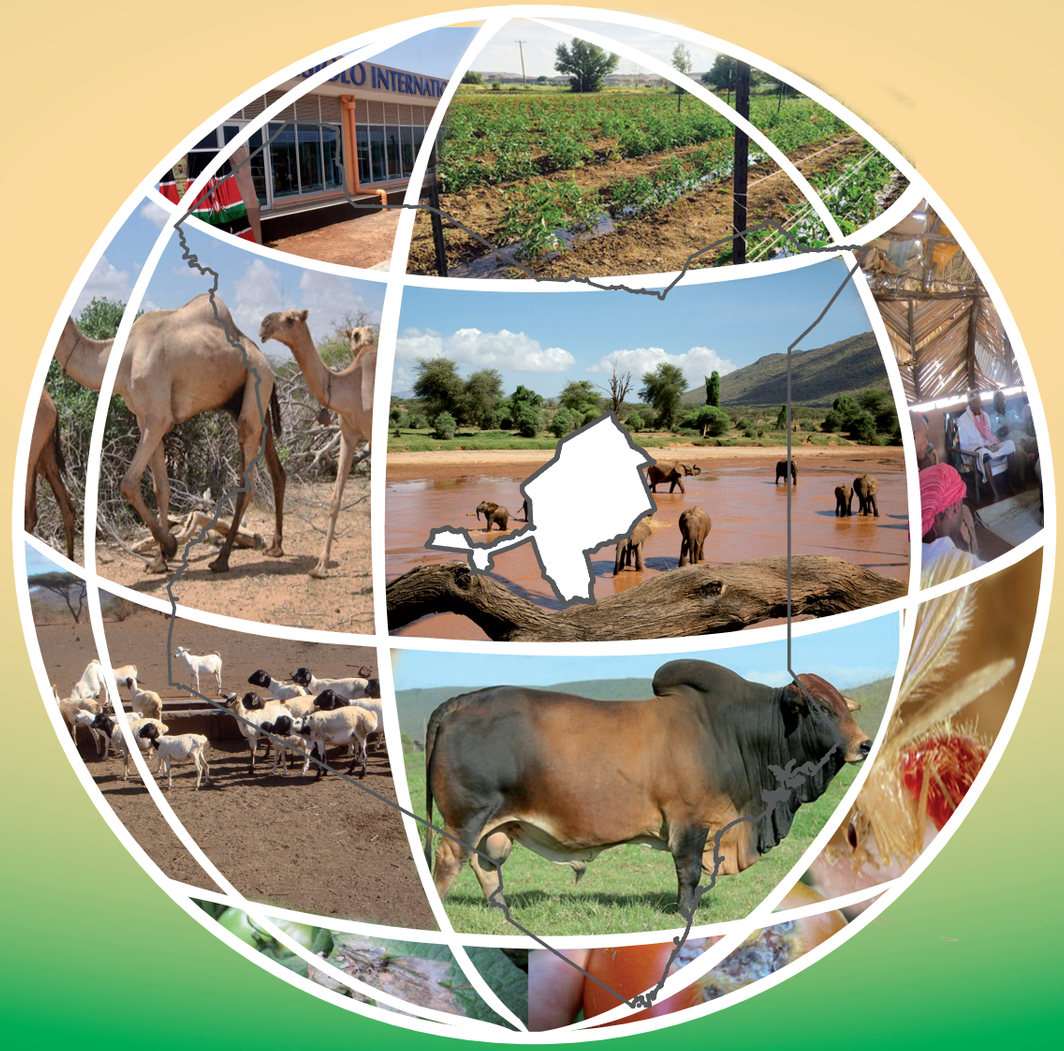
ISIOLO COUNTY
Hazard Atlas



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Printed by:
Progress Press Co. Ltd, Malta

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List Of Abbreviations And Acronyms

AIDS	Acquired Immunodeficiency Syndrome
ASAL	Arid and Semi-Arid Land
CAG	Conflict Analysis Group
CFSPH	Centre for Food Security and Public Health
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CIDP	County Integrated Development Plan
CISP	County Information Service Plan
CNAR	Capacity Needs Assessment Report
DHIS	District health Information System
DRR	Disaster Risk Reduction
EACCCP	East African Community Climate Change Policy
ECF	East Coast Fever
EWS	Early Warning System
FAO	Food and Agriculture Organization
FEWS NET	Famine Early Warning Systems Network
FMD	Foot and Mouth Disease
GoK	Government of Kenya
HIV	Human Immunodeficiency Virus
ICCSIP	Isiolo County Climate Services Information Plan
ICIDP	Isiolo County Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agricultural and Livestock Research Organization
KFS	Kenya Forest Service
KNBS	Kenya National Bureau
LAPSSET	Lamu Port South Sudan Ethiopia Transport
LSD	Lumpy Skin Disease
MAM	March April May
NCCAP	National Climate Change Action Plan
NDMA	National Drought Management Authority
NDVI	Normalized Difference Vegetation Index
OND	October November December
RCMRD	Regional Centre for Mapping of Resources for Development
RVF	Rift Valley Fever
UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
UNISDR	United Nations Office for Disaster Risk Reduction
URTI	Upper Respiratory Tract Infection
VCI	Vegetation Condition Index
VL	Visceral Leishmaniasis
WHO	World Health OrganisationOrganization

Preface

One of the principal obligations of any government is to protect its citizens from harm. The Fourth Schedule of the Constitution of Kenya 2010 allocates disaster management to the two levels of government, underlining the fact that both have important contributions to make. Given their proximity to populations at risk, the devolved authorities have a particular responsibility to ensure that they are equipped to respond in a timely and appropriate manner.

The purpose of this hazard atlas is to improve our efforts to reduce disaster risk and respond effectively when disaster strikes. The atlas is a visual tool which brings together basic information about the various hazards faced by the people of Isiolo. Unless we are conscious of these hazards and deal with them appropriately, our security, development and prosperity as a county will all be compromised.

As a government, we will use the atlas to guide the design and implementation of programmers and integrate measures that reduce disaster risk in our policies, strategies and plans. We hope that our partners in the county will also make use of the atlas so that we are all operating from a common base of knowledge.

The content of the atlas was generated through consultations with relevant parts of the County Government, supplemented with information from other sources where required, and validated by the relevant institutions. We started working on it in April 2019 and are delighted that it is now complete. We welcome feedback on the document so that future editions can be improved.

I would like to thank the National Drought Management Authority for their support in developing the atlas, which they have done as part of their wider efforts to strengthen the county's capacity in disaster risk management. I also thank the many other institutions involved in the process, and all our partners who work with us to improve the well-being of our people.

Hon. Dr. Mohammed .A. Kuti
Governor
Isiolo County Government

Foreword

Like all counties in Kenya, Isiolo faces a particular combination of threats associated with different hazards. This atlas has been produced in order to increase our understanding of these hazards and improve our management of the risks they pose.

The mandate of the National Drought Management Authority concerns drought, but we recognize that individual hazards should not be considered in isolation. Drought and conflict, for example, are mutually reinforcing: each exacerbates the other, while an improvement in one can reduce the risk posed by the other. For this reason, we are pleased to be associated with a publication which places drought risks within this wider context.

The Authority is a State Corporation tasked with leading and coordinating the government's efforts to manage drought. This can only be done through a collaborative partnership between the national and county governments. Our teams in each county work closely with the devolved authorities in ways which strengthen the capacity of the County Governments to manage the risks they face. This atlas is an example of that assistance, provided through a project financed by the United Nations Development Programme.

The atlas focuses on the specific hazards prioritized by the county: drought, environmental degradation, disease, conflict, and floods. There is a chapter on each of these, as well as a concluding chapter on the underlying factors that cause and perpetuate vulnerability to disaster. Dealing with vulnerability is key to reducing disaster risk and is why the solution to the suffering currently caused by disasters lies in sustainable and equitable development.

The profile of risk changes over time, and therefore the process of identifying, mapping and analyzing hazards should be a dynamic one. Moreover, different hazards are experienced by different population groups in different ways, which reinforces the importance of mapping being done in participatory ways. I hope that readers of this atlas will share their feedback on this first edition, and that the pool of those involved in shaping its content will gradually widen and deepen.

James Oduor
Chief Executive Officer, National Drought Management Authority

Acknowledgement

The documentation process and publishing of the Isiolo County Hazard Atlas was made possible with financial support from UK Aid from the UK Government through United Nations Development Programme (UNDP) under the Integrated Support Programme to the Devolution Process in Kenya.

NDMA wishes to recognise the Government of Isiolo County and its various institutions for its critical role in the provision of data, technical support and guidance which has resulted to content that is robust and reflective of the county's challenges and priorities in management and response to disasters.

NDMA appreciates the Regional Center for Mapping of Resources for Development for the professional and technical support provided towards the production of this Hazard Atlas for Isiolo County.

The Authority also acknowledges the participation and contribution of all other stakeholders who engaged in the production process through workshops for their valuable time and information towards the compilation of this Hazard Atlas.

Chapter 1:
Context and Background to the Hazard Atlas Map

Figure 1.1 Location of Isiolo County in local and national context

1.1 County Background

Isiolo County is located in the northern part of the former Eastern Province between latitude 0°05" South and 20 North, and between longitude 36°50" and 39°50" East. The county covers an approximate area of 25,700 km2 (ICIDP, 2018-2022) and shares its borders with 7 other counties namely: Samburu and Garissa counties to the East, Tana River county to the South East, Kitui and Meru counties to the South West, Marsabit county to the North West and Wajir County to the North East. The County is divided into two constituencies; Isiolo North and Isiolo South constituencies with 3 administrative sub-counties namely Garbatulla, Merti and Isiolo; 10 wards; 22 locations and 43 sub-locations (KNBS, 2013).

Most parts of Isiolo County are semi-arid and receive low rainfall ranging between 300-500 mm per year with mean temperatures of 28°C. The County is generally hot and dry in most of the year with two rainy seasons though in most months of the year, the vegetation cover is very low and scattered. Activities such as charcoal burning, sand harvesting, overgrazing and overstocking contribute to the rapid depletion of the vegetation cover in the County exposing the land to soil erosion. The short rains season occurs in October and November while the long rain occurs between March and May with an annual average of 580mm. Generally, the county supports little agricultural activity as a result of the limited rainfall with most residents practicing pastoralism often moving into neighboring counties in search of water and pasture for their livestock especially during the dry season.

(ii) Climate

Isiolo County lies within the Arid and Semi-Arid lands (ASAL) of Kenya which accounts for approximately 70% of the total land mass of the entire country. ASAL regions often support limited rainfed agricultural activities with most inhabitants in these regions depending on pastoralism to sustain their livelihoods. The erratic levels of rainfall received in Isiolo County makes crop farming and livestock production activities unsustainable thus exposing the inhabitants to cases of extreme droughts often experienced in the county. This phenomenon inturn leads to conflicts between nomadic pastoralists and farmer communities who compete with each other for already limited resources, in addition to existing challenges of high levels of poverty, extreme weather, unsecure land tenure, poor state of education, unemployment, general insecurity and poor infrastructure within the county.

The common disasters in the county therefore, include severe drought, floods, conflicts (human and human-wildlife), human diseases, livestock diseases, crop diseases and pests; and environmental degradation which have all along led to displacement, loss of lives of both animals and humans, loss of shelter and severe degradation of the environment. The most prevalent hazard, however, is drought which leads to loss of human life and livestock and also causes frequent migration of affected communities that often result in conflicts over grazing rights. Desktop studies conducted by RCMRD have brought out challenges in land tenure as a major cause of disputes in the Isiolo County.

(iii) Soils

The soils in the County are mostly sandy and saline with low water retention capacity. The county has a combination of metamorphic rocks and other superficial rock deposits. Tertiary rocks (Olive Basalt) are found in the northern parts of the county, where oil exploration has been going on. The areas covered with tertiary marine sediments have a high potential for groundwater harvesting. The altitude of the county rises from 200 meters above the sea level at Lorian swamp (Habaswein) to 300 metres at Merti Plateau with the highest region around Isiolo town rising up to 1,100 meters above sea level. There are six perennial rivers in the county namely; Ewaso Ngiro North, Isiolo, Kinna, Bisanadi, Likiundu and Liliaba rivers (ICIDP, 2018-2022).

1.2 Hazard Profile in Isiolo County

Kenya is already extremely susceptible to climate-related events and such events pose a serious threat to the socio-economic development of the country, with droughts and floods in particular having devastating consequences on the environment, society and the wider economy (NCCAP Risk Assessment Report). Isiolo is one of the most vulnerable counties to climate change in Kenya. Some of the key vulnerabilities emanating from climate change include drought and unpredictable rainfall, floods, and the spread of water and vector-borne diseases, loss of forests and wetland ecosystems, land degradation and desertification and scarcity of portable water.

Isiolo County lies within the Arid and Semi-Arid Lands (ASAL) of Kenya which accounts for approximately 80% of the total land mass of the entire country. ASAL regions often support limited rainfed agricultural activities with most inhabitants in these regions depending on pastoralism to sustain their livelihoods. The erratic levels of rainfall received in Isiolo County makes crop farming and livestock production activities unsustainable thus exposing the inhabitants to cases of extreme droughts often experienced in the county. This phenomenon inturn leads to conflicts between nomadic pastoralists and farmer communities who compete with each other for already limited resources, in addition to existing challenges of high levels of poverty, extreme

weather, unsecure land tenure, the poor state of education, unemployment, general insecurity and poor infrastructure within the county.

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1.2.1 Drought

Agricultural and livestock productivity in the county has significantly reduced as a result of the limited, unreliable and poorly distributed rainfall patterns. In recent years the rains have become erratic and unpredictable hence making it difficult to plan on farming. Drought and unpredictable rainfall impact negatively on the economy of the county leading to reduced crop yield, low livestock productivity, high livestock mortality, and loss of income for farmers, famine and malnutrition.

1.2.2 Conflicts

Isiolo County is a characteristic multiracial county with inhabitants from the Borana, Turkana, Somali and Samburu communities. Conflicts in the county are often as a result of competition for pasture and water resources with the majority Borana community being worst affected by people from neighbouring Wajir, Samburu and Garissa Counties. The proliferation of small arms among these communities have further exacerbated the situation with the situation worsening during periods of elections. The dispute over boundaries and land ownership have also further aggravated the situation fueled by interest in controlling the rich resources and development projects in the county.

1.2.3 Environmental Degradation

Environmental degradation would generally affect most aspects of human life including water quality, land productivity, air quality and disease incidents. Isiolo County is hot and dry in most months of the year hence the vegetation cover is very low and scattered. The county faces the challenge of managing soil erosion with wind as the major agent of erosion caused by inadequate tree cover. Charcoal burning, sand harvesting, overgrazing and overstocking and the presence of various invasive species in most parts of the county has rapidly depleted the vegetation cover leaving land exposed to soil erosion. Poor management of natural resources is the major cause of localized environmental degradation though other causes such as flash floods from catchment areas outside the county have impacted on the levels of degradation in the county.

1.2.4 Human, Livestock and Crop Diseases and Pests

Pest infestation, human and livestock diseases which lead to loss of livestock and crop yields are the major cause of food insecurity in the county of Isiolo according to FAO Resilience Analysis Report, 2016. This situation is further compounded by the low and erratic levels of rainfall received and increased drought frequency in the county. Migration of animals during the search of pasture and water resources often lead to the spread of vector-borne diseases. Flash floods and contamination of water sources cause massive outbreak of water-borne diseases with the situation being exacerbated by inadequate sanitation services. There is therefore need for coordinated efforts in controlling and managing the spread of pests and diseases in the county by all relevant stakeholders to restore and sustain the current situation.

1.2.5 Floods

Floods could occur as a natural phenomenon but are often triggered by torrential rainfall or due to human manipulation of watersheds, drainage basins and flood plains. Some cases of floods are as a result have occurred in the river basins even with normal rains because of excess surface water runoff occasioned by deforestation and land degradation upstream (UNDP Kenya Natural Disaster Profile). Floods is not a major hazard in Isiolo County though it happens in a few areas.

Plates 1.1 and 1.2: Partcipants of Stakeholders' participatory mapping workshop and community consultative forum in Isiolo County

1.3 Need for Hazard Mapping and Atlas Development

Disasters are increasingly becoming a common phenomenon globally and in many regions of Kenya. This may be attributed to changes in the ecosystem driven by many factors such as increased population growth that puts pressure on many resources and climate change among others. Disasters that occur in large scale may have a serious impact on society and the economy, resulting in a significant national loss. Preventing the adverse impacts disasters is one of the most important priorities of governments. Although it is difficult to avoid impacts of hazards and related disasters, it is essential to understand their behaviour and how we can reduce their impacts by strengthening our ability to deal with their effects. Understanding hazards and related disasters and vulnerabilities starts by answering such questions as:

- What hazards are likely to occur?
- Where do they occur?
- How significant are they in scale?
- When are related disasters likely to happen?
- And what elements are most at risk?

The purpose of hazard maps is to provide a set of information in form of visual presentation concerning hazards and related disasters prevailing in a given geographic area for subsequent use in systematically addressing underlying risk factors and taking necessary measures to reduce potential adverse impacts on their geographic location so that disaster prevention activities and measures could be undertaken. Depending on the details they provide, hazard maps therefore, would be an important tool for enhancing early warning, preparedness, contingency planning and implementing relief, early recovery, and rehabilitation interventions. As importantly hazard maps could be used for planning and implementation of preventive measures including building resilience and adaptive capacity.

Chapter 2:
Climate Profile

2.1 Introduction

Kenya is already highly susceptible to climate-related hazards with many areas experiencing weather variability and extreme events characterised by irregular and unpredictable rainfall while droughts have become more frequent during the long rainy season and severe floods during the short rains (Isiolo County, Climate Risk Profile). The ASAL regions of Kenya, comprise of approximately 88% of the total land area of Kenya (Kenya: Country situation assessment Working Paper) and are home to about 36% of the popolation, 70% of the national livestock herd and 90% of wildlife (National Policy for the Sustainable Development of Arid and Semi-Arid Lands). ASAL regions are characterised by low and uncertain levels of rainfall, high desiccating factors and periodic droughts, with these uncultivated lands being grazed and browsed by both domestic and wild animals (Talbot, 1986). The adverse impacts of climate change are a major challenge to socio-economic development globally with the impacts of climate change affecting key economic drivers such as water resources, agriculture, energy, transport, health, forestry, wildlife, land and infrastructure, disaster risk management among others. These impacts include; water stress and scarcity, food insecurity diminished hydropower generation potential, loss of biodiversity and ecosystem degradation, increased incidence of disease burden, destruction of infrastructure, high costs of disaster management as a result of increased frequency and intensity of droughts, floods and landslides associated with the El Niño phenomenon (EACCCP, 2011).

Major indications of climate change effects in Isiolo County include temperature increases, rainfall irregularity and intensification, reduced food production, disruption of natural ecosystems and subsequent change and loss of habitats and species (ICCISP, 2018). According to the Intergovernmental Panel on Climate Change (IPCC), man-made climate change is already underway with changes in physical and biological systems already being observed and are projected to intensify over the coming decades. The projected increase in temperature, changes in rainfall abundance, sea-level rise and frequency and severity of extreme events places greater strain on natural resources and contribute to deterioration in food security, political stability, health and poverty (NCCAP Risk Assessment Report).

2.2 General Climate

Kenya has a complex climate that varies significantly across the country. The country's dry landmass is commonly divided into 6 major agro-ecological zones namely: Agro-Alphine, High Potential, Medium Potential, Semi-Arid, Arid and Very Arid zones with approximately 1.9% of the rest of the area covered by water (infonet-biovision.org). Isiolo County is profiled into three ecological zones namely Semi-Arid, Arid and the very Arid (Isiolo CIDP, 2013-2017). These zones are characterised by low trees and shrubs, and minimal rainfall that is quite unreliable. The semi arid zone has medium potential mostly characterised by agro-pastoral activities in areas of Wabera Ward, Bulla Pesa Ward and some parts of Burat Ward in Isiolo North Constituency. It also covers some Southern part of Kinna Ward in Isiolo South Constituency. Isiolo County is generally hot and dry most of the year with two rainy seasons. The long rain season occurs between March and May while the short rain season occurs in October and December.

2.2.1 Rainfall

The County is hot and dry in most months in the year with two rainy seasons. The short rain season occurs between October and December with a peak in November while the long rain occurs between March and May with a peak in April. Relatively high rainfall received in the southern regions of the county is as a result of the influence of Mount Kenya and Nyambene Hills in the neighbouring Meru County. The average rainfall received in the county is 580mm per annum with November and April being the wettest months receiving 149mm and 143mm respectively. Rainfall regime in the county is mainly governed by the Inter-Tropical Convergence Zone (ITCZ), The El Nino Southern Oscillation (ENSO) and altitude effects of the neighbouring Mt. Kenya and Nyambene hills. These factors causes rainfall variability across the county with the eastern regions and northern parts receiving less than 250mm of rainfall. Rainfall in the county is often characterized by high inter-annual variability which directly affects hydrological, ecological and biochemical processes that have an eventual influence on the climate of the county (Isiolo County, CIS Plan, 2018).

Figure 2.1 below shows total annual rainfall for Isiolo County from 1981 to 2018. Amount of rainfall received is unpredictable. Analysis indicates that total rainfall received has been decreasing in the last 35 years.

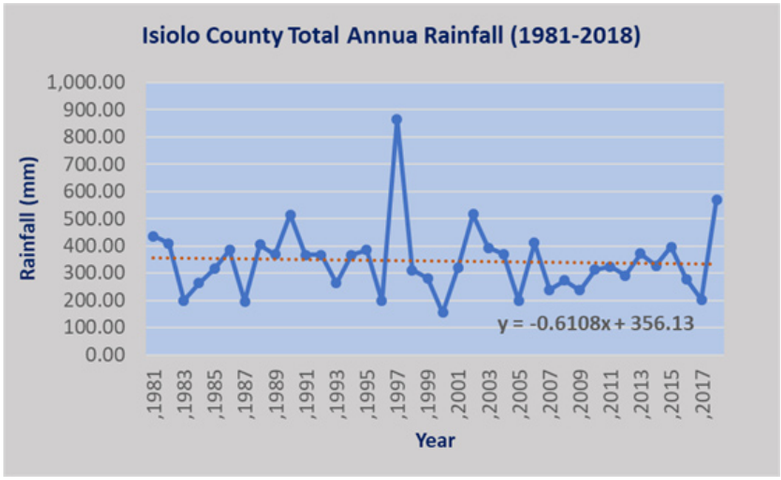


Figure 2.1: Isiolo County Total Annual Rainfall (1981-2018) (Source: CHIRPS/GeoCLIM/RCMRD)

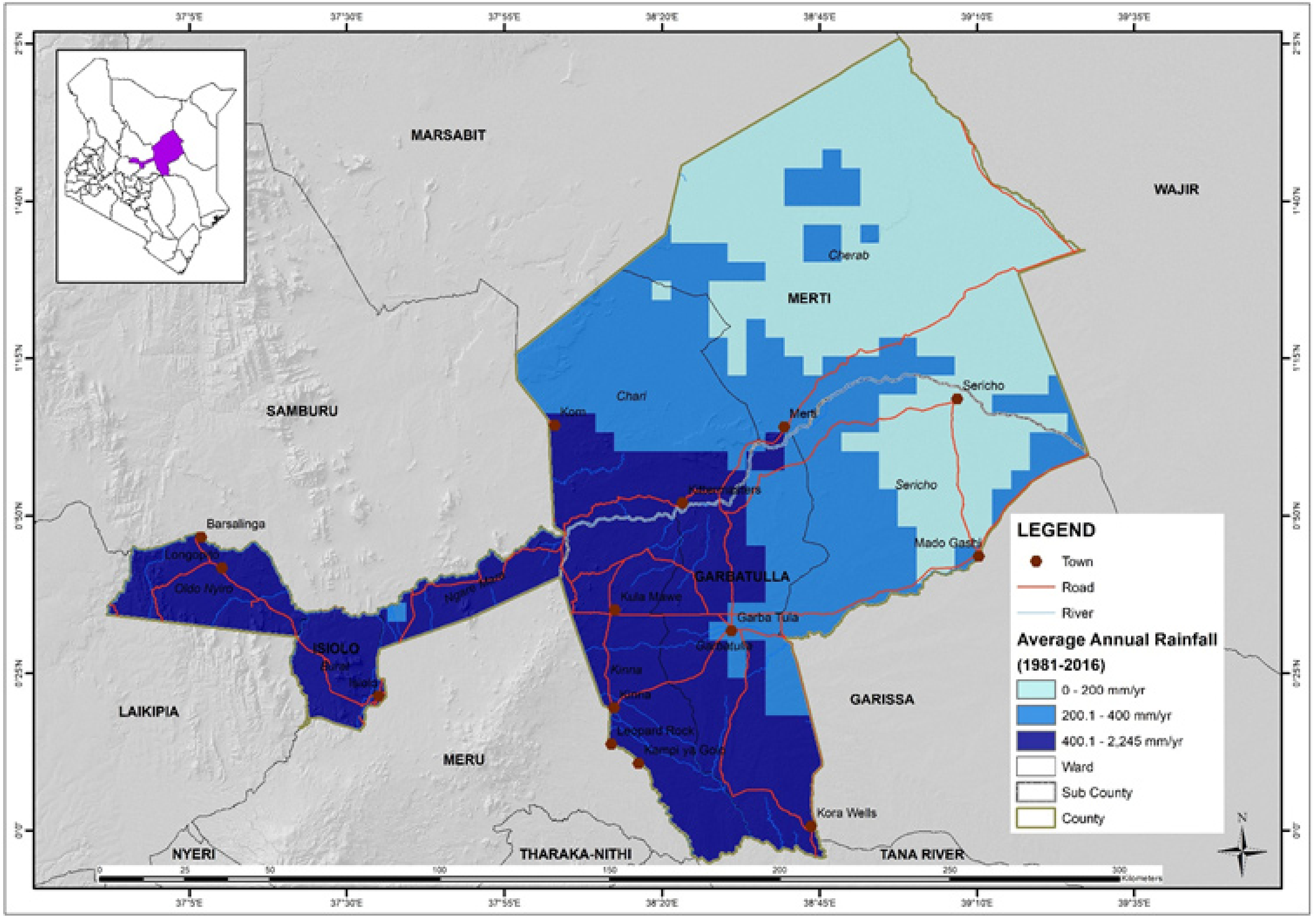


Figure 2.2: Isiolo County Average Annual Rainfall (1981-2018) (Source: CHIRPS/GeoCLIM/RCMRD)

Further analyses by RCMRD (Figures 2.3 and 2.4) indicate that both the short and long rains seasons are erratic. The amount of rainfall varies from year to year. Short rains have been increasing while the long rains have been decreasing from 1981 to 2018.

