Mandrici, Paola Mariani, Elard Mawala  
Photo credits: Mauro Fabris, Giampiero Gandolfo, Andrea Mandrici, Carlo Mari, Stefano Macchetta, Istituto Oikos.  
Concept and design: M-design  
Printed in 2011 by Ancora Libri, Milano (Italy)

Recommended citation:

Istituto Oikos (2011)  
THE MOUNT MERU CHALLENGE Integrating conservation and development in Northern Tanzania  
Ancora Libri, Milano (Italy)

This publication has been produced in the framework of the project “Economic development and Environmental rehabilitation of Maasai pastoral areas in Arumeru District (Tanzania)” co-financed by the Italian Ministry of Foreign Affairs (Grant 8152/oikos/TZA) and the Arumeru District Council, with the scientific supervision of the University of Insubria.



The contents of this publication are the sole responsibility of Istituto Oikos and can in no way be taken to reflect the views of the Italian Ministry of Foreign Affairs.



# THE MOUNT MERU CHALLENGE

Integrating conservation and development  
in Northern Tanzania



---

# CONTENTS

6	<b>FOREWORD</b>
8	<b>ACKNOWLEDGEMENTS</b>
9	<b>ACRONYMS</b>
11	<b>INTRODUCTION</b>
15	<b>THE PROJECT AREA: STATUS AND PROBLEMS</b>
16	ENVIRONMENT
28	SOCIETY
34	LAND USES AND LIVELIHOODS
44	CHALLENGES TO SUSTAINABLE NATURAL RESOURCES MANAGEMENT
50	GOVERNANCE AND SERVICES
61	<b>THE FIELD INTERVENTIONS</b>
61	FROM PROBLEM IDENTIFICATION TO FIELD ACTION
62	EDUCATION FOR SUSTAINABLE DEVELOPMENT
63	COMBINING ENVIRONMENTAL GOALS AND REVENUE GENERATION
77	PLANNING WITH THE ENVIRONMENTAL DIMENSION
86	IMPROVING SERVICES, PRESERVING THE ENVIRONMENT
97	<b>CONCLUSIONS</b>
101	<b>RECOMMENDATIONS</b>
106	<b>REFERENCES</b>
110	<b>ANNEX A</b> CHECKLIST OF TERRESTRIAL VERTEBRATES IN THE MOUNT MERU NATURAL SYSTEM
128	<b>ANNEX B</b> ASSESSMENT OF 18 PRIMARY SCHOOLS IN NGARENANYUKI AND OLDONYOSAMBU WARDS
130	<b>ANNEX C</b> VILLAGE GAME SCOUT WILDLIFE MONITORING



## FOREWORDS

Istituto Oikos believes that biodiversity conservation and equitable natural resources management are crucial to ensure a livelihood for the local population. The approach is based on the assumption that land degradation and poverty are directly connected and that a well conserved environment is the only guarantee for socio-economic development, poverty alleviation, food security, health and wellbeing for current and future generations. That is why the core of all Istituto Oikos' projects is the relationship between man and nature, whether our activities are technical-scientific assistance, environmental evaluation programs, fauna monitoring or support for youth or women's cooperatives. Many actions focus on protected areas and on natural areas risking deterioration due to irrational and unplanned use of natural resources. Moreover, the projects never leave aside the awareness-raising factor, to share the Istituto Oikos' objectives and strategies, as well as the training component, to ensure the sustainability of work.

After 15 years of field activities and more than 150 projects implemented, in Italy and abroad, on biodiversity conservation and sustainable development, Istituto Oikos has gained a wealth of experience in the definition and implementation of methodologies and strategies aimed at integrating the environmental dimension into the socio-economic processes. To reach concrete and sustainable results, as well as to ensure the highest standards of quality in its activities, Istituto Oikos has established firm collaboration with local and national governments, universities, research institutes, development organizations and business companies, both in Italy and worldwide.

Istituto Oikos has been operating in Tanzania since 1996, with the objective of supporting local institutions and organisations in their efforts to preserve the country's environmental heritage.

Natural resources are still well preserved in Tanzania and its national parks, through a flourishing tourism industry, give a substantial contribution to the national economy. Since 2002 the Istituto Oikos program mainly focused on the Mount Meru, a natural system that plays a fundamental role to ensure the water supply and the climate stability of the entire northern part of Tanzania. The key areas of the system are under the administration of the Arumeru District and Arusha National Park, one of the most profitable protected area of the country. A rapid population increase, associated with inadequate land use practices and poor governance, is causing the unsustainable exploitation of the Mount Meru natural capital with the genuine risk that the rural populations, whose livelihood is entirely based on the environmental products, will be seriously affected in their efforts to build a better future.

The Italian Ministry of Foreign Affairs, through the funding of the project "Economic development and environmental rehabilitation of Maasai pastoral areas in Arumeru District (Tanzania)", provided the Istituto Oikos with an invaluable opportunity to join hands with the Arumeru District, the village authorities and the rural communities to build together a substantial and enduring experience where the environmental considerations are at the base of local development strategies, to prevent climate change, loss of economic potential and biodiversity, and to enhance cultural values and historical traditions.

The publication "THE MOUNT MERU CHALLENGE. Integrating conservation and development in Northern Tanzania" is one of the outputs of the project. It has been designed to present the most relevant project outputs and share the experience with the decision-makers, the actors and stakeholders, in Tanzania and abroad, who wish to contribute to the open debate on how to harmonize the environment and development objectives. It is also an attempt to promote practices that have shown to be cost-effective, innovative and successful, to provide inputs for policy review processes and to mobilize international awareness and support towards the building of new relations between people and the environment.

**Rossella Rossi** *President Istituto Oikos*

In the last few years working as the District Commissioner for Arumeru District, I have encountered tangible conflicting issues between conservation and development.

Arusha region is where pastoralism and agriculture are fighting for 'the survival of the fittest' facing drastic climate changes, harsh environment, wildlife interference, limited resource mobilization and sharing and inadequate capacity to adapt to innovation and good governance.

The Mount Meru ecosystem is one of the most important natural areas of the Arusha region and of Tanzania as a whole. Most of the water sources are from Mount Meru, covered by dense forests which are only partially protected. The Arusha National Park hosts many species of animals and plants, which are a vital resource of Tanzania's biodiversity and an important economic resource for the tourism sector of the region. Similarly the plains on the foothills of Mount Meru host a high variety of animal and plant species currently threatened by a consumptive and fast development.

The Arumeru District is administratively divided into the two District Councils of Meru and Arusha; 65% of the area is utilised for agriculture and livestock activities and the remaining part is all wilderness areas and includes the National Park, forests, and hunting blocks which contribute to the economy of the country.

In such context the Istituto Oikos, in partnership with Oikos East Africa and Arumeru District, embarked on one of the greatest challenges. It has been working in this area since 2002 and has initiated many interventions and enjoyed a fruitful collaboration with our District. Many initiatives have been carried out in water, renewable energy, wildlife, sustainable tourism, school infrastructures as well as agriculture and livestock. All these interventions have benefited the communities of Mount Meru and have ensured more attention is given to one of the most important natural areas of Tanzania.

The integrated and participatory approach adopted by Oikos was mostly beneficial for taking into consideration all the aspects related to economic and social development, environment and governance.

Owing to the "Economic development and environmental rehabilitation of Maasai pastoral areas in Meru District (Tanzania)" project, financed by the Italian Ministry of Foreign Affairs, a great achievement has been put in place.

The results obtained are an example of high competencies and motivation that should be followed so as to overcome environmental degradation and to eradicate poverty.

The Village Land Use Plan realized for the Uwiro Village is a highly valuable and detailed work, also because of the strong participation of the community leaders and members who worked together with District personnel in completing the process.

The sustainability of all this work, together with the intervention so far carried out, now depends on the Government, and the way in which the benefits obtained by the presence of Oikos in the area will be proficiently used. The holistic approach described in this book is what should be used in the decision making-process for the long-term sustainable socio economic development. Through this project, the Arumeru District has strengthened a capacity-building process by training the personnel and providing technical instruments of analysis as well as equipment, which now enhances the continuity of development actions.

I wish that the communities touched by the fruitful collaboration of Oikos and Arumeru District to continue to be aware, to use the knowledge acquired and act according to the Government Laws and Policies for the sake of future generations in pursuing a long-term sustainable development.

This book might be the tool to keep the memory of what has been done and what can still be done.

**Mercy Sila** *District Commissioner Arumeru District*

## ACKNOWLEDGEMENTS

This book is the result of the collaboration of many organizations and individuals, from the development, scientific and institutional worlds, which contributed to the implementation of the project “Economic development and environmental rehabilitation of Maasai pastoral areas in Arumeru District (Tanzania)”. Istituto Oikos wishes to warmly thank all of them. A particular acknowledgement is due to the Italian Ministry of Foreign Affairs/Italian Co-operation which provided funds to run the project and prepare this book, and to the main implementing partners: Arumeru District, Oikos East Africa and University of Insubria.

Many thanks are owed to the several institutions of Tanzania that gave a fundamental contribution to the success of the initiative and, in particular, to the Ministry of Land, the Ministry of the Natural Resources and Tourism, the Arusha Region, the Meru District, the Ngarenanyuki Ward and the villages of Kisimiri Chini, Kisimiri Juu, Ngabobo, Olkung’wado and Uwiro. Special thanks are due to the project technical staff: Caterina Carugati, project manager, Alessandra Confalonieri, Ahimidiwe Josephat, Andrea Mandrici, Elard Mawala, Jane Mary Ntalwila. They all have been hard working for the success of the project and the preparation of this book.

The success of the project was also the result of the commitment and efforts of the many individuals who, from the institutional to the grass root levels, maintained faith in the initiative and strongly contributed to the pursuit of its objectives: Jackson Saitabahu, the Arusha Regional Land Surveyor, Raphael Mbunda, Pius Affa and Transians Kagenzi, District Executive Directors, Mwajabu Abdalla, District Planning Officer, Anna Muhamba, Yohana Shumbi, Shairu Chuma, of the District Department of Land, Environment and Natural Resources, Grace Mghase of the Department of Planning and Community Development, Eliphasi Saanya, Ngarenanyuki Ward Councilor, Senyaeli Pallangyo, Ngarenanyuki Ward Executive Officer, Dauson Urio, Uwiro village chairperson, Imanuel Nnko Uwiro Village Executive Officer, Isaya Shakweti, Mkuru sub-village leader and all Village council members and adjudication committee of the Uwiro village. Their invaluable contribution and collaboration were highly appreciated during all phases of the project.

Istituto Oikos warmly acknowledges Michela Romanelli, of the Italian Technical Unit in Dar es Salaam, who went beyond the call of duty in her support to the Istituto Oikos programme in Tanzania and is also very grateful to many other project stakeholders for their valuable technical and institutional inputs and data provision: African Wildlife Foundation (AWF Tanzania), Arusha National Park (ANAPA), Community Research and Development Services (CORDS), Istituto Europeo di Design (IED), Livestock Training Institute (LITI), Meru Usa Forest Plantations, Osotwa Community Based Conservation Organisation, the Netherland Development Organisation (SNV), Selian Agriculture Research Institute (SARI), Tanzania Natural Resource Forum (TNRF), Tanzania Tourism Board (TTB), Tanzania Wildlife Research Institute (TAWIRI), Terre Solidali Onlus, Tropical Pesticides Research Institute (TPRI), University of Sassari - NDR, National Ranching Corporation. Istituto Oikos wishes to thank the participants in all of the meetings, discussions and interviews organized by the project – villagers, scientists, foresters, protected area managers, NGO workers and executives – who shared the willingness to make a positive contribution towards the sustainable resource use and livelihood improvement of the Mount Meru Natural System.

Special thanks are also due to Serena Arduino, who reviewed the draft text of the book and provided valuable corrections and suggestions and to Guy Waley, for English language editorial support.



## ACRONYMS USED IN THE TEXT

<b>AE Project</b> – Arumeru Environmental Project	<b>MD</b> – Medical Doctor
<b>AEP</b> – Arumeru Environmental Project	<b>MDG</b> – Millennium Development Goal
<b>AEZ</b> – Agro Ecological Zone	<b>MWA</b> – Maasai Women Art
<b>ANAPA</b> – Arusha National Park	<b>NARCO</b> – National Ranching Corporation
<b>AWF</b> – African Wildlife Foundation	<b>NCD</b> – Newcastle Disease
<b>CAHW</b> – Community Animal Health Worker	<b>NGO</b> – Non-governmental Organization
<b>CAHWN</b> – Community Animal Health Worker Network	<b>ODBC</b> – Open Database Connectivity
<b>CBPP</b> – Contagious Bovine Pleuropneumonia	<b>OGC</b> – Open Geospatial Consortium
<b>CBC</b> – Community Based Conservation	<b>QGIS</b> – Quantum Geographic Information System
<b>CCPP</b> – Contagious Caprine Pleuropneumonia	<b>SACCOS</b> – Saving and Credit Cooperative/Society
<b>CERC</b> – Community Energy Resource Centre	<b>SNV</b> – Netherlands Development Organization
<b>CRD</b> – Chronic Respiratory Disease	<b>SQL</b> – Structured Query Language
<b>DB</b> – Database	<b>TANAPA</b> – Tanzania National Parks
<b>DBMS</b> – Database Management Systems	<b>TANESCO</b> – Tanzania Electric Supply Company
<b>ECF</b> – East Coast Fever	<b>TAWIRI</b> – Tanzania Wildlife Research Institute
<b>FMD</b> – Foot and Mouth Disease	<b>TFNC</b> – Tanzania Food and Nutrition Center
<b>FS</b> – Farming System	<b>TLU</b> – Tropical Livestock Unit
<b>FOSS</b> – Free and Open Source Software	<b>TMWA</b> – Tanzania Maasai Women Art
<b>GIS</b> – Geographic Information System	<b>TNR</b> – Tanzania Natural Resources Forum
<b>IUCN</b> – World Conservation Union	<b>TZS</b> – Tanzanian Shilling
<b>LSD</b> – Lumpy Skin Disease	<b>TTB</b> – Tanzania Tourism Board
<b>LUP</b> – Land Use Plan	<b>TTM</b> – Tanganyika Triangulation Mercator
<b>LUZ</b> – Land Use Zoning	<b>VGS</b> – Village Game Scout
<b>MCF</b> – Malignant Catarrhal Fever	<b>VICOPA</b> – Village Community Banks
<b>MCHA</b> – Maternal Child Health Attendants	<b>WC</b> – Water Committee
<b>MCS</b> – Mkuru Camel Safari	<b>WHO</b> – World Health Organization
	<b>WMA</b> – Wildlife Management Area





## INTRODUCTION

This book is the final outcome of the three-years project “*Economic development and environmental rehabilitation of Maasai pastoral areas in Arumeru District<sup>1</sup> (Tanzania)*” funded by the Italian Ministry of Foreign Affairs and implemented by Istituto Oikos from July 2007 to September 2010, from now on mentioned as the Arumeru Environmental Project (AEP). With a Human Development Index at the 159<sup>th</sup> position out of 177 countries (World Development Indicators, 2010), 89% of its population still living on less than two dollars per day, more than 14 million out of 43 million people without access to safe water, Tanzania is struggling to reach the Millennium Development Goals. The Arumeru District is no exception. It is located in Northern Tanzania, along the Eastern edge of the Great Rift Valley, close to the rapidly expanding Arusha municipality, and it is shaped by the presence of Mount Meru (m 4565 asl), a dormant volcano covered by a catchment forest that acts as a condenser and a key source of water for about 500,000 people. The foothills of the mountain are inhabited by well established communities of farmers and pastoralists who rely on natural resources to make their living.

Over the years, the Mount Meru forests and fertile foothills have been over-exploited to meet the needs of a fast-growing population. Despite the fact that most of the catchment forest is preserved within Arusha National Park, human encroachment is very high and the agro-ecosystems are becoming increasingly vulnerable to rainfall shortages, droughts and climate instability. Consequently Mount Meru’s capacity to provide the ecosystem services that lie at the heart of the livelihood of the local people is declining, as is demonstrated by the recurrent food crises (2005, 2007 and 2009) and the increasing conflicts over resource use.

With a total population of about 290,000 in 2010, the Arumeru District is a heavily populated rural area (228 inhabitants per km<sup>2</sup>) where the population density, the rapid demographic increase (annual growth rate 3.1%, 2002 national census) and the climate-related hazards (irregular rains and droughts) are major sources of stress for rural communities, whose livelihood is entirely dependent on natural resources. Land degradation and soil erosion are reducing the natural assets while the impact of rapidly-changing human activities, developed to cope with the new scenario, make sustainable development a challenging objective.

All in all, the Arumeru Environmental Project is an attempt to answer the following question: is the Mount Meru natural capital capable of satisfying local needs? Considering the “structural environment fragility” of the area, which strategies and technologies need to be applied to ensure that the rural population can make a living out of its environment without depleting the natural capital and, consequently, the environmental long-term sustainability? The AE Project worked with local communities and institutions to set up strategies, mechanisms and concrete experiences aimed at making socio-economic development compatible with the long-term preservation of the natural capital. It entailed the following two components:

- **an analysis of the environmental and socio-economic characteristics of the project area, with a focus on land use factors;**
- **a participatory and community-based effort to translate this knowledge into**

---

<sup>1</sup> Arumeru District was recently split into Arusha and Meru District Councils, two administrative units under the same Arumeru District.



**concrete actions and land use planning and management initiatives in a sustainable development perspective.**

The strategies and approaches described below drove Istituto Oikos' intervention.

#### At community level

- **Training and awareness raising** aimed at:
  - **Enhancing local people's knowledge of the significance of sustainable natural resources use.** The understanding of the Mount Meru's environmental "structural fragility", the unsustainable behaviours and the links between land degradation and poverty was increased among local communities.
  - **Developing a sense of land ownership.** Specific training sessions on government land regulations were organised to make villagers aware of their land rights and to increase their feeling that land degradation is a loss of their own economic capital. Maasai are changing their traditional semi-nomadic lifestyle, traditionally associated with a weak sense of land ownership, into more permanent settlement arrangements. Therefore, they are only recently developing a sense of ownership towards their land.
  - **Improving land management capacities.** Rational practices applied to the use of natural resources can increase the capacity of the environment to satisfy the local people's needs without depletion of the natural capital. Therefore local people were sensitized on the application of sustainable practices in the livestock keeping, agriculture and forestry sectors.
- **Developing innovative income-generating activities in the environmental sector.** Environmental conservation can become a target among local people only if it shows evidence that it is the best option for socio-economic development. The AE Project developed some promising experiences in the sector.

#### At institutional level

- **Strengthening the local authorities' capacity to take decisions based on appropriate information.** The project provided technical assistance to the District offices (Planning, Environment and Rural Development Units) to set up a system to collect, store and analyse environmental data and use them for planning and decision-making purposes.
- **Supporting, at village level, the Central Government decision of making Land Demarcation and Land Use Planning a top priority on the village development agenda.** Village Land Use Plans based on appropriate sets of information and able to include the environmental dimension are the most appropriate tools to foster sustainable development.

The project was rooted in the long-term commitment of Istituto Oikos in the area. In particular, the training activities were developed at Mkuru Training Centre, a sustainability center established by Istituto Oikos in 2003 in the village of Uwiro to train local communities on sustainable natural resources practices in the energy, water, agriculture and livestock sectors. The AE Project provided an invaluable opportunity to integrate the traditional knowledge with modern approaches, methodologies and techniques. It was built on the awareness that economic growth in the Mount Meru Area is expected to be based on the intensification of the use of natural resources. In this

context, the project experience was an attempt to pursue environmental health, community development and the strengthening of local governance through the integration of environmental knowledge with concrete field experiences and innovative decision-making mechanisms.

This report combines the scientific knowledge gathered through the project with a discussion of the significance of the field interventions in the framework of sustainable development.

It consists of:

- an analysis of the environmental and socio-economic characteristics of the area, with the identification of the critical aspects that are challenging development;
- a description of the most relevant field interventions;
- a conclusion with an analysis of the most relevant achievements and main lessons learnt;
- recommendations for future actions.

The final aim of this publications is to make the experience available to the decision-makers and the development co-operation actors, to stimulate the joint evaluation on how environmental, social and economic considerations have to fit together and how policies, plans and programs of interacting sectors have to be harmonized to balance long-term and short-term objectives and to make the environment-development equation possible.

*Mkuru Training Centre: accommodation and training facilities.*



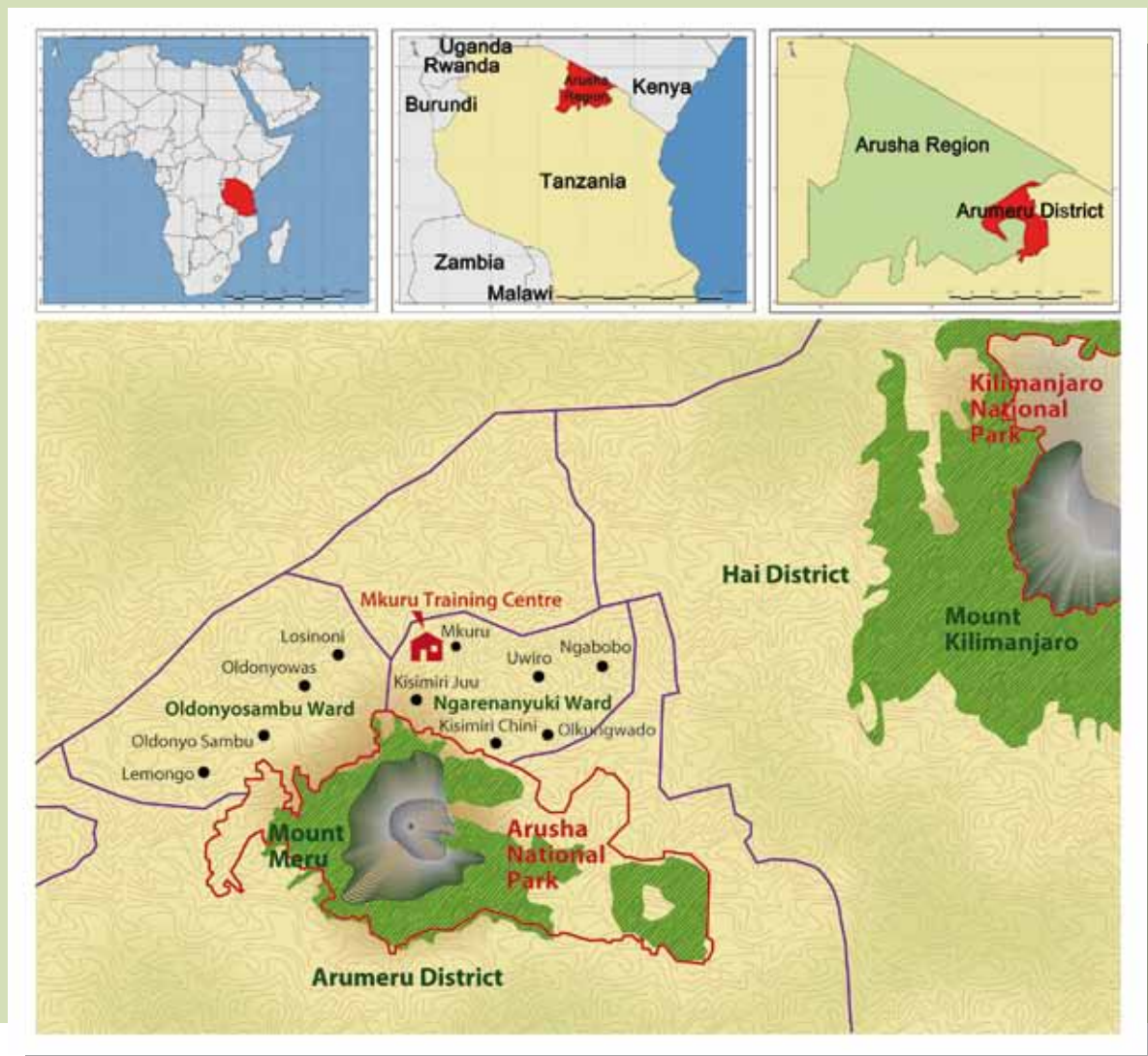


## THE PROJECT AREA: STATUS AND PROBLEMS

This chapter provides a brief environmental and socio-economic profile of the intervention area and is built on the information gathered and analysed by Istituto Oikos within the framework of the AE Project. It also highlights the main problems that need to be addressed and that are at the root of Istituto Oikos' commitment in the area.

It starts from an overall description of the Mount Meru Natural System, the environmental unit which includes the Arumeru District, and then focuses on the Ngarenanyuki and Oldonyosambu Wards, located in the north and north-eastern sector of the system, two areas particularly vulnerable to the increasing human pressures (Map 1).

Map 1 - The intervention Area (Istituto Oikos, AE Project, 2010)





## ENVIRONMENT

The **Mount Meru Natural System** is located within one of the most important biodiversity areas of the country: the **Maasai Steppe**, a territory traditionally inhabited by Maasai nomad shepherds and extending more than 200,000 km<sup>2</sup> within the East African Rift Valley, from the Turkana Lake, in Kenya, to central Tanzania. The natural environment is mainly savannah, with wide plains, hills and volcanic mountain crests. The climate is overall semi-arid, with a dry and a rainy season.

Within the Maasai Steppe, the **Mount Meru Natural System** is strongly conditioned, in its climate, geology, vegetation and wildlife, by the presence of Mount Meru (4566 m, the 5th highest mountain in Africa), which, with its evergreen forests is an invaluable resource for the long-term climate stability of all Northern Tanzania. At the heart of the system is **Arusha National Park**, a key attraction for international tourists and climbers.

The **Ngarenanyuki Ward** and, to a certain extent, the **Oldonyosambu Ward**, bordering Arusha National Park, are experiencing particularly high levels of population growth, economic development, land-use conflicts and encroachments on the park resources. They can play a strategic role in combining conservation and development efforts. Therefore, most of the project activities were concentrated in the Ngarenanyuki Ward and, partly, in the Oldonyosambu Ward. Located in the northern part of the Arumeru District, at approximately 50 km from the town of Arusha, the Ngarenanyuki Ward covers an area of 22,130.43 hectares and comprises five villages: Uwiro, Olkungwado, Ngabobo, Kisimiri Chini and Kisimiri Juu. Uwiro can be considered as the geographical, environmental and socio-economic centre of the Ward. In this village Istituto Oikos established Mkuru Training Centre, a field base for the project staff and a place for developing training activities.

*View of Mount Kilimanjaro from the top of Mount Meru.*

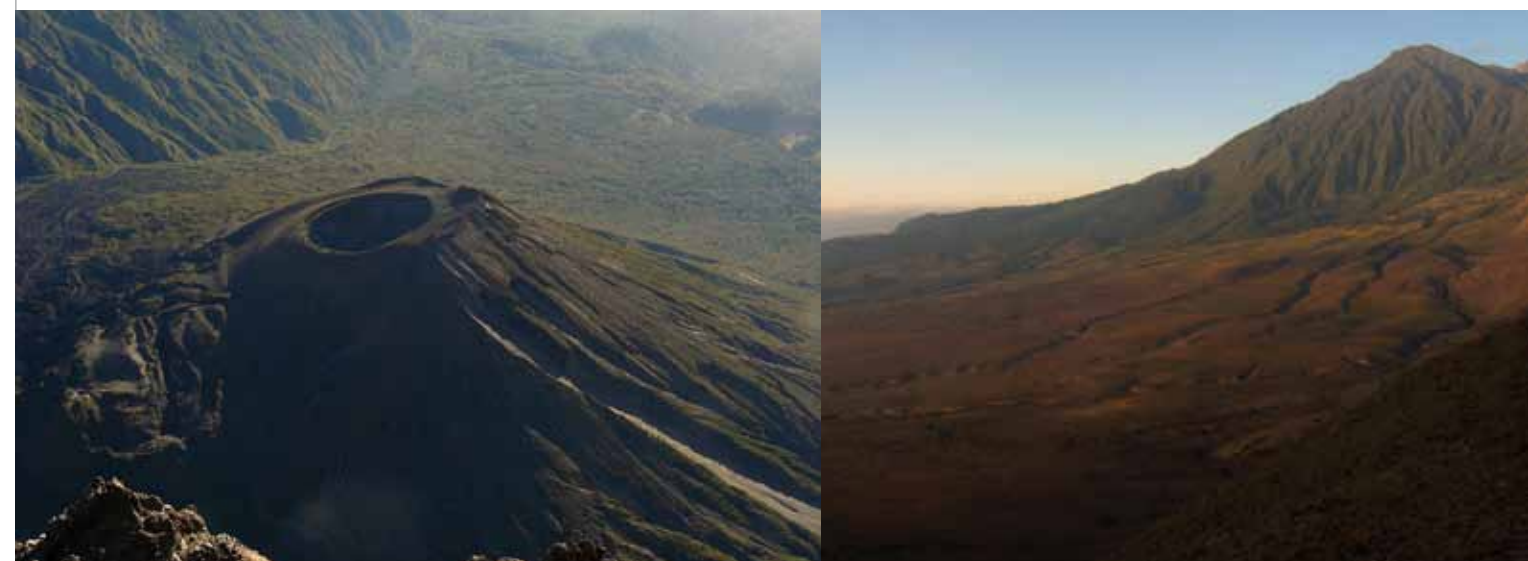


## ENVIRONMENT/ GEOMORPHOLOGY

Mount Meru is a large area of a pile of extrusive volcanic rocks (porphyries, basalts, trachytes, etc.) on the eroded surface of the Precambrian metamorphic basement, with intrusive granitic granodioritic plutons. These metamorphic rocks of the Mozambiquean orogenic belt range from various kinds of schists to gneisses and granulites. The Precambrian basement was completely covered by sediments mainly consisting of volcanic materials and originated by mudflow (lahar) from the volcanic slope or by pyroclastic ashes deposited after explosive eruptions. The action of petrologic processes on these particles originated clay soils (very rich in montmorillonite, illite and kaolinite).

The topography is dominated by the Mount Meru, a young volcano of Pleistocene origin. The Meru crater was formed by a vast explosion and further activities increased its size, as the series of violent explosions that 6000 years ago caused the collapse of the whole eastern crater wall. This resulted in a landslide and in a consequent extensive mudflow which travelled eastward to the base of Mount Kilimanjaro and caused the formation of many lakes, ponds and swamps (eg. Big Momella, Small Momella, Rishatani, Tulusia, Lekandiro, Longil, El Kekhotoito and Kusare). About 1800 years ago the caldera wall further collapsed. The flood this time laid down a sand/ash layer in all lakes sharing the Ngare Nanyuki River drainage, with the exception of Lake Longil.

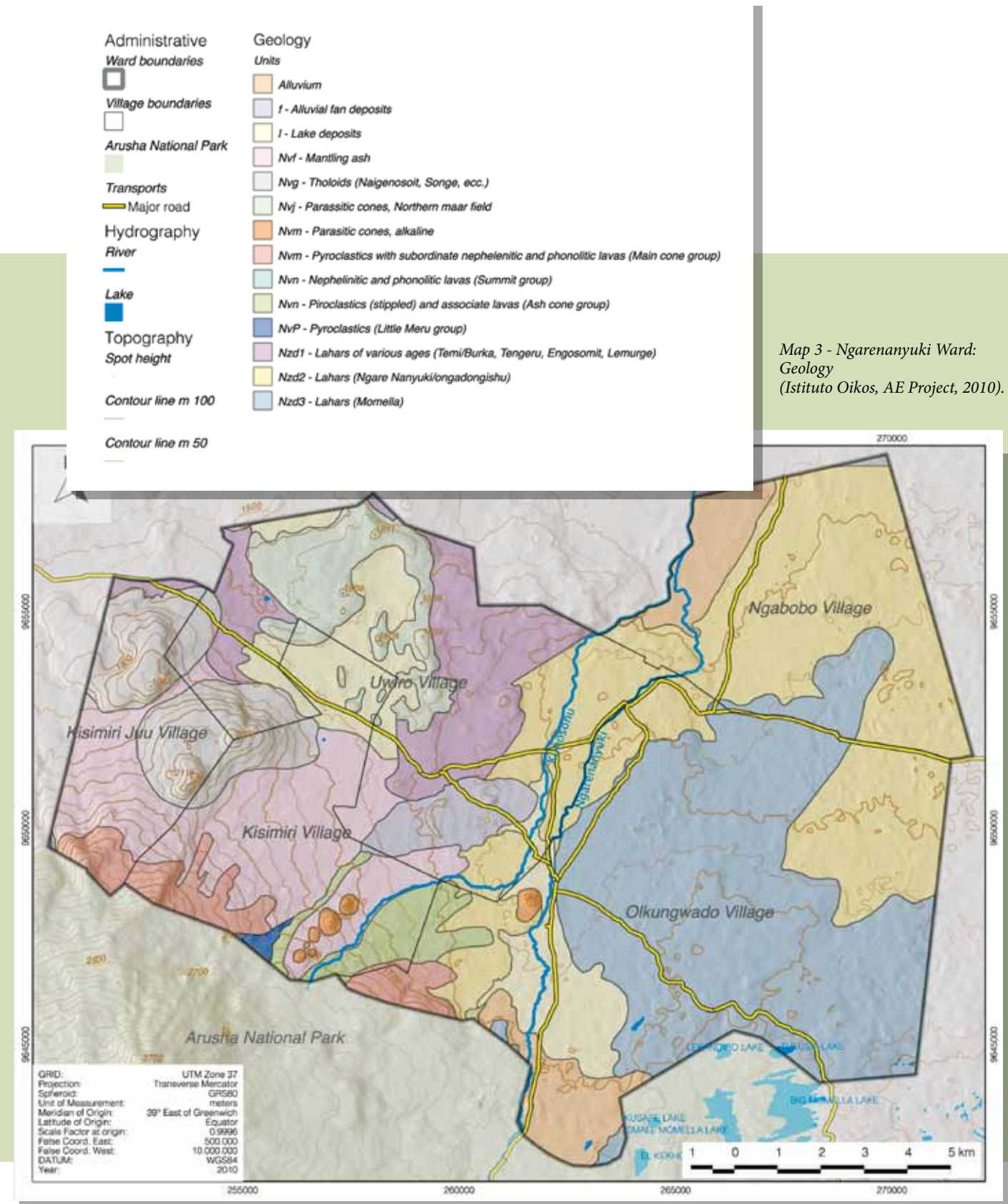
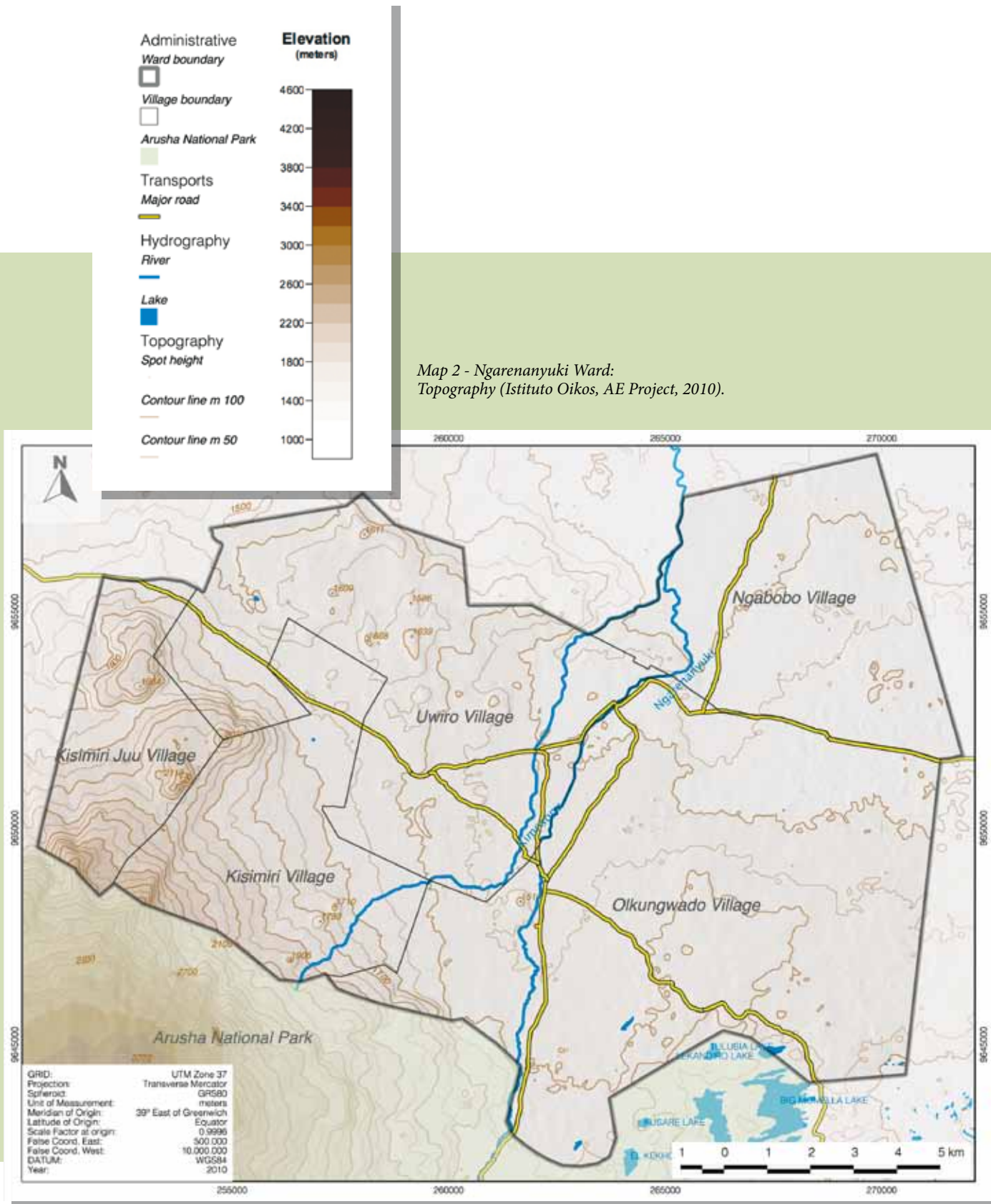
This flood changed the course of the river, that started to drain more northerly. As a result, all lakes, except Small Momella, became closed and are now fed only by ground-water and by surface run-off and precipitation. Permanent saline water characterises the Big Momella Lake and the Small Momella Lake, both located on the east side of Mount Meru, inside the Arusha National Park. The last eruption of Mount Meru was recorded in 1877. Map 2 shows the topography and Map 3 the geology of Ngarenanyuki Ward.



