Adaptation to Climate Change and Insurance

Climate Risk and Vulnerability Profiles for

Homa Bay and Busia Counties, Kenya

January 2013

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Acronyms

ACCI	Adaptation to Climate Change and Insurance
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CCCMA CGCM2	Canadian General Circulation Model 2 by the Canadian Centre for Climate Modelling and Analysis
CGIAR	Consultative Group on International Agricultural Research
CSIRO Mk2	CSIRO Atmospheric Research Mark 2b
GCM	General Circulation Models
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
HADCM3	Hadley Centre Coupled Model version 3
ICRAF	World Agroforestry Centre
IPCC	Intergovernmental Panel on Climate Change
KMD	Kenya Meteorological Department
KARI	Kenya Agricultural Research Institute

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Executive Summary

Kenya has a poverty rate as high as 52%, and 73% of the workforce depend on agricultural production. The country is already experiencing strong adverse effects – especially in their agricultural sector – due to accelerated climatic changes and increasing climate variability. Busia County in Western Province and Homa Bay County in Nyanza Province witness droughts, floods, erratic rains and hailstorms with increasing frequency and severity. Impacts of these climate stimuli range from reduced yields or total crop failure to water shortages and increasing amounts of pest and disease attacks or the occurrence of new pests and diseases. Future projections for the area predict increasing temperatures and further changes in rainfall patterns.

The effects of climate change and climatic variability on agricultural production differ among the cultivated crops. Legumes like groundnut, cowpea and beans are predicted to be among the crops experiencing the most severe effects altering yields and potentially making Homa Bay and Busia Counties climatically less suitable for their production. Bananas, pineapple and mango, generally tree crops, on the other hand may benefit from climatic changes in the area.

Various factors increasing vulnerabilities of the local population and the local ecosystems worsen negative impacts of the observed climate stimuli. Soil erosion, land degradation, poor soil fertility and decreasing quality and quantity of water bodies leave local ecosystems with little resilience towards climate change. Over-dependence on rain-fed agriculture, little diversification of household incomes and crops as well as limited access to agricultural information (training) and financial resources further expose the local population to impacts of climate change.

Introduction

Climate change is putting at risk the livelihoods of many farmers around the world. In Kenya 68% of the total population live in rural areas and their livelihoods heavily depend on agricultural activities. The agricultural sector is the engine of economic development in Kenya. This sector alone accounts for 25% of the GDP and employs over 80% of the Kenyan population (National Food and Nutrition Policy, 2011). In turn Kenyan agriculture depends almost 100% on natural precipitation, with only 105,800 ha or 8.14% of national irrigation potential so far developed. Climatic changes and climate variability are increasingly witnessed and jeopardize agricultural yields and thus income from agricultural production. Especially smallholder producers have always had to manage uncertainties and fluctuations in yield quality and quantity. They have developed their own coping strategies but their adaptive capacities in the face of climate change are limited. Prominent local vulnerabilities in Kenyan smallholder production systems enforce negative impacts caused by climate stimuli.

The Adaptation to Climate Change and Insurance (ACCI) Project, a bilateral project between the Kenyan and the German Government, was initiated to address these climate change issues, especially adaptation. The project is funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Government of Kenya and jointly implemented between the Kenyan Ministry of Agriculture and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH between January 2011 and December 2013.

The project aims to support agricultural extension services through the development of appropriate advisory packages. The overall goal of the project is to enable small-scale enterprises, cooperatives as well as processing and marketing enterprises to increase their capacities to adapt to climate change. This is done via support packages for climate risk management, which help to minimize vulnerabilities and to stabilize and improve yields in agriculture. Additionally, index-based insurance solutions are promoted to cover risk arising from weather events. The project is being piloted in the counties of Homa Bay and Busia to identify and test promising adaptation strategies that serve as references for actors in other regions of Kenya and Africa. One of the expected outputs of the project is a methodology to measure changes in adaptative capacity among the farming community. This methodology is expected to contribute to the international discussion on “Measurement, Reporting and Verification”.

The present document condenses earlier ACCI project reports and includes scientific views as well as stakeholder opinions and perceptions of the local population.

1. The two Pilot Regions

Homa Bay County

Homa Bay County is located in Nyanza Province and extends over six districts, namely Ndhiwa, Mbita, Rachuonyo South, Rachuonyo North, Suba and Homa Bay itself (Figure 1). The county borders Lake Victoria to the north eastern part of the lake and stretches over 4128km^2. It has five major agro-ecological zones, namely lower medium (LM) 1-5, and small spots of upper medium zones (UM) 1-4 as indicated in Figure 2. This means the county includes dry zones with only one cropping season as well as wet zones with almost permanent cultivation possibilities. These differenct climatic zones are due to the differences in temperatures between Lake Victoria and the heated landmasses causing almost permanent winds.

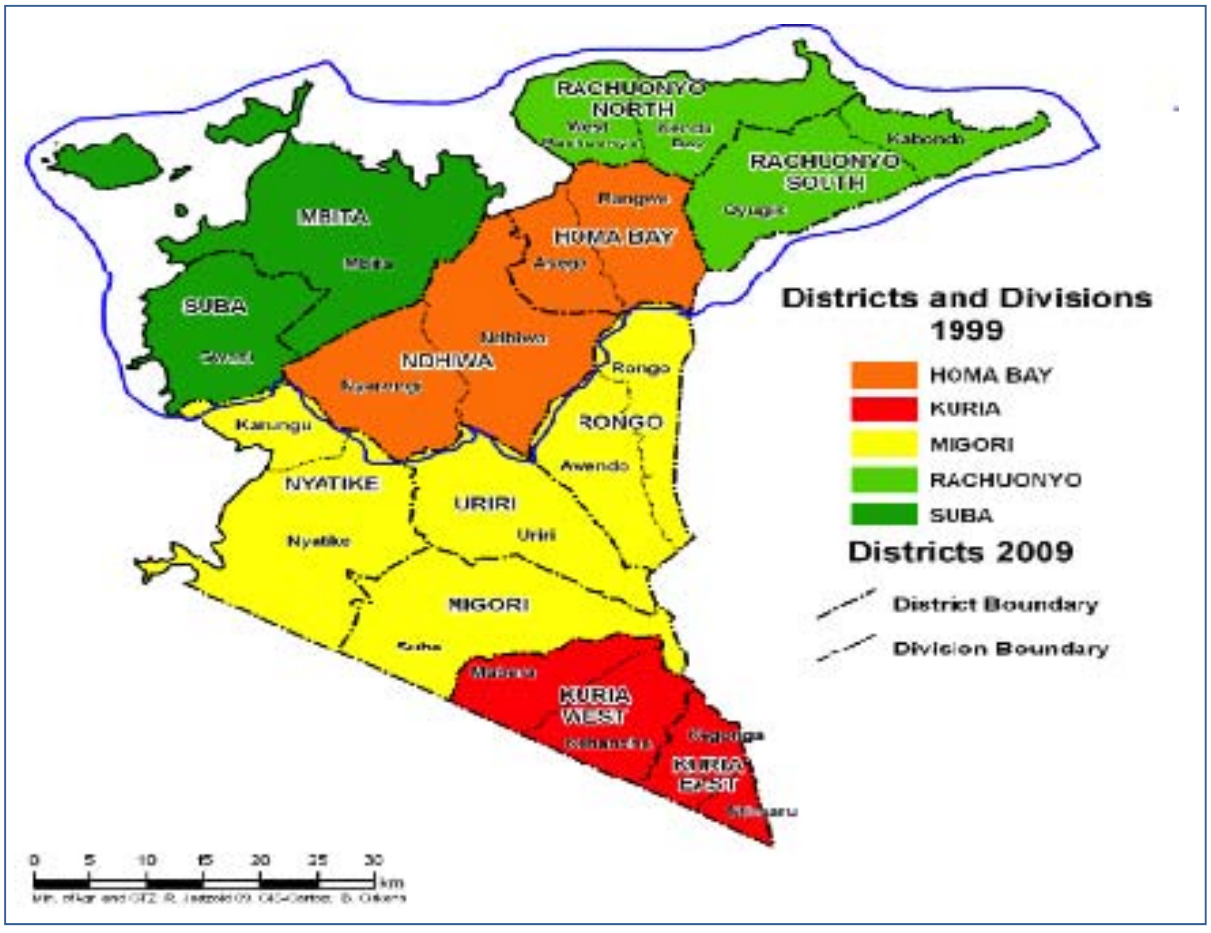


Figure 1: South Nyanza including Homa Bay County (Jätzold et al, 2009)

The topography of Homa Bay County varies from uplands of different levels to plains and alluvial valleys. Along the shores of Lake Victoria steep mountains such as Gwassi and Gembe Hills characterize the landscape. Soils in Homa Bay County have a moderate to high fertility in the east and low fertility in the south, the north and the centre.

The preferred crops in the county include maize, beans, sorghum, groundnuts, millet, cotton and cassava among many other minor crops.