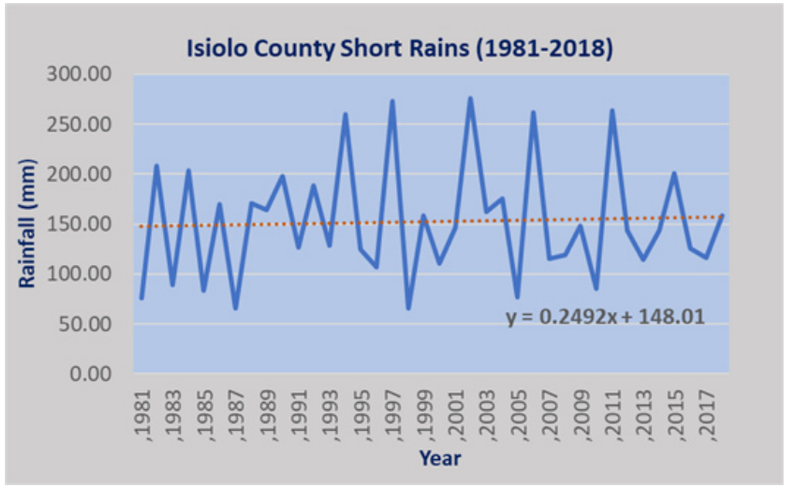


Figure 2.3: Isiolo County Short Rains Seasonal Trend (1981-2018)
(Source: CHIRPS/GeoCLIM/RCMRD)

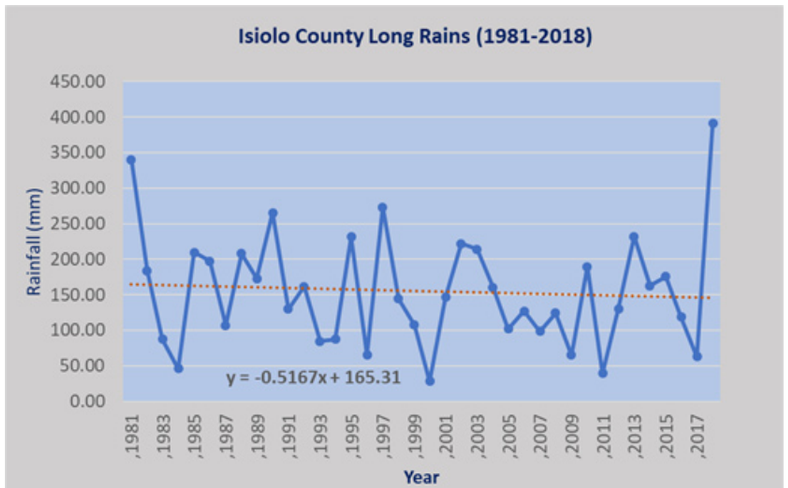


Figure 2.4: Isiolo County Long Rains Seasonal Tend (1981-2018)
(Source: CHIRPS/GeoCLIM/RCMRD)

2.2.2 Temperature

High temperatures are recorded in the county throughout the year, with variations in some places due to differences in altitude. The mean annual temperature in the county is 29 degrees centigrade with more than 9 hours of sunshine per day being recorded. Strong winds blow across the county throughout the year peaking in the months of July and August (ICIDP, 2018-2022). Figures 2.5 and 2.6 below show the trend of Isiolo County's minimum and maximum temperatures from 1981-2012.

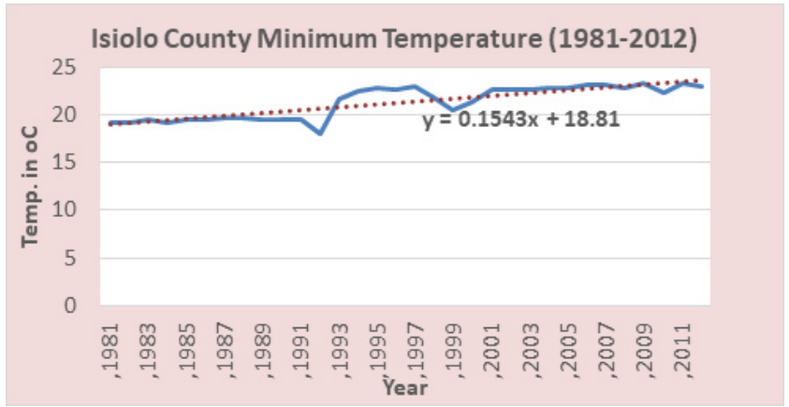


Figure 2.5: Isiolo County Minimum Temperature (1981-2012)
(Source: FEWSNET/GeoCLIM/RCMRD)

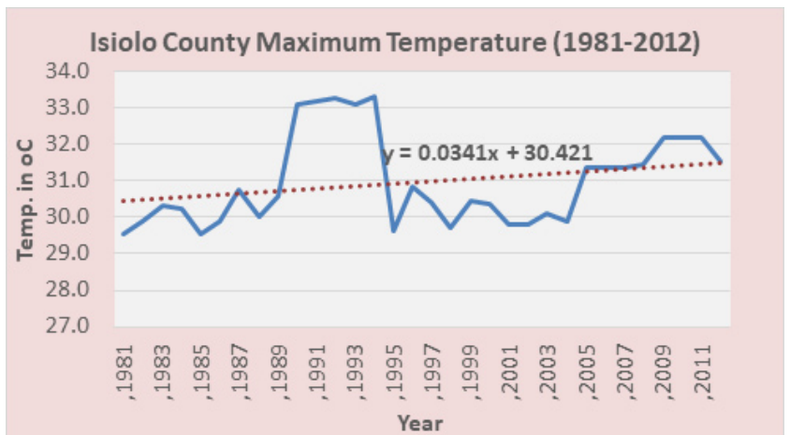


Figure 2.6: Isiolo County Maximum Temperature (1981-2012)
(Source: FEWSNET/GeoCLIM/RCMRD)

Figures 2.5 and 2.6 indicate that there was a slight increase in temperatures from 1981 to 2012. Participants of community consultative forums in the three sub-counties affirmed that temperature increase is evident in the county. Temperature increase in the county may be attributed to deforestation. Another major factor that contributes to warmer temperatures is the retention of heat by greenhouse gases such as methane, carbon dioxide and nitrous oxide. Most of the warming is believed to have been caused by anthropogenic increases in greenhouse gases. Rise in temperature has caused several changes in the environment and will continue to do so if not controlled. Warmer temperatures will have effect on amount of water available for use, crop success and health. Hot conditions may cause crop failure, water sources may dry up and health may deteriorate due to the spread of infectious diseases and survival of disease vectors among others.

2.3 Climate Change

United Nations Framework Convention on Climate Change (UNFCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. A majority of Isiolo County is arid and semi-arid and therefore residents are often exposed to various vulnerabilities occasioned by climate change that include: drought and un-predictable rainfall, floods, the spread of water-borne and vector-borne diseases, loss of forests and wetland ecosystems, land degradation and desertification and scarcity of potable water (ICIDP, 2013-2017). Potential effects of climate change in Isiolo County is expected to result in an increase in precipitation in some seasons thereby leading to increased cases of flash floods. This could subsequently lead to negative impacts of landslides, erosion, damage to infrastructure and potential loss of lives. Effects of climate change in the county have been worsened by deforestation, unsustainable land-use practices and intensified pastoralist farming. Other effects of climate change evident in the county have led to the scarcity of water sources due to high levels of evaporation leading to drying up of the limited waters sources available in the county. This inturn

leads to conflicts between communities for this resource and conflicts between humans and wildlife for a county endowed with several conservancies.

Diminishing water availability and quality, together with rising water demand, have created immense challenges for most poor and vulnerable communities in the county. Climate change is expected to affect food security in the county due to dependence on rain-fed agriculture; high levels of poverty; and low levels of human and physical capital as well as generally poor infrastructure.

A number of coping mechanisms have been put in place including community sensitization on climate change, sanitation and rain water harvesting; afforestation and reforestation, early warning systems and awareness creation, diversification and adoption of renewable of energy sources. Mitigation measures, rehabilitation of degraded lands, irrigation and sustainable crop and animal farming are also being done through various local programmes to combat the effects of climate change.

Chapter 3: Drought

3.1 Introduction

Drought is a natural phenomenon that can be challenging to address. Drought is a temporary occurrence and is a direct consequence of a reduction in the amount of precipitation received over an extended period of time, usually a season or more (UNDP, 2011). Kenya is frequently affected by weather-related disasters, particularly droughts and floods with most of the ASAL counties being affected. Historically, drought is known to occur cyclically affecting the country's economy since 75% of the country's population earns its living from agriculture, that depends heavily on rainfall. Due to the vast areas prone to drought, Kenya's vulnerability to food insecurity is highest among the pastoralists and small-scale agriculturalists in the ASALs of the country (UNDP Kenya Natural Disaster Profile).

Agriculture remains the backbone of the economy of Isiolo County with over 80% of the inhabitants relying on livestock for their livelihood and about 26% of its inhabitants practising agro-pastoralism even though a large portion of the county is arid and cannot support rain-fed farming. Majority of the inhabitants practise nomadic pastoralism with a minority practising subsistence crop farming. Agro-pastoralism is also pracisted in the county especially where rainfall can support crop growth under irrigation, along the Ewaso Ngiro river, in Isiolo Central, Bisanadhi and Kinna areas. Drought frequency has however increased over the past three decades leading to high poverty rates of up to 77% thus causing dependency of the residents on food aid for survival.

Cases of food insecurity in Isiolo are largely as a result of low agricultural production, prolonged droughts, low rainfall and periodic outbreak of diseases and pests. Limited access of water also contributes to drought vulnerabilitys in the county with the average distance to the closest water source estimated at 5km. Majority of the communities depending on water pans, sand dams, shallow wells and boreholes for domestic water supply (ICIDP, 2018-2022). Erratic and unreliable rainfall received in the county supports little crop farming which partly explains the high food insecurity and poverty levels recorded in the county. However, over 80% of the land cannot support crop farming and is used as grazing land by the pastoralists with agro-pastoralism being practised in some areas (ICIDP, 2018-2022).

According to Isiolo County's Climate Risk Profile, analysis of temperature trends in the county indicate an increase of about 0.5°C in the mean temperatures for both seasons. On the other hand, analysis of rainfall, showed a slight change in rainfall amounts with average MAM season rainfall remaining fairly constant and average OND season rainfall increasing only moderately. The combination of the moderate increase in temperatures and the relatively unchanged precipitation have resulted in an increase in the number of heat stress days in both seasons, as well as an increase in drought risk for the first season (Isiolo Climate Risk Profile, 2018).

3.2 Types of Drought

According to United Nations International Strategy for Disaster Reduction (2007), broad definition of drought is deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors. However, in terms of typologies, droughts are commonly classified as meteorological, agricultural, hydrological, and socio-economic (UNISDR, 2007). Further explanation of these types of drought is as indicated below:

3.2.1 Meteorological drought

Meteorological drought depends on precipitation deficit and duration of period with precipitation deficit. It is simply expressed in terms of a rainfall deficit in relation to some average amount and duration of drought period. Many people relate with his type of drought as it is more evident. Erratic, inadequate and unreliable rainfall is attributed to meteorological drought in the county. Both short and long rains have become unpredictable. For instance, long rains started in April as opposed to March in 2019. Some of the impacts of this drought include reduced animal productivity, conflict over resources, crop failure, poor recharge of water sources, poor pasture regeneration and it leads to agricultural and hydrological drought. Some mitigation measures include restocking, conservation agriculture, irrigation, rain water harvesting, livestock vaccination planting drought resistant crops, provision/drilling water for irrigation in feasible areas, cash transfer, pasture production and preservation, setting up strategic food reserves formation of peace committees and proper rangeland management..

3.2.2 Agricultural drought

Agricultural drought refers to situations with insufficient soil moisture level to meet the plant needs for water during vegetative period. Agricultural drought links various categories of meteorological and hydrological drought to agricultural impacts, focusing primarily on soil water deficits and differences between actual and potential evapo-transpiration. Impacts of this drought include moisture stress, crop failure, reduced productivity, loss of income and food insecurity. Food insecurity leads to diseases like anaemia, malnutrition and underweight children. Just like meteorological and hydrological droughts, mitigation measures include irrigation, planting drought resistant crops, conservation agriculture, investing in strategic food reserves and an effective early warning system.

Vegetation Condition Index (VCI) is an effective index based on satellite observations for assessing vegetation quality and condition thereby determining the severity levels for agricultural drought. This indicator is suitable to measure the status of pasture and therefore can be used to assess grazing resources available to livestock (NDMA, 2016). The Vegetation Condition Index is based on the relative NDVI change with

respect to minimum and maximum historical NDVI value (NDMA, 2016). The NDVI of a given week is compared to the minimum NDVI found in the archive (of that week: NDVImin) and the maximum NDVI found for that week (NDVImax), (NDMA, 2016).

Based on figure 3.1 below, Isiolo County did not experience a single episode of extreme agricultural drought from 2001 to 2004, 2007,2008 and 2012. The severe and extreme agricultural drought was experienced in 2005, 2006, 2009 to 2011 and 2013 to 2019.

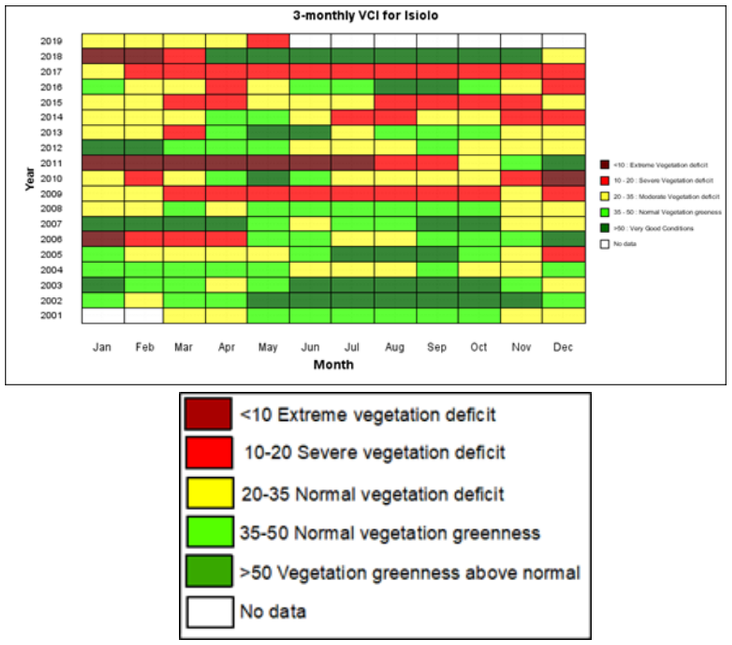


Figure 3.1: Vegetation Condition Index for Isiolo County 2001-May, 2019 (Source: NDMA, 2019)

3.2.3 Hydrological drought

Hydrological drought occurs after a longer period of precipitation deficit. Hydrological drought is characterized with the effects of periods of rain shortfall on surface and sub-surface water supply. They lag behind meteorological and agro-meteorological drought. Groundwater drought is outlined by lower than average annual recharge for more than one year. Groundwater levels are good indicators in an aquifer area. Major impacts of this type of drought in the county include drying of water sources, conflicts, diseases, reduced productivity and animal deaths. Mitigation measures are water trucking, irrigation, provision of livestock feeds, livestock vaccination and water harvesting.

Plates 3.1: Carcass of livestock in Isiolo County after recent drought episode (Source: NDMA)

3.2.4 Socio-economic drought

Socio-economic drought refers to the relationship between supply and demand for a certain commodity or economic good that is dependent on precipitation (UNISDR, 2007). Socio-economic drought is a direct result of agricultural, hydrological and meteorological droughts. This type of drought cuts across people regardless of their economic status. In this scenario, the ability to purchase commodities is limited to a few causing those who are economically disadvantaged to suffer the most. The little that is available is not within their reach. Notable impacts of this type of drought include loss of livelihood, migration, the collapse of social systems, insecurity and malnutrition. Mitigation measures that can be adopted are livelihood diversification through promotion and adoption of alternative income-generating activities, social safety nets, restocking, support to livestock health care resources and livestock insurance.

Table 3.1: Phases of Drought and Effects on Pastoral Communities

Phase	Effects
First	❖ Decline in forage production ❖ Imbalance between livestock numbers and available forage ❖ Livestock numbers dwindle through mortalities and sales ❖ Conditions of livestock become worse and grains harvest fail ❖ Grains prices rise and livestock prices reduce
Second	❖ Herd numbers continue to fall as deaths and sales continue ❖ Shortage of grains ❖ continue to keep food prices high ❖ There is still pressure on herders to further sell livestock in order to purchase food
Third	❖ Livestock numbers remain below the level, which could make effective use of the available pasture ❖ Poorer may still be under pressure to sell livestock due to food shortage ❖ Richer households may be able to reconstitute herds ❖ Some pastoral households become totally destitute and must receive food aid

Source: (Toulmin, 1995)

3.3 Drought in Isiolo County

Drought is the most prevalent hazard in Isiolo County. Drought incidences have in the recent past increased in Isiolo County with unpredictable rains being the major cause of droughts. The unpredictable rainfall often experienced in the county negatively affects crop yields leading to loss of income for farmers, famine and malnutrition among children. Isiolo County's fragile ecosystem makes it prone to effects of climate change like drought. Based on the community consultative forums that were held in Isiolo County, it is evident that drought frequency and episodes are increasing in the county. Drought frequency in the past was after more than 10 years however this frequency has increased to every 1 or 2 years in recent times. The 2018 long rains were reported to be normal in Isiolo County though the short rains failed and subsequent long rains of 2019 also failed. These unpredictable rainfall patterns have resulted in lack of water and pasture with the community's only dry season grazing areas located at Awayi. The worst drought in the county was experienced in 1984 followed by another one in 1994 that led to the loss of human life and livestock. The most affected sub-county is Merti.

3.4 Impacts of Drought

There are several impacts of drought episodes in Isiolo County. These include:

3.4.1 Loss of Livelihoods

Droughts are often characterised by severe reduction in water and moisture content in the soil resulting in dryness that fails to support plant life. Although little farming is practised in the county, one major risk due to drought and unpredictable rainfall is loss of income to farmers. Rainfed agriculture commonly practised in the county bears the biggest brunt of the erratic rainfall in the county.

Recurrent droughts in Isiolo County have destroyed livelihoods, triggered local conflicts over scarce resources and eroded the ability of communities to cope (Isiolo County Climate Information Service Plan). Isiolo County has four dry season grazing zones namely: Nanapa, Nanpcho, Narupa and Naapu under the Northern Rangelands Trust that provides pasture for livestock during dry seasons with shallow wells and rainwater as their main sources of water. These frequent drought episodes in recent years has forced community members to sell the livestock in efforts to destock and cut their losses in the event of livestock deaths. This often leads to residents incurring losses due to a fall in market value for their livestock.

3.4.2 Economic Loss and General Poverty

Prevailing droughts in recent times in Isiolo County have forced residents who used to practice livestock herding to consider other occupations including casual waged labour in order to supplement their income, according to the Integrated SMART Survey Report of 2018. The report indicates that there is a marked increase in the number of residents doing waged labour compared to those practising livestock herding. The report attributes this change to the prevailing droughts in recent years that resulting in loss of livestock.

3.4.3 Migration and Displacement of households

Migration of families to areas with food and water resources is characteristic of most pastoralist communities in Isiolo County during periods of drought. Such movements often result in conflicts between communities over resources with some leading to deaths. Movement of people and livestock is also a cause for the spread of human and livestock diseases. Livestock diseases like foot and mouth, lumpy skin disease and black quarter tend to increase during the drought seasons.

3.4.4 Increased Conflicts

Conflicts resulting from diminished water and pasture and invasion from neighbouring communities have led to conflicts between the Borana community considered the majority in the county against the Somalis from Wajir and Garissa counties and the Turkana and Samburu from neighbouring Samburu county.

3.4.5 Malnutrition

Long term effects of deteriorating poor health conditions during droughts especially among the children and the aged in the society some times leads to deaths. Deaths are mainly as a result of malnutrition due to lack of sufficient food supplies. In the recent past, government agencies have reduced the amounts of relief food supplied during drought episodes with focus only on the vulnerable communities.

3.5 Drought Cycle Management

Drought is a natural occurrence but timely intervention by all the relevant stakeholders can reduce the vulnerability of a community and the impacts. Drought cycle management (DCM) is a model that was developed to act as a guide in planning and responding to droughts. Drought cycle management is a cyclic process that affirms that drought is a cyclic event and defines what actions to be taken at each stage of a drought (Lesukat, 2012). It aids in ensuring that practitioners improve the timeliness, appropriateness, and ultimately the effectiveness of work by inviting them to consider whether activities are appropriate given the current stage of drought cycle (NDMA). DCM conceives drought as a cycle of five warning phases; Normal, Alert, Emergency and Recovery (NDMA).

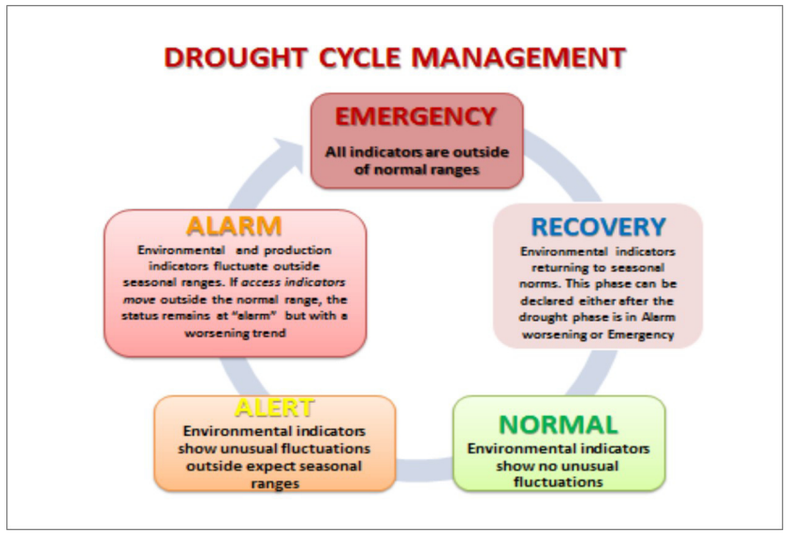


Figure 3.2: Drought Cycle Management (Source: NDMA)

Drought Management has four phases. Drought Preparedness (Readiness measures before the onset of drought), Mitigation, Relief assistance/emergency operations and Recovery or Reconstruction (measures after the drought to facilitate fast normalcy).

3.6 Drought Management for Pastoral Communities

According to studies conducted by Barton et al. (2001), drought early warning system, drought contingency planning and policies to support pastoral communities' resilience to drought are key components for drought management policy for pastoral areas. Moreover, Barton et al (2001) further emphasized that drought contingency planning must consequentially allow for the execution of three sorts of measures: Mitigation –to minimize the impact of drought on pastoral production systems and livelihoods; Relief -to cater, first in a targeted way, to the interests of those made destitute by drought; Rehabilitation of pastoral production systems from the outcome of drought

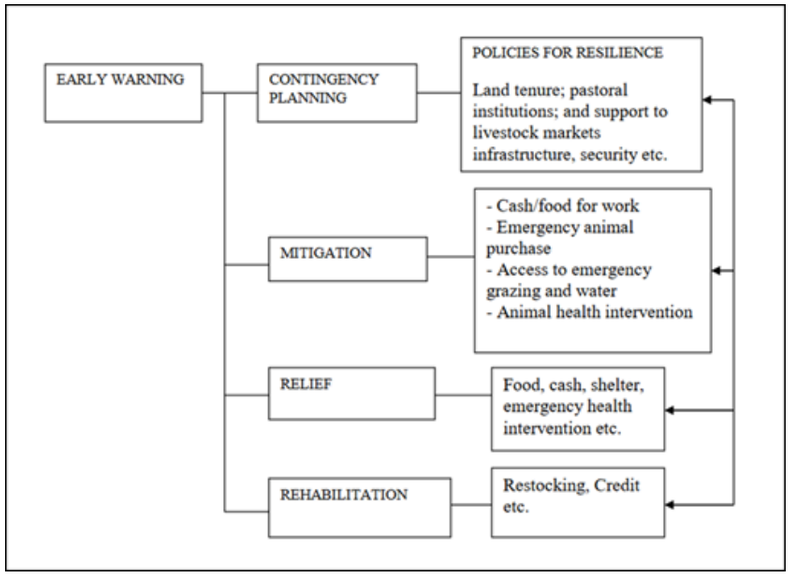


Figure 3.3: Components of Drought Management in Pastoral Areas
Source: Barton et al., 2001

3.7 Drought Interventions in Isiolo County

3.7.1 Government Efforts

The National Drought Management Authority (NDMA) supports the communities in Isiolo County during drought periods through water trucking. Other government agencies such as the Kenya Meat Commission (KMC) destocked livestock during the recent drought episodes though payments are yet to be made to the community. Additionally, school feeding programmes for Early Childhood Development (ECD) pupils offered by government programmes are not consistent despite the World Food Programme (WFP) and the Red Cross offering more assistance.

3.7.2 Integrated Soil Management Practices

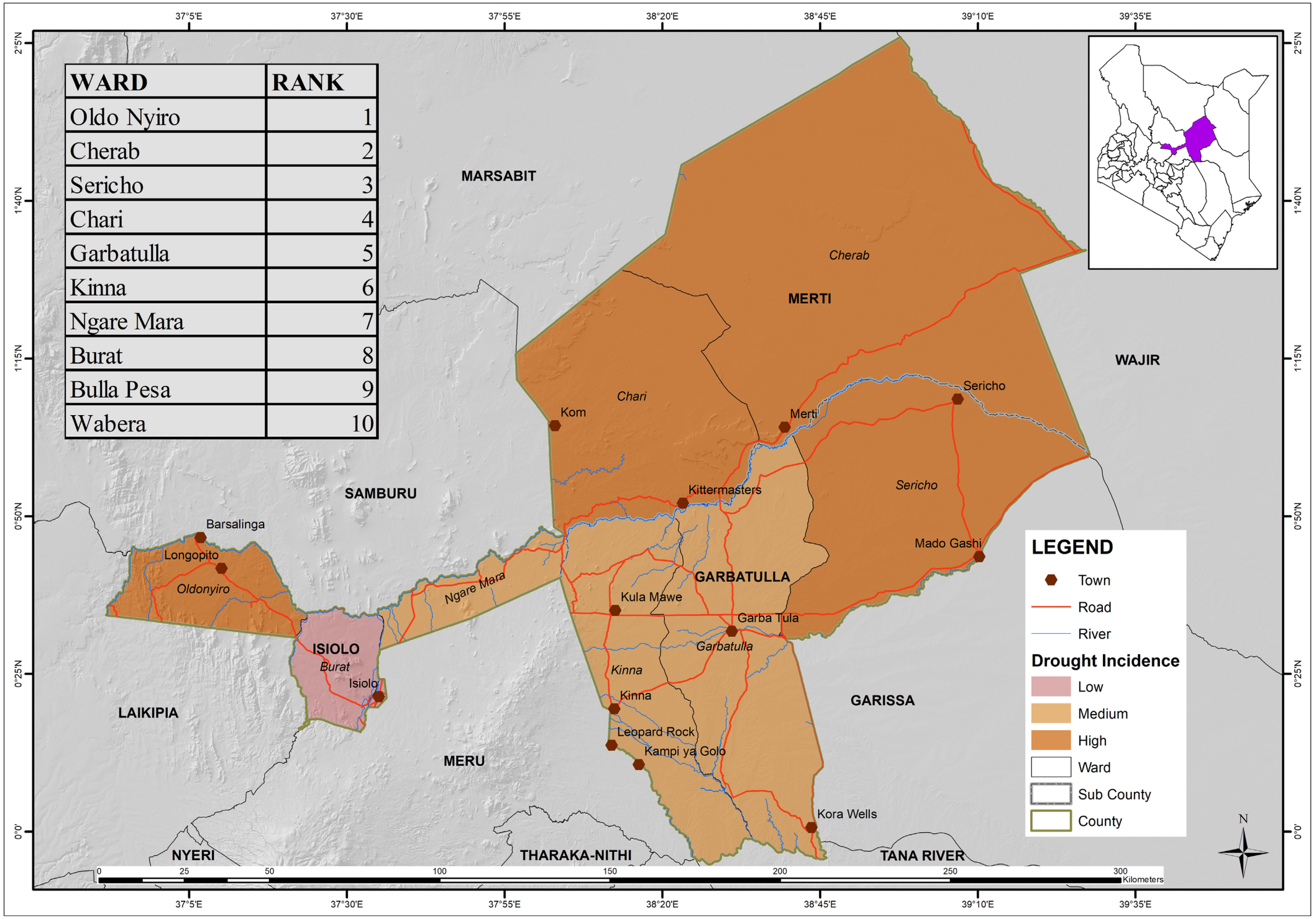
There is a need for integrated soil conservation measures being practised both within Isiolo and other counties that are catchment areas to the rivers in Isiolo County. This will assist in reducing the effect of destruction of forests in the upper catchment areas that eventually results in siltation of water reservoirs and reduction in their water holding capacity of water pans and dam reservoirs. Local initiatives are currently ongoing in a few communities in the county such as the Chari Community Forest Association who spearhead the creation of awareness on environmental conservation. However, the association has since stopped its activities due to lack of funds because the grant provided could only last for two years. With deforestation rampant in the area, women groups have taken the initiative to plant trees but the salty waters of the area inhibit their growth.