*The Mount Meru crater (Little Meru).*

*The foothills of Mount Meru.*

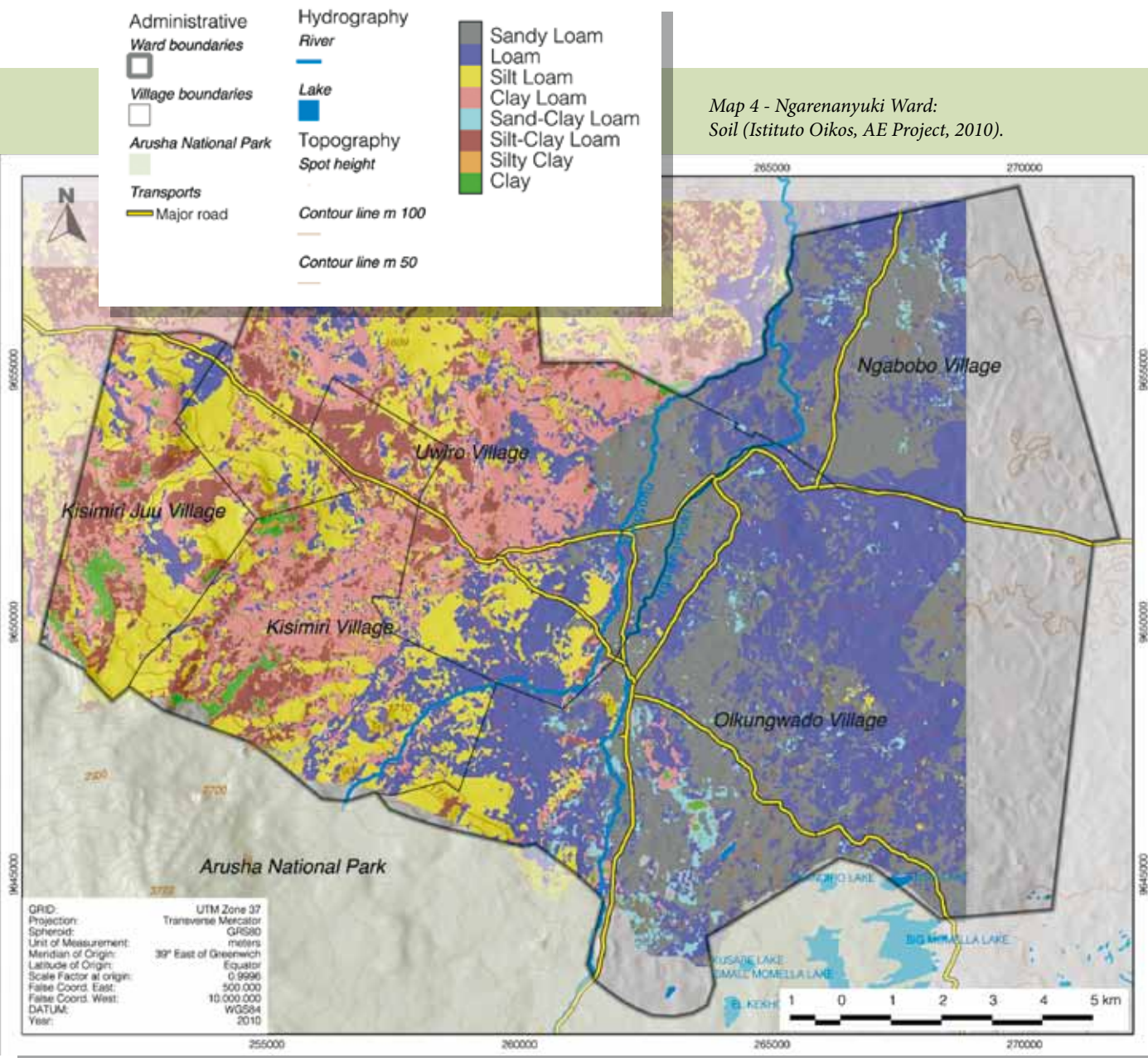






ENVIRONMENT/ SOIL

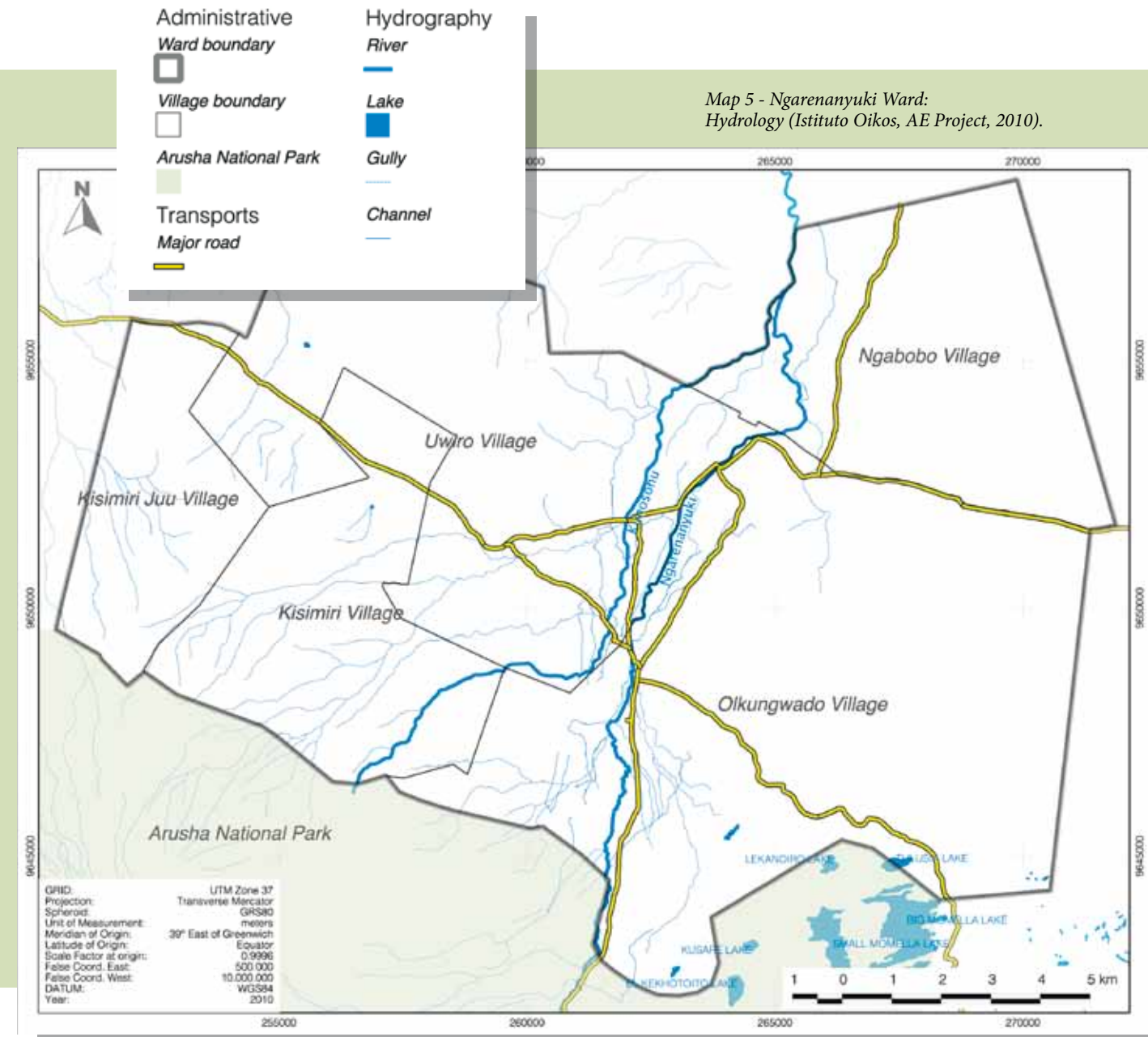
In the slopes of Mount Meru, soils are derived from the volcanic rocks and ashes hurled down during the Meru and Kilimanjaro eruptions. They are very deep and rich in ashes in the upper area while they become more shallow and rocky moving away from the volcano. Most of the soil of the region is recent and scarcely weathered especially in arid or eroded areas. In swamps and depressions, soils are alkaline in nature, dominated by leached soluble materials being transported from higher slopes. These areas have very high pH values, reaching more than 10, are poorly drained and inadequate for agriculture. In conclusion, due to its volcanic origin, the soil has a high fertility potential, but is very fragile. Its weak structure, associated with the declivity of the slopes and the scarce vegetation coverage in non-forested land, are causing high erosion rates and recurrent risks of landslide. Map 4 shows the soil typologies of Ngarenanyuki Ward.



Map 4 - Ngarenanyuki Ward: Soil (Istituto Oikos, AE Project, 2010).

ENVIRONMENT/ HYDROLOGY

Mount Meru, with its forested slopes, represents a very important water catchment for the whole area and supplies water to Arusha town and to the many settlements of the dry, but densely inhabited Arumeru District. The drainage pattern around Mount Meru is radial, but downhill the stream courses are modified by tilting and capture. In the intervention area, east and north-east of the Mount Meru, the only perennial river is the Ngare Nanyuki, that flows for 41 km northwards into the inner Amboseli Basin and its main affluent, the 16 km long Kimosonu river. These sources supply - by way of a network of open ditches - small-scale irrigation schemes covering approximately 1214 ha. Spring water is utilized for domestic consumption as well. Map 5 shows the Hydrology of Ngarenanyuki Ward.



Map 5 - Ngarenanyuki Ward: Hydrology (Istituto Oikos, AE Project, 2010).



## ENVIRONMENT/ CLIMATE

The climate of the Mount Meru Natural System falls within the semi-arid belt of Sub-Saharan Africa. It is characterized by two distinct seasonal weather patterns: the dry and the wet season, with short rains in November and December and long rains from mid March to late May. Short rains are highly variable both in intensity and in distribution, while long rains are more regular.

Mount Kilimanjaro and Mount Meru have a great influence on the climate and can be considered wet 'islands' in a dry matrix. While the higher south-western slopes of Mount Meru receive up to 2000 mm/y of rainfall with a maximum in the montane belt of around 2200 mm/y, on the northern slopes only 500-600 mm/y are recorded as the result of the shade effect of the mountain (Table 1).

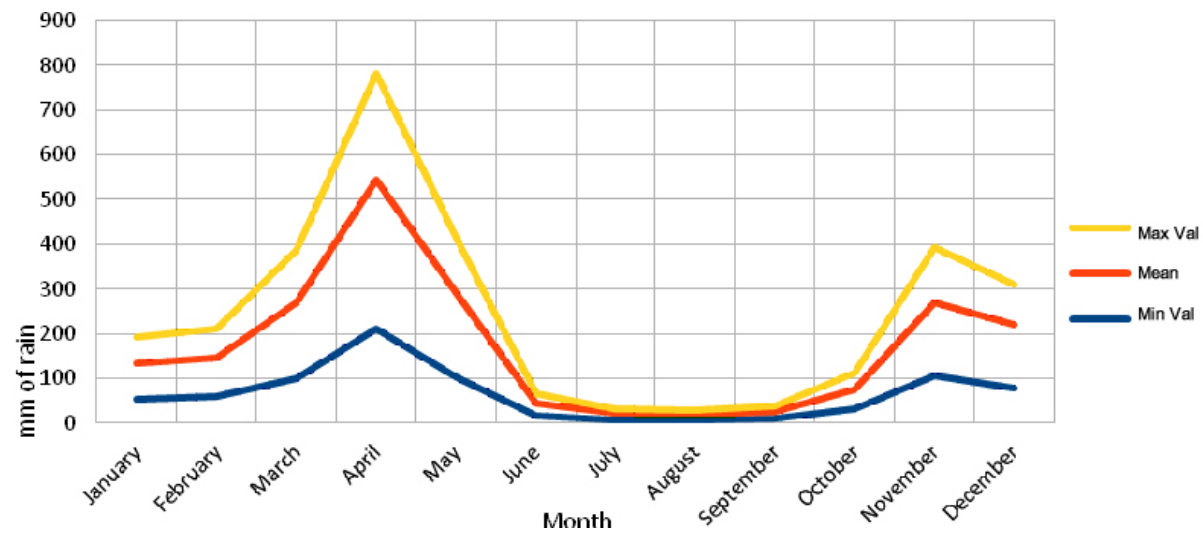


Table 1 - Ngarenanyuki Ward: Rainfall patterns (Istituto Oikos, AE Project, 2010).

At Ngarenanyuki Ward, the average minimum temperature is 8°C in July and the maximum average temperature is 28.45°C in February. The annual mean temperature is 18.68°C. The hottest season is between January and February with temperatures sometimes exceeding 25°C, while the cold season is from June to August with temperature at midday just below 16°C. On the highest parts of Mount Meru temperatures are lower and frost occurs at night during the cold season.

In conclusion, the unpredictable climate, exacerbated by the effects of climate changes, is historically the major constraint to the agricultural and pastureland productivity of the area. In the immediate slopes of Mount Meru, where rainfall is enough to permit agriculture, the shorter and more intensive rainy season increases soil erosion and landslide risks. Longer periods of drought also have an impact on rain-fed agriculture. In the dry lands where Maasai communities live, recurrent droughts have a major impact on the pastoralists, who are forced to walk longer distances in search of water and fodder. Recent prolonged droughts (2005 and 2007-2009), associated with strong winds, have caused severe livestock and rain-fed crop losses and repeated food crises. They have also affected the natural regeneration capacity of the forests, the tree planting and re-forestation initiatives, as well as pasturelands conservation and wildlife movement and survival.

## ENVIRONMENT/ VEGETATION

The **vegetation of Mount Meru**, within Arusha National Park, can be divided into three main zones, distributed along a vertical gradient that occurs in all East African mountains:

- 1) the **Mountain Forest Zone (evergreen forest)** dominated by multi-stratified closed evergreen trees with heights up to 30 m and more. It is the most delicate and threatened environment. It includes the Dry Montane Forest, on the eastern, north-western and northern slopes, between 1,500-2,600 m asl, with the threatened *Juniperus procera*, *Podocarpus falcatus* and *Olea africana*; the Moist Montane Forest, on the eastern and western slopes between 1,500 and 2,400 m asl, with a great number of broad-leaved hardwood trees; and the Upper Montane Forest between 2,300-3,000 m asl, with the bamboo thickets (*Arundinaria alpina*) and *Hagenia abyssinica* forests.
- 2) The **Sub-afroalpine Heath Zone (Ericaceous Zone)**, between 3,000 – 3,600 m asl, dominated by arborescent or shrubby species of *Philippia* and *Erica*.
- 3) The **Afroalpine Zone**, up to the summit at 4,560 m asl, with a poor flora, mainly consisting of an open steppe-like community, dominated by two grasses of the genus *Pentaschistis*.

The **vegetation of the area surrounding Mount Meru** is semi-arid, with poor cover dominated by grassland, shrub-land, thickets and open woodlands. A Vegetation Cover (Map 6), based on the FAO Land Cover Classification System, was produced for Ngarenanyuki and Oldonyosambu Wards. At the end of the book there is a pocket containing Map 6 in A3 size.

**Savannah with trees or shrubs** covers flat lands and is characterized by a perennial herbaceous coverage with sparse trees and shrubs. It is a typical sign of poor rangeland conditions. The dominant species are graminoid grasses such as *Panicum sp.*, *Cynodon dactylon*, *Cynodon plechtostachys*. The dominant species are *Acacia tortilis*, *Acacia nubica*, *Balanites aegyptiaca*, *Commiphora sp.*, *Maerua triphylla*, *Euphorbia cuneata*, *Euphorbia candelabrum*.

**Shrub-land** usually covers hills, flat lands or rocky slopes and is dominated by open deciduous shrubs 0.5 to 3 m high. Tree coverage is sparse or absent. The dominant species are *Acacia tortilis*, *Acacia mellifera*, *Acacia etbaica*, *Commiphora sp.*, *Maerua triphylla*, *Euphorbia cuneata*, *Euphorbia candelabrum*, *Balanites aegyptiaca*.

**Thicket** often occurs in escarpment or steep hilly slopes. It is dominated by closed deciduous shrubs or woody vegetation and tree coverage is sparse or absent. The dominant species are *Acacia mellifera*, *Acacia etbaica*, *Commiphora sp.*, *Maerua triphylla*, *Grewia sp.*





**Woodlands** are most frequently found on hilly landscapes. They are dominated by an open coverage of broad-leaved deciduous trees often lower than 7 m and are usually characterized by sparse or open shrubs and herbaceous cover. The dominant species are *Acacia drepanolobium*, *A. tortilis*, *A. mellifera*, *A. etbaica*, *A. senegal*, *Commiphora sp.*, *Euphorbia candelabrum*, *Euphorbia boussei*. Other non-dominant but typical species are *Balanites aegyptiaca*, *Maerua triphylla*, *Euphorbia cuneata*, *Erythrina abissinica*.

**Wet forests** are located in flat land seasonally flooded, waterlogged or along rivers. They are dominated by open to closed trees, with heights up to 30 m. Also shrubs and herbs are usually present in these areas. Dominant species are *Acacia xanthophloea*, *Ficus sp.*, *Faidherbia albida*.

**Forest plantations** of exotic species such as *Pinus sp.*, *Casuarina sp.* and *Eucalyptus sp.* for industrial production are located on the Mount Meru slopes close to Arusha National Park boundaries.



First line from the left: *Acacia drepanolobium*, *Acacia mellifera*.  
 Second line from the left: *Acacia tortilis*, two images of *Acacia xanthophloea*.  
 Left: *Balanites aegyptiaca*.

## ENVIRONMENT/ AGRO ECOLOGICAL ZONES

In the intervention area five agro-ecological zones were identified mainly on the basis of climatic (rainfall) data and physiographic factors.

**AEZ1 - Flat plains (1,200-1,400 m asl).** Shallow soils developed on ashes and lahars of variable fertility with localized salinity problems. Unreliable bimodal rainfall (300-600 mm/year). Vegetation cover: grassland and/or low deciduous shrubland. Main land use: rangeland and very marginal rain fed agriculture. Very low agricultural potential.

**AEZ2 - Undulated to hilly landscape (1,300-1,600 m asl).** Soils of variable depth and fertility, developed on lahars and craters with a discontinuous deposit of ashes. Unreliable bimodal rainfall (300-700 mm/year). Vegetation cover: deciduous woodland and/or shrub-land. Main land use: rangeland and rain-fed agriculture limited to the areas with deeper soils and receiving more rainfall (near the 1600 m isohyetal line) and surface run-off from Mount Meru slopes. Poor to medium agricultural potential in relation to rainfall and topography.

**AEZ3 - Gently undulated landscape (1,400-1,600 m asl).** Soils of variable depth and fertility, developed on lahars or ashes. Bimodal rainfall (>700mm/year). Potential vegetation cover: semi-deciduous to semi-evergreen woodland and forest. Actual land use: scattered perennial and annual rain-fed crops and pastureland. Medium to good agricultural potential.

**AEZ4 - Mountain slopes and foot slopes (above 1,600 m asl).** Deep soils, erosion-prone, developed on ashes. Bimodal rainfall (>800mm/year). Potential vegetation cover: evergreen forest. Actual land use: perennial and annual rain-fed crops. Good potentialities for agriculture if good soil management is adopted (erosion control measures). This zone is only marginally represented in the study area.

**AEZ5 - Flat alluvial plains (1,200-1,500 m asl).** Medium deep soils, localized salinity problems. Bimodal rainfall (400-700mm/year). Highly anthropized landscape, irrigated crops. High agricultural potential.





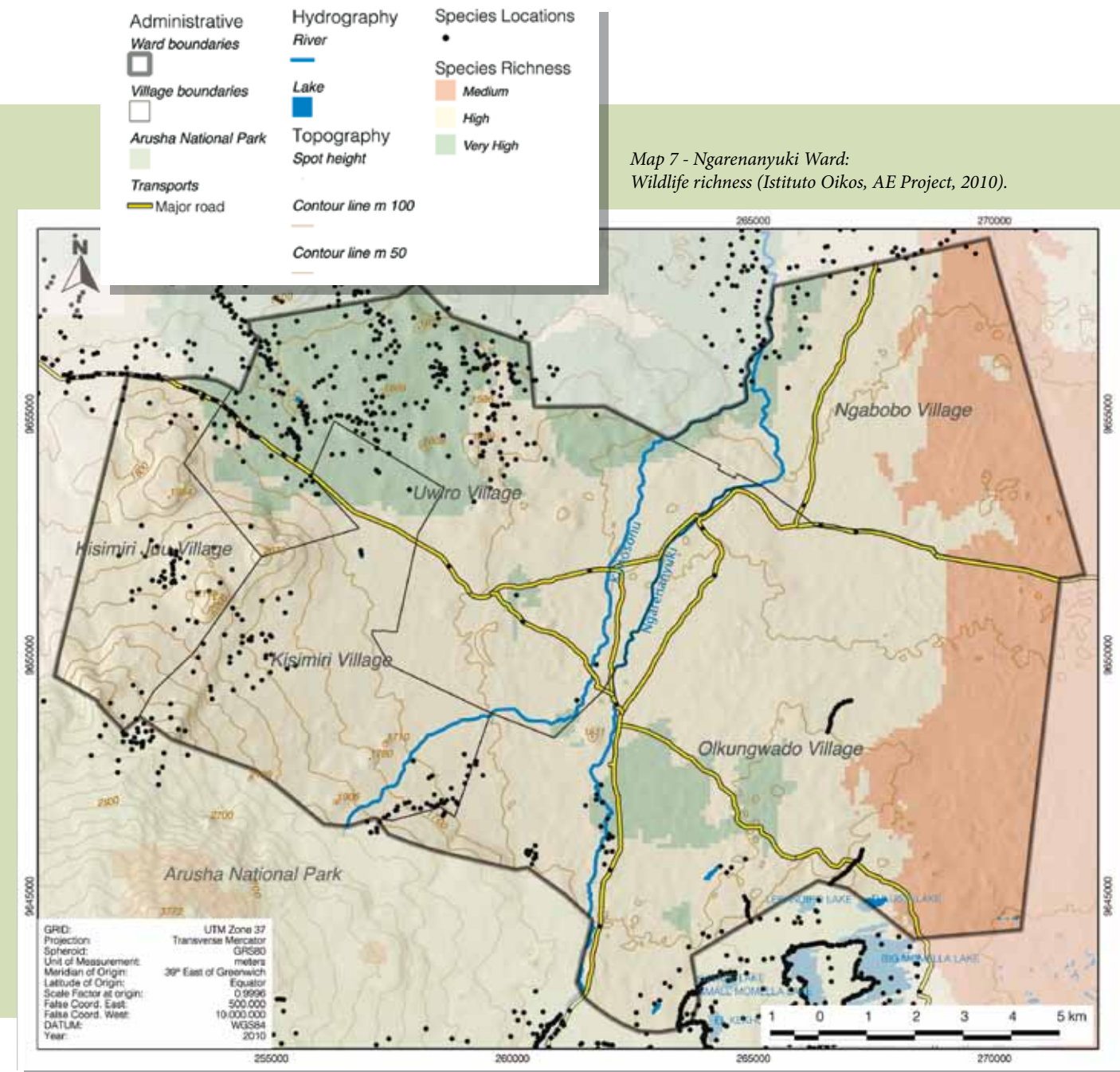
ENVIRONMENT/ WILDLIFE

Within the Mount Meru Natural System, Arusha National Park is the core area in terms of wildlife biodiversity: it hosts about 72 species of mammals, 10 species of amphibians, 36 species of reptiles and more than 500 bird species. In the early 1900s, the entire System was known for its large concentration of game animals, particularly ungulates, which were abundant in the open plains. Today, the area is still considered an outer limit for migratory large herbivores, which concentrate in the Kenyan Amboseli swamps in the dry season and spread towards Tanzania in the wet season, up to the Longido mountain, the foothills of West Kilimanjaro and the northern part of Mount Meru. Elephants, the main remaining migrating species, still move between Arusha National Park, Kilimanjaro National Park, Amboseli and Lake Natron. Nevertheless, their seasonal movements are very limited due to the blockage of wildlife corridors. About 150 elephants are still resident inside Arusha National Park.

Outside the Park, the northern sector of the Mount Meru is very rich in terms of wildlife (Map 7). It hosts several resident and migratory uncommon species, such as lesser kudu (*Tragelaphus imberbis*), gerenuk (*Litocranius walleri*), steinbok (*Raphicerus campestris*), klipspringer (*Oreotragus oreotragus*), wild dog (*Lycaon pictus*), cheetah (*Acinonyx jubatus*) and striped hyena (*Hyaena hyaena*). The open grassland plains of Ngasurai, Eng'ata Osugati, and West Kilimanjaro Ranch provide important calving ground for wildebeest (*Connochaetes taurinus*), zebra (*Equus burchellii*), Thomson's gazelle (*Gazella thomsoni*) and Grant's gazelle (*Gazella granti*) in the wet season. The importance of the area is also underlined by the fact that 12 out of the 44 species of medium and large mammals of the ecosystem are found only outside the park, including lesser kudu, gerenuk, cheetah and wild dog.

Logging was a major source of destruction in the early 1960s, but settlements and agriculture expansion are also contributing to the blockage of the migratory routes. Arusha National Park is almost becoming an isolated island after all its boundaries have been surrounded by field crops and settlements. The blockage of corridors means wildlife population isolation with risk of inbreeding and hence loss of genetic diversity. The Kisimiri Wildlife Corridor is the only remaining link between the park and the other protected areas and is cutting across the Arumeru District. This corridor is very narrow, squeezed in by crop fields and settlements. It runs through Kisimiri - Uwiro villages and Mkuru sub-village (Ngarenanyuki Ward) and then becomes wider towards the West Kilimanjaro Ranch and Amboseli National Park. The checklist of the terrestrial vertebrates identified in the Mount Meru Natural System is annexed (Annex A).

Elephants are the main cause of human-wildlife conflicts. A group of male Impala.



Zebras at the foot hills of Mount Meru.





## SOCIETY

### SOCIETY/ POPULATION

The Meru District Council, the administrative unit under the Arumeru District where most of the project activities were focused, has a surface of 126,800 hectares, and hosts, according to the latest National Census (2002), a total population of 225,000, with a projection of about 290,000 people in 2010. The population growth rate is 3.1 % (2.9% at national level), while the average life expectancy is 47 years (56 at national level) due to the high incidence of HIV/AIDS pandemic (District Council socio-economic profile, 2009).

According to the 2002 projections for 2010, the population density of the Arumeru District (228 Inhabitants/km<sup>2</sup>) is 4 times higher than at national level (46 Inhabitants/km<sup>2</sup>), making human pressure over the delicate and vital Mount Meru natural resources a key issue for sustainable development. Population statistics for the Ngarenanyuki Ward are reported in Table 2.

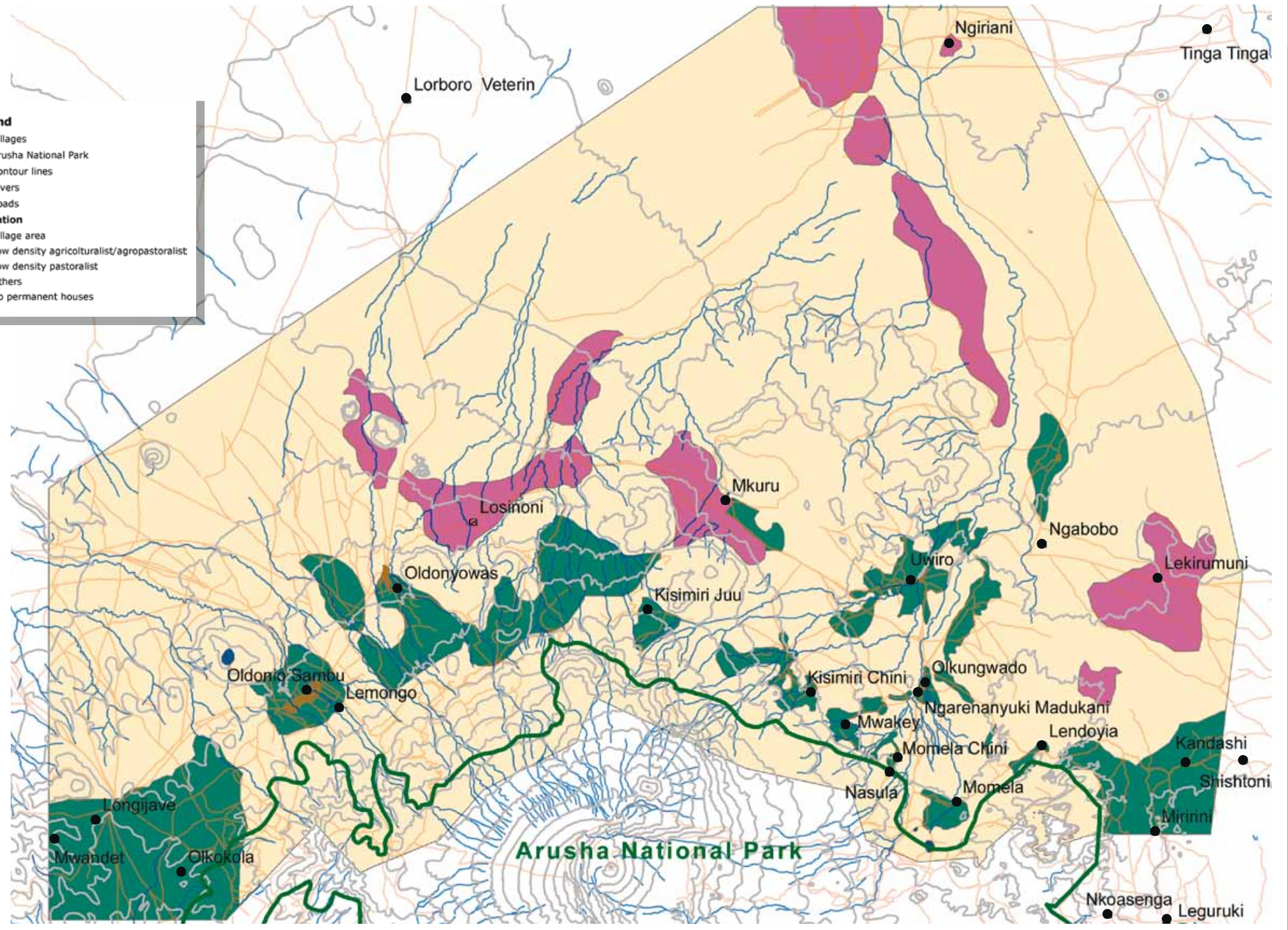
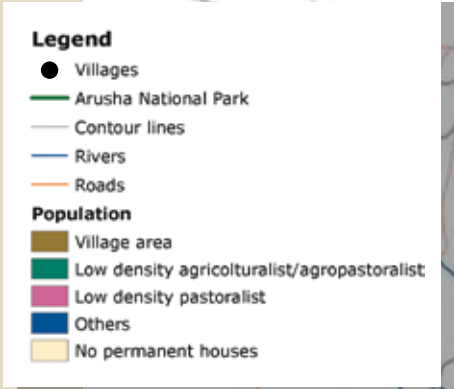
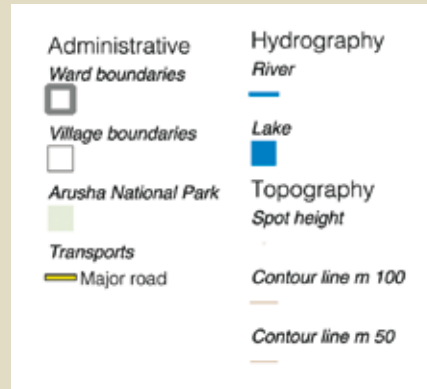
Village	2002*			2007**	Main ethnic group
	Male	Female	Total	Total	
Uwiro	1715	1610	3325	3972	Wameru and Maasai
Olungwado	3364	3240	6604	8050	Wameru
Ngabobo	1282	1241	2523	2798	Maasai
Kisimiri Chini	1099	1086	2185	3217	Wameru
Kisimiri Juu	1074	1228	2302	2783	Warusha
<b>TOTAL</b>	<b>8534</b>	<b>8405</b>	<b>16,939</b>	<b>20,820</b>	

Table 2 - Population statistics per village for Ngarenanyuki Ward  
(\* National Census, Tanzania Bureau of Statistics, 2002; \*\* Village offices reports, 2007)

Even though the population density is very high, it is not equally distributed throughout the intervention area. Therefore, an analysis to identify the areas with the highest population pressure was developed. Map 8 integrates the distribution of permanently inhabited houses and infrastructures with the land-cover information and the field observations with the objective of showing the areas in Ngarenanyuki and Oldonyosambu Wards where the demand for land for agriculture and/or livestock keeping is expected to be higher and, consequently, where conflicts over land uses and unsustainable land use practices are more common.







**Description of categories:**

*Village area:* High population concentration and high pressure on natural resources. Buildings and infrastructures cover most of the land in a continuous pattern. Public services and commercial activities are present. Population comes from mixed tribes.

*Low density agriculturalist/agropastoralist:* Scattered houses and infrastructures mixed with fields or grazeland in rural landscape. The population is sedentary Wameru, Waarusha or Maasai, active mainly in agriculture or both in agriculture and pastoralism but with agriculture as prevalent activity.

*Low density pastoralist:* Sedentary or semi-nomadic Maasai population living in traditional scattered boma in grazeland landscape. Pastoralism is the dominant activity.

*Others:* Modern infrastructures with low population but with a relevant impact on territory and population economy.

*No permanent houses:* Area without any permanently inhabited house.

Map 8 - Ngarenanyuki and Oldonyosambu Wards: houses and infrastructures density. The map shows areas with different densities of permanently inhabited houses and infrastructures; it is based on photo interpretation and field observations. (Istituto Oikos, AE Project, 2009)



## SOCIETY/ ETHNIC GROUPS

Three main ethnic groups populate the Ngarenanyuki and Oldonyosambu Wards: Wameru, Warusha and Maasai. Although they had severe conflicts among themselves over the use of the land in the late fifties, at the beginning of the colonization of Mount Meru, a form of cooperation and synergy has now been achieved.

**Wameru** are the dominant group of the area (Table 2). They arrived in Ngarenanyuki Ward about 300 years ago and occupy the immediate slopes of Mount Meru, where rainfall is enough to permit agriculture. The Wameru speak a Bantu language. Their main economic activity is small-scale farming. Within the intervention area, they inhabit the villages of Uwiro, Olkung'wado and Kisimiri Chini.

Also **Warusha** dominate the higher slopes of Mount Meru, in Kisimiri Juu, practising both agriculture and livestock keeping. The Warusha are Nilotic, like the Maasai, of which they are an offshoot. They arrived in the area around 1830 and shared with the Wameru the agricultural land on the fertile slopes of Mount Meru. Both Warusha and Wameru have traditional agroecosystems which are complex intercropped multi-layer systems with plantain, coffee, finger millet, sorghum and, today, maize and beans, which replaced the more drought resistant lablab and cowpeas. Coffee represented the most important and successful cash crop for both Wameru and Warusha for more than one century. The Wameru were also introduced to the practice of "zero grazing livestock" and are the only ethnic group growing livestock feed, usually plantain and elephant grass, and fruits for domestic consumption. However, in recent years Wameru communities started irrigated vegetable production in the lower areas, mainly with tomatoes and onion still rotated with maize and beans inter-cropped. This farming system is supported by 13 main traditional irrigation schemes and led the area of Ngarenanyuki to become one of the major tomato producers of Northern Tanzania. Tomatoes are sold to Dar es Salaam and Mombasa markets. This kind of agriculture has changed the life style considerably, leading to higher incomes, intensification of land use, introduction of common use of pesticides and fertilizers, environmental problems and exacerbation of land and water use conflicts.