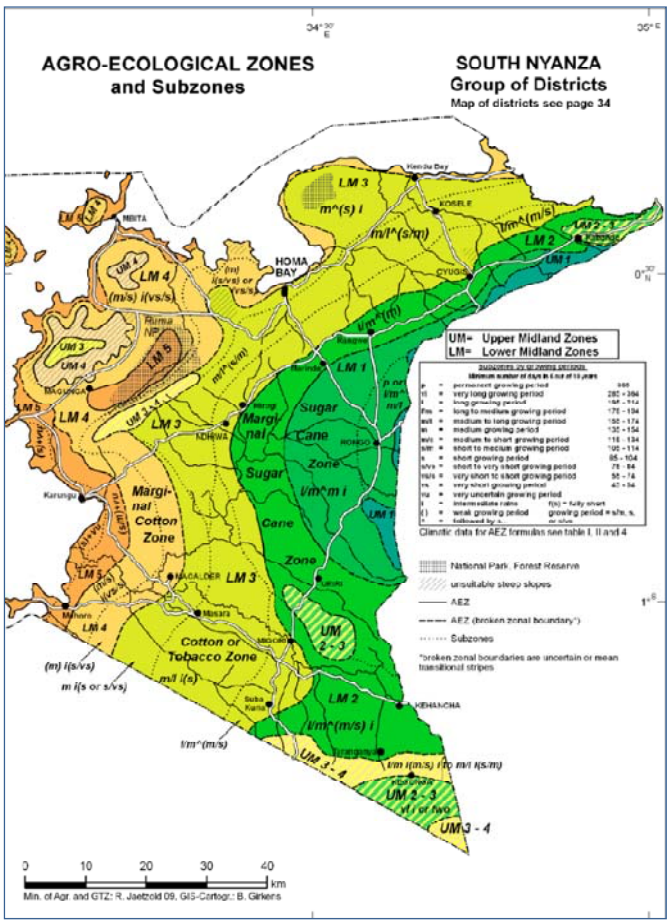


Figure 2: Agro-ecological Zones in South Nyanza including Homa Bay County (Jaetzold et al 2009)

Busia County

Busia County is part of Western Province and extends over seven districts, namely Busia, Nambale, Butula, Bunyala, Samia, Teso North and Teso South. Busia is approximately 431 km west of Nairobi and borders the Republic of Uganda to the west. It stretches over 1683km^2.

Due to its location at the border Busia county has become a major trading location and accounts for trade as well as for human traffic between the two East African countries.

The predominant communities living in Busia County include the Iteso, Luhya and the Luo.

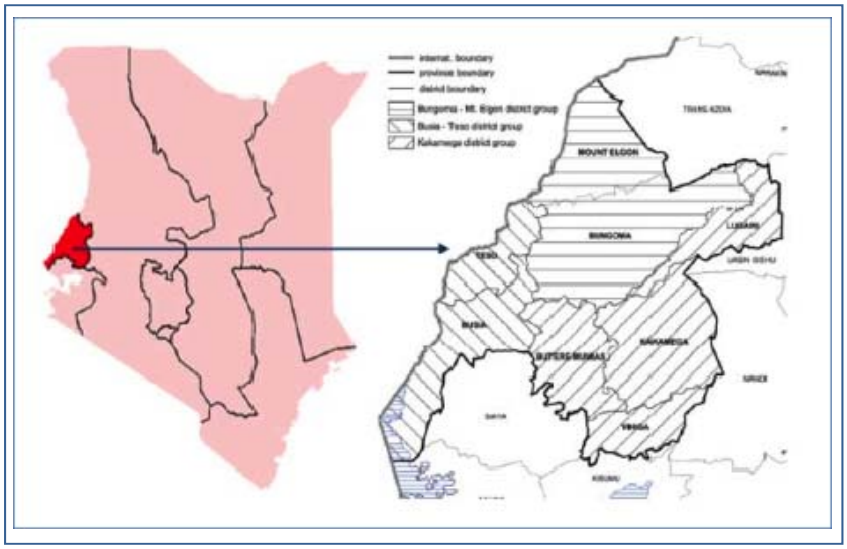
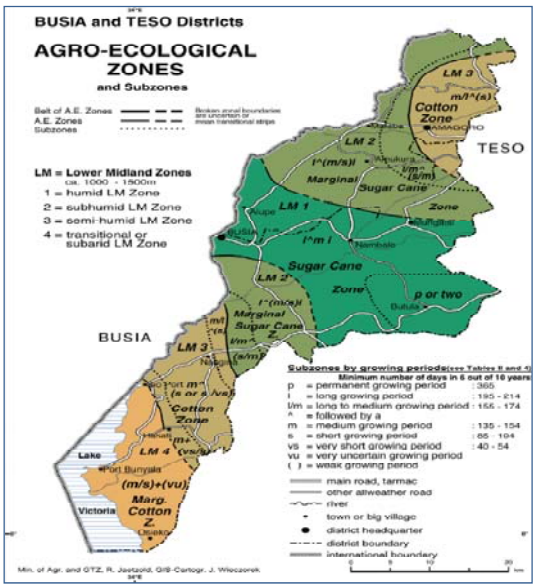


Figure 3: Western Province including Busia (reflecting 2009 district boundaries) (Jaetzold et al 2005)



The County has four agro-ecological zones: lower medium (LM) 1-4 with the wetter LM1 in the centre of the county. Soils in Busia County are generally shallow to moderately deep (50-80cm) with low fertility.

The preferred crops in the county include maize, beans, sorghum, groundnuts, millet, cotton, sugarcane and cassava among many other minor crops.

Figure 4: Agro-ecological Zones in Busia County (Jaetzold et al 2005)

2. Climate

Current Climate Busia County

Precipitation and Temperature

Busia County's climate is tropical humid and dominated by the influence of Lake Victoria. Humidity levels with potential evapo-transpiration rates between 1800 and 2030mm per year are around 100% throughout the wet months, April to June, and around 23% during the drier months of January to March.

Annual temperatures in the county's districts range from 17 to 30°C with mean annual temperatures between 24 and 26°C.

Yearly average precipitation is between 900 and 1500mm distributed throughout two main rainy seasons: long rains between March and June and short rains between September and December. However, in the wetter parts of the county such as Butula district these two rainy seasons are not clearly separated as it may rain during the afternoon throughout most parts of the year.

Mean monthly rainfall trends as captured throughout the different weather stations in the county indicate clear differences:

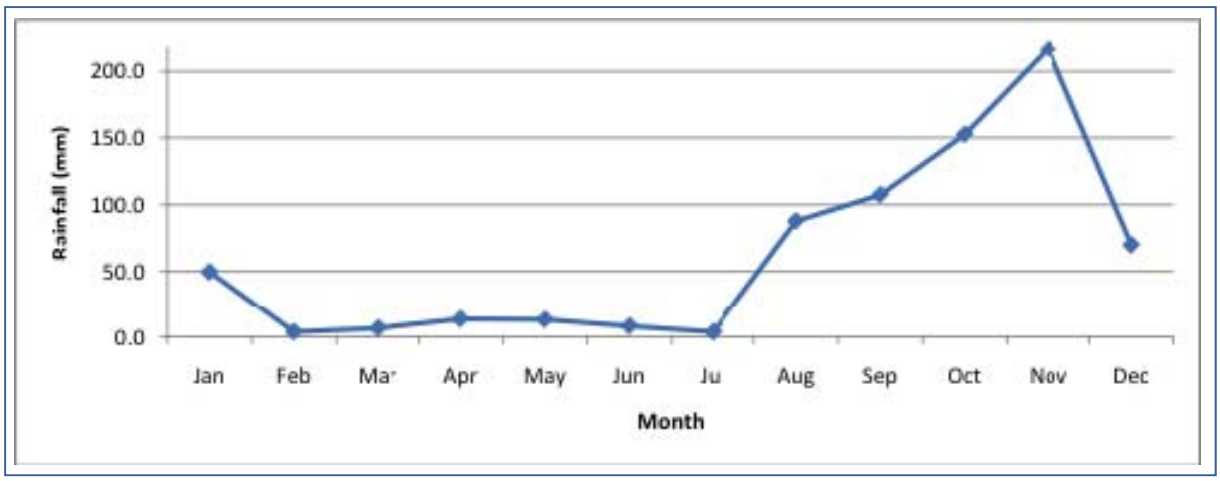


Figure 5: Mean Monthly Rainfall in Busia District, 2005 - 2010 (Busia ATC Weather Station)

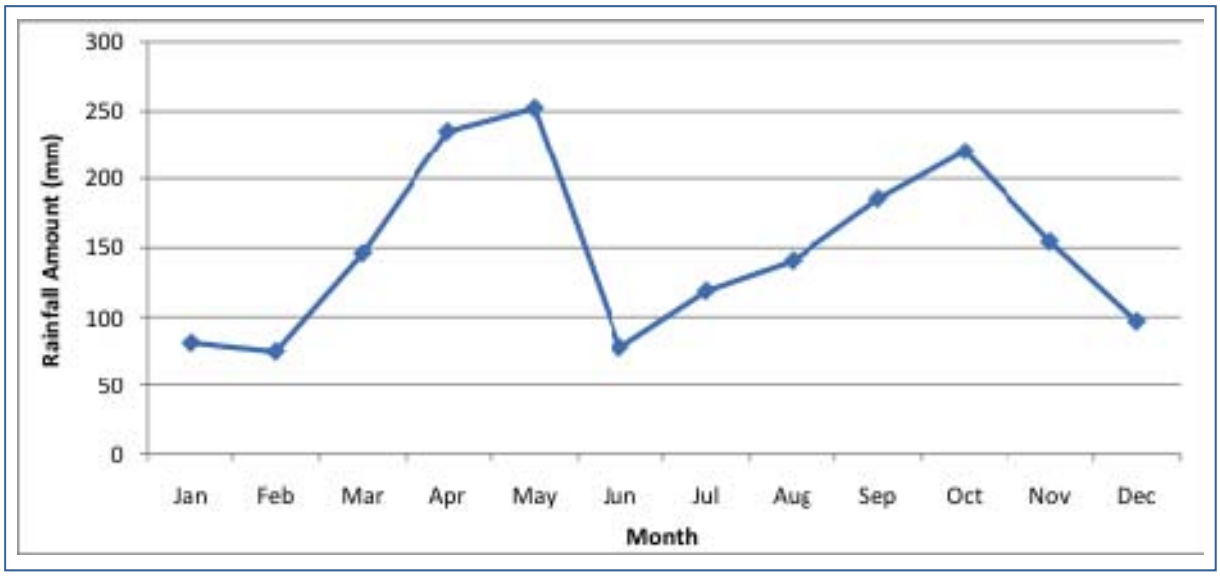


Figure 6: Mean Monthly Rainfall in Teso North District, 2002 – 2010 (KARI Alupe Weather Station)