3.7.3 Community Conservancies

Community members shield themselves against drought by conducting businesses that involve trading of livestock.
Although the county of Isiolo has no ranches, a ranch in the neighbouring Lewa Wildlife Conservancy is used as a fattening area for livestock bought from Isiolo County. Moreover, through five NRT facilitated conservancies (Nakupratt-Gotu, Leparua, Biliqo-Bulesa, Nasulu and Oldonyiro Community Conservancy) as fattening grounds and migration areas. The NRT through its trading arm, NRT-Trading has been supporting communities in these conservancies by way of commercial livestock off takes.
Other important strategies to mitigate the impact of droughts in Isiolo County are:

- Introduction of drought-resistant crop varieties
- Use of water-saving irrigation
- Putting more land into production
- There is need for improved weather forecasting
- Introduction of better-adapted livestock where the community prefer Zebu and Borana cattle breeds that are drought-and disease-resistant in addition to rearing local goat and sheep breeds
- Food processing and preservation techniques as well the establishment of food banks so as to adapt and cope with the effects of climate change
- Diversification of food production is also necessary

Drought Incidence



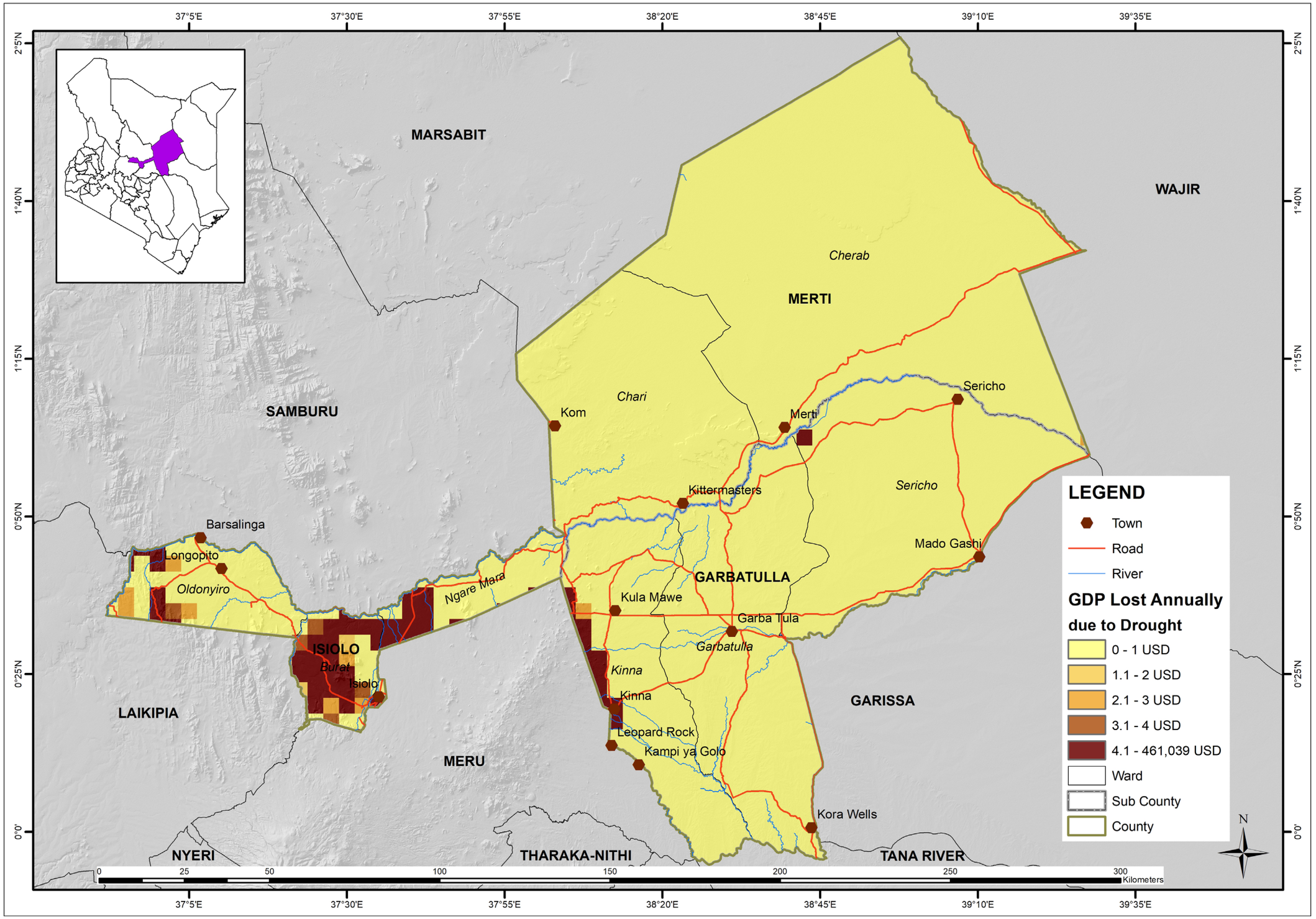
WARD	RANK
Oldo Nyiro	1
Cherab	2
Sericho	3
Chari	4
Garbatulla	5
Kinna	6
Ngare Mara	7
Burat	8
Bulla Pesa	9
Wabera	10

Data sources: *RCMRD (Drought Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows sub-county drought incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. The stakeholders mapped Chari,Cherab, Sericho and Oldonyiro as the wards mostly affected by drought followed by Ngare Mara, Garbatulla and Kinna with medium incidence. Burat, Bulla Pesa and Wabera were ranked as low.

Drought Economic Exposure

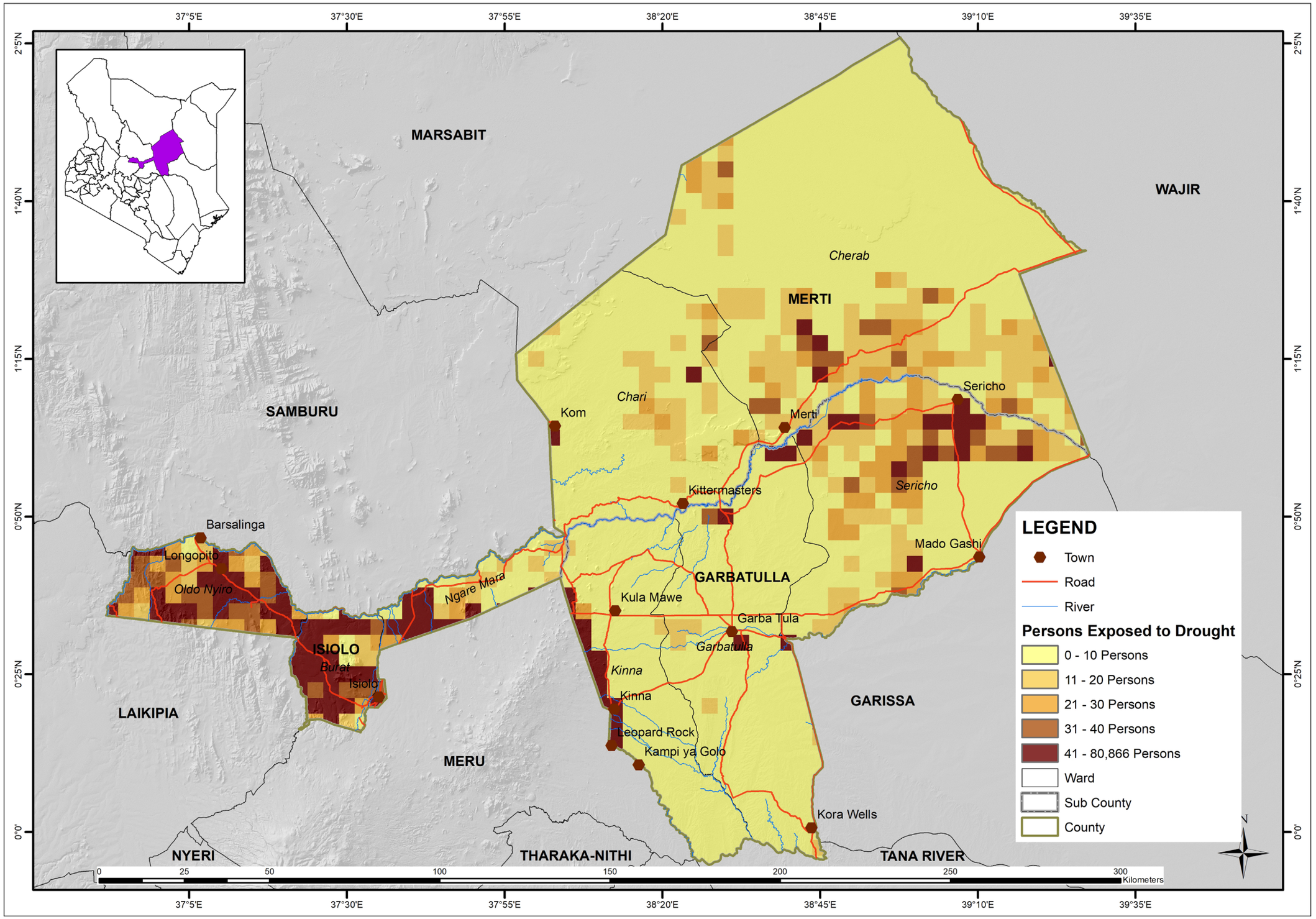


Data sources: *UNEP DEWA-GRID*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map reflects on the impact of drought on both human and livestock population as well as the estimates of economic losses incurred (approximated GDP) in the event of severe drought occurrences in the Isiolo County. Isiolo is the most affected sub-county. Other major losses will be incurred in areas of Kinna and Merti.

Drought Physical Exposure



Data sources: *UNEP DEWA-GRID*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map reflects on the impact of drought on human populations in the event of severe drought occurrences in the county. Most of the persons affected are in densely populated areas in the county such as in Isiolo sub-county. Generally, all people in the county do bear the brunt of drought when it occurs.

Chapter 4:
Conflicts

5.1 Introduction

Conflict is the number one hazard in most areas of Isiolo County mainly affecting Bisan Bilaqo, Chari and Kom regions. Conflicts in the county are mainly between the Samburu, Turkana and Borana communities in the southern regions of the county; and between the Somali and Borana communities in the northern regions. Conflicts are often as a result of competition for water and pasture pitting residents from neighbouring Mandera, Wajir and Samburu counties with the proliferation of arms exacerbates conflicts in the region.

Historically, the county of Isiolo has been embroiled in a series of violent conflicts pitting the different ethnic groups in the county against each other, also affecting the communities in the neighbouring counties. These conflicts have always led to loss of lives, property being looted or destroyed and thousands of people internally displaced. Isiolo County has been affected over the years due to ethnic clashes associated with politics notwithstanding the fact that the county was already mired in resource-based conflicts with pastoralists groups bearing the brunt of the conflicts.

4.2 Types of Conflicts in Isiolo County

4.2.1 Human Conflict

Are a result of competition for pasture. Conflicts are common in Dadara between the Somalis from Garissa and Wajir counties and the Borana of Isiolo County when the Somalis migrate with their livestock into Isiolo County in search of pasture. There have been attempts at improving cohesion through the establishment of Modogashe-Garissa Declaration in 2001 and Nanyuki Declaration in 2019 with local leaders and Civil Society Organizations leading the processes though with little progress so far. There is organized grazing in areas such as Sericho but outsiders often do not follow the set rules. There are few reported cases of human conflicts in Oldonyiro area.

According to Amani Papers developed by UNDP in 2010, a Conflict Analysis Committee/Group (CAG) conducted an assessment of the conflict sub systems in Isiolo County and surrounding region and identified three sub-sets of conflict dynamics (subsystems). These are:

1. Isiolo County internal conflict
2. Isiolo-Samburu East conflict
3. Isiolo-Laisamis conflict

From their findings, it was evident that Isiolo County is the convergent point of conflicts in the region with the Borana community being the hardest hit although they also revenge but in less equal measure.

4.2.2 Human-Wildlife Conflicts

Isiolo County is well known for its abundant wildlife and spectacular landscapes. However, residents of the county have a perennial challenge of access to arable land and pasture for their animals often leading to conflicts between residents and wildlife. The Borana, who consist of the largest ethnic community in the county are nomadic pastoralists, moving from one area to another - within the county and in neighbouring counties in search of pasture and water. Traditionally, men are entrusted with livestock rearing and securing against cattle rustlers, while the women stay home and perform domestic duties. Among the Borana, Turkana, and Ameru living in the county, cattle raids are often a common phenomenon and as expected, the young strong men are often armed during their search for pasture and water for livestock (UNDP, Amani Papers, 2010).

Plate 4.1: A section of a police station fence in Oldonyiro area destroyed by elephants (Source: RCMRD)

Human-Wildlife conflicts involve elephants, leopards, wild dogs, snakes, hyenas and lions. Lions, leopards and hyenas often kill goats and cows but there is no compensation by Kenya Wildlife Service (KWS) who only consider compensation in cases of death or injuries on the residents. There are reported cases of snake bites and hyena attacks in some villages in the county. Community members attempts of keeping lions and hyenas at bay by lighting torches during the night has not been successful hence leading to increased attacks. Despite these frequent attacks from wild animals, generally, the community embraces co-existence with wild animals as they are considered an important part of the environment.

4.3 Causes of Conflicts

4.3.1 Competition for Scarce Resources

The major causes of conflicts are competition for pasture and water. There are existing by-laws that dictate sharing of resources between the communities but are not followed by most communities in the area. The by-laws state that the neighbouring communities need to seek permission to use a watering point or grazing area belonging to an adjacent community. However, according to residents of the county,

the Somali and Samburu do not respect these laws.
Competition for resources including conservancies, boundary disputes and implementation of mega-projects such as the LAPPSET have contributed to resource-based conflicts in the county. Such projects have been met with mixed reactions since some believe that they will contribute to increased opportunities while other members of the community believe that it will impact on their rights, cultures and livelihoods, of concern is their land tenure rights.

4.3.2 Culture and Traditions

Culture and traditions of the Samburu community are also believed to contribute to cattle rustling. Moranism and traditions such as the use of stolen cows for dowry payment have enhanced attacks. The interventions by the government have not borne much fruit with the county commissioner and the Governor of Samburu having tried to act as mediators in the conflict where the Borana accuse the Samburu of not honouring peace agreements. This has contributed to Borana elders boycotting peace meetings with the recent one organized at Kom by the government officials where only two elders from the Borana community attended the meeting. Commercialisation of cattle raids is also an emerging cause of increased conflicts in Isiolo County, often used by those involved as a source of income through the sale of livestock to other regions.

4.3.3 Politics and Community Misconceptions

Cattle rustling, road banditry and border/grazing disputes are the main manifestation of the conflicts. However, these conflicts have not only been greatly politicized but also ethnicized in the process changing the whole dynamic of the conflict to be more political than the traditional resource based jostling (UNDP, Amani Papers, 2010). Easy access to illicit arms, drought, the culture of moranism and misunderstood functions of the various conservancies (under the umbrella of Northern Rangeland Trust) have all conspired to trigger and escalate conflicts in Isiolo County and neighbouring regions.

4.3.4 Challenges in the Land Tenure System

A big percentage of the land in Isiolo County is communally owned and is under the trusteeship of the county government. Since most the land in Isiolo County is communally owned and as a result of lack of documentation, families are often exposed to land fraudsters as the value of land especially around Isiolo town keeps rising due to these mega-projects. Two major causes of challenges in land tenure system include low land registration and initiation of mega projects like LAPSSET. The low registration of titles is a source of resource-based conflicts while major projects cause an influx of people into the county.

4.4 Effects of Conflicts

4.4.1 Property Destruction and the loss of Livelihood

Most of the violent conflicts always result in the destruction of property. Human conflicts often result in residential houses being broken into or burnt down. On the other hand, wild animals such as elephant normally destroy crops in farms costing thousands of Kenya shillings while leopards, lions and hyenas kill livestock causing economic losses to residents.

4.4.2 Injuries

Humans, livestock and wild animals always sustain injuries during conflicts. Injuries are always sustained when wild animals attack humans, cattle rustlers shoot people and animals as well. Competition for pasture leaves wild animals with injuries as well.

4.4.3 Human and Livestock Deaths

Animals and humans lose lives during conflicts. Some of the human deaths are caused due to retaliatory attacks. A huge number of livestock and wildlife are also killed as competition for the limited water and pasture heighten.

4.4.4 Displacement of People

Displacement of people from their homes is a common phenomenon with violent disputes. This occurs when one group overpowers the other conflicting party and forces them to leave their homes and farms.

Plate 4.2: Abandoned village following conflicts between the Somalis and Borana in Garbatulla sub-county (Source: RCMRD)

4.4.5 Disruption of learning

Conflicts disrupt normal school programmes. The schools may remain closed as they are inaccessible. Teachers and students might be forced to remain indoors to avoid injuries and deaths. In some severe cases, schools might be burnt down and learning materials destroyed in the process.

4.5 Conflict Interventions

4.5.1 Integrated Conflict Resolution

The assessment conducted by the CAG recommends that there is a critical need to organize a rapid response and dialogue specifically targeting morans in Isiolo, Samburu and Marsabit, support peace dialogues in the region, strengthen peace committees and address the issue of illicit arms. Conflicts are always solved (managed) after a number of actors, including civil society and communities themselves intervene resulting to a semblance of peace, albeit punctuated by a number of sporadic conflict incidences.

4.5.2 Education and Awareness Creation

In tackling human-wildlife conflicts, scouts from neighbouring conservancies assist in the conservation of trees and wildlife in the county though elephants sometimes destroy property during the dry seasons as they move into the villages to look for water. The community around Oldonyiro areas is working with Save The Elephant initiative to point out wildlife corridors

and educate members of the community not to settle along the corridors to prevent the destruction of property by the elephants. However, along the Ewaso Nyiro River where most residents practice crop farming, there has been reported cases of elephants destroying crops and causing injuries to residents.

The government should initiate steps to address some of the concerns of the residents of Isiolo County including issues regarding land tenure and training of communities to prepare them to be part of the implementation process of some of the mega-projects being piloted in the county.

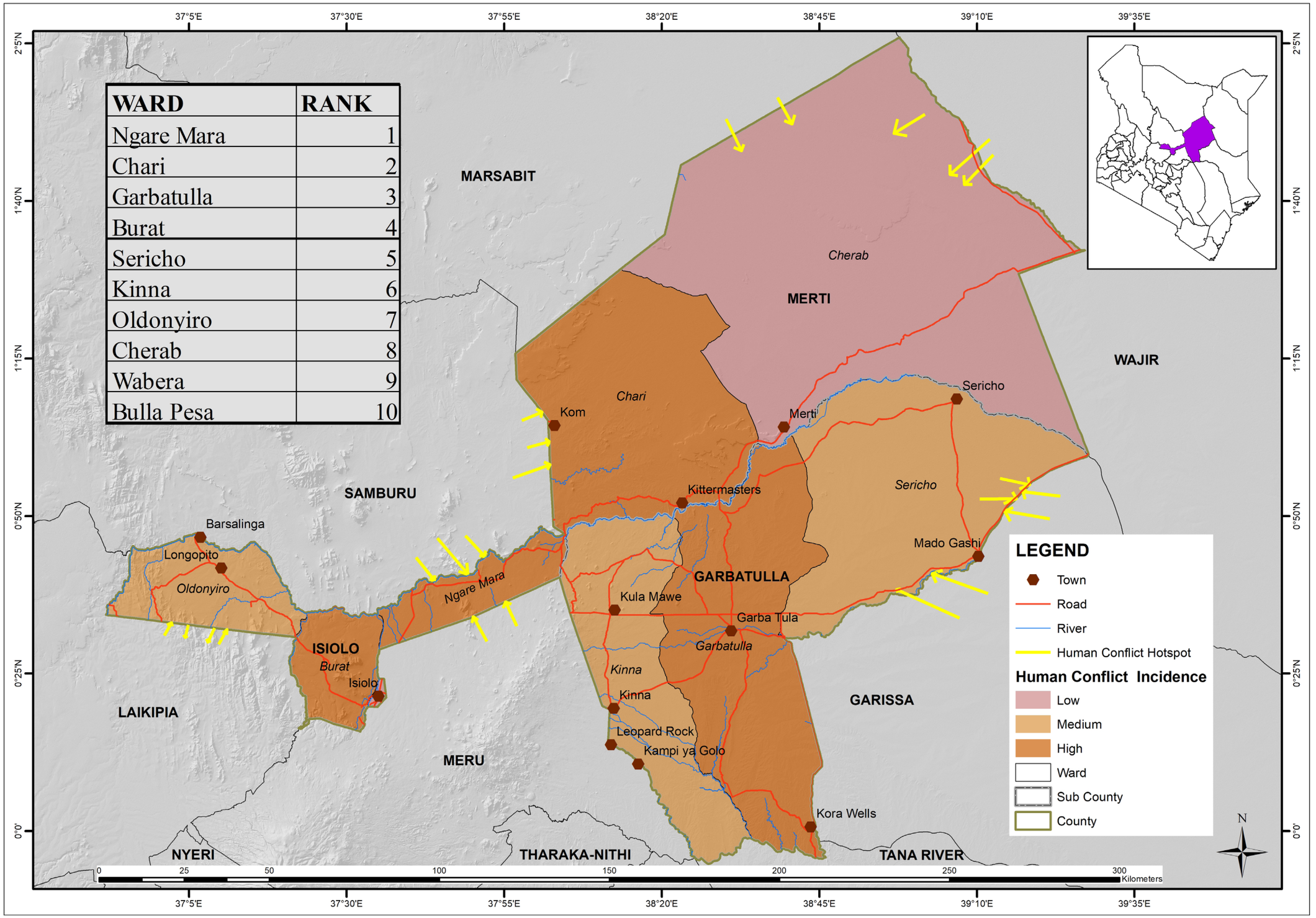
4.5.3 Land Registration

The government, both the national and county governments need to initiate efforts to register land in the county in order to provide proper ownership and determine the value for land. This will assist residents to determine the value of what they own and reduce cases of fraudsters duping them of their property and will also help control the price of land in the county. The community Land Act could also provide a solution to land ownership issues once it is implemented.

Other proposed initiatives to address conflict issues especially related to resource sharing and use would include:

1. Enactment of proper natural resource management policies especially on the management of grazing lands of the county
2. Strengthening the "Nyumba Kumi" initiative
3. Developing livestock traceability techniques
4. Education and empowerment

Human Conflict Incidence



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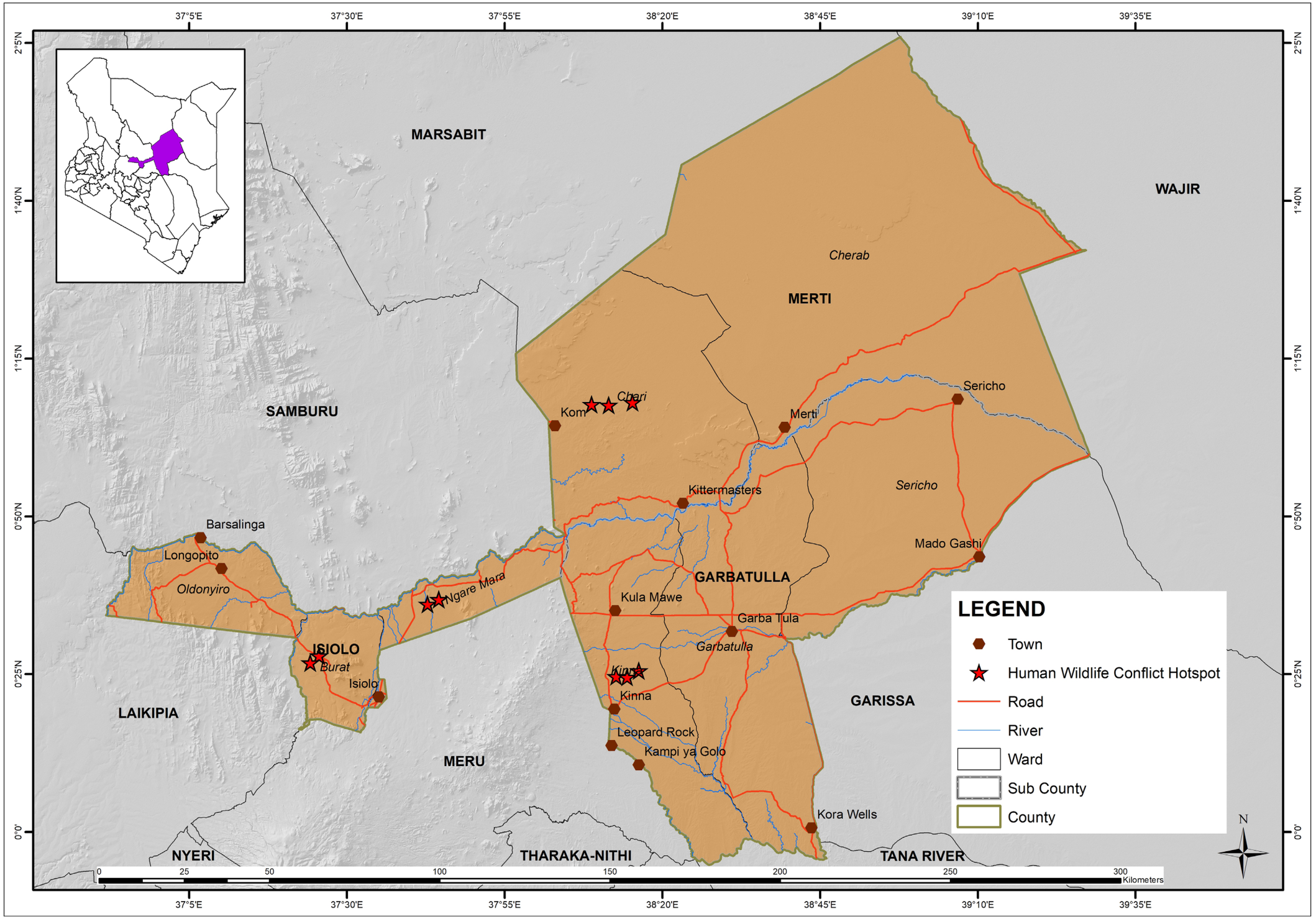
Bulla Pesa	10

Data sources: *RCMRD (Human Conflict Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows human conflict incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Human conflict incidence is high in Chari, Garbatulla, Ngare Mara and Burat, medium in Oldonyiro, Kinna and Sericho and; low in Bulla Pesa, Cherab and Wabera.

Human-Wildlife Conflict Prevalence



Data sources: *RCMRD (Human-Wildlife Conflict Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows human-wildlife conflict hotspots. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Human-wildlife conflict hotspots are in Burat, Ngare Mara, Kinna and Chari wards.

Chapter 5:
Environmental Degradation

5.1 Introduction

Environmental degradation refers to the reduction of the capacity of the environment to meet social and ecological objectives and needs (WHO, 2008). Organization for Economic Co-operation and Development (OECD) further states that environmental degradation is the deterioration in environmental quality from ambient concentrations of pollutants and other activities and processes such as improper land use and natural disasters. Land pressures in the rangelands are increasingly becoming acute due to influx of pastoralist from the neighbouring counties leading to an increase in degradation of much of the dry-season grazing areas on which the locals depend on. Uncontrolled charcoal burning and trade has further led to massive environmental degradation, leading to decreased vegetation cover and increase in environment-related disasters. The vegetation cover has been rapidly depleted exposing the area to the threats of floods and strong winds.

The main challenge in the county remains poor management of natural resources and consequent land degradation. There are no controls over grazing lands, the spread of settlements and water points. Further, no mechanisms exist to ensure equitable sharing of benefits from the natural resource base. This has led to localized degradation of the environment and intensified community conflicts over natural resources (ICIDP, 2013-2017).

5.2 Causes of Environmental Degradation

5.2.1 Soil Erosion

Cases of soil erosion evidenced in Oldonyiro areas of Isiolo County are compounded by the effects of climate change. The County is hot and dry in most months of the year hence the vegetation cover is very low and scattered. This, coupled with strong winds and limited vegetation cover leads to massive soil erosion. Charcoal burning, sand harvesting, overgrazing and overstocking in most parts of the county has been rapidly depleting the vegetation cover leaving more land exposed to soil erosion. Much pressure has been exerted on semi-arid zones due to the rising influx of pastoralists from the neighbouring counties like Wajir, Samburu, Garissa and Marsabit (ICIDP, 2013-2017).