The **Maasai**, the third major ethnic group of the area, are semi-nomadic pastoralist people who inhabit the dry lands further north and who speak a Nilotic language called Maa. Their social system is based on age classes, polygamy and patriarchy. Traditionally, the male's role is to take care of cows, sheep and goats, while females take care of the household. Their traditional economy is based on livestock keeping and, occasionally, on subsistence maize cultivation. With the exception of the Maasai, the other communities live in permanent settlements concentrated in small villages. The Wameru are the most well-off: most of their houses are constructed in cement bricks and roofed with sheet iron. Warusha have permanent huts where the whole family lives together.



Maasai woman with children.



Warusha woman.



A traditional Maasai boma and a hut.

Huts are generally built with mud and thatched with grasses, even though few of them have sheet iron roofs. Most of the Maasai community, however, still live in scattered homesteads, known as "boma" in Kiswahili, the national language. The boma, a settlement belonging to one family, is a cluster of huts set in a circle and consisting of a large space for the cattle and an average of 4 huts, made of mud and dung, all protected by a common shield of live fence or dried acacia branches. The more protected central portion is the night-time pens for the livestock, with separate partitions for sheep and goat, and cattle. Each wife of the family leader owns an independent hut which she shares with her unmarried children. Each boma comprises a number of family members and represents the basic unit of the Maasai cultural and economic life. Bomas are generally headed by one married man, who owns the livestock and has many wives. The number of wives is directly proportional to the wealth of the family leader.

Women are in charge of all domestic issues, including water and firewood collection. Recently Maasai people engaged in more profitable activities such as irrigated vegetable cropping, mostly in Ngabobo Village. This, thanks to the higher revenues and the need of a permanent presence in the village, led the families to shift from the traditional "bomas" to cement block houses with iron sheet roofs. Despite this, Maasai still invest a big proportion of the farming income in livestock activity. Many Maasai households, in more traditional areas like Uwiro Village, are also engaged in rain-fed agriculture using animal traction or tractors. They mostly plant maize in former grazing areas; this habit is increasing their vulnerability to drought. While changing life style and income, women still face strong gender bias. Poor Maasai families send women and children to seasonal tomato harvesting work in neighbouring villages.

Meru woman with child.





## LAND USES AND LIVELIHOOD

The use of natural asset for the production of food and raw material is the primary source of income for the communities living in the Mount Meru Natural System. A brief description of the main **Farming Systems (FS)**, intended as “a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate” (J.Dixon and A.Gulliver with D.Gibbon - FAO 2001) is provided below. Map 9 is an attempt to show how these different strategies are combined into the complex mosaic of land uses that shape the Mount Meru environment.

### LAND USES AND LIVELIHOOD/ PASTORAL, LIVESTOCK ONLY, RANGELAND-BASED FARMING SYSTEM

This extensive and traditional grazing system is characterized by seasonal movements of herds to exploit the temporal and spatial availability of range resources. It is mainly practiced by the Maasai communities and represents their main (often only) source of income. Herds usually consist of cows, goats and sheep (Table 3). Amongst cattle, the most frequent breeds are the Tanzania short zebu and cross breeds mainly of Borana type. Generally herding takes place on rangelands close to the sparse settlements, but in dry season herds migrate to more distant areas in search of pasture and water. The Maasai traditionally re-invest all their profits in the herd, and the growth of animal stocks, as a source of income and food security, has been their main livelihood strategy in response to population increase.

Village	Rangeland area	Cattle*	Small ruminants*	Total Livestock Units	Stocking density
	<i>Acres</i>	<i>Units</i>	<i>Units</i>	<i>Units</i>	<i>TLU/acre</i>
UWIRO	9040	3400	7000	4800	0.5
OLKUNGWADO	12873	4050	7100	5470	0.4
NGABOBO	6085	4250	10400	6330	1.0
<b>TOTAL</b>	<b>27998</b>	<b>11700</b>	<b>24500</b>	<b>16600</b>	<b>0.6</b>

Table 3 - Estimated stocking density in Uwiro, Olkungwado and Ngabobo villages (Ngarenanyuki Ward) (Agriculture Department Meru District, 2008).

The main functions of livestock in this system are subsistence, store of wealth, source of cash income and cultural identity. The major constraints are:

- great climatic variability and recurrent droughts leading to de-stocking or complete loss of livestock;
- market volatility linked to drought;
- increasing difficulties in the access to land – limiting livestock mobility - due to changes in tenure rights (privatization, reserved lands) and expansion of crop cultivation, with subsequent problems of overstocking;
- difficulty in disease control related to poor extension services and high costs of treatment.



Every evening livestock is gathered inside the boma to reduce the risk of wildlife attacks.

### LAND USES AND LIVELIHOOD/ AGRO-PASTORAL, LIVESTOCK RANGELAND BASED SYSTEM ASSOCIATED WITH RAIN-FED CROP CULTIVATION

This system develops from the previous one as a strategy, among Maasai communities, to supplement livestock production with subsistence food crop. Main crops are rain-fed maize and beans; the harvest is very low because the weather is too dry, the soils too shallow and wildlife a constant threat. Besides traditional roles, cattle provides draft power and manure. Outputs are low. The main constraints for livestock are as in farming system above; for agriculture they are:

- drought and unpredictable weather conditions;
- choice of unsuitable crops. Sorghum would be more appropriate than maize, but it is not much prized by local people and yields could be severely affected by birds' attacks at harvesting time.

### LAND USES AND LIVELIHOOD/ MIXED CROP-LIVESTOCK SYSTEM

In this small-scale farming system, mainly practiced by Wameru and Warusha, the contribution of crop cultivation to the livelihood of households becomes more significant but with a wide range of combinations related mainly to the availability of land and to climatic conditions. Main crops are maize, beans, cassava, bananas, sweet potatoes and coffee cultivated under rain-fed conditions. Farm equipment is limited to manual tools and ox plough, owned by less than 40% of households.



Inputs such as seeds, fertilizers and pesticides are frequently purchased or hired (animal draft). Outputs are employed for subsistence, source of income and capital accumulation (livestock). Livestock helps to clear stubble and provide manure and draft power for cultivation. Sources of animal feed are crop by-products and residues, grasses around settlements and communal grazing lands.

The main constraints of this system are:

- drought and unpredictable weather conditions;
- high price and/or unavailability of agriculture inputs;
- lack of farm credit;
- lack of seeds of improved/appropriate varieties;
- high incidence of pests and diseases particularly in maize, beans and coffee;
- lack of extension services;
- high inter-annual fluctuations of food commodity prices.

*Mixed crop-livestock system*



## LAND USES AND LIVELIHOOD/ IRRIGATED CROP SYSTEM

This intensive land use system has increased a lot in recent years in response to population pressure on arable land and to unreliable rainfall and drought. Main crops are tomato (more than 75% of total vegetable crop), onion, maize and beans. Its widespread success is also due to the high incomes that cash crop cultivation (mainly tomatoes) can generate.

The system labour-intensive (some farmers can cultivate three crops per year on the same plot). It is dependent on capital and land (rented, share-cropped or owned), vulnerable to water shortage, deterioration of input/output price ratios and overproduction. It is receptive to new technology and the use of purchased inputs is considerable. Farm equipment is comparatively significant and some farmers own tractors and trucks. Outputs are the main source of income, but frequently food crops are cultivated in rotation with cash crops.

The main constraints are:

- diminishing water availability;
- increasing incidence of pests and diseases;
- inappropriate use of pesticides with negative consequences for health and environment;
- lack of extension services;
- limited access to finance and lack of financing mechanism for farmers;
- high farmer price fluctuations;
- high transport cost;
- weakness of organization among farmers.

*Irrigated crop system.*





### Tomato cultivation

Tomato is the principal cash crop cultivated under irrigation. The main cropping seasons are from January to April and from September to December. The majority of farmers grow only the variety “Onyx” in continuous cropping with little or no rotation (two crops per year). Average yield is about 15 tons per hectare but farmers adopting sound cultural practices can achieve productions of up to 35 t/ha. Continuous cropping and the lack of crop rotations are most likely the main cause of the increasing incidence of pest and diseases (aphids, red spider mites, army worm, late blight, early blight, powdery mildew). An increasing utilization of agrochemicals is the solution adopted by farmers to maintain the yield levels. Unfortunately, inadequate techniques (improper use of pesticides in terms of types, quantities, respect of time and distribution precautions, etc) are producing severe consequences for the health of local people (many cases of poisoning are locally reported), environment conservation and soil fertility. The cost of pesticides represents 35-40% of the total production cost with an absolute value up to around 900 €/ha. The budget analysis of tomato production shows that at minimum selling price the break-even point is at around 174 crates per acre (17 t/ha), a little above the average yield recorded in different surveys (around 15 t/ha). Tomato production is therefore a risky enterprise for average farmers, especially if they do not have any negotiating power on prices, and product supply is not planned. Nevertheless, as selling prices are just above the minimum selling price, tomato growing can be a very profitable activity, also at average yield levels.

Moreover, tomato production is highly labour-intensive. Operations like transplanting, weeding, irrigating, spraying, harvesting, sorting and packing in crates require on average 100 days’ work per hectare: assuming that the cultivated area is about 600 hectares per year in Ngarenanyuki Ward, with 50 percent of hired labor, tomato growing enterprise supposedly redistributes a large amount of money and certainly contributes to poverty reduction in the area. However, this potential is reduced by the tomato market systems, controlled by local big farmers and agro-dealers who, after giving credits (mostly in kind) to small farmers for the next cropping season they get the control of the product. This creates a sort of credit dependence, a concentration of wealth and induces a higher use of pesticides or fertilizers. In conclusion, despite the fact that tomato cultivation is supporting the local economy, many challenges still need to be addressed to fully exploit the tomato potential for the well-being of local people and long-term environmental conservation.

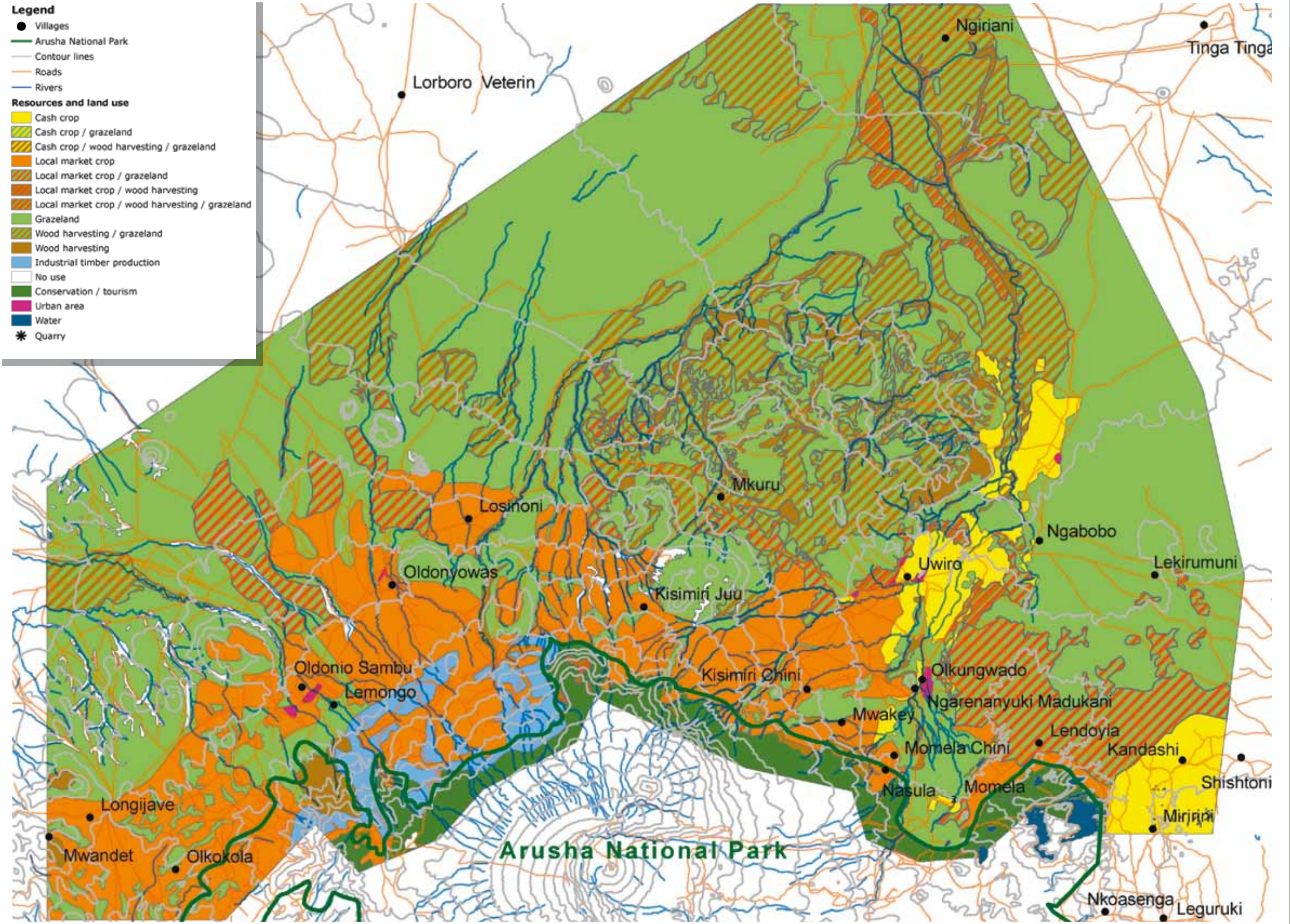
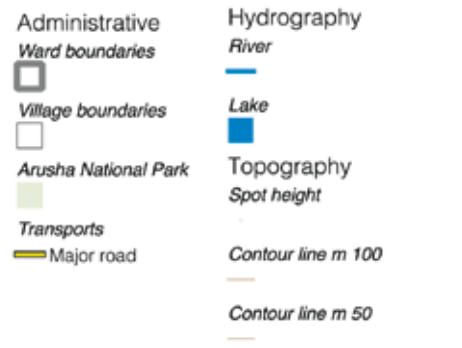
Tomato harvesting in Uwiro Village.



### LAND USES AND LIVELIHOOD/ RESOURCES AND LAND USE

Map 9 provides a tentative overview of the main natural resource uses that are at the base of the livelihood of people in Ngarenanyuki and Oldonyosambu Wards. It shows great differences among villages and the integration of different land utilizations, mainly correlated to the agricultural potential of the land. For instance, in Uwiro and Ngabobo villages, the irrigated crops, mapped under the category “cash crop” cover about 90% and 76% of the cultivated land respectively. Both villages fall entirely in AEZ1 (Flat plains, 1,200-1,400m) and AEZ2 (Undulated to hilly landscape, 1,300-1,600m) and irrigated cropping is – along with livestock production - the agriculture land use system most suitable for the improvement of food security and for generating income. In Olkungwado village, where at least one third of the territory falls in AEZ3 (Gently undulated landscape, 1,400-1,600m), irrigated crops cover about 20% of the cultivated land and livestock keeping is a key livelihood resource. An estimation of the livestock density on rangelands inside Olkungwado (Table 3) shows high stocking densities - exceeding the theoretical carrying capacity (from 0.13 to 0.2 TLU per acre) – and indicates overstocking on the village land resources.





**Description of categories:**

*Cash crop:* Irrigated tomato crop or rain-fed coffee and banana crops.

*Local market crop:* Rain-fed maize, beans and other vegetable crops.

*Grazeland:* Land used for grazing livestock. Vegetation categories include savannah, savannah with trees or shrubs, shrub-land, woodland, wet grassland.

*Wood harvesting:* Land used for firewood or small timber collection for house building, charcoal production, beekeeping, traditional medicine harvesting. Vegetation categories include woodland, thicket, and all kinds of forest.

*No use:* Bare soil.

*Urban area:* Village and built-up areas.

*Conservation/tourism:* Arusha National Park.

*Quarry:* small-scale sometimes occasional or abandoned extractive activities of limestone, gravel, stones.

Many polygons (areas on the map) have multiple use because many vegetation cover categories have multiple use: for example woodland is used both for wood harvesting and as grazeland. Polygons of scattered or isolated crops have combined both the crop use and the use of the secondary land-cover: for example scattered irrigated crops with secondary vegetation of woodland have use for cash crops, grazeland and wood harvesting.

Map 9 -Ngarenanyuki and Oldonyosambu Wards: Resources and land use. The map shows the use of the main natural resources (woodlands, grazelands, croplands) by local communities. It is based on the Vegetation Cover Map (see Map 6) and the field surveys (Istituto Oikos, AE Project, 2009).



## LAND USES AND LIVELIHOOD/ TOURISM

According to the World Travel & Tourism Council, in 2008, Tanzanian tourism generated directly and indirectly US\$ 1.95 bn, equivalent to 10.2% of GDP. In fact, the annual growth rate of the sector exceeded the GDP growth rate of 6-8%. Consequently it became the third (recently second) largest recipient sector of FDI after mining and manufacturing, and the second largest foreign exchange earner (about US\$ 1.3 Billion) after gold (US\$ 1.4 Billion) in 2009. Although small in absolute terms, the world share of Tanzania tourist arrivals has grown by above world average, from 0.05% in 1995 to 0.07% in 2004 (World Bank, 2010).

Within this framework, the Mount Meru Natural System is considered a key destination. The main tourist attraction is the Arusha National Park, reachable with a 40 minute drive from Arusha town. The park can be visited in a half-day trip, at the beginning or at the end of a longer safari and it is thus included in the plans of most tourists in northern Tanzania. Visitors willing to further explore the area can try a mountain climb, a forest walk or stop in one of the numerous picnic sites. Three or four days Mount Meru climbs are also a good acclimatization for those who are planning to climb Mount Kilimanjaro. Tourists can choose among a wide range of accommodations inside the park (lodges, rest houses, camp sites and mountain huts), in the Usa River area outside the park or in Arusha. The park receives a mean of about 60,000 visitors per year who contribute, through the payment of the park fees, with about 2,300,000 USD/year to the Tanzania National Parks (TANAPA) income.

This tourist flow, is a precious economic potential for the entire area, but it is still largely unexploited. Local communities living in the Park surroundings, due to the lack of education, skills, financial resources and investment capacities, are not yet capable of taking advantage of the opportunity. Nevertheless, some community-based tourism initiatives, that offer the opportunity to get in touch with local traditions and habits, have started in the area. The Mkuru Camel Safari (see The field interventions) is a successful example.



*Elephants are one of the main tourist attraction in Northern Tanzania.*

## LAND USES AND LIVELIHOOD/ OTHER LOCAL EMPLOYMENT OPPORTUNITIES

Construction and artisan sectors, tree-felling, retail and wholesale sales, transportation, small local restaurants, clerical services and health care provide a few additional employment opportunities.

The commerce sector is neither very developed nor diversified. The generalized poverty level means that the small commercial activities keep a reduced stock of basic goods. As in most rural areas, the shops provide basic articles essential for the livelihood and the prevalent economic activities, livestock and agriculture.

Craft production could be developed in relation to the tourism industry. A good example of its potential is Tanzania Maasai Women Art, a successful initiative linked to the production of traditional Maasai jewellery (see The field interventions).



## CHALLENGES TO SUSTAINABLE NATURAL RESOURCES MANAGEMENT

As described above, the Mount Meru Natural System is providing environmental services that are vital for at least 290,000 people. At the same time, the system is intrinsically fragile and this fragility is exacerbated by climate change hazards, inappropriate land management practices and the increasing pressure on natural resources due to population increase. Land use changes are clearly shown by the comparison of vegetation inside and outside Arusha National Park. Woodland, evergreen and wet forests are retreating in favour of savannah and shrub-land and herbaceous plant cover is broken and fragile. In the long-term, the rapid spreading of exotic invasive species (especially not palatable *Cactaceae* and *Solanaceae*) could eliminate more grazing land. These constraints, associated with poor technical knowledge and assistance and lack of land use planning, are causing concrete challenges to the economic and ecological sustainability of both agriculture and livestock keeping and are threatening livelihood to such an extent that out-migration is rapidly increasing, especially among young Maasai.

A thorough understanding of the main hazards to the long-term conservation of the Mount Meru Ecosystem is a pre-condition to the development of a strategy capable of addressing the major environmental challenges and avoiding the loss of the vital Mount Meru natural capital.

### CHALLENGES TO SUSTAINABLE NATURAL RESOURCES MANAGEMENT/ IMPACTS OF LAND USE ON SUSTAINABLE NATURAL RESOURCES MANAGEMENT

- **Tree-felling for wood harvesting and farming expansion** is producing uncontrolled deforestation and forest degradation. Consequently, water run-off is increasing, reducing the recharging capacity of the aquifers and increasing soil exposure to erosion and desertification. As a result, the Mount Meru Natural System's capacity to retain water is threatened and the local climate is changing. Unfortunately, the impact on forest resources is expected to grow with increasing population density.
- **Expansion of irrigated cropping systems to produce cash crop tomatoes** is causing two main problems:
  - the reduction of water availability per surface unit. The existing data do not allow a correct assessment of the limits of water uses for irrigation/agricultural purposes; nevertheless, according to local farmers, crop expansion, associated with water loss due to poor maintenance of channels and inadequate flood irrigation technique, has reached a critical point.
  - the increasing soil salinization with, in a few cases, the abandonment of land. The water analysis ("Water Master Plan for the wards of Ngarenanyuki and Oldonyosambu" - NRD-UNISS, 2008) shows that one out of 5 springs in Uwiro village has a high content of dissolved salt. Consequently, the use of these waters for irrigation needs constant leaching and good drainage to avoid salts accumulation in the soil.

In conclusion, the expansion of irrigated cropping has led to the cultivation of more and not always suitable land, with poor or impeded drainage; at the same time the increasing demand



*The expansion of cropping systems is encroaching on Mount Meru forest resources.*



for water has reduced its availability per surface unit, which has led to a reduction of the water leaching fraction (amount of extra irrigation water that must be applied above the amount required by the crop to maintain an acceptable root zone salinity).

- **Increasing monoculture, widening areas under the same cropping system and abandoning crop rotation** are all favouring a reduction of soil nutrients and a gradual fertility depletion, as well as a major incidence of specialised pest and diseases that are more difficult to control.
- **Increasing land fragmentation** due to population growth and cultural factors is causing a decrease of the average farm size per household and inadequate food production for subsistence. The land is shared amongst the male descendants of the family and, generation after generation, the farms become smaller. At present the estimated average farm size per household is about 1 hectare (Avitabile, 2008). As a result, the food production per household is often not even enough to satisfy family needs and family leaders are forced to seek suitable agricultural land elsewhere, away from the original homestead. These increasing migration patterns produce conflicts over land and water uses, in particular where the land is more fertile and water is available, which leads to unsustainable exploitation of resources .
- **Overgrazing** is affecting soil fertility. The high concentration and long permanence of herds on the same grazing area damages the pasture quality as it does not allow palatable and nutritious grass species to re-grow, especially in arid climatic conditions. The persistent trampling on the delicate ash soil speeds up the erosion process, further limiting the germination of new grasses after the rainy season. Due to persistent and recurring **droughts**, demand for grass is relatively easy to meet during the rainy season but might become extremely difficult in the dry season.

*Overgrazing is a major cause of soil erosion.*



- **Increasing competition between water users** is creating social conflicts.
- **Human-wildlife conflict** is a major challenge for wildlife conservation. Wildlife outside Arusha National Park has a serious impact on livestock keeping and agriculture activities. Diseases like tick borne diseases, rabies, Ormilo and eye infections are spread by wildlife. Crops are damaged by elephants, buffalos, zebras, monkeys, and other wild herbivores while livestock is targeted by predators such as hyenas, wild dogs, jackals and leopards. Human injuries and deaths caused by wild animals (mainly elephants) are uncommon. Few measures are adopted for the prevention of damages, such as fencing crop areas and stockyards, using traditional methods such as burning substances which are unpleasant for the animals or enforcing security on livestock herds while at grazing. Moreover, there isn't any system to compensate losses due to wildlife attacks. An approach that integrates education, prevention and compensation measures could reduce poaching, which is currently the main strategy of local people for coping with wildlife conflicts. It could also increase the survival possibilities of the carnivore population, starting from the wild dogs, an endangered species, still present in the area. Unfortunately, such measures are very difficult to implement and would need the involvement of many stakeholders, including tourists.

*Zebras and cows sharing the same pastureland.*



#### CHALLENGES TO SUSTAINABLE NATURAL RESOURCES MANAGEMENT/ IMPACTS OF INAPPROPRIATE TECHNICAL ASSISTANCE AND SERVICES ON SUSTAINABLE NATURAL RESOURCES MANAGEMENT

The traditional knowledge and practices have become inadequate and insufficient to face agricultural and livestock keeping production challenges, environmental concerns and market demand. Nevertheless, neither the government nor the private sector have shown the capacity, or interest, in providing the necessary technical assistance for the introduction of more appropriate technologies and spreading the principle of sustainable utilization of land resources.

Basic infrastructures and services in support of the agricultural and the livestock keeping sectors, such as cattle troughs, are insufficient or entirely non-existent. The livestock sector is particularly affected by the lack of public investment; consequently the quality of the products remains low and inadequate to compete on the international market. The areas where the insufficient technical assistance is producing relevant negative impacts on conservation and development issues are listed below.



### In the agriculture sector:

- **Technical assistance and knowledge are insufficient. For instance:**
  - **Agrochemicals** are massively used without any use direction and control, especially on irrigated fields of tomatoes. Different products are mixed without any knowledge of specific compatibilities; spraying operators do not wear any protective clothing (rubber boots, gloves, face shield and face mask); spraying is frequently done in the wrong weather conditions (hot hours, windy days, etc) and without any care for the proximity of persons or animals in the area under treatment; there is no respect of re-entry intervals (the time period recommended between the application of pesticides to crops and the entrance of persons into those crops without protective clothing); the cleaning of applicators is done in the water channels; empty containers are not destroyed and sometimes are utilized for other purposes. The inappropriate management of pesticides causes primary environmental and health problems which need to be addressed.
  - **Seeds of improved or more appropriate varieties are missing.** Some farmers purchase commercial seeds at local markets. But mostly they keep their own seeds for planting the following season. However seed quality and performances of the varieties are not assured. Moreover, usually it is not recommended to re-use maize seed coming from composites longer than 4 - 5 crop cycles. To assure stable yields, appropriate seed maintenance and multiplication techniques should be adopted to avoid inbreeding depression or loss of genetic quality.
- **Food storage systems are inadequate.** For instance, since storage systems are inadequate, during drought periods farmers are forced to buy at a high price the same products that they had sold at a low price at the end of the rainy season.
- **Farmers' organizations** need to be strengthened. They do not fully control the production chain, they have poor knowledge of market mechanisms and are unable to make effective business plans.

### In the livestock keeping sector:

- **Technical assistance on livestock management is insufficient. For instance:**
  - **Animals** are still purchased mainly according to their price rather than according to the breeding characteristics, as the size of the herd is culturally a very important aspect. Improved free-range breeds (drought and disease resistant) are available on the market, but their cost is valued too high by Maasai people.
  - **Disease control services are inadequate and inefficient.** Several diseases, such as East Coast Fever (ECF), Ormilo (Turning sickness), Contagious Bovine Pleuro-Pneumonia (CBPP), Foot and Mouth Disease (FMD), Mange, Trypanosomiasis and Helminthiasis (worm and flukes), Anthrax, Black-quarter, Lumpy Skin Disease (LSD), Malignant Catarrhal Fever (MCF), retained foetal membranes and mastitis, affect livestock. The occurrence of most diseases is linked to vectors such as ticks and flies and is higher during the rainy season. Most of the diseases, if properly managed, could be controlled. Nevertheless, even though a number of actors (traditional healers, Extension Officers, Community Animal Health Workers, Tanzania National

Park Veterinary staff, Meru District Veterinary officers) offer animal health care services, there are no scheduled disease prevention measures, although occasionally vaccinations for New Castle Disease are done with the help of Extension Officers.

- **The limited technical capacities of the animal health care officers** is combined with the **high costs of treatment, the poor distribution of drugs, the absence of veterinary centres** and the **lack of livestock owners' awareness** concerning animal health. Failure to establish control measures, regular screening and treatment of sick animals result in disease outbreaks, loss of livestock and consequent economic impoverishment.
- **New livestock by-products or breeding activities are not experienced.** **Leather** could have a good economic potential, but the farmers' awareness of the value and importance of this by-product is very low, while poor and limited skills used in skin processing further reduce the economic potential of the sector. **Poultry breeding**, despite its huge potential in improving income and nutrition and the limited investment, is still very limited and there is no organized market system for chickens and eggs.
- **Livestock infrastructures**, such as veterinary centres and cattle dips and troughs, are very limited in number and low in quality.
- **The market sites** have poor infrastructure for the slaughtering and processing of meat. The hygienic conditions of most of the slaughter slabs (mostly privately owned) and the butcheries are below the minimum standards. The poor quality of the meat also hinders the marketing potential of the sector.
- **Livestock information is missing.** The last comprehensive livestock census in Tanzania was done in 1985. The lack of reliable data increases the risks of mismanagement and under estimation of the actual problems, impeding a correct and sustainable expansion of the sector.





## GOVERNANCE AND SERVICES

The brief overview of the administrative system provided below is integrated with a short discussion of two key aspects for environmental conservation: the land tenure system and the policies for wildlife management. Following this, the status of the key infrastructures and services that are conditioning socio-economic development is summarised.

### GOVERNANCE AND SERVICES/ ADMINISTRATIVE STRUCTURE

Tanzania consists of 26 Regions (21 on the mainland and 5 on Zanzibar) and 99 Districts. Districts consist of Divisions that are made up by Wards. Within each Ward there are several Villages that are made up by Sub-Villages. The Ngarenanyuki Ward is part of the Arumeru District, within the Arusha Region, and it consists of 5 Villages (Uwiro, Olkungwado, Ngabobo, Kisimiri Chini and Kisimiri Juu). The Village of Uwiro has 5 Sub-Villages: Mkuru, Nkuuny, Iyan, Kyamakata and Kimosonu.

As a consequence of decentralization processes (1972-1982) local authorities have increased the importance of their role. Villages are governed by the Village Assembly and the Village Council. The Village Assembly consists of all the village residents aged 18 and above. The Village Council consists of members elected by the Village Assembly. It is headed by a Chairperson and a Village Executive Officer (a technical officer employed by the District Council). The Village Council and the Village Assembly represent the two most important bodies for management and development of land and natural resources. The Village Council has the power to form committees for the management of different sectors with the participation of the community members. For instance, Uwiro Village relies on the following committees: Health and Environment, Planning and Finance, Peace and Security, Village Land Adjudication and Village Water Committees.

### GOVERNANCE AND SERVICES/ LAND TENURE

In Tanzania, land is a government property and can be allocated to private individuals only in the form of lease agreements, which can last up to 99 years. The Villagization Act of 1975 established the Ujamaa, where scattered people were forced to concentrate and rebuild their homes in designated areas where community services e.g. schools, were planned. Under this Act, the state was expected to allocate land to the registered villages and to delegate to the Village Councils the handling of the land issues. The village government in turn was expected to allocate the land to households and hold communal agricultural land, grazing areas, forests and, sometimes, non-utilized reserved lands for future allocation.

Though the Villagization Act, together with the National Land Policy of 1995 and the Village Land Act of 1999, were expected to override the Customary Law, the process is still underway. The village registration process, that constitutes the first step for land assignment to the villages, is a complicated and time-consuming process and only a few villages have completed it. As a consequence, people have continued to abide by Customary Law and Rights and to adjust their traditional subsistence system to the changing economic structure.

In the Mount Meru Natural System, uncertainty regarding land tenure is causing increasing conflicts. The demand for irrigated land for tomato production has grown a lot. Many pasturelands have been reversed into agricultural lands. Renting agreements or sharecropping have been done mainly through farmers groups or associations. But the legal background remains weak. Most

villages are not officially registered and, consequently, do not even have certainty about their own village boundaries. This situation causes inefficiency, uncertainty about land titles and severe conflicts.

In Ngarenanyuki Ward land conflicts are very common and they pitch communities against one another (e.g. Mkuru - Kisimiri Chini communities), community versus development NGOS (e.g. Uwiro – African Wildlife Foundation) and community versus State (e.g. National Ranching Corporation-NARCO Ranch, Arusha National Park, etc). Conflicts have a number of different causes: they are linked to land shortages; to inadequate understanding of villages, sub-villages and farm boundaries; to the lack of cooperation among and within communities; and to the lack of village land use plans and institutions capable of enforcing the laws at national, district and village levels. The overall effects of land conflicts is a general increase in insecurity and vulnerability for the whole community.

It has been observed that there is pressure from the Wameru community to open more lands for farms in the areas claimed by Maasai communities for livestock grazing. This is associated to the rapid population increase and to the lack of alternative economic activities. Moreover, despite the fact that everyone has the right to access land, currently no women in the area own land, beside the Nasaruno Group linked to the Maasai Women Art initiative, owning a small piece of land in Mkuru sub-village thanks to the Cultural Boma Initiative promoted by the Istituto Oikos (see The filed intervention).

### GOVERNANCE AND SERVICES/ POLICIES FOR WILDLIFE CONSERVATION

In the African continent, the conservation of wildlife resources dates back to before the colonial era, when African societies co-existed with wildlife and its protection was governed by tribal culture. Maasai's taboos and customs, for instance, never allowed them to hunt or utilize game meat. With colonialism, however, the creation of protected areas was centralized and strong rules were imposed on the use of wildlife resources. The creation of parks included the eviction of local communities living in, and adjacent to, the protected areas. The customary laws and the authority of traditional African leaders were undermined. No wildlife use was allowed to local communities and no alternatives were provided.

In the post-colonial period most of the African states continued to adopt the colonial approach to wildlife management. In Tanzania, after 1964, the year of Independence, many Game Reserves and National Parks continued to be managed by the central government and imposed strong rules and punishment measures that created barriers between protected areas and local communities living adjacent to them. Rural people felt marginalized, without control over wildlife, from which they received no or few benefits, but great damages, such as crop losses due to elephant rides and livestock losses due to carnivore attacks. Therefore they developed an increasingly negative attitude toward conservation. This resulted in higher poaching rates in the 1970s and 1980s, a dramatic decrease of wildlife population outside the park and a lack of support for wildlife protection.

After many wildlife species were lost following massive poaching, many African states recognized the importance of involving local communities in wildlife management. It has now been recognized that the challenge is to develop a new strategy to cope with poaching and encroachment by introducing sustainable wildlife utilization schemes in rural areas, thus allowing rural people to benefit from this resource. During the 80s, in Tanzania, local communities started to become involved in wildlife management for both conservation and community development goals. The



National Conservation Strategy for Sustainable Development (1995) and the National Environment Policy (1997) encouraged NGOs, communities, private sectors and individuals to promote public participation and understanding of the linkages between environment and community development. The Wildlife Policy (1998), the Wildlife Law (2002) and the Wildlife Conservation Act (2009) streamlined this strategy. They called for better management and sustainable use of wildlife resources, and for the establishment of Wildlife Management Areas (WMAs), a new category of protected areas that enables local communities to benefit directly from the village wildlife resources. Within WMAs the villages are given the responsibility to decide which form of wildlife utilization they wish to pursue. If benefits are realized, then a sense of stewardship will return, and schemes to employ Village Game Scouts will succeed in reducing illegal exploitation of natural resources. By August 2007, eight WMAs were officially established in Tanzania. However, the policy still retains state ownership and control over wildlife resources.

*Bones of two elephants illegally killed in 2010 in Ngarenanyuki Ward.*



## GOVERNANCE AND SERVICES / INFRASTRUCTURES AND SERVICES

The quality, distribution and functionality of the infrastructures and services in the area are often below the minimum standards necessary to foster socio-economic development. Basic facilities such as roads, electricity, health centers and schools are absent, insufficient or inadequate to fulfil the local people basic needs and to allow a more appropriate control on the territory and its resources.

### WATER SUPPLY

Several water distribution systems, fed by springs and rivers originating in the Mount Meru forests and by a few scattered boreholes, provide water to people, livestock and irrigated crops through a network of distribution points, cattle troughs and irrigation channels. Water harvesting systems have been built in many schools, health centres and public buildings, while man-made dams, artificial ponds and water retained in big gullies after rains represent additional water reservoirs for livestock and wildlife during the wet season.

Despite the great effort of donor's agency and local population to improve water access, quality, supply and management, many challenges still need to be addressed.