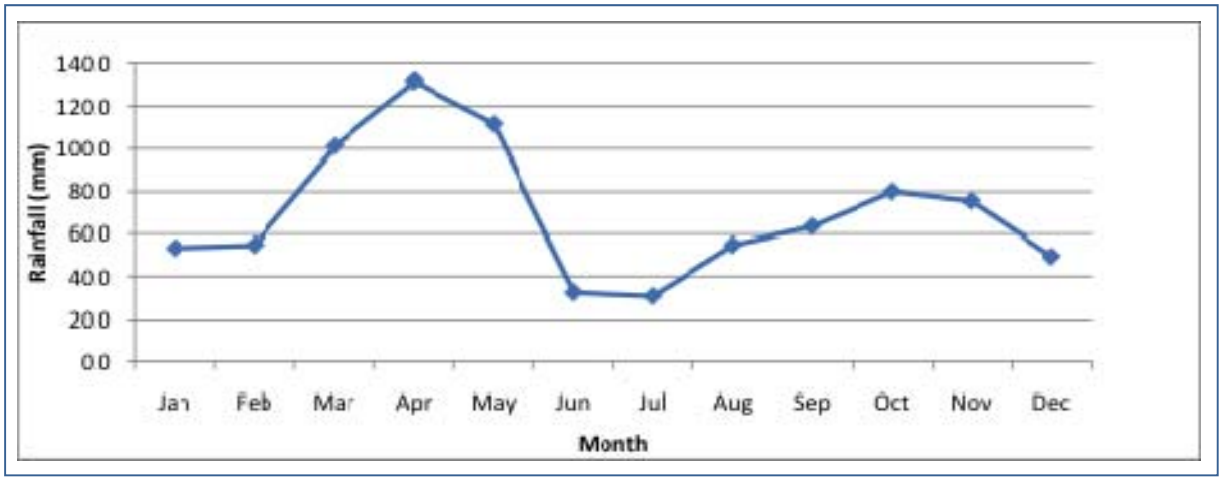


Figure 7: Mean Monthly Rainfall in Bunyala District, 2002 – 2010 (Sisenye Weather Station)

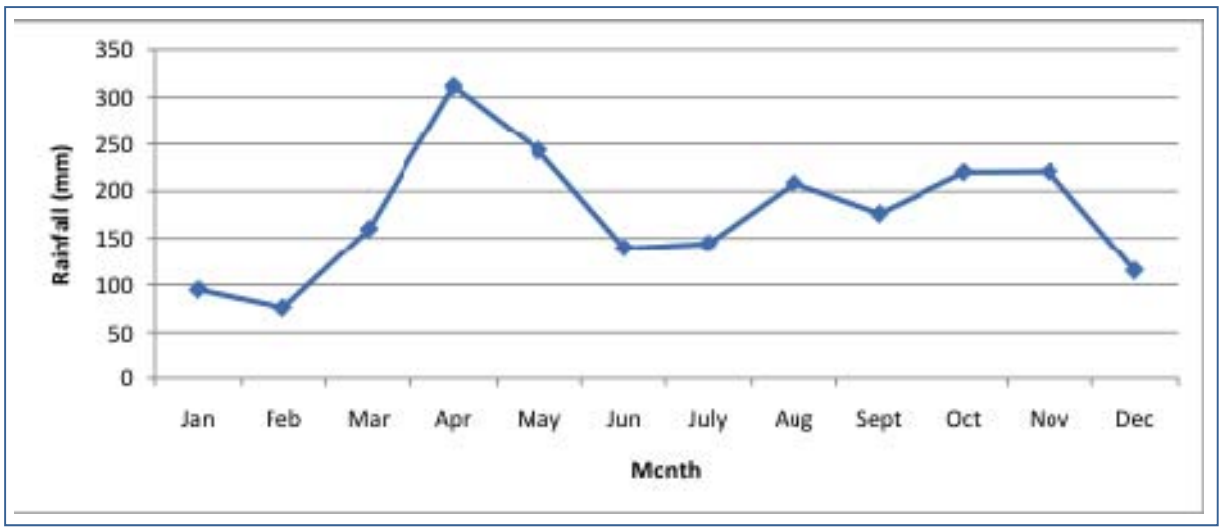


Figure 8: Mean Monthly Rainfall in Nambale District, 2002 – 2010 (Nambale DAO Weather Station)

In Busia County the wettest period has shifted towards August – December during the past years. In Bunyala, Teso North and Nambale Districts the two peaks of the two rainy seasons are clearly indicated around April and October – November. Also the amounts of rainfall per year range throughout the districts. Butula is the wettest and Bunyala the driest district as shown in table 1.

Table 1: Annual Rainfall in Busia County

	Annual Rainfall in mm
Busia District	1200 – 1800
Bunyala District	700 – 1000
Teso North District	800 – 1600
Nambale District	1200 – 1800
Butula District*	1500 – 2000

** No monthly rainfall trend available.*

Extreme Weather Events

The predominant extreme weather occurrence throughout Busia County is drought. Formerly droughts used to occur about every ten years. Later the frequency of droughts reduced to five years and currently dry spells are experienced almost every other year.

In the districts Teso North, Nambale and Bunyala occasionally floods and hailstorms occur.

Current Climate Homa Bay County

Precipitation and Temperature

Homa Bay County's climate is as well tropical humid and strongly dominated by the influence of Lake Victoria. Humidity is high with potential evapotranspiration rates between 2000 and 2200mm per year.

Annual temperatures in the county range from 17 to 34°C. February is the hottest month while temperatures are lowest in April and November.

Yearly average precipitation is between 700 and 1800mm with an annual average (1982 – 2002) of around 949mm. In the period between 1961 and 1981 annual average used to be 1093mm, thus decreasing amounts of rainfall are already documented. The long rainy season in Homa Bay County starts in March and the short rains commence in November. In the eastern parts of the county "middle rains" in between the two rainy seasons may be received; ultimately connecting the long and the short rains.

Mean monthly rainfall trends as captured throughout the different weather stations in the county indicate clear differences:

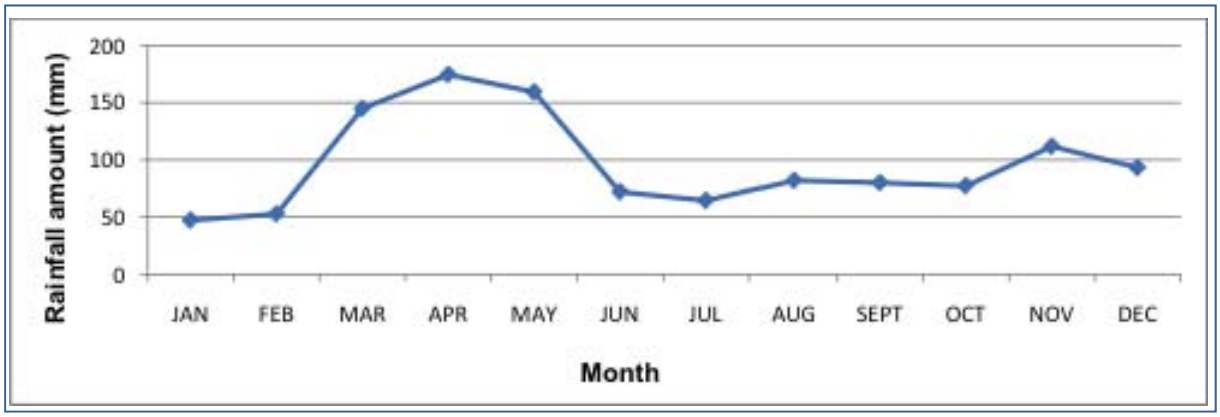


Figure 9: Mean Monthly Rainfall in Homa Bay District, 2000 – 2010 (Homa Bay ATC Weather Station)

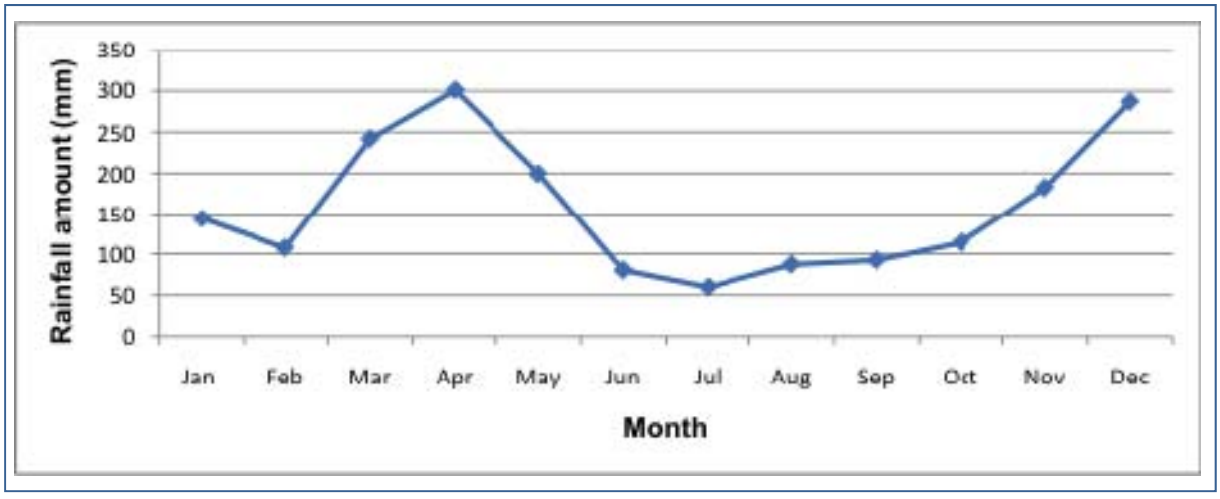


Figure 10: Mean Monthly Rainfall in Mbita District, 2001 – 2010 (ICIPE Mbita Station)