Plate 5.1: Degarded land in oldonyiro sub-county
(Source: RCMRD)

5.2.2 Invasive Species

Invasive species have negative impacts on biodiversity even though some of the invasive species were introduced with the aim of reducing environmental degradation in most of the arid and semi-arid areas in northern Kenya. However, some of these species have proved detrimental to livestock and the ecosystem in general. Some of these plants choke other beneficial plants and affect human health too. Livestock are affected with some of these plants e.g. *prosopis juliflora (mathenge)*, opuntia and ipomoea prevent the growth of grasses and other livestock pasture. In addition, people have been displaced to other lands as a result of total invasion by some of these plants.

There are several species of invasive plants in Isiolo County such as *Acacia Reficiens*, *Opuntia, Raraiti, Sigiit, mathenge* and *Lokitengi*. Plates 5.2, 5.3, 5.4, 5.5 and 5.6 indicate the various invasive species in the county.

Plate 5.2: Lokitengi in oldonyiro sub-county
(Source: RCMRD)

Plate 5.3: Sigiit in oldonyiro sub-county
(Source: RCMRD)

Plate 5.4: Raraiti in oldonyiro sub-county
(Source: RCMRD)

Plate 5.5: Prosopis juliflora (mathenge) in merti sub-county
(Source: RCMRD)

Plate 5.6: Opuntia in Isiolo Central sub-county
(Source: RCMRD)

5.2.3 Need for Energy Sources

The county's main source of energy is wood fuel with over 85% of the households relying on charcoal as their main source of energy (GoK, 2013). Loss of forest land and wetland ecosystems have also lead to loss of biodiversity and ecosystem services. In the absence of mitigation, climate change will lead to reduced crop yields, community migration and loss of livestock productivity.

Plate 5.7: Charcoal selling in Garbatulla sub-county
(Source: RCMRD)

5.2.4 Overgrazing

Livestock farming forms the backbone of the economy of Isiolo County with over 80% of the inhabitants relying on livestock for their livelihoods. Nomadic pastoralism defines the lifestyle of most of the county's inhabitants though it has had a negative impact on the environment due to the tendency of overgrazing caused by overstocking. Intensive dairy production is less prominent economic activity in the county but lately gaining importance as a business with increasing demand for milk products from the growing urban population.

5.2.5 Forest Fires

Forest fires are not common in Isiolo County with the few reported incidences being ignited by honey harvestors and herders.

5.2.6 Poor Solid Waste Management

Cases of improper management are evidenced in Isiolo particularly in the townships and urban centres of the county.

Plate 5.8: poor disposal of polythene bags in Merti sub-county
(Source: RCMRD)

5.3 Effects of Environmental Degradation

5.3.1 Environmental Threats

Environmental degradation has led to decreased vegetation cover caused by massive erosion of the fertile topsoil. This has also led to the loss of fertile soils leading to reduced crop yields. Environment-related diseases such as kalazar, eyes and respiratory problems have also been on the rise as a result pollution of the environment. During the windy season, visibility becomes very poor due to the huge amount of dust. This has induced an increase in both air and water-borne diseases in the county.

5.3.2 High Spatial and Temporal Variability of Rainfall

Agricultural and livestock productivity is worsened by limited, unreliable and poorly distributed rainfall pattern. In recent years the rains have become erratic and unpredictable hence making it difficult to plan on farming. Degradation of the environment through loss of forest land, overgrazing and soil erosion contributing to such changes.

5.3.3 Increased Flooding

Flooding events in recent years have increased in Isiolo County as a result of unpredictable rainfall and the loose bare soil increasing surface runoff. Flash floods have led to sediment pollution, erosion and destruction of infrastructure.

5.3.4 Water Shortages

Degradation generally leads to a reduction of tree cover hence leading to reduced levels of rainfall received in an area. The county's most arid areas are in Merti and Garbatulla sub-counties. Most inhabitants of the county depend on the availability of water for their livelihoods, especially for their livestock. However, water levels in the recent past have reduced leading to drying of shallow wells and ponds that are important reservoirs for the community.

5.3.5 Reduced Crop Yields

Crops need essential nutrients and enough rainfall to reach maturity. However, reduced soil fertility due to erosion and erratic rainfall received in the county have led to crop failure and reduced yields. Reduced crop productivity compromises food security.

5.3.6 Low Pasture productivity

Most of Isiolo County is arid and semi-arid. Any loss in vegetation cover translates to a major reduction in pasture. Livestock rearing is the main livelihood in the drylands practised by over 80% of the inhabitants of the county. Deterioration of such situation eventually leads to deaths of livestock causing economic losses.

5.3.7 Competition for dwindling resources/Human-wildlife conflict

Water shortage, low crop yields and pasture loss as a result of environmental degradation lead to competition for the limited available sources between area residents and animals. Competition for resources can trigger both human conflict and human-wildlife conflict.

5.4 Interventions

5.4.1 County Land Use Policy and Spatial Plans

To be able to control environmental degradation, infrastructure and integrated land use planning is needed (ICIDP, 2018-2022). A County Land Policy and Spatial Plan is set to be formulated by the county government of Isiolo to provide a framework to address many of the land challenges facing the county including land and boundary disputes, land degradation and sharing of benefits from natural resources.

5.4.2 Control of soil erosion

Environmental degradation through soil erosion has increased though the county government is supporting building of gabions, especially in Oldonyiro areas. Control of soil erosion through planting of fruit trees using modern methods of water harvesting in the rehabilitated areas. Other land reclamation activities currently ongoing in the county include: controlled grazing, water harvesting, and pasture reseeding.

Plate 5.9: Control of soil erosion in Oldonyiro using gabions (Source: RCMRD)

5.4.3 Adaptation strategies to loss of forests ecosystems

Coordination of ecosystem restoration efforts being led by the Kenya Forest Service (KFS) and the county government need to be strengthened in order to achieve restoration and sustainability of the ecosystem of the county. Such strategies would include forest fire management and prevention as well as promoting energy efficiency; forest conservation and promotion of other construction materials will help ease pressure on forest resources in the county; forest farming through the establishment of tree nurseries and sale of seedlings would provide income for residents; and protection of water catchment areas. Improvement of soil fertility in Isiolo County has been significantly achieved through agroforestry.

5.4.4 Provision of alternative sources of energy

Wood fuel is collected from shrubs and trees on community land mainly for domestic use though with the rapid growth of Isiolo town due to major development projects, there is potential demand for energy. There is, therefore, need to invest in renewable energy e.g. solar, wind and biogas to meet the increasing demand and reduce pressure on available wood fuel sources.

5.4.5 Promoting Tree Planting Initiatives

Various stakeholders with coordination from KFS could promote tree planting initiatives in schools, institutions and private farms. Notably, women groups in Merti sub-county are currently engaged in efforts to plant trees though a major concern is the availability of water since most undergroundwater is salty, and destruction of these trees by wild animals is a major setback to their efforts.

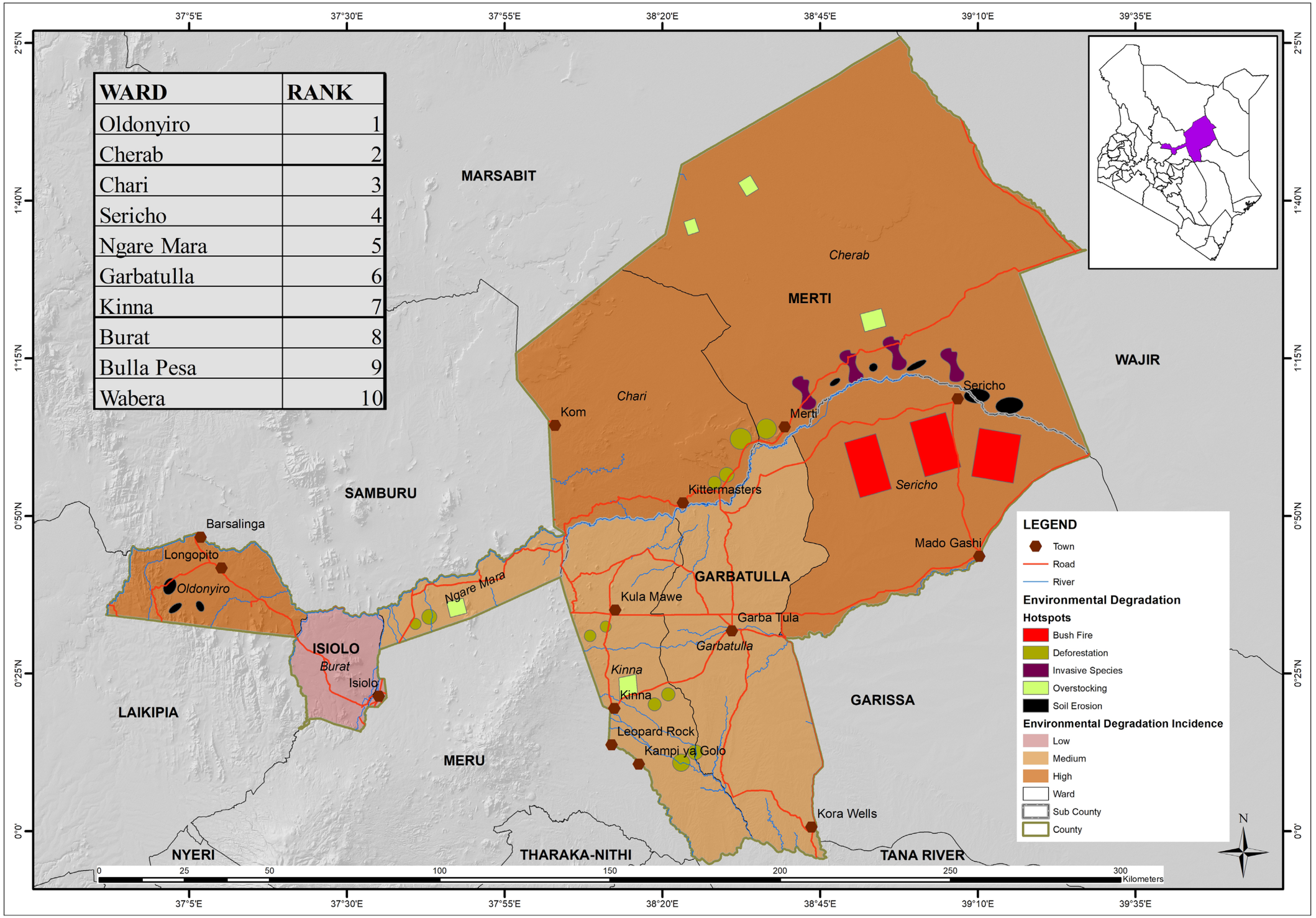
Beautification activities in towns, highways, schools, homes and other public places could also promote these initiatives and farming of fruit trees including pawpaw, avocados and guavas could help in increasing the general tree cover in the county. KFS in collaboration with other stakeholders are looking for ways of coming up with medicinal farms in the county through planting of species such as: Neem (Muarobaini), cabbage tree (Muringaste stenopetala), Terminalia brownii and Tamarind (mkwaju) (ICIDP 2018-2022).

5.4.6 Proper Solid Waste Management Facilities

In addition to the integrated spatial plan that the county government is planning to formulate, there is a need to develop legislations on solid waste management. There is only one dumpsite in Isiolo County and its located in Isiolo town even though there are still challenges of coordination of solid waste collection in the county as a result of few disposal sites and refuse collection areas.

Environmental Degradation Incidence

WARD	RANK
Oldonyiro	1
Cherab	2
Chari	3
Sericho	4
Ngare Mara	5
Garbatulla	6
Kinna	7
Burat	8
Bulla Pesa	9
Wabera	10



Data sources: *RCMRD (Environmental Degradation Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows environmental degradation incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Factors that contribute to degradation are bush fire, increment of invasive species, deforestation, overstocking and soil erosion. Environmental degradation incidence is high in Chari, Cherab, Sericho and Oldonyiro, medium in Garbatulla, Kinna and Ngare Mara and; low in Burat, Bulla Pesa and Wabera

Chapter 6:
Human, Livestock And Crop Diseases And Pests

6.1 Introduction

A disease is a particular abnormal, pathological condition that affects part or all of an organism (Dor-land's Medical Dictionary). The most prevalent diseases in Isiolo County in the order of prevalence are: Upper Respiratory Tract Infections, Malaria, Pneumonia, Otitis Media and Gastroenteritis (ICIDP, 2018-2022). Substance abuse is a major concern in the county. Some of the commonly abused drugs are *miraa, 'Kete', Cocaine, bhang, kuber* and *muguka*. Drug abuse impairs judgement and causes people to abscond their duties and responsibilities.

The spread of water-borne and vector-borne diseases has been exacerbated by inadequate sanitation services. This has led to disease proliferation and compromised public health. Prevalence of human diseases like cancer, HIV, Diarrhoea, Diabetes and Kalazar have increased with most health facilities lacking medication, especially in Sericho and Merti areas. Medical laboratory services in Merti and Garbatulla sub-counties are also inadequate with the only available facilities in Isiolo town and in the neighbouring town of Habaswein, Wajir County. There is no maternity facility in Sericho area with the only existing dispensary in the area need some renovations. The average distance to a health facility is 20 km and due to the fact that there are inadequate health facilities in the county, access to family planning is a big challenge (ICIDP, 2018-2022).

6.2 Human Diseases

6.2.1 Upper Respiratory Tract Infection (URTI)

Upper Respiratory Tract Infections are viral infections that affect the nose, paranasal sinuses, pharynx, larynx, trachea, and bronchi. Dust and cold are the two causative agents of URTI in Isiolo County. Types of URTIs include rhinitis, pharyngitis/tonsillitis and laryngitis also known as a common cold. Common and rare symptoms include vomiting, sneezing, itchy and watery eye, nasal discharge, cough, shortness of breath, nasal congestion, body aches, foul breath, nasal breathing, reduced ability to smell, fever, scratchy or sore throat, painful swallowing, nausea, fever, sinus pain, running nose, diarrhoea, headache and malaise. Some of the URTI are contagious. Control involves covering nose while sneezing or coughing, avoiding congested areas and proper hand washing and thorough ventilation in housing (www.medicinenet.com & www.clevelandclinicmeded.com).

6.2.2 Malaria

Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female anopheles mosquitoes. The disease is caused by plasmodium parasites. The first symptoms are chills, fever and headache. Other symptoms include muscle pain, fatigue, sweating, chest and abdominal pain, nausea and vomiting. Children under 5 years are mostly affected by malaria. If not treated soon enough malaria causes severe anaemia, respiratory distress in relation to metabolic acidosis, or cerebral malaria. In adults, multi-organ failure is also frequent. Prevention is by vector control through use of Insecticide Treated Nets (ITN) and indoor residual spraying once or twice a year. Other measures include draining stagnant water and clearing any vegetation that might act as mosquito breeding ground.

6.2.3 Pneumonia

Pneumonia is an infection that inflames the air sacs in one or both lungs. Pneumonia can be caused by bacteria, viruses and fungi. Symptoms of pneumonia include cough with phlegm or pus, fever, chills, difficulty breathing, rapid heartbeat, loss of appetite and chest pain. Prevention include washing especially hands regularly, eating right, exercising, getting enough sleep, quitting smoking and staying away from sick people, if possible.

6.2.4 Otitis Media

Ear infections occur when a cold, throat infection or allergy attack causes fluid to become trapped in the middle ear. Symptoms include earaches, drainage of fluid from the ears, diminished hearing, headache and difficulty sleeping. Children exhibit crying than usual, loss of balance, pulling of the ears, fever and loss of appetite. Prevention include proper hygiene and avoiding illnesses like common cold. Antibiotics may be administered depending on the severity of the infection (www.healthline.com).

6.2.5 Gastroenteritis (Stomach Flu)

This is a condition that affects the stomach and it is caused by bacteria. The main symptoms are watery diarrhoea, vomiting, cramping, fever, nausea, loss of appetite, aching limbs and headache. Gastroenteritis affects people of all ages but mostly children. Main causes are poor hygiene and being in contact with someone who has the virus. Remedy include observing proper hygiene like cleaning hands with soap after visiting the toilet, taking lots of fluids to avoid dehydration, taking rest and taking pain killers for the aches (www.nhsinform.scot). Doctor should be seen for proper diagnosis.

6.2.6 HIV and AIDS

The medical reports from Isiolo County health department (DHIS, 2017) indicate that HIV prevalence has reduced from 4.9 percent in 2012 to 3.8 in 2017. However, the major affected areas are Isiolo town, Garbatulla, Ngaremara and Merti. The threat posed by HIV and AIDS is the increase of orphaned and vulnerable children and the death of productive population. It also increases demand for health services and health care provision. The Interventions to address the threat should be multi-sectoral. The county and constituency AIDS technical committees must mobilize all stakeholders in the fight against new infections and promote community-based care for those infected and affected by AIDS. HIV and AIDs related issues must further be mainstreamed in all the development activities in the county and also need to focus more on health education for prevention of mother to child transmission.

6.2.7 Kalazar (Visceral Leishmaniasis)

Visceral Leishmaniasis (kalazar) is a deadly disease caused by the Leishmania protozoan parasite and transmitted through

the bite of infected female sandflies. There are three forms of leishmaniasis; Visceral leishmaniasis (VL), Cutaneous, Muco-cutaneous. VL is the common form leishmania in Marsabit (Aduba, 2016). Symptoms of kalazar include swollen lymph nodes, bleeding, enlarged liver, decreased production of blood cells, enlarged spleen, fever that lasts for weeks or months and weakness (www.healthline.com). Kalazar is a common disease in Isiolo County. Lack of awareness, inadequate trained medical personnel, cultural practices and long distances to the referral hospital are some of the challenges faced with regards to kalazar treatment in the county. Kalazar can be prevented by wearing clothes that cover as much skin as possible and using repellant.

Plate 6.1: Sandfly
(Source: https://scroll.in Credit: Frank Collins/Wikimedia Commons)

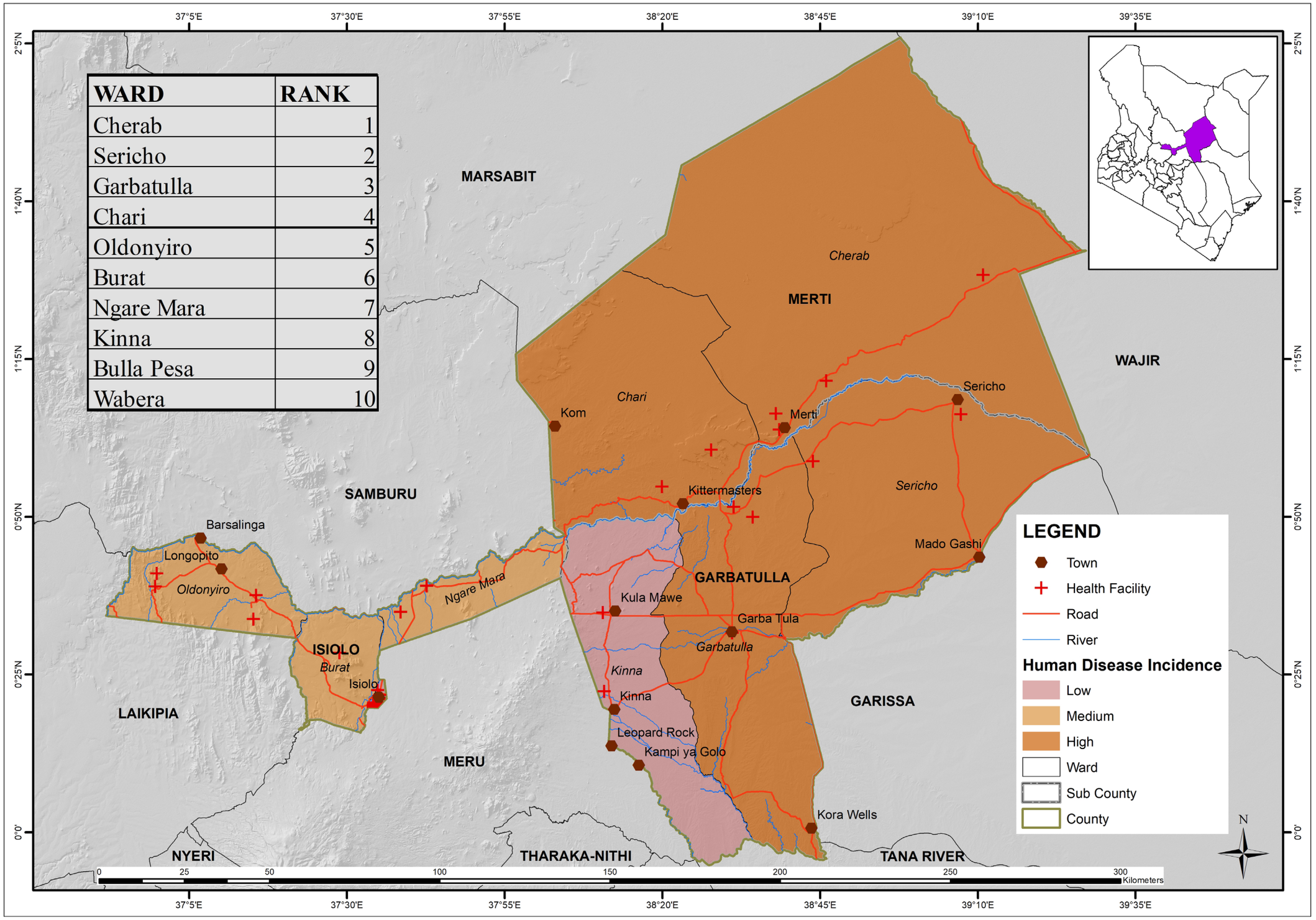
6.3 Impacts of Human Diseases

- Affected health nutrition status
- Malnutrition
- Weakened immune system
- Reduced productivity
- Health deterioration
- Loss of weight
- Loss of appetite
- Anaemia
- Death

6.4 Interventions

- Health education
- WASH promotion
- Community outreaches for the very remote areas
- Treatment through referrals
- Provision of right drugs at the facilities
- Provision of long-lasting insecticidal treated nets
- Provision of water treatment supplies
- Adequate personnel and health equipment

Human Disease Incidence



WARD	RANK
Cherab	1
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Data sources: *RCMRD (Human Disease Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows human disease incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Human disease incidence is high in Chari, Cherab, Sericho and Garbatulla, medium in Oldonyiro, Burat and Ngare Mara and; low in Kinna, Bulla esa and Wabera.

6.5 Livestock Diseases

Livestock production in Isiolo County is a major economic activity in the county with over 80% of the inhabitants relying on livestock for their livelihoods. Though nomadic pastoralism is more prominent in the county and often characterised by the tendency of overgrazing as a result of overstocking, intensive dairy farming. Conseqently, this has resulted in increased cases of livestock diseases.

Common livestock diseases in Isiolo County include Foot and mouth, Lumpy skin disease, Peste des Petits Ruminants (PPR), East coast fever and Trypanosomiasis, Newcastle disease, Contagious Caprine pleuropneumonia (CCPP), Heart Water, Goat Pox and camel flu. Ticks, tsetse fly, Tite (Buko) and fleas are not common livestock pests. There are seasonal vaccinations conducted by the county government and Food and Agriculture Organization (FAO), CARITAS and RLPRP although locals often take the initiative to purchase drugs and pesticides and have veterinary officers administer the medication.

6.5.1 Foot and mouth disease

Foot-and-mouth disease (FMD) is a highly contagious acute viral infection of cloven-hoofed animals including domesticated ruminants and pigs and more than 70 wildlife species and is one of the most important economic diseases of livestock (Coetzer et al., 1994, Broonsvoort et al., 2004). The disease is characterized by fever, loss of appetite, salivation and vesicular eruptions in mucosa of the mouth, skin of the inter-digital spaces and coronary bands of the feet and teats. It is also characterized by high morbidity and low mortality (Coetzer et al.,1994).

The disease spreads rapidly by the movement of infected animals or mechanically on fomites such as clothing, shoes, vehicles, and veterinary instruments. The reasons for the rapidity of spread to fully susceptible populations is due to the highly infectious nature of the virus, the production of high titer in respiratory secretions and the large volumes of droplets and aerosols of virus shed by infected animals. The stability of virus in such droplets, the rapid replication cycle with very high virus yields and the short incubation period begins (Sellers, 1971).

Plate 6.1: Goat suffering from foot and mouth disease (Source: RCMRD)

Plate 6.2: Cow that exhibits signs of foot and mouth disease (Source: www.informante.web.na)

6.5.2 Lumpy Skin Disease

Lumpy skin disease is a viral disease of cattle that is spread by biting insects. Less commonly, the virus may be spread by direct contact to the skin lesions, saliva, nasal discharge, milk, or semen of infected animals. The virus, which is closely related to the pox viruses of sheep and goats and causes nodular skin lesions on the animal's body. The most apparent sign is multiple nodules on the body, including the muzzle, nostrils, head, neck, back, legs, scrotum, perineum, udder, eyelids, nasal and oral mucosa and tail. Other signs include fever, loss of appetite, discharge from the eyes and nose; drop in milk production and weight loss (CFSPH, 2018). Treatment involves use of strong antibiotic therapy. Prevention includes control of vector (mosquitoes and other biting flies) and quarantine of infected animal.

Plate 6.3: Cow suffering from lumpy skin disease (Source: www.tieraerzteverlag.at)

6.5.3 East Coast Fever

East Coast fever is a disease of cattle, sheep, goats and buffalo caused by a protozoan parasite transmitted by ticks. The major symptoms include enlarged lymph nodes, soft cough due to fluid in lungs, difficulty in breathing, bloody diarrhoea, muscle wasting, white discolouration of eyes and gums, paralysis and death if not treated early enough (University of Strathclyde, 2016). East Coast fever is managed by tick control, vaccination and chemotherapy (GALVmed, 2016)

6.5.4 Contagious Caprine Pleuropneumonia (CCPP)

Contagious Caprine Pleuropneumonia (CCPP) is a highly contagious infectious disease of goats caused by the *Mycoplasma mycoides capri and Mycoplasma F38 bacteria.* CCPP causes inflammation of the lungs and accumulation of fluid in the chest cavity. Damaged lung tissue can harden and adhere to the chest wall, which interferes with effective respiration and causes the goat to die from lack of oxygen. Mortality rates can reach 100%. The disease is spread through the inhalation of airborne droplets from coughing/sneezing animals. Direct goat-to-goat contact is necessary for the disease to spread. Symptoms include fever, weakness, lethargy, coughing, difficulty in breathing, frothy nasal discharge, stringy saliva,

anorexia (poor appetite) and exercise intolerance (FAO, 2016). CCPP can be treated by the use of antibiotics. Vaccinations and quarantine of infected animals can be used to control the disease.

6.5.5 Peste des Petits Ruminants (PPR)

Peste des petits ruminants is a viral disease of sheep and goats. The virus is secreted in nasal discharge, tears, secretion from coughing and faeces of infected animals. Transmission is through close contact between animals. Symptoms are loss of appetite, clear nasal discharge, sores in the mouth, diarrhoea, pneumonia, eye infection-causing eyelids to mat together with discharge, fever and sometimes death. Goats are more affected than sheep. Infection is common in young animals. Control is through vaccination, cleaning and disinfection, quarantine, control of movement and culling (www.oie.int).

6.5.6 Newcastle Disease (NCD)

Newcastle disease is an infection of domestic poultry and other bird species with virulent Newcastle Disease Virus (NDV). It primarily as an acute respiratory disease, but depression, nervous manifestations, or diarrhoea may be the predominant clinical form. Severity depends on the virulence of the infecting virus and host susceptibility. The occurrence of the disease is reportable and may result in trade restrictions. Newcastle Disease (NCD) was reported in local poultry in both the mixed farming and livestock zone. One can lose a whole brood of birds in a single stroke. This spells out serious economic loss to the family.

6.5.7 Anaplasmosis/Rift Valley fever

Anaplasmosis is a vector-borne, infectious blood disease that affects cattle. The disease is also known as yellow fever or yellow bag. Anaplasmosis is caused by parasites Anaplasma marginale and Anaplasma centrale that infect the red blood cells and causes severe anaemia. The disease is mostly spread by ticks. Symptoms include weight loss, anaemia, difficulty in breathing, fever, uncoordinated movements, abortion, jaundice and death (www.thecattlesite.com). Medicines can be used for treatment but prevention is through vector control and vaccinations to enhance resistance.