- **The high concentration of fluoride found in many water sources**, a natural pollution phenomenon that characterises most of the Rift Valley fresh water system, remains a major concern. According to the World Health Organization's guidelines for Drinking Water Quality, the acceptable value of fluoride content in drinking water is 1.5 mg/litre. Tanzania, to deal with the high levels of fluoride content in its water of volcanic origin, increased the Tanzania Temporary Water Standard up to 8.0 mg/litre in 2008 and up to 4.0 mg/litre in 2010. Low doses of fluoride prevent decay of teeth, whereas concentrations above 1.5 mg/litre in drinking water cause fluorosis and other related diseases. Fluorosis can affect soft tissues, such as muscles and ligaments, teeth and bones. The critical period of exposure is between 1 and 4 years. Dental fluorosis, in its mild form, appears as tiny permanent white streaks or specks, that may darken over time. In its severe form it is characterized by black and brown stains, as well as cracking and pitting of the teeth (see pag 89). The more severe skeletal fluorosis causes pain and damage to bones and joints. About 85% of dental fluorosis and 2% of skeletal fluorosis are reported among the Arusha Region population (WHO). To address this problem, defluorination filters or rain harvesting systems should be used, with the priority objective to reduce fluoride consumption among children.
- **Water infrastructures and distribution systems are often obsolete and in need of maintenance.** Breakages in the systems, illegal connections and bad management reduce the amount of water that reach the beneficiaries up to 35% of the total availability. Inefficient management of irrigation canals reduce significantly water availability for agriculture.
- **Water management needs to be improved.** In urban centres, like Arusha, water management is quite efficient. Good recovery and maintenance service is accompanied by an adequate policy of network extension in the remote zones of the town. But in the rural areas many challenges are open.
- **Water Committees (WCs) and Water User Associations (WUAs)** are established where the District is building water schemes, but they need to be followed up in their mandate of ensuring a proper maintenance and use of water infrastructures. Technical



and financial assistance is still necessary to assure a self-sustainable management. WCs staff is often illiterate and turn-over is high. The District Water Office has only recently received capacity building support from the World Bank to assist the communities and the decentralised institutions. Moreover, internal conflicts, accompanied by a lack of commitment, sometimes further affect the scarce performance of the WCs.

- **There is lack of effective control to preserve water sources.** In general terms, human encroachment on forest resources, associated with climate changes, recurrent droughts and demographic increase, are dramatically jeopardizing water availability. Moreover, the springs and river banks are not sufficiently preserved from environmental degradation such as tree cutting, pollution and the abandonment of wastes. Ngare Nanyuki, the main river crossing the Ngarenanyuki Ward, used to flow from the Mount Meru north to the Amboseli basin. Currently, due to the high water demand for irrigation, it reaches only Ngabobo village and the NARCO Ranch. Consequently, Mkuru, Engutukoit, Losinoni and other villages and sub-villages rely only on seasonal rivers available during the wet season for their agriculture activities.
- **The use of water resources is often the cause of conflicts** amongst farmers and between livestock keepers and farmers. Livestock keepers do not pay respect to the farm “boundaries” set by farmers to protect their farms and, in the absence of a land use plan, farmers are extending their cultivation into rangeland areas, reducing the access to water sources as well as the availability of pasture.
- **Improper water uses**, such as water for domestic use diverted for irrigation purposes, mainly due to lack of enforcement of community by-laws, affect sustainable water management. Scarce community awareness of Tanzanian water law (enhancing priorities of water use for human consumption, environment and agriculture respectively) affects the negative reaction to abuses and mismanagement.

*Water collection is a tiring and time consuming daily activity for women and children.*



*Drinking water is often collected from polluted water sources, with serious health consequences.*



A set of interventions, developed in the framework of AE Project (see The field interventions) have strongly improved water supply and management for about 17,600 people in Ngarenanyuki and Oldonyosamby Wards, while the new project “Improving Water and Sanitation access and Hygiene standards to achieve the MDGs in Arusha Region, Tanzania” funded by the European Commission and managed by Istituto Oikos (2011-2015) will increase access to water and improve hygiene and sanitation practices for another 45,000 people in the Arumeru District. Nevertheless, water remains one of the major constraints for human, livestock and wildlife in the Mount Meru Natural System.

### HEALTH AND SANITATION

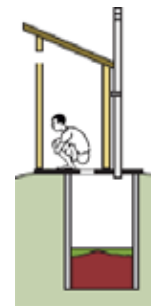
Each Ward, including Ngarenanyuki, has a Health Centre and a few dispensaries at village level. The Uwiro Health Centre, in Ngarenanyuki Ward, is served by 3 Clinical Officers, 4 midwives, 2 nurses, 1 Maternal Child Health Attendants and 1 Health Officer, but no Medical Doctor. It has a capacity of 30 beds and serves up to 25–30 people per day. It does not have facilities for radiology or surgical operations. It operates especially in the treatment of minor common illnesses such as malaria, worms, water-borne and respiratory diseases. For serious cases the patients are referred to the nearest hospitals in Ngarantoni and Tengeru (between 60 and 40 km of unpaved road, with no transport facilities). Consequently, the traditional medicine is still in use in many villages, especially among Maasai, that live in scattered huts, far away from health centres, without any transport facility. One traditional clinic, run by a Maasai healer, is located in Mkuru sub village and is a reference point for many Maasai, who come to Mkuru also from villages located outside the Arumeru District.

In terms of **diseases**, most of the problems are linked to the traditional life style. The excessive smoke in the huts, for example, results in respiratory diseases and eye problems. Among water and excreta borne/related diseases, malaria represents 94.6%, diarrhoea 4.3%, eyes diseases 0.4%, skin infections 0.4% and typhoid 0.3% (2009 DHO data). Malnutrition, especially among children, is extremely common; it is due to the scarcity of food and unbalanced alimentation.

In terms of **sanitation facilities**, most people use latrines, though their distribution and general conditions are often of minimum standards. Most latrines are dry pit type without ventilation and appropriate discharge facility.

Istituto Oikos commitment in the health and sanitation sectors are mainly concentrated in education and hygiene campaigns, as well as in the supply of water and energy facilities to health centers. In these sectors, the main constraints are listed below.

- **A long-term program of awareness and hygiene campaigns is not operative in the area**, despite the development of good hygiene and nutritional practices among the population could significantly reduce the disease incidence in the area. But, up to now, the Ministry of Health hasn't set up a diffuse system of awareness and most of hygiene campaigns are left to NGO initiatives. Moreover, the weak presence in the field of the District Health Office is a further obstacle for a rapid increase in hygiene standards.
- **The use of Ventilated Improved Pit (VIP) latrines should be promoted and encouraged.** A VIP latrine is a pit toilet with a black pipe (vent pipe) fitted to the pit, and a screen (flyscreen) at the top outlet of the pipe. VIP latrines are an improvement to overcome the disadvantages of simple pit latrines, i.e. fly and mosquito nuisance and unpleasant odors. The smell is carried upwards by the chimney effect and flies are prevented from



*Ventilated improved Pit*



leaving the pit and spreading disease. This introduced technology is cheap and sustainable for the beneficiaries, but only a long lasting hygiene and sanitation awareness campaign would be capable of persuading the population to develop and use it. Istituto Oikos has introduced 130 VIP latrines at domestic level, according to the government Household and Community Latrine Improvement Campaign, “Choo Bora Chawezekana, Maendeleo Hadi Chooni” launched in April 2010. The initiative has been accompanied by an awareness campaign related to the environmental and hygiene damages of open defecation.

- **Waste collection hygiene campaigns should be regularly implemented.** Currently even a basic waste collection system with an adequate site disposal does not exist. At household level, waste is burnt in the home yards. Non-recyclable material such as plastic bags and containers accumulate in the village areas, especially along streams and rivers and in the market places.
- **Water use for personal hygiene should be encouraged.** Local people, and especially Maasai communities who have been recently reached by water, have to be trained to use water for personal hygiene and move from the 3-4 litres/person/day currently used to the 20 litres recommended by the Millennium Development Goals.
- **Nutritional campaigns** addressed to improve the traditional habits, especially with regards to children, could improve significantly the nutritional status of children with very limited and affordable increase for the family investment in food supply, and relevant benefits in terms of health improvement.

#### ROADS AND TRANSPORT

A **network of unpaved roads** connects the intervention area to the towns of Arusha and Moshi. This network is up to minimum standards during the dry season, but it is often interrupted during the rainy season, with a consequent blockage of goods and people transportation which limits social and commercial activities.

During the rainy season some areas cannot be crossed even with carts pulled by animals because of the slippery and muddy terrain and even the access to Health Centres becomes particularly difficult.

The irrigation channels crossing the roads are contributing a great deal to the degradation of pathways: water is left running along the surface, creating large impassable zones and increasing the effects of erosion.

**Public transportation services are underdeveloped** in the area. Privately owned vehicles and lorries, used mainly for the transport of goods, occasionally transport also people. Public buses do exist, but there is no public transport across the Maasai areas, where people have to rely on walking.

The main constraints that need to be addressed are:

- **The insufficient road maintenance** especially after the rains.
- **The absence of public transport in the Maasai areas** that contribute to further increase the Maasai people isolation and make it difficult to reach the Health Centers.



*Public transportation services are inadequate in the intervention area, particularly in the Maasai land. Road maintenance is insufficient, especially during the rainy season.*

#### ENERGY

Most of the Mount Meru Natural System and the entire Ngarenanyuki and Oldonyosambu Wards are not reached by any National Power Grid and no grid connection is foreseeable in the near future. People rely on energy sources deriving mainly from kerosene (to light lamps), firewood and charcoal for cooking and heating. Firewood is used by 75% and charcoal by 15% of households. The remaining 10% rely on other energy sources (kerosene or gas). Petrol/diesel for transportation is sold in small quantities at the local grocery shops; no petrol station is present. Some solar panel systems have been installed in health centres, schools and public offices. However, most activities requiring electrical power (milling machines, restaurants, schools) rely on the use of diesel/petrol generators, which are costly and polluting. Energy consumption has also a strong economic impact. At family level, between 15% and 20% of income is used to purchase kerosene to light lamps in the huts. At school level, 20% of the income that schools collect from the families to provide school meals to the children is spent to buy firewood. Energy saving strategies, which, through the use of improved stoves, could reduce the firewood consumption by up to 50%, have only recently been introduced through awareness raising and education campaigns. Despite the scarce availability of funds and of communal land for medium size reforestation programs, few re-forestation initiatives have been undertaken, also employing fast growing species for energy production.

The main constraints that need to be addressed are:

- **Affordable and sustainable off-grid energy systems**, capable of meeting the energy demand at individual and community levels, need to be identified and made available locally.
- **Illegal wood harvesting for firewood and charcoal production** need to be efficiently controlled. Tree cutting contributes dramatically to the decrease of forest area; the limited



economic, institutional and technical investments in re-forestation programs intended to meet the energy demand have hampered the potential success of such initiatives.

- **Socially and economically acceptable alternatives to the Maasai tradition of making fires** for cooking and heating inside the dwellings have to be encouraged. The traditional use of three stones fires without chimney produces excessive smoke in the huts resulting into respiratory and eye problems, as well as a high number of pneumonia cases amongst children.



*In remote rural areas there is high demand of energy to recharge cell phones.*



*The interior of a Maasai home: the only energy sources are kerosene, firewood and charcoal.*

## EDUCATION

The standard of the primary school infrastructures is poor throughout the intervention area. Schools are provided with teacher's houses, latrines and in the last two years, access to water, but the number of classrooms is generally inadequate to the number of children and the quality of infrastructures is low. A full assessment of the school status is provided in Annex B. See table 4 for a snapshot of schools in the Uwiro Village. The four Secondary Schools are in better conditions and benefit from the support of private donors. The building of new secondary schools is indicated as a priority in the 2010-2015 development plans of most villages, including Uwiro. Nevertheless, a proper school management remains the major challenge to be addressed.

School name	Number of students	Number of teachers	Number of classes	Students per teacher / class
Ngarenanyuki	446	7	7	64
Kimosonu	312	5	5	62
Mkuru	214	3	3	71

*Table 4 - Primary schools in Uwiro village (Istituto Oikos, AE Project, 2010).*

Teachers are over-loaded with work, underpaid, inadequately prepared and poorly motivated. School attendance is very low. Many children are busy with family tasks (cattle grazing, farming, fetching water, cooking) and the school system does not take any action to encourage attendance. Even if, according to the data on Millennium Development Goals progress ([http://www.tz.undp.org/mdgs\\_progress.html](http://www.tz.undp.org/mdgs_progress.html)) the target of achieving primary education in Tanzania has almost been reached (97.2 % of primary net enrolment ratios in 2006-2007), major constraints, summarized

below, limit the effectiveness of the school system.

- **The quality standard** of the infrastructures is very low; the demoralisation and discomfort of the teachers render the education system at the whole scarcely effective.
- **The classrooms capacities** are not sufficient to satisfy the needs of the students and, due to the lack of space, students must go to school in turns.
- **Classrooms** are often lacking in furniture, windows and doors.
- **Electricity** is not available.
- **Many schools completely lack water or have access to very low** quantity and quality water, not drinkable and/or contaminated with fluoride.
- **Some schools have an inadequate number of latrines** for the number of students, which in acute situations reaches more than 100 students per latrine.
- **Most schools do not have kitchens** and refectories.
- **School meals are inadequate or lacking**, malnutrition is very high. A recent survey carried on in 2010 by the Tanzania Food and Nutrition Center (TFNC) in collaboration with Istituto Oikos in the schools of Ngarenanyuki and Oldonyosambu Wards, shows that 64% of the children are malnourished and, of these, 27.6% suffer from severe malnutrition. Protein-energy malnutrition, nutritional anaemia, iodine deficiency disorders or vitamin A deficiency are commonly present.
- **The cost of meals**, not included in the government budget, must be covered by parents and consequently the quality of food (only water and flour) is inadequate to meet basic nutrition needs, also because it is usually not integrated at home.

In conclusion, the poor school infrastructures, associated with inefficient management and lack of balanced school meals cause growth delay, poor resistance to diseases and, all in all, long term inadequate education as well as physical development.

*A classroom in Ngarenanyuki Primary School.*

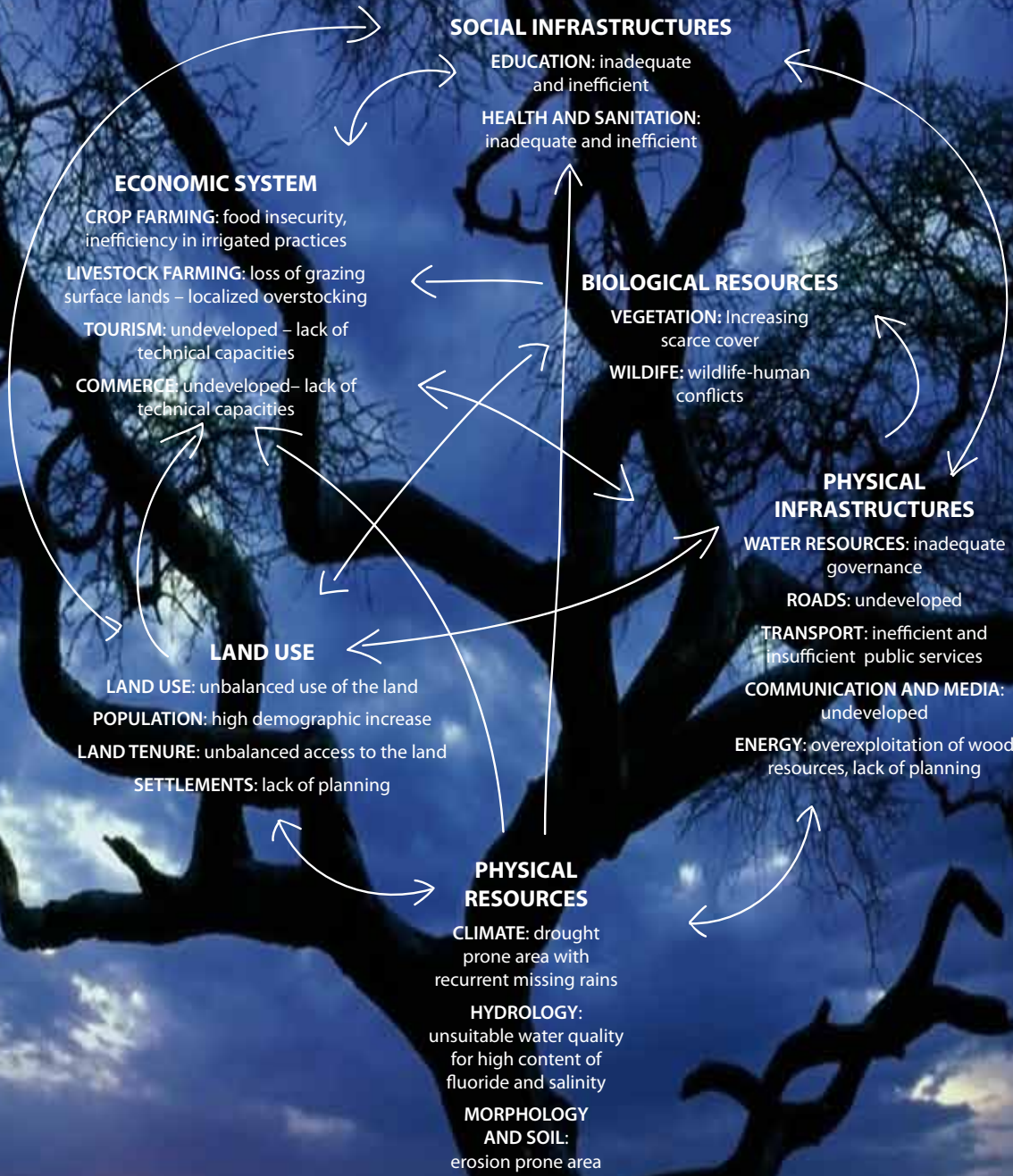




# THE FIELD INTERVENTIONS

## FROM PROBLEM IDENTIFICATION TO FIELD ACTION

The problem identification phase was crucial in shaping all the interventions implemented within the AE Project. An holistic, practical and community-based approach oriented all decisions. Consultation meetings and workshops with local communities and authorities started during the project preparation period and continued throughout the project, until its completion, as an on-going process to design periodic plans of work and to verify that activities are fulfilling local expectations and needs. A combination of quick-impact investments, such as the building of water dams, boreholes or pipelines, and long term investments in awareness raising and planning, was selected. The costs of these interventions were shared among the main donor (Italian Ministry of Foreign Affairs), Istituto Oikos, local organisations and local communities, which participated through their community work.



### SUMMARY OF THE MAIN PROBLEMS AFFECTING THE INTERVENTION AREA

#### PHYSICAL FEATURES

CLIMATE: drought-prone area with recurrent missing rains  
 HYDROLOGY: unsuitable water quality for high content of fluoride and salinity  
 MORPHOLOGY AND SOIL: erosion-prone area

#### BIOLOGICAL RESOURCES

VEGETATION: Increasingly scarce cover  
 WILDIFE: wildlife-human conflicts

#### LAND USE

LAND USE: unbalanced use of the land  
 POPULATION: high demographic increase  
 LAND TENURE: unbalanced access to the land  
 SETTLEMENTS: lack of planning

#### ECONOMIC SYSTEM

CROP FARMING: food insecurity - inefficiency in irrigation practices  
 LIVESTOCK FARMING: loss of grazing lands – localized overstocking  
 TOURISM: undeveloped – lack of technical capacities  
 COMMERCE: undeveloped – lack of technical capacities

#### PHYSICAL INFRASTRUCTURES

WATER RESOURCES: inadequate management  
 ROADS: underdeveloped  
 TRANSPORT: inefficient and insufficient public services  
 COMMUNICATION AND MEDIA: undeveloped  
 ENERGY: overexploitation of wood resources, lack of planning

#### SOCIAL INFRASTRUCTURES

EDUCATION: inadequate and inefficient  
 HEALTH AND SANITATION: inadequate and inefficient



Based on the problems identified, **four main priority fields of interventions** were selected:

1. **Education**, to increase people's awareness of the value and importance of natural resources and their sustainable use.
2. **Income-generating, community-based initiatives** in the environmental sector, to show that environmental and development goals can be combined.
3. **Governance** in the environmental sector.
4. **Key social services** for environmental conservation.

The majority of the interventions targeted the most vulnerable area of the Mount Meru Natural System and, in particular, the Ngarenanyuki Ward. This chapter will provide a brief description of each action, with its main achievements, lessons learnt and co-donors involved, when applicable.

## EDUCATION FOR SUSTAINABLE DEVELOPMENT

The key activities aimed at raising awareness on natural resources value, ownership and management, with a focus on women, school children and rural communities.

### EDUCATION FOR SUSTAINABLE DEVELOPMENT/ ENVIRONMENTAL EDUCATION AND AWARENESS RAISING AMONG LOCAL COMMUNITIES

The Tanzania Government has recognized the need for environmental education to reach out to the community level where changes in behaviour can result in meaningful improvements towards a sustainable development. Thus, the National Conservation Strategy for Sustainable Development (1995) and the National Environment Policy (1997) call for NGOs, groups, communities, private sectors and individuals to promote public participation and understanding of the essential linkages between environment and community development.

In 2007-2010 Istituto Oikos conducted an environmental education programme aimed at increasing the awareness of young generations, teachers and local population on the risks connected with the inappropriate use of natural resources. The initiative reached all the 18 schools listed in Annex B and all the villages of the Ngarenanyuki and Oldonyosambu Wards. Preliminary assessment meetings were organized at village level to identify the most critical environmental hazards, which turned out to be: water pollution, water and sanitation, forest degradation, soil erosion and poaching. The following tools were used:

- seminars, workshops and classroom teaching with preparation of posters and drawings;
- study tour visits to Arusha National Park;
- film shows, in collaboration with Maajabu, a local group under the organization Tanzania Natural Resources Forum (TNRF) that has developed this specific expertise;
- drumming, traditional dances and songs;
- the creation of tree nurseries, wood lots, school gardens and environmental clubs, in collaboration with Osotwa Community-based Conservation Organisation.

For each school, an environmental education teacher was identified for supervision and periodic reporting. The nurseries were established only in schools with easy water access, with the multiple purpose of promoting conservation, school greening and small income generation through seedling selling. Istituto Oikos' initiative to provide water to the school (see Annex B) contributed significantly to the successful implementation of programmes for the creation of tree nurseries and trees watering. The tree nurseries were designed to accommodate more than 2000 seedlings. Fast growing indigenous species for shades, fruits, hedges and fuel wood were planted.

Following the environmental education initiative and the tree nursery creation, several schools donated part of their seedlings to the community and to the school compound for tree planting initiatives. Most schools planted tree plots and live fences, that could also serve as wind breakers and shades for kids. Some water sources and village degraded forest lands were rescued by joint school children and villagers initiatives.

Most schools were also sensitized on energy efficiency and now use energy-saving cooking stoves, provided under the EU funded "BEST RAY – Bringing Energy Services to Tanzanian Rural Areas" project (2008-2011).

### EDUCATION FOR SUSTAINABLE DEVELOPMENT/ ADULT BASIC LITERACY

Several community members, especially among the pastoral societies, have never received formal education. Many adults, particularly women, are therefore highly marginalized. As part of its intervention, Istituto Oikos developed a set of non-formal education programs on reading, writing, counting, record keeping, health and sanitation. Adult basic literacy courses were organized for the Mkuru Camel safari members (see Mkuru Camel safari) and for the Maasai Women Art group (see Maasai Women Art), which also attended tailored basic English, client care and computer skills courses.

## COMBINING ENVIRONMENTAL GOALS AND REVENUE GENERATION

Through concrete and successful initiatives, the project aimed at demonstrating that the pursuit of conservation goals and the application of sustainability principles can generate new business opportunities at community level which, if properly developed, can contribute to income generation and poverty alleviation.

The following areas were selected as the most promising for community-based income generation initiatives:

- **Tourism and crafts sectors.** The vicinity of Arusha National Park and of Arusha town, both attracting a great number of international tourists, combined with the natural and cultural interest of the area, are important pre-conditions to implement community-based tourism and associated initiatives, such as the craft production, a potentially powerful development option. The project experienced two successful programs: Mkuru Camel Safari and Tanzania Maasai Women Art, described below.
- **Environmental monitoring and patrolling sectors,** at village level. Despite national laws and village by-laws regulating the use of forests, wildlife and water resources, law enforcement is very weak. In particular, wildlife poaching and illegal tree cutting are



almost unpunished at village level. The AE Project, according to District guidelines, instructed the Village Game Scouts (VGS) to support the local authorities and the private sector (mainly the tourism sector) in village land monitoring and patrolling (see The Village Game Scouts).

- **Veterinary Health Services.** As already underlined, despite the fact that a number of diseases affect the livestock, animal health care services are not adequately provided. The AE Project applied international tested procedures to instruct Community Animal Health Workers (CAHW) to provide basic animal health treatment at village level (see The Community Animal Health Workers).

#### COMBINING ENVIRONMENTAL GOALS AND REVENUE GENERATION/ MKURU CAMEL SAFARI: AN ECO-TOURISM INITIATIVE

<http://www.mkurucamelsafari.com/>



Mkuru Camel Safari (MCS) is a community-based initiative managed by a group of Maasai and Meru people under the umbrella of Tanzania Tourism Board (Ministry of Natural Resources and Tourism). It is part of a wider national program (Tanzania Cultural Tourism Program - CTP) started by the Netherlands Development Organization (SNV) in 1996 with the objective to engage local communities in income generating tourism activities to alleviate poverty. The idea behind the MCS was to exploit the presence of camels in the area by allowing tourists to travel on the camels' back through the Maasai steppe and to experience the enchanting beauty of the environment while getting to know the Maasai culture. However, with the end of the SNV project, in 2001, and without any further external support, the activity was struggling, mainly due to lack of experience of the Mkuru Camel Safari group. The Maasai realized that they could not manage the tourism business independently and went back to traditional herding activity.

The AE Project decided to provide further support to the MCS with the building of the Mkuru Camel Camp, the base camp for hosting tourists and to start the camel safari tours, the provision of training opportunities for Maasai and Meru tourist guides and the development of a new business strategy.

A survey identified the following profile of the average tourist potentially interested in the MCS experience or in community based initiatives in general: origin from Europe or the United States; age ranging from 20 to 55 years, medium income, adventurous spirit and great eagerness to get in touch with the local culture and nature. An expert of responsible tourism was asked to develop a new business strategy and to design a touristic product according to the following criteria:

- direct and exclusive management by local people; 100% of income retained locally and used to pay the staff's salary, the guides' fees, to cover the running costs of the camp and to contribute to the village development;
- sharing of employment opportunities among Maasai and Meru people;
- enhancement of the local culture value;
- minimum environmental impact;
- safari at a slow pace;
- search of synergies with Istituto Oikos and the private sector, locally and abroad, for product development.

Technical support was also provided to register, in 2009, the Mkuru Camel Safari Group as a Company Limited by Guarantee, a locally recognised "non for profit business organisation". The company currently consists of 16 funding members, 14 men and 2 women, Maasai or Meru, from the village of Uwiro. After registration, the company members were offered training opportunities (English and tourist guiding courses). Even though some difficulties remain, Mkuru Camel Safari is today a well-established cultural tourism initiative. In 2004 only 14 people visited the area, while in 2009 there were 246 (Table 6). Consequently, the income has increased significantly, especially since 2007, when the AE Project started to support the program, and so did the salaries, both in terms of number of people involved (about 16, most of them part time) and in terms of earning per person, which is in line with the local standards for rural areas (about Euro 60/month for full time work). In 2009 MCS generated an income of about Euro 10,000 (Table 5) and a further increase of about 30% is expected for 2010. The profit did not grow steadily as the investments (purchasing of new tents, etc) increased with the increasing number of tourists.

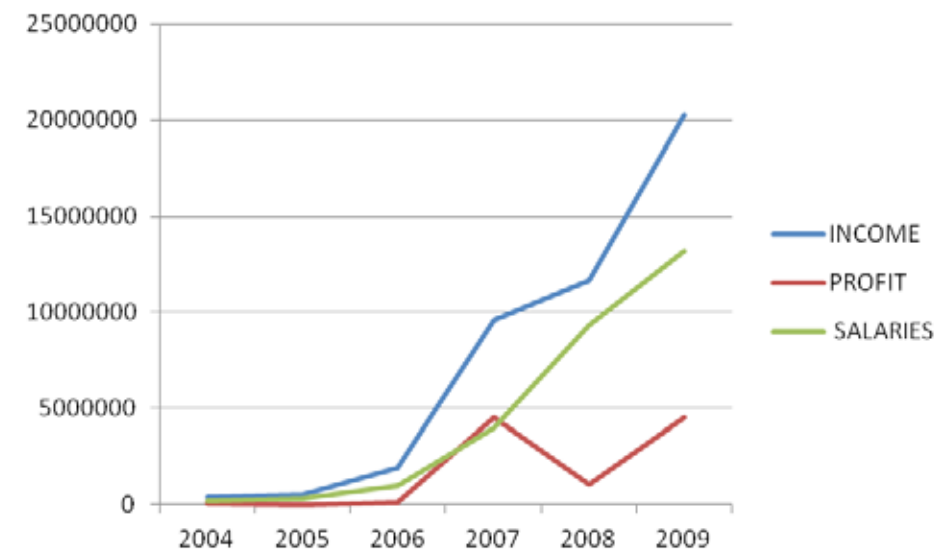


Table 5 – Income, profits and salaries of Mkuru Camel Safari, in Tanzanian Shillings (1 Euro = about 1900 TZS) (Istituto Oikos, AE Project, 2009).



## Number of tourists per year

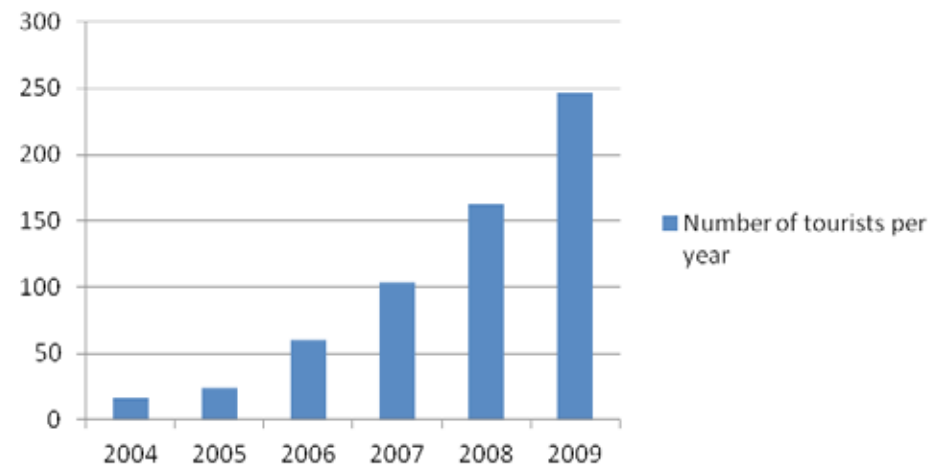


Table 6 – Number of tourists per year visiting the Mkuru Camel Camp (Istituto Oikos, AE Project, 2010).

Tourists on a Camel Safari.



Approaching Lake Natron, a Camel Safari destination.

Lake Natron.



## THE PRODUCT

With the most incredible view, Mkuru Camel Camp, the base camp built in the frame work of the AE Project, is situated on the north side of Mount Meru, not far from the irrigated fields of Ngarenanyuki and from the Momella gate of Arusha National Park. The area around the camp is alive with colourful birds and small mammals, with zebra and giraffe in the plains to the north, which is also a corridor for elephants travelling between Mount Meru and Mount Kilimanjaro. Close to the camp, Maasai families live in small traditional bomas. The camp offers accommodation in tents and it provided with toilets and showers facilities with hot water, a dining area serving hot meals, office, fire place and resting area. There are two kinds of accommodation: comfortable safari tents on wooden platforms or ground camping tents.

Depending on the wishes of the clients, the cultural tourism experience can last from half day to a week. The shortest safaris allow the tourist to get in touch with the Maasai culture by meeting a Maasai healer, having a bush dinner or attending Maasai dances. With a one-day tour it is possible to visit a cave hosting almost 300 baboons every night, to climb the Oldonyo Lendare hill or to get to know the local Maasai population by listening to their stories and getting in touch with their traditions. Finally, long safaris (from 2 to 7 days) involve crossing the elephants' natural corridor, admiring unique landscapes during expeditions that give the best and clearest impression of the many resources of north-eastern Tanzania. Long safaris can also be adventurous: the tourist can explore the plains surrounding Mount Meru, where the Maasai steppe becomes wild, and go toward the Longido Mountain, crossing paths with several species: antelope, zebra, giraffe, ostrich and many other birds. Those who are willing to engage in the seven days trips, can ride the camels through the big plains between Gelai and Ketumbaine Mountains, and reach Lake Natron, one of the most beautiful corners of Tanzania, famous for its huge flocks of pink flamingos, and the sacred mountain of Oldonyo Lengai, an active volcano.

The bush dinner at Mkuru Camel Camp.





## LESSONS LEARNED AND SUSTAINABILITY

As a result of a joint effort of Uwiro local communities and Istituto Oikos, Mkuru Camel Safari is now an independent, economically sustainable and community-based tourism business, acknowledged as a successful initiative by the World Conservation Union (IUCN) and several tourism organisations. Moreover, MCS has a potential for further development, in terms of number of tourists received, of quality of services rendered and of profitability of the business, with bigger positive impact on the local community economy. Nevertheless, some major weaknesses are still limiting the MCS development potential:

- **The Mkuru Camel Group members' education is still insufficient** to ensure fair and efficient management. Guiding and tourism capacities seem to be appropriate. Customer satisfaction sheets, compiled by the visitors, show that most of the tourists visiting the camp and/or experiencing the Camel Safari are satisfied with the services. But management skills (booking systems, payment procedures, marketing, etc) need to be strengthened with additional training. Moreover only few guides speak good English.
- **The Mkuru Camel Group younger members are not given sufficient opportunities.** The Group leadership remains in the hands of the elders, traditional community leaders who are not ready to leave the floor to the more educated younger generation, with better skills, English language skills and entrepreneurial capacities.
- **Internal group conflicts are always at risk of arising.** The group consists of Maasai and Meru people. The Meru members are more educated and tend to take the lead of the group. Nevertheless, the Camp and the safari are in the middle of the Maasai territory and the guiding and camel management skills are a Maasai tradition. Therefore, with the business becoming more and more profitable, internal conflict for the group leadership are always at risk of arising. Nevertheless, up to now, the group showed a genuine interest in working together and sharing the opportunities.
- **The money management is not always transparent.** Financial management capacities, including book-keeping and savings management, need to be strengthened, to avoid mismanagement and internal conflicts.

In conclusion, MCS is a tangible, successful example of how a preserved and attractive environment can contribute to integrate the income coming from the traditional livestock keeping activities. Nevertheless, for long-term sustainability, further support in terms of training, with a focus on business management, accountability and English skills, should be provided to the Mkuru Camel Safari members, also to ensure that the community is capable of obtaining the maximum advantages from the experience. Istituto Oikos has committed itself to setting aside funds to fulfil this long-term commitment. Additional resources might be made available by the tourists themselves.

*Mkuru Camel Camp dining room and night accommodation.*



## COMBINING ENVIRONMENTAL GOALS AND REVENUE GENERATION/ MAASAI WOMEN ART: INCOME GENERATION AND THE ART OF BEADED JEWELRY

<http://www.tanzaniamaasaiwomenart.com/>



In 2006 Istituto Oikos launched the initiative called Maasai Women Art, to help a group of about 80 women of the Mkuru sub-village (Uwiro village) in structuring a commercial activity based on their traditional engagement in the production of beaded jewels for decoration and income generation. The group was in fact struggling to sell the products and people often took advantage of the women's inability to count and manage money. The overall objective of Maasai Women Art was to increase Mkuru Maasai women's access to income generation opportunities through the creation of a successful small enterprise committed to the production and commercialization of handmade jewellery. The specific goal was to start an activity able to expand its market from Tanzania to other parts of Africa, Europe and America, in order to provide the women with a reliable source of income. Maasai women in Mkuru, in fact, did not have any access to paid job opportunities and lived in conditions of severe poverty, from which they were trying to escape by producing and selling charcoal, an illegal, tiring and hardly remunerative practice, that produces severe impacts on the conservation of the fragile savannah environment.

After its launch in 2006, the initiative was further developed under the AE Project: the women group was strengthened and the business improved. Since 2009 the group is officially registered as a cooperative called "Nasaruno group" and today, about 140 people, almost all the women of the Mkuru community, have abandoned charcoal production and have a stable income deriving from the commercialization of their beaded work. From the illegal sale of charcoal bags to local middleman, women earned on average 6000 TZS (about 3,15 Euro per month, equivalent to 2 bags made by 20 kg of product each, which required a week of very hard work). Moreover, trees were rapidly disappearing from the savannah environment, leaving the soil much more exposed to desertification. The jewellery business, on the other hand, ensured, in 2010, a minimum average income of 17,000 TZS per woman (about 9 Euro per month for a much less fatiguing work) (Table 7).