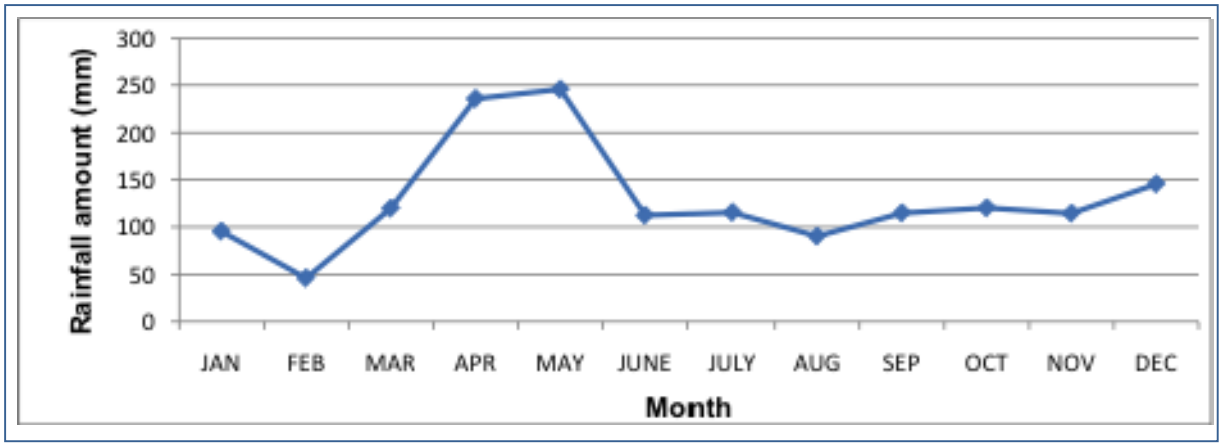


Figure 11: Mean Monthly Rainfall in Rachuonyo North District, 2001 – 2010 (Homa Hill Station)

In the districts of Homa Bay and Rachuonyo North the long rains between March and June clearly receive the highest amount of rainfall, while throughout the other months of the year no distinct peaks of high precipitation volumes are experienced. In Mbita District there is a clear peak between March and May and again between November and December. Rachuonyo North district receives more rainfall throughout the drier months of June – August than the recorded in the other two districts.

Table 2: Annual Rainfall in Homa Bay County

	Annual Rainfall in mm
Homa Bay District	Average: 1158,8
Mbita District	Average: 1896
Rachuonyo North District	Range: 500 – 1000
Ndhiwa District*	Range: 500 – 1650

** No monthly rainfall trend available*

Extreme Weather Events

The predominant extreme weather occurrences in Homa Bay County are droughts and flooding. In Mbita district strong winds leading to windstorms especially on the Rusinga – Mfangano strait have been experienced and in Rachuonyo North districts hailstorms have been experienced.

Climate Change Scenarios

Methodology

On behalf of ACCI the Kenya Meteorological Department (KMD) and ICRAF came together to carry out a study to assess climate variability and change in the two pilot regions (Ambenje et

al., 2011). For this study rainfall and temperature data from the last 30 years and above was collected and assessed from the meteorological stations within and in the vicinity of Busia and Homa Bay County. However, distribution of the stations within the two counties is rather poor with little or no stations in northern and south-eastern Busia County and southern and western Homa Bay County.

Based on that future climate predictions for the pilot regions were modelled. Three different General Circulation Models (GCM) were applied (Lüdeling, 2011) to conduct the study: the Hadley Centre Coupled Model version 3 (HADCM3), the Canadian General Circulation Model 2 by the Canadian Centre for Climate Modelling and Analysis (CCCMA CGCM2) and the CSIRO Atmospheric Research Mark 2b (CSIRO Mk2). For these models, the statistically downscaled versions provided by the CGIAR Research Program on Climate Change, Agriculture and Food Security with a spatial resolution of 2.5 min (approx. 25 km in the study region) were used for the analysis. The two greenhouse gas emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC), A2a, 'business as usual emissions', and B2a, 'reduced emissions', and three points in time (2020s, 2050s and 2080s) were applied.

Additionally

Results

Across the pilot regions there is a clear trend of increasing temperatures. By the 2020s a temperature rise around 1°C is expected and for the 2080s the models indicate an increase in temperature between 4 and 5°C under the A2a emissions scenario and between 2 and 3°C under the B2a emissions scenario. Mean annual temperatures in the study counties are around 22°C in the lower areas, and about 20°C in areas at higher elevations. Under the B2a scenario, mean annual temperatures rise to 25°C in the lowlands and 23°C at higher elevations by the 2080s. In the A2a emissions scenario, mean annual temperatures in the lowlands reach 27°C, and even for the higher regions of Homa Bay 25°C are indicated as annual mean temperature.

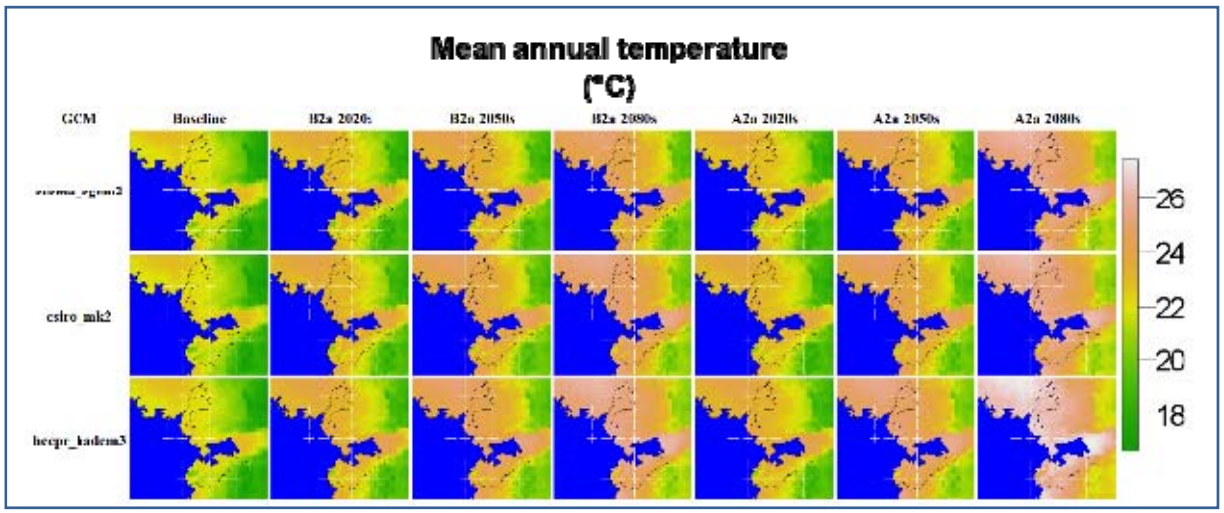


Figure 12: Predictions for Mean Annual Temperature

A future increase in especially minimum temperature is expected as based on historical temperature data from Kisumu Airport Meteorological Station. Although Kisumu is not within either of the two pilot counties, temperature data of this station was the only dataset, which in terms of duration of recording, number of parameters and quality of data, could be analysed. It had therefore to be taken as a proxy. Long-term temperature data was not available from the meteorological stations within the two counties as these were mainly focusing on rainfall data only.

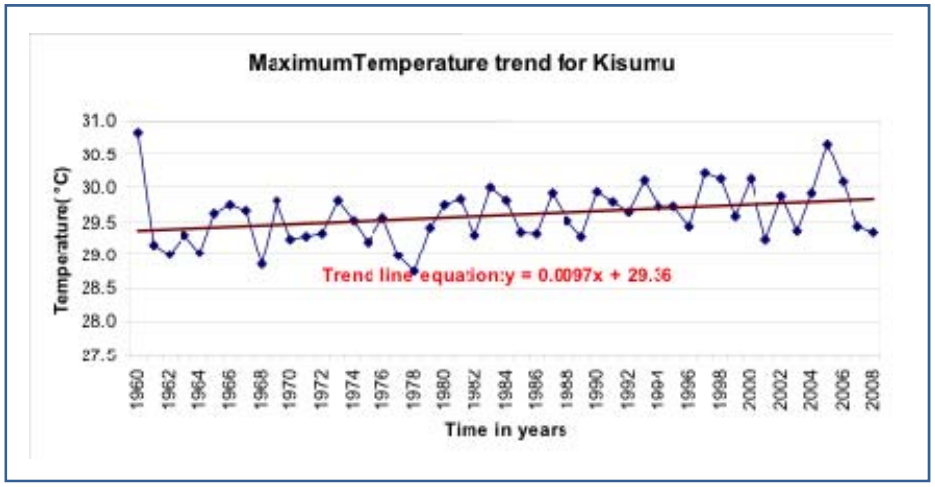


Figure 13: Predictions for Maximum Temperature Trend

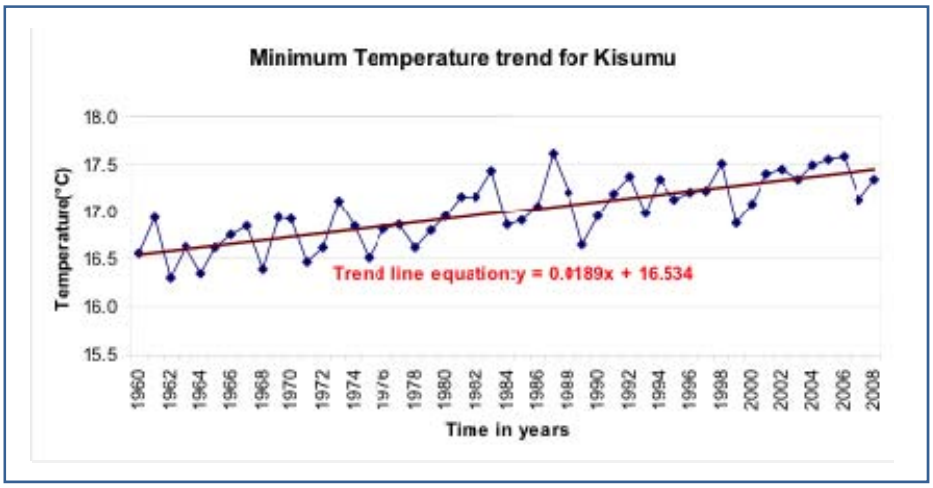


Figure 14: Predictions for Minimum Temperature Trend

Annual rainfall is not expected to decrease more than 200mm. For the 2080s the CSIRO model in fact indicated an increase in annual rainfall of up to 800mm under the A2a emissions scenario. However, not only the total amount of rainfall is important to secure the agricultural sector, but rather the annual distribution. For some regions May and June are projected to become drier, while the months from October to April may become substantially wetter.