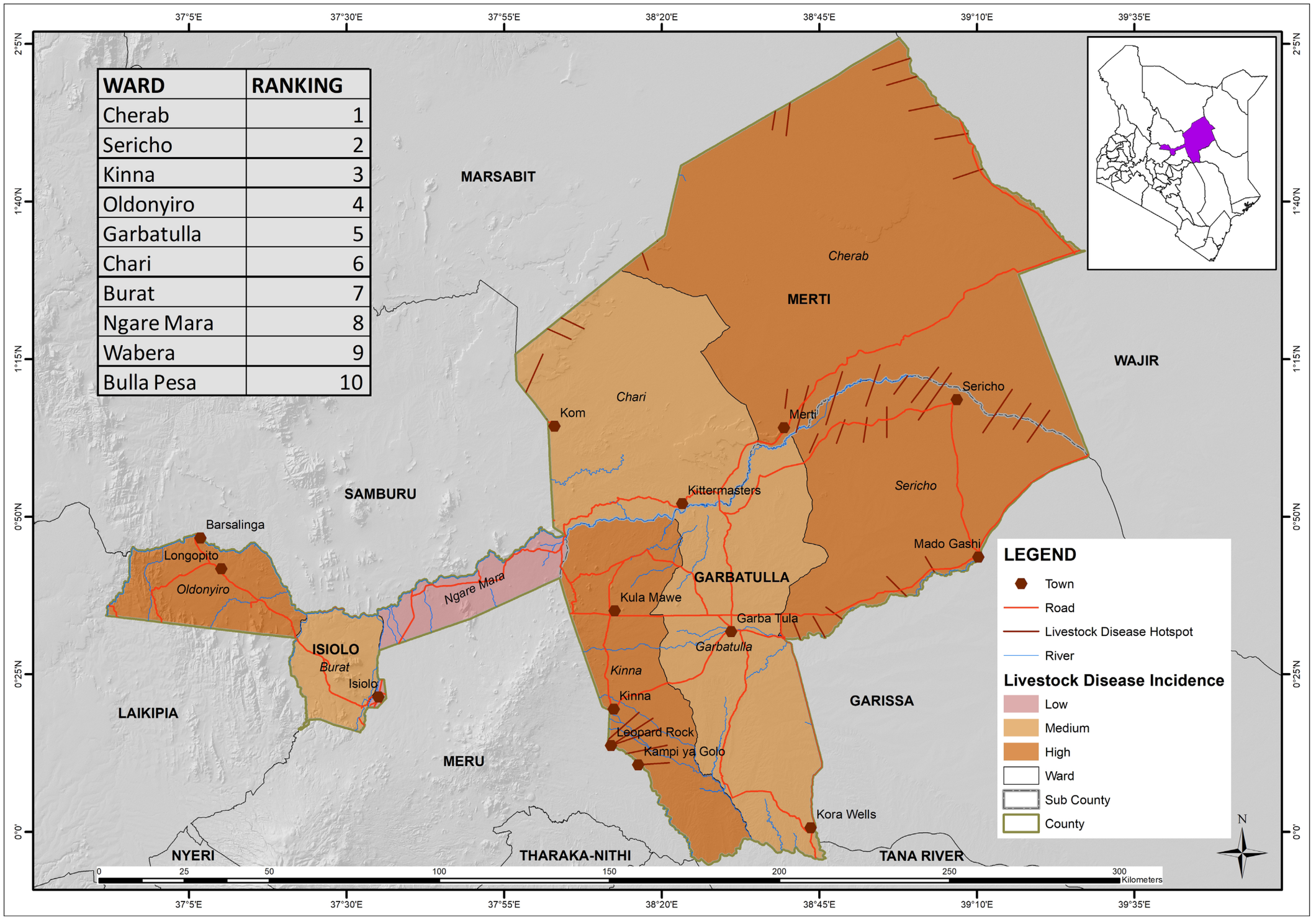
6.6 Impacts of Livestock Diseases

- Loss/ Reduction of income
- Loss/decline of household assets
- Loss of livelihood

6.7 Interventions/Control

- Provision of Veterinary expertise and conducting regular disease surveillances and community awareness programs on a regular basis
- Routine livestock vaccination
- Vector control –Dips
- Livestock training and veterinary extension services to all livestock keeping communities
- Deworming
- Breed improvement programmes
- Quarantine
- Disease Surveillance

Livestock Disease Incidence



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Data sources: *RCMRD (Livestock Disease Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows livestock disease incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Livestock disease incidence is high in Cherab, Sericho and Kinna, medium in Garbatulla, Burat and Chari and; low in Ngare Mara, Wabera and Bulla Pesa.

6.8 Crop Diseases and Pests

Minimal crop farming takes place in Isiolo County. Irrigated farming is the only viable type of farming and is practised mostly along the river beds. Major rivers that provide water for irrigation include Bisan Adhi, Kinna and Waso Nyiro (ICIDP, 2018-2022). According to ICIDP (2018-2022), there are 20 irrigation schemes in the county namely: Iresaboru, Malkadaka, Garfarsa, Kinna, Rhapsu, Guba Dida, Darazani, Korobesa, Mata Arba, Mlanda Nur, Bulesa, Biliqo Marara, Gambella, Kambi Seikh, Kakili, Kilimani- Game Galana, Ntirim, Oldonyiro, Elsa Ntirim, Akideri and Bulesa Dima. The main crops grown in the county include maize, sorghum, beans, green grams, nerica rice, cowpeas, dolicos, kales, tomatoes, onions and watermelons (ICIDP, 2018-2022). Fruit trees grown are avocados, citrus, mangoes, guavas and pawpaw (ICIDP, 2018-2022). The main crop diseases and pests in the county are: Early and late blight, powdery mildew, smut, rust, maize streak, root rot, bacterial wilt, fall army worms, locusts, thrips, aphids, whiteflies and rodents.

6.8.1 Bacterial Wilt

Bacterial wilt is a disease caused by a *bacterium Ralstonia Solanacearum* which lives in the soil. The disease affects tomatoes, potatoes, tobacco, eggplant and bananas. Bacterial wilt causes the plant to wilt and die quickly with little warning. Bacterial wilt happens where plants have been cut, injured or weakened by insects or simply by cultivation. The bacterium clogs up the stem, preventing water and nutrients from reaching the leaves and the plant dies. All branches wilt at about the same time. When the stem of a wilted plant is cut across, the pith has a darkened, water-soaked appearance. There is a greyish slimy ooze on pressing the stem. In later stages of the disease, decay of the pith may cause extensive hollowing of the stem. Bacterial wilt causes no spotting of the fruits. Affected roots decay, becoming dark brown to black in colour. If the soil is moist, diseased roots become soft and slimy (www.infonet-biovision.org). Prevention is through adequate spacing between plants, crop rotation, growing resistant crops and washing hands after handling infected plants (www.tomatodirt.com).

Plate 6.1: Bacterial wilt on tomatoes
(Source: www.tomatodirt.com)

6.8.2 Head Smut

Head smut is a fungal disease that affects maize. The disease is caused by the fungus *Sphacelotheca reiliana*. Symptoms are most commonly noticed when corn tassel and ear appear. Affected ears are round or tear-drop shaped, lacking silks, and filled with black spores. Tassel infection may be limited to individual spikelets or may cover it completely with leaf-like formations emerging, forming unusual structures on infected tassels (www.pioneer.com). Infected tassels do not produce pollen. Control is through use of fungicides on seeds before planting, use of certified seeds, crop diversification and proper disposal of affected crops by burning and burying in pits.

Plate 6.2: Maize cobs affected by head smut
(Source: www.gardeningknowhow.com)

6.8.3 Late Blight

Late blight is a fungal disease that affects potatoes and tomatoes. It is caused by the fungus *Phytophthora infestans.* The disease occurs later in the growing season. Symptoms include blackish/brown lesions on leaves and stems that may be small at first and appear water-soaked or have chlorotic borders but expand rapidly and the entire leaf becomes become necrotic (www.apsnet.org). Control is through the application of fungicide immediately the disease is detected. Other measures include use of certified seeds and capacity building.

Plate 6.3: Tomato plant severely affected by late blight
(Source: newsstand.clemson.edu Credit: Howard Hart)

6.8.4 Powdery Mildew

Powdery mildew is a fungal disease. It is caused by a variety of closely related fungal species, each with a limited host range (www.planetnatural.com). Conditions such as dampness, crowded plantings and poor air circulation contribute to the spread of powdery mildew. Powdery mildew starts on young leaves as raised blister-like areas that cause leaves to curl, exposing the lower leaf surface. Infected leaves become covered with a white-grey powdery growth, usually on the upper surface. Leaves of severely infected plants may turn brown and drop. The disease is common in young, succulent growth and mature leaves are usually not affected. Control involves growing non-resistant varieties, destruction of all infected plant parts, thinning and pruning to improve air circulation, not watering plants from above and application of fungicide.

6.8.5 Fall army worms

Fall army worms also known as *Spodoptera frugiperda* are crop pests that prefer to feed on maize but also target wheat, millet, cotton, sorghum, sugarcane, tobacco, potatoes and rice. The fall armyworm's head has a predominantly white, inverted Y-shaped suture between the eyes. Young larvae are greenish or brownish in colour and smooth-skinned. Mature larvae vary from light tan or green to nearly black. They have three yellow-white hairlines down their backs. On each side and next to the yellow lines is a wider dark stripe. The moths have dark grey, mottled (coloured spots) on the forewings with light and dark splotches (marks), and a noticeable white spot near the extreme end of the worm. The cause tattered edges and holes on leaves. Control is by use of pesicides (www.theorganicfarmer.org), certified seeds, crop diversification, crop rotation and push-pull technology that relies on use of natural plant chemicals that drive insect pests away from the crop and attract them to other host plants.

Plate 6.5: Fall army worm lava
(source: syngenta)

Plate 6.6: Maize crop affected by fall army worm
(Source: RCMRD)

6.8.6 Rust

This is a fungal disease that affects various plants such as beans and tomatoes. The disease affects mature plants with symptoms appearing on lower leaves. The first symptoms include raised spots on the underside of leaves and stems. The spots become covered with reddish-orange spore masses. Severe infestations deform leaves and cause them to drop. Control is through spacing plants well to aid in circulation, removing infected leaves, clearing fallen debris under plants and avoiding splashing water on leaves (www.planetnatural.com).

Plate 6.6: Bean Rust
(Source: www.plantwise.org)

6.8.7 Maize Streak Virus

This is a viral disease transmitted by leafhoppers. The disease causes yield losses due to plants stunting, termination of ear formation, development and grain filling (KALRO, 2014). The first sings are very small, round, scattered spots in the youngest leaves. The number of spots increases with plant growth and they enlarge parallel to the leaf veins. Fully elongated leaves develop chlorosis with broken yellow streaks along the veins, contrasting with the dark green colour of normal foliage (KALRO, 2014). Control is through planting maize in an open area as leaf hoppers prefer shade, planting resistant varieties, rotating maize with legumes, avoiding planting maize in the direction of the wind, keeping the field free of weeds that can harbour the virus such as grasses, planting early to avoid the optimal temperature for vector multiplication and subsequent transmission of the virus and using appropriate insecticides (KALRO, 2014).

Plate 6.7: Maize plant infected with maize rust virus
(Source: www.plantwise.org)

6.8.9 Aphids/Turnip Aphid

Aphids are insects that affect various crops such as cabbages, corn, pea, rice and soybeans. Aphids are small, soft-bodied, pear-shaped insects that may be green, yellow, brown, red or black in colour depending on species and food source. Generally, adults are wingless, but some can grow wings, especially if populations are high. These insects feed on plant sap which may cause rolling, twisting or bending of leaves. A heavy infestation can turn leaves yellow and eventually wilt. Aphids feeding on flower buds and fruits may cause malformed flowers and fruits. Aphids excrete a sugary, sticky liquid called honeydew that accumulates on leaves and branches. Heavy coating with honeydew and sooty moulds may reduce photosynthesis, affecting plant growth and yield (www.infonet-biovision.org). Control is by pruning heavily infested plant parts and spraying with cold water.

Plate 6.8: Corn leaf aphids
(Source: www.omafra.gov.on.ca)

Plate 6.9: Aphid colonization on corn
(Source: www.extension.entm.purdue.edu)

6.8.10 Tomato Leafminer (*Tuta absoluta*)

This is a destructive insect pest to tomato plants and fruit and also infests other plants. The larvae live as miners in the leaves, fruits and stem of plants. The larvae leave marks all over the plants. The adults attack at night. Control is by ploughing, manuring, irrigation, crop rotation, solarization and the elimination of symptomatic leaves and destruction of infested tomato plants have all been used to control this pest (www.greenlife.co.ke).

Plate 7: Tomato leaf and fruit affected by Tuta absoluta
(Source: agropedia.iitk.ac.in)

6.8.11 Parasitic Worm Infections - Helminthiasis

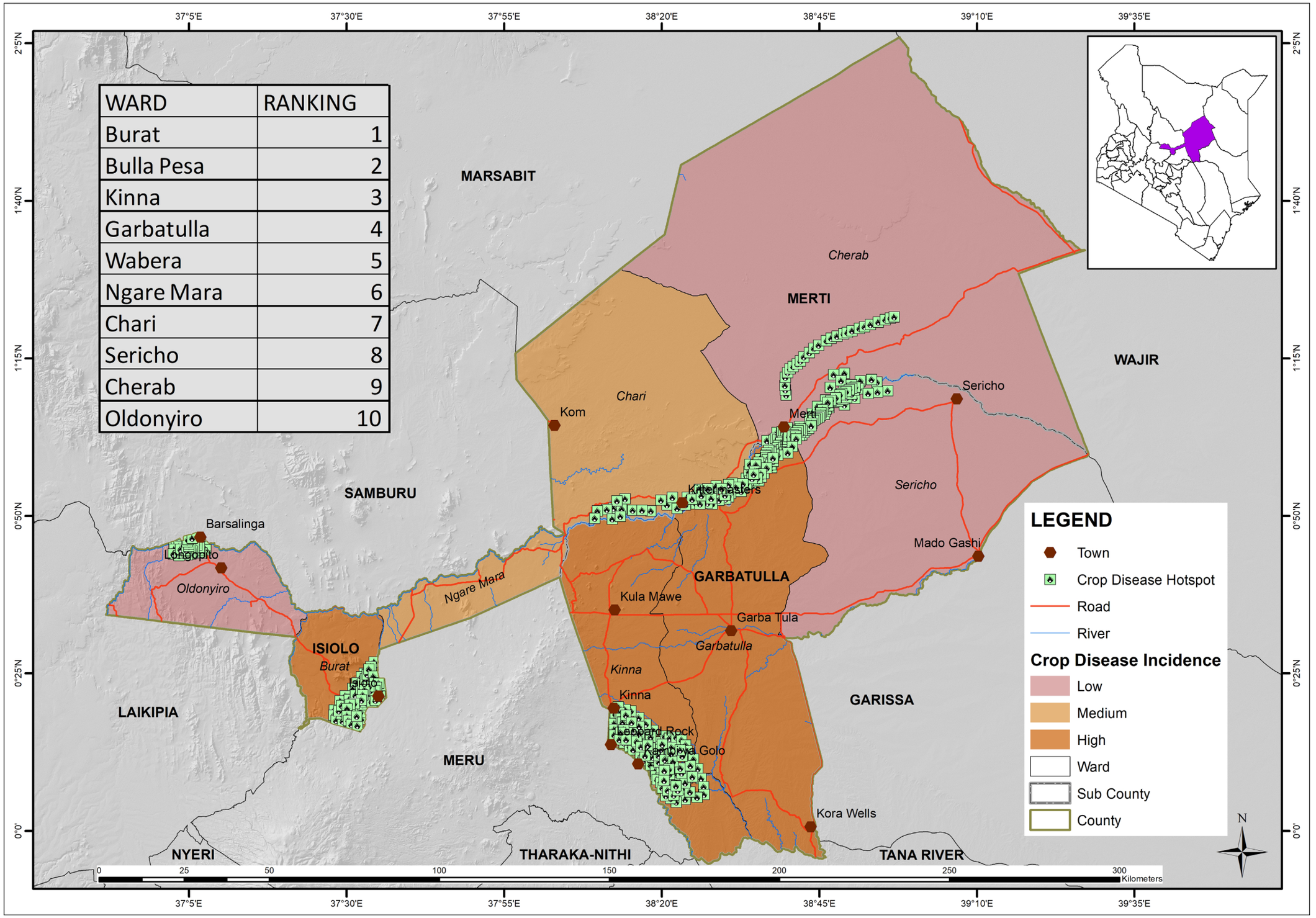
Parasitic worm infections are a major public health issue in many tropical and subtropical low-income communities (Swiss Tropical and Public Health Institute). Infections are transmitted by eggs released in feaces or urine which contaminate soil and water bodies

Helminths are a broad range of organisms that include intestinal parasitic worms, (roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*), or hookworms (*Necator americanus* and *Ancylostoma duodenale*).

Infected people excrete helminth eggs in their faeces, which then contaminate the soil in areas with inadequate sanitation. Other people can then be infected by ingesting eggs or larvae in contaminated food, or through penetration of the skin by infective larvae in the soil (hookworms).

Infestation can cause morbidity, and sometimes death, by compromising nutritional status, affecting cognitive processes, inducing tissue reactions, such as granuloma, and provoking intestinal obstruction or rectal prolapse. Control of helminthiasis is based on drug treatment, improved sanitation and health education (TDR For research on disease of poverty)

Crop Disease Incidence



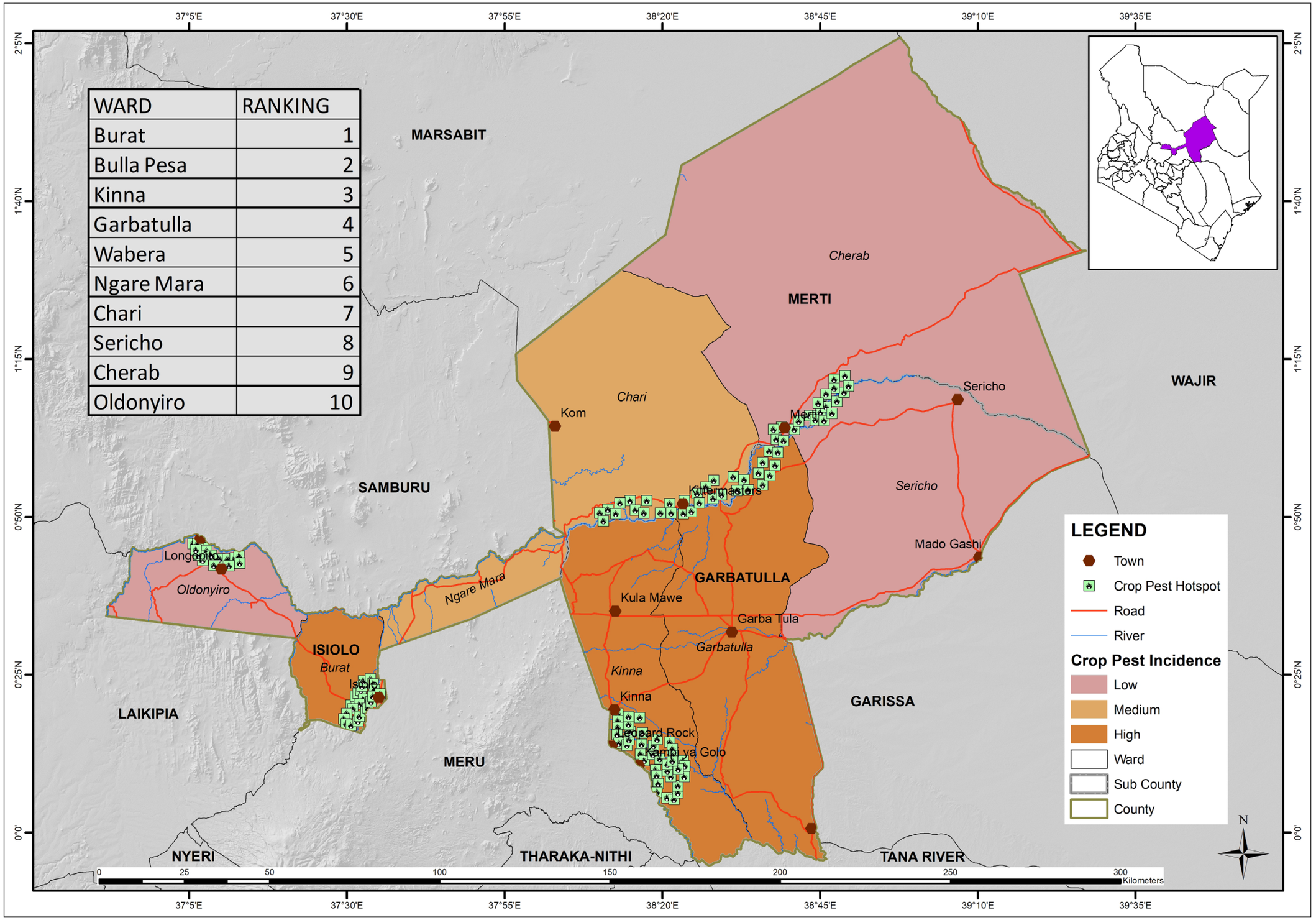
WARD	RANKING
Burat	1
Bulla Pesa	2
Kinna	3
Garbatulla	4
Wabera	5
Ngare Mara	6
Chari	7
Sericho	8
Cherab	9
Oldonyiro	10

Data sources: *RCMRD (Crop Disease Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows crop disease incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Crop disease incidence is high in Burat, Bulla Pesa, Kinna and Garbatulla, medium in Wabera, Chari and Ngare Mara and; low in Sericho, Oldonyiro and Cherab.

Crop Pests Incidence



WARD	RANKING
Burat	1
Bulla Pesa	2
Kinna	3
Garbatulla	4
Wabera	5
Ngare Mara	6
Chari	7
Sericho	8
Cherab	9
Oldonyiro	10

Data sources: *RCMRD (Crop PestAssessment by County Sector teams)*
Spatial reference: *Geographic, WGS 84*
Administrative Boundaries: *(OCHA ROSEA)*

This map shows crop pest incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Crop disease incidence is high in Burat, Bulla Pesa, Kinna and Garbatulla, medium in Wabera, Chari and Ngare Mara and; low in Sericho, Oldonyiro and Cherab.

Chapter 7:
Floods

7.1 Introduction

Surface water availability in Isiolo County varies with seasons of the year with the main surface water sources include rivers, streams, springs and runoff. Isiolo County has three main rivers namely Ewaso Nyiro, Isiolo river, and Bisanadhi which flows through the county. Ewaso Nyiro River originates from the Aberdare ranges and north-western slopes of Mount Kenya and drains into the Lorian Swamp; The Isiolo river originates from Mount Kenya and drains into Ewaso Nyiro, and Bisanadhi originates from Nyambene ridges and drains into Tana River.

Floods are not a common phenomenon in many parts of Isiolo County, and are often considered a blessing for majority of the pastoralist communities in the county. Nonetheless, floods have in the past been recorded mostlly along the rivers and in Kombora and Rumatei areas of the county. Merti and Garbatulla sub-counties are worse affected by flooding as a result of the Ewaso Nyiro river bursting its banks. During flooding events, residents of Merti town often vacate their homes and are hosted by their relatives who live on higher grounds due to its proximity to the river.

7.2 Types and Causes of Floods

Flooding in Isiolo County is mainly as a result of intensive precipitation over a short period of time that occurs mostly in the catchment areas of the main rivers. The main amplifiers of floods in the county include: deforestation and unsustainable land use practices such as overstocking and overgrazing and poor drainage mostly in the urban centres.

7.2.1 Flash Floods

Flash floods usually occur within a short period of time without much warning as a result of accelerated runoff or a dam failure. Flash floods in Isiolo County as mainly as a result of increased precipitation in the upper catchment areas of Aberdare ranges and the Mt. Kenya region.

7.2.2 River Floods

River floods are mainly as a result of prolonged rainfall which leads to the ground becoming saturated since the soils can no longer hold any more water resulting in increased surface runoff. River floods often build up slowly at the onset and usually, occur over a long period. River flooding in Isiolo County occurs mostly along the Ewaso Nyiro river affecting areas such as Merti town.

7.3 Impacts of Floods

7.3.1 Loss of Property and Livelihoods

Floods as a result of increased precipitation especially in the catchment areas of Meru county and in the Aberdare ranges have often led to sediment pollution especially for farming communities along river valleys resulting in loss of fertility, landslides and erosion. Physical damage to infrastructure has also been reported causing loss of communication and power utilities, damage to roads and bridges hence disruption communication and learning in schools leading to closure. For residents living in flood -prone areas, displacement of households and their livestock is often a common phenomenon.

Plate 7.1: A bridge over the Ewaso Nyiro River at Archers Post damaged by flood waters (Source: Daily Nation)

7.3.2 Disease Outbreaks and Deaths

Outbreak of water-borne and vector-borne diseases and deaths have also been reported especially for residents living along the Ewaso Nyiro river. Floodwaters often result in damage of pit latrines, which could contaminate drinking water and those affected are exposed to vector-borne diseases. Malaria, cholera and dysentery are the common hygiene-related diseases caused by flooding. Increase in mortality and morbidity rates is also reported as a result of drowning and injuries caused by debris in the floodwaters.

7.3.3 Economic losses

Tourism is also affected by floods in the county especially affecting lodges along the Ewaso Nyiro river that sometimes get submerged during flood events resulting in losses. Flood induced destruction is recorded in Kulamawe, Bullapesa, BullaArera, Juakali, Kambiodha, Kambibulle, Kabigarbaa and Kabiwacho villages. Generally, the displacement of people due to floods, destruction of infrastructure and loss of livestock and farm produce often leads to increased costs of food prices consequently leading to increased cases of malnutrition and eventual deaths of the vulnerable in society.

7.4 Interventions

7.4.1 Environmental Conservation Efforts

In order to adapt to the effects of floods as a result of climate change, there is need to reconstitute basin slopes, undertake restoration of silted ponds, and initiate afforestation and reforestation programmes (ICIDP, 2018–2022). Other efforts such as building gabions are being undertaken in Oldonyiro areas to alleviate the effects of erosion caused by flooding; and diversification of energy sources to wind, solar and biogas to reduce the dependence on wood fuel, hence reduce the level of deforestation since wood fuel is primarily the leading source of energy in the county.