Beadwork is an important part of the Maasai culture: all women are adorned with colourful necklaces, bracelets and long earrings. Jewels have a ritual value and they are part of the Maasai identity. The beadwork tradition is transmitted from mothers to daughters across generations. The majority of the women are therefore capable of producing highly elaborate beaded jewels. However, when the Maasai Women Art project started, it appeared clear that to exploit western markets, the products needed to reflect the buyers' tastes and needs. The traditional Maasai jewels were therefore readapted with the collaboration of experts and students from the European Institute of Design (IED) in Milan.



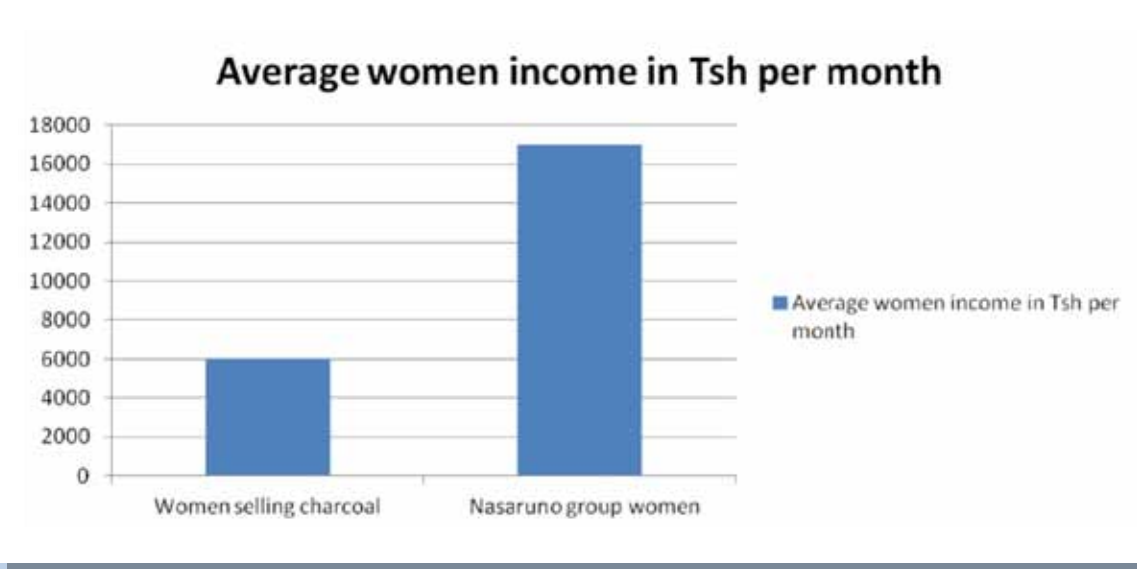


Table 7 - Average women income in Tanzanian Shillings (1 euro=1,900 TZS) comparing the charcoal business with the jewellery business (Istituto Oikos, AE Project, 2010).

Women participated in a number of trainings, where new models were proposed and quality standards were set. In addition, the training process covered the basic marketing and counting knowledge necessary to start a commercial activity. Finally, some additional classes focused on raising women's awareness on environmental issues. A Cultural Boma was also built, a space located in Mkuru area and intended as the headquarters, workshop and shop of the Nasaruno group. The final step was the creation of a company, Tanzania Maasai Women Art (TMWA, Company Limited by Guarantee) established in 2008 and consisting of the Nasaruno Women Group, Istituto Oikos and Sanjan (a local company). TMWA has a shop in Arusha and a web site (<http://www.tanzaniamaasaiwomenart.com/>) with an online catalogue for the international commercialization of the items. Eighty % of the profits of TMWA goes directly to the Nasaruno group women. The remaining 20% covers the Company's management costs. Currently, the group of women is responsible for the production of beaded jewels, while TMWA is responsible for quality control, selling the products and expanding the distribution network. Thank to this initiative, the women of the Nasaruno group have improved their overall socio economic conditions. They can better support the education of their children and they are starting to reinvest their profits in other income generating activities (such as the purchasing and re-sale of goats and poultry).

The Maasai women of the Nasaruno group.



Beadwork is part of the the Maasai tradition.



A Maasai Women Art necklace.



The making of a Maasai Women Art jewel.

#### LESSONS LEARNED AND SUSTAINABILITY

The establishment of the jewellery business has been a great success, both at national and international level, and the women express great satisfaction for the life change that the new activity has engendered. Moreover, from an environmental perspective, tree cutting for charcoal production ended in Mkuru sub-village, with great benefits for the soil, pastureland and climate stability. This change was possible because the income produced by the charcoal sale (charcoal was not produced for personal use but for cash generation) was replaced by the more profitable and traditional income generated by the jewels sales. Moreover, the dramatic depletion of the wood resources, traditionally used by the Maasai women in a sustainable way for cooking and heating, was stopped. In conclusion the success of Maasai Women Art initiative shows that only through the provision of concrete economic alternatives, unsustainable activities can be rapidly and easily abandoned.

Two important achievements of the initiative were also the engagement of a large and always growing number of women and the establishment of the Tanzania Maasai Women Art Company, which guarantees the sustainability of commercial activity. Nevertheless, some difficulties remain. There are two major issues that need to be addressed and constantly monitored: the quality check and the business management.

- **The quality of the jewels is not always adequate for the standards of the international market.** The staff of TMWA is constantly working to improve the quality of the products and the efficiency of the activity, in close collaboration with the Nasaruno group. This constant effort has to be ensured. The quality problems are linked to the fact that a growing number of women are joining the group without having had the chance to attend proper trainings on the making of the revised models. As a consequence, not all products pass the quality check, causing discontent.
- **The money management is at constant risk of causing conflicts.** The institution of a commercial activity from scratch, with a group of women originally unable to read, write and count, is a complicated and never-ending process. Despite the trainings, women sometimes have a hard time in splitting and counting money that they earn and small fights regularly occur.



In conclusion, as in the case of Mkuru Camel Safari, Tanzania Maasai Women Art is a sustainable and successful initiative, based on a strong and equitable synergy between the production efforts, ensured by the Nasaruno Women Group, and the marketing effort, provided by TMWA. Nevertheless, the perspective of a long-term success of the initiative is attainable only if training opportunities remain a priority and accompany the empowerment of women. Women, and especially the young generation, need to become more confident with the jewellery business, the market rules, as well as group management and basic literacy skills. Istituto Oikos has committed itself to set aside a few funds to fulfil this long term commitment. Additional resources might be made available from the TMWA income.

#### COMBINING ENVIRONMENTAL GOALS AND REVENUE GENERATION/ THE VILLAGE GAME SCOUTS: WILDLIFE MONITORING FOR INCOME GENERATION

As already mentioned, the northern part of the Mount Meru Natural System is the only remaining corridor linking the Arusha National Park with the nearby protected areas; it provides pasture for both livestock and wildlife. However, a number of illegal practices, such as game poaching, tree cutting for charcoal production, bush fires and water pollution, are damaging the environment. Some voluntary village members, known as Village Game Scouts (VGS), have been concerned about the conservation of the territories and were already active in patrolling the area before Istituto Oikos began its activities. However, their effectiveness was low: they all lacked the technical know-how on monitoring and patrolling and the necessary equipment, such as binoculars, two-way radios and uniforms. Moreover, they had no official recognition by the Ward and District authorities that allowed them to contribute to law enforcement.

The need for a VGS reorganization was highlighted by the community members of the Ngarenanyuki and Oldonyosambu Wards as an opportunity to make local people play an active role in the Mount Meru conservation efforts. The initiative was in line with the Wildlife Policy of Tanzania, which emphasizes the participation of local communities in sustainable wildlife use and conservation. Therefore Istituto Oikos, in the framework of the AE Project, in collaboration with the Ward and District authorities, carried out a reorganization and a professional requalification of the VGS.



*Village Game Scouts training on wildlife foot print identification.*



*Village Game Scout training on bird identification.*

The first step of the activity consisted of verifying the commitment of the existing VGS, mobilizing and engaging them, and recruiting additional personnel. This methodology allowed the re-selection, in collaboration with the local authorities, of a group of 22 VGS. Then, a four-week training course was organized, to increase the VGS's ability to efficiently monitor, patrol and protect the environment, and to raise awareness of the importance of natural resource conservation, on the essential role played by the local community in the protection of the territories adjacent to protected areas and on the benefits to the community of a healthier environment. The course included both theory and practice. Lessons were held in classrooms – at Mkuru Training Camp - on daily basis and covered patrolling strategies, safety, handling of fire arms and natural resource monitoring and conservation. This theoretical part provided the basis for the field classes, which included an intense physical training and firearms handling. By the end of the course, 22 VGS were recruited. The graduated trainees received a full uniform, an official identity card as VGS released by the District and a certificate. The VGS acquired the knowledge to carry on qualitative and quantitative



*Village Game Scouts training on firearms use*





monitoring and patrolling of the wildlife resources, they gained the operative skills to implement anti-poaching strategies in collaboration with the Arumeru District and with Arusha National Park and they learnt how to foster environmental and wildlife requalification.

For the entire duration of the AE Project the trained VGS carried on regular monitoring of the wildlife in their respective villages (See Annex C).

#### LESSONS LEARNED AND SUSTAINABILITY

Overall, the VGSs reorganization and training program was a success, as it provided the basis for a greater control of the territory undertaken by the local communities themselves. Nevertheless, the program still needs to be strengthened in some of its aspects, listed below.

- **VGSs equipment, especially transports and communication, is still insufficient to allow a good performance.** Currently, the lack of telephone, radio and a vehicle for patrolling the remote areas limits the VGSs' ability to report events, especially in cases where urgent assistance is needed, such as encountering armed poachers. With regard to Tanzania rules and regulations, VGSs do not possess guns unless under a special authorization, while poachers are equipped with modern firearms. In the event of conflicts with armed poachers, the VGSs report to Arusha National Park or to the Arusha anti-poaching Unit for assistance. Unfortunately, in many cases, ANAPA, which is understaffed, takes too long to get to the place for actions.
- **The collaboration among VGSs and local authorities needs to be strengthened.** A full support of the village leaders and institutions is necessary to keep the VGS motivation high. In some cases, the insufficient support provided by Villages, Wards and Districts authorities has been highly demoralizing for the VGS. Some villages do not have adequate offices where the VGSs can report their patrolling - law enforcement activities. Consequently, some reporting activities are carried on in private houses, in unofficial ways and with no documentation.
- **Employment opportunities for trained VGSs are below expectations.** Most VGSs collaborate with the villages for the enforcement of environmental laws, but they do not receive any payment for their services. In some villages, the village government decided to pay back to VGSs a percentage of the fines paid by the arrested poachers. But the system is not properly implemented and fines are mainly used for village development purposes. VGSs are sometimes employed by tourism and hunting companies or NGOs such as Istituto Oikos or AWF for patrolling and/or wildlife monitoring goals, but these opportunities are limited.

In conclusion, VGSs might provide a fundamental support to the public and private sectors to ensure law enforcement in rural areas, as well as to monitor and preserve natural resources. Nevertheless, their role needs to be promoted and financial mechanism to cover their work need to be properly identified and tested. Moreover, networking among VGSs working in different villages need to be strengthened and encouraged, with the double objective to increase VGSs motivation, capacities and experience and to make monitoring, patrolling and anti poaching efforts more efficient.

#### COMBINING ENVIRONMENTAL GOALS AND REVENUE GENERATION/ THE COMMUNITY ANIMAL HEALTH WORKERS

Livestock is an essential resource for Maasai livelihood and its quality is crucial to their well-being. The results of the last national livestock census (1988) are reported in Table 8 and shows a total of more than 200,000 animals for both Ngarenanyuki and Oldonyosambu Wards. More recent data

(2010) limited to the villages of Uwiro, Kisimiri Chini and Losinoni and based on surveys carried out by Istituto Oikos, are reported in Table 9. Despite the high number of livestock, within the project area, animal health delivery services and supply of genuine drugs are inadequate to satisfy the needs of the population. As a consequence, the high rate of livestock illness (morbidity) and deaths (mortality) is reducing animals' productivity and therefore the household income of the livestock keepers. In Ngarenanyuki Ward there is only one government assistance office to provide animal health services and private veterinarian services are significantly limited by the extremely little financial resources of the local people.

Ward	Cattle	Goat	Sheep	Chicken	Donkey	Dogs	Camel	Cats	Total
Ngarenanyuki	8999	4737	2254	10126	832	871	25	286	28130
Oldonyosambu	49170	63250	36750	12163	9325	2331	-	435	173424
<b>Total</b>	<b>58169</b>	<b>67987</b>	<b>39004</b>	<b>22289</b>	<b>10157</b>	<b>3202</b>	<b>25</b>	<b>721</b>	<b>201554</b>

Table 8 - Livestock Population in Ngarenanyuki and Oldonyosambu Wards (1988 National Census)

Village	Sub-Village	Number of animals		
		Donkeys/camels	Cattle	Sheep/goats
Uwiro	Mkuru	241	967	1902
	Nkuuni	15	350	2300
	Iyan	12	415	720
	Kyamakata	34	726	687
	Kimosonu	0	1500	4200
Kisimiri Chini	Uzunguni	60	300	700
	Langare			
	Karafia	100	200	1000
Losinoni	Engutukoit			
	Engedeko		600	3000
	Losinoni Juu			
	Paturuman			
<b>Total</b>		<b>462</b>	<b>4458</b>	<b>11509</b>

Table 9 - Animal population estimation in the villages of Uwiro, Kisimiri Chini (Ngarenanyuki Ward) and Losinoni (Oldonyosambu Ward) (Istituto Oikos, AE Project, 2010)

To overcome this lack of assistance, Istituto Oikos conducted a 4-week training to form Community Animal Health Workers (CAHWs), officially intended as semi-professional figures that, once properly trained and organized, can provide a capillary support to the governmental veterinarian assistance and get a small income for the services rendered to the livestock keepers.

The training was developed in close partnership with the communities at all levels. This collaboration was essential to get first hand information of the felt needs by the targeted people, to help the trainees and the community members to establish the nature and extent of animal health problems, to identify the existing service delivery gaps and to highlight the strengths and limitations of ethno-veterinary medicine knowledge and modern practices. Secondly, dialogue was fundamental to sensitize the population on the role that CAHWs could cover and to inform on



issues related with the support, supervision and monitoring of CAHWs performance. Seventeen trainees, able to write and read, willing to serve the community, honest and enthusiastic about the opportunity, were selected from the Ngarenanyuki and Oldonyosambu communities. Trainees were livestock owners or people raised in households where livestock was kept, long-term residents in the village and both female and male.

The trainings were carried out at the Mkuru Training Centre, with the aim of instructing the CAHWs on improving animals' care and management through simple treatments and preventive approaches. The course was conducted with a participatory method, with group activities, practical sessions, frequent quizzes on the topics already covered and a final examination (40% theory and 60% practice).

The training comprised a wide range of topics: introduction of CAHWs program and the roles of CAHWs in animal health delivery; animal anatomy (body organs and functions); instruments used during treatment and preventive approaches; techniques used to restrain animals; important diseases affecting livestock and other animals; origins and causes of the diseases; importance of weighing animals and dosage calculations; worms; ecto-parasites; wounds, swelling and fractures; disbudding, dehorning and hoof trimming; eye infection and preventive measures; poultry diseases; animals' reproduction; mastitis and bloats; poisonous plants; record keeping; drugs and ethno-veterinary medicine; business management; gender issues.

By the end of the training, the CAHWs were able to make diagnosis, to decide treatments and to refer to qualified government officers, to advise on proper animal husbandry management and nutrition, as well as to calculate simple profit margin from the drugs bought and from the animal health services offered to their clients in the villages. Their role is now to provide timely and affordable services to livestock keepers, to report diseases and outbreaks of diseases to the government officers, to write periodical reports, to provide basic treatments and to improve husbandry management practices (preventive approaches) such as vaccinations.

#### LESSONS LEARNED AND SUSTAINABILITY

A steady collaboration among the different parties is essential for the long-term success of the initiative. Village authorities have the task of informing the community about the (affordable) services that CAHWs can offer, to involve CAHWs in the vaccination campaigns, and to collaborate with the government officers to implement the campaigns. Government officers are responsible for taking care of referrals and difficult cases, of checking the quality of the drugs and of strengthening good working relationship between private veterinarians and CAHWs. Private veterinarians have the task of providing drugs and relevant equipments at good prices, if not made available by the public institutions.

The training of CAHWs is a good start for building up a reservoir of basic skills and knowledge in the community that provides opportunity for sharing and further extending knowledge through farmer to farmer government assistance system. This implies that trained CAHWs are positioned to assist the government in spreading best practices to livestock keepers. Their presence might assist in combating early ailment and thus reducing livestock's morbidity and mortality, with a positive impact on animals' productivity and households' income. The linking of CAHWs to the existing government veterinarian offices will further provide an opportunity for the government officers to improve the efficiency of the routine reporting of the outbreak of diseases in the villages that will enrich the District' data on the incidence of diseases. Nevertheless, the following aspects need to be further strengthened to make CAHWs services more effective.

- **The collaboration between CAHWs, village authorities and government officers needs to be better coordinated.** Memoranda of Understanding need to be signed; refresh courses and in-service training opportunities need to be regularly provided. Seasonal vaccination calendars need to be prepared by government officers, and the CAHWs work properly supervised and monitored.
- **CAHWs should be encouraged to found an association that can enable them to develop an economically and operationally coordinated activity,** to meet and discuss issues pertaining to animal health delivery services and to improve their expertise. For this purpose it would be useful for them to get in touch with other areas where CAHWs operations are well consolidated.

Community Animal Health Workers training



## PLANNING WITH THE ENVIRONMENTAL DIMENSION

One of the main AE Project objectives was to strengthen the land use planning capacities of the local institutions. In particular, due to the lack of background information, decisions about land uses were based upon local expectations and needs and not on the analysis of the status and potential of the land resources. This approach made it difficult for local authorities to take thorough decisions in a sustainable development perspective. The AE Project worked hard, on a daily basis, with the District and village authorities and technical staff to revert this approach and set up a new mechanism whereby the decision making process is based on the integrated analysis of the relevant baseline information and on a strong consultation/involvement of the local people. The two main achievements were:

- a Geo-referenced Database for the Arumeru District;
- the Uwiro Village Land Use Plan, built with a participatory approach and on the basis of the integrated analysis of the existing environmental and socio-economic data.



## PLANNING WITH THE ENVIRONMENTAL DIMENSION/ THE ARUMERU DISTRICT GEO-REFERENCED DATABASE

A geo-referenced database was created, as the basis to structure a Decision Support System to improve the governance of the Arumeru District. The Decision Support System is a set of data and methodologies that allow quantifiable comparisons among the possible solutions to a given problem. The decision to target the District is justified by its central role in coordinating ward and village authorities for data collection and decision making processes.

### *The database*

**DataBase (DB):** a system intended to organize, store, and retrieve large amounts of data. The standard output of a DB is a tabular (e.g. in a table format) view of the data.

DBs are managed using **DataBase Management Systems (DBMSs)**, software that provide storage, access, security, integrity, backup and the chance to specify the **logical organization** of the data and the option to extract information in a **query language**. The most widespread query language is the **Structured Query Language (SQL)**, and the most common logical organization is the **relational data model**.

**SQL** is the language used to communicate with the database. Users mostly access the database by filling standard forms, which are easy interfaces for the SQL language. Almost every database software comes with an **Open DataBase Connectivity (ODBC)** driver that allows the information to be accessed from other applications.

A **Geographic Information System (GIS)** is a system able to manage **geographical data**.

A **geo-referenced DataBase**, or **spatial database**, is a DB able to manage both geometries and attributes. This is usually possible thanks to a **spatial extension** on top of a standard DBMS. Within a geodatabase, spatial data are treated as any other data type manipulated and queried using standard SQL. Storing spatial and non-spatial data in a unique environment improves the efficiency in query building, spatial analysis and data viewing.

The **Open Geospatial Consortium (OGC)** is an international consortium of companies, agencies, and universities participating in the development of publicly available conceptual solutions that can be useful with all kinds of applications that manage spatial data. The OGC describes a set of SQL geometry types, as well as functions on those types to create and analyze geometry values. Some spatial DBMS are available as Free and Open Source Software (FOSS).

To sum up, a **spatial DBMS** is the core of a powerful geographic standardized system that allows to store, analyze and retrieve spatial and aspatial information in a unique environment through the SQL language. Spatial and aspatial information can be viewed and accessed through common GIS and it's possible to develop standardized forms to help users to enter and retrieve attributes.

Two District employees, selected on the basis of their IT knowledge, were trained for the development of the information system: a surveyor, with a basic knowledge on the use of ESRI ArcView, and a statistician. The project's main activities were the following: participative system design, field data collection, District staff training, system testing and validation.

Two different spatial DBMSs were selected according to the needs of the District: the system PostgreSQL/PostGIS and the system SQLite/Spatialite. The software QGIS was selected as standard GIS for map purposes. All of them are free and open source software, with the DBMS supporting OGC standards.

PostgreSQL is one of the world's most advanced open source databases, while PostGIS is its spatial extension. This system has a complete and unrestricted GIS support and it can handle large amounts of data. It is not easy to use but is suitable for the development of standardized forms to allow non-specialized users to access the database. PostgreSQL/PostGIS was selected to store data about economy, natural resources, demography, social services, infrastructures and service (geodatabase 1). These data are characterized by a predominant aspatial component and PostgreSQL/PostGIS is suitable to develop client-database connection based on simple forms.

SQLite is one of the smallest and simplest DBMSs, and Spatialite is its spatial extension. This light and effective system does not need complex installation or administration procedures, has very low system requirements, maintaining good performances, and consists of a unique cross-platform file that can be easily transferred, with all his geographical content. SQLite/Spatialite was used to store data with a predominant spatial component: topography, land use, vegetation, hydrography, soil and wildlife (geodatabase 2). Since these data do not require a continuous update, there is no need for client-database connection with forms whereas SQLite/Spatialite is more suitable to serve as a full effective desktop GIS.

QGIS is a powerful open-source GIS, with embedded capability of direct access to both PostGIS and Spatialite spatial databases, and extensible through available plug-ins. All the geodatabases are accessible through QGIS; data contained in geodatabase 1 and geodatabase 2 can be linked since they share a common identifier. All the final geodata are referenced in WGS84 UTM37 South Reference System. The correct parameter transformations between all the systems have been provided.

*GEODATABASE 1: ECONOMY, NATURAL RESOURCES, DEMOGRAPHY, SOCIAL SERVICES, INFRASTRUCTURES AND SERVICE*

This database contains the data described below, linked to geographical information.

- **Demography and settlements:** Demography; Settlements; Ethnic groups.
- **Social services:** Administration; Education; Health; Waste management; Water sources.
- **Infrastructures and service:** Communication (antenna tower, internet point, satellite dishes, etc); Energy sources.
- **Natural resources use:** Firewood collection areas; Medicinal plants collection sites; Honey production areas.
- **Economy:** Livestock (typology of cows, grazing system, markets, quality of the product and services provided); Agriculture (typology of crop, income generated, production costs,



markets, quality of the product and services provided; Tourism (attractions, type of the service, number of employees, number of visitors); Commerce (typology of commerce, origin of the goods, product type).

The database design reflects the official Government Form used by the District and Ward officers to collect information. Each table of the database corresponds to a table in paper format.

**Cooperazione Italiana allo Sviluppo**  
Ministero Affari Esteri

**Daftari la Kilimo Mkoa wa Arusha**  
Halmashauri ya Wilaya-Meru

Workplan and Estimates for Livestock and Agriculture			
Ward Statistics		Extension Services	
Population	Agromechanization	Food Crops	
Agriculture	Markets and Shops	Cash Crops	
Livestock	Cooperative Societies	Livestock Products	
Contacts	Saccos	Workplan of key Activities	
Groups	Dips and Abattoirs		

Implementation Report on Livestock and Agriculture			
Ward Statistics		Extension Services	
Contacts	Crop	Consultation 1	Development plans 2
Groups	Livestock products	Consultation 2	Training
Agromechanization	District revenues	Communication	Inputs - seeds
Weather	Value of products	Groups/study visits	Inputs - agrochemicals
		Development plans 1	Inputs - fertilizers
		Livestock vaccination	Opinions

Basic data		
Subvillages	List of crops	List of livestock

W3C HTML 4.01 W3C CSS

The Arumeru District Geodatabase 1.

**GEODATABASE 2: TOPOGRAPHY, LAND USE, VEGETATION, HYDROGRAPHY, SOIL, WILDLIFE**

This database puts in relation socio-economic data with specific geographic sites and aids to better understand the interactions among variables.

The QGIS/SQLite/Spatialite system is used for the management of the geographical layers, assembled inside the Spatialite engine through free software tools Spatialite-GUI and Spatialite-GIS. The main user of the spatial database is the District surveyor, who was properly trained

on GIS. Special attention was paid to the land demarcation. The data collection was done using cadastral and technical maps, and GPS data. Topographic surveys were based on the following reference systems:

- Tanganyika Triangulation Mercator (TTM)
- New Arc 1960
- WGS84 Lat Long

Quantum GIS 1.6.0-Copilao

Layers

- Text
- Contour\_50
- Vegetation\_saver
- LANDCOVER
- Contour\_100

LANDCOVER

- barren ground
- forest
- irrigated area
- rainfed area
- savannah
- savannah with trees or shrubs
- shrubland
- swamps
- urban area
- water
- wet forest
- wet grassland
- woodland

Coordinates: 202702.866483 Scale: 1:250000

The Arumeru District geodatabase 2.

**Topography** was derived from Sheet 55-Arusha of the Geological Survey of Tanzania.

**Land use characteristics** were derived from the FAO Africover digital georeferenced database.

**Climatic variables** were derived from the BIOCLIM project, a bioclimatic prediction system which uses surrogate terms (bioclimatic parameters) derived from mean monthly climate estimates, to approximate energy and water balances at a given location. The layers used were precipitation (mean, max, min) and temperature (mean, max, min).

**SRTM 90m and ASTERDEM 30m digital elevation models** were used to compute Digital Elevation Model, slope, contour lines.

**Six Landsat images** from the 1980s to the present were used to analyze landscape evolution, especially the expansion of agriculture and settlements.

Other topographical layers were compiled with data from field surveys by Istituto Oikos.

**Hydrography layers** were derived from Istituto Oikos previous dataset (digitized on Tanzanian Standard toposheet 1:50000), integrated with GPS field data on: Springs, permanent and temporary Rivers, Channels, Water Distribution Systems.



**The layer on wildlife observations** is based on Istituto Oikos data collection on wildlife locations (19946 points).

Other GPS-based layers were collected from scratch: location of settlements, infrastructures and other data on agriculture, livestock, energy, tourism and social services.

A total of 76 layers is available. The officers currently possess the necessary technology to support the database and are able to update the dataset and consult the database output for management and decision making purposes.

The maps found in this publication are an example of possible outputs of the database.

#### LESSONS LEARNED AND SUSTAINABILITY

The DBs produced by the AE Project and made available to the District technical staff are a powerful tool and an invaluable source of information for any planning and management purposes. They include a significant amount of primary and secondary data, coming from different sources, including, but not limited to, Istituto Oikos and the AE Project. Data can be easily consulted and updated and maps can be generated by the District technicians, according to the District needs. Nevertheless, until now only a few District technicians are able to handle the DBs. Moreover, the instructed DB managers may be transferred from one District to another, with the constant risk that the DB remains without staff able to properly handle and update it. Regular courses and training opportunities on DB management should be provided to the District staff to ensure the full utilization and the regular updating of the products.

#### PLANNING WITH THE ENVIRONMENTAL DIMENSION/ THE UWIRO VILLAGE LAND USE PLAN

The preparation of the Uwiro Village Land Use Plan (LUP) provided the opportunity to experience a new approach to decision-making based on:

- **A wide participation** of the local communities in all the phases of the planning process, from need identification, prioritization and analysis, to stakeholders involvement and strategy selection.
- **The inclusion of the marginalised sectors** of the society such as women.
- **The integrated analysis** of the existing socio-economic and environmental information.
- **The identification of concrete strategies and interventions** to address the main economic sectors and the environmental sustainability issues, with a thorough understanding of village constraints and development objectives.

The exercise gave the opportunity to use the Arumeru District database and show that development objectives can be environmentally, economically and socially sustainable if they are based on an in-depth knowledge and analysis of the territory.

Therefore, for local decision makers, the structure and methodology of the Uwiro LUP represents a blueprint to follow for future land use choices.

The LUP consists of **three parts**. The **first part** analyses the environmental, social and economic

conditions of the village. The **second part** provides a picture of the constraints to sustainable development, with a particular focus on land use inefficiencies. Many data and considerations included in this publication are derived from the Uwiro LUP. The **third part** provides possible approaches and solutions to the existing problems and it is meant to guide the village authorities in their choices. This part includes the identification of different “zones” that are associated with different development objectives and, consequently, with different limits of use. A summary of the Uwiro Village Land Use Zoning process is provided below. The full Uwiro Village Land Use Plan document is available at Istituto Oikos on request.

The Uwiro Village LUP was developed between July 2009 and September 2010 through a number of meetings, stakeholders workshops and training sessions aimed at making local communities aware of the land issues (government regulations, local people’s land rights, etc) and the value and significance of the land use planning process. The Uwiro LUP was developed according to the National Land Use Planning Commission guidelines, whose objectives are to encourage sustainable utilisation of land, to foster socio-economic development and to preserve land quality for long-term productivity. The LUP harmonises and co-ordinates all national land use policies (environmental, water, forestry, wildlife and energy policies) and, at the same time, promotes an effective and sustainable protection of the land. Since Uwiro shares resources with other villages, the LUP was designed involving the neighbouring villages, especially for the village land boundaries and the sharing of common resources such as wood, water and pasture. It was prepared in accordance with the Ngarenanyuki Ward and refers to development plans at district level. The entire process was developed in close collaboration with the Village Council, the Village Assembly, and District technical advisors.

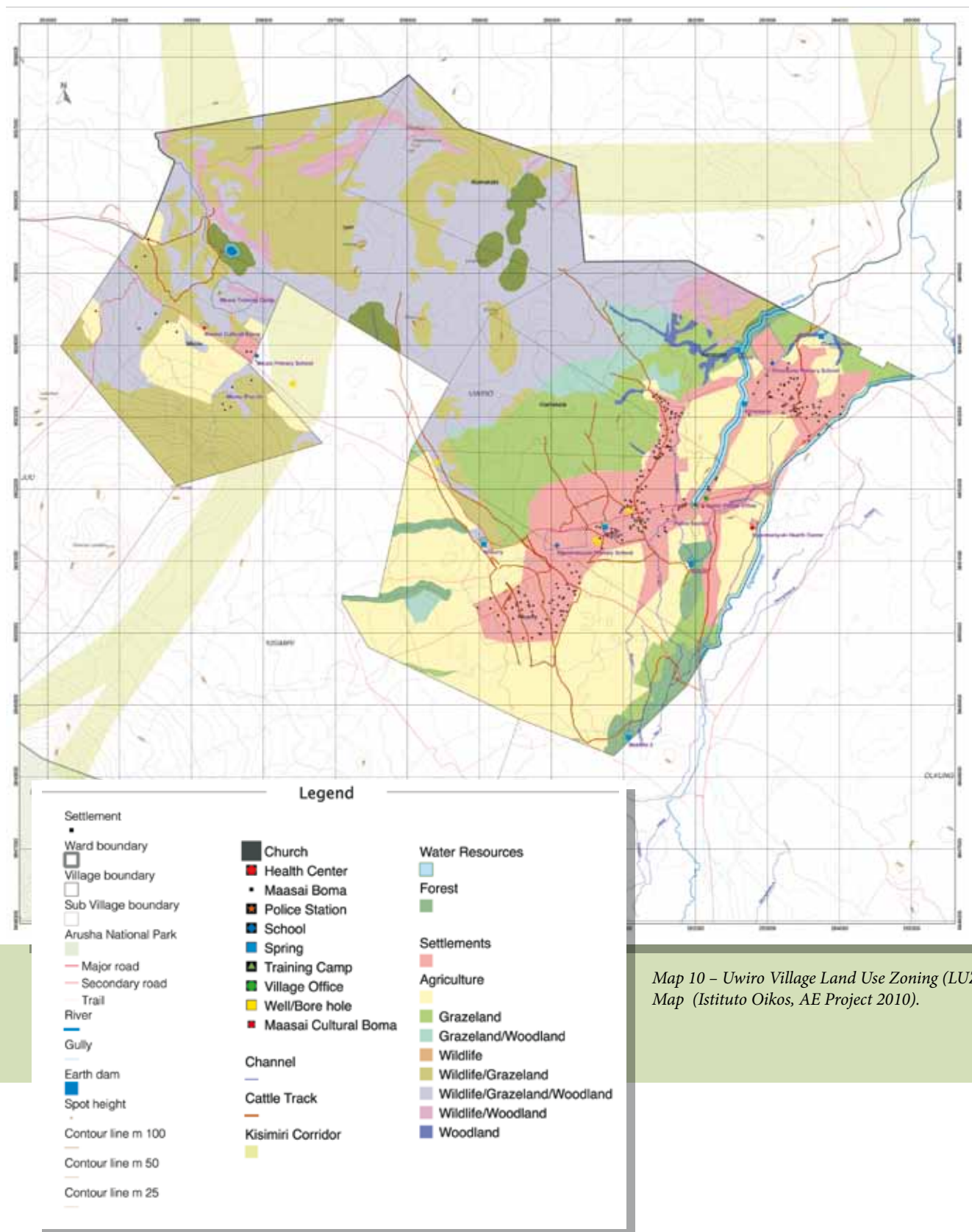
#### VILLAGE LAND USE ZONING

The key component of a village land use planning process is the Land Use Zoning (LUZ), which aims at understanding the land use status, regulating land use and exploiting its economic potential whilst reducing conflicts on land tenure and protecting the natural environment. Through a participatory process, on the basis of the information available, the village land was divided into different zones according to current land uses, threats, potential developments and management requirements. The LUZ was based extensively on the resource use maps drawn by trained community members for each of the five sub-villages of Uwiro (Iyan, Nkuuni, Kimosonu, Kyamakata and Mkuru). Resource maps and inventories were then combined with the information and maps produced by the AE Project to create the LUZ map (Map 10).

*The areas with the highest agricultural potential have been identified in the Uwiro Village Land Use Plan.*







Map 10 – Uwiro Village Land Use Zoning (LUZ) Map (Istituto Oikos, AE Project 2010).

The following “zones” were reported on the Uwiro Village Land Use Zoning (LUZ) Map: forest, settlements, agriculture, grazeland, grazeland/woodland, wildlife, wildlife/grazeland, wildlife/grazeland/woodland, wildlife/woodland, woodland. Key features such as the Kisimiri Wildlife Corridor, the cattle tracks, rivers, earth dams, water resources and the main infrastructures were also reported on the LUZ map.

For each zone and for each development sector management criteria and objectives were identified together with the village community. The criteria for the selection of the most appropriate management options were: poverty reduction, improvement of government services (social impact), development potential, community welfare (economic impact), and sustainable resource use (environmental impact).

*UWIRO LAND USE PLAN SUSTAINABILITY*

With the formal approval of the document, the Village Council committed itself to implement the Land Use Plan. Financial and technical constraints might limit the village capacities to implement all the planned interventions. But the environmental considerations and the principle of sustainable development have become stable and fundamental components of the village governance system.

Despite the limited financial resources available, the village and local communities commitment towards LUP implementation is already tangible. In terms of infrastructures, the village has already initiated infrastructural improvements, such as adding more classrooms to the primary schools and rehabilitating roads with the support of community members in volunteer jobs. In terms of sustainable natural resource use, individuals of the villages have joined forestation programs by planting trees in their plots, whilst the village authorities have started supporting entrepreneurship addressed to ecotourism initiatives. From the governance point of view, in consideration of the above zoning, the village revised its by-laws intensifying control and enforcement measures.

These results can be used to set the basis for a more integrated and sustainable development of the Mount Meru Natural System and the Uwiro Village can be regarded as a pilot experience to be repeated in other villages of the Arumeru District.

*Village land demarcation carried out by the Village Land Adjudication Committee members*



*Resource use map drawn by the community of Kimosonu sub-village.*





## IMPROVING SERVICES, PRESERVING THE ENVIRONMENT

The inadequacy of key basic facilities and services in the water, health, sanitation, roads, electricity and education sectors have been briefly discussed in previous chapters. The AE Project contributed to face some major challenges focusing on a few interventions, economically affordable, easy to implement and monitor and capable of having sizeable impact on both socio-economic development and environmental conservation.