The study of KMD and ICRAF indicates decreasing rainfall trends in Busia County especially around the meteorological station of Namuichula Nursery between March and May. For Homa Bay County no particular regional trends were detected. Rainfall intensity of the long rains is predicted to decrease around Namuichula Nursery station, KARI Alupe station, Nambale Agriculture Office in Busia County and around Homa Bay FTC station in Homa Bay County.

Mean annual rainfall ranges from 1000 to 2000 mm in the baseline scenario. It is highest in the hilly areas north of Kisumu and east of Homa Bay. The least rainfall falls along the lakeshore. This general pattern is expected to be the same in the future, however the three models differ significantly in projections of future rainfall. The HadCM3 and the CCCMA models show rainfall patterns similar to the baseline for all future scenarios. Only the CSIRO model projects a marked increase in rainfall, reaching more than 2500 mm in the highlands.

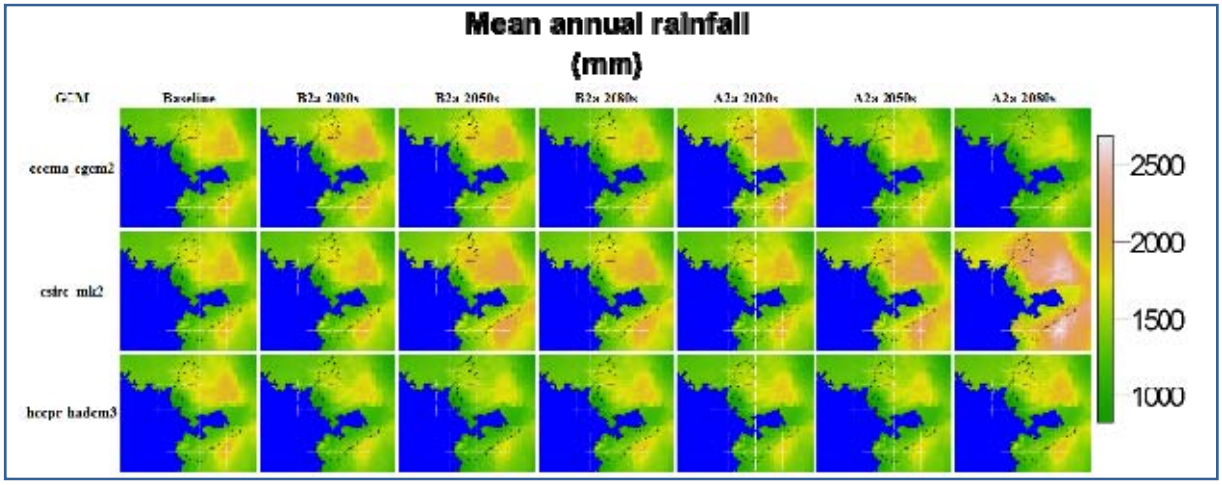


Figure 15: Projected Mean Annual Rainfall

Kenya has two main rainy seasons: March to May and October to December. Currently the long rains start around mid March and the short rains between the end of September and the end of October. The projections indicate a later onset of the long rains, especially by the 2080s. Despite differences in the models there is one scenario predicting a tendency of the short rains merging with the long rains and thus having one single long rainy season. In general this could lead to less seasonality with no longer clearly defined onsets and lengths of the rains.

In general, the studies predict less intense impacts of climate change on rainfall amounts and precipitation patterns than impacts of climate change on minimum and maximum temperature in the two counties. The highest storm occurrence in both counties is predicted for the region around the meteorological station of the Kenya Agricultural Research Institute (KARI) in Alupe, Busia County.

3. Demographics and Socio-Economics

Looking into climate change adaptation socio-economic factors is very relevant to accurately determine the vulnerabilities as well as the adaptive capacities of the target groups.

In 2009 Kenya's population was 38.6 million with around 68% living in rural areas (Population Census Results – Kenya National Bureau of Statistics, 2009). Population has steadily increased and almost doubled from 1989 with 21.4 million to 38.6 million in 2009. Population density is highest in the province of Nairobi with 4515 people per square kilometre and second highest in Western Province, where Busia County is located, with 522 people per square kilometre.

Demographics Homa Bay County

According to the Kenya National Bureau of Statistics Homa Bay County has a total population of 1.2 million with 52% women and 48% men. Around 39% of the county's population lives in Homa Bay District. The second biggest district in regards to population is Rachuonyo South with around 18% of the district's general public. The smallest district is Mbita with 7% of the total population of Homa Bay County.

It was found that there are quite a number of female-headed households in Homa Bay County, between 22 and 29%, specifically in Ndhiwa district. The average age of the household head is between 44 and 53. Monogamous couples run 72% of the households in Homa Bay County, thus 28% are run by either polygamous structures or single or widowed parents. These latter households tend to be more sensitive to impacts of climate change and climatic variability mainly due to a limited access to resources.

On average, household size ranges from six to seven people. Generally, in both counties, there are more female than male family members. This indicates that household chores as well as farming activities heavily depend on the women in the two pilot counties. With 33% Homa Bay and Ndhiwa districts show the highest percentage of family members under the age of 18. On the one hand this indicates a potential strong future workforce, on the other this implies strong current financial restraints due to such a high percentage of the population depending on their families.

46% of the household heads in Homa Bay County count on basic primary education, while only 4% are indicated as illiterate. 29% even count on secondary education and 13% graduated from college.

On average farmers in Homa Bay County count on 17 years of farming experience. This is a little less than farmers in Busia County (22 years), but nonetheless indicates long-term involvement in farming.

Demographics Busia County

Busia County has a total population of 488075 with around 52% women and 48% men.

Monogamous couples run 86% of the households in Busia County and the average age of the household head is between 47 and 53.

About 55% of the household heads in Busia County count on basic primary education, while 6% are indicated as illiterate with the highest illiteracy levels in Butula and Bunyala districts. Compared to Homa Bay County the level of household heads with secondary education is a little lower at 26% (Homa Bay County 29%) and only 8% that graduated from college (13% in Homa Bay County). The average size of the farming families in the county range from seven to nine people, with the majority of the larger families, nine members on average, identified in Busia district.

On average farmers in Busia County count on 22 years of experience in farming. This indicates long-term commitment in the agricultural sector, but may also indicate aging farmers, meaning young people looking for other sources of income, while the older generation sticks to farming activities for income generation.

Socio-Economics Homa Bay County[1]

Household Income and Expenditures

Farming is the main occupation throughout the county, followed by non-specified business and other types of labour. This is also demonstrated by the different sources of income: the main source of income in Homa Bay County is the sale of the crops, followed by non-specified business and salaried employment. Additionally remittances and the sale of chicken, cattle and goats and sheep generate part of the household incomes.

Average household income ranges from 26,869 Kenya Shillings per month to 53,213 Kenya Shillings (status 2011, data from ACCI Baseline Study). Ndhiwa district has the highest average income in the county, while Rachuonyo North has the lowest mean income. Average household income is higher in Homa Bay County than in Busia County, however there seems to be a wide disparity among the household incomes in the county, indicating that some households have high incomes, while others have very low incomes.

Average annual household expenditures differ among the districts with the highest of 179,020 Kenya Shillings in Homa Bay district and the lowest of 136,115 Kenya Shillings in Ndhiwa district. Food and groceries and education are the main matters of expenses totalling between 47 and 60% of total expenditures. Homa Bay is the only district where more money is spent on education than on food and groceries. The third biggest cost factors in Homa Bay and Ndhiwa districts are housing and maintenance, while in for example Rachuonyo North it is transport.

Average household income is roughly 31% higher in Homa Bay County than in Busia County and expenses are roughly 28% higher than in Busia County. Thus average net income is slightly higher in Homa Bay County.

Household Assets

Over 90% of the county's households own at least one radio and throughout the districts between 26 and 38% even own at least one television.

The majority of the population, around 72%, live in houses made out of mud and cow dung. 23% can afford to build their houses out of concrete blocks and 5% live in houses made out of stone and / or wood. Stone or concrete constructions usually indicate quite a wealthy status. Looking at the different districts, Homa Bay is the one with the highest percentage, 83%, of houses build of mud and cow dung and Ndhiwa district the one with the lowest percentage, 64%, of such houses. The majority of the rooftops, over 94%, are made out of iron sheets and most of the households, over 70%, own chairs, tables and even sofas.

The major source of fuel is firewood, 97%, indicating enormous wood consumption and thus high deforestation rates throughout the county. Water sources for household use differ quite substantially. Rivers, ponds, shallow tube wells and wells provide most of the water. Water quality is considered mostly "fair" throughout the county while in Homa Bay district the majority of the population consider water quality to be "good".