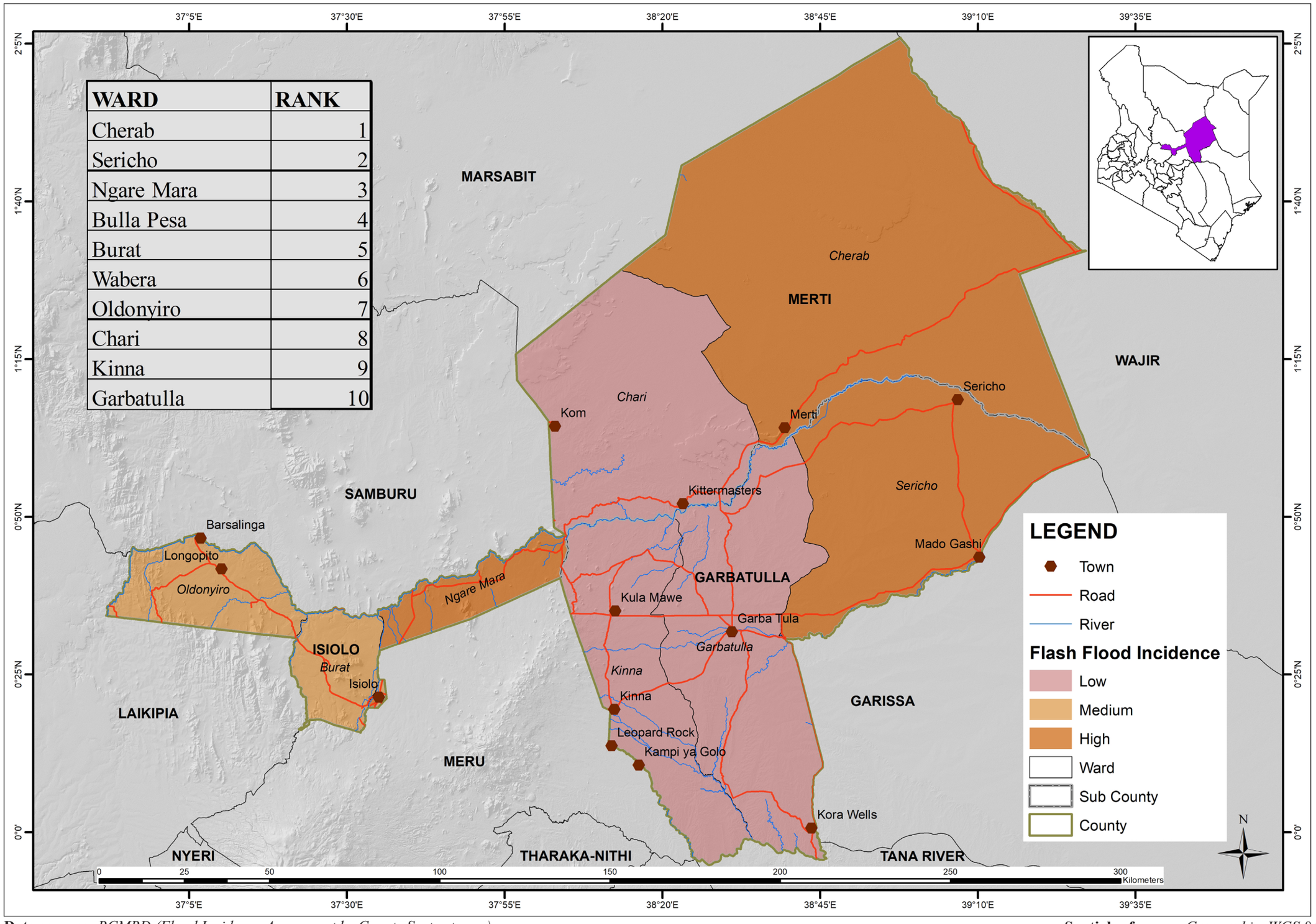
7.4.1 Early Warning Systems

Flood forecasting and early warning is essential for emergency responses and in limiting damages. The meteorological department needs to inform the locals of impending floods especially flash floods originating from the catchment areas and culminating in Isiolo County. Awareness creation on flooding detailing causes of floods, mitigation measures and need for keeping off harm's way. For instance, the need for moving to higher grounds by those persons who live in areas that are prone to flooding.

Other interventions involve the County government of Isiolo coming up with a county spatial plan that will ensure that all important aspects such as drainage are taken care of to minimise the effect of flooding especially affecting the urban centres.

Flash Flood Incidence

WARD	RANK
Cherab	1
Sericho	2
Ngare Mara	3
Bulla Pesa	4
Burat	5
Wabera	6
Oldonyiro	7
Chari	8
Kinna	9
Garbatulla	10

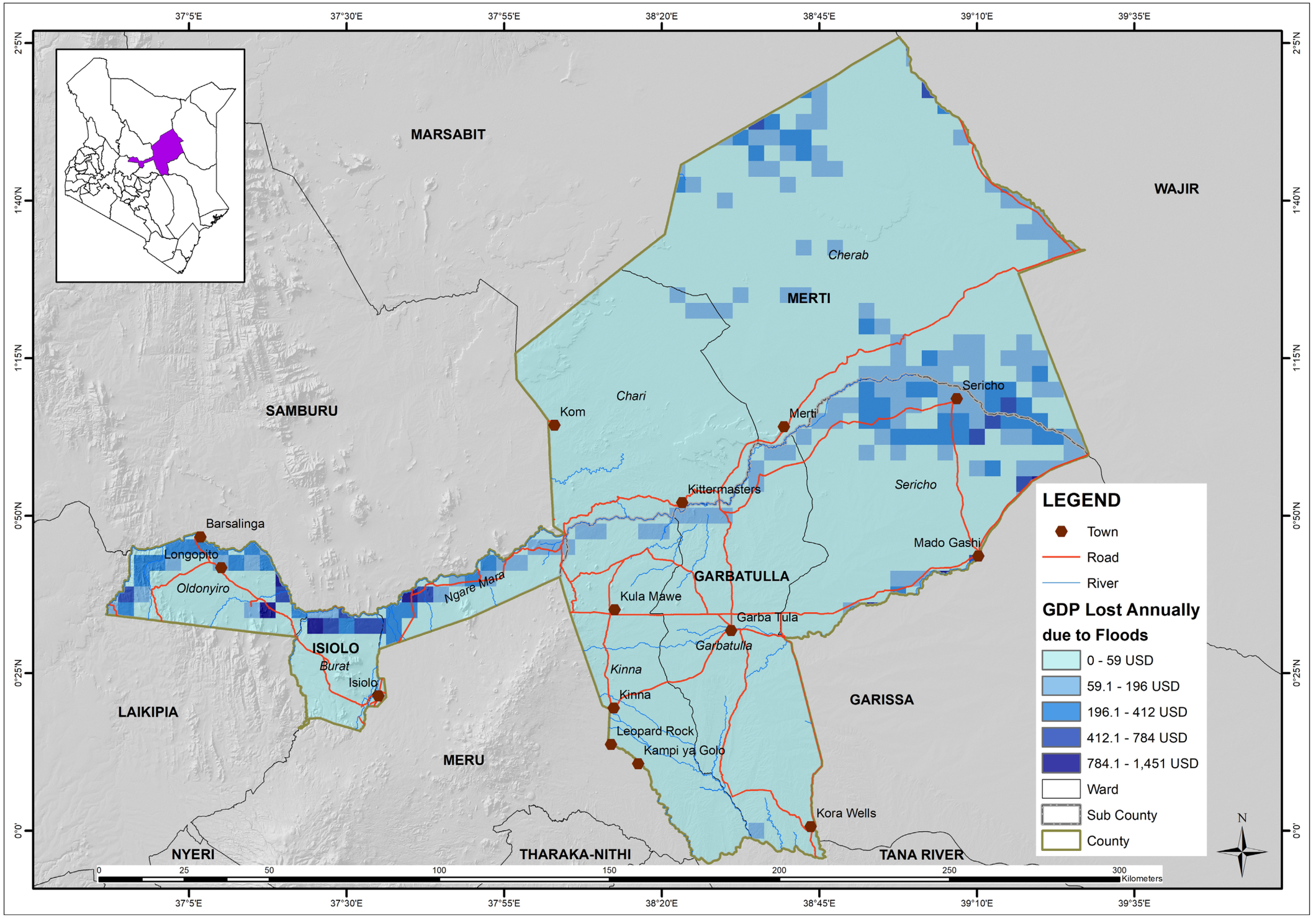


Data sources: *RCMRD (Flood Incidence Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows flash flood incidence. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Flash flood incidence is high in Cherab, Sericho, Ngare Mara and Bulla Pesa, medium in Burat, Wabera and Oldonyiro and; low in Chari, Kinna and Garbatulla.

Flood Economic Exposure



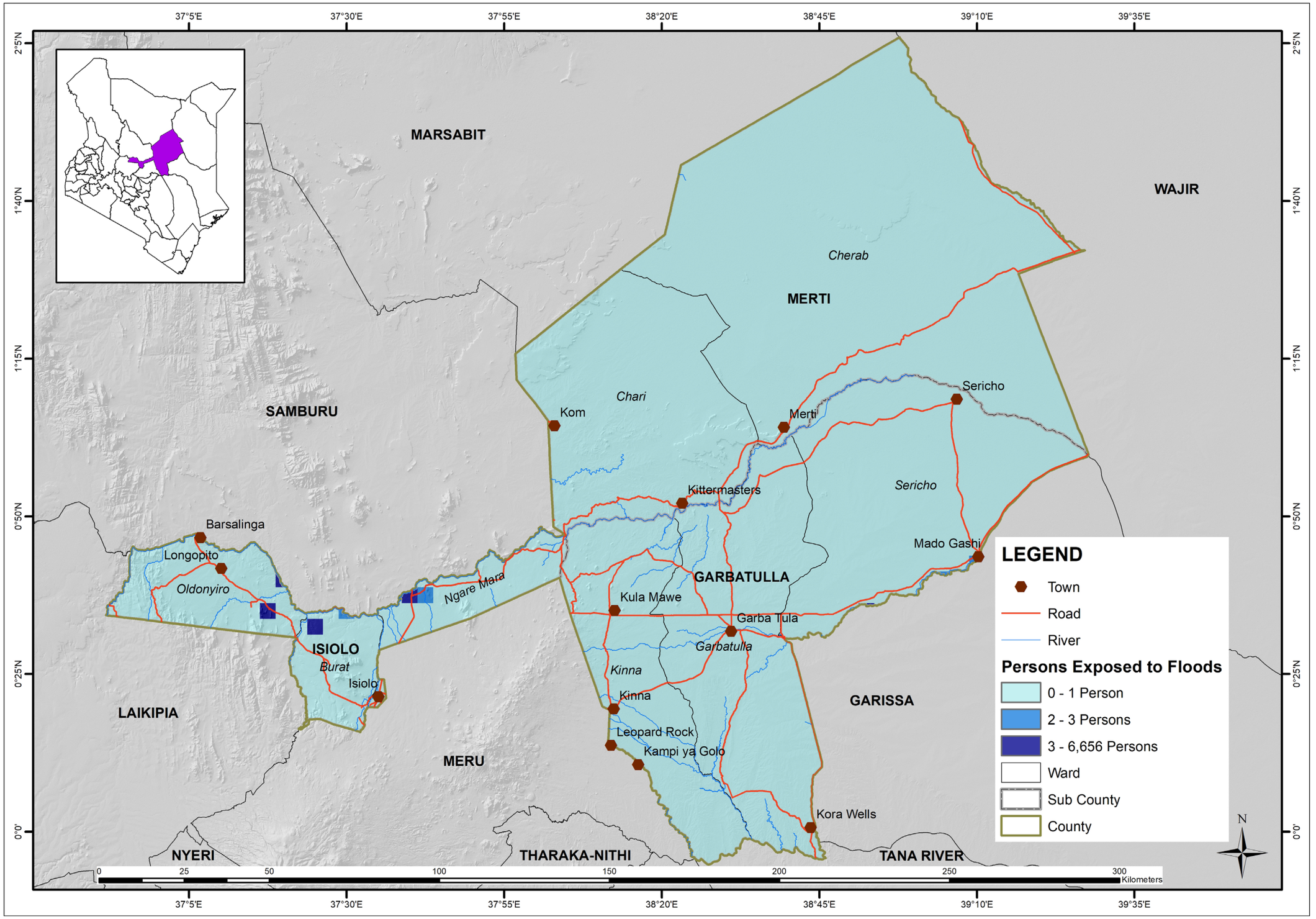
Data sources: *RCMRD (Drought Assessment by County Sector teams)*

Spatial reference: *Geographic, WGS 84*

Administrative Boundaries: *(UNEP DEWA-GRID)*

This map reflects on the impact of flood on both human and livestock population as well as the estimates of economic losses incurred (approximated GDP) in the event of extreme flood event. Most of the flooding takes place along the rivers and some parts of Meti sub-county.

Flood Physical Exposure

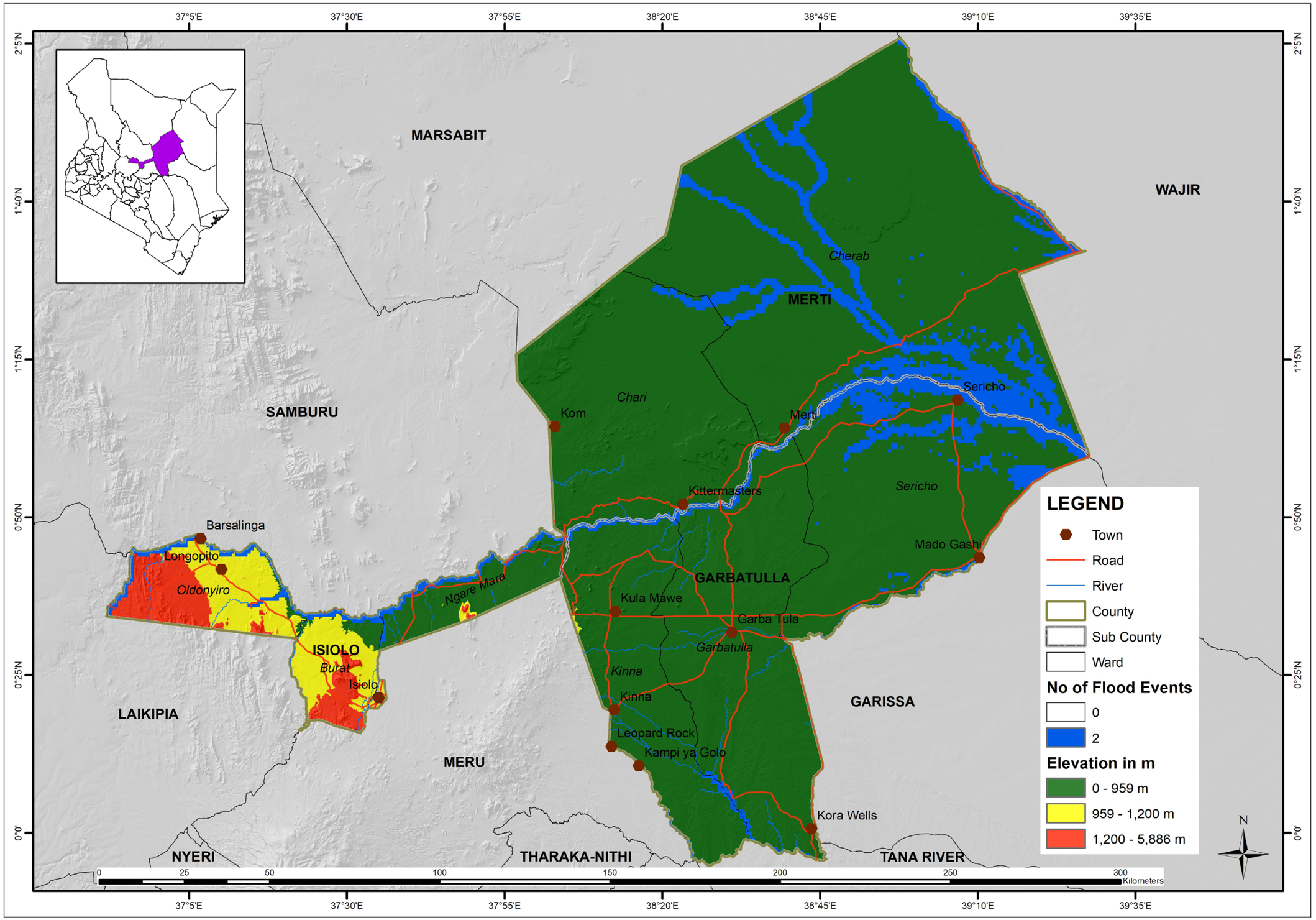


Data sources: *RCMRD (UNEP DEWA-GRID)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map indicates the impact of floods on human populations in the event of an extreme flood event in the county. Flooding is not a major hazard in the county as the number of persons affected is low in the entire county with the exception of selected areas in Isiolo.

Flood Frequency



Data sources: *RCMRD (Drought Assessment by County Sector teams)*
Administrative Boundaries: *(UNEP DEWA-GRID)*

Spatial reference: *Geographic, WGS 84*

This map shows topographic variation of Isiolo County and the flood events. The County's altitude is quite high with lots of hills. Number of flood events are common along the rivers.

Chapter 8:
Vulnerability Indicators

8.1 Introduction

United Nations International Strategy for Disaster Reduction defines vulnerability as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. People differ in their exposure to hazards due to gender, age, culture and socio-economic well-being. Poor communities are more vulnerable to hazards because they lack means and ways of being prepared and respond to hazards. Vulnerability can be addressed by reducing impact of hazard through mitigation, early warning and preparedness.

Climate change and variability is believed to have increased incidences of hazards all over the world. Increasing or decreasing temperatures and unpredictable rainfall have contributed to more drought episodes, flooding and human, livestock and crop diseases. Drought, floods, diseases, land degradation and conflicts also affect the livelihood of the people. Drought, crop diseases, land degradation (especially soil erosion) and floods can lead to poor yields or total destruction of crops. Likewise, human and livestock diseases render people too weak to work and cause the death of livestock.

8.2 Livelihood

The main economic activities in Isiolo County include rainfed crop farming mostly practised along the Ewaso Nyiro river, Isiolo Central and Kinna where maize, sorghum, beans, green grams, nerica rice, cowpeas, dolicos, kales, tomatoes, onions and watermelons are the common crops grown (ICIDP, 2018-2022). Livestock rearing is common economic activity in the entire county with most residents practicing nomadic pastoralism through intensive dairy production has gained prominence in recent years due to increased urban demand.
Other minor livelihood types in the county include: formal employment/ casual labour borne from the rapid urbanization of Isiolo town; fish farming mostly semi-intensive and for subsistence; tourism from the presence of wildlife and other tourist attraction sites; and apiculture (beekeeping) with the county having a honey refinery in Isiolo town though currently operating below capacity due to challenges in honey production.

8.2.1 Crop Farming

A large portion of the county is arid and cannot support rain fed crop farming although both rainfed and irrigated crop farming are practised in the county. In addition to maize, sorghum, beans, green grams, nerica rice, cowpeas, dolicos, kales, tomatoes, onions and watermelons, fruit trees such as pawpaw, avocado, citrus, mangoes and guavas are grown together for subsistence and commercial purposes, and they also act as windbreaks and in improving soil fertility (ICIDP, 2018-2022). According to ICIDP (2018-2022), only 1,500 hectares are currently under crop production with averagely smaller farm sizes under cultivation with production mainly for subsistence use. Fragile soils are a characteristic of the county with wind being the main agent of erosion coupled with low erratic rainfall levels that can barely sustain crop growth. The County government together with other stakeholder organizations are supporting farmers through extension services, training, research and information services distributed around the county educate on crop and livestock production technology.

8.2.2 Livestock Rearing

As the main economic activity in Isiolo, nomadic pastoralism defines the lifestyle of residents of the county drawn from the Borana, Somali, Samburu and Turkana communities who reside in the county. Nomadic pastoralism accounts for up to 80% of the economic activities of the county though intensive dairy production is gaining popularity due to increased demand for milk products. Traditional livestock breeds are however preferred by residents because they are drought and disease tolerant unlike their exotic counterparts, and are mostly reared for meat production.

Livestock keeping faces various challenges in the county such as cattle rustling, lack of pasture and water resources and livestock diseases. With increased drought frequency and intensity in recent years, other hazards such as human-wildlife conflicts and human conflict between other communities within and outside the county have also increased. Environmental impacts of overstocking and overgrazing by nomadic communities has in turn, led to environmental degradation caused by soil erosion.

Plates 8.1 and 8.2: Camels and Sheep in Isiolo County (Source: RCMRD)

8.2.3 Tourism

Tourist attractions in Isiolo County can be categorized as: nature and wildlife, culture, heritage and community-based tourism, adventure, agro-tourism and eco-tourism. The county has three national game reserves namely, Shaba, Buffalo Springs and Bisanadi and is home to African wild dog (Lycaon pictus), giraffes, elephants, ostrich, monkeys, antelopes, impala, leopards, waterbucks, lesser kudu, greater kudu, hippo, grevy zebra, buffalo, lion and over 300 species of birds (ICIDP, 2018-2022). The county boasts of many hotels and campsites mostly found in Isiolo North constituency. Tourism plays a part as a source of income for many residents of the county though there is a need to strengthen existing measures to conserve and sustainably manage the wildlife resources in the county in partnership with the community and other stakeholders.

Plates 8.3 and 8.4: Ostriches and gazelles in Isiolo County (Source: RCMRD)

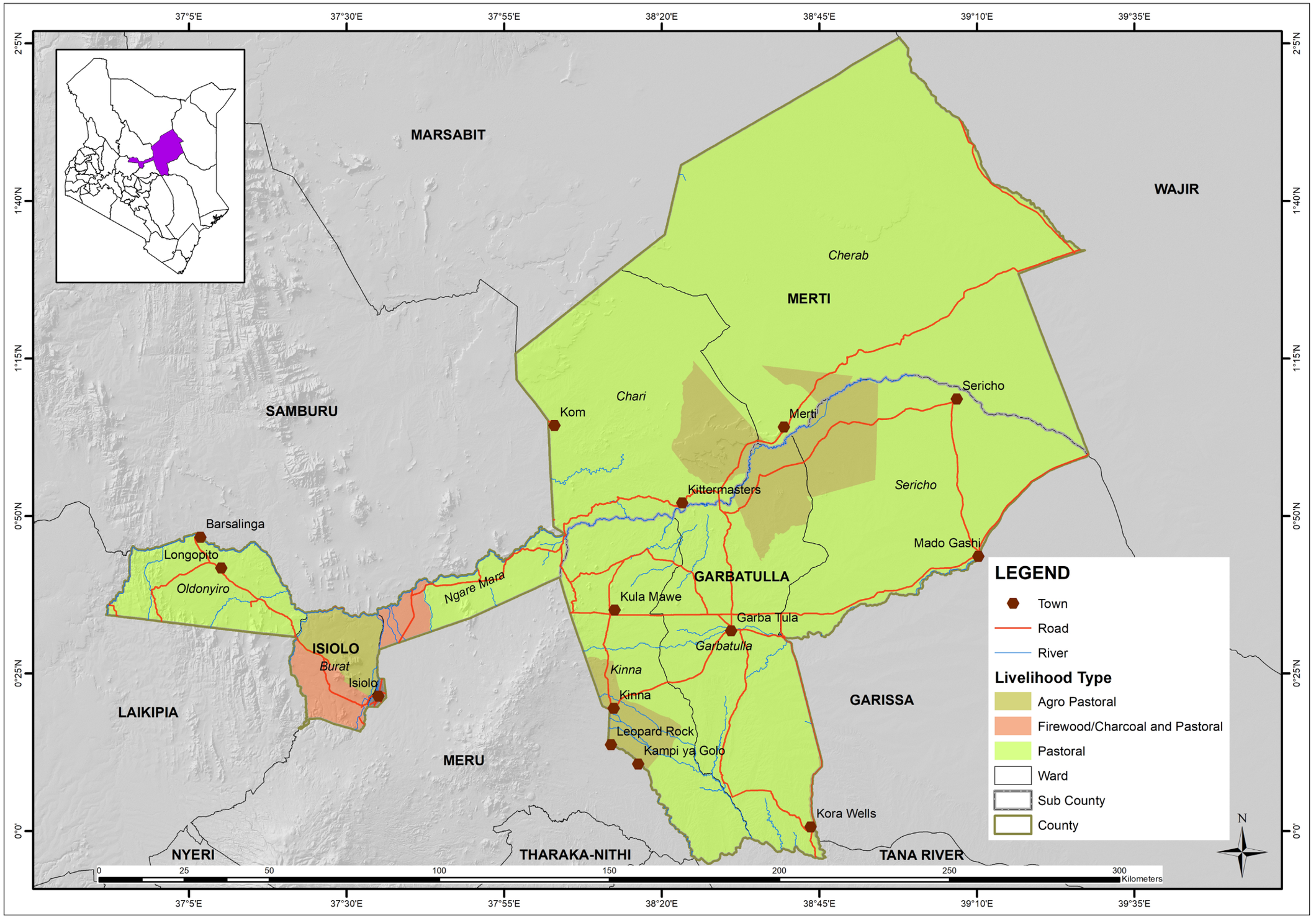
8.2.4 Apiculture (Beekeeping)

Potential areas of bee farming in Isiolo County include Oldonyiro, Isiolo Central, Merti and Kinna. However, the main challenges to bee farming in Isiolo County is the recurrent droughts and a general lack of investment into the sector leading to low production of honey.

8.2.5 Fish farming

Fish farming in Isiolo County is primarily semi-intensive and for subsistence use with two main types of production as: aquaculture and riveline fish farming. In aquaculture, the most culture species of fish are tilapia and African catfish while riverline fisheries mostly practised along the Ewaso Nyiro river produces clarias, common carp, lung fish, tilapia, *barbus* and *labeo* (ICIDP, 2018-2022).

Livelihood



Data sources: *NDMA*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows different livelihood types in Isiolo County. The main livelihood types in the county include Pastoral, Agropastoral and Firewood/Charcoal and Pastoral.

8.3 Vulnerability Assessment

According to the Isiolo County sector teams and evidence from existing literature, the critical factors affecting food security and in essense contributing largely to vulnerabilities of the population and existing systems in Isiolo include; extreme climatic events leading to hazards like droughts and floods, livestock and crop pests and diseases, human diseases, conflict, inadequate access to basic amenities including water, health and education facilities. In the previous chapters, individual hazards have been tackled; this section will look at access to basic amenities as indicators to population's vulnerabilities. The section will then assess the overall vulnerability of Isiolo County based on the IPCC framework and definition of vulnerability with the intention of bringing out the geographical variation of vulnerability stratified into three (3) categories of vulnerability: Low, Medium and High.

8.3.1 Major water sources

Water is a scarce resource in Isiolo County with the main surface water sources being rivers, streams, springs and runoff from the Isiolo sub-catchment of the Middle Ewaso Nyiro catchment. Surface water availability in the county varies with seasons and the county has three main rivers namely Ewaso Nyiro, Isiolo and Bisanadhi which originate from springs or surface runoff during the rainy season. There are three main sub-catchments in the county with each draining into the Ewaso Nyiro river which is the main drainage system in the area (ICIDP, 2018-2022).

Isiolo County experiences two rainy seasons a year though rainfall is often poorly distributed both spatially and temporarily (Isiolo County SMART Survey Report, 2018). Most residents travel over 2 Kilometres to access drinking water with about 93% of the county area lacking access to safe and clean water within 5 Kilometres reach. Some villages in Modogashe area are about 25 km from the nearest safe water source. Most residents of Isiolo rely on piped water 39%, 34% on borehole water, 10% on river water, water pans account for 4%, Rain water 2% and 11% on any other means of getting water during dry seasons. During the wet season, 37% of the residents rely on piped water, boreholes 25%, river 11%, rain water 10%, water pans 7% and the remaining 10% is sourced from any other source (ICIDP, 2018-2022).

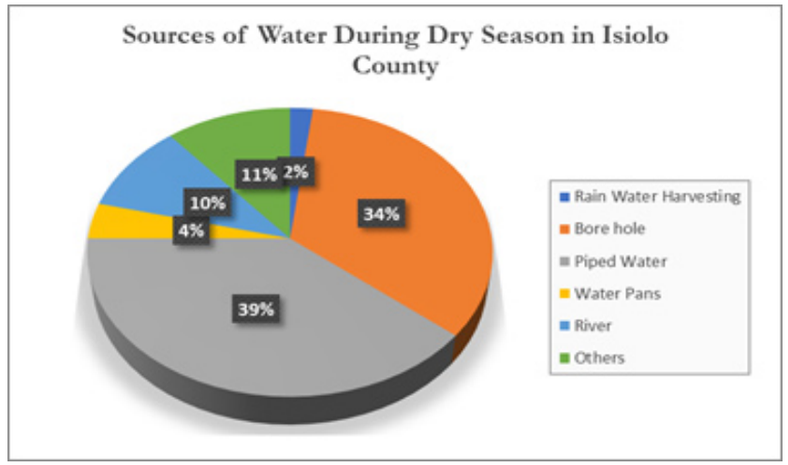


Figure 8.1: Sources of water during the dry season (Source: ICIDP, 2018-2022)

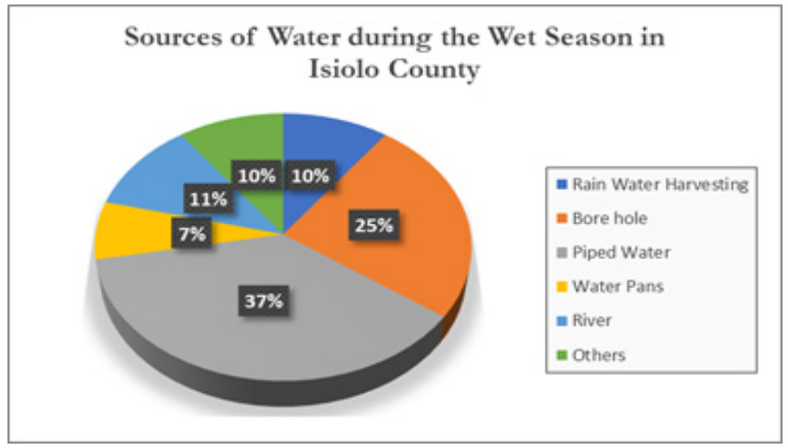


Figure 8.2: Sources of water during the wet season (Source: ICIDP, 2018-2022)

The main challenge to the access of water is the levels of salinity of most water sources with 58% of water sources producing saline water (ICIDP, 2018-2022). This poses a risk to the health of residents of the county in addition to inhibiting growth of various food crops. A lack of proper sanitation facilities especially in urban centres is a major cause for contamination of water sources leading to disease outbreak especially during flooding events.