The following areas of intervention were prioritized: water, sanitation and energy. They all involve the use of natural resources, they all have a remarkable impact on local economies and health, and - if not properly addressed - can produce serious consequences on people and environmental well-being. All the interventions have been accompanied by education, training and awareness raising initiatives. Moreover, in the framework of the Uwiro Land Use Plan, guidelines were provided for a fair development of the basic facilities in the respect of the sustainability principle.

### IMPROVING SERVICES, PRESERVING THE ENVIRONMENT / WATER AND SANITATION INTERVENTIONS

A number of interventions in the water and sanitation sectors were designed within the framework of the AE Project<sup>2</sup> to increase access to safe and properly managed water for domestic use, livestock and wildlife, and to improve hygiene and sanitation awareness and practices. The interventions focused on Ngarenanyuki Ward (Uwiro, Kisimiri Chini, Ngabobo and Olkungwado villages) and Oldonyosambu Ward (Losinoni village).

**For domestic use**, the objective was to guarantee the access to a minimum of 20 liters per person per day within a 1000 m radius. This objective was in line with the MDG in Tanzania and with the priorities of the Tanzanian Government strategic plan. The actions were designed to guarantee water access to the population according to a projection for the year 2025.

**For domestic animals** (cows, camels, goats, sheep and donkeys), the objective was to guarantee a minimum of 25 liters per TLU (Tropical Livestock Unit = 0.7 cow or 10 goats /sheep).

**For wild animals** the objective was to realize water distribution points on the territory available also during the dry season, when the wildlife mortality due to the lack of water can be extremely high.

A total of 17,600 people and 39,000 TLU units benefitted directly from the water distribution system. The project reached also 4,930 children of the primary and secondary schools. The entire water supply system was based on spring catchment as the source of water and gravity pipeline as the distribution system. This technical solution was chosen because these systems are technically easier to manage, they follow traditional practice in the area and have minimum running costs as no electricity is necessary to raise water to the distribution points. All the interventions were driven by the following principles:

- **Development of every action on the basis of specific requests brought forward by local people and authorities** and preliminarily discussed in open meetings.
- **Building of a strong sense of ownership** among local communities and authorities for the water systems.

<sup>2</sup> Additional financial resources were provided by the Charity and Defense of Nature Trust

- **Design of the intervention in harmony with environmental conservation.** This meant avoiding over-exploitation of water by granting an adequate release of the collected water for the wellbeing of the ecosystem equilibrium.
- **Strong involvement of the communities at all levels**, from the decision-making processes, to the concrete contribution to the project's realization. All beneficiaries were always an active part of the project implementation, from its inception to its design and final development. They organized themselves in brigades to dig the trenches and lay pipes, provided local material (stones) and appropriate spaces for the construction of community offices. This approach had multiple outputs: the community learnt to cooperate and organize itself as a group for a common benefit; the sense of ownership was achieved; the interest is long lasting, and the technical training was easily completed.
- **Decentralization of water system management.** The beneficiaries availability to pay flat tariffs to cover future maintenance and repairs costs were encouraged through appropriate training and the establishment of WCs.
- **Institutional strengthening**, with the creation or the enhancement of efficient Village **Water Committees (WCs)** and **Water Users Association (WUA)**, responsible for the management of the water distribution services and the collection of tariffs. Counselling sessions were offered to WCs for opening and managing a bank account where families could deposit their financial contributions and for the formation of Water Users Associations. A cost recovery system at household level was introduced to face ordinary maintenance costs and a set of rules was formulated in order to be prepared to face extraordinary and unpredictable events.

The construction of the water distribution system was followed by a hygienic-sanitary awareness raising campaign and by trainings on water use and hygiene, with direct community involvement in the construction of latrines and relative structural choices, which are culturally determined.

### INTERVENTIONS IN THE WATER SECTOR

**Water supply for domestic use.** A total of 85 km of gravity water pipe systems was constructed. The system collects water from 6 springs and 2 deep wells and brings it to 15 reservoirs storing 755 m<sup>3</sup>. A distribution network with 152 distribution points was set up to reach 17,600 people and supply a minimum of 20 liters/person/day. The location of the public fountains was designed together with the beneficiaries in order to assure access within 1000 m radius. Water Committees offices were constructed or rehabilitated, and equipped. Technical drawings and spare parts were delivered to the communities.

**Watering for domestic and wild animals.** A total of 11 cattle troughs and 2 earth dams for a total volume of 18,500 m<sup>3</sup> water storage, able to supply water to 39,000 TLU were constructed. Earth dams can guarantee storage for 6-8 months yearly. These distribution points represent an important water source for wildlife during the dry season. It is deemed that the increase of wildlife in the intervention area is linked, among other things, to the increase of water availability.

**Water Committees.** Twelve Water Committees were established with members from the communities and selected by the communities themselves, ensuring the participation of a 50% of women. Three of those WCs constituted a Water Users Association in Olkungwado to face all the difficulties of a more complex water distribution system. The WCs became the guarantor





*A distribution network with 152 distribution points was set up to reach 17,600 people.*

for the good functioning of the project. Currently they manage the funds and are responsible for the ordinary and extraordinary maintenance works. The WCs, supported by village and ward authorities, often solve water use conflicts, particularly for the appropriate use of the water distributed, which is sometimes used for non-domestic agriculture purposes.

**Awareness raising campaigns in the schools.** Hygienic-sanitarian awareness raising campaigns on the correct use of water and on the need of sanitary structures were carried on in all schools (Annex B). The campaigns involved the school teachers and the students' families. Moreover, an information campaign on the health risk associated to the presence of high levels of fluoride in the water, a natural pollutant widespread in the area, was developed.

**Defluorinator filters.** To reduce the incidence of fluorosis among the population (see also Water Supply, pag 53) defluorinator filters were distributed at household level. Each filter costs about 16 Euro and can treat water to meet daily family need for drinking and cooking. The project, through an incentive campaign that covered 50% of the cost of the filter, distributed about 120 filters in the areas where paramets exceed the Tanzanian standards. Moreover, one pilot community filter was built in Kimosonu Primary school. These filters, made with burnt grinded cow bones, have been developed and are produced locally, and the beneficiaries must replace them every six months/ one year.

*A total of 11 cattle troughs and 2 earth dams for a total volume of 18,500 m<sup>3</sup>, able to supply water to 39,000 TLU were constructed.*



*Defluorinator filters reduces fluorine related health problems.*

**Erosion protection.** The entire area is markedly erosion-prone. During colonial times a series of dams were realized along seasonal and water basins, currently largely destroyed. The increased velocity of the water flowing into those gullies and the consequent dragging of mountain sediments are causing both strong lateral erosion phenomena, with the formation of pools with emerging rocks, and retrograde erosion. A number of small interventions were therefore realized to slow down the water flow in the gullies and reduce the erosion phenomena. These interventions also served to protect the water sources and to reduce run-off in order to increase infiltration.

The new project "Improving Water and Sanitation access and Hygiene standards to achieve the MDGs in Arusha Region, Tanzania" funded by the European Commission and managed by Istituto Oikos (2011-2015) is about to start. It is expected to increase access to safe and properly managed drinking water, and to improve hygiene and sanitation awareness and practices for another 45,000 people in the Arumeru District.

*A total of 85 km of gravity water pipe systems was constructed. The system collects water from 6 springs and 2 deep wells and brings it to 15 reservoirs storing 755 m<sup>3</sup>.*



*Community work: digging trenches.*



## LESSONS LEARNED AND SUSTAINABILITY

The impact of the intervention in the area is very visible from many points of view: less women and children time devoted to water collection, greater influx of children in the school, spontaneous rise of small activities linked with the stable water presence (rest points, tea shops, domestic vegetable gardens with greenhouses etc.). A reduction of water-borne disease is also expected to occur.

Being based on the traditional practice of community participation for social works, one of the most important achievements of the project was the involvement of the beneficiary communities, who got organized in order to face what was frequently hard work. In this way a sense of ownership of the project itself was granted. The independent organization of communities is a very long process, as small internal conflicts and the institutional weakness in these remote areas sometime hinder the correct functioning of the WCs. The experience of the preparation, at community level, of agreements (by-laws) for the use and maintenance of the water system and of supply sources, was a valuable and appreciated practice, as it created a good governance basis. The intervention's sustainability is granted by the WC itself and by the opening of a bank account in the name of the WC members to face the expenses of the water system. Moreover, it was verified that the community is able to mobilize concretely also in the case of extraordinary maintenance works or accidents such as theft or break-downs caused by external events.

## IMPROVING SERVICES, PRESERVING THE ENVIRONMENT / ENERGY SERVICES

The initiative, aimed at improving the access of rural people to energy services (especially for lighting and cooking), has its roots in the request of the Arumeru Districts to provide basic energy services in rural contexts. A set of interventions were implemented under the sustainable development principles promoted by the AE Project, in close collaboration with the District authorities, with financial resources provided by the European Commission, the Milan Municipality and the Regional Administration of Lombardy. The interventions focused on Ngarenanyuki and Oldonyosambu Wards. Neither Ward is connected to the main National Grid, whose future development plans will hardly be able to reach a significant part of the identified population. The entire community lives without electricity services, with the exception of a few diesel generators and some scattered Photovoltaic (PV) installations. For cooking most people use open fires, which means low burning efficiency and therefore high wood demand, with serious consequences for both environment and health (see also Energy, pag 57).

The objectives of the interventions were:

- To provide at least a basic electricity service in all public institutions in the area.
- To improve the cooking services in the most relevant institutions.
- To facilitate access to appropriate rural energy technologies to the local population.
- To preserve the forest resources through the increase of the fuel wood availability and the energy efficiency.
- To increase the people awareness about the environmental and health problems linked to inappropriate energy uses.

The initiative reached an estimated overall population of about 40,000 people (8,000 households).

All the interventions were driven by the following principles:

- **Strong involvement of the communities in all aspects:** from the identification of the energy needs, to the selection of appropriate technologies and the concrete contribution to the project's implementation through community work. The participatory work was implemented through focus groups and open meetings.
- **Institutional strengthening,** with the creation of the **Energy Committees (EC)**, one for each Ward. Training opportunities were offered to EC members on different aspects (from computer use to PV instalment).
- **Promoting the most appropriate energy technologies for the local context** (economically affordable, efficient, minimum maintenance costs, easy to manage and repair, etc). The technologies promoted by the project (Table 10) fall into two categories: lighting and cooking.
  - **Lighting technology.** Technologies for off grid electricity services are Photo Voltaic (PV) panels and small hydro power installations. The PV proved to be the cheapest and most appropriate technology in the intervention area. Sunshine availability is constant during the year and a basic electricity service for domestic use can be provided with an investment of about 75€, equivalent to the cost of a solar panel capable of powering one light and mobile recharging service. Currently the Community Energy Resource Centers are able to install PV systems of any size at an installation cost of about 7-10 € per W. The installation, in Ngarenanyuki Secondary School, of a pilot water turbine (2kW), to provide light and electricity for a computer room, is currently in the test phase as a result of a partnership between Istituto Oikos, the University of Dar es Salaam and the Arusha Technical College.
  - **Heat for cooking technology.** The technologies listed in Table 10 were made available to the local population.
- **Promoting the market access to the selected technologies.** Two Community Energy Resource Centers (CERCs – see below) were used as tools to promote and sell locally the appropriate technologies, listed in Table 10.

Technology	Indicative cost
Biogas – household level	700 €
Improved stove, high efficiency, chimney	60 €
Improved stove, high versatility, chimney	40 €
Improved stove, mud, chimney	Free
Improved stove, cement, no chimney	8 €
Little cookers, metal, no chimney	2.5 €
Sawdust brickets to substitute wood logs	

Table 10 - The main cooking technologies capable of reducing the fuelwood consumption available at Ngarenanyuki and Oldonyosambu CERCs.



## INTERVENTIONS IN THE ENERGY SECTOR

**Establishment of Energy Committees**, one for each Ward. Two Energy Committees (EC) were established, under the umbrella of the Ward authorities, to plan the energy interventions and follow up activities. They include members appointed by the village and Ward governments and the women's cooperative involved in energy related activities, such as the production of Jatropha oil or improved stoves. Skilled workers with a specific interest in the energy technologies were also included. The EC objectives were: project support in targeting the problems and selecting the technologies, locations of the project intervention, means of dissemination, relationship with ward and village representatives, targets for awareness campaign and education initiatives. The Committees meet regularly once a week.

**Establishment of Community Energy Resource Centers (CERCs)**, one for each Ward. Two CERCs were opened with the objective of becoming a reference point for local people to gather information and to purchase the most appropriate technologies for domestic use. CERCs are also providing energy services (cell phone recharge, internet access, computer courses, secretarial services, etc) and information about the existing incentives and micro-credit opportunities available.

*Energy efficient stoves significantly reduce the time that women and children dedicate to wood collection.*



**PV system installation.** The project installed PV systems in all primary and secondary schools, health centers, dispensaries, village and Ward offices, and in social centers (see Table 13). Thirty-nine public institutions received an installation ranging from 40W to 1kW. Priority was given to secondary schools (4 schools in the project area), with larger installations and provision of a computer room (from 6 to 12 computers), and health centers. Small, portable PV items such as torches, mobile charges, etc. were also promoted through CERCs (see Table 12).

**Improved stoves installation and dissemination.** In all primary and secondary schools the project installed improved wood stoves to reduce wood consumption and cooking time. For private households, several improved stove models were promoted. Among these, the mud stoves for the Maasai huts and the Jiko Janja (JJ) stoves for the Meru households (see Table 11) turned out to be the most appreciated. Jiko Janja stoves are built by women's groups as an income-generating activity and have been widely promoted in the area.

**Domestic biogas plants installation.** Specific courses were addressed to train local technicians in the building of domestic biogas plants. The initiative was developed in collaboration with CAMARTEC, a Tanzanian government institution responsible for disseminating appropriate rural technologies, in the framework of the National Biogas Program. Twenty biogas plants were installed (Table 12).

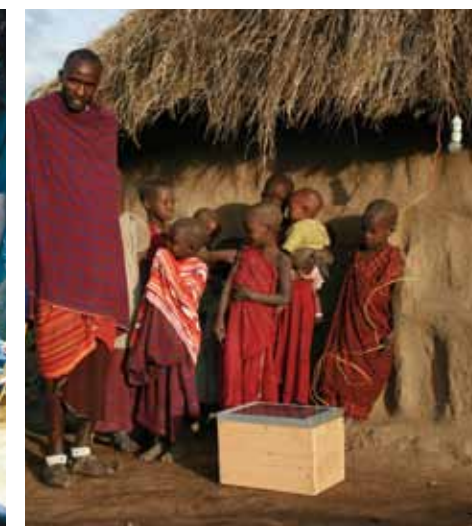
**Increase of fuelwood availability.** Five tree nurseries were opened and seedling were distributed to households and public institutions.

**Training of local technicians.** Training modules were organized in two main sectors. 1) Training for women's cooperatives, designed to disseminate small energy related technologies that can be reproduced locally as income generating opportunities. Training has focused on different models of improved stoves. 2) Training for local technicians on installation of PV systems, biogas plants and large energy efficient stoves for schools, public institutions, etc. The training consisted in a theory part, followed by practical experiences. All the installations done by the project provided an opportunity to "train on the job" local technicians with the double objective to increase their capacities and employment opportunities and to create skilled workers for future maintenance of local plants. Energy Committee members attended all trainings.

*Computer training room powered by solar panels.*



*Photo voltaic panels provide affordable off grid electricity in Maasai boma.*



*An example of Jiko Janja stove.*





**Combining Energy installations with awareness raising.** The project has run some itinerant awareness campaigns focusing mainly on women and primary school children. Women are responsible for fuel wood collection and cooking. Primary school students represent some 20-25% of total population. It is plausible to assume that each household (average of 5 members per household) has at least one family member attending primary school. Through the itinerant campaign the project had the opportunity to disseminate different messages and technology options about energy and through the women's cooperatives to get the feedback from the community. The itinerant campaign was focused chiefly on the improved stoves technologies, capable of reducing health hazards by decreasing the smoke in huts, and to increase efficiency. An estimate of the number of households reached by the campaign is provided in Table 11.

Village	N° of JJ Stoves installed	N° of households reached by the awareness campaign	Percentage of households with JJ stoves
Olkunguado	58	1225	4.73%
Uwiro <sup>1</sup>	32	852	3.76%
Ngabobo	24	475	5.05%
Kisimiri Chini	26	399	6.52%
Kisimiri Juu	14	378	3.70%
Lemongo	22	1203	1.83%
OldonyoWass	23	371	6.20%
Losinoni	12	878	1.37%
<b>TOTAL</b>	<b>211</b>	<b>5781</b>	<b>3.65%</b>

Table 11. Number of efficient stoves installed at household level and percentage of penetration of the technology.

Technology	N° of Units disseminated or sold at CERCs
<b>Solar technology for lighting</b>	
Small portable light, torch	85
Small portable light with mobile phone recharger	100
Small PV box 10W, one good quality light, mobile phone recharger	80
Small PV installation 20W, 3 lights, mobile charger	45
Larger PV installation	30
<b>Heat for cooking</b>	
Biogas plant	20
Jiko Janja stove	211
Mud stove	40
Other small technologies	100

Table 12. Energy units disseminated at household level in the period 1 January 2009 – 30 September 2010.

Public institutions	N° of systems installed
Primary Schools with PV system: light in teacher room and one classroom	12
Primary Schools with larger PV system, as above plus two computer	5
Secondary Schools with large PV system to power library and computer room	3
Health Centre with PV system in all buildings	2
Dispensaries with PV system	4
Ward offices with PV system	2
Village offices with PV system	7
Public Places with PV system	4
Secondary Schools with improved energy stoves	3
Primary Schools with improved energy stoves	16
Public places (e.g. Mkuru Training Centre) with improved stoves	3

Table 13. Energy systems installed in public institutions in the period 1 January 2009 – 30 September 2010.

#### LESSONS LEARNT AND SUSTAINABILITY

Energy services are not perceived by the local population as a primary need, such as water. Energy, especially electricity, is intended more as “an opportunity” rather than a service *per se* and is not considered a priority. Therefore, technology dissemination and success depend on the appropriateness of the technology selected, in terms of effectiveness, efficiency, capacity to cope with people's needs and, last but not least, economic affordability. The presence of microcredit schemes or economic incentive mechanisms might be of great help to disseminate the most promising technologies. Another very important component is the capacity to explain and show through practical demonstrations the advantages and potentials of the different technologies. For instance, the availability of electricity provided by solar panels to use a computer and have access to internet is simply not imaginable by the rural people and is not listed among the community priority needs. Nevertheless, the instalment of solar panels connected with computer rooms in 4 secondary schools and in the CERCs, and the provision of computer training courses was one of the most appreciated components of the initiative and represented a great opportunity for the young generation to improve their skill and have access to information.

At the same time, forcing technology introduction may be totally useless in the presence of stronger cultural dynamics. Cultural resistance was experienced especially when the beneficiaries of the technology are the women, who are not taken into consideration in the family decision making process. For example, the introduction of smokeless, energy efficient stoves in the Maasai huts was quite difficult. Only zero cost options (such as the mud stove) seem to have the possibility of being accepted.

In conclusion, several rural energy technologies have great potential to be spread among communities to improve their livelihood, either directly and through the creation of a local market that can generate employment opportunities. Nevertheless, many aspects such as the in-depth knowledge of the potential of the technologies, the medium/long-term reliability and cultural implications that their use may generate, the existence of economic incentives or credit schemes to facilitate investments, need to be taken into thorough consideration to facilitate the wide penetration of the new technologies among local people.





## CONCLUSIONS

The project was a first attempt to analyze the Mount Meru environmental and human capital and to identify, promote and develop, together with the local communities and authorities, approaches, methodologies and interventions addressed to make the Mount Meru Natural System able to ensure the ecosystem services necessary to cover the local population's needs in the long run.

As a direct result of the project:

- The District, Ward and Village authorities can now rely on a good set of baseline information and maps, organized on a user friendly database, available for any planning and management purposes.
- The Arumeru District, Ngarenanyuki Ward and Uwiro village technical staff are able to apply an innovative approach to land use planning, based on the integrated data analysis and on the intention to preserve the natural capital for future generations; Uwiro Village Land Use Plan is a concrete example of this new approach.
- The local communities have improved their knowledge regarding environmental values; they are more aware of the sustainability principles and have increased their technical capacities to manage their resources in some key sectors for sustainable development: natural resources monitoring, anti-poaching, water management, livestock keeping, tourism management, energy production, sanitation.
- The basic literacy has improved among the adult population and, in particular, among Mkuru Camel Safari members, Nasaruno Women Group members, VGS, CAHW, Mkuru Training Centre staff.
- The school-children have improved their knowledge of environmental resources; they are more aware of the sustainability principles and have contributed to the environmental rehabilitation through the creation of tree nurseries and tree planting initiatives.
- Income generating initiatives in the livestock, environment and tourism sectors have shown that environmental sustainability can be easily combined with economic development. Community Animal Health Workers and Village Game Scouts are available to provide services at private and village levels; Mkuru Camel Safari and Tanzania Maasai Women Art initiatives are stable sources of income, directly or indirectly, for almost all Mkuru subvillage (about 800 people – 110 households).
- Water availability for human, wildlife and livestock has increased: 17,600 people are now served with a minimum of 20/liters/person/day; 11 cattle troughs and 2 earth dams make available 18,500 m<sup>3</sup> of water for livestock and wildlife. Local communities are able to manage their own water resources, to guarantee maintenance and plan extension.
- Access to affordable and sustainable energy services has improved.

The success of the initiative is due to the invaluable commitment and capacities of the project staff and partners. But it is also a tangible result of the **multi stakeholders approach**. Key stakeholders (local authorities, local NGOs, civil society members, water operators, the private sector, etc.)

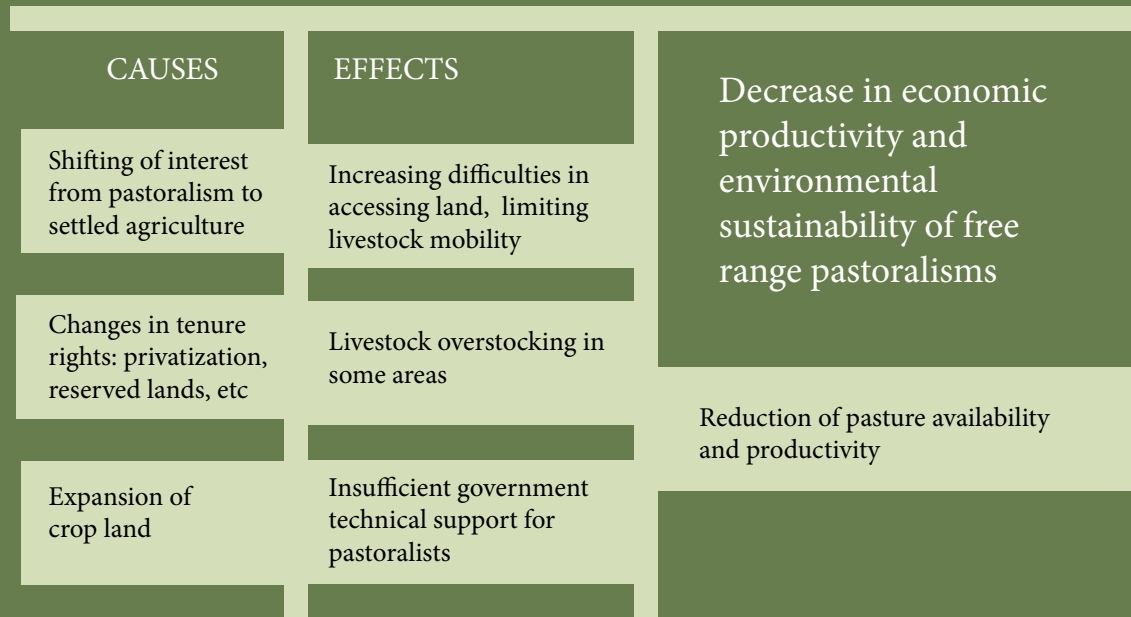


participated in the project design and actively contributed to project implementation, according to their specific skills. This strategy facilitated local empowerment, knowledge transfer, strengthening of local capacities to coordinate activities, but also contacts with other development programs and the establishment of strategic directions and priorities.

Facilitating the participation of local people and analyzing with them how problems are strongly interconnected in a complex web of causes and effects which produce changes was also fundamental for the introduction of new visions and attitudes towards land management. The diagrams given below summarize the results of the village participatory work, developed in the framework of the Uwiro Land Use Plan production, aimed at identifying the most crucial causes of changes and at understanding their impact on people's livelihood. As the experience shows, changes remain partly unpredictable and are not always under control, such as the effects of climate variability on field crop productivity. Nevertheless, with appropriate monitoring, planning and management measures, most of the changes can be detected, their negative impacts reduced and resilience to adverse conditions significantly increased. The understanding of these principles, strengthened by the concrete field results, is the most important achievement of the project and can make sustainable development a viable option.

### LAND USE CHANGES

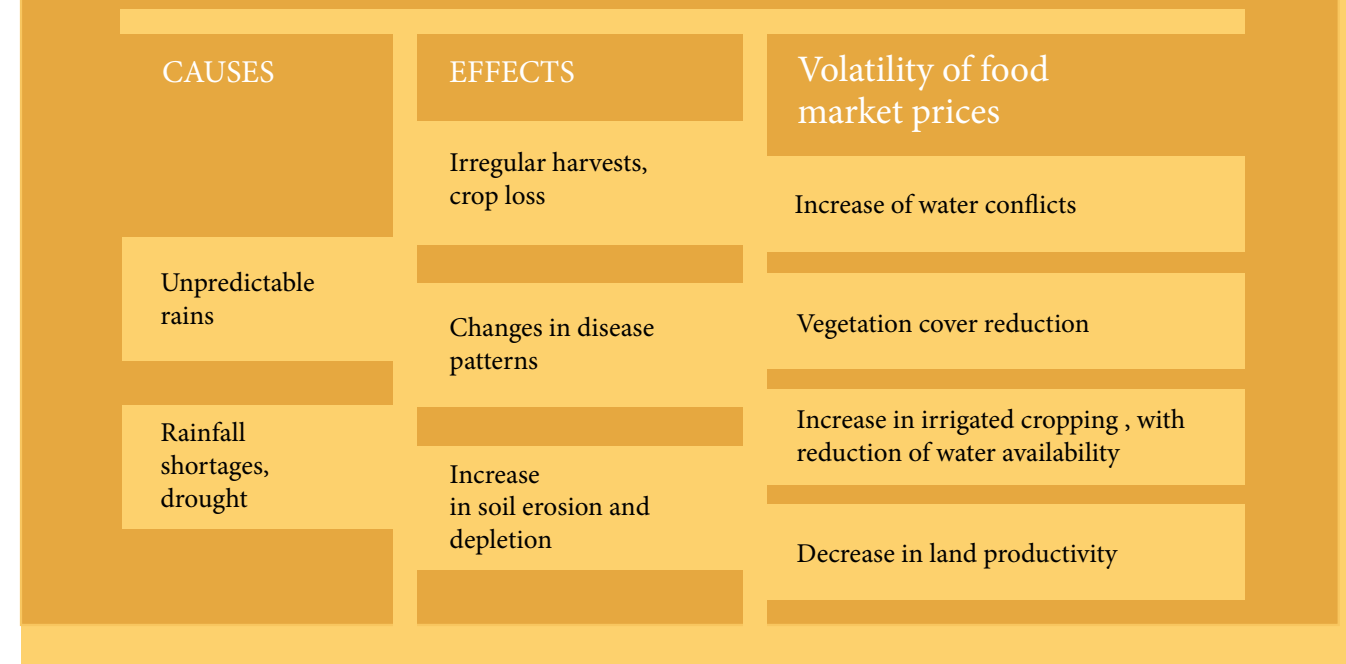
#### Increased marginalization and vulnerability of the Maasai pastoralists



Participatory analysis of the effects of land use changes on the livelihood of the Maasai.

### CLIMATE RELATED HAZARDS

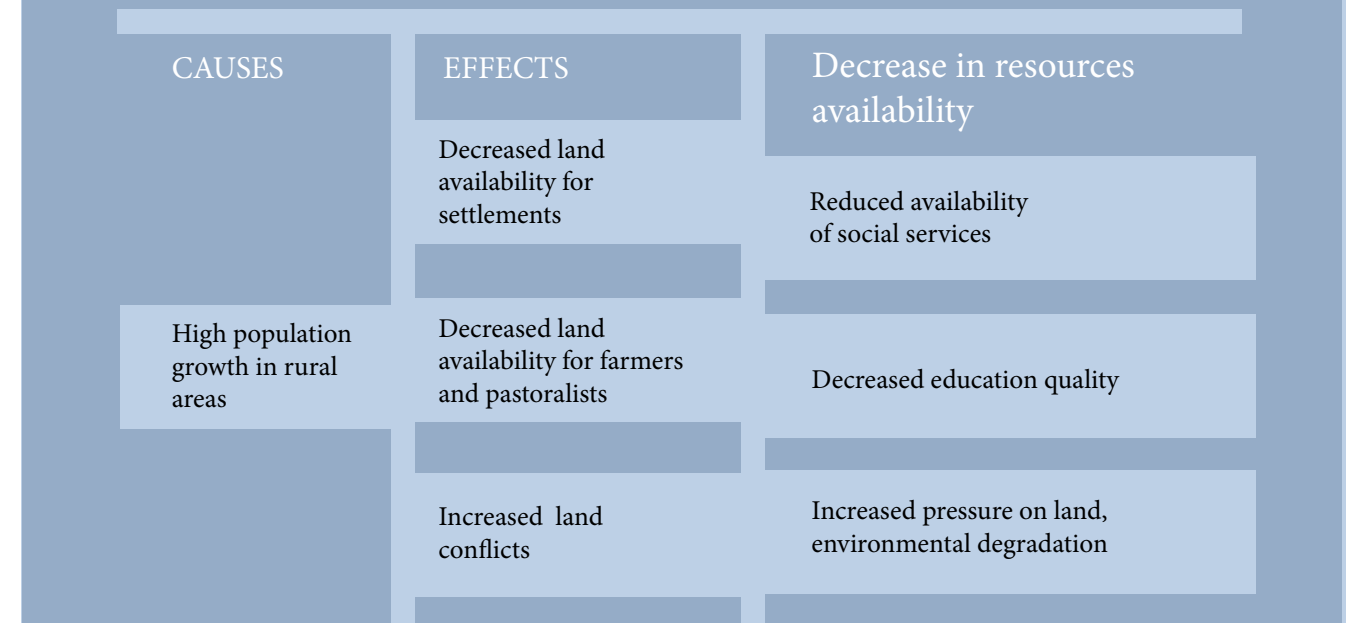
#### Food insecurity, Increased people vulnerability



Participatory analysis of the impact of climate-related hazards on livelihood.

### DEMOGRAPHIC INCREASE

#### Increased marginalization and vulnerability of rural populations



Participatory analysis of the impact of demographic increase on rural populations.





# RECOMMENDATIONS

## LIVESTOCK KEEPING

Regardless of the large number of livestock in the area, the sector is still poorly developed and does not fully contribute to income generation and subsistence. Introducing appropriate pastureland management measures, strengthening both government and private technical assistance and enhancing local knowledge are necessary measures to improve the healths, value and profitability of the herds. In particular:

- **Ensure that pastureland is properly managed** to avoid overgrazing and desertification.
- **Improve disease control** services and introduce scheduled disease prevention measures.
- **Promote the improved free range breeds**, which are better resistant to drought.
- **Develop facilities and techniques to store** maize and bean straws to meet the livestock fodder demand in the dry season.
- **Give greater value to traditional livestock keeping**, especially for health services.
- **Give greater value to livestock by-products** (skin, hides).
- **Create more water points** in the rangelands to avoid concentration of herds in one point.

## AGRICULTURE

The improvement of agricultural practices through appropriate planning and management measures, technical assistance and local knowledge increase, is urgently needed to improve human health and environmental sustainability, to strengthen subsistence and revenue generation. In particular:

- **Reduce the incidence of monoculture.** Adopt long rotation periods, also to reduce diseases incidence on crops and promote integrated, mixed cropping systems.
- **Promote the use of alternative crops** with comparable economic results to introduce in the rotation. Sorghum would be more appropriate but it is not much valued by local people and yields could be severely affected by bird' attacks at harvesting time. Onion could be a good alternative to tomato but investigations are needed to understand its present poor performance.
- **Promote measures for improving soil fertility.**
- **Control the expansion of irrigated cropping systems** to avoid reduction of water availability and increase of soil salinity.
- **Monitor pests** and diseases outbreaks and improve the efficiency and safety of the use of pesticides.



- **Identify and test appropriate methodologies** to control the spreading of exotic, invasive, non palatable species.
- **Value the traditional practices** that have been mainly abandoned since the market requests new products, not original of the area.
- **Strengthen farmers' organizations** and associations. They could permit a better control of the production chain and a greater power of negotiation in the marketplace on issues like pricing, facilitated access to export-markets, infrastructure development, credit provision. Collectively owned trucks could reduce transport costs.
- **Equip, train and organise into a service group, crop protection operators.** This could permit the improvement of the working conditions of "spraying operators" and to promote more appropriate utilization methods.
- **Improve the food storage systems.**
- **Ensure appropriate seed maintenance** and multiplication techniques to avoid inbreeding depression or loss of genetic quality.

## FORESTS

Tree cutting for wood harvesting and farming expansion is producing forest degradation and reduction of forest land with uncontrolled impacts on the water regime and the climate stability. Sustainable forest management techniques have to be implemented. In particular:

- **Reduce illegal utilization of forest resources** by strengthening patrolling and law enforcement, also through a better empowerment and coordination of Village Game Scouts.
- **Encourage reforestation** initiatives using appropriate fast growing indigenous species.
- **Promote tree planting** initiatives to support charcoal and firewood production, improve the agro ecosystems, increase biodiversity, reduce wind impact, etc.
- **Reduce wood consumption** through encouraging the use of energy-saving technologies whenever possible.

## WILDLIFE

The survival of wild animals outside Arusha National Park depends on local communities willingness to protect them. Nevertheless, the costs of wildlife protection are mainly met by local people and they outweigh the advantages. The direct interest of local people in preserving wildlife has to be sought and encouraged.

- **Concentrate wildlife conservation efforts in key areas** where strategies to allow coexistence of wildlife, agriculture and livestock keeping activities have to be sought. Give priority attention to Kisimiri Wildlife Corridor and rangelands. In these areas, combine (and make viable) prevention measures to reduce damages from wildlife with compensation mechanisms for species which cause problems, such as wild dog and elephant.

- **Combine education, prevention and compensation measures** to reduce poaching as the prevailing local community strategy to avoid wildlife damage to agriculture and livestock. Innovative prevention and compensation schemes have to be identified. For example, compensation measures could involve tourists making a contribution to a village conservation fund for every carnivore spotted in the area.
- **Involve local communities in benefit sharing** of revenues accrued from tourism and hunting initiatives.
- **Promote the establishment of Wildlife Management Areas** and other conservation enterprises in the area.
- **Search for new approaches to strengthen collaboration** between Arusha National Park and local communities.
- **Encourage and strengthen community based tourism initiatives** such as Mkuru Camel Safari in pastoral range lands where suitable habitats for wildlife are still available.
- **Promote and implement land use planning mechanisms and approaches**, such as Uwiro Village Land Use Plan, that take into consideration wildlife conservation objectives.

## WATER

It is expected that by 2015 most of the population of the Arumeru District will have access to a minimum of 20 liters of drinkable safe water per person per day within a 1000 m radius, in line with the Millennium Development Goal in Tanzania. With more that 62,600 people served by 2015, Instituto Oikos has made a major contribution to reaching this objective. Nevertheless, the needs to regulate and optimize the use of water for agricultural land, to increase the use of water for hygiene purposes, combined with the persisting problems of fluoride contamination bring additional challenges, that have to be addressed and which call for the implementation of innovative, sustainable and participatory developed water management systems.

- **Set up measures aimed at reducing the health problems linked to high fluoride intake**, especially among children. In particular:
  - In the areas between Mount Meru and Mount Kilimanjaro, where the level of precipitation is 700-1100 mm/year and the underground water has unsafe concentrations of fluoride, **encourage rain water harvesting especially in schools.**
  - **Promote**, also through economic incentives, **the use of the cow bone filters** at household and school levels to reduce the content of fluoride and encourage their appropriate maintenance.
  - **Strengthen the investigation and technical capacity** of local institutions in locating and developing new water sources and relevant distribution networks.
- **Strengthen the capacity of local communities and authorities to improve water management** to optimise the use of water and to mitigate competition between water users.