[1] Data from this chapter from ACCI Baseline report, 2012)

Usually the households own small pieces of land between 2.6 and 3.4 acres and over 70% of the households in the county own all the land they farm on. Ndhiwa district represents an exception with only 45% of the farmer families owning all the land they farm on, 37% owning parts of the land they farm on and 18% owning none of the land they farm on. Around 83% inherited their land, while 17% purchased their land. On average 23% of the farmer families in Homa Bay have title deeds for their land and 60% have demarcated their land but do not hold title deeds. The higher the insecurity of tenure regarding their land, the less likely farmers are to look into long term investments and the less likely they are to access credits due to a lack of collateral.

Socio-Economics Busia County

Household Income and Expenditures

Also in Busia County the main sector of occupation is agriculture. Second then comes driving which usually refers to taxi services on motorcycles and thirdly other types of labour. In Nambale and Butula districts driving even accounts for higher percentages in occupation than agriculture: 50% of Butula's population are occupied in driving, while only 22% indicate to be farmers. In Nambale district 47% are occupied in driving, while 33% indicate to be farmers. Off-farm occupation usually attracts men more than women, as such activities tend to generate more income than farming and are usually less laborious than farming. Looking into how income is generated indicates a strong dependence on the agricultural sector, though. The majority of the agricultural income is from sale of crops, followed by non-specified business and sale of chickens. Labour wages, remittances and sale of cattle, goats and sheep complement household incomes.

Average household income ranges from 24,426 Kenya Shillings per month to 33,613 Kenya Shillings throughout the county. Nambale is the district with the highest average monthly income while Butula is the district with the lowest mean income. Big differences in household incomes were mainly identified in Nambale district.

Mean annual expenditures are the highest in Butula district with 151,073 Kenya Shillings and the lowest in Nambale district with 95,545 Kenya Shillings. The biggest cost factors throughout the districts are, just as is the case in Homa Bay County, food and groceries and education. In Bunyala district 56% of yearly average expenditures are on food and groceries, while in Busia district only 25% are spent on average on food and groceries per year. In Busia and Butula district the third biggest cost factors are medical and hospital fees, while in the other districts the third highest matters of expenses differ between firewood and clothing.

Household Assets

Over 50% of the households own at least one radios, in Butula and Busia districts even over 70%, while in Nambale and Bunyala districts 44% of the households are without a radio. Throughout the different districts between 26 and 39% even own at least one television.

Throughout all districts around 80% of the houses are made of mud and cow dung, around 18% are built with (or made of) concrete blocks and about 4% made of stone. Rooftops are usually made out of iron sheets, 75%, or out of grass and straw thatch, 23%. interestingly, looking into

the ownership of furniture a different scenario is revealed. In Bunyula district around 70% of the households do not own sofas, chairs and tables, while in all other districts in the county more than 70% do own such furniture.

Firewood is the major source of fuel, around 93%, indicating enormous wood consumption and thus high deforestation rates throughout the county. Sources of water for household use differ widely. Wells, rivers and streams seem to provide most of the water used at household level and water quality is mainly considered “good” to “fair” except in Bunyala district where water quality is considered “not good”.

Similar to Homa Bay County the average land size in Busia County ranges between 2.4 and 3.8 acres per household. The largest pieces of land, with an average of 3.8 acres, are found in Busia district. In Nambale and Bunyala districts over 90% of the farmer families own all the land they farm on. Throughout the rest of the county around 75% of the farmer families own all the land they farm on and only 1 to 2% of the households do not own any of the land they farm on. The majority, around 76%, inherited their land, while around 19% bought their land. On average 38% of the farmer families in Busia County own title deeds and 54% have their land demarcated without holding title deeds.

4. Agriculture

Current Status

A substantial proportion of the land in both counties is allocated to crop production. In Homa Bay County crop production accounts for around 80% of the land uses in the districts, around 13% is allocated to grazing and pasture and the rest is for homesteads, kitchen gardens and other uses. In Busia County the scenario is similar except for Busia district where 61% of the land is used for crop production and 23% for grazing and pasture and for Nambale district where only 30% are allocated for crop production and 4% are for grazing and pasture and the rest is allocated to non-specified other land uses.

The main crops grown in both counties include maize and beans. Other crops in the counties include cassava, napier grass, arrow roots and cotton. Almost all crops produced serve as food as well as cash crops. The prominent land management practices include conventional tillage and terracing, with a focus on terracing in Homa Bay County and a focus on conventional tillage in Busia County. Practices such as infiltration ditches, cover crops, mulching, irrigating, composting or agroforestry are poorly practiced throughout. Most of the communal land in Homa Bay as well as in Busia County is available for open grazing of livestock.

Soils are generally perceived to be moderately fertile tending to very fertile in Bunyala district, Busia County, and in Rachuonyo North district, Homa Bay County. This indicates a misperception of reality – according to Jaetzold (2009) soil fertility in Homa Bay County is low except in the east and soil fertility in Busia County is also low. Mild soil erosion is identified predominant throughout all districts in both counties. Technical assistance on crop production is rarely received in the two counties and farm inputs are hard to get. Despite the many years of being involved in farming (17 years on average in Homa Bay County and 22 years on average in Busia County), there is little knowledge on fertilizer management and on potential benefits of fertilizer application. Neither inorganic nor organic fertilizers are thus applied.

On average one household in Busia County owns three cows, three goats or sheep and eleven chickens, while in Homa Bay households on average even have six cows, four goats or sheep and 16 chickens.

According to participatory assessments the climate related events currently impacting most severely on agricultural production are drought and increasing or new pest and disease attacks. Maize, beans and groundnuts seem to suffer most from these events. The population generally expects an increase in the severity of the impacts of such climatic hazards in case no counter measures are taken.

Predicted Climate Change Impacts on Agricultural Production

The Climate Modelling for the area (Lüdeling, 2011) indicates expected impacts of the predicted climatic changes in the pilot regions on some annual as well as perennial crops. It considered soil type, the predicted rainy season and amount of rainfall, minimum and maximum temperature and type of crop to derive conclusions of the predicted changes in precipitation and temperature on specific crops.

The crops analyzed included maize, cotton, sorghum, green gram, soybean, groundnut, cowpea, fababean (as a proxy for common bushbeans), mango, sugarcane, pineapple, banana, cassava, sweet potato, and finger millet. According to this study climate change will impact these crops as presented in table 3.

Table 3: Climate Change Impacts on Specific Crops (Lüdeling, 2011)

Crop	Baseline scenario	Predicted suitability
Maize	Stable and relatively high yields in long and short rains	Moderate losses in yields due to higher minimum and maximum temperatures
Cotton	Only recommended on Humid Andosols, Eutric Histosols and Chromic Vertosols; all other soils are not suitable; still yields on these three types of soils vary strongly	High yield fluctuations and declining yields mainly through changes in rainfall
Sorghum	Stable yields in short and long rainy season	Yield losses, although less than in maize, due to changes in the length of the short rains
Greengram	Some yield variability during the short rains	Yield decline due to higher temperatures
Soybean	Insignificant yields during the long rains; short rains not long enough for soybean production	Yield decline due to temperature increase
Groundnut	High yields, especially during the long	Substantial losses due to temperature

	rains	increase
Cowpea	Stable and moderately high yields; variable yields during the short rains	Substantial yield losses (2050s halved yields compared to baseline scenario) due to temperature increase
Fababean	High and stable yields during the long rainy season; high but more variable yields during the short rains	Steady decline over time due to increasing temperature
Mango	Both counties suitable for mango production	Expected increase in suitability for mango production in both counties
Sugarcane	Due to insufficient rainfall in both counties only the higher reaches of Busia are currently suitable for sugar cane production (not taking into account management practices such as irrigation)	The two counties will gain suitability for sugarcane production, especially towards the 2080s
Pineapple	Both counties are highly suitable for pineapple production	Suitability is expected to increase further
Banana	Both counties are suitable for banana production, with less suitability in the highlands	Suitability is expected to increase further
Cassava	Both counties are suitable for cassava production	Suitability is expected to remain more or less the same
Sweet potato	Both counties are highly suitable for production of sweet potato	Suitability is expected to remain at high levels, although a slight drop in suitability is predicted towards the 2080s
Common bean	Both counties are highly suitable for production of the common bean	Suitability is expected to drop slightly with some regions becoming unsuitable due to high temperatures
Finger millet	High suitability for finger millet production is found in the lowland areas near the lake	Suitability in these areas is expected to remain high up to the 2080s when a considerable decline in suitability is predicted due to high temperatures

5. Climate Risks

A climate risk depends on the likelihood of a climate stimulus coupled with a given vulnerability of a specified system, whereby a climate stimulus is an impulse given by the climate, such as changes in temperatures and precipitation, droughts or erratic rains, and vulnerability is the

factor that makes a specified system susceptible to such climate stimuli. Climate risks usually cause impacts, positive or negative, that need to be tackled.

Climate risk = Climate Stimulus + Vulnerability → Impact

Effective adaptation to climate change needs to be based on thorough understanding of existing vulnerabilities. Impacts of climate change depend on the capacities of the system or the people to respond to these impacts. Thereby also – and especially – socio-economic dimensions of prominent vulnerabilities need to be considered.

For this purpose participatory risk and vulnerability assessments have been carried out in both counties. These assessments were carried out in groups of men, groups of women and mixed groups of young men and women in several locations per county as to identify potential differences and overlaps between the different ages and between the sexes. The participatory sessions were based on activities such as open brainstorming or defined dynamics as, for example, timelines or problem trees.

Throughout the assessments the main climatic stimuli identified in Busia County were drought, excessive rainfall and hailstorms and new or increasing numbers of pests and diseases were observed as impacts of these events. For Homa Bay County the main climatic stimuli identified were drought, hailstorms and strong winds; as well floods were observed to occur more frequently. The identified climate related risks did not differ much; neither among the different groups as described above nor in the two counties.

Drought is the prominent climate risk in both counties and is observed to be more frequent in recent years than in the past.