Plates 8.5 and 6.6: Goth Rupa Borehole in Merti and water dam in Oldonyiro (Source: RCMRD)

8.3.2 Education

Kenya has made great strides in ensuring that its people have access to an affordable education with the introduction of universal free primary education in 2003. Isiolo County however records an illiteracy level of 20% of the population having not attended school with less than 10% of the population having completed secondary school and a majority only achieving primary school education (ICIDP, 2018-2022). Lack of school fees and early marriages are cited as the major causes for school dropout outs.

According to the Isiolo County Integrated Development Plan (2018-2022), there are 160 ECD centres of which 42 are private with the teacher-pupil ratio in the ECD centres is 1:87. This ratio is far above the optimal of 1:40 implying that the county is running short of ECD teachers. Dropout rates from ECD centres to primary school is nil though a majority of the age group supposed to be attending ECD centres are not attending due to effects of drought and inadequate ECD facilities calling for extensive investment in infrastructure development, facilitation through the introduction of school feeding programmes and increasing the number of teachers in these centres. Isiolo County has 125 primary schools of which 108 are public and 17 are private. The county has 25 secondary schools of which 17 are public and 8 are private; and 3 tertiary institutions (KNBS, 2016).

Challenges faced by the education sector in Isiolo County

1. Inadequate teachers especially at ECD level
2. Insecurity
3. Absenteeism amongst adolescent girls during their menstruation
4. Low transition from primary to secondary
5. Cultural issues like early marriages and pastoralism

6. School dropouts due to climate-related issues such as drought
7. Poverty and lack of school fees
8. Long distances to the nearest schools

8.3.3 Health Access

Good health is a paramount aspect of human welfare and one of the ways it can be achieved is through having quality and affordable health care available for all citizens. Health care is a devolved function under the new constitution of Kenya though it faces challenges including frequent worker strikes and inadequate facilities in hospitals and health care centres. A majority of the population of Isiolo County reside in rural areas where health facilities are inadequate, sparsely distributed and understaffed. Most health facilities are located in Isiolo and Garbatulla sub-counties with the few available in Merti sub-county needing operationalization through facilitation with drugs and health personnel.

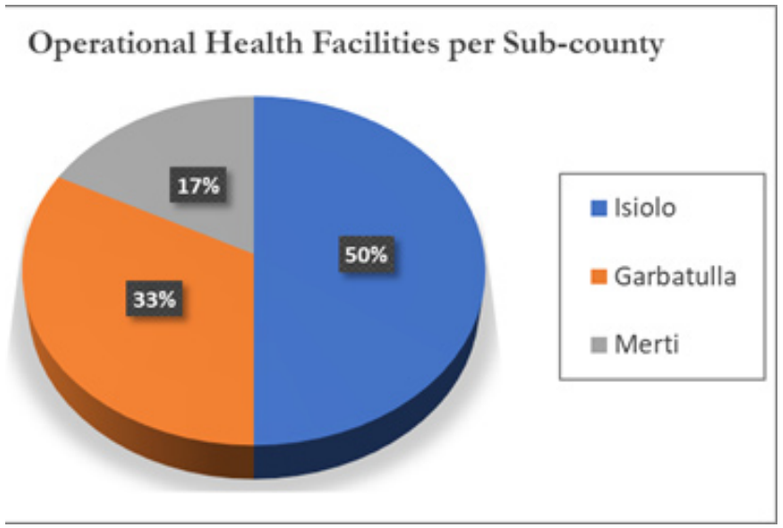


Figure 8.3: Health facilities and their distribution by sub county (Source: ICIDP, 2018-2022)

Table 8.1: Distribution of Health facilities per sub-county

Sub-county	No. of Health Units
Merti	9
Garbatulla	17
Isiolo Central	26

(Source: County Health Human Resource Department, 2018

Challenges faced by the health sector in Isiolo County

Inadequate health workers

Isiolo County's doctor: population ratio for the county is about 1:5,000 while nurse: population ratio 1:1500 (ICIDP, 2018-2022). This is a clear indication of the strain in health care provision due to the shortage of health workers. Budget constraints has been attributed to understaffing in most of the county health facilities and therefore creates the need for training and deployment of more local health workers to reduce this deficit.

Cultural Practices

The health system of Isiolo County is reported to face challenges related to the indigenous cultural practices that encourage high birth orders, early marriage, teenage pregnancy, cultural barriers like female-genital mutilation that have contributed to the high maternal and neonatal mortality rates. There is a need for proper health sensitization and education of residents of the county to enable them shun some of these practises that lead to deterioration of the health status of the county.

Lack of facilitation in health centres

In addition to the low ratio of health care personnel to population in the county, there is a considerable lack of adequate health commodities (medicine and equipment) in these centres especially in Merti cub-county. Most facilities barely have a laboratory for testing and diagnosis of diseases with the average distance to a health facility in the county at 20Km further exacerbating the current health situation in the county.

Poor Sanitation Practices

Poor sanitation is one of the leading causes of child illnesses such as respiratory infections and diarrhoea and improving sanitation is known to have a significant beneficial impact on the health of the community (Isiolo SMART Survey Report, 2018). Though the county has recorded significant improvement in sanitation according to the report, there is need to further increase public health promotion activities by the department of public health in collaboration with stakeholders supporting water, sanitation and hygiene promotion in the county.

8.4 Overall Vulnerability Assessment in Isiolo County

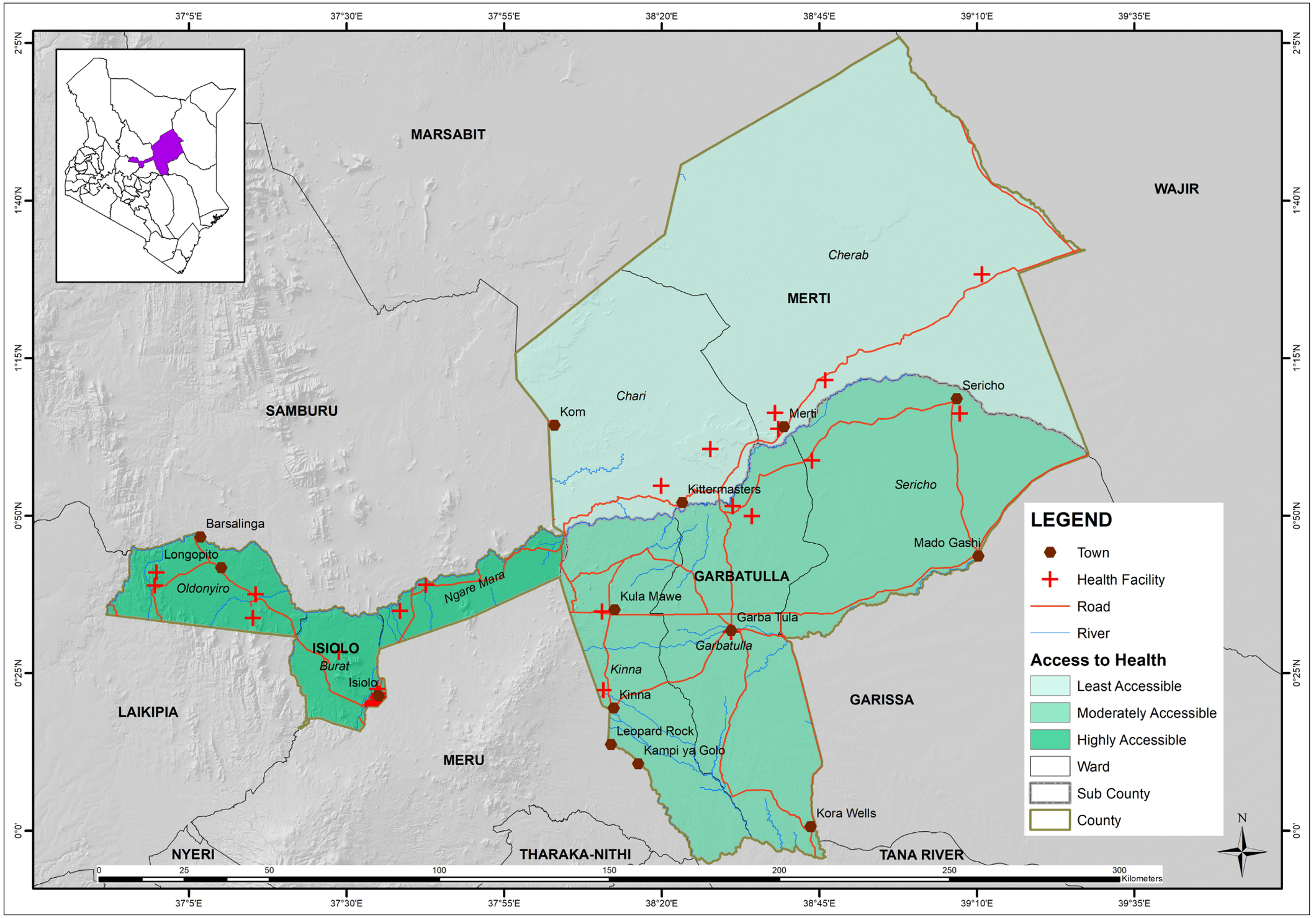
The conceptualization used in vulnerability assessment in this atlas is outcome vulnerability (Füssel, 2009), which "represents an integrated vulnerability concept that combines information on potential climate impacts and on the socio-economic capacity to cope and adapt." The IPCC framework builds on this, in that vulnerability, is considered to be a function of exposure to climate impacts, including variability and extremes, and the sensitivity and adaptive capacity of the system being exposed (Parry et al., 2007). The three components are further expanded on as follows:

Exposure (E) - the size of the area and/or system, sector or group affected and the magnitude of the stressor. This factor (exposure) was largely defined by climatic layers these included the drought risk, flood risk, long-term rainfall average and long-term temperature average layers which were ranked in accordance with the risk level.

Sensitivity (S) - the characteristics of a system or population and the governance/market structures that Influence the degree to which it is affected by stressors. This factor (sensitivity) by defined by the following layers: human, livestock and crop dieases.

Adaptive capacity (A) - capacities of the system, sector or group to resist impacts, cope with losses and/or regain functions. This component comprised the following layers: access to health, water and school facilities.

Access to Health

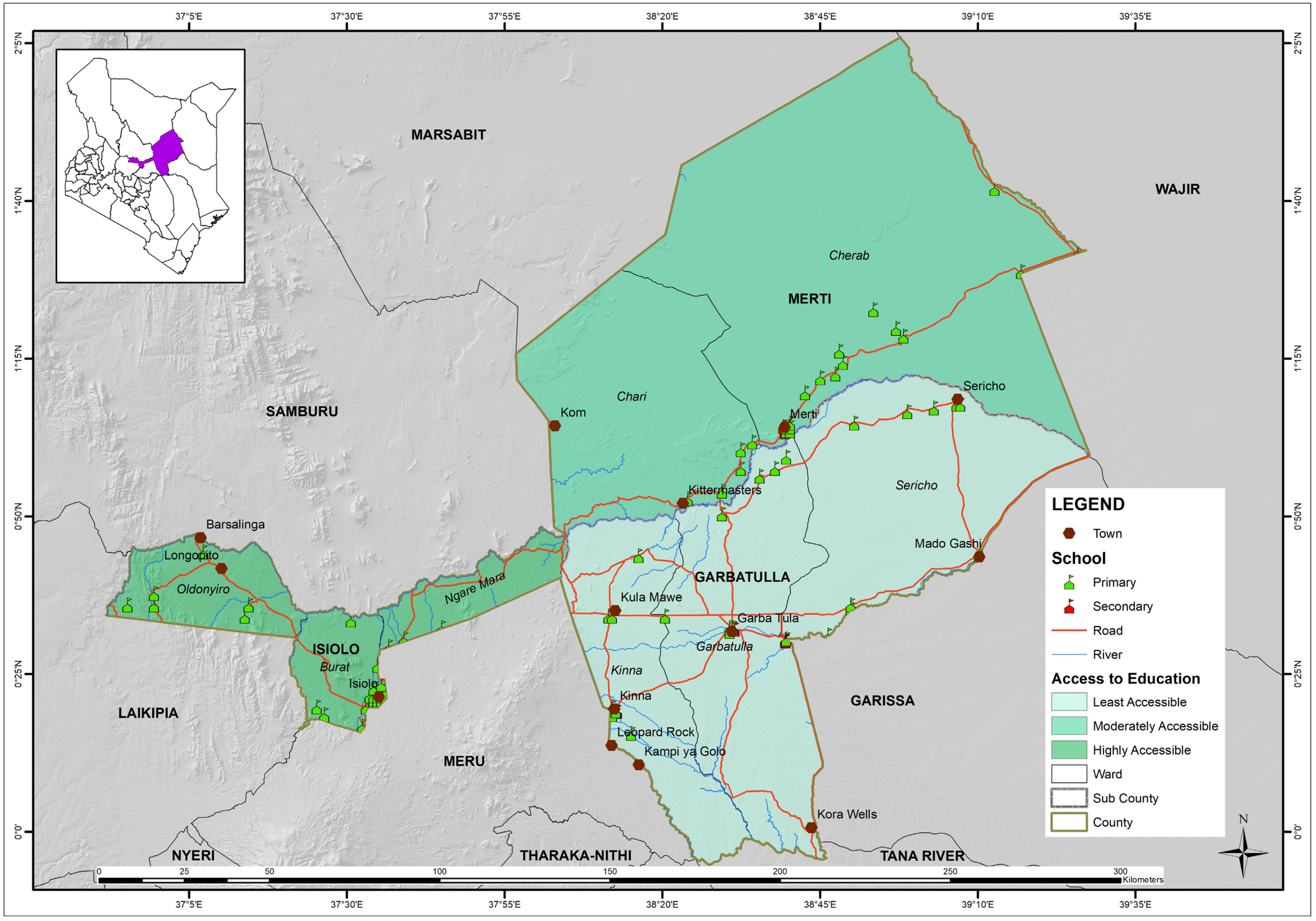


Data sources: *RCMRD (Drought Assessment by County Sector teams)*
Administrative Boundaries: *(UNEP DEWA-GRID)*

Spatial reference: *Geographic, WGS 84*

This map shows sub-county access to health based on number of health facilities and proximity. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Access to health is high in Isiolo, medium in Garbatulla and low in Merti.

Access to Education

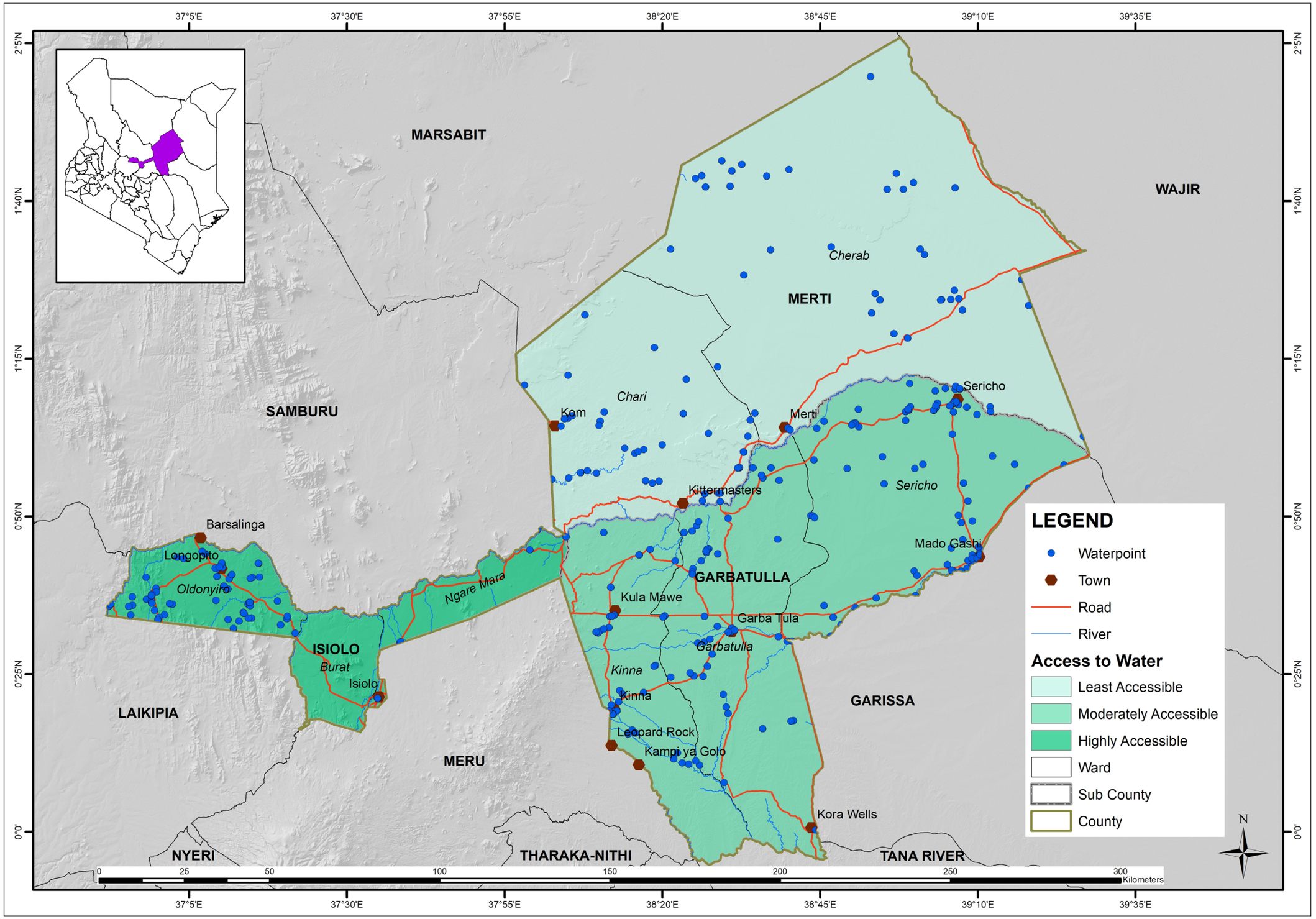


Data sources: *RCMRD (Access to Education Assessment by County Sector teams)*
Administrative Boundaries: *(OCHA ROSEA)*

Spatial reference: *Geographic, WGS 84*

This map shows sub-county access to education based on number of schools and proximity. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Access to education is high in Isiolo, medium in Merti and low in Garbatulla.

Access to Water

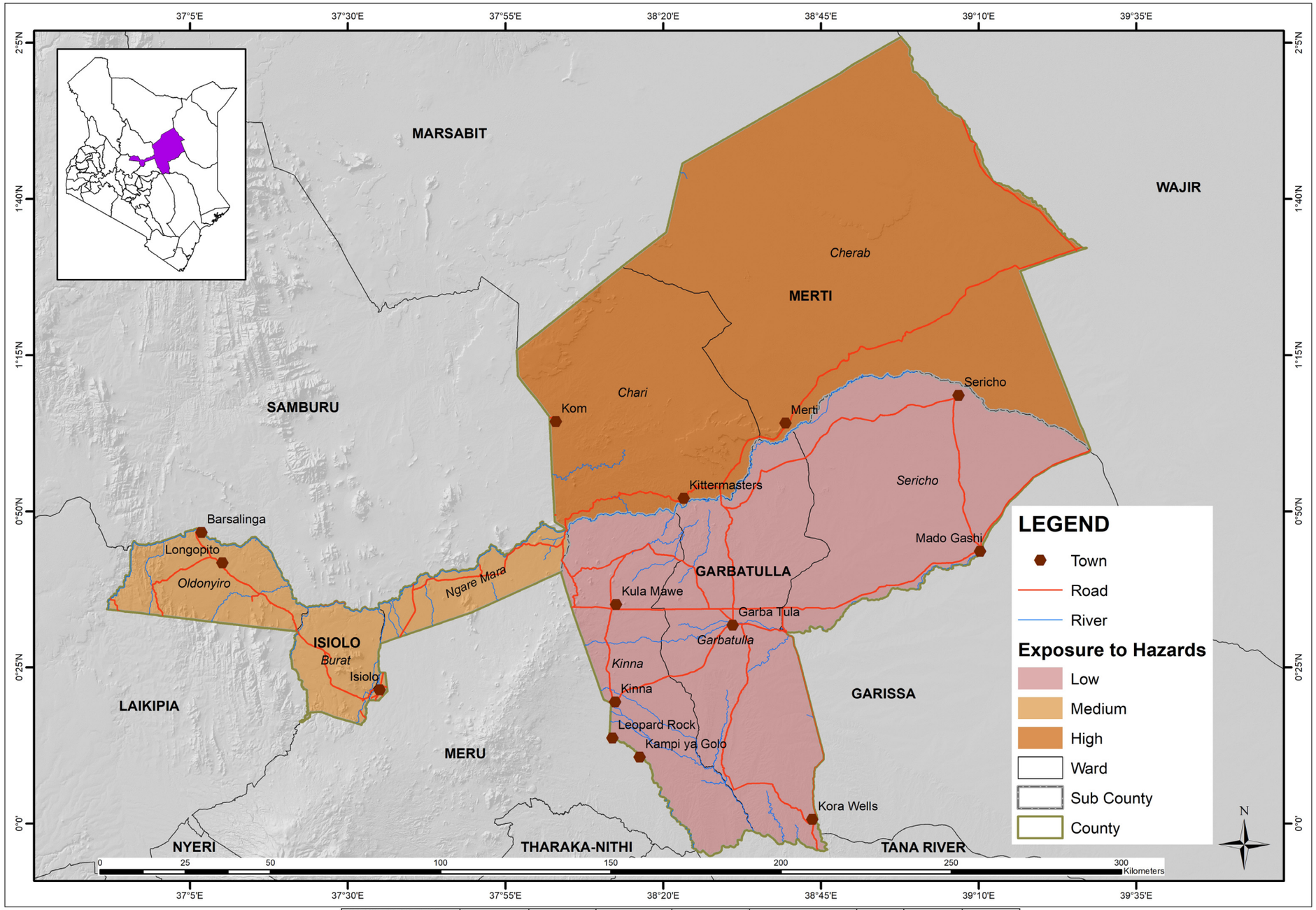


Data sources: *RCMRD (Drought Assessment by County Sector teams) & Mercy Corps*
Administrative Boundaries: *(UNEP DEWA-GRID)*

Spatial reference: *Geographic, WGS 84*

This map shows sub-county access to water based on distribution and proximity. This map was developed after county stakeholders' participatory mapping workshop in Isiolo County. Access to water is high in Isiolo, medium in Garbatulla and low in Merti.

Exposure to Hazards



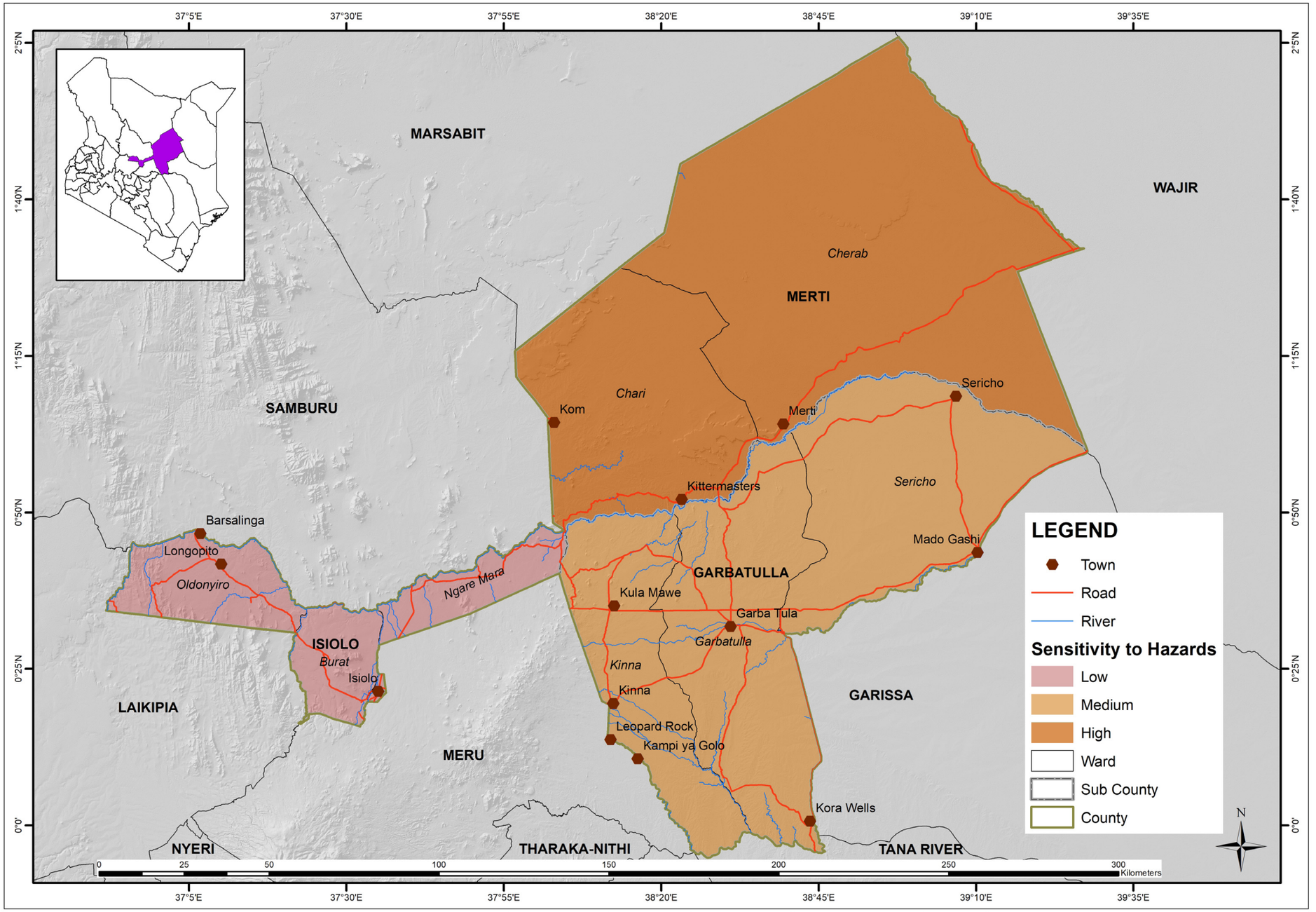
Data sources: *RCMRD (Exposure Assessment by RCMRD)*
Administrative Boundaries: *(OCHA ROSEA)*

GENERATION OF EXPOSURE								
SUB_COUNTY	FLOOD	DROUGHT	SUBSTANCE ABUSE	HUMAN CONFLICT	ENVIRONMENTAL DEGRADATION	TOTAL	RESCALE	RECLASS
ISIOLO	2	3	1	1	2	9	1	2
MERTI	1	1	2	3	1	8	0	1
GARBATULLA	3	2	3	2	3	13	3	3

Spatial reference: *Geographic, WGS 84*

This map is a by-product of stakeholders' workshop held in Isiolo County. It shows sub-county level of exposure. Exposure is based on sub-county prevalence to drought, flood, substance abuse, environmental degradation and conflicts. Merti has high exposure level, Isiolo medium and Garbatulla low.

Sensitivity to Hazards



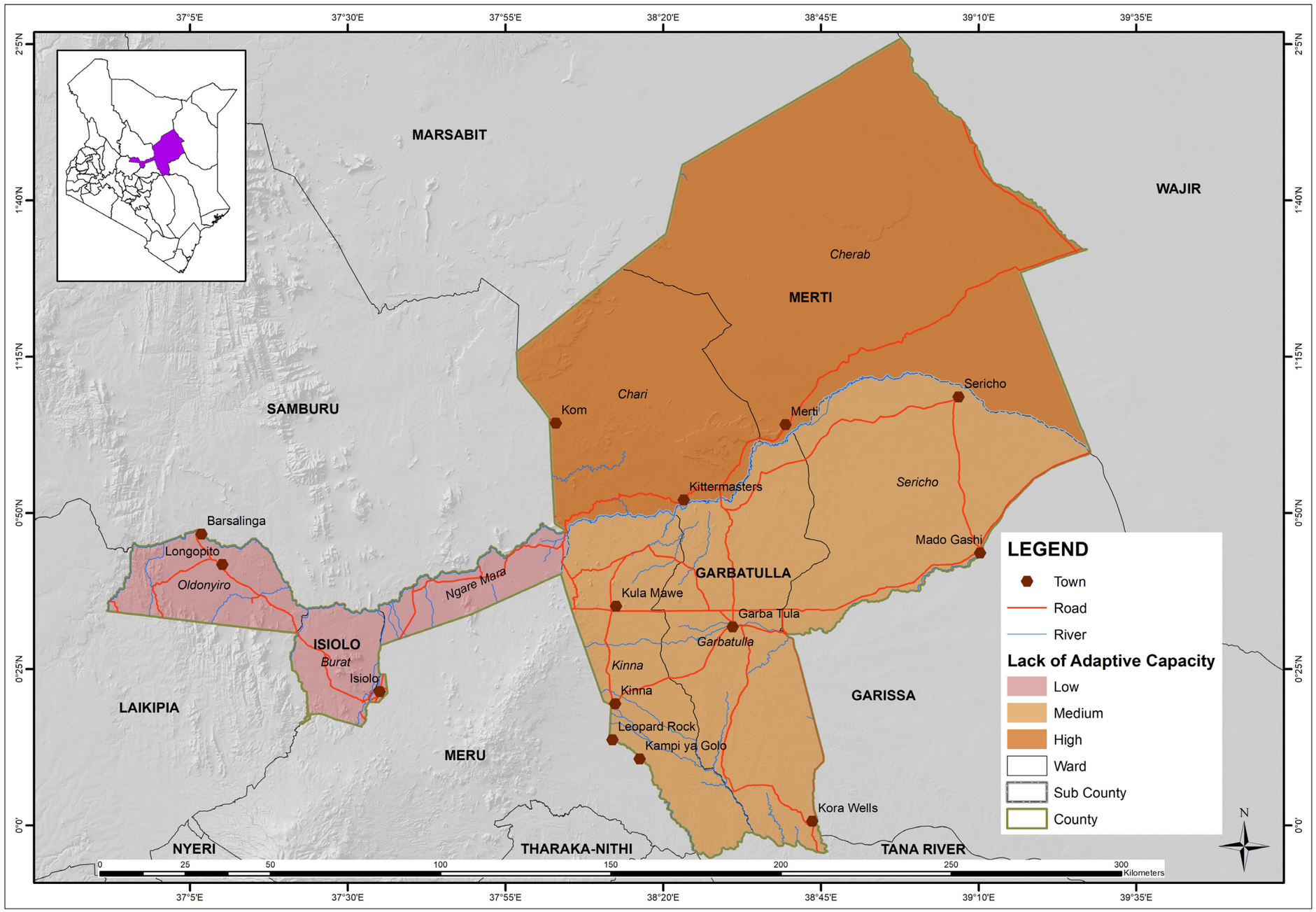
Data sources: *RCMRD (Sensitivity Assessment by RCMRD)*
Administrative Boundaries: *(OCHA ROSEA)*

GENERATION OF SENSITIVITY						
SUB_COUNTY	HUMAN DISEASES	CROP DISEASES	ANIMAL DISEASES	TOTAL	RESCALE	RECLASS
ISIOLO	3	1	3	7	3	3
MERTI	1	3	1	5	0	1
GARBATULLA	2	2	2	6	2	2

Spatial reference: *Geographic, WGS 84*

This map is a by-product of stakeholders' workshop held in Isiolo County. It shows sub-county level of sensitivity. Sensitivity is based on sub-county prevalence to human, crop and livestock diseases. Merti was ranked as high, Garbatulla as medium and Isiolo as low.

Lack of Adaptive Capacity



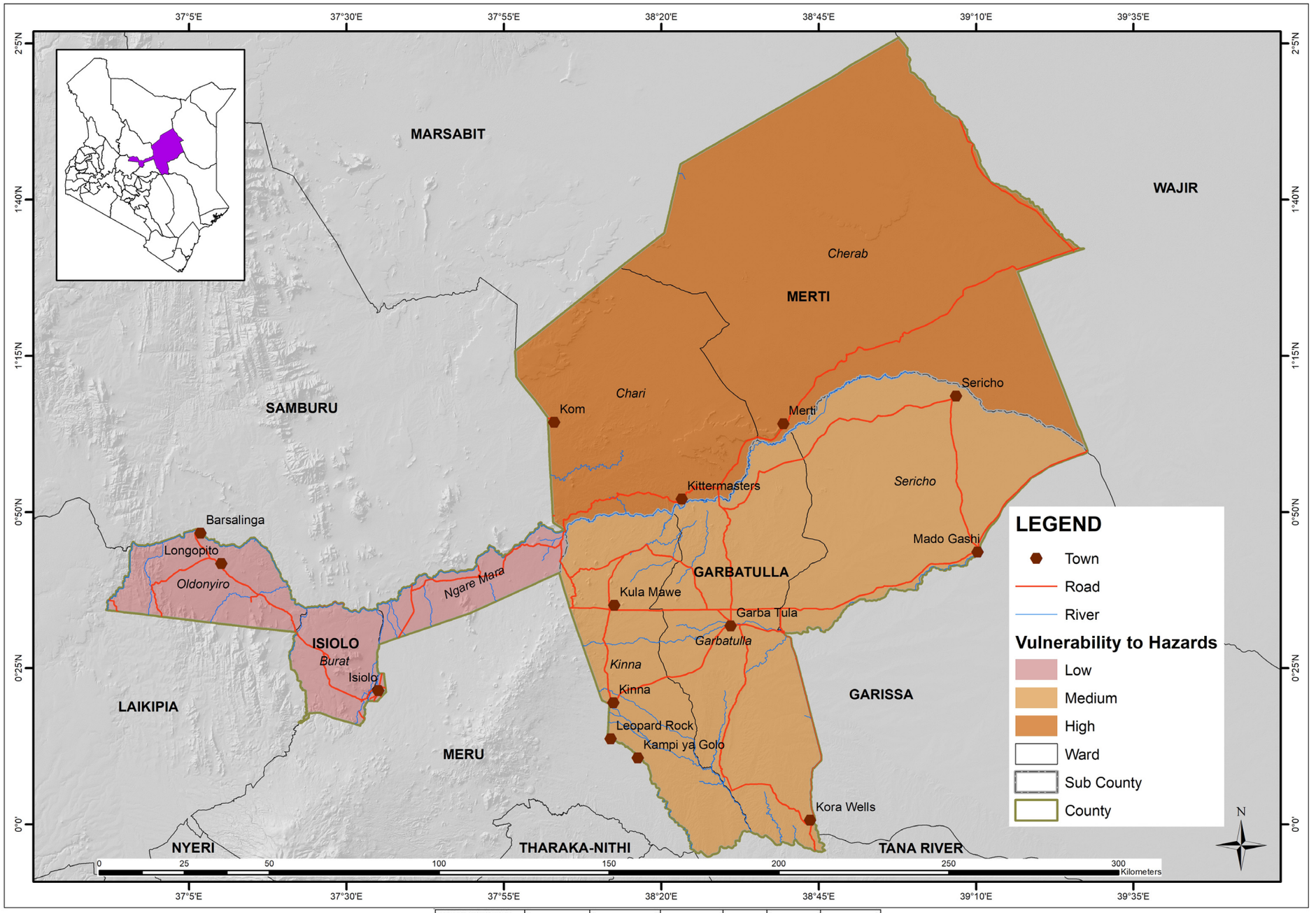
Data sources: *RCMRD (Lack of Adaptive Capacity Assessment by RCMRD)*
Administrative Boundaries: *(OCHA ROSEA)*

GENERATION OF LACK OF ADAPTIVE CAPACITY						
SUB_COUNTY	CLEAN WATER	EDUCATION	HEALTH	TOTAL	RESCALE	RECLASS
ISIOLO	3	3	3	9	3	3
MERTI	1	2	1	4	0	1
GARBATULLA	2	1	2	5	1	2

Spatial reference: *Geographic, WGS 84*

This map is a by-product of stakeholders' workshop held in Isiolo County. It shows sub-county level of adaptive capacity. Adaptive capacity is based on sub-county access to health, water and education. Isiolo has the least adaptive capacity followed by Garbatulla. Merti has the highest adaptive capacity.

Vulnerability to Hazards



Data sources: *RCMRD (Vulnerability Assessment by RCMRD)*
Administrative Boundaries: *(OCHA ROSEA)*

GENERATION OF VULNERABILITY						
	EXPOSURE	SENSITIVITY	LACK OF ADAPTIVE CAPACITY	TOTAL	RESCALE	RECLASS
ISIOLO	2	3	3	8	3	3
MERTI	1	1	1	3	0	1
GARBATULLA	3	2	2	7	2	2

Spatial reference: *Geographic, WGS 84*

This map is a by-product of stakeholders' workshop held in Isiolo County. It shows sub-county vulnerability to hazards. Vulnerability is based on exposure, sensitivity and adaptive capacity. Merti is most vulnerable to hazards. Garbatulla was ranked as medium and Isiolo as low

REFERENCES

Broonsvoort. B.M, Hamman. S.M, Tanya. V.N, Kitching. R.P and Morgan. K.L, (2004). Risk factors for herdsman-reported foot and mouth disease in the Adamawa province of Cameroon. Prev. Vet. Med. (66): 127-139.

Bruce.J. and Boudreaux.K. (2013). Land and Conflict. Land disputes and land conflicts. Retrieved from: https://usaidlandtenure.net/issue-brief/land-disputes-and-land-conflict/
Coetzer JAW, Thomson G R and Tustin R C, (1994). Infect. Dis. Livest. Vol II, pp 825-852.

FAO (2009). Human-wildlife conflict in Africa: Causes, consequences and management strategies, Rome, Italy. Retrieved from: http://www.fao.org/docrep/012/i1048e/i1048e00.pdf

Fischlin, A., Midgley, G. F., Price, J. T., Leemans, R., Gopal, B., Turley, C. M., ... & Velichko, A. (2007). Ecosystems their properties goods and services. climate change 2007: Impacts adaptation and vulnerability. contribution of working group ii to the fourth assessment report of the intergovernmental panel on climate change ml parry of canziani jp palutikof pj van der linden and ce hanson eds. cambridge university press cambridge. Assessment Report of the Intergovernmental Panel on Climate Change, 4, 211-272.

FSNG. Maize Lethal Necrosis Disease. A Snapshot. Retrieved from: http://www.fao.org/fileadmin/user_upload/emergencies/docs/MLND%20Snapshot_FINAL.pdf

Füssel, H. M. (2009). An updated assessment of the risks from climate change based on research published since the IPCC Fourth Assessment Report. Climatic change, 97(3-4), 469.

Government of Kenya. (2010). National Climate Change Response Strategy, Executive Brief, Nairobi, Kenya.

Government of Kenya. (2012). National Climate Change Action Plan 2013-2017, Executive Summary, Nairobi, Kenya.

Government of Kenya. (2014). Ending Drought Emergencies: Common programme framework for Drought Risk Management. Retrieved from: http://www.ndma.go.ke/index.php/resource-center/ede-reports/send/43-ending-drought-emergencies/4256-pillar-5-drought-risk-management

Isiolo County Climate Needs Assessment Report

Isiolo County Climate Risk Profile

Isiolo County Government. (2013). Isiolo County Integrated Development Plan 2013-2017

Isiolo County Government. (2018). Isiolo County Integrated Development Plan 2018-2022

Isiolo County SMART Survey Report - February 2018

KALRO. (2014). Maize Streak Virus Fact Sheet. Retrieved from: http://www.kalro.org/emimi/sites/default/files/1%20Maize%20streak%20virus%20fact%20sheet%20Felister.pdf

KNBS. (2014). Kenya Demographics and Health Survey

Lesukat, M. (2012). Drought Contingency Plans and Planning in the Greater Horn of Africa: A desktop review of the effectiveness of drought contingency plans and planning in Kenya, Uganda and Ethiopia, UNON publishing services, Nairobi.

Modagashe declaration 2011

MOH (2006). Malaria Communication Strategy. Division of Malaria Control. Republic of Kenya, Nairobi.

NCDC (2017). Drought: Monitoring Economic, Environmental and Social Impacts. Retrieved from: https://www.ncdc.noaa.gov/news/drought-monitoring-economic-environmental-and-social-impacts

NDMA .(2019). Isiolo County Drought Early Warning Bulletin for May 2019
Nordberg, E. (1999). Communicable diseases: A manual for health workers in Sub-Saharan Africa. Nairobi: AMREF

Party. J., Echeverria.D. & Maitima.J. (2012). Climate Risks, Vulnerability and Governance in Kenya: A Review. Retrieved from: https://www.iisd.org/sites/default/files/publications/climate_risks_kenya.pdf

Sellers R.F (1971). Quantitative aspects of spread of foot and mouth disease. Vet. Bul. 41: 431-439.

Shier, R. P., Dollimore, N., Ross, D.A., Binka, F. N., Quigley, M., & Smith, P. G. (1996). Drinking water sources, mortality and diarrhoea morbidity among young children in Northern Ghana [Electronic version]. Tropical Medicine International Health, 1(3), 334-341.

Talbot, L. M. (1986). Demographic factors in resource depletion and environmental degradation in East African rangeland. Population and Development Review, 441-451

UN (1992). United Nations Framework Convention on Climate Change. Retrieved from: https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

UNCCD (2016) The Ripple Effect: A fresh approach to reducing drought impacts and building resilience. Retrieved from:http://www2.unccd.int/sites/default/files/documents/27072016_The%20ripple%20effect_ENG.pdf

UNDP. Kenya National Disaster Profile

UNDP (2011) Mainstreaming Drought Risk Management. A primer

UNISDR, (2007). Drought Risk Reduction Framework and practices: Contributing to Implementation of the Hyogo Framework for Action, Preliminary version, UN Secretariat, Geneva, Switzerland.

World Organization for Animal Health. Peste des petitis ruminants. Retrieved from: http://www.oie.int/doc/ged/D13983.PDF

http://api.commissiemer.nl/docs/os/i71/i7152/climate_change_profile_kenya.pdf

https://www.tutor2u.net/geography/reference/river-floods

https://albertawater.com/impacts-of-drought/social-impacts-of-drought

http://wmo.multitranstms.com/MultiTransWeb/Web.mvc

http://www.australiancollaboration.com.au/pdf/FactSheets/Land-degradation-FactSheet.pdf

https://www.conserve-energy-future.com/causes-effects-solutions-soil-degradation.php

https://www.cdc.gov/globalhealth/countries/kenya/

https://www.eular.org/myUploadData/files/10%20things%20on%20RD.pdf

https://www.galvmed.org/

http://www.who.int/features/qa/typhoid-fever/en/

https://www.planetnatural.com/pest-problem-solver/plant-disease/common-rust/

https://www.infonet-biovision.org/PlantHealth/Pests/Aphids#simple-table-of-contents-1

http://www.omafra.gov.on.ca/IPM/english/sweet-corn/insects/aphids.html

https://extension.entm.purdue.edu/pestcrop/2009/issue23/index.html

https://www.greenlife.co.ke/tuta-absoluta/

http://agropedia.iitk.ac.in/content/tomato-pinworm-tuta-absoluta-new-invasive-pest-india

Metadata

Mapping of Drought Hazard

Total failure or rainfall below expected levels is the major attribute to drought. Lack or excess precipitation directly affects the vegetation conditions. Climate Hazards Group Infrared Precipitation with Stations (CHIRPS) datasets were used to derive seasonal rainfall trends for the years 1981-2013 using GEOCLIM tool and Standard Precipitation Index (SPI) datasets from FEWSNET were used in mapping of drought. Long rains (March-June) and short rains (October-December) for the years 2000, 2009 and 2012 were used as a reference in mapping SPI.

a. Mapping of Standard Precipitation Index

The Standardized Precipitation Index presents a rainfall anomaly as a normalized variable that conveys the probabilistic significance of the observed/estimated rainfall. By expressing anomalies in terms of their likelihood of occurrence it is easier to evaluate the rarity of the observed event, in the absence of a nuanced understanding of the rainfall regime at a location. This method offers a different, and complementary, perspective compared to anomalies (which can be relatively large, but not very significant in areas with highly variable rainfall) or percent of normal (which can be extreme, but not very significant in dry locations).

To evaluate the likelihood of occurrence, probability distribution functions (PDFs) are fit at each pixel for each accumulation interval. These PDFs are fit to the Collaborative Historical African Rainfall Model (CHARM), which provides a 36-year time series with which to estimate gamma distribution parameters. The CHARM data establishes the shape of the distribution, as well as an estimate of the variance. SPI values which are greater than zero indicate conditions wetter than the median, while negative SPI indicate drier than median conditions. For drought analysis, a SPI less than -1.0 indicates that the observation is roughly a one-in-six dry event, and is termed "moderate". A SPI less than -1.5 indicates a one-in-fifteen dry event, and is termed "severe". Values less than -2.0 are typically referred to as "extreme", indicating the event is in the driest 2% of all events. For more information, please see: http://earlywarning.usgs.gov/fews/africa/web/readme.php?symbol=sp

b. Mapping of Rainfall Trends

Rainfall trends map are the product of CHIRPS datasets. Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a 30+ year quasi-global rainfall dataset. Spanning 50°S–50°N (and all longitudes), starting in 1981 to near-present, CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring. The CHIRPS datasets used in the rainfall trends mapping are products of USGS, CHG scientists, Agency for International Development (USAID) the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA). For more information, please see: http://pubs.usgs.gov/ds/832/pdf/ds832.pdf

c. Mapping of Drought Physical Exposure

Drought Physical Exposure map is a product of dataset that includes an estimate of global drought annual repartition based on Standardized Precipitation Index. It is based on three sources: 1) A global monthly gridded precipitation dataset obtained from the Climatic Research Unit (University of East Anglia). 2) A GIS modeling of global Standardized Precipitation Index based on Brad Lyon (IRI, Columbia University) methodology. 3) A population grid for the year 2007, provided by LandScanTM Global Population Database (Oak Ridge, TN: Oak Ridge National Laboratory). Unit is expected average annual population (2007 as the year of reference) exposed (inhabitants). This product was designed by UNEP/GRID-Europe for the Global Assessment Report on Risk Reduction (GAR). It was modeled using global data. Credit: GIS processing UNEP/GRID-Europe. For more information, please see: http://www.unisdr.org

Mapping of Natural Resource Conflicts

Map of Conflict prone areas is a product of conflict dataset from Armed Conflict Location and Event Data Project (ACLED) and Range condition dataset from Virtual Kenya.

a. Conflict Prone Areas

Conflict prone areas data is a source of real-time data on political violence in African states, Media sources, access and coverage of conflict and human rights violations by civil society and international organisations. Information is designed for disaggregated conflict analysis and crisis mapping. Shows exact location, date and other characteristics of politically violent events in unstable and warring states. For more information, please see: http://www.acleddata.com/

b. Range Condition

Range Condition map is a product of a shapefile which was obtained from the Range Management Handbook of 1992. It was slightly modified by the Turkana district resource persons to reflect the situation. The dataset shows areas of good, fair and poor range conditions in Turkana County. The range condition was overlaid over the access to water coverage (livestock water sources buffers of 10, 15 & 30km) to obtain the accessibility.

Mapping of Flood Hazard

Food maps are products of models from regional earth observation datasets based on weighted overlay analysis of flood observation datasets.

a. Flood Economic Exposure

This dataset includes an estimate of the annual economical exposition to flood. It is based on four sources: 1) A GIS modeling using a statistical estimation of peak-flow magnitude and a hydrological model using HydroSHEDS dataset and the Manning equation to estimate river stage for the calculated discharge value. 2) Observed flood from 1999 to 2007, obtained from the Dartmouth Flood Observatory (DFO). 3) The frequency was set using the frequency from UNEP/GRID-Europe PREVIEW flood dataset. In area where no information was available, it was set to 50 years returning period. 4) A population grid for the year 2010, provided by LandScanTM Global Population Database (Oak Ridge, TN: Oak Ridge

National Laboratory). 4) A Global Domestic Product grid for the year 2010, provided by the World Bank. Unit is expected average annual GDP (2010 as the year of reference) exposed in (US $, year 2000 equivalent). This product was designed by UNEP/GRID-Europe for the Global Assessment Report on Risk Reduction (GAR). It was modeled using global data. Credit: GIS processing UNEP/GRID-Europe, with key support from USGS EROS Data Center, Dartmouth Flood Observatory 2008. For more information, please see: http://www.preventionweb.net/english/professional/contacts/v.php?id=2781

b. Flood Physical Exposure

This dataset includes an estimate of the annual physical exposition to flood. It is based on three sources: 1) A GIS modeling using a statistical estimation of peak-flow magnitude and a hydrological model using HydroSHEDS dataset and the Manning equation to estimate river stage for the calculated discharge value. 2) Observed flood from 1999 to 2007, obtained from the Dartmouth Flood Observatory (DFO). 3) The frequency was set using the frequency from UNEP/GRID-Europe PREVIEW flood dataset. In area where no information was available, it was set to 50 years returning period. 4) A population grid for the year 2010, provided by LandScanTM Global Population Database (Oak Ridge, TN: Oak Ridge National Laboratory). Unit is expected average annual population (2007 as the year of reference) exposed (inhabitants). This product was designed by UNEP/GRID-Europe for the Global Assessment Report on Risk Reduction (GAR). It was modeled using global data. Credit: GIS processing UNEP/GRID-Europe, with key support from USGS EROS Data Center, Dartmouth Flood Observatory 2008. For more information, please see: http://www.preventionweb.net/english/professional/contacts/v.php?id=2781

c. Flood Frequency

This dataset includes an estimate of flood frequency. It is based on three sources: 1) A GIS modeling using a statistical estimation of peak-flow magnitude and a hydrological model using HydroSHEDS dataset and the Manning equation to estimate river stage for the calculated discharge value. 2) Observed flood from 1999 to 2007, obtained from the Dartmouth Flood Observatory (DFO). 3) The frequency was set using the frequency from UNEP/GRID-Europe PREVIEW flood dataset. In area where no information was available, it was set to 50 years returning period. Unit is expected average number of event per 100 years. This product was designed by UNEP/GRID-Europe for the Global Assessment Report on Risk Reduction (GAR). It was modeled using global data. Credit: GIS processing UNEP/GRID-Europe, with key support from USGS EROS Data Center, Dartmouth Flood Observatory 2008. For more information, please see: http://www.preventionweb.net/english/professional/contacts/v.php?id=2781

d. Flood Risk

This dataset includes an estimate of the global risk induced by flood hazard. Unit is estimated risk index from 1 (low) to 5 (extreme). This product was designed by UNEP/GRID-Europe for the Global Assessment Report on Risk Reduction (GAR). It was modeled using global data. Credit: UNEP/GRID-Europe. For more information, please see:
http://www.preventionweb.net/english/professional/contacts/v.php?id=2781

e. Flood Prone areas

Flood prone areas map is a product of Dartmouth University. This product consists of individual GIS vector polygons which define the surface water detected by the MODIS 250 m bands and also depict a multi-temporal composite of the accumulating record of flooded land. These data are produced on a routine basis (1-2 day lag time) as part of the Observatory's flood measuring and mapping projects. When cloud cover and satellite coverage allows, vectors are produced from a single image for each flood event listed in the Archives (generally from 2000 forward). Vectors are also produced on a routine basis which shows rivers in in non-flood conditions. For more information, please see: http://www.dartmouth.edu/~floods/DataProducts/MODIS/

Mapping of Malaria Hazard

Malaria Hazard map is a product of Africa malaria mapping exercise. The methodology is based on household survey data interpolation and climatic suitability modeling. For more information on climatic suitability modelling approach, please see: http://www.mara.org.za/trview_e.htm

Mapping of Seismic, Volcanic and Earthquake activities

Seismic, Volcanic and Earthquake maps were derived from coverage showing the earthquake intensity zones in accordance with the 1956 version of the Modified Mercalli Intensity scale (MMI). The intensity zones describe exclusively the effect of an earthquake on the surface of the earth by integrating numerous parameters including acceleration, duration of earthquake, sub-soil effects, as well as historical reports. The seismic hazard grading is based on its expectation over a period of 50 years, which also corresponds to the mean service life of a modern building. The probability of the degree of intensity being exceeded in 50 years is 20% shown on the maps. GRID digitized the original maps on earthquakes at a scale 1:34,000,000 and further added the coastlines from PC World Databank-II (by ESRI, as modified by GRID)
The zone as provided by the MMI scale (probable of maximum intensity once in 50 years) is 0 – V and below, 1- VI, 2- VII,3- VIII,4- IX and above. The data was further validated by experts from the participating IGAD member states and by incorporating expert knowledge, the MMI scales were classified into four levels of seismic risk as follows: Very High (IX and above);High (VIII); Medium (VII) and Low (below VI). For more information, please see:
http://www.geodata.grid.unep.ch/mod_download/download.php

Mapping of Livelihood Zone

Livelihood Zone map is a zones/an area within which people share broadly the same pattern of livelihood, including options for obtaining food and income and market opportunities. A livelihood zoning is essential for the following reasons:

- It provides geographic orientation of livelihood systems to inform food security analysis and assistance targeting
- It provides the basis for identifying geographically relevant food security monitoring indicators
- It provides a sampling frame for future on-the-ground assessments

Livelihood patterns clearly vary from one geographic area to another, which is why the preparation of a Livelihood Zone Map is a logical first step for livelihoods-based analysis.

Glossary/ Defination of Terms

Disaster: A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Disaster contingency plan: to address a disaster or impending disaster with in a fairly finite time, such as from early warning to response to recovery, including mechanisms for generation of disaster-specific operational plans.

Disaster preparedness strategy: a broad exercise, which sets out objectives for disaster preparedness in a country or region, reviews the current status of disaster preparedness capacities in relation to those objectives, and identifies what measures must be taken for maintaining and enhancing those capacities for the objective to be met.

Disaster Risk: tThe potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.

Disaster Risk Management: the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

Disaster Risk Reduction: This is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development.

Drought: Naturally occurring phenomenon that exist when precipitation has been significantly below normal recorded levels causing a serious hydrological imbalance that adversely affects land resource production systems.

Early warning: provision of early and relevant information on potential or actual disasters, and normally involved monitoring hazards, especially in relation to communities or areas known to be vulnerable to their effects, so that more timely and effective response measures is taken.

Emergency: An extraordinary situation in which people are unable to meet their basic survival needs, or there are serious and immediate threats to human life and well-being.

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

Impacts: specific effects of hazards or disasters also referred to as consequences or outcomes. Impacts and needs assessment: Assessing the nature and magnitude of a disaster once it occurs, its impact on affected populations, and the type and extent of emergency assistance that is required.

Agricultural drought: an agricultural drought is the impact of meteorological droughts and hydrological droughts on crop yields. This kind of drought is associated with extreme heat.it occurs when extended dry periods and general lack of rainfall result in a lack of moisture in the root zone of the soil. This severally damages the plants that live in the area.

Hydrological drought: occurs when there are critically low groundwater tables and reduced river and stream flow. Hydrological drought is distinguished by a reduction in water resources in reservoirs, lakes, rivers, underground aquifers and streams.

Meteorological drought: A reduction in rainfall over a specific period, for example a day, month, season, or year. There is no agreement on what the lack of rain or the time without rain should be before it is considered a drought. Usually the area affected determines these especially in non-arid regions. Meteorological drought leads to depletion of soil moisture and this almost always has an impact on crop production.

Mitigation: The lessening or minimizing of the adverse impacts of a hazardous event.

Preparedness: The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.

Prevention: Activities and measures to avoid existing and new disaster risks

Response: Actions taken directly before, during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Risk: Combination of the probability of an even and its negative consequences. The probability of a harmful consequence or loss resulting from an interaction between natural hazards and vulnerable conditions of property and people.

Risk Assessment: a methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing condi- tions of vulnerability that together could potentially harm exposed people, property, services,

livelihoods and the environment on which they depend.

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

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