- **Elaborate bylaws and adopt water use regulations** to prevent social conflicts due to the increasing competition between water users.
- **Rationalize the irrigation systems** to avoid wasting water and soil salinity contamination; ensure a proper maintenance of the irrigation canals; decrease water consumption in the flood irrigation techniques.
- **Test drip irrigation** as a solution for water scarcity and salinity problems.
- **Encourage the use of crop varieties** that require less water (with a lower water footprint).
- **Create more water points for livestock**, especially in the outreach pasture areas, to reduce the pressure on the existing water points and relevant grazing areas, mitigating pastoralists-farmers conflicts.
- **Couple** the integrated approach to water resource management with improvement of hygiene practices.

## ENERGY

Wood is expected to remain the main source of energy, at least for the near future. But, unfortunately, wood harvesting for firewood and charcoal production is inefficiently controlled and contributes dramatically to the decrease of the forest area.

- **Promote energy saving strategies**, such as the use of improved stoves, that can reduce firewood consumption by up to 50%.
- **Promote the use of affordable and sustainable energy systems**, such as biogas, mini hydro power and solar technology.
- **Increase investments in re-forestation** programs intended to increase firewood availability and meet the energy demand. Test agro-forestry with species such as *Acacia nilotica*, *Acacia tortilis*, *Azadirachta indica*, *Cassia siamea* in areas where water harvesting is possible.
- **Discourage unsustainable practices**, such as the Maasai tradition of making open fires for cooking and heating inside the dwellings without a chimney. This practice, on top of being energetically inefficient, produces excessive smoke in the huts resulting in respiratory and eye problems.
- **Make available economic incentives** and micro-credit opportunities to encourage investment in the sustainable energy sectors.

## ECONOMIC ACTIVITIES IN THE ENVIRONMENTAL SECTOR

Agriculture and livestock keeping will remain the driving economic forces of the area. Nevertheless, the changing socio-economic environment is opening new income-generating opportunities that, if properly identified and addressed, could create new forms of revenue. The project offered the possibility to identify a few of these options and to test their effectiveness. The following action could foster the development of new local businesses:

- **Facilitate the opening of micro-credit** opportunities, not available at the moment in the project area, as a pre-condition for encouraging new businesses.
- **Experience innovative payment schemes** to make the activities of Village Game Scouts economically sustainable or other services of community interest that cannot easily be covered by the local government.
- **Encourage the establishment of small businesses**, managed by women groups, in the production and selling of improved stoves.
- **Train technicians** to install and maintain energy devices such as domestic biogas plant and solar panels.
- **Encourage the establishment of a local market for affordable energy** devices such as small solar panels, solar battery/telephone chargers, solar torches, etc.
- **Encourage the establishment of economic initiatives** that give due value to the cultural heritage, including historic resources, art and crafts production.
- **Provide training** opportunities to increase local standards in key tourism sectors such as handling visitors and the provision of restaurants and hotels services.
- **Value (and preserve) wildlife resources**, landscape and traditions, as they are the basis of a tourism industry.
- **Encourage the establishment of small businesses** in the provision of technical services such as pest control and animal health care.
- **Strengthen the role** and the capacities of Community Animal Health Workers (CAHWs).

## INFRASTRUCTURES

- **Ensure that public institutions** providing meals (mainly schools) are using improved stoves.
- **Reduce leakages** and water losses in the water distribution systems.

## TRAINING AND AWARENESS RAISING

- **Provide training** opportunities (formal and informal, for children and adults) in the above-mentioned sectors.
- **Organise meetings and seminars**, at village and school levels to promote general awareness of environmental and health risks linked to inappropriate management of natural resources.
- **Strengthen** the Water Committee, Water Users Association and Energy Committee members, farmers and livestock association members.



## REFERENCES

- Adams W. M. and Hulme D. (2001) “*If community conservation is the answer in Africa, what is the Question?*” *Oryx* 35: 193-200.
- Arumeru District (2009) “*Arumeru District Council socio-economic profile*”.
- Arusha National Park (2003) “*Arusha National Park General Management Plan*”.
- Avitabile V. (2009) Terre Solidali Mission Report “*Tanzania Arusha and Meru Districts 16<sup>th</sup> March - 27<sup>th</sup> April 2009*”.
- Balia R. and Ghiglieri G. (2008) “*Water Master Plan for the Wards of Ngarenanyuki and Oldonyosambu (Arumeru District) – Tanzania, Hidrogeological and Geophysical Researches*”.
- Beffasti L. (2006) “*Mkuru Camel Safari e Maasai Women Art. Strategie di Sviluppo Sostenibile tra i Maasai della Tanzania*” Tesi di laurea per il Corso di Laurea Magistrale in Lingue, Culture e Comunicazione Internazionale, Facoltà di Scienza Politiche, Università degli Studi di Milano, anno accademico 2005-2006.
- Bolick M. R. (1974) “*A Vegetation history of the Mount Meru lahar, Tanzania*”. A thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts in the Department of Zoology in the Graduate School of Arts and Science of Duke University.
- Chinellato G. and Trentin M. (2006) “*Analisi dell’Approvvigionamento Idrico di Alcuni Villaggi nel Distretto di Arumeru, Tanzania*.” Tesi di Master in Gestione delle Acque e Uso del Territorio nei Paesi in Via di Sviluppo.
- Di Gregorio et al. (1997) “*LCCS Land Cover Classification System*” FAO.
- Du Toit J.T. (2002). “*Wildlife harvesting guidelines for community-based wildlife management: a southern African perspective*.” *Biodiversity and Conservation* 11:1403.
- Ecosystems Ltd. (1980). “*The status and utilization of Wildlife in Arusha region Tanzania*”. A final report to Arusha and Village Development Project. pp 82.
- Gadd, M. E. (2005) “*Conservation outside of parks: attitude of local people in Laikipia, Kenya*” *Environmental Conservation* 32(1): 50-60.
- Gaidet N., Fritz H. and Nyahuma C. (2003) “*A Participatory counting method to monitor populations of large mammals in non-protected areas: a case study of bicycle counts in the Zambezi Valley, Zimbabwe*”. *Biodiv.Cons.*, 12:1571-1585.
- Ghiglieri G., Balia R., Oggiano G. and Pittalis D. (2010) *Prospecting for safe (low fluoride) groundwater in the Eastern African Rift: the Arumeru District (Northern Tanzania)* - Hydrology and Earth System Sciences (HESS) ISSN 1027-5606 *Hydrol. Earth Syst. Sci.*, 14, 10811091, 2010.
- Gillingham S. and Lee P.C. (1999) *Community wildlife management around Selous Game*

- Reserve, Tanzania: The impact of wildlife-related benefits on the conservation attitude of local people*” *Environmental Conservation*, 26, 218-228. Gillingham, S. and Lee, P.C. 2003. People and protected areas: A study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve, Tanzania. *Oryx* 37(3), 316-325.
- Gregory J.W. (1921) “*The Rift Valleys and geology of East Africa*” Seeley Service and Co. Ltd., London.
- Grimshaw J.M and Foley C. A. (1990) “*Kilimanjaro elephant project final report*”.
- Haule K.S., Johnsen F.H. and Maganga S.L.S. (2002) “*Striving for sustainable wildlife management, the case of Kilombero Game Controlled Area*” *Journal of Environmental Management*: 66, 31-42.
- Hill C. M. (1997) “*Crop raiding by wild vertebrates: The farmer’s perspective in an agricultural community in western Uganda*” *International Journal of Pest Management*, 43, 77-84.
- Hulme D. and Taylor R. (2000) “*Intergrating, economic and social appraisal in the real world: from impact assessment to adaptive management*”. In: Lee N. and Kirkpatrick, C. (eds), *Sustainable Development and Intergrated Appraisal in Developing world*, Pp. 81-10.
- IIED (International Institute for Environment and Development) (1994) “*Whose Eden? An overview of community Aproaches to Wildlife Management*” Overseas Development Administration, U.K.
- Kahurananga J. N.M. (1976). “*The ecology of large herbivore in Simanjiro plains, Northern Tanzania*”. PhD thesis part I, Biology of Conservation, Nairobi University, 183 pp.
- Kidane A. (1974). “*Interaction of Livestock, game and vegetation in Longido controlled hunting area*” Thesis dissertation Mwaka Wildlife Management College, 40 pp.
- Kiss A. (1990) “*Living with wildlife. Wildlife Resources Management with Local participation in Africa*” World Bank technical paper number 130, Africa Technical Department Series. The World Bank Washington DC.
- Kiunsi R.B.R. (1993) “*Land cover change in the Longido Game Controlled Area and their possible effect on the function of the Amboseli Biosphere Reserve*” Unpublished Master’s thesis, International Institute for Aerospace survey and earth Science, Netherlands, 70 pp.
- Kharb P. and Susheela A.K. (1994) “*Fluoride ingestion in excess and its effects on organic and certain inorganic constituents of soft tissues*”. *Med. Sci. Res.* 22: 43-44.
- Istituto Oikos (2010) “*Proposed Land Use Plan - Uwiro Village, Ngarenanyuki Ward, Meru District Council*”.
- Lasan A.H. (1971) “*Formulation of management plan for the Longido Controlled area, Ngaserai*” Diploma theis submitted for the fulfillment of an award of diploma in Wildlife Management, Mwaka, 30 pp.
- Lamprey H. F. (1963) “*Ecological separation of the large mammals species in the Tarangire Game*



- Reserve, Tangayika*” E. Afr. Wildl.J 1: 1-30.
- Lewis D. M. (1995) “*Importance of GIS to community based management of wildlife: Lesson from Zambia*” Ecological Applications. Vol. 5 No 4, 861-971.
  - Mboya S. D. B, Shechambo F. C., Sosovele H., Kulindwa K., Naho A. A. and Cromwell, E. (1995) “*Structural Adjustment and Sustainable Development in Tanzania*” Dar es salaam University Press, Tanzania, 210 pp.
  - MMCP (Mount Meru Conservation Project) (2004) “*Long term wildlife monitoring in Arusha National Park, Tanzania*” A report prepared by Istituto Oikos for the European Commission, 109 pp.
  - Naughton-Treves L. (1997) “*Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda*” The Geographical Review 87: 27-47.
  - Naughton-Treves L. (1998) “*Predicting pattern of crop damage by wildlife around Kibale National Park, Uganda*” Conservation Biology 12. 156-168.
  - Naughton-Treves L. (1999) “*Whose animals? A history of property rights to wildlife in Toro, western Uganda*” Land Degradation and Development 10. 311-328.
  - NRD-UNISS, DIT-UNICA (2008) “*Water Master Plan for the wards of Ngarenanyuki and Oldonyosambu*”.
  - Nelson F. (2007) “*Emergent or illusory? Community wildlife management in Tanzania*”. IIED, Issue paper no. 146 38 pp.
  - Newmark, W. D. (1996) “*Insularization of Tanzanian Parks and the Local Extinction of Large Mammals*” Conservation Biology, Vol. 10, No. 61549-1556.
  - Newmark W. D. and Hough, J. L. (2000) “*Conserving wildlife in Africa: Integrated conservation and development projects and beyond*” Bioscience 50:585-592.
  - Ntawila J. (2007) “*Wildlife diversity and their interaction with people for sustainable use in the semi arid areas of northern Mount Meru ecosystem (Tanzania)*” Ph.D. School “Analysis, Protection and Management of Biodiversity” Insubria University (Italy).
  - Ntalwila J., Codipietro P., Galanti V., Masoy J., Rossi R., Tosi G. (2003) “*Humanwildlife conflict. A case study on six villages adjacent to Arusha National Park Tanzania*” Proceeding of the fourth annual scientific conference by Tanzania Wildlife Research Institute in Arusha, Pp. 115-128.
  - Noe C. (2003) “*The Dynamics of land use changes and their impacts on the wildlife corridor between Mount Kilimanjaro and Amboseli National Park Tanzania*” LUCID working paper no31, 39 pp.
  - Parry D. and Campbell B. (1992) “*Attitudes of rural communities to animal wildlife and its utilization in Chobe, Enclave and Mabade Depressions in Botswana*” Environmental conservation 63: 177-183.

- Pittalis D. (2010) “*Interdisciplinary Studies for the Knowledge of the Groudwater Fluoride Contamination in the Eastern African Rift: Meru District – North Tanzania*” Dissertation of the Degree of PhD School in Natural Science, University of Sassari, 2010, XXII Cycle.
- Poole J. and Reuling M. (1997) “*A survey of Elephant and other wildlife of the west Kilimanjaro basin, Tanzania*” 57 pp.
- Salvini G., Biodiversity (2006) “*Gis-Mapping for the Suistanable Management of a Primary forest. Case study of Nadung'oro Reserve (Tanzania Africa)*” Anno Accademico 2005-2006, Corso di Laurea in Conservazione e gestione del patrimonio naturale, Facoltà di Scienze Matematiche, Fische e Naturali.
- TAWIRI (Tanzania Wildlife Research Institute) (2003) “*Aerial Total Count of elephants in West Kilimanjaro, Tanzania, Dry Seasons, 2002*” TAWIRI Aerial Survey Report Commissioned by African Wildlife Foundation (AWF) , 13 pp.
- TAWIRI (Tanzania Wildlife Research Institute) (2001) “*Wildlife Census of Oryx, Gerenuk and Lesser kudu in the Lake Natron Game Controlled Area*”.
- Trivellini G. (2006) “*Environmental and Socioeconomic Analysis for a Plan of Integrated Development of Northern Mount Meru Area, Tanzania*” Dissertation – Master in: Land Use and Water Management in Developing Countries, University of Milan, Bicocca.
- UN (2009) “*The Millennium Development Goals Report*” UNITED NATIONS New York.
- Western D. (1973) “*The structure, dynamics and changes of the Amboseli Ecosystem*” Ph.D. thesis. University of Nairobi.
- Weladji R.B. and Tchamba, M.N. (2003) “*Conflict between people and protected areas within the Be 'noue' Wildlife Conservation Area, North Cameroon*” Oryx, 37, 72–79.
- Western D. (1976) “*Amboseli- Integration of people land and wildlife seeks to end the conflicts which threaten the national parks*” Parks 1,2: 1-4.
- Western D. (1982) “*Amboseli National Park: Enlisting land owners to conserve migratory wildlife*” Ambio, 17, 1:11-19.
- Western D. and J. Semakula (1981) “*The future of the savannah eco- systems: ecological islands or faunal enclaves?*” African Journal of Ecology 19: 7-19.
- WHO (World Health Organization) (1984) “*Guidelines for drinking water quality, vol. 2. Health criteria and other supporting information*” WHO, Geneva.
- WWG (Wildlife Working Group) (2002) “*Loliondo: A case study of wildlife management in northern Tanzania*” Unplushed report.



# ANNEXES

## ANNEX A

### CHECKLIST OF TERRESTRIAL VERTEBRATES IN THE MOUNT MERU NATURAL SYSTEM

Mammals			
Scientific name	Common name	Arusha National Park	Mount Meru Natural System
<i>Acinonix jubatus</i>	Cheetah		*
<i>Aepyceros melampus</i>	Impala		*
<i>Aethomys kaiseri</i>	Kaiser's rock rat	*	
<i>Alcelaphus buselaphus</i>	Hartebeest		*
<i>Atelerix albiventris</i>	Four-toed hedgehog	*	
<i>Atilax paludinosus</i>	Marsh mongoose	*	*
<i>Canis adustus</i>	Side-striped jackal		*
<i>Canis aureus</i>	Common jackal		*
<i>Canis mesomelas</i>	Black backed jackal		*
<i>Cephalophus harveyi</i>	Harvey's red duiker	*	*
<i>Cephalophus monticola</i>	Blue duiker	*	
<i>Cercopithecus aethiops</i>	Vervet monkey	*	*
<i>Cercopithecus mitis</i>	Blue monkey	*	*
<i>Civettictis civetta</i>	African civet	*	*
<i>Colobus guereza spp. caudatus</i>	White and black colobus monkey	*	*
<i>Connochaetes taurinus</i>	Wildebeest		*
<i>Crociodura montis</i>	Montane white-toothed shrew	*	
<i>Crociodura mariquensis</i>	Swamp musk shrew	*	
<i>Crocuta crocuta</i>	Spotted hyaena	*	*
<i>Crycetomis sp.</i>	Giant pouched rat	*	
<i>Dendromus sp.</i>	Climbing mice	*	
<i>Equus burchellii</i>	Common zebra	*	*
<i>Felis silvestris</i>	African wild cat	*	*
<i>Gazella granti</i>	Grant's gazelle		*
<i>Gazella thomsonii</i>	Thomson's gazelle		*
<i>Galago senegalensis</i>	Lesser galago		
<i>Genetta genetta</i>	Common genet	*	*
<i>Genetta maculata</i>	Large-spotted genet	*	*
<i>Giraffa camelopardalis</i>	Giraffe	*	*

All data sources are listed in the Reference chapter.

<i>Grammomys dolichurus</i>	Woodland thicket rat	*	
<i>Graphiurus murinus</i>	Woodland dormouse	*	
<i>Helogale parvula</i>	Dwarf mongoose	*	*
<i>Herpestes sanguineus</i>	Slender mongoose	*	*
<i>Hippopotamus amphibius</i>	Hippopotamus	*	
<i>Histrix cristata</i>	Crested porcupine		*
<i>Hyaena hyaena</i>	Striped hyaena		*
<i>Hylochoerus meinertzhageni</i>	Giant forest hog	*	
<i>Ichneumia albicauda</i>	White-tailed mongoose	*	*
<i>Ictonyx striatus</i>	Zorilla	*	*
<i>Kobus ellipsiprymnus ellipsiprymnus</i>	Waterbuck	*	*
<i>Leggada sp.</i>	Mice sp.	*	
<i>Lemniscomys striatus</i>	Zebra mice	*	
<i>Leptailurus serval</i>	Serval	*	
<i>Lepus capensis</i>	Cape hare	*	
<i>Litocranius walleri</i>	Gerenuk		*
<i>Lophuromys flavopunctatus</i>	Brush-furred mice	*	
<i>Loxodonta africana</i>	Elephant	*	*
<i>Lycaon pictus</i>	Wild dog	*	*
<i>Madoqua kirkii</i>	Kirk dikdik	*	*
<i>Mastomys natalensis</i>	Mulimammate rat	*	
<i>Mastomys sp.</i>	Mulimammate rat	*	
<i>Mellivora capensis</i>	Honey badger	*	*
<i>Mungos mungo</i>	Banded mongoose	*	*
<i>Mus bufo</i>	Toad mouse	*	
<i>Mus minutoides</i>	Pigmy mice	*	
<i>Mus triton</i>	Gray-bellied pygmy mouse	*	
<i>Neotragus moschatus</i>	Suni	*	*
<i>Oreotragus oreotragus</i>	Klipspringer	*	*
<i>Orycteropus afer</i>	Aardvark		*
<i>Oryx beisa (gazella)</i>	Beisa oryx		*
<i>Otocyon megalotis</i>	Bat-eared fox		*
<i>Otolemur crassicaudatus</i>	Large-eared greater galago	*	
<i>Otomys sp</i>	Groove-toothed rat	*	
<i>Panthera leo</i>	Lion	*	*
<i>Panthera pardus</i>	Leopard	*	*
<i>Papio anubis</i>	Olive baboon	*	*
<i>Pedetes capensis</i>	Springhare	*	*
<i>Pelomys fallax</i>	Creek groove-toothed swamp rat	*	
<i>Phacochoerus africanus</i>	Warthog	*	*
<i>Potamochoerus larvatus</i>	Bushpig	*	



<i>Praomys delectorum</i>	East african praomys	*	
<i>Praomys jacksoni</i>	Jackson's soft-furred mouse	*	
<i>Praomys delectorum</i>	Delectable soft-furred mouse	*	
<i>Raphicerus campestris</i>	Steinbuck	*	*
<i>Rattus rattus</i>	Black rat	*	
<i>Redunca fulvorufula</i>	Mountain reedbuck	*	*
<i>Redunca redunca</i>	Bohor reedbuck	*	*
<i>Rhabdomys pumilio</i>	Four-striped grass mouse	*	
<i>Sylvicapra grimmia</i>	Bush duiker	*	*
<i>Sylvisorex spp. (3 species)</i>	Climbing shrew	*	
<i>Syncerus caffer</i>	African buffalo	*	*
<i>Tachyoryctes daemon</i>	Root rat (Mole rat)	*	
<i>Tragelaphus oryx (Taurotragus oryx)</i>	Eland	*	*
<i>Thryonomys gregorianus</i>	Marsh cane-rat	*	
<i>Tragelaphus imberbis</i>	Lesser kudu		*
<i>Tragelaphus scriptus</i>	Bushbuck	*	*
<i>Tragelaphus strepsiceros</i>	Greater kudu		*

## Birds

Scientific name	Common name	Arusha National Park	Mount Meru Natural System
<i>Accipiter melanoleucus</i>	Great sparrowhawk	*	
<i>Accipiter minullus</i>	Little sparrowhawk	*	
<i>Accipiter rufiventris</i>	Rufous sparrowhawk	*	
<i>Accipiter tachiro</i>	African goshawk	*	
<i>Acrocephalus baeticatus</i>	African reed warbler	*	
<i>Acrocephalus rufescens</i>	Greater swamp warbler	*	
<i>Acrocephalus schoenobaenus</i>	Sedge warbler	*	
<i>Actitis hypoleucos</i>	Common sandpiper	*	
<i>Actophilornis africanus</i>	Jacana	*	
<i>Agapornis fischeri</i>	Fischer's lovebird	*	*
<i>Agapornis fischeri</i>	Fischer's-lovebird		*
<i>Agapornis personatus</i>	Yellow-collared lovebird	*	
<i>Alcippe (Pseudoalcippe) abyssinica</i>	African hill babbler	*	
<i>Alopochen aegyptiacus</i>	Egyptian goose	*	*
<i>Alopochen aegyptiacus</i>	Egyptian-goose		*
<i>Amadina fasciata alexanderi</i>	Cut-throat	*	

<i>Amandava subflava</i>	Zebra waxbill	*	
<i>Amaurornis flavirostris (ex Limnocorax flavirostra)</i>	Black crane	*	
<i>Amblyospiza albifrons melanota</i>	Grosbeak weaver	*	
<i>Anaplectes rubriceps</i>	Red-headed weaver	*	
<i>Anas acuta</i>	Pintail	*	
<i>Anas capensis</i>	Cape wigeon (cape teal)	*	*
<i>Anas capensis</i>	Cape teal		*
<i>Anas clypeata</i>	Shoveler	*	
<i>Anas erythrorhyncha</i>	Red-billed teal	*	
<i>Anas hottentota</i>	Hottentot teal	*	
<i>Anas penelope</i>	Eurasian wigeon	*	
<i>Anas querquedula</i>	Garganey	*	
<i>Anas sparsa leucostigma</i>	African black duck	*	
<i>Anas undulata</i>	Yellow-billed duck	*	
<i>Anastomus l. lamelligerus</i>	Open-billed stork	*	
<i>Andropadus importunus</i>	Zanzibar sombre greenbul	*	
<i>Andropadus milanjensis</i>	Stripe-cheeked greenbul	*	
<i>Andropadus nigriceps</i>	Mountain greenbul	*	
<i>Phyllastrephus placidus</i>	Olive mountain greenbul	*	
<i>Andropadus virens</i>	Little greenbul	*	
<i>Anhinga rufa</i>	African darter	*	
<i>Anthoscopus caroli</i>	African penduline tit	*	
<i>Anthreptes collaris garguensis</i>	Collared sunbird	*	
<i>Anthreptes orientalis</i>	Eastern violet-backed sunbird	*	
<i>Anthus caffer</i>	Bush pipit (little tawny pipit)	*	
<i>Anthus cervinus</i>	Red-throated pipit	*	
<i>Anthus cinnamomeus (ex A. novaeseelandiae)</i>	African pipit (Grassland or Richard's pipit)	*	
<i>Anthus similis</i>	Long-billed pipit	*	
<i>Anthus trivialis</i>	Tree pipit	*	
<i>Apalis flavida</i>	Yellow-breasted apalis	*	
<i>Apalis melanocephala</i>	Black-headed apalis	*	
<i>Apalis thoracica</i>	Bar-throated apalis	*	
<i>Apaloderma narina</i>	Narina trogon	*	
<i>Apaloderma vittatum</i>	Bar-tailed trogon	*	
<i>Aplopelia larvata</i>	Lemon dove	*	
<i>Apus aequatorialis</i>	Mottled swift	*	
<i>Apus affinis</i>	Little swift	*	
<i>Apus apus</i>	Eurasian swift	*	



<i>Apus barbatus roehli</i>	Black swift	*	
<i>Apus caffer</i>	White-rumped swift	*	
<i>Apus horus</i>	Horus swift	*	
<i>Apus melba</i>	Alpine swift	*	
<i>Apus niansae</i>	Nyanza swift	*	
<i>Aquila nipalensis orientalis</i>	Steppe eagle	*	
<i>Aquila pomarina</i>	Lesser-spotted eagle		*
<i>Aquila rapax</i>	Tawny eagle	*	
<i>Aquila verreauxi</i>	Verreaux's eagle	*	
<i>Aquila wahlbergi</i>	Wahlberg's eagle	*	
<i>Ardea cinerea</i>	Grey heron	*	
<i>Ardea melanocephala</i>	Black-headed heron	*	
<i>Ardea purpurea</i>	Purple heron	*	
<i>Ardea rufiventris</i>	Rufous-bellied heron	*	
<i>Ardeola idea</i>	Madagascar squacco heron	*	
<i>Ardeola rallide</i>	Squacco heron	*	
<i>Asio capensis</i>	African marsh owl	*	
<i>Aviceda cuculoides verreauxii</i>	Cuckoo hawk	*	
<i>Aythya ferina</i>	Common pochard	*	
<i>Aythya fuligula</i>	Tufted duck	*	
<i>Balearica regulorum</i>	Grey crowned-crane	*	
<i>Batis mixta</i>	Forest batis	*	
<i>Batis molitor</i>	Chinspot batis	*	*
<i>Bostrychia hagedash brevirostris</i>	Hadada ibis	*	*
<i>Bradypterus baboecala</i>	Little rush warbler	*	
<i>Bradypterus cinnamomemus</i>	Cinnamon bracken warbler	*	
<i>Bradypterus mariae</i>	Evergreen forest warbler	*	
<i>Bubo africanus</i>	Spotted eagle owl	*	
<i>Bradornis microhynchus</i>	Grey flycatcher	*	
<i>Bubo lacteus</i>	Verreaux's eagle owl	*	
<i>Bubulcus ibis</i>	Cattle egret	*	
<i>Buphagus africanus</i>	Yellow-billed oxpecker	*	
<i>Buphagus erythrorhynchus</i>	Red-billed oxpecker	*	
<i>Burhinus capensis</i>	Spotted thicknee	*	
<i>Butastur rufipennis</i>	Grasshopper buzzard	*	
<i>Buteo augur</i>	Augur buzzard		*
<i>Buteo oreophilus</i>	Mountain buzzard	*	
<i>Buteo vulpinus</i>	Steppe (common) buzzard	*	
<i>Butorides striatus</i>	Green-backed heron	*	
<i>Bycanistes brevis</i>	Silvery-cheeked hornbill	*	

<i>Bycanistes bucinator</i>	Trumpeter hornbill	*	
<i>Calandrella athensis (ex C. rufescens)</i>	Athi short-toed lark	*	
<i>Calandrella cinerea</i>	Red-capped lark	*	
<i>Calidris ferruginea</i>	Curlew sandpiper	*	
<i>Calidris minuta</i>	Little stint	*	
<i>Camaroptera brachyura</i>	Grey-backed camaroptera	*	
<i>Campephaga flava</i>	Black cuckoo shrike	*	
<i>Campephaga quiscalina</i>	Purple-throated cuckoo-shrike	*	
<i>Campethera abingoni</i>	Golden-tailed woodpecker	*	
<i>Campethera cailliautii</i>	Little spotted woodpecker	*	
<i>Campethera nubica</i>	Nubian woodpecker	*	*
<i>Caprimulgus clarus apatelius</i>	Slender-tailed nightjar	*	
<i>Caprimulgus fraenatus</i>	Dusky nightjar	*	
<i>Caprimulgus inornatus</i>	Plain nightjar	*	
<i>Caprimulgus p. poliocephalus</i>	Montane nightjar	*	
<i>Caprimulgus poliocephalus</i>	Montane nightjar	*	
<i>Casmerodius albus melanorhyncos</i>	Great white egret	*	
<i>Centropus superciliosus</i>	White-browed coucal	*	
<i>Cercomela sordida ernesti</i>	Alpine chat	*	
<i>Cercotrachus hartlaubi</i>	Brown-backed scrub-robin	*	
<i>Cercotrachus leucophrys</i>	White-browed scrub robin	*	*
<i>Cercotrachus q. quadrivirgata</i>	Easter bearded scrub robin	*	
<i>Ceryle rudis</i>	Pied kingfisher	*	
<i>Ceuthmochares aereus</i>	Yellowbill	*	
<i>Ceyx (Ispidina) picta</i>	Pigmy kingfisher	*	
<i>Charadrius dubius curonicus</i>	Little ringed plover	*	
<i>Charadrius hiaticula</i>	Ringed plover	*	
<i>Charadrius mongolus</i>	Lesser (mongolian) sandplover	*	
<i>Charadrius pallidus venustus</i>	Chestnut-banded sandplover	*	
<i>Charadrius pecuarius</i>	Kittlit's plover (sandplover)	*	
<i>Charadrius tricollaris</i>	Three-banded plover (sandplover)	*	
<i>Chlidonias hybridus delalandii</i>	Whiskered tern	*	
<i>Chlidonias leucopterus</i>	White-winged (black) tern	*	
<i>Chlorocicla flaviventris centralis</i>	Yellow-bellied greenbul	*	



<i>Chloropeta natalensis</i>	Yellow warbler	*	
<i>Chloropeta similis</i>	Mountain yellow warbler	*	
<i>Chrysococcyx caprius</i>	Didric cuckoo	*	
<i>Chrysococcyx cupreus</i>	Emerald cuckoo	*	
<i>Chrysococcyx klaas</i>	Klaas's cuckoo	*	
<i>Cichladusa guttata</i>	Spotted-morning thrush		*
<i>Ciconia abdimii</i>	Abdim's stork	*	
<i>Ciconia ciconia</i>	White stork	*	
<i>Ciconia episcopus</i>	Woolly-necked stork	*	
<i>Ciconia nigra</i>	Black stork	*	
<i>Cinnyricinclus femoralis</i>	Abbott's starling	*	
<i>Cinnyricinclus leucogaster verreauxi</i>	Violet-backed starling	*	
<i>Cinnyricinclus sharpii</i>	Sharpe's starling	*	
<i>Circaetus cinereus</i>	Brown snake eagle	*	
<i>Circaetus pectoralis</i>	Black-chested snake eagle	*	
<i>Circus aeruginosus</i>	Eurasian marsh harrier	*	
<i>Circus macrourus</i>	Pallid harrier	*	
<i>Circus pygargus</i>	Montagu's harrier	*	
<i>Circus ranivorus</i>	African marsh harrier	*	
<i>Cisticola aridula</i>	Desert cisticola	*	
<i>Cisticola brachypterus</i>	Siffling cisticola	*	
<i>Cisticola cantans</i>	Singing cisticola	*	
<i>Cisticola chiniana</i>	Rattling cisticola	*	
<i>Cisticola cinereolus</i>	Ashy flycatcher	*	
<i>Cisticola erythrops</i>	Red-faced cisticola	*	
<i>Cisticola galactotes</i>	Winding cisticola	*	
<i>Cisticola hunteri</i>	Hunter's cisticola	*	
<i>Cisticola juncidis</i>	Zitting cisticola	*	
<i>Cisticola nanus</i>	Tiny cisticola	*	*
<i>Cisticola natalensis</i>	Croaking cisticola	*	
<i>Cisticola robustus</i>	Stout cisticola	*	
<i>Cisticola woosnami</i>	Trilling cisticola	*	
<i>Colius kikuyuensis</i>	Speckled-mousebird		*
<i>Colius striatus</i>	Speckled mousebird	*	
<i>Columba (Turturoena) delegorguei</i>	Eastern bronze-naped pigeon	*	
<i>Columba arquatrix</i>	Olive pigeon	*	
<i>Columba guinea</i>	Speckled pigeon	*	
<i>Coracia n. naevia</i>	Rufous-crowned roller	*	
<i>Coracias caudata</i>	Lilac-breasted roller	*	
<i>Coracias garrulus</i>	Eurasian roller	*	

<i>Coracina pectoralis</i>	White-breasted cuckoo-shrike	*	
<i>Corvus albicollis</i>	White-necked raven	*	*
<i>Corvus albus</i>	Pied crow	*	
<i>Corythaixoides (Criniferoides) leucogaster</i>	White-bellied go away bird	*	*
<i>Corythornis (Alcedo) christata</i>	Malachite kingfisher	*	
<i>Cossypha caffra</i>	Robin chat	*	
<i>Cossypha h. heuglini</i>	White-browed robin chat	*	
<i>Cossypha semirufa</i>	Rueppell's robin chat	*	
<i>Coturnix delegorguei</i>	Harlequin quail	*	
<i>Creatophora cinerea</i>	Wattled starling	*	
<i>Crex egregia</i>	African crane	*	
<i>Cryptospiza salvadorii kilimensis</i>	Abyssinian crimsonwing	*	
<i>Cuculus canorus</i>	Eurasian cuckoo	*	
<i>Cuculus clamosus</i>	Black cuckoo	*	
<i>Cuculus gularis</i>	African cuckoo	*	
<i>Cuculus poliocephalus</i>	Asian lesser cuckoo	*	
<i>Cuculus solitarius</i>	Red-chested cuckoo	*	
<i>Cuncuma vocifer</i>	Fish eagle	*	
<i>Cypsiurus parvus</i>	Palm swift	*	
<i>Delichon urba</i>	House martin	*	
<i>Dendrocygna bicolor</i>	Fulvous whistling duck	*	
<i>Dendrocygna viduata</i>	White-faced whistling duck	*	
<i>Dendropicos fuscescens</i>	Cardinal woodpecker	*	*
<i>Dendropicos goertae</i>	Grey woodpecker	*	
<i>Dendropicos griseocephalus</i>	Olive woodpecker	*	
<i>Dicrurus adsimilis</i>	Drongo	*	*
<i>Dinemellia dinemelli boehmi</i>	White-headed buffalo weaver	*	
<i>Dryoscopus cubla</i>	Black-backed puffback	*	
<i>Egretta garzetta</i>	Little egret	*	
<i>Elanus caeruleus</i>	Black-shouldered kite	*	
<i>Emberiza flaviventris kalaharica</i>	Golden-breasted bunting	*	
<i>Emberiza t. tahapisi</i>	Cinnamon-breasted rock bunting	*	
<i>Ephippiorhynchus senegalensis</i>	Saddle billed stork	*	
<i>Eremopterix leucopareia</i>	Fischer's sparrow lark	*	
<i>Eremopterix leucotis</i>	Chestnut-backed sparrow lark	*	
<i>Erenomela icteropygialis abdominalis</i>	Yellow-bellied erenomela	*	*



<i>Estrilda astrild</i>	Common waxbill	*	
<i>Estrilda quartinia kilimensis</i>	Yellow-bellied waxbill	*	
<i>Estrilda rhodopyga</i>	Crimson-rumped Waxbill	*	
<i>Euplectes albonotatus eques</i>	White-winged widowbird	*	
<i>Euplectes ardens</i>	Red collared widowbird	*	
<i>Euplectes axillaris phoeniceus</i>	Fan-tailed widowbird	*	
<i>Euplectes capensis crassirostris</i>	Yellow bishop	*	
<i>Eupodotis (Lissotis) melanogaster</i>	Black-bellied bustard	*	
<i>Eupodotis senegalensis</i>	White-bellied Bustard	*	
<i>Eurystomus glaucurus</i>	Broad-billed roller	*	
<i>Falco amurensis</i>	Amur falcon	*	
<i>Falco biarmicus</i>	Lanner falcon	*	
<i>Falco cuvierii</i>	African hobby	*	
<i>Falco eleonora</i>	Eleonora's falcon	*	
<i>Falco naumanni</i>	Lesser kestrel	*	
<i>Falco peregrinus</i>	Peregrine falcon	*	
<i>Falco subbuteo</i>	Eurasian hobby	*	
<i>Falco tinnunculus</i>	Common kestrel	*	
<i>Francolinus afer</i>	Red-necked spurfowl	*	
<i>Francolinus hildebrandti</i>	Hildebrandt's francolin	*	
<i>Francolinus leucoscepus</i>	Yellow-necked spurflowl		*
<i>Francolinus sephaena</i>	Crested francolin	*	
<i>Francolinus shelleyi</i>	Shelley's francolin	*	
<i>Francolinus squamatus</i>	Scaly francolin	*	
<i>Fulica cristata</i>	Red-knobbed coot	*	
<i>Gallinago gallinago</i>	Common snipe	*	
<i>Gallinago nigripennis aequatorialis</i>	African snipe	*	
<i>Gallinula angulata</i>	Lesser moorhen	*	
<i>Gallinula chloropus</i>	Common moorhen	*	
<i>Glareola pratincola</i>	Common pratincole	*	
<i>Glaucidium perlatum licua</i>	Pearl-spotted owlet	*	
<i>Gypaetus barbatus</i>	Lammergeier (or Bearded vulture)	*	
<i>Gypohierax angolensis</i>	Palm-nut vulture	*	
<i>Gyps africanus</i>	White-backed vulture	*	
<i>Gyps rueppellii</i>	Ruppell's griffon vulture	*	
<i>Halcyon albiventris</i>	Brown-hooded kingfisher	*	
<i>Halcyon chelicuti</i>	Striped kingfisher	*	*