An example on how the participants analyzed causes and effects of the identified climate stimuli is shown in figure 16: Causes and Effects of Drought. Understanding especially the causes for being affected, helps to identify solutions in order to reduce negative impacts – particularly as they are more often than not linked to own vulnerabilities or vulnerabilities of the production systems and surrounding ecosystems.

As the example in figure 16 shows, the root causes identified for drought are “Unemployment”, “Capital shortage”, “Poor agricultural knowledge” and “No alternative energy sources than wood”. The immediate effects of drought are on the environment and ecosystems, which in turn impacts on the population. The green-framed effects in figure 16 indicate natural or environmental relations while the red-framed causes and effects indicate socio-economic relations. Socio-economic relations are clearly in the majority and can largely be influenced by the communities themselves. Thus addressing causes and root causes brought about by the population itself, can play a key role in minimizing the effects of drought.

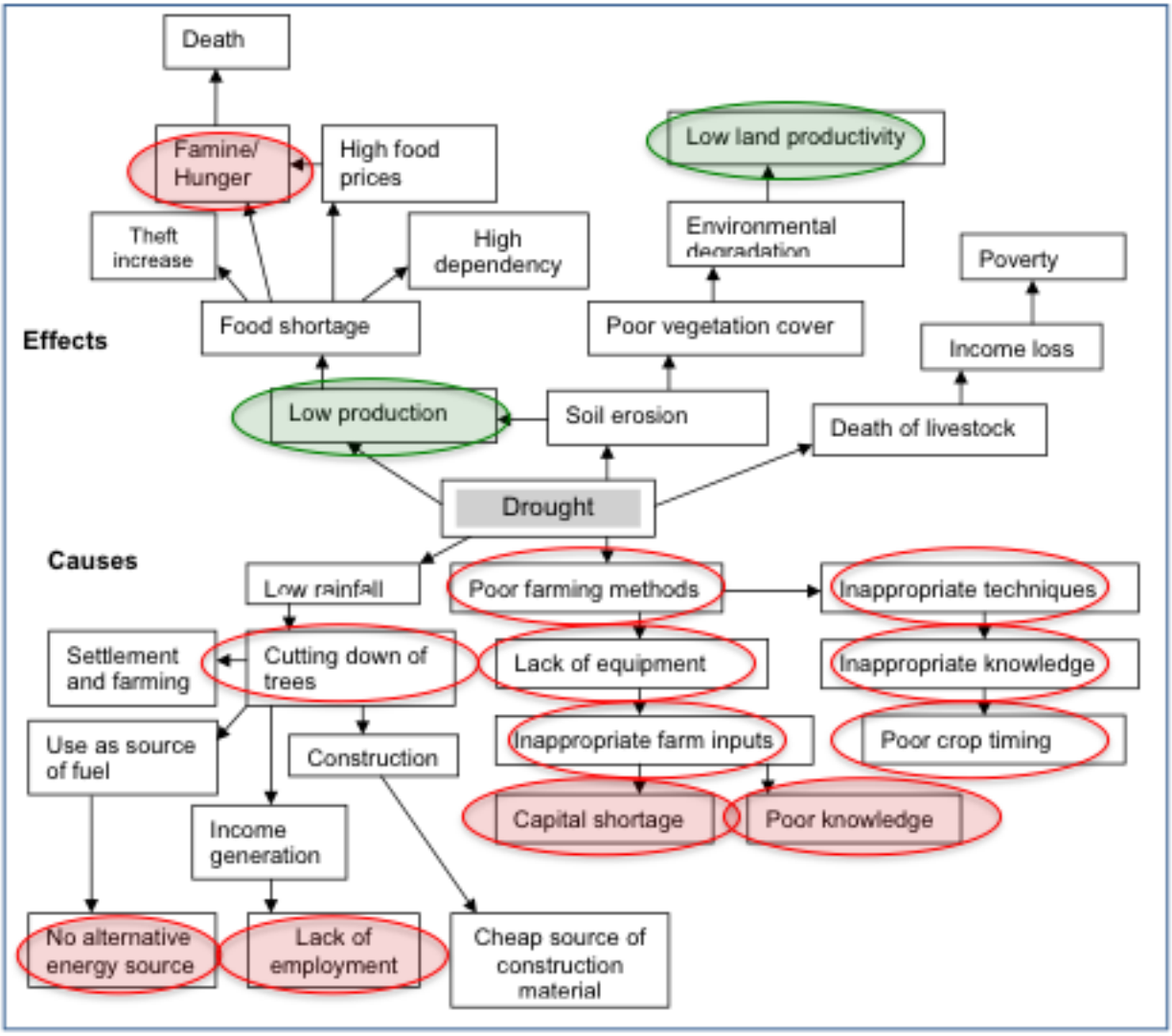


Figure 16: Causes and Effects of Drought – as elaborated during local participatory PVAs

There is a general trend of increasing likelihood to be hit by climate stimuli in both counties. The frequency of droughts, excessive rains and hailstorms has been increasing over the past years and even higher frequencies are expected for the next 20 years. Additionally severity of the impacts of these climate stimuli is expected to worsen if no preventive measures are taken.

Climate Vulnerabilities

Between October and November 2011 the ACCI project carried out participatory risk and vulnerability assessments in several locations in Busia and Homa Bay Counties. Participants were mixed of community and farmer group members, rural development experts, church members (Western Region Christian Community Services), non-governmental organizations (Sustainet), the International Centre for Insect Physiology and Ecology, the Agriculture and Environment Program of the Catholic Diocese of Homa Bay and members of the Ministry of Agriculture. The results of these sessions are summarized in table 4.

Table 4: Climate Risks and Vulnerabilities

Climate Stimulus	Frequency / Severity	Vulnerabilities	Impacts
Drought	Increasing frequency, decreasing severity (though increasing severity is expected again in the future)	• Dependence on rain-fed subsistence farming • Over dependence on maize / no diversification • Deforested areas • Low technical know-how / lack of access to training • High poverty levels • Little / no financial resources to invest (lack of collateral) • Low adoption rate of improved farming practices (esp. soil fertility management) → already low / declining yields • No protection of riparian areas • Ignorance / lack of knowledge on good agricultural practices • Low financial literacy • Lack of irrigation technology • Lack of water harvesting & conservation methods • Water pollution • Application of burning practices • High population density → pressure on natural resources	• Inadequate water availability • Decrease in yields / crop failure • Decrease in household income • Low purchasing power • Low / no budget to invest in production • Food shortages / food insecurity • Famine • School dropouts • Increase in prostitution to generate income • Increase in domestic violence due to scarce resources • Less / no available water for household use • Increase in human diseases / decrease in human health; even death • Social unrest • Death
Short lived excessive rainfall	Cyclic recurrence; high frequency; high severity	• Poor water-holding capacities of the soils • Poor drainage • Eroded soils • Little / no application of soil and water conservation measures • Little / no cover crops and trees	• Floods • Moisture stress • Yield losses • Soil erosion • Reduced soil fertility • Increase in pests and diseases • Destruction of crops and infrastructure

			• Low harvests • Food shortages • Famine
Changes in temperature and rainfall		• Little knowledge on pest and disease control methods • Poor farming methods: Little application of improved farming methods (for example crop rotation or diversification) • Low technical know-how • Lack of financial resources to invest (lack of collateral) • Planting of uncertified seeds	Increase in and new pests and diseases leading to: • Rotting of root tubers (cassava) • Reduction in area under cassava • Reduction in maize yields by over 70% (due to striga weed) • Destruction of stored grain (larger grain borer) • Food shortages / famine • Pest-infected water bodies → poor hygiene → decreasing human health
Hailstorms	Moderate frequency; low severity	• Overdependence on crop production as sole source of income • No / little financial resources to invest in technology (for example greenhouses) • Lack of technical know-how • Inadequate housing	• Flower abortion (if hail occurs during flowering) • Crop destruction • Damage to homesteads • Damage to livestock • Loss of income • Food shortages • Increased local food prices • Reduced income • Famine

The top two vulnerabilities in both counties are poor farming practices and lack of access to financial resources (Resource poverty) for necessary, which constrains investments. Lack of knowledge regarding appropriate good agricultural practices causes much vulnerability in the production systems and surrounding areas, such as soil erosion, poor soil water-holding capacity and poor soil fertility. Due to the lack of access to financial resources the, implementation of good agricultural practices, such as efficient fertilizer management, is hindered as necessary inputs cannot be obtained. The high dependence on crop production for income generation tremendously worsens negative impacts brought about by climate stimuli and climatic variability.

Geographic Risk Spread

Throughout the different localities in the two counties the identified climate risks vary in severity and likelihood. According to the outcome of participatory workshops in 2011 the locations hit

hardest by climate change in Homa Bay and in Busia County are more situated towards the shore of Lake Victoria. Here especially drought, pests and diseases and floods stick out as having severe impacts and as being highly likely.

Table 5 shows the locations with a high severity as well as high likelihood of the identified climate risks. The risks “hailstorms” and “erratic rainfall” occur throughout all districts in the two counties, but were hardly indicated as having severe impacts and at the same time being highly likely. Droughts, increasing or new pests and diseases as well as floods show to be the most severe and likely climate risks in both counties. Floods could be caused by strong winds coming from the lake or by strong rains and related overflowing water bodies, heavy rains have a higher likelihood.

Table 5: Geographic Risk Spread

County	District	Drought	Increasing tempera-tures	Increase in / new pests and diseases	Floods	Hail-storms	Erratic rainfall
Homa Bay County	Homa Bay	Kochia Township Kanyada East Kagan Gongo	Kochia Township Kanyada East Kagan Gongo	Kochia Township Kanyada East Kagan Gem Kanyada West			
	Rachuonyo North	Wanga-chieng		Kanjira Kamser Nyakongo Wangachieng	Wanga-chieng Koyugi Kobala		Wanga-chieng
	Mbita	Lambwe East Rusinga East Rusinga West Gembe Central		Mfangano East Rusinga East Rusinga West			
	Ndhiwa			Kobodo (Malaria) Amoyo (Malaria)	Amoyo Kobodo Aura-chuodho		
Busia County	Busia						
	Nambale						
	Butula	Bumala		Bumala Bujumba			

	Bunyala	Bunyala North Bunyala South			Bunyala East Bunyala South Bunyala Central Khajula		

6. Coping Strategies - Opportunities and Limitations

There are quite a number of options for reducing the given vulnerabilities and thus increasing the resilience to climate change in both counties. However, factors such as feasibility and prevailing conditions influence the choice of appropriate intervention measures and have to be looked at carefully. Important to note that the results presented were obtained from local stakeholders and often farmers and therefore are influenced by their own perceptions and possibilities to effect changes (by own means). Measures which would require resources or interventions far beyond that (e.g. larger infrastructural measures) do therefore not feature here, but need to be considered to assist the local communities.

The potential coping strategies were generally categorized based on:

a. Measures to increase the resilience of the production systems and crops, meaning activities on the farms related to crop management (for example improved soil management, appropriate fertilizer management)
b. Measures to increase the resilience of the ecosystems around the farms, meaning activities on landscape level related to natural resources (for example forst covera and conservation of water bodies)
c. Measures to increase the resilience of the local population, meaning activities on household or family level (for example access to extension services, increased access to credit/ credit worthiness or safe housing)

In order to build a strong adaptation strategy all three dimensions need to be addressed. As shown in chapter 6 socio-economic shortcomings are highly responsible for increased vulnerability towards negative impacts of climate change. Therefore the socio-economic dimension of adaptation requirements is very important in Busia and Homa Bay Counties.

To reduce negative impacts as experienced by the two counties, for example, the following strategies come to mind:

<u>Drought:</u>

- Selection of the right crop (drought tolerant and early maturing)
- Irrigation
- Water harvesting
- Re- / Afforestation
- Agroforestry
- Introduction of greenhouses
- Enhanced soil management (for example soil moisture retention through mulching and cover crops)

- Early planting (right at the onset of the rains)
- Income and crop diversification

Excessive rainfall:

- Terracing
- Drainage channels
- Agroforestry
- Safe housing
- Construction of homesteads in safe areas (for example a location not prone to landslides)

Increase / new pests and diseases:

- Application of pesticides and herbicides
- Integrated pest management; making use of natural enemies
- Plant resistant species
- Use certified seeds and clean planting material

Floods:

- Set up disaster management committees
- Introduce early warning mechanisms
- Building of dams
- Wind breaks

For some crops, specific recommendations were mentioned:

Sugarcane:	Looking into irrigation practices and access to groundwater
Green Gram:	Concentrate on green grams only during the long rains.
Sorghum:	Increase production area; recommended crop also in the future due to its low susceptibility to climate change.
Cotton:	Irrigate during the dry season.
Maize:	Use heat tolerant varieties. Apply measures to influence microclimate, for example shade management through agroforestry.

In order to consider the socio-economic dimension of adaptation in the two counties one important factor is the attitude and motivation of the local population. Without their share in regards to ownership and drive behind adaptation activities, implementation of the identified measures is likely to be limited. Especially activities on the broader landscape level (resilience of the surrounding ecosystems) are likely not to be implemented if the local population does not understand the over-arching relevance of strong ecosystems in regards to their own personal resilience or farm-level resilience. Therefore it is highly important to sensitize and train local communities on climate related issues. At the same time sensitization and training need to go hand in hand with enabling the affected population to take action. Creating an enabling environment includes also capacity building in other areas like financial/ insurance literacy and availing suitable financial products, for example crop insurance or credits, availing necessary

farm inputs in the region, providing farmers with up to date information on weather and setting up necessary structures, for example for early warning systems.

In the selection of appropriate intervention measures feasibility and effectiveness need to be looked at specifically for each site. For example, it may well be an effective counter (adaptive) measure to build dams in order to prevent severe damages by floods. Whether it is feasible to build dams in certain areas heavily depends on local conditions and capacities. The larger the counter (adaptive) measure in regards to financial resources and labour necessary, the more important it is to include local, regional and / or national stakeholders. Otherwise implementation feasibility is very low. Feasibility in general seems to heavily depend on the availability of financial resources. Unfortunately, financial constraints seem to be among the major limiting factors for the implementation of suitable adaptation options.

7. Conclusions and Recommendations

This report is based on the analysis of seven districts in Busia and Homa Bay, but it is assumed that the situation described is somehow comparable to a number of counties in the lower parts of Western Kenya, with similar poverty levels and climatic conditions and might therefore provide valuable insights for other locations as well.

Looking into the different districts of the two counties, Butula and Bunyala districts, both in Busia County, are the ones most vulnerable to negative impacts of climate change with regards to their socio-economic status. Illiteracy levels are highest in these two districts, mean monthly income is the lowest (Butula: 24,426 Kenya Shillings; Bunyala: 25,896 Kenya Shillings; average income in Busia County: 28,368 Kenya Shillings; average income in Homa Bay County: 41,356 Kenya Shillings) and average annual expenditures are the highest in Butula (151,073 Kenya Shillings; average in Busia County: 115,073 Kenya Shillings). 56% of average annual expenditures are spent on food and groceries in Bunyala district, which is by far the highest (on average 38% of annual expenditures in Busia County are spent on food and groceries and 30% in Homa Bay County). This indicates a strong dependence on available financial resources to obtain sustenance, while income and income sources are limited. All these factors reduce the adaptive capacities in these two districts enormously and expose the population to negative impacts of climate related hazards.

Looking into the ecological dimension of climate vulnerability in the two counties they seem to be on similar levels. High deforestation rates, low to moderate soil fertility, high pressure on natural resources and the absence of good agricultural practices minimize the capacities of the local ecosystems to cope with climate related hazards.

According to participatory vulnerability assessments the likelihood of climate stimuli as well as the severity of their impacts is higher in Homa Bay County than in Busia County. Especially in the districts of Homa Bay, Rachuonyo North and Mbita, farmers expressed the experience of climate stimuli and their related impacts. In Busia County, Bunyala district is indicated to be hit hardest by climate change in regards to the likelihood of climate stimuli and the severity of their impacts. However, these results are based on personal perceptions of few farmer groups and a larger sample would be required to make a final statement. As such, further monitoring of climate stimuli and their impacts in both counties are necessary.

A general lack of knowledge on potential adaptation strategies or not being aware of better farming techniques seems to be one major barrier to increase resilience; in fact seems to be

one major contributor of worsening existing vulnerabilities. Therefore sensitization and training on climate related challenges in agricultural and livestock production as well as in living conditions, such as housing, can support in better preparing the population of Busia and Homa Bay Counties to confront climate change and its impacts.

Another major barrier for the implementation of effective response strategies to climate change challenges seems to be financial constraints of the rural population. Without availability of funds to invest in better farm technology and management practices or in broader landscape activities implementation of identified adaptation options will at best be slow or even limited. Therefore strengthening financial literacy (staring with a savings culture) in both counties, further building up adequate financial service providers offering suitable financial products, for example agricultural credits, and as an alternative option working towards appropriate and affordable agricultural insurance schemes seems indispensable.

The predominant climate stimuli are drought, erratic rains and hailstorms and the major impact of changes in temperature and humidity levels is an increase in and the occurrence of new pests and diseases. To better buffer negative impacts of these climate related hazards diversifying crops and incomes of the households is crucial. Cultivation of perennial crops (e.g. mango, sugarcane, pineapple and banana), for example, might offer opportunities on the domestic market and climatic suitability for these crops is predicted to increase. Groundnuts, cowpeas and beans are likely to be among the crops suffering most from climate change due to increasing temperatures. Cotton, although potentially a good option in the market, is also not predicted to perform well under the calculated climatic changes, unless it is irrigated. Reasons for that are however not only climatic conditions, but also related to soil conditions. Due to the alterations in rainfall cotton yields are projected to fluctuate highly and to decline ultimately (at least under rainfed conditions).

An effective adaptation strategy for the two counties Homa Bay and Busia, which can be managed on local level, needs to comprise of a good mix between climate change adaptation measures on farm level, landscape level and household or family level needs. Only then can the resilience of the two counties towards climate change be increased and impacts for the farming community be reduced. As shown existing vulnerabilities on socio-economic as well as on ecological level are quite severe. Therefore both dimensions need to be considered and an enabling environment for actively increasing adaptive capacities needs to be created.

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Annex

ACCI Project Brief

Seizing opportunities in a changing climate

Climate change is a reality and is taking place around us. Communities are compelled to adapt to this situation. Therefore we must understand and plan for the potential impact of a changing climate, which is already visible in shifting weather patterns and extremes in droughts or floods. Recognizing the positive opportunities that climate change can offer, and making the most of them, will, contribute to successful adaptation.

Adaptation to Climate Change and Insurance (ACCI) is a bilateral project between the Kenyan and German Governments, funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Government of Kenya. It is implemented by the Kenyan Ministry of Agriculture and GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit.

The goal of the **ACCI** project is to enable farmers and small-scale enterprises to increase their capacity to adapt to climate change in Homa Bay and Busia County.

ACCI through its partners supports

- ► Systematic collection, analysis and dissemination of information about climate change and related risks
- ► Dissemination of adapted site specific good agricultural practices
- ► Promotion of insurance products as measures to mitigate climate risks
- ► Support to create an enabling political environment for the insurance sector
- ► Monitoring of local adaptation capacity to climate change

ACCI collaborates with public and private sectors to provide these services to farmers. The extension structure of the Ministry of Agriculture is the main implementing partner. In addition, local NGOs, CBOs, insurance companies and financial institutions are involved in implementation. The project started at the beginning of 2011 and will run until the end of 2013.

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