<i>Halcyon leucocephala</i>	Chestnut-bellied kingfisher (or Grey-headed kingfisher)	*	
<i>Hieraaetus ayresii</i>	Ayres hawk eagle	*	
<i>Hieraaetus pennatus</i>	Booted eagle	*	
<i>Hieraaetus spilogaster</i>	African hawk eagle	*	
<i>Himantopus himantopus</i>	Black-winged stilt	*	
<i>Hippolais olivetorum</i>	Olive-tree warbler	*	
<i>Hippolais pallida</i>	Olivaceous warbler	*	
<i>Hirundo (Pseudhirundo) griseopyga</i>	Grey-rumped swallow	*	
<i>Hirundo abyssinica</i>	Lesser striped swallow	*	
<i>Hirundo daurica</i>	Red-rumped swallow	*	
<i>Hirundo fuligula</i>	African rock martin	*	
<i>Hirundo fusciventris</i>	Rock-martin		*
<i>Hirundo rustica</i>	European swallow (or Barn swallow)	*	
<i>Hirundo senegalensis</i>	Mosque swallow	*	
<i>Hirundo smithii</i>	Wire-tailed swallow	*	
<i>Indicator indicator</i>	Greater honeyguide	*	
<i>Indicator meliphilus</i>	Pallid honeyguide	*	
<i>Indicator minor</i>	Lesser honeyguide	*	
<i>Indicator variegatus</i>	Scaly-throated honeyguide	*	
<i>Irania gutturalis</i>	Irania (or White-throated robin)	*	
<i>Ixobrychus minutus</i>	Little bittern	*	
<i>Ixobrychus sturmii</i>	Dwarf bittern	*	
<i>Lagonosticta rhodopareia taruensis</i>	Jameson's firefinch	*	
<i>Lagonosticta rubricata hildebrandti</i>	African firefinch	*	
<i>Lagonosticta senegala ruberrima</i>	Red-billed firefinch	*	
<i>Lamprotornis hildebrandti</i>	Hildebrandt's starling	*	
<i>Lamprotornis superbus</i>	Superb starling	*	*
<i>Laniarius aethiopicus</i>	Tropical boubou	*	
<i>Laniarius funebris</i>	Slate-coloured boubou	*	*
<i>Lanius cabanisi</i>	Long-tailed fiscal	*	*
<i>Lanius collaris</i>	Common fiscal	*	
<i>Lanius collurio</i>	Red-backed shrike	*	
<i>Lanius dorsalis</i>	Taita fiscal	*	
<i>Lanius isabellinus</i>	Red-tailed shrike	*	
<i>Lanius minor</i>	Lesser grey shrike	*	
<i>Larus cirrocephalus</i>	Grey-headed gull	*	



<i>Leptoptilus crumeniferus</i>	Marabou stork	*	
<i>Limosa limosa</i>	Black-tailed godwit	*	
<i>Linurgus olivaceus elgonensis</i>	Oriole finch	*	
<i>Locustella fluviatilis</i>	River warbler	*	
<i>Lonchura cantans</i>	African silverbill	*	
<i>Lonchura cucullata</i>	Bronze mannikin	*	
<i>Lonchura griseicapilla</i>	Grey-headed silverbill	*	
<i>Lonchura nigriceps</i>	Rufous-backed mannikin	*	
<i>Lophoetus occipitalis</i>	Long-crested eagle	*	
<i>Luscinia luscinia</i>	Sprosser	*	
<i>Lybius leucocephalus</i>	White-headed barbet	*	
<i>Lybius melanopterus</i>	Brown-breasted barbet	*	
<i>Macronyx aurantiigula</i>	Pangani longclaw	*	
<i>Malaconotus blanchoti</i>	Grey-headed bush-shrike	*	
<i>Telophorus multicolor</i>	Many coloured bush-shrike	*	
<i>Malaconotus nigrifrons</i>	Black-fronted bush-shrike	*	
<i>Malaconotus sulfureopectus</i>	Sulphur-breasted bush-shrike	*	
<i>Mandingoa nitidula</i>	Green-backed twinspot	*	
<i>Martial eagle</i>	Martial eagle	*	
<i>Megaceryle maxima</i>	Giant kingfisher	*	
<i>Melaenornis fischeri</i>	White-eyed slaty flycatcher	*	
<i>Melaenornis pammelaina</i>	Southern black flycatcher	*	
<i>Melierax poliopterus</i>	Eastern pale chanting goshawk	*	*
<i>Melocichla mentalis</i>	Moustached warbler	*	
<i>Merops albicollis</i>	White-throated bee-eater	*	
<i>Merops apiaster</i>	Eurasian bee-eater	*	
<i>Merops bullockoides</i>	White-fronted bee-eater	*	*
<i>Merops nubicus</i>	Carmine bee-eater	*	
<i>Merops oreobates</i>	Cinnamon-chested bee-eater	*	
<i>Merops persicus</i>	Blue-cheeked bee-eater	*	
<i>Merops pusillus</i>	Little bee-eater	*	
<i>Merops superciliosus</i>	Madagascar bee-eater	*	
<i>Mesophoyx intermedia</i>	Yellow-billed egret	*	
<i>Melierax gabar</i>	Gabar goshawk	*	
<i>Microparra capensis</i>	Lesser jacana	*	
<i>Milvus migrans</i>	Black kite OR Black-billed kite	*	
<i>Mirafra africana</i>	Rufous-naped lark	*	
<i>Mirafra africanoides intercedens</i>	Fawn-coloured lark	*	
<i>Mirafra albicauda</i>	White-tailed lark	*	
<i>Mirafra cantillans</i>	Singing bush lark	*	

<i>Mirafra hypermetra</i>	Red-winged bush lark	*	
<i>Mirafra rufocinnamonea</i>	Flappet lark	*	
<i>Monticola saxatilis</i>	Rock thrush	*	*
<i>Motacilla aguimp</i>	African pied wagtail	*	
<i>Motacilla cinerea</i>	Grey wagtail	*	
<i>Motacilla clara</i>	Mountain wagtail	*	
<i>Motacilla flava</i>	Yellow wagtail	*	
<i>Motacilla flava lutea</i>	Yellow (blue-headed) wagtail	*	
<i>Muscicapa adusta</i>	Dusky flycatcher	*	
<i>Muscicapa striata</i>	Spotted flycatcher	*	
<i>Mycteria ibis</i>	Yellow-billed stork	*	
<i>Necrosyrtes monachus pileatus</i>	Hooded vulture	*	
<i>Nectarinia amethystina kalckreuthi</i>	Amethyst sunbird	*	
<i>Nectarinia famosa cupreonitens</i>	Malachite sunbird	*	
<i>Nectarinia k. kilimensis</i>	Bronze sunbird	*	
<i>Nectarinia mediocris</i>	Eastern double-collared sunbird	*	
<i>Nectarinia olivacea changamwensis</i>	Olive sunbird	*	
<i>Nectarinia r. reichenowi</i>	Golden-winged sunbird	*	
<i>Nectarinia senegalensis lamperti</i>	Scarlet-chested sunbird	*	
<i>Nectarinia tacazze jacksoni</i>	Tacazze sunbird	*	
<i>Nectarinia venusta</i>	Variable sunbird	*	*
<i>Neophron percnopterus</i>	Egyptian vulture	*	
<i>Netta erythrophthalma brunnea</i>	Southern pochard	*	
<i>Nigrita canicapilla schistacea</i>	Grey-headed negrofinch	*	
<i>Nilaus afer</i>	Brubru	*	
<i>Numida meleagris</i>	Helmeted-guinea fowl		*
<i>Nycticorax nycticorax</i>	Night heron	*	
<i>Oena capensis</i>	Namaqua dove	*	*
<i>Oenanthe isabellina</i>	Isabelline wheatear	*	
<i>Oenanthe schalowi</i>	Schalow's wheatear	*	*
<i>Oenanthe oenanthe</i>	Northern wheatear	*	
<i>Oenanthe pileata</i>	Capped wheatear	*	
<i>Oenanthe pleschanka</i>	Pied wheatear	*	
<i>Onychognathus morio</i>	Red-winged starling	*	*
<i>Onychognathus walleri</i>	Waller's starling	*	
<i>Oriolus auratus</i>	African golden oriole	*	



<i>Oriolus larvatus rolleti</i>	Black-headed oriole	*	
<i>Oriolus oriolus</i>	Golden oriole	*	
<i>Oxylophus jacobinus</i>	Black and white cuckoo	*	
<i>Oxylophus levaillantii</i>	Levaillant's cuckoo	*	
<i>Oxyura maccoa</i>	Maccoa duck	*	
<i>Pandion haliaetus</i>	Osprey	*	
<i>Parus fringillinus</i>	Red-throated tit	*	
<i>Passer domesticus indicus</i>	House sparrow	*	
<i>Passer eminibey</i>	Chestnut sparrow	*	
<i>Passer griseus</i>	Grey-headed sparrow	*	
<i>Passer rufocinctus</i>	Rufous sparrow	*	
<i>Passer suahelicus</i>	Swahili sparrow		*
<i>Pelecanus onocrotolatus</i>	White pelican	*	
<i>Pelecanus rufescens</i>	Pink-backed pelican	*	
<i>Pernis apivorus</i>	Honey buzzard	*	
<i>Petronia pyrgita</i>	Yellow-spotted petronia	*	*
<i>Phalacrocorax africanus</i>	Long-tailed cormorant	*	
<i>Phalacrocorax carbo</i>	White-breasted (greater) cormorant	*	
<i>Philomachus pugnax</i>	Ruff	*	
<i>Phoeniconaia minor</i>	Lesser flamingo	*	*
<i>Phoenicopterus roseus</i>	Greater flamingo	*	*
<i>Phoeniculus purpureus</i>	Green wood hoopoe	*	
<i>Phyllastrephus cabanisi</i>	Cabanis' greenbul	*	
<i>Phyllastrephus cerviniventris</i>	Grey olive greenbul	*	
<i>Phyllastrephus fischeri</i>	Fisher's greenbul	*	
<i>Phyllolais pulchella</i>	Buff-bellied warbler	*	
<i>Phylloscopus trochilus</i>	Willow warbler	*	
<i>Phylloscopus umbrovirens</i>	Brown woodland warbler	*	
<i>Pinarocorys nigricans</i>	Dusky lark	*	
<i>Platalea alba</i>	African spoonbill	*	
<i>Platysteira p. peltata</i>	Black throated wattle eye	*	
<i>Plectropterus gambensis</i>	Spur winged goose	*	
<i>Plegadis falcinellus</i>	Glossy ibis	*	
<i>Ploceus baglafecht</i>	Baglafecht weaver	*	*
<i>Ploceus castaneiceps</i>	Taveta golden weaver	*	
<i>Ploceus cucullatus</i>	Village weaver	*	
<i>Ploceus intermedius</i>	Masked weaver	*	
<i>Ploceus jacksoni</i>	Golden-backed weaver	*	
<i>Ploceus ocularis suahelicus</i>	Spectacled weaver	*	
<i>Ploceus spekei</i>	Speke's weaver	*	

<i>Ploceus subaureus</i>	Golden weaver	*	
<i>Ploceus vitellinus</i>	Vitelline masked weaver	*	
<i>Podiceps cristatus</i>	Great crested grebe	*	
<i>Poeoptera kenricki bensoni</i>	Kenrick's starling	*	
<i>Pogoniulus chrysoconus</i>	Yellow-fronted tinkerbird		*
<i>Pogoniulus leucomystax</i>	Moustached green tinkebird	*	
<i>Pogoniulus pusillus</i>	Red-fronted tinkebird	*	
<i>Pogonocichla stellata</i>	White-starred robin	*	
<i>Poicephalus gulielmi</i>	Red-fronted parrot	*	
<i>Polyboroides typus</i>	Harrier hawk or Gymnogone	*	
<i>Porphyrio (alba) porphyrio</i>	Purple swamphen (gallinule)	*	
<i>Prionops plumatus</i>	White helmet-shrike	*	
<i>Prinia melanorhyncha</i>	Towny-flanked prinia		*
<i>Prinia subflava</i>	Tawny-flanked prinia	*	
<i>Prionops retzii</i>	Retz's helmet shrike	*	
<i>Prodotiscus insignis</i>	Cassin's honey-bird	*	
<i>Prodotiscus regulus</i>	Wahlberg's honeybird	*	
<i>Psaldiprocne albiceps</i>	White-headed roughwing	*	
<i>Psaldiprocne holomelas</i>	Black roughwing	*	
<i>Pterocles decoratus</i>	Black-faced sandgrouse	*	
<i>Pycnonotus barbatus</i>	Yellow-vented bulbul	*	*
<i>Quelea cardinalis</i>	Cardinal quelea	*	
<i>Quelea quelea</i>	Red-billed quelea	*	
<i>Rallus caerulescens</i>	African water rail	*	
<i>Recurvirostra avocetta</i>	Avocet	*	
<i>Rhinopomastus cabanisi</i>	Abissinian scimitarbill		*
<i>Rhinopomastus cyanomelas</i>	Common scimitarbill	*	
<i>Rhinoptilus chalcopterus</i>	Violet-tipped courser	*	
<i>Riparia cincta</i>	Banded martin	*	
<i>Riparia paludicola</i>	African sand martin	*	
<i>Riparia riparia</i>	Sand martin	*	
<i>Rostratula benghalensis</i>	Painted snipe	*	
<i>Rynchops flavirostris</i>	Skimmer	*	
<i>Sagittarius serpentarius</i>	Secretary bird	*	
<i>Sarkidiornis melanotos</i>	Knob-billed duck	*	
<i>Saxicola rubetra</i>	Whinchat	*	
<i>Saxicola torquata</i>	Stonechat	*	
<i>Schoenicola brevirostris</i>	Broad-tailed warbler (or Fan-tailed grassbird)	*	
<i>Schoutedenapus myoptilus</i>	Scarce swift	*	
<i>Scopus umbretta</i>	Hamerkop	*	*



<i>Serinus burtoni</i>	Thick-billed seed-eater	*	
<i>Serinus hypostictus</i>	East African citril	*	
<i>Serinus canicollis</i>	Yellow crowned canary	*	
<i>Serinus donaldson</i>	Northern-grosbeak canary		*
<i>Serinus mozambicus</i>	Yellow-fronted canary	*	
<i>Serinus reichenowi</i>	Yellow rumped seed-eater	*	*
<i>Serinus striolatus</i>	Streaky seed-eater	*	
<i>Serinus sulphuratus sharpii</i>	Brimstone canary	*	
<i>Smithornis capensis</i>	African broadbill	*	
<i>Sporopipes emini</i>	Speckle-fronted weaver		*
<i>Stactolaema leucotis kilimensis</i>	White-eared barbet	*	
<i>Stephanoaetus coronatus</i>	Crowned eagle	*	
<i>Sterna nilotica</i>	Gull-billed tern	*	
<i>Streptopelia capicola</i>	Ring necked dove	*	
<i>Streptopelia decipiens</i>	Mourning dove	*	
<i>Streptopelia lugens</i>	Dusky turtle dove	*	
<i>Streptopelia semitorquata</i>	Red-eyed dove	*	*
<i>Streptopelia senegalensis</i>	Laughing dove	*	*
<i>Streptopelia somalica</i>	Ring-nacked dove		*
<i>Strix woodfordii</i>	African wood owl	*	
<i>Sylvia atricapilla</i>	Blackcap	*	
<i>Sylvia borin</i>	Garden warbler	*	
<i>Sylvia communis</i>	Common whitethroat	*	
<i>Sylvietta whytii</i>	Red-faced crombec	*	*
<i>Tachybaptus ruficollis</i>	Little grebe	*	
<i>Tchagra australis</i>	Brown-headed tchagra	*	
<i>Tchagra emini</i>	Brown-crowned chagra		*
<i>Tchagra senegala</i>	Black-crowned tchagra	*	
<i>Terathopius ecaudatus</i>	Bateleur	*	
<i>Terpsiphone viridis</i>	Paradise flycatcher	*	
<i>Thalassornis leuconotus</i>	White-backed duck	*	
<i>Threskiornis aethiopicus</i>	Sacred ibis	*	
<i>Thripas namaquus</i>	Bearded woodpecker	*	
<i>Tmetothylacus tenellus</i>	Golden pipit	*	
<i>Tockus alboterminatus</i>	Crowned hornbill	*	
<i>Tockus erythrorhynchus</i>	Red-billed hornbill	*	
<i>Tockus nasutus</i>	Grey hornbill	*	
<i>Torgos tracheliotus</i>	Lappet-faced vulture	*	
<i>Trachyphonus erythrocephalus</i>	Red and yellow barbet	*	*
<i>Treron calvus</i>	Green pigeon	*	

<i>Tricholaema diademata</i>	Red-fronted barbet	*	
<i>Tricholaema lacrymosa</i>	Spotted-flanked barbet	*	
<i>Tricholaema melanocephala</i>	Black-throated barbet	*	
<i>Tricholaema stigmatothorax</i>	Black-throated barbet		*
<i>Trigonoceps occipitalis</i>	White-headed vulture	*	
<i>Tringa glareola</i>	Wood sandpiper	*	
<i>Tringa nebularia</i>	Greenshank	*	
<i>Tringa ochropus</i>	Green sandpiper	*	
<i>Tringa stagnatilis</i>	Marsh sandpiper	*	
<i>Trochocercus cyanomela</i>	Crested flycatcher	*	
<i>Turaco hartlaubi</i>	Hartlaub's turaco	*	
<i>Turdoides hypoleucus</i>	Northern pied-babbler	*	
<i>Turdoides jardineii emini</i>	Arrow-marked babbler	*	
<i>Turdoides rubiginosus</i>	Rufous chattering	*	
<i>Turdus olivaceus</i>	Northern olive thrush	*	
<i>Turnix sylvatica</i>	Common button-quaile	*	
<i>Turtur chalcospilos</i>	Emerald-spotted Wood-dove	*	*
<i>Turtur tympanistria</i>	Tambourine dove	*	
<i>Tyto alba</i>	Barn owl	*	
<i>Tyto capensis</i>	Grass owl	*	
<i>Upupa epops</i>	Hoopoe	*	
<i>Uraeginthus. bengalus</i>	Red-cheeked cordonbleau	*	
<i>Uraeginthus ianthinogaster</i>	Purple grenadier	*	
<i>Urocolius macrourus</i>	Blue-naped mousebird	*	
<i>Vanellus armatus</i>	Blacksmith plover	*	*
<i>Vanellus coronatus</i>	Crowned lapwing (plover)	*	
<i>Vanellus lugubris</i>	Senegal plover	*	
<i>Vanellus melanopterus minor</i>	Black-winged plover	*	
<i>Vanellus spinosus</i>	Spur-winged plover	*	
<i>Vidua macroura</i>	Pin-tailed whydah	*	
<i>Vidua paradisaea</i>	Paradise whydah	*	
<i>Xenus cinereus</i>	Terek sandpiper	*	
<i>Zoothera gurneyi</i>	Orange ground thrush	*	
<i>Zosterops abyssinicus</i>	Abyssinian white-eye	*	
<i>Zosterops poliogaster</i>	Montane white-eye	*	



Amphibians			
Scientific name	Common name	Arusha National Park	Mount Meru Natural System
<i>Bufo gutturalis</i>	Guttural toed, Greater cross-marked toed	*	
<i>Hemisis marmoratus</i>	Mottled shovel-nosed frog	*	
<i>Hyperolius nasutus</i>	Long reed frog	*	
<i>Hyperolius viridiflavus ommatostictus</i>	Painted reed frog	*	
<i>Kassina senegalensis</i>	Bubbling kassina senegal running frog	*	
<i>Phrynobatrachus keniensis</i>	Puddle frog,	*	
<i>Ptychadena mascareniensis</i>	Mascarene grass frog	*	
<i>Rana angolensis</i>	Common river frog, angola river frog	*	
<i>Xenopus muelleri</i>	Northern platanna	*	

Reptiles			
Scientific name	Common name	Arusha National Park	Mount Meru Natural System
<i>Adolfus jacksoni</i>	Jackson's forest lizard	*	
<i>Agama agama</i>	Rock agama	*	
<i>Aparallactus capensis</i>		*	
<i>Atractaspis bibronii</i>		*	
<i>Bitis arietans arietans</i>	Puff adder	*	
<i>Bradypodion tavetanum</i>	Kilimanjaro two-horned chameleon	*	
<i>Causus rhombeatus</i>		*	
<i>Chamaeleo dilepis</i>	Common flap-necked chameleon	*	
<i>Chamaeleo gracilis</i>	Gracile chameleon	*	
<i>Chamaeleo jacksoni merumontanus</i>	Meru three-horned chameleon	*	
<i>Chamaeleo rudi</i>	Ruwenzori side-striped chameleon	*	
<i>Crotaphopeltis hotamboeia</i>	Herald snake, white-lipped snake	*	
<i>Dasypeltis scabra</i>	Common egg-eater	*	
<i>Dendroaspis angusticeps</i>	Green mamba	*	
<i>Duberria lutrix</i>		*	

<i>Elapsoidea loveridgei loveridgei</i>	Loveridge's garter snake	*	
<i>Geochelone pardalis</i>	Tropical leopard tortoise	*	
<i>Hemidactylus mabouia</i>	Tropical house gecko	*	
<i>Hemirhagerrhis hildebrandtii</i>		*	
<i>Lamprophis fuliginosus</i>	Brown house-snake	*	
<i>Lycophidion capense jacksoni</i>	Jackson's wolf-snake, Jackson's tiger snake	*	
<i>Lygosoma afrum</i>	Peter's writhing-skink	*	
<i>Mabuya striata</i>	Common striped skink (Eastern striped skink)	*	
<i>Mabuya varia</i>	Variable skink	*	
<i>Naja haje haje</i>	Egyptian cobra	*	
<i>Natriciteres olivacea</i>	Olive marsh-snake	*	
<i>Nucras boulengeri</i>	Boulenger's scrub-lizard	*	
<i>Pachydactylus turneri</i>	Bibron's thick-toed gecko	*	
<i>Panaspis wahlbergii</i>	Wahlberg's snake-eyed skink	*	
<i>Philothamnus hoplogaster</i>		*	
<i>Prosymna stuhlmanni</i>		*	
<i>Psammophis phillipsii</i>	Olive grass snake	*	
<i>Python natalensis</i>	Southern african python	*	
<i>Thelotornis capensis mossambicus</i>	Mozambique twig snake	*	



# ANNEX B

## ASSESSMENT OF 18 PRIMARY SCHOOLS IN NGARENANYUKI AND OLDONYOSAMBU WARDS (ISTITUTO OIKOS, 2010)

SCHOOL NAME	Emanuel	Engutukoit	Ilkirumuni	Kimosomu	Kisimiri Chini	Kisimiri Juu	Leminyor	Lendoiya	Losinoni
Village name	Olkung'wado	Losinoni	Olkungwado	Uwiro	Kisimiri Chini	Kisimiri Juu	Lemongo	Olkung'wado	Losinoni
Number of students	304	248	173	305	590	599	662	227	815
Number of teachers	6	8	4	5	10	4	7	5	7
Drinking water system	Under construction	Tap water	Tap water	Tap water with filter	Tap water	Insufficient tap water	Unsuufficient tap water	Tap water	Insufficient tap water
Water source	Pipeline	Rain water harvesting system	Pipeline	Pipeline	Pipeline	Pipeline not always available.	Pipeline not always available.	Pipeline	Pipeline - not always available. Rain water harvesting system
Water fluoride value	5.4 mg/l	15.5 mg/l	3.6 gm/l	10mg/l	6 mg/l	0.8 mg/l	2.9 mg/l	3.6 mg/l	From 2.7 mg/l to 15.5 mg/l
Number of latrines	10	6	8	3	8	7	10	6	21
Facility to wash hands before meals	Yes	No	No	No	No	No	No	Yes	No
Facility to wash hands at toilets	Yes	No	No	No	Yes	No	No	Yes	No
Kitchen presence	Yes	Yes	No	Yes	Yes	No	Yes	Temporary	Yes
Kitchen status	Adequate	Poor	-	Poor	Poor	-	Poor	-	Poor
Meals produced	Lunch	Lunch	None	Lunch	None	None	None	Lunch	Lunch
Cooking fuel	Firewood provided by the students	Firewood provided by the students	-	Firewood provided by the students	Firewood provided by the students	-	Firewood provided by the students	Firewood provided by the students	Firewood provided by the students
Electricity	No	No	No	No	No	No	No	No	No

SCHOOL NAME	Mkurru	Mwakeni	Nasula	Ngabobo	Ngarenanyuki	Oldonyosambu	Oldonyowas	Olkung'wado	Sinai
Village name	Uwiro	Olkungwado	Olkung'wado	Ngabobo	Uwiro	Lemomo	Oldonyowas	Olkungwado	Olkung'wado
Number of students	214	365	242	325	466	1057	806	448	289
Number of teachers	4	7	8	7	7	10	10	12	4
Drinking water system	Tap water	Unsuufficient tap water	Tap water - illegal	Under construction	Tap water	Tap water	Tap water	Under construction	Tap water
Water source	Pipeline and rain water harvesting system	Pipeline - not always available	Pipeline	Canal	Pipeline	Pipeline	Pipeline and rain water harvesting system.	Pipeline and canal	Pipeline
Water fluoride value	3.9 mg/l	6.6 mg/l	4.8 mg/l	5.4 mg/l	6 mg/l	20 mg/l	From 20 mg/l to 4.2 mg/l	5.4mg/l	3.6 mg/l
Number of latrines	8	10	10	10	6	12	22	10	2
Facility to wash hands before meals	Yes	Yes	Yes	Canal	Yes	No	No	Canal	Yes
Facility to wash hands at toilets	Yes	Yes	Yes	Canal	Yes	No	No	Canal	Yes
Kitchen presence	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kitchen status	Good	Poor	Good	Good	Adequate	Poor	Poor	Good	Good
Meals produced	None	Lunch	None	None	Lunch	None	None	Lunch	None
Cooking fuel	Firewood provided by the students	Firewood provided by the students	Firewood provided by the students	-	Firewood provided by the students	-	-	Firewood provided by the students	Firewood provided by the students
Electricity	No	No	No	No	No	No	No	No	No



## ANNEX C

### VILLAGE GAME SCOUT WILDLIFE MONITORING

A program for regular wildlife monitoring was set up by Istituto Oikos in collaboration with the VGS and the village authorities. In each village, the core village wildlife areas were identified, then two foot transects for each village area were established, as well as a specific procedure for wildlife monitoring. The objective of this activity was to monitor, in a medium-long term frame, the distribution and the abundance of the medium and large mammals, to identify areas with greater species richness and to ensure the long-term sustainability of a wildlife program.

The VGS are currently working in 5 villages: Uwiro, Olkungwado, Kisimiri Chini, Kisimiri Juu and Losinoni.

The methodology used for wildlife monitoring is direct count of individuals and groups of the different species and it is based on the work of two observers covering, by feet, the sample transects distributed in the study area and counting the spotted animals. The transects are repeated twice a month, in the wet and the dry seasons, in the morning and in the afternoon. The data collected are registered by the observers on datasheets.

Within the study area 43 species of medium and large mammals, and the ostrich, were spotted. The abundance index (from 0 to 1) was calculated for each species. Species with an index = 1 were observed each month, while species with a value close to 0 were only rarely spotted.

ALL VILLAGES		ENGUTUKOIT	KISIMIRI CHINI	KISIMIRI JUU	LOSINONI	UWIRO (Mkuru Subvillage)	UWIRO	OLKUNGWADO	Index of abundance
Scientific name	Common name								
<i>Orycteropus afer</i>	Aardvark	*	*	*	*	*	*	*	100
<i>Madoqua kirkii</i>	Kirk's dik dik	*	*	*	*	*	*	*	1.00
<i>Papio anubis</i>	Baboon	*	*	*	*	*	*	*	0.86
<i>Genetta genetta</i>	Common genet	*	*	*	*	*	*	*	0.86
<i>Canis aureus</i>	Common jackal	*	*	*	*	*	*	*	0.86
<i>Crocuta crocuta</i>	Spotted hyaena	*	*	*	*	*	*	*	0.86
<i>Hystrix cristata</i>	Crested porcupine	*	*	*	*	*	*	*	0.86
<i>Lepus capensis</i>	Cape hare	*	*	*	*	*	*	*	0.86
<i>Cercopithecus aethiops</i>	Vervet monkey	*	*	*	*	*	*	*	0.86
<i>Tragelaphus scriptus</i>	Bushbuck	*	*	*	*	*	*	*	0.71
<i>Loxodonta africana</i>	Elephant	*	*	*	*	*	*	*	0.71
<i>Caudatus</i>	Black and white colobus monkey	*	*	*	*	*	*	*	0.57
<i>Cercopithecus mitis</i>	Blue monkey	*	*	*	*	*	*	*	0.57
<i>Neotragus moschatus</i>	Suni	*	*	*	*	*	*	*	0.57
<i>Canis mesomelas</i>	Black-backed Jackal	*	*	*	*	*	*	*	0.43

<i>Tragelaphus strepsiceros</i>	Greater kudu	*	*	*	*	*	*	*	0.43
<i>Cephalophus harveyi</i>	Harvey's red duiker	*	*	*	*	*	*	*	0.43
<i>Mellivora capensis</i>	Honey budger	*	*	*	*	*	*	*	0.43
<i>Panthera pardus</i>	Leopard	*	*	*	*	*	*	*	0.43
<i>Tragelaphus imberbis</i>	Lesser kudu	*	*	*	*	*	*	*	0.43
<i>Procavia capensis</i>	Rock hyrax	*	*	*	*	*	*	*	0.43
<i>Gazella thomsonii</i>	Thomson gazelle	*	*	*	*	*	*	*	0.43
<i>Equus burchellii</i>	Common zebra	*	*	*	*	*	*	*	0.43
<i>Civettictis civetta</i>	African civet	*	*	*	*	*	*	*	0.29
<i>Otocyon megalotis</i>	Bat-eared fox	*	*	*	*	*	*	*	0.29
<i>Potamochoerus larvatus</i>	Bushpig	*	*	*	*	*	*	*	0.29
<i>Giraffa camelopardaris</i>	Giraffe	*	*	*	*	*	*	*	0.29
<i>Gazella granti</i>	Grant's gazelle	*	*	*	*	*	*	*	0.29
<i>Pedetes capensis</i>	Spring hare	*	*	*	*	*	*	*	0.29
	Squirrel	*	*	*	*	*	*	*	0.29
<i>Raphicerus campestris</i>	Steinbok	*	*	*	*	*	*	*	0.29
<i>Syncerus caffer</i>	African buffalo	*	*	*	*	*	*	*	0.14
<i>Helogale parvula</i>	Dwarf mongoose	*	*	*	*	*	*	*	0.14
<i>Taurotragus oryx</i>	Eland	*	*	*	*	*	*	*	0.14
<i>Litocranius walleri</i>	Gerenuk	*	*	*	*	*	*	*	0.14
<i>Hylochoerus meinertzhageni</i>	Giant forest hog	*	*	*	*	*	*	*	0.14
<i>Aepyceros melampus</i>	Impala	*	*	*	*	*	*	*	0.14
<i>Oreotragus oreotragus</i>	Klipspringer	*	*	*	*	*	*	*	0.14
	Mongoose spp.	*	*	*	*	*	*	*	0.14
<i>Struthio camelus</i>	Ostrich	*	*	*	*	*	*	*	0.14
<i>Phacochoerus africanus</i>	Warthog	*	*	*	*	*	*	*	0.14
<i>Potamochoerus larvatus</i>	Bushpig	*	*	*	*	*	*	*	0.14
<i>Connochaetes taurinus</i>	Wildebeest	*	*	*	*	*	*	*	0.14
		24	18	12	19	25	19	16	

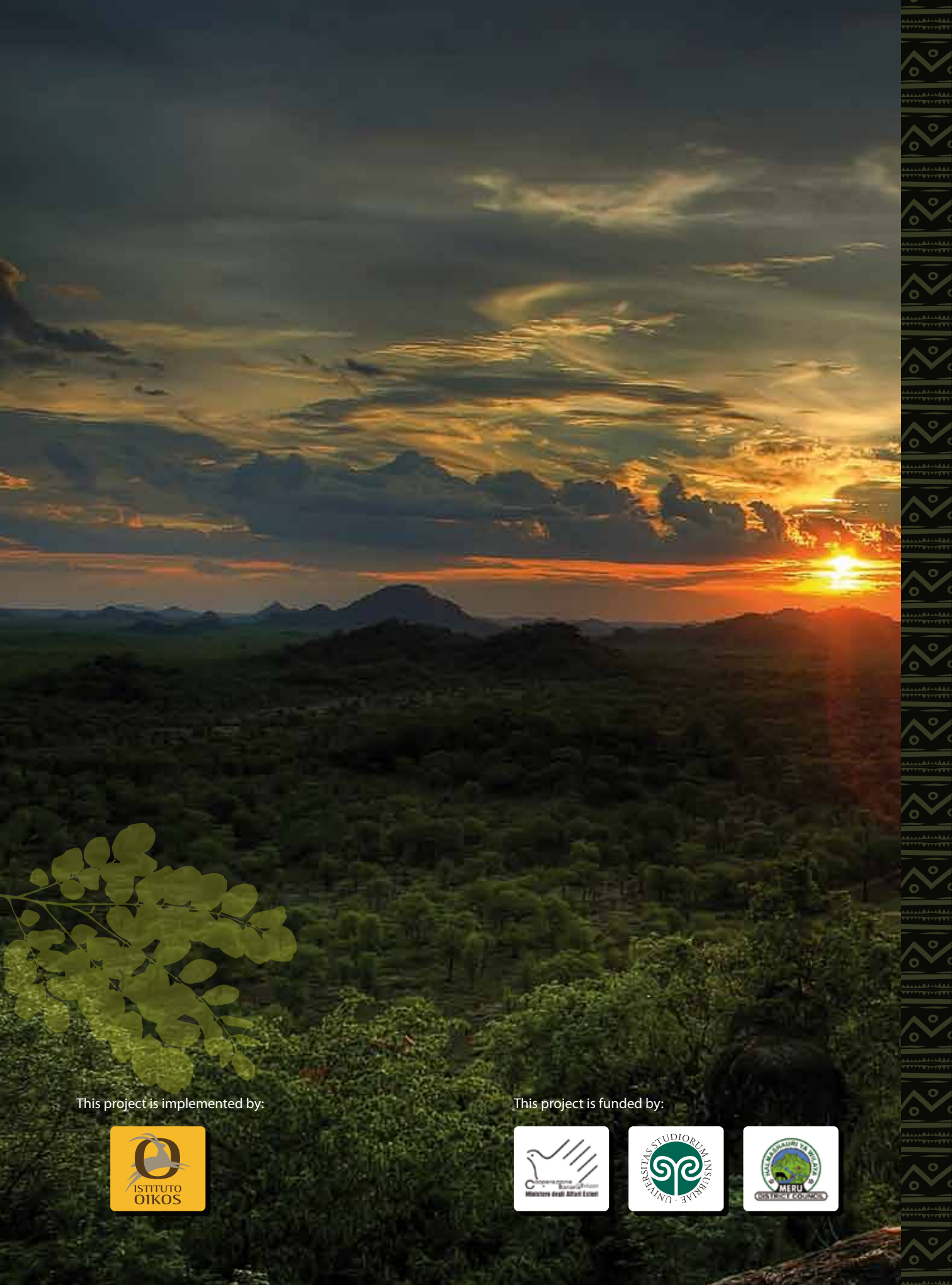
Abundance index per species, per village.

The VGSs reported that they currently perform the monitoring and patrolling activities twice a month, as scheduled. Within each village the main focus areas are those with greater problems of poaching, tree cutting and charcoal burning. The VGSs are highly motivated and carry out their duties with a positive attitude. However, in some villages people still do not value the VGS' contribution in terms of protection of natural resources. Moreover, most of the illegal activities having detrimental effects on the environment, such as charcoal burning and poaching, are done as alternative sources of income generation and are therefore even more difficult to eradicate.









This project is implemented by:



This project is funded by